

# The Quarterly Review Of Interest Rate Risk

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



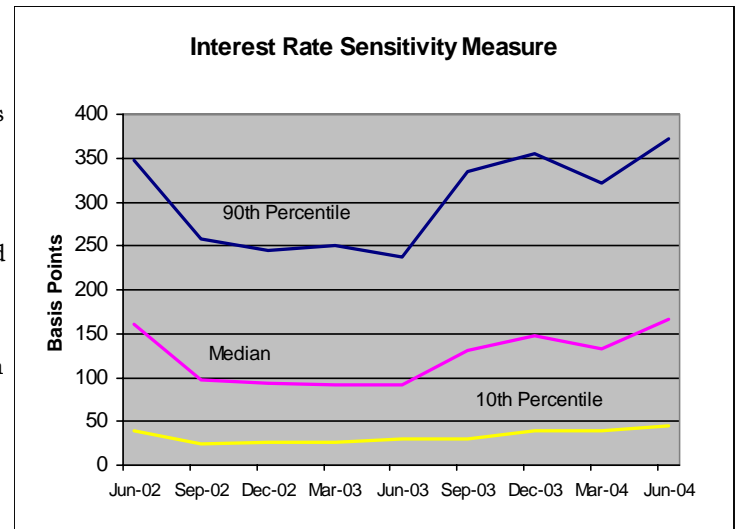
## Special points of interest:

- 30-yr mortgage rate rises
- Yield curve shifts upward in the second quarter
- Second quarter median interest rate sensitivity rises
- Asset duration increases
- Comparative Regional Analysis
- Feature Article on Prepayment Risk and Collateralized Mortgage Obligations

## Interest Rate Sensitivity Rises in Second Quarter

Median interest rate sensitivity rose from 132 basis points in the first quarter to 167 basis points in the second quarter of 2004. The rise in sensitivity for the thrift industry was due to the increase in interest rates in the second quarter.

Both the median pre-shock Net Portfolio Value (NPV) ratio and the median post-shock NPV ratios also rose in the second quarter. The number of thrifts with post-shock NPV ratios below 4 percent fell to three institutions, down from six in the previous quarter.



(Continued on page 4)

## Prepayment Risk and Collateralized Mortgage Obligations

In the previous issue of this publication, we discussed the basics of asset securitization. Asset securitization refers to the process where interests in the cash flows associated with loans and other receivables are pooled, packaged, underwritten, and sold to investors in the form of securities. The cash flows associated with these loans and other receivables serve as the collateral for the issued securities.

The past three decades have witnessed tremendous growth in asset securitizations in the United States, starting with the first securitizations of mortgage pools back in the 1970s that were undertaken to increase li-

quidity in the residential mortgage market.

Securitized assets take many forms in today's financial markets and include securities backed by residential mortgages, commercial mortgages, home equity loans, automobile loans, and credit card receivables. By far the most popular form that asset securitizations take are the agency residential mortgage pass-through securities issued by Ginnie Mae, a U.S. government agency, and Fannie Mae and Freddie Mac, two government-sponsored enterprises.

For these pass-through securities, pools of conventional residential mortgages serve as the collateral. As

an illustration of the huge popularity of these mortgage-backed securities, in 1998, over 47 percent of residential mortgages were securitized, compared with less than 15 percent in 1980.

With mortgage pass-through securities, the scheduled principal repayments and interest payments, as well as any prepayments, are passed through to the investors on a pro rata basis net of a servicing spread and a guarantor fee. Payments are made to investors monthly.

Mortgage pass-through securities are attractive to those investors who are willing to hold securities

(Continued on page 2)

## Charts in this issue:

Yield Curves	5
Mortgage Rates	5
Portfolio Mix	5
IRR & NPV Measures	6
TB13a S-Rating Matrix	7
Comparative Trends in the Four OTS Regions	8
Aggregate and Regional Appendices	9-13

## Prepayment Risk and Collateralized Mortgage Obligations (continued)

(Continued from page 1)

with long and uncertain investment horizons in exchange for the high yields and good credit quality these securities offer. In addition, mortgage pass-through securities are a much more transactionally efficient way to invest in mortgages compared to investing in individual mortgage loans.

The uncertain investment horizon associated with mortgage pass-through securities is the direct result of the uncertainty surrounding the prepayment behavior of mortgagors. This uncertainty is known as prepayment risk and arises largely because interest rate changes produce changes in the rate at which residential mortgages are refinanced. When interest rates fall, prepayment speeds increase, whereas prepayment speeds decrease when interest rates rise.

Prepayment behavior affects the expected average life of mortgage pass-through securities and their price performance and duration. From the point of view of a financial institution, such as a savings institution, it is important to be able to accurately forecast the duration of its mortgage-related assets in order to effectively manage interest rate risk by controlling the duration gap between assets and liabilities.

In order to accommodate the demands of investors for mortgage-related products that offer a better estimate of the duration associated with mortgage pass-through

securities, so-called derivative mortgage securities were developed. These securities allow for the redistribution of the total prepayment risk associated with mortgages among different classes of bondholders, and they can be issued against either whole mortgage loan pools or mortgage pass-through securities.

Derivative mortgage securities—such as collateralized mortgage obligations (CMOs) and stripped mortgage-backed securities, including interest-only securities (IOs) and principal-only securities (POs)—have emerged as attractive alternative mortgage-related investments for institutional investors such as banks, life insurance companies, and pension funds. With these securities, investors are better able to control their prepayment risk exposure.

In this issue, we discuss the structure of collateralized mortgage obligations in detail and show how this type of derivative mortgage security can be used to better manage interest rate risk. This is possible because CMOs provide investors with the ability to more effectively control their exposure to prepayment risk.

More specifically, CMOs are better vehicles for achieving asset-liability management objectives than mortgage pass-through securities because investors can choose the desired type and amount of prepayment risk. As a result, there is less uncertainty about the duration or expected

average life of mortgage-related investments.

### Prepayment Risk, Contraction Risk, and Extension Risk

Prepayment risk arises because mortgagors have a call option on the mortgage loans they take out from banking institutions. They will choose to exercise this option and prepay their mortgages as interest rates fall sufficiently below the contract mortgage coupon rates.

As such, prepayments are the most important determinant of the durations of these securities, and of their price performance. This means that investors must be able to accurately predict prepayments in order to effectively manage their interest rate risk exposure in these financial products. Unfortunately, it is very difficult to model the prepayment behavior of mortgagors and to generate accurate forecasts of prepayment speeds.

Several basic factors affect mortgage prepayments. These factors are the spread between the prevailing market mortgage rate and the contract mortgage coupon rate; the time path taken by the market mortgage rate to reach its current level; characteristics of the underlying pool of mortgages, such as LTV, fixed-rate vs. adjustable-rate, FHA- and VA-insured vs. conventional, and maturity; seasonal factors; and general economic activity. By far the most important of these is the spread between the prevailing mort-

gage rate and the contract mortgage coupon rate.

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. When interest rates fall, prepayments rise due to increased mortgage refinancings, and the present value of expected mortgage cash flows also rises.

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.

It is well known that there is an inverse relationship between the prices of fixed-income financial instruments, such as mortgages and mortgage pass-through securities, and interest rate changes. This inverse relationship is known as the “discount effect.” Interest rate changes also affect the prices of mortgage-related products by causing the expected prepayments of principal to either speedup or slow-down. This is known as the “prepayment effect.”

For example, as interest rates fall below mortgage contract coupon rates, borrowers prepay their mortgages and refinance their mortgage debt at lower rates. As a result, investors in mortgage pass-through securities receive the entire principal on the mortgage loans

(Continued on page 3)

## Prepayment Risk and Collateralized Mortgage Obligations (continued)

(Continued from page 2)

early and forego the full stream of interest payments that mortgagors were to make over what had been the expected average life of the loans. This relationship, whereby the rate of prepayments increases as rates fall (especially as they fall below the contract rate), produces negative convexity in the price-yield curve for mortgage pass-through securities and leads to “price compression.”

Price compression refers to the fact that interest rate decreases do not produce increases in the prices of mortgage pass-through securities that are as large as those of option-free bonds. In addition, investors in mortgage pass-through securities are forced to invest the cash flows that are prepaid at a lower rate of interest.

“Contraction risk” is that part of prepayment risk that derives from the decrease in the duration of mortgage pass-through securities and the reinvestment risk associated with the speedup of prepayments resulting from a decline in interest rates within the negatively convex region of the price-yield curve.

Alternatively, when interest rates rise above mortgage contract coupon rates, the speed of mortgage prepayments by borrowers slows. This rate increase produces an increase in the duration of mortgage pass-through securities and a steeper decline in the price of these securities than is

the case for option-free bonds. This occurs because investors in mortgage pass-through securities are not able to reinvest the expected principal cash flows at the higher interest rate because of slower actual prepayments.

“Extension risk” is 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. The reinvestment risk associated with interest rate increases highlights the fact that prepayment risk is not just the risk that mortgages will prepay, but rather the variability, or uncertainty, in the rate at which they will prepay.

Not all investors in mortgage pass-through securities have the same preferences with regard to contraction risk and extension risk due to differences in their overall balance sheet profiles. For example, thrifts typically raise funds that are characterized by short durations either through issuing short-term money market debt or certificates of deposit.

Because fixed-rate mortgage pass-through securities have long expected durations, a duration mismatch between assets and liabilities is created when a typical thrift purchases these mortgage-related products and puts them on its books. In order to have a better match between the durations of assets and liabilities, thrifts would want to purchase mort-

gage-related products with shorter maturities.

Thrifts using short-term funding should prefer contraction risk and should generally like to avoid extension risk as much as possible. In contrast, institutional investors, such as life insurance companies and pension funds, prefer extension risk to contraction risk given that their liabilities have long-term maturities.

### Collateralized Mortgage Obligations and Their Basic Structure

Collateralized mortgage obligations are multi-class securities that were created in order to accommodate the variety of demands across different banking institutions and institutional investors for mortgage-related securities that provide protection from prepayment risk.

These various demands are accommodated through the CMO structure by reallocating the cash flows of the underlying mortgage collateral, and therefore the prepayment risk, among investors that want to reduce their exposure to either contraction risk or extension risk.

The first collateralized mortgage obligation was issued in 1983 by Freddie Mac. It was a so-called “plain vanilla,” or “sequential-pay,” CMO with three classes of bonds, or “tranches.” Mortgage pass-through securities served as the collateral for the issue. In a sequential-pay CMO,

the principal cash flows from the underlying pool of whole mortgages (for non-agency or private CMOs), or mortgage pass-through securities (for agency CMOs), are paid to the tranches according to some prioritized payment scheme specified in the prospectus.

The sequential-pay CMO has bond classes with varying maturities, and these classes can also have coupons that are not identical to that on the underlying collateral. There are separate rules given for the payment of coupon interest and the payment of principal. Principal payments consist of both scheduled principal payment and any prepayments.

In a sequential-pay CMO, the principal payments from the underlying mortgage collateral are used to retire the various bond classes sequentially, going from the bond class with the shortest maturity to the one with the longest maturity.

From an investor’s perspective, purchasing the bond classes with the shorter-term maturities will provide protection against extension risk, while purchasing the bond classes with the longer-term maturities will provide protection against contraction risk.

Sequential-pay CMOs frequently also include an accrual tranche, or Z bond. A Z bond receives no interest payments until all earlier maturing classes are retired. The interest that is due the Z bond accrues and is added to its principal in-

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## Prepayment Risk and Collateralized Mortgage Obligations (continued)

(Continued from page 3)

stead.

Inclusion of a Z bond in a CMO produces shorter maturities for the earlier bond classes. This occurs because the interest that would have been paid to the accrual bond class is used to pay down the principal on the earlier classes faster.

It is important to note that CMOs do not eliminate the prepayment risk associated with the underlying mortgage collateral. Indeed, the total prepayment risk remains unchanged. Instead, CMOs redistribute the contraction and extension risk that comprise prepayment risk among the different bond classes.

The shorter-term tranches provide protection against contraction risk to the longer-term tranches because the

bond classes with the shorter maturities are retired first. On the other hand, the longer-term tranches provide protection against extension risk to the shorter-term tranches because the bond classes with the longer maturities are retired after the short-term tranches.

While sequential-pay CMOs provide investors with more protection against prepayment risk than is true for mortgage pass-through securities, there is still substantial variation in the average lives of the various bond classes.

Since 1983, several innovations have been made in structuring CMO deals in order to address this uncertainty. Included among these are the planned amortization class (PAC) bond and the support, or companion,

class bond.

A PAC bond has a principal repayment schedule that must be met. This produces greater predictability of its cash flows. PACs have upper and lower bounds, known as collars, for expected prepayment speeds on the underlying collateral.

Principal repayment is made to these bond classes as scheduled, despite variation in prepayment speeds between the two bounds. In the event that actual prepayment speeds vary between the upper and lower bounds, the companion tranches absorb the speedup or slowdown in principal repayments.

As a result, PAC bonds provide investors with protection against both contraction risk and extension risk as long as there remain enough sup-

port bonds in the CMO to absorb the prepayment risk. The non-PAC support bonds are the riskiest tranches in a CMO with PAC classes.

In the next issue, we will focus on the structure of stripped mortgage-backed securities, such as IOs and POs, and show how these instruments can be used to manage interest rate risk. These derivative mortgage securities have risk-return profiles that make them useful to financial institutions for hedging.

More specifically, the convexity characteristics of their price-yield curves make IOs and POs attractive for hedging the interest rate risk exposure of mortgage portfolios and mortgage servicing rights. ■

## Interest Rate Sensitivity Rises in Second Quarter (continued)

(Continued from page 1)

Treasury rates rose for all maturities in the second quarter. The yields on medium-term maturities between two years and five years displayed the largest increases.

The Freddie Mac contract interest rate on commitments for fixed-rate 30-year mortgages rose to 6.21 percent at the end of the second quarter from 5.52 percent at the end of the previous quarter.

Thrift profitability was slightly lower in the second quarter. The average return on assets (ROA) for the industry fell to 1.16 percent from 1.19 percent

in the prior quarter.

This decrease in ROA for the thrift industry was attributed to higher loan loss provisions, lower other non-interest income, and higher non-interest expense.

The second quarter saw an average net interest margin of 291 basis points, up from 288 basis points in the first quarter. This increase resulted from a rise in interest income as loan portfolios grew and a fall in interest expense from the first quarter.

Total thrift industry earnings rose one percent to \$3.38 billion in the sec-

ond quarter, from \$3.34 billion in the prior quarter.

In the second quarter, total fee income, which includes mortgage loan servicing fee income and other fee income, rose to 1.06 percent of average assets, up from 0.64 percent in the first quarter. Other fee income rose to 1.08 percent of average assets in the second quarter, up from 0.90 percent in the prior quarter.

For the most part, fee income has increased over the past four years. This growth has been due to increases in retail

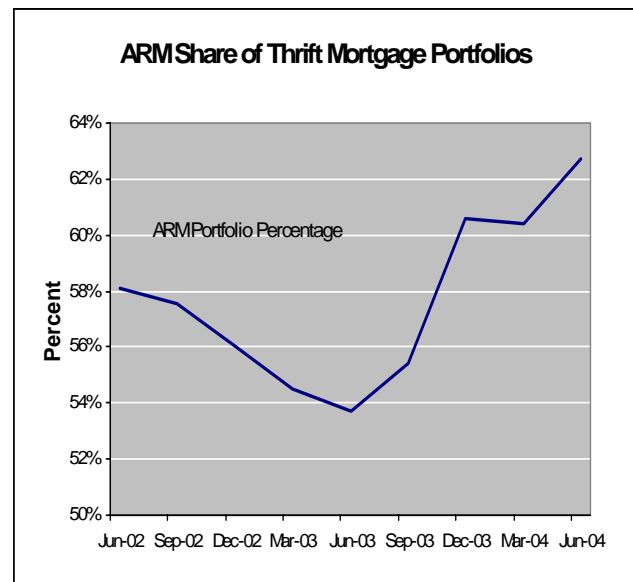
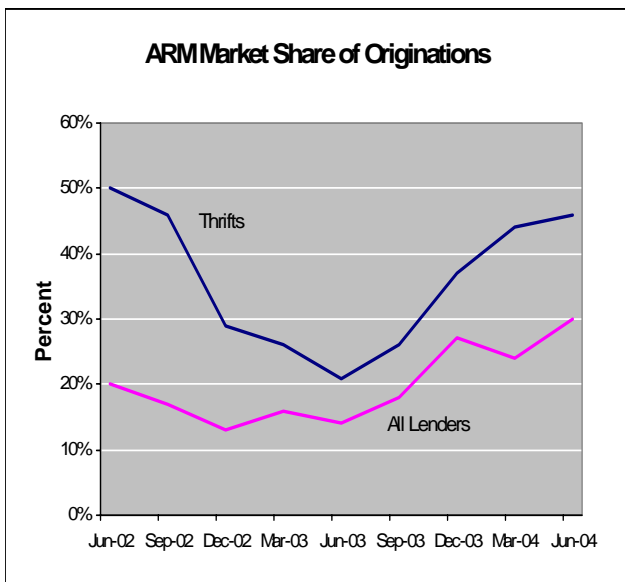
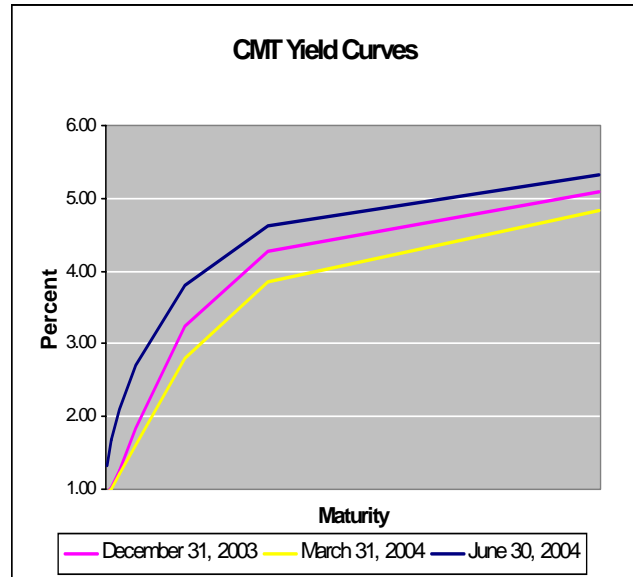
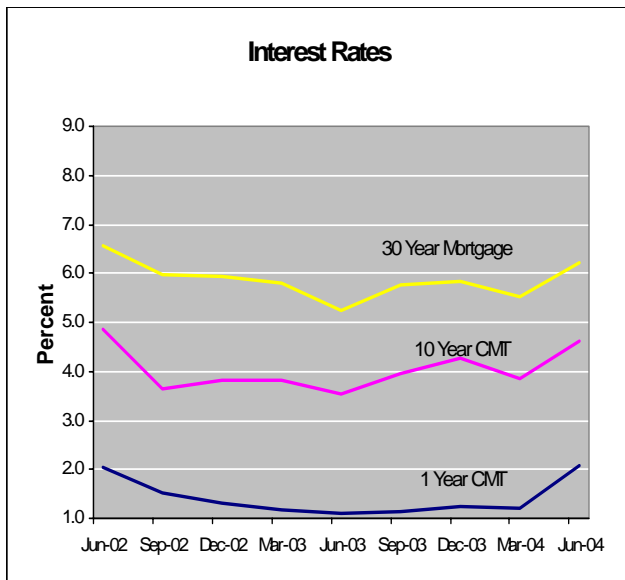
banking fees, growth in trust assets, fees from sales of mutual funds and annuities, and loan servicing income from non-mortgage loans.

Other non-interest income fell to 0.62 percent of average assets from 0.96 percent between the first and second quarters. Other non-interest income can be extremely volatile because it includes gains and losses on assets sold and also reflects balance sheet restructuring activities.

The second quarter saw the ARM share of total thrift mortgage origi-

(Continued on page 5)

## Interest Rates and ARM Market Share



### Interest Rate Sensitivity Rises in Second Quarter (continued)

(Continued from page 4)  
 nations rise to 46 percent, up from 44 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 62.7 percent from 60.4 percent in the prior quarter.

Second-quarter 1-4 family mortgage originations by thrifts rose to \$180.4 billion, up from \$130.4 billion in the first quarter.

Total mortgage originations in the second quarter were \$203.4 billion, up sharply from \$148.9 billion in the first quarter. Along with the rise in total mortgage loan

origination volume, the volume of mortgage refinancing activity also increased in the second quarter.

Thrifts' share of all 1-4 family originations was 22.1 percent in the first quarter, down from 25.9 percent in the fourth quarter.

The rate of U.S. home ownership stood at 69.2 percent at the end of the

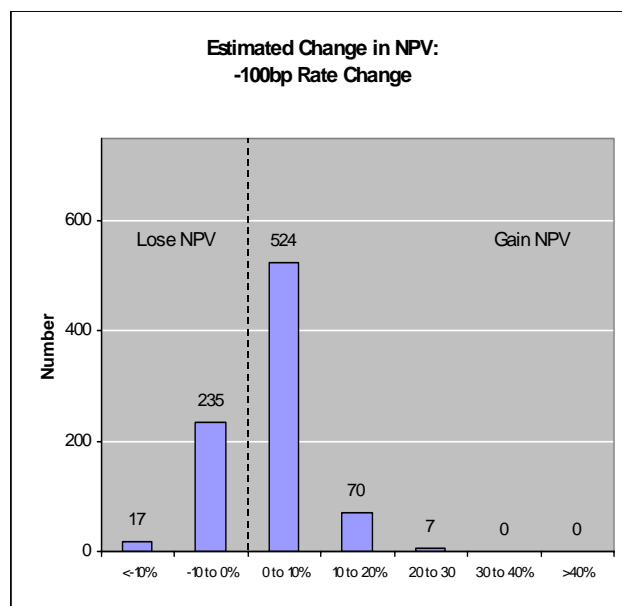
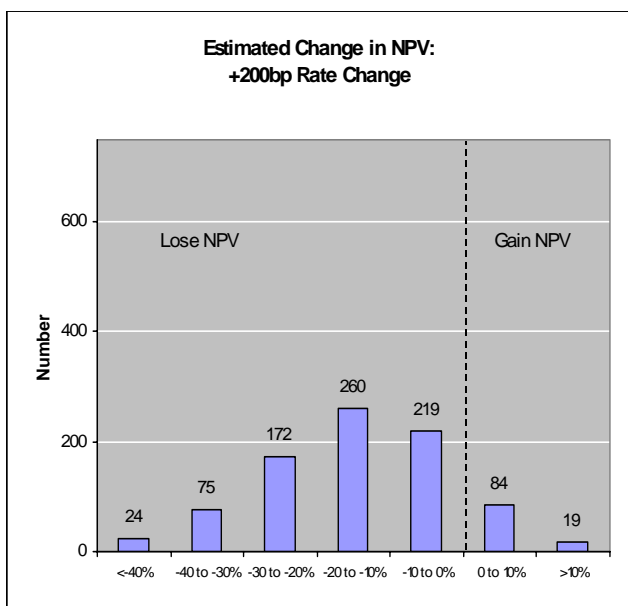
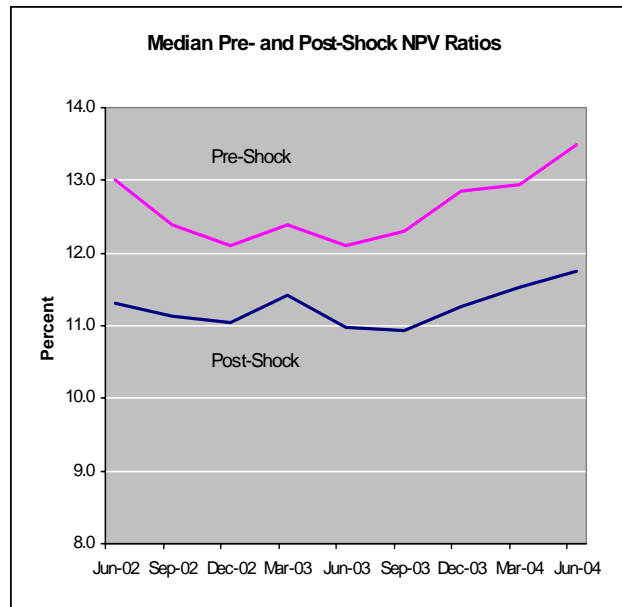
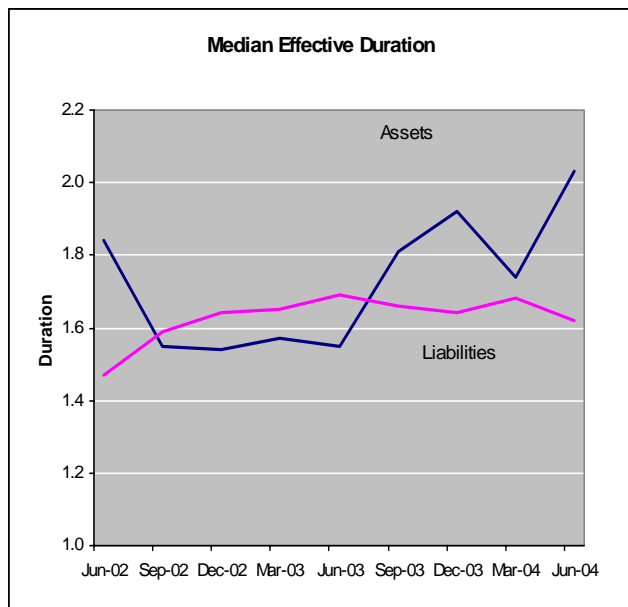
second quarter, up slightly from 68.6 percent in the first quarter.

Refinancing accounted for 35.1 percent of thrift originations of single-family mortgages in the second quarter, down from 36.2 percent in the first quarter.

This decrease is consistent with the refinancing

(Continued on page 6)

### Duration and NPV Sensitivity Measures



### Interest Rate Sensitivity Rises in Second Quarter (continued)

(Continued from page 5)  
activity of all lenders, where the rate declined to 49 percent from 53 percent between the first and second quarters.

The industry's effective duration of assets rose from 1.74 to 2.03 between the first and second quarters. With the increase in interest rates in the second quarter, the NPV model

predicted a decrease in the rate of prepayments of mortgages held in portfolio. This raised the duration of mortgages and, therefore, total assets duration.

The industry's effective duration of liabilities fell slightly from 1.66 to 1.62 in the second quarter.

The changes in asset and liability durations in the second quarter pro-

duced an increase in the positive duration gap for the thrift industry as a whole. This reverses the narrowing of the positive duration gap for the industry in the prior quarter.

The median pre-shock NPV ratio for the industry rose during the second quarter from 13.0 percent to 13.5 percent.

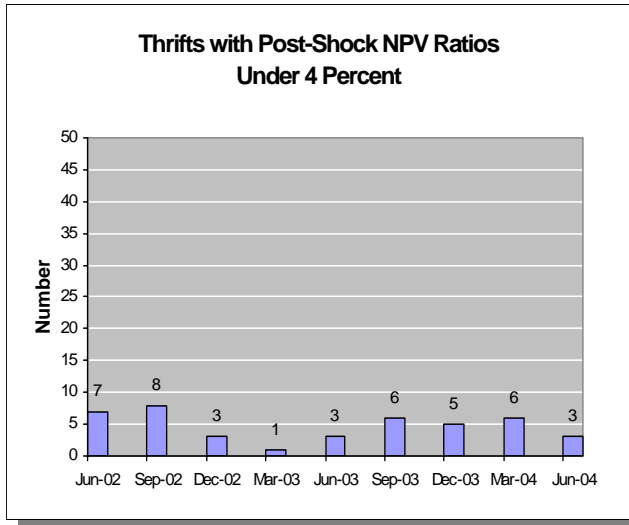
Along with this rise in

the median pre-shock NPV ratio, the median post-shock NPV ratio also rose, moving from 11.5 percent at the end of the first quarter to 11.7 percent at the end of the second quarter.

The number of thrifts with a post-shock NPV ratio below 4 percent fell to three institutions from six in the previous quarter.

(Continued on page 7)

## Interest Rate Risk Measures



	NPV as % of PV of Assets		% Change in NPV	
	Mar-04	Jun-04	Mar-04	Jun-04
<b>+300</b>	7.87%	8.40%	-31%	-30%
<b>+200</b>	9.11%	9.62%	-18%	-18%
<b>+100</b>	10.12%	10.61%	-7%	-8%
<b>Base</b>	10.80%	11.36%	0%	0%
<b>-100</b>	10.92%	11.56%	2%	3%
<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>	258	157	141	17	573
<b>6% to 10%</b>	93	79	73	8	253
<b>4% to 6%</b>	3	5	21	2	31
<b>Below 4%</b>	0	1	3	2	6
<b>Total</b>	354	242	238	29	863

Minimal
Moderate
Significant
High

	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

Minimal
Moderate
Significant
High

### Interest Rate Sensitivity Rises in Second Quarter (continued)

(Continued from page 6)

The percentage of thrifts with a post-shock NPV ratio over 6 percent rose between the first and second quarters. In the first quarter, these thrifts comprised 95.7 percent of the industry, while they comprised 96.7 percent in the second quarter.

The number of thrifts with a post-shock NPV ra-

tio below 6 percent fell to 28 institutions in the second quarter, down from 37 in the prior quarter.

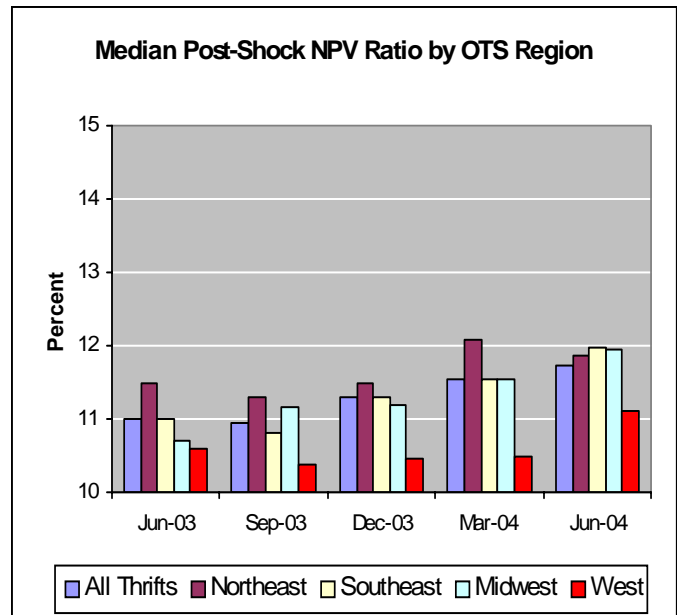
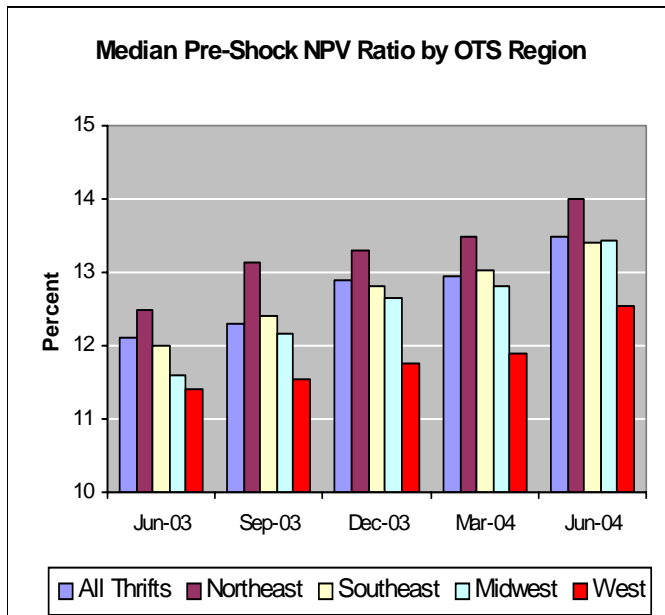
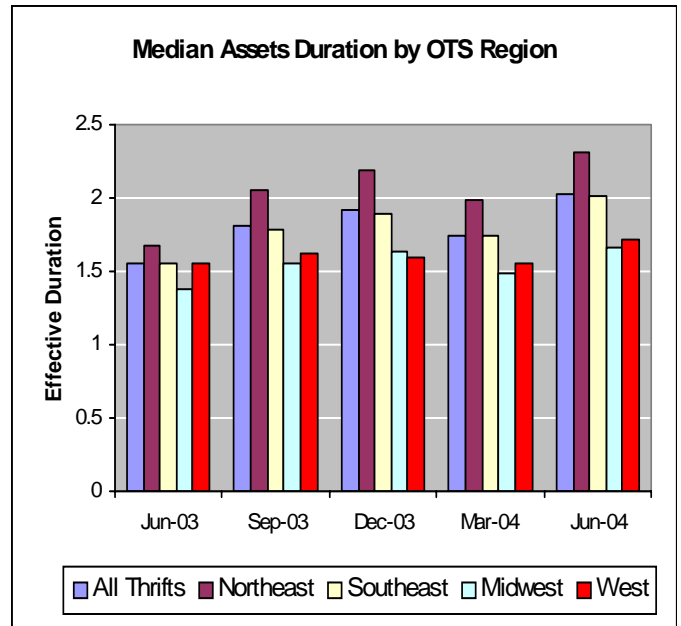
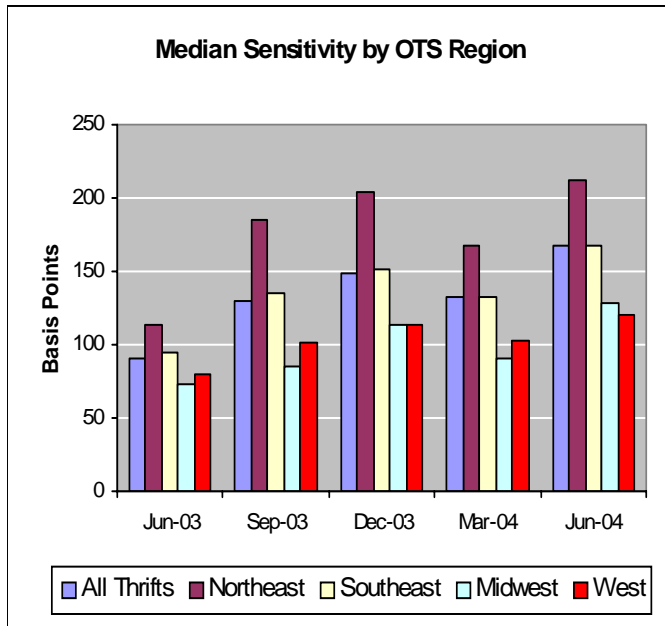
The percentage of thrifts with a sensitivity of 200 basis points or less decreased sharply in the second quarter, falling to 57.1 percent from 69.1 percent in the prior quarter.

In addition, the per-

centage of thrifts with over 400 basis points in sensitivity more than doubled to 7.9 percent in the second quarter from 3.4 percent in the prior quarter.

These results are consistent with the widening in the industry's positive effective duration gap and with the rise in its median sensitivity in the second quarter. ■

### Comparative Trends in the Four OTS Regions



#### Regional Comparisons

The Northeast Region had the highest median sensitivity, at 212 basis points at the end of the second quarter, while the West Region had the lowest median sensitivity, at 120 basis points.

All OTS regions experienced an increase in their interest rate sensitivity in the second quarter. The Midwest Region saw its

median sensitivity rise by 41.8 percent, the largest relative increase of the four regions. The Northeast, Southeast, and West Regions saw their median sensitivities rise by 26.9 percent, 25.6 percent, and 16.5 percent, respectively.

The Northeast Region had the highest median asset duration, at 2.31 at the end of the second

quarter. All four OTS regions witnessed a rise in their median asset durations as a result of the increase in interest rates between the first and second quarters.

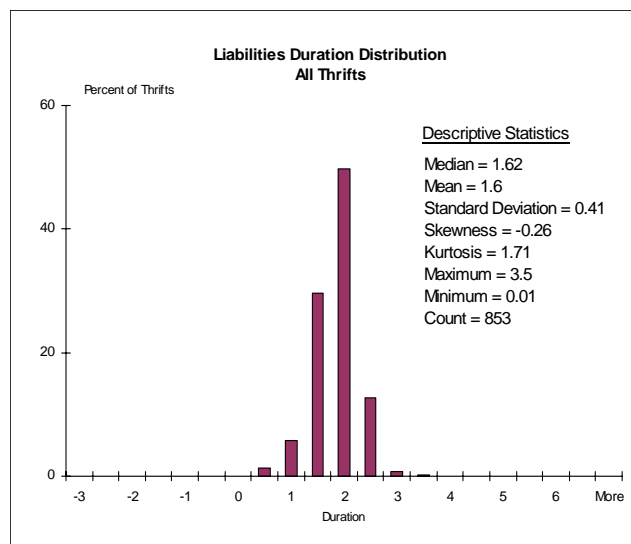
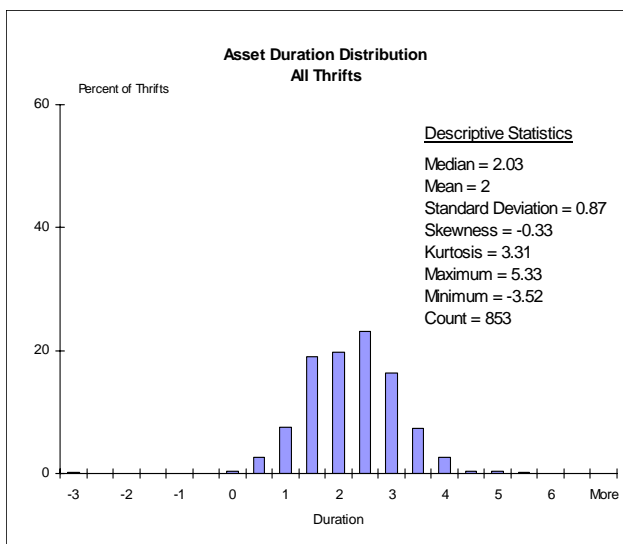
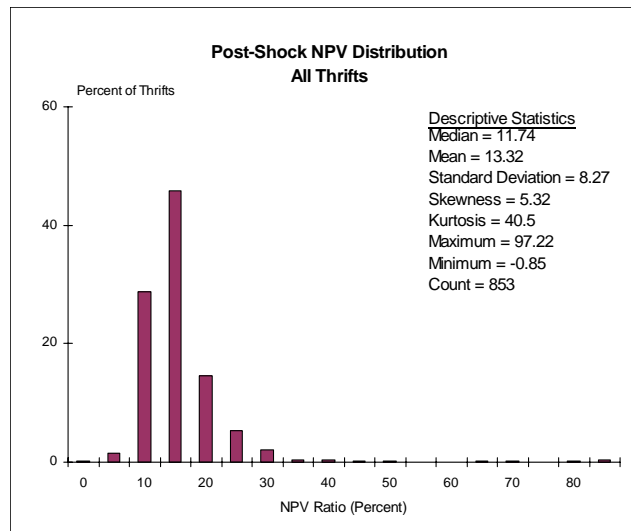
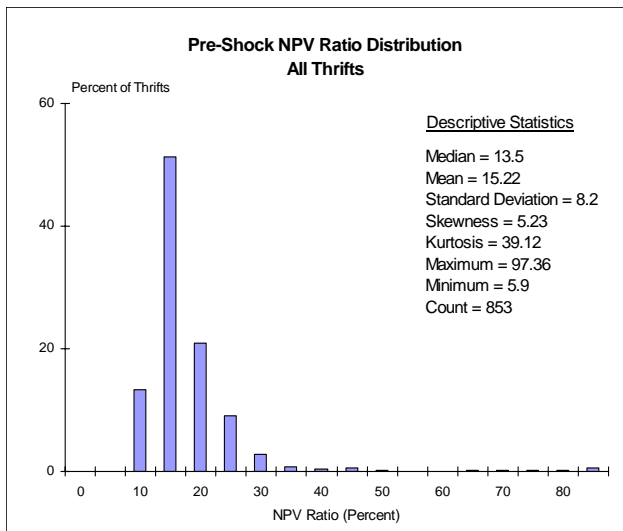
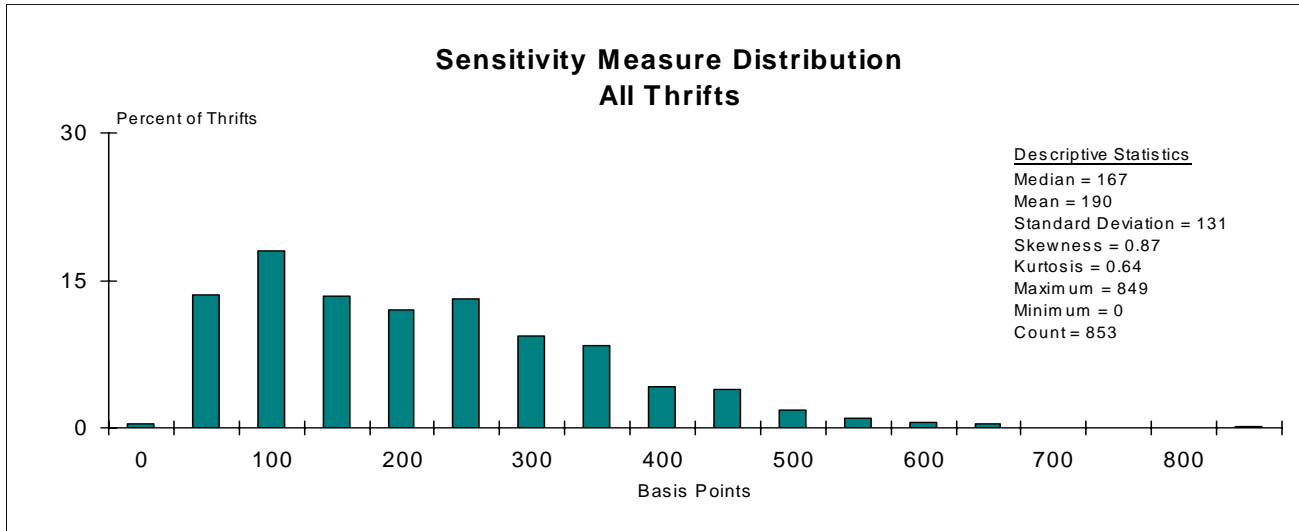
All OTS regions saw their median pre-shock NPV ratios rise in the second quarter. The Northeast Region had the highest pre-shock NPV ratio at

14.0 percent, while the West Region had the lowest pre-shock NPV ratio at 12.6 percent.

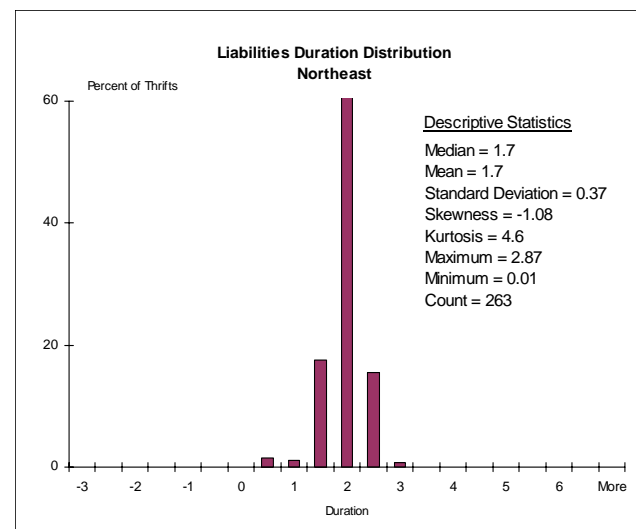
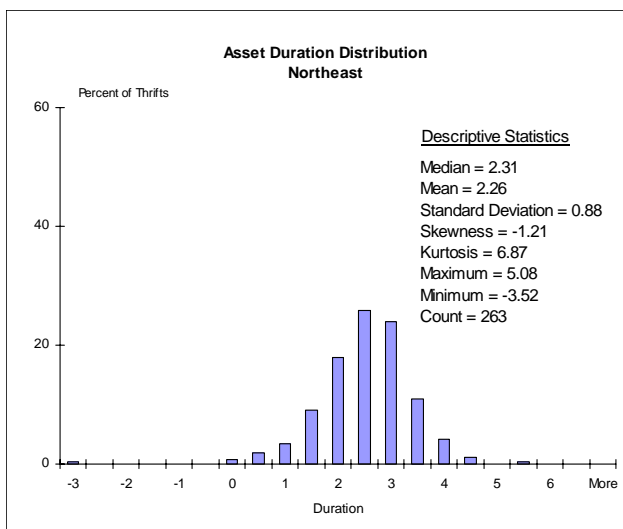
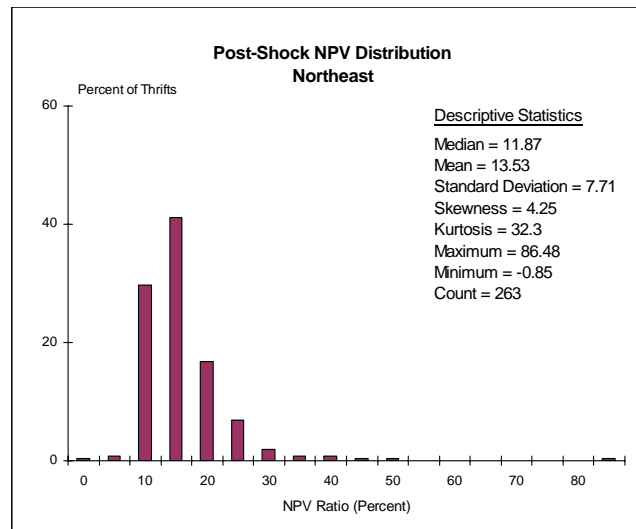
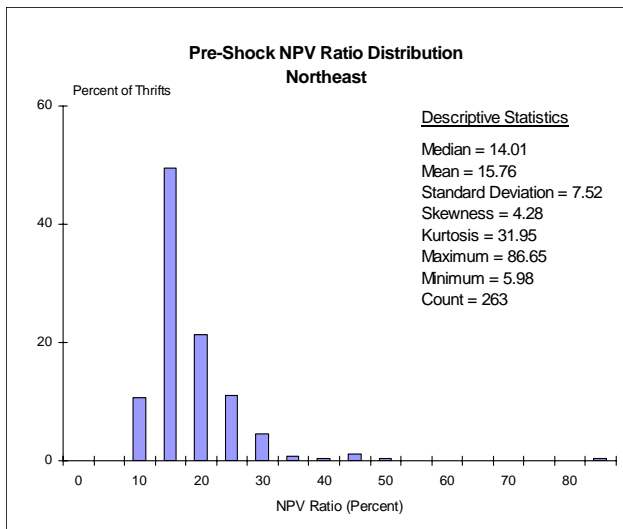
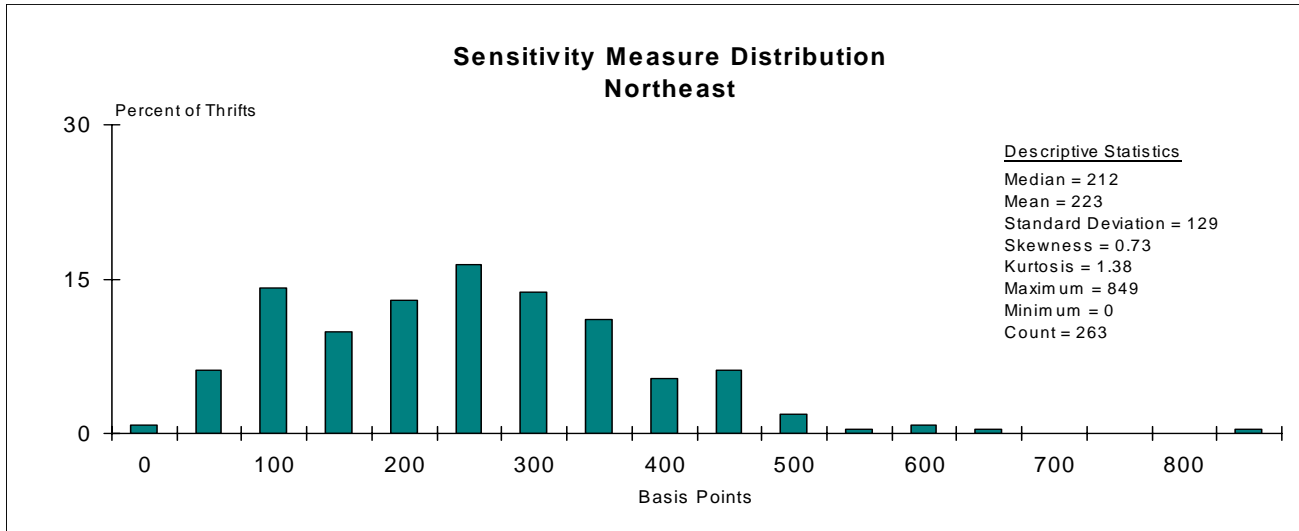
Finally, median post-shock NPV ratios rose for the Southeast, Midwest, and West Regions, but fell slightly for the Northeast Region in the second quarter. ■



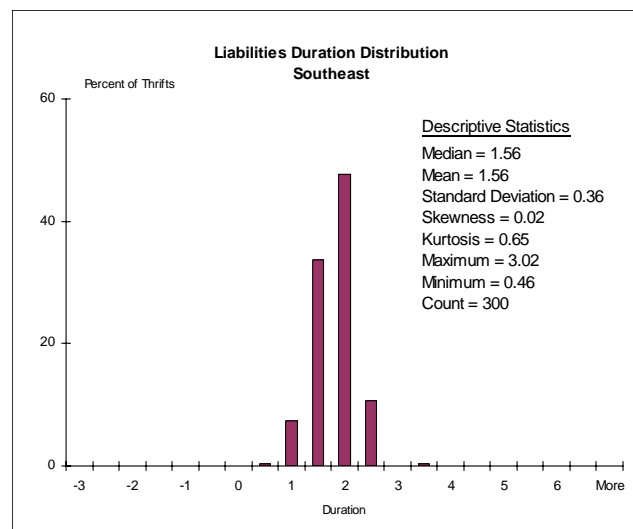
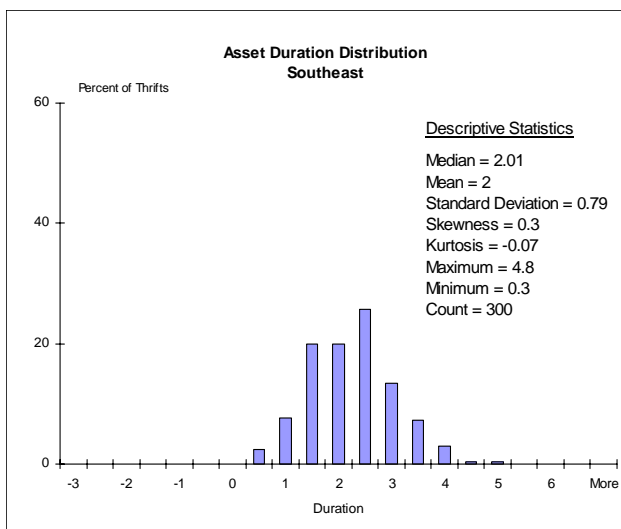
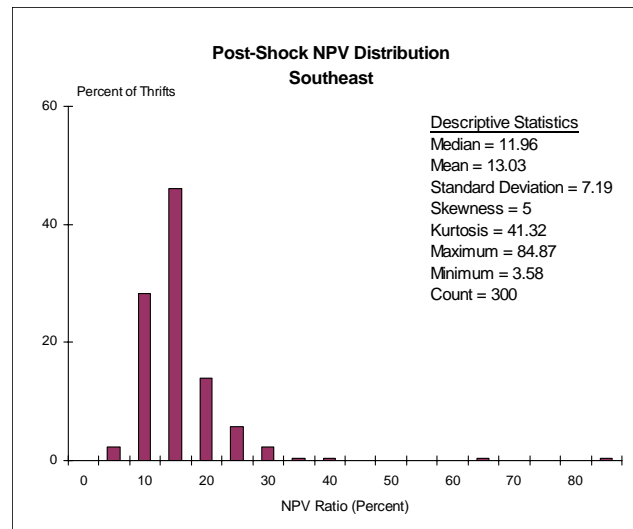
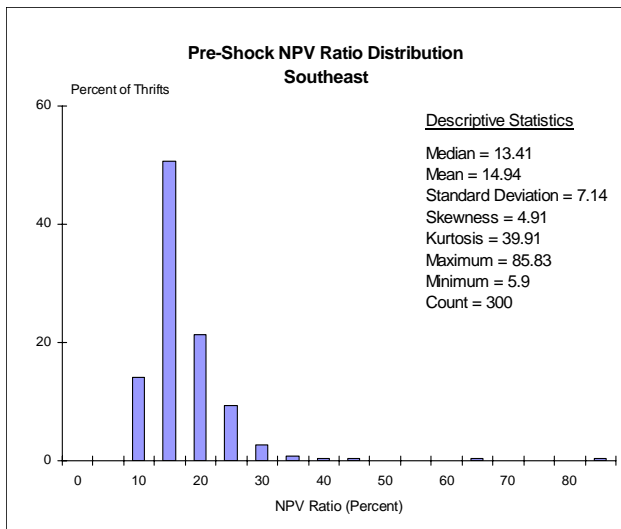
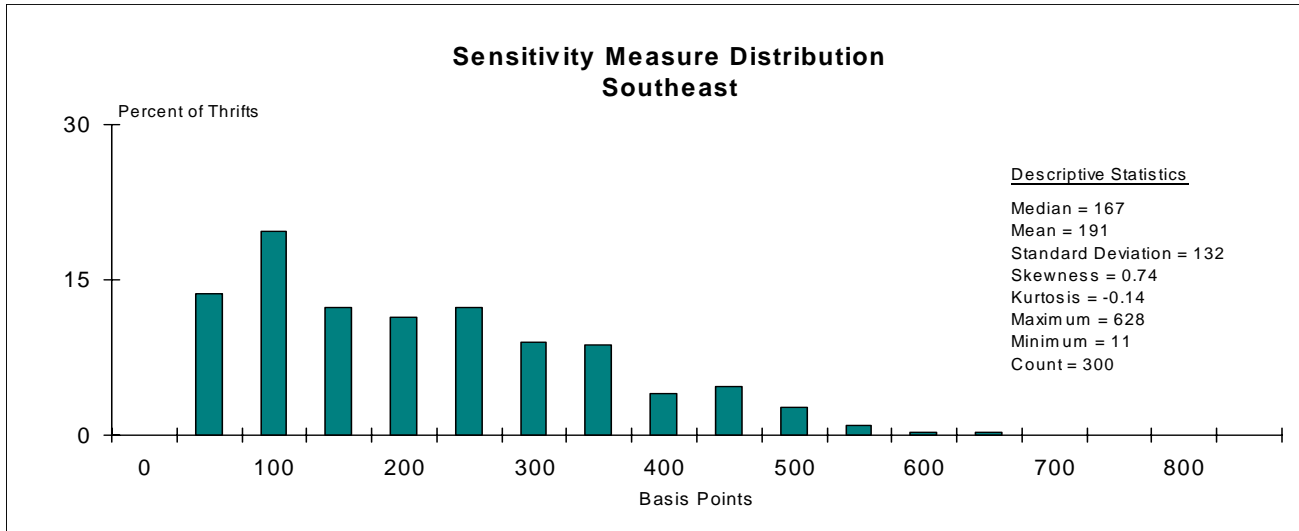
## Appendix A – All Thrifts



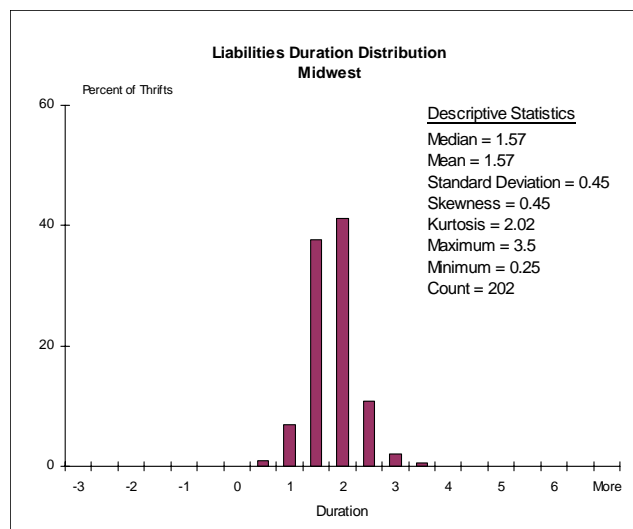
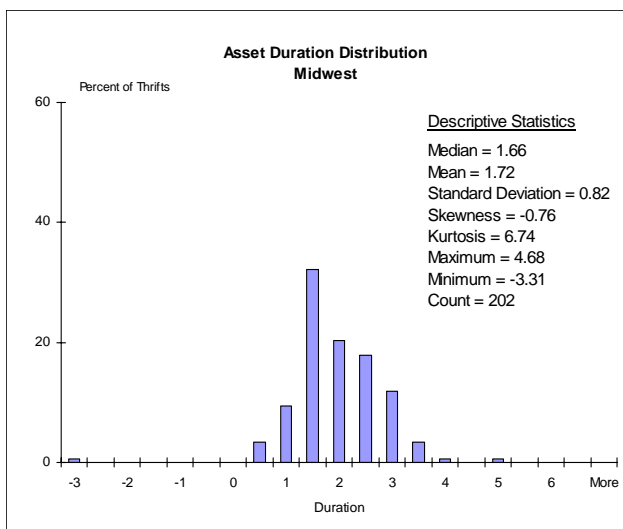
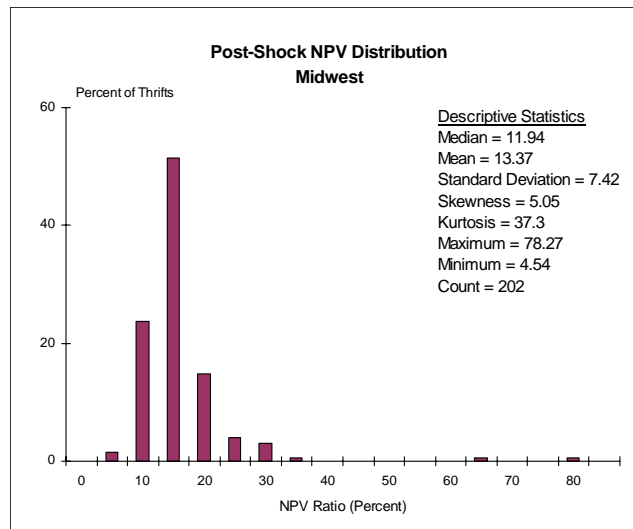
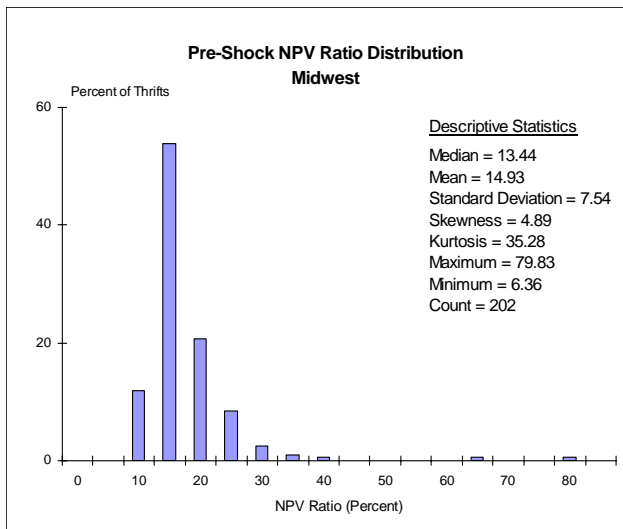
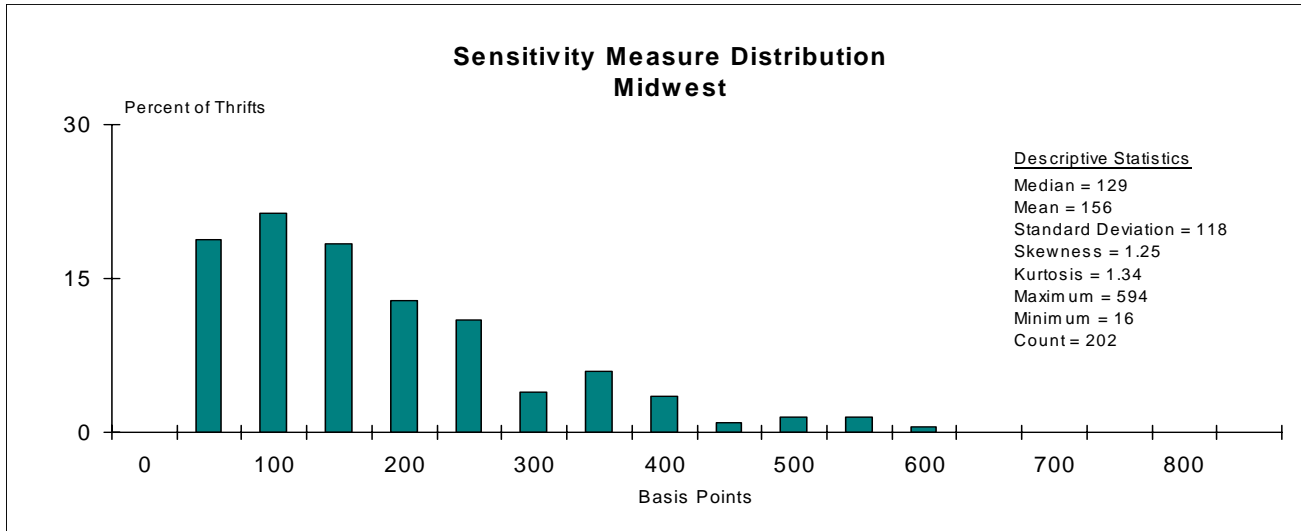
## Appendix B – Northeast Region



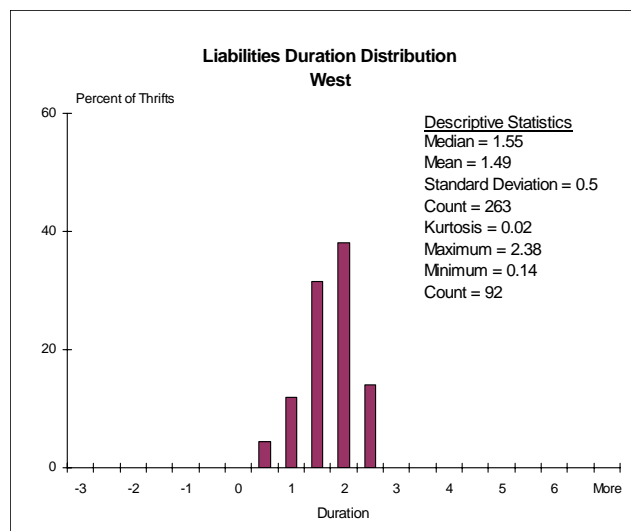
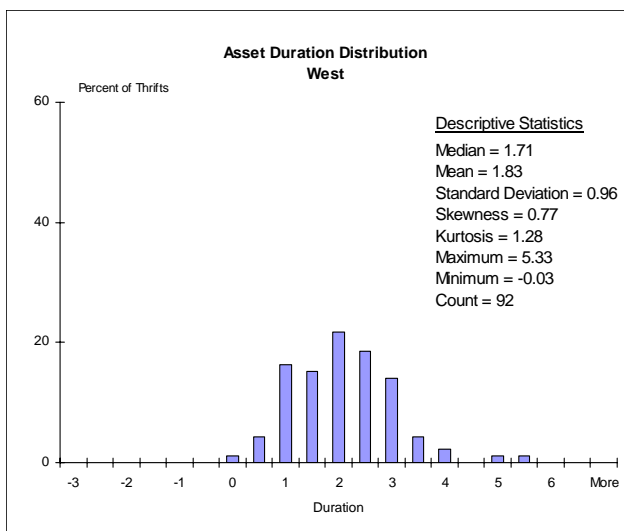
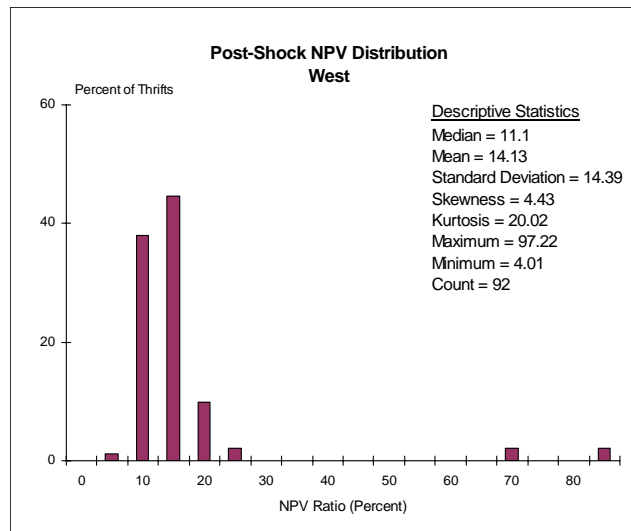
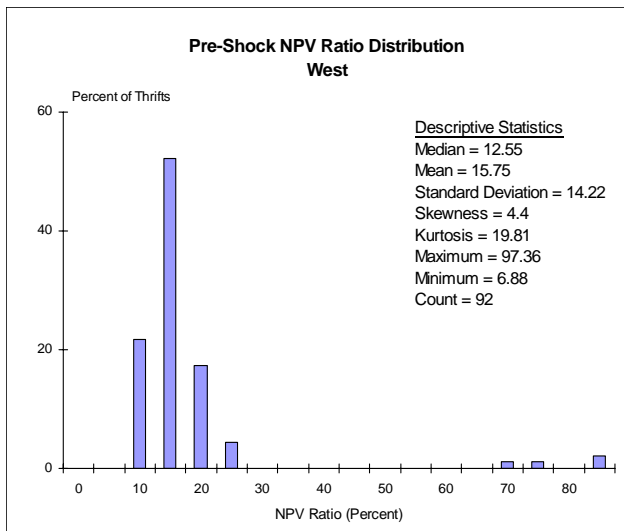
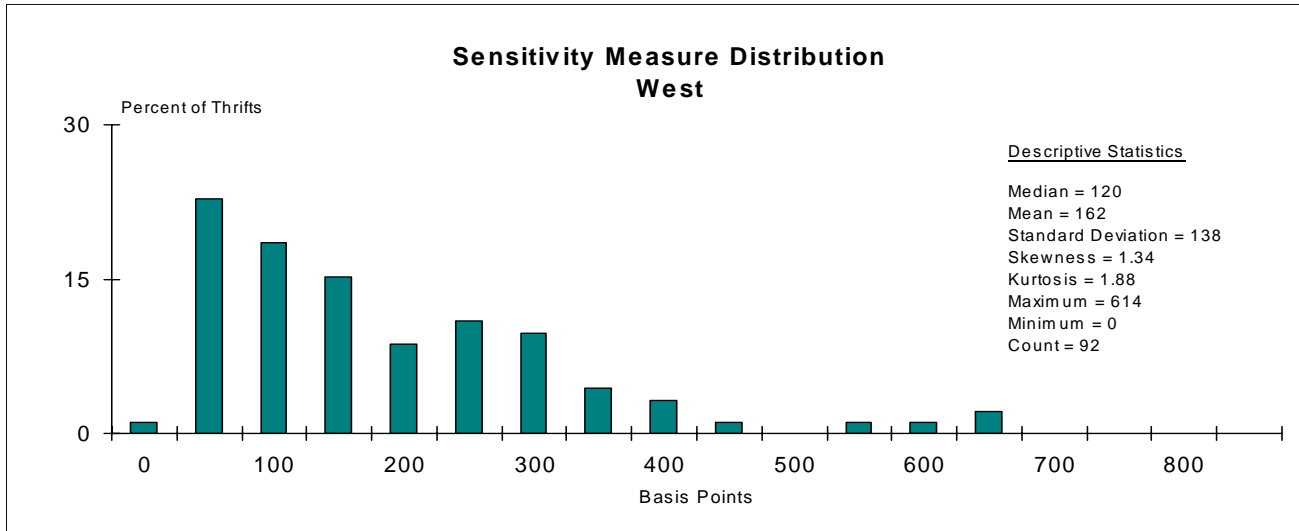
## Appendix C – Southeast Region



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

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