Volume 8, Issue 2

Second Quarter, 2003

The Quarterly Review Of Interest Rate Risk

Office of Supervision,
Economic Analysis Division

Special points of interest:

- 30-yr mortgage rate falls
- Yield curve flattens in the second quarter
- Second quarter median interest rate sensitivity remains unchanged
- Asset duration falls while liability durations rises
- Comparative Regional Analysis
- Feature Article on Prepayment Models

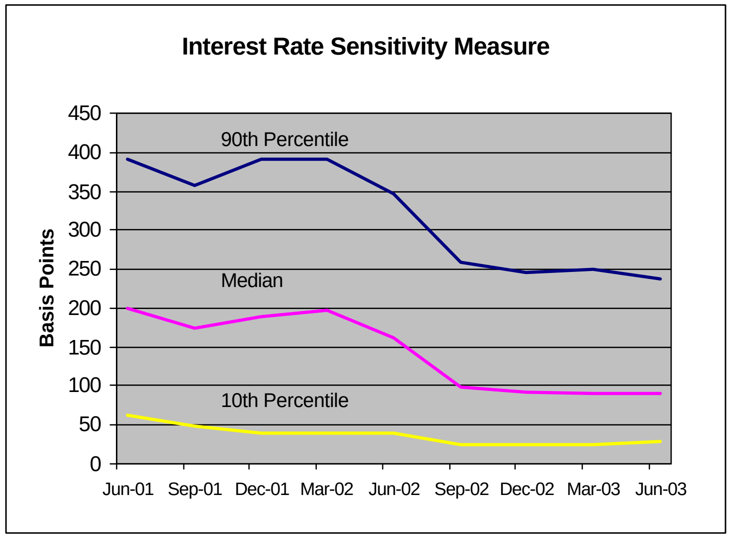
Charts in this issue:

Second Quarter Sets New Earnings Record

The thrift industry saw record earnings of $3.52 billion in the second quarter, up six percent from the previous record of $3.33 billion in the first quarter.

Median sensitivity remained unchanged at 91 basis points. The continuing low interest rate sensitivity for the industry reflects the favorable low interest rate environment.

Both the median pre–shock and post-shock Net Portfolio Value (NPV) ratios fell in the second quarter. The number of thrifts with high risk rose to three, up from two in the previous quarter. (*Continued on page 4*)



Prepayment Models

Between May 31, 2000, and May 31, 2003, the Fannie Mae 60-day commitment rate for 30-year, fixed-rate mortgages fell from 8.68 percent to 4.85 percent, a decrease of 383 basis points. This dramatic fall in rates triggered an unprecedented level of mortgage refinancings that left many thrifts struggling to maintain decent interest rate spreads.

During this declining rate environment, prepayment models have received much attention. Most thrift executives realize that such models are necessary for valuing mortgages and mortgage-backed securities, and for quantifying the risks associated with holding these instruments.

However, most don't understand how these models are constructed or how they should be integrated into interest rate risk models. To even fairly sophisticated investors, prepayment models are often viewed as "black boxes."

Why Prepayment Models Are Important

The majority of mortgages issued in the U.S. allow borrowers to prepay their loans for any reason at any time without penalty. Because of this prepayment "option," the expected life of a mortgage is considerably shorter than its stated maturity.

Thus, when valuing a mortgage, the value of the prepayment option–since the borrower holds it–must be netted out. This option is similar to the option held by a corporation issuing callable debt.

However, modeling early payoff is inherently far more complex for a mortgage than it is for callable corporate debt. This is due to the fact that a mortgage is both a debt instrument and something that enables the borrower to live in a particular place of residence.

In the former capacity, early payoff will largely be driven by interest rates. In the latter capacity, early payoff will be driven by life

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Prepayment Models (continued)

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events specific to the borrower such as marriage, having children, career-driven relocation, retirement, loss of employment, divorce, or death.

Therefore, all prepayment models, even those based on loan-level data, will be incomplete, and therefore subject to error. This means that prepayment modeling is problematic, and even the most sophisticated financial institutions are prone to make errors in this area. In addition, in periods such as we experienced recently, where rates fall to levels not seen in decades, it is quite possible to get regime shifts, even in the purely interest-rate driven component of prepayment behavior

These complexities and data shortcomings aside however, it is important to do the best possible job with the information available.

Early Static Prepayment Models

At one time, the standard approach to prepayment modeling was to assume that all mortgage prepayments occurred in year 12. This assumption was based on Federal Housing Administration (FHA) data that showed, on average, that mortgages terminated in their twelfth year. Today, however, this method is rarely, if ever, used because it clearly produces unrealistic and unreliable results.

In an effort to develop a more realistic approach to prepayment modeling, the Public Securities Association (PSA) developed a simple prepayment model, once again based on the behavior of FHA borrowers. The PSA model assumes that prepayments are driven exclusively by the age of the mortgage.

Specifically, this model assumes that a pool of mortgages will prepay at a rate of 0.2 percent in the first month and increase at a constant rate of 0.2 percent each month until month 30, at which point prepayments are assumed to level off at an annual "conditional prepayment rate" (CPR) of 6.0 percent until maturity. (When a CPR is restated in monthly form, it is referred to as a single monthly mortality rate or "SMM.")

Although more realistic than the 12-year average life model noted above, the PSA model too was deemed inadequate because it did not account for prepayments driven by factors other than loan age, such as the ability to refinance the mortgage because of lower interest rates.

This shortcoming notwithstanding, the PSA model provides a "prepayment speed" benchmark that is still used today. Prepayment speeds are often quoted in terms of "CPR" or "PSA." If prepayments on a particular mortgage or mortgage-backed security are assumed to follow the 0.2 percent/6.0 percent profile established in the PSA model, the prepayment speed is referred to as "100 PSA." A prepayment speed estimate of 200 PSA means that prepayments occur twice as fast as the PSA model benchmark, that is, 0.4 percent in the first month, 0.8 percent in month two and 12 percent after month 30.

Dynamic Prepayment Models

The need for more robust prepayment models motivated Wall Street to develop more sophisticated models that project prepayment rates as a function of both interest- and non-interest-related variables. For the most part, these statistical models use regression techniques to identify variables that affect prepayment behavior. Although the specific variables in these models can vary considerably, there is general agreement that three factors appear to drive prepayments: (1) the prevailing mortgage rate relative to the coupon; (2) the characteristics of the mortgage (e.g., size of the loan, age of the loan, location of the property); and (3) the time of year.

The prevailing market mortgage rate relative to the contract rate on an existing mortgage is the single largest driver of prepayments. When the prevailing mortgage rate falls below the contract rate, the likelihood of prepayment increases. In the past, the rule of thumb was that the prevailing mortgage rate had to be at least 200 basis points below the contract rate on the mortgage for refinancing to be economically feasible.

This was based on the assumption that at any interest-rate differential less than 200 basis points, the cost of obtaining the mortgage (points, fees, etc.) would offset the benefits gained from getting a lower interest rate on the loan. In recent years, however, the cost associated with obtaining a mortgage has fallen considerably and the threshold for refinancing has fallen as a result.

With respect to age, it has been observed that new loans (loans less than 30 months old) prepay at slower rates than seasoned loans. This is somewhat analogous to the observed default distributions for consumer loans. Generally, defaults peak in the second or third year, and decline thereafter. This is because it may take a while for over-committed borrowers to address their financial situation.

However, in the case of a mortgage, what typically happens is that the borrower will sell the property and move into a smaller residence that they can afford, rather than default. We tend to see prepayments on mortgages rather than defaults unless the remaining loan balance exceeds the market value of the property. Thus, the term "seasoned" refers to loans that are past this default/prepayment hump.

Another reason that the age of a mortgage might be related to prepayment is that the older the loan, the greater the potential for equity buildup due to paying down of principal and increase in the value of the

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Prepayment Models (continued)

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underlying property. This increases the incentive for cash-out refinancing, or for selling and trading up. A better way to model this than using age per se would be to use the change in a home price index since the date of origination in the particular zip code or census tract.

A third source of influence of mortgage age on prepayments is burnout. A burned-out mortgage is one where the market has provided many opportunities to refinance, but the borrower did not take advantage of them.

But while burnout may be related to age, it too is not mortgage age per se, because the opportunities to refinance depend on the path of interest rates since the mortgage origination date. Burned-out loans tend to be less likely to refinance than other loans.

Besides age, loans with high loan to value ratios (LTVs) and loans with small balances are also less likely to prepay. In addition, location of the property is important because in areas of the country where the local economy is strong, the housing turnover rate is often higher, and because the potential for cash-out refinancing is greater.

It should be noted, however, that many of the available prepayment models are designed for GSE-based mortgage pools and because many of the details regarding the underlying loans in these pools are unknown to the investor, most of these models do not incorporate many loan-level details into the process.

Finally, the remaining factor that affects prepayment behavior is the time of year. This seasonality stems from the fact that more houses are likely to be sold during the spring and summer.

Thus, prepayment rates during those months tend to be higher than the rates experienced during the fall and winter months, reflecting the fact that more people move during the late spring and early summer when children are not in school.

Prepayment Models and Valuation

In order to be useful in valuation, a prepayment model must not only be able to quantify current prepayment speeds but also expected future prepayment speeds. Expected future prepayment speeds are largely a function of expected future mortgage interest rates. Since we don't know the precise path of future rates, we need an approach that takes into account a wide range of possible interest rate outcomes.

Thus, information developed from prepayment models is often used in connection with dynamic simulation models for the valuation of mortgages. One such dynamic approach is the Monte Carlo process. Using this process, one can project several hundred potential mortgage and forward rate paths that could occur over the next 360 months.

Using these projections in conjunction with a prepayment model, a unique prepayment speed and cash flow estimate is generated for each month along each simulated path. The cash flows generated in each path are discounted by the forward rates generated in the Monte Carlo process plus a spread to derive a unique price for each set of cash flows in each randomly generated path. The option-adjusted spread (OAS) is that spread which, when added to the forward rates, will result in a "benchmark" on-the-run MBS being priced at par. The prices generated in each path are then averaged to produce one "average" price for the mortgage pool or security.

To determine how the price of the mortgage or mortgage pool security will change if rates fall or rise by 1 percent, the simulation model will merely adjust the randomly generated rate paths by +100 or –100 basis points (holding the option-adjusted spread constant) and then merely repeat the pricing process.

The generation of future mortgage rates and forward rates is highly dependent on the volatility assumption used in the Monte Carlo process. In general, a high volatility estimate will decrease the average value of the mortgage or mortgage pool security. This occurs because the embedded option, which is owned by the borrower, becomes more valuable as volatility increases.

The OTS Prepayment Model

To better understand how prepayment models work in practice, let's look at the prepayment model used in the OTS NPV model. The NPV model currently uses a three-factor prepayment model in conjunction with a Monte Carlo process that generates 200 rate paths to solve for the OAS. (The mortgage rate simulated during the Monte Carlo process is a function of a simulated five-year Treasury rate plus a fixed spread). The three factors in the prepayment model are the age of the mortgage (the seasoning factor) the time of the year (the seasonality factor) and the interest incentive (refinance factor).

The seasoning and seasonality factors are stable and, therefore, are not re-estimated each quarter. The refinance factor, however, is re-estimated for each cycle.

In order to re-calibrate the refinance factor function for 30-year loans, OTS obtains, from the "VAL" screen on Bloomberg, dealer prepayment estimates (in PSA form) for Fannie Mae and Ginnie Mae 30-year MBSs with pass-through rates ranging from 5 percent to 10 percent in 50 bps increments. The "VAL" screen segments the Fannie Mae and Ginnie Mae 30-year MBSs into three groups based on the age of the underlying collateral: new-loans with a weighted average remaining maturity (WARM) between 330 and

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Prepayment Models (continued)

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360 months, moderately-seasoned-loans with a WARM between 300 and 330 months, and fully-seasoned-loans with a WARM below 300 months.

OTS, in its NPV model, estimates a nonlinear (arctangent) regression model to obtain predicted prepayment speeds as a function of interest rates. The dependent variable in this regression is dealer PSA estimates (in CPR form) and the independent variable is the corresponding ratio of mortgage coupon to the current market rate on 30-year fixed-rate mortgages. This relationship is estimated for new, moderately-seasoned, and fully-seasoned Fannie Mae and Ginnie Mae securities.

An arctangent function is essentially a slanted s-shaped curve that many believe accurately depicts the refinancing behavior of borrowers.

It should be noted that for all 30-year fixed rate mortgage products (e. g., conventional mortgages/Ginnie Mae), OTS estimates three separate arctangent functions: one for new mortgages, one for moderately seasoned mortgages, and one for fully seasoned mortgages. The NPV model uses one of the three arctangent function estimates depending on the age of the mortgage in the Monte Carlo simulation. For example, the model applies the moderately seasoned prepayment function to a newly issued mortgage during the 30th month of the simulation.

Once the refinance factor is calculated for each month along each simulated path, it is multiplied by the seasoning and seasonality factors to produce the final CPR estimates, which are then converted to SMM form.

To illustrate the calculations involved, assume that on June 30, 2003, the current simulated mortgage rate is 5.34 percent. For a 6.50 percent, 30-year conventional mortgage with a WAM of 358 months, the NPV model would assign the following prepayment parameter values for month one of the simulation: refinance factor (CPR)=63.7, seasonality factor=1.1, and seasoning factor=0.033, resulting in a final CPR estimate of 2.31.

Using the same set of assumptions, but changing the WAM to 329 months, the NPV model would assign the following prepayment parameter values for month one of the simulation: refinance factor (CPR)=42.9, seasonality factor=1.1, and seasoning factor=1.0, producing a final CPR estimate of 47.2.

Conclusion

It is hoped that the foregoing provides at least a basic understanding of prepayment modeling in the context of mortgage valuation as well as some insights into how the OTS NPV model approaches the issue.

For more details on the valuation of the prepayment option in the OTS NPV model, see Chapter 5 of the *Net Portfolio Value Model Handbook*.

Second Quarter Sets New Earnings Record (continued)

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Treasury rates fell for all maturities, but the decline for longer-term maturities was greater. As a result, the yield curve was less steeply sloped than it was at the end of the first quarter.

The Freddie Mac contract interest rate on commitments for fixed-rate 30-year mortgages declined to 5.24 percent at the end of the second quarter from 5.79 percent at the end of the previous quarter.

Despite the flattening of the Treasury yield curve, thrift profitability improved. The average return on assets for the industry rose to a record 1.34 percent in the second quarter from 1.30 percent in the prior quarter. This rise was attributed to lower loan loss provisions, lower impairment charges for mortgage servicing rights, higher fee income, and other non-interest income in the second quarter.

Although profitability improved, the second quarter average net interest margin fell to 294 basis points, down from 311 basis points in the first quarter. This reduction was caused by the fall in long-term interest rates that caused the yields on new and re-priced assets to fall more than the costs of liabilities.

Thrift industry earnings rose to a new record level of $3.52 billion in the second quarter, from $3.32 billion in the prior quarter. This was due to increases in both other fee income and other non-interest income.

Other fee income includes retail banking fees, mutual fund and annuity sales commissions, loan servicing income from non-mortgage loans, and loan origination fees. Other non-interest income primarily includes sales of assets, dividends on FHLB stock, and income from leasing office space.

In the second quarter, other fee income rose to 0.93 percent of average assets from 0.90 percent in the prior quarter. Other non-interest income rose to 1.29 percent of average assets from 0.98 percent between the first and second quarters.

The ARM share of total thrift mortgage originations fell to 21 percent, down from 26 percent in the prior quarter. Along with the relative fall in ARM originations, the

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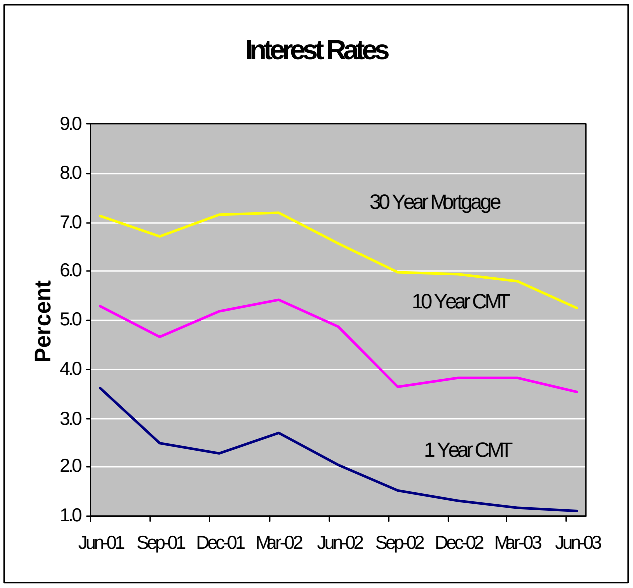
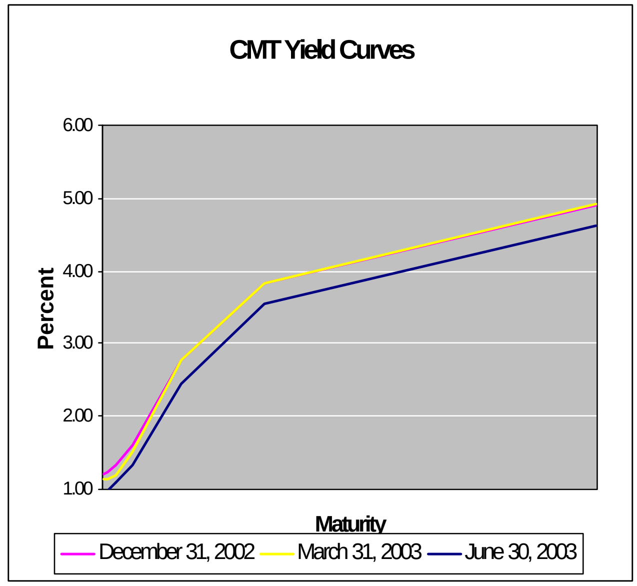
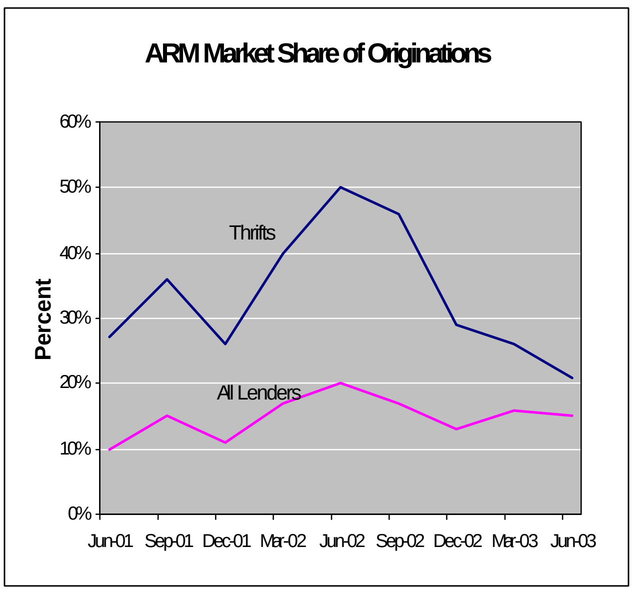
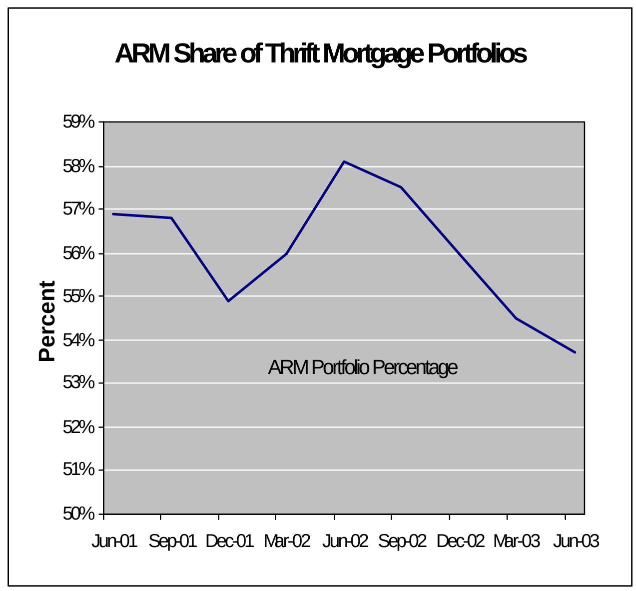
Interest Rates and ARM Market Share









Second Quarter Sets New Earnings Record (continued)

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ARM share of total 1-4 family mortgages held in portfolio fell to 53.7 percent from 54.5 percent in the first quarter.

Second-quarter 1-4 family mortgage originations by thrifts were at a record of $193.2 billion, up from $160.2 billion in the first quarter. Total mortgage originations in the second quarter were $212.5 billion, up from $176.2 billion in the first quarter.

Thrifts' share of all 1-4 family originations was 20.7 percent in the second quarter, down from 21.9 percent in the first quarter. The rate of U.S. home ownership remained unchanged between the first and second quarters at 68 percent.

Refinancing accounted for 54.4 percent of thrift originations of single-family mortgages in the second quarter, down from 59.1 percent in the first quarter. This decrease is consistent with the refinancing activity of all lenders, where the rate fell to 68 percent in the second quarter, down from 71 percent in the prior quarter.

The industry's average effective duration of assets fell slightly from 1.57 to 1.55 between the first and second quarters.

With the already low and declining interest rates in recent quarters, the NPV model predicts an increase in prepayments of higher coupon mortgages in port-

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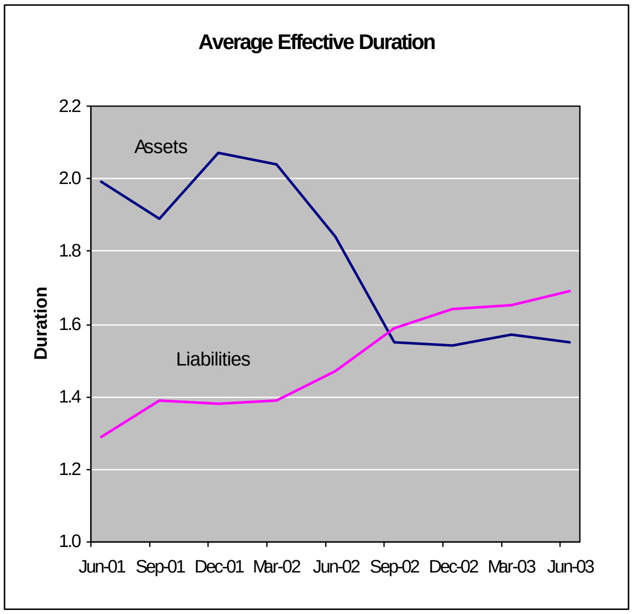
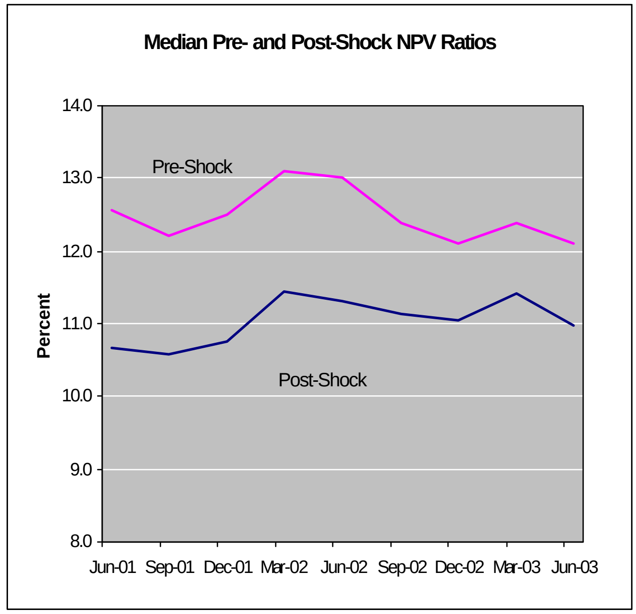
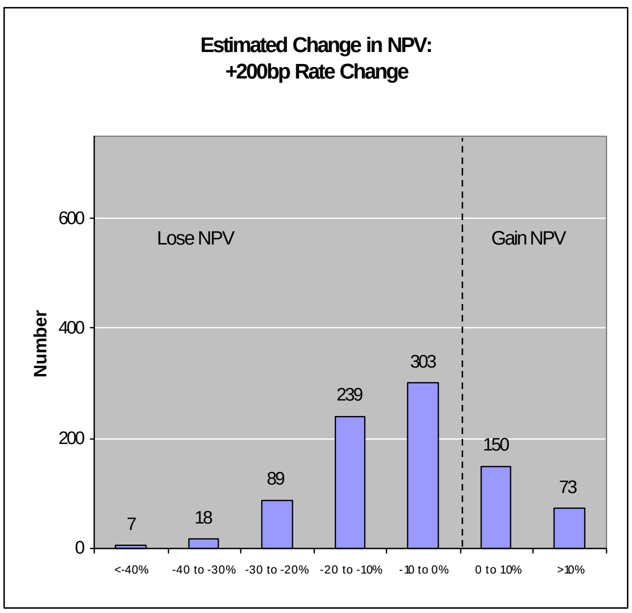
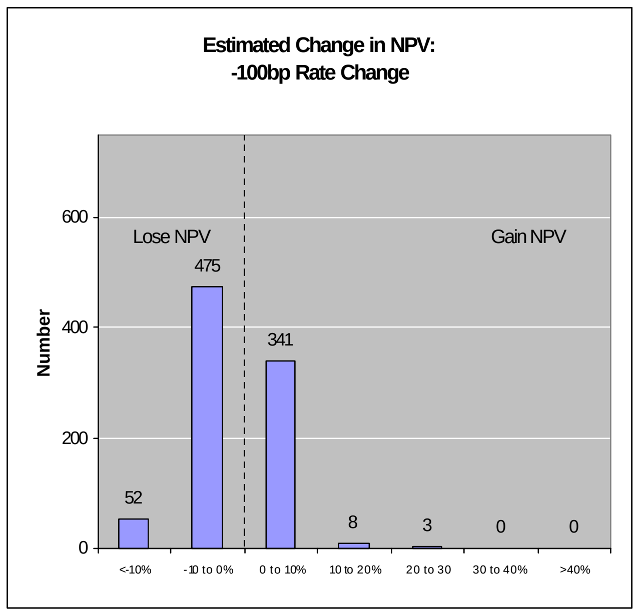
Duration and NPV Sensitivity Measures









Second Quarter Sets New Earnings Record (continued)

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folio. This tends to lower the average duration of these mortgages and, therefore, total assets duration.

The industry's average effective duration of liabilities rose slightly from 1.65 to 1.69 in the second quarter.

The changes in asset and liability durations in the second quarter resulted in a larger negative duration gap for the thrift industry as a whole. While asset duration fell slightly in the second quarter due to the fall in long-term rates, it is likely that asset durations will increase in the near future. This will happen, in part, because of lower-coupon mortgages replacing higher-coupon mortgages held by thrifts and also because of the sharp rise in rates that occurred in July.

Given the sharp rise in rates in July, these newly-refinanced mortgages will have a much lower likelihood of prepaying, resulting in an increase in asset duration. As a result, thrifts can probably expect to see their interest rate risk exposure increase over the next several quarters.

In fact, sharp increases in 30-year fixed-rate mortgage durations have already been documented. The Lehman Brothers MBS Index saw its duration jump from 1.02 at the end of the second quarter to 3.14 at the end of August.

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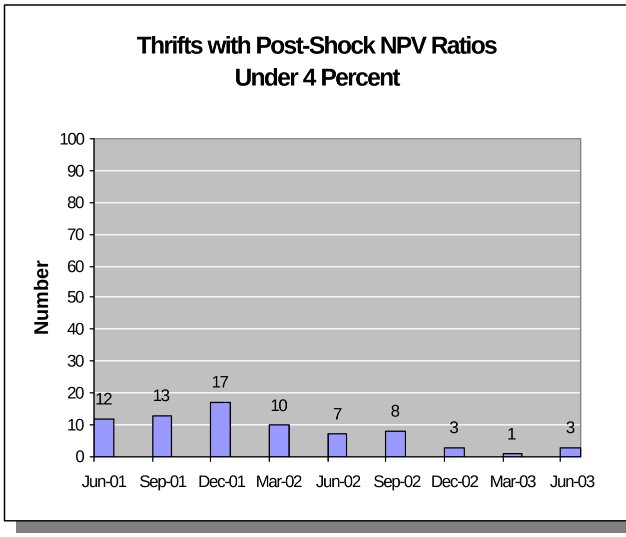
Interest Rate Risk Measures



Interest Rate Risk Measures
Industry Aggregates
Last Two Quarters

	NPV as % of PV of Assets		% Change in NPV	% Change in NPV
	Mar-03	Jun-03	Mar-03	Jun-03
+300	9.10%	8.57%	-16%	-19%
+200	9.70%	9.29%	-9%	-11%
+100	10.12%	9.81%	-4%	-4%
Base	10.38%	10.12%	0%	0%
-100	10.41%	10.09%	1%	0%
-200	N/A	N/A	N/A	N/A
-300	N/A	N/A	N/A	N/A

Post-Shock NPV Ratio and
Sensitivity Measure Matrix
March 2003

	Under 100bp	101-200bp	201-400bp	Over 400bp	Total
Over 10%	313	144	103	5	565
6% to 10%	163	90	43	3	299
4% to 6%	7	11	8	1	27
Below 4%	0	0	1	0	1
Total	483	245	155	9	892

Minimal Moderate Significant High

Post-Shock NPV Ratio and
Sensitivity Measure Matrix
June 2003

	Under 100bp	101-200bp	201-400bp	Over 400bp	Total
Over 10%	304	131	93	6	534
6% to 10%	166	105	36	5	312
4% to 6%	10	12	7	1	30
Below 4%	0	1	2	0	3
Total	480	249	138	12	879

Minimal Moderate Significant High

Second Quarter Sets New Earnings Record (continued)

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The median pre-shock NPV ratio for the industry fell during the second quarter from 12.4 percent to 12.1 percent. Along with this fall in the median pre-shock NPV ratio, the median post-shock NPV ratio also fell slightly, moving from 11.4 percent at the end of the first quarter to 11 percent at the end of the second quarter.

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

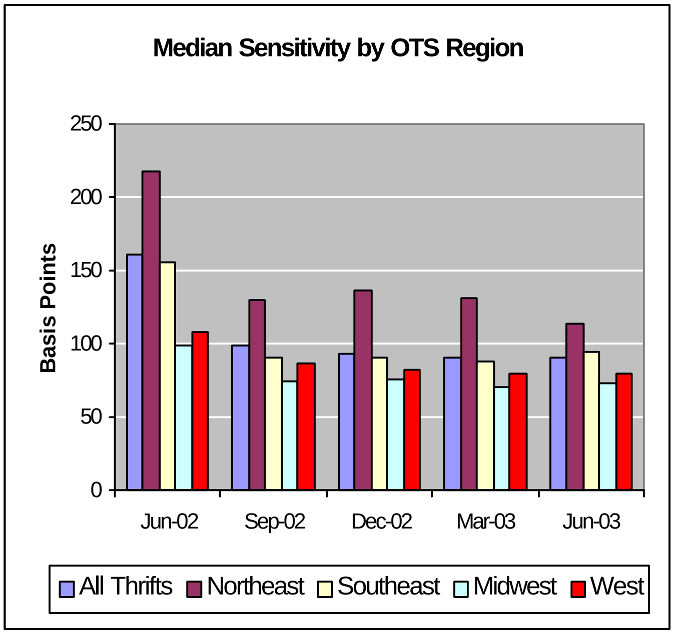
The percentage of thrifts with a post-shock NPV ratio over 6 percent decreased between the first and second quarters. In the second quarter, such thrifts comprised 96.2 percent of the industry, compared to 96.9 percent in the prior quarter.

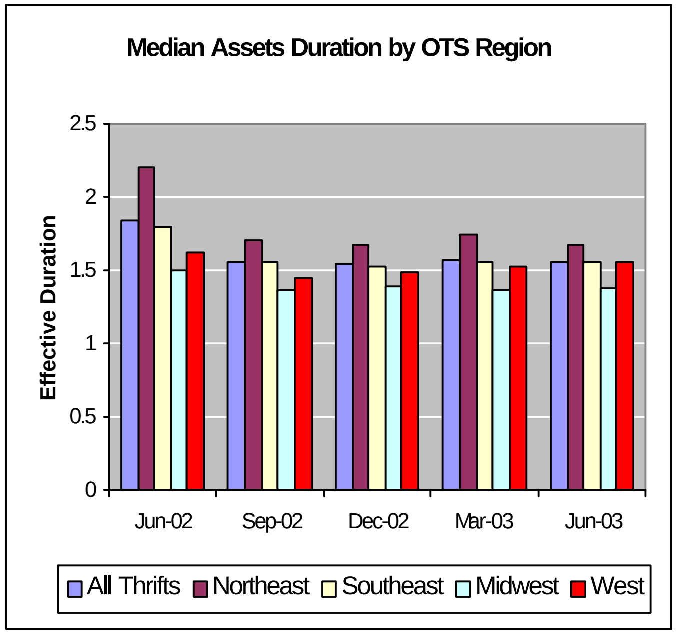
The number of thrifts with a post-shock NPV ratio below 6 percent rose to 33 in the second quarter, up from 28 in the first quarter.

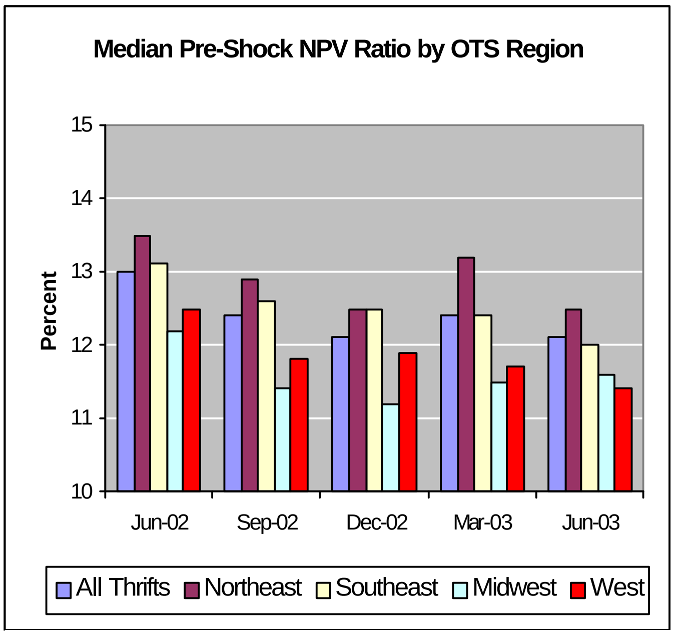
The number of thrifts with a sensitivity of 200 basis points or less increased by one to 729 in the second quarter.

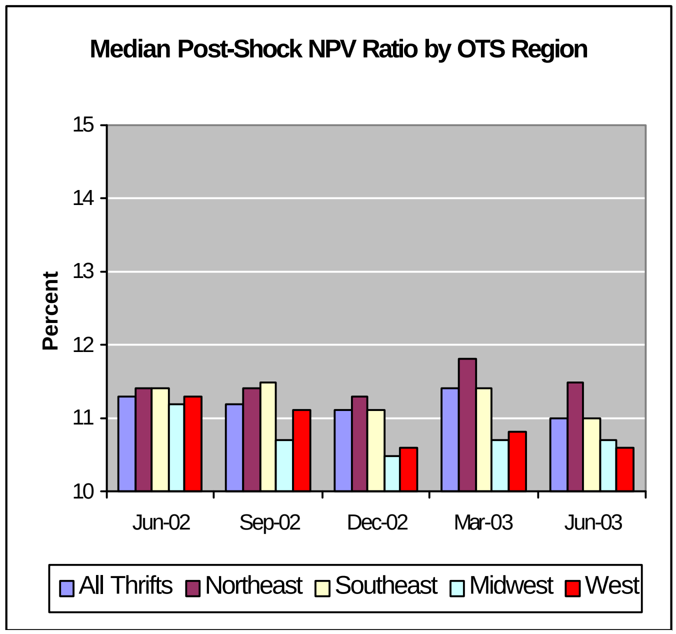
The number of thrifts with over 400 basis points in sensitivity rose to twelve, from nine in the prior quarter.

Comparative Trends in the Four OTS Regions









Regional Comparisons

The Northeast Region had the highest median sensitivity, at 114 basis points at the end of the second quarter, while the Midwest Region had the lowest, with 73 basis points.

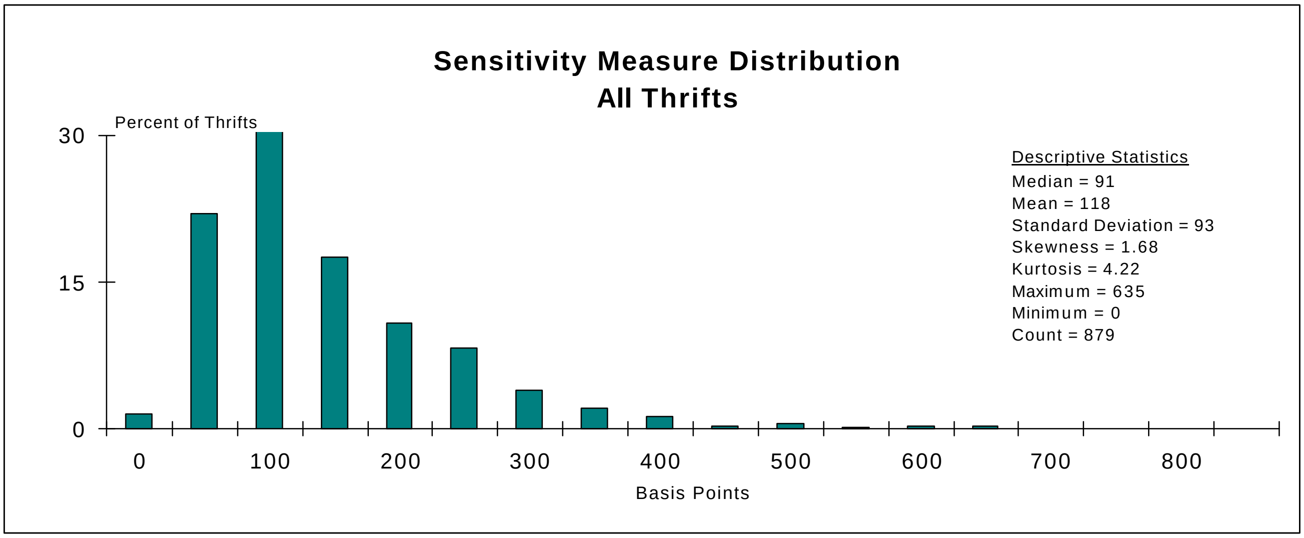
The Northeast Region was the only OTS region that saw its median sensitivity fall in the second quarter. Both the Southeast and Midwest Regions experienced increases in median sensitivities, while the West Region's median sensitivity was unchanged.

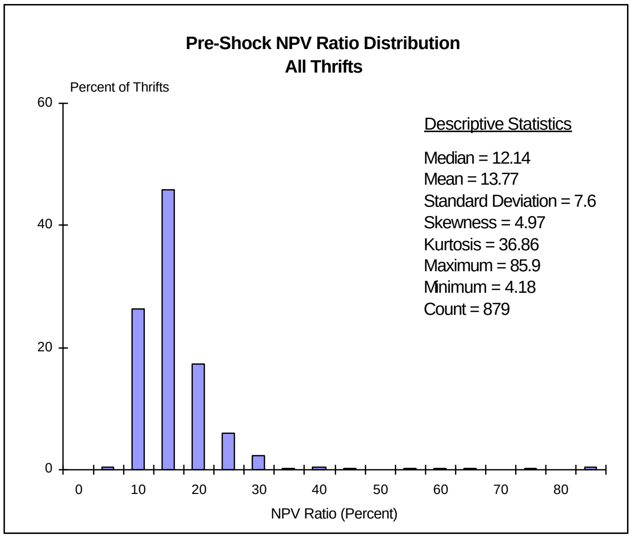
The Northeast, Southeast, and West Regions experienced decreases in their pre-shock NPV ratios, while the Midwest Region saw its pre-shock NPV ratio rise very slightly. The Northeast Region's median pre-shock NPV ratio fell from 13.2 percent to 12.5 percent, representing the largest regional absolute decline, while the Midwest Region's median pre-shock ratio rose slightly from 11.5 percent to 11.6 percent.

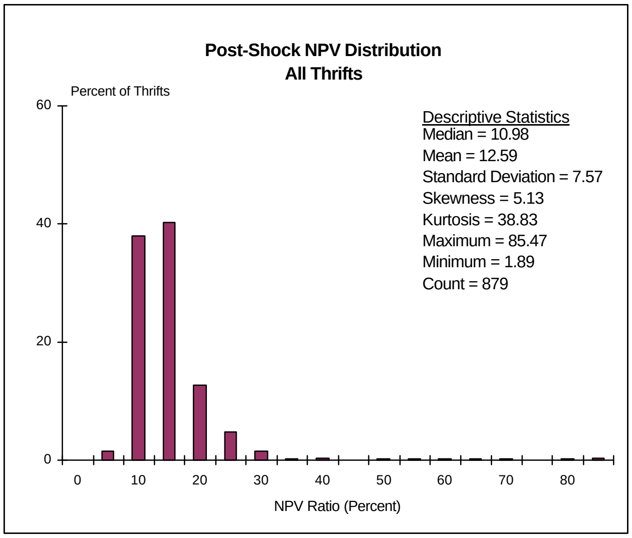
All regions saw either a decline or no change in their median post-shock NPV ratios. The Northeast, Southeast, and West Regions had a decrease in post-shock NPV, while median post-shock NPV remained unchanged in the Midwest Region.

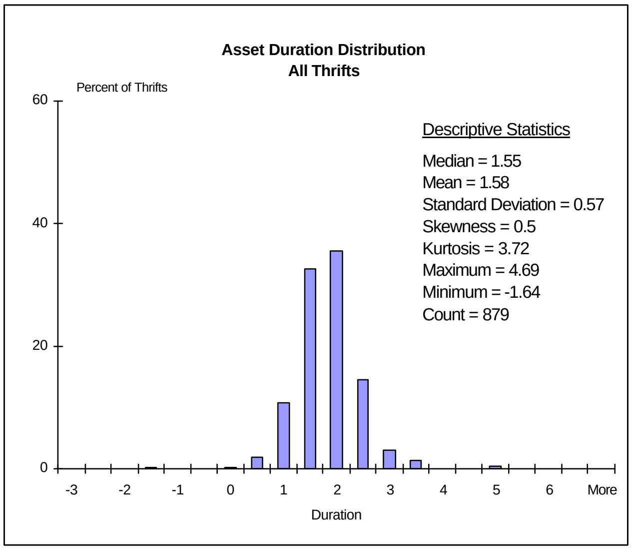
The Midwest and West Regions saw their median assets durations rise in the second quarter, the Southeast Region's stayed the same, while the West Region saw it rise.

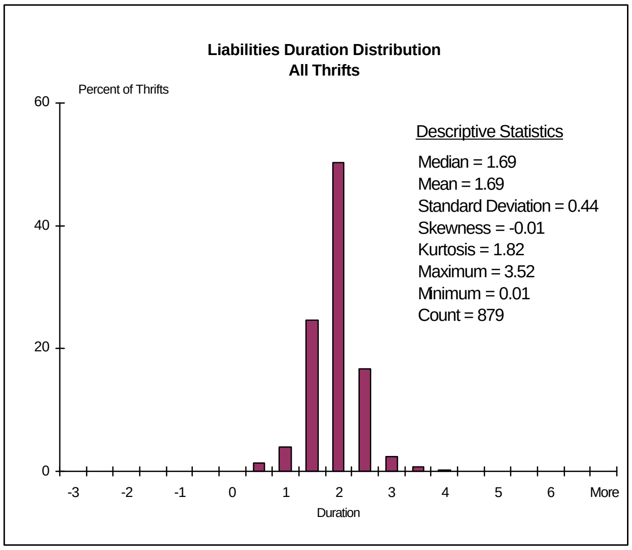
Appendix A — All Thrifts



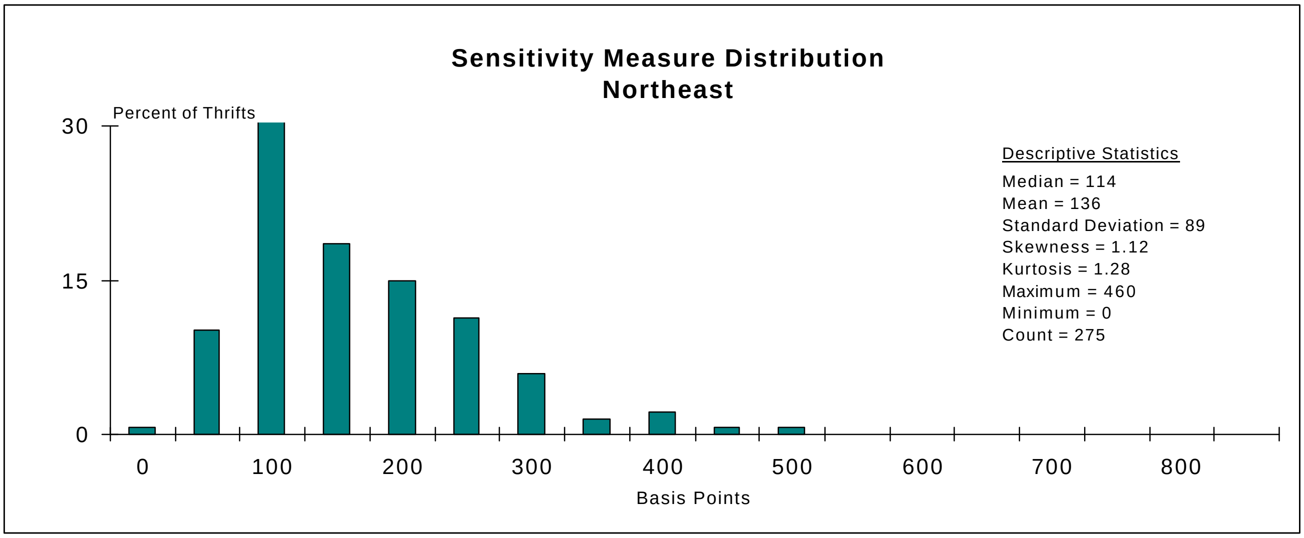


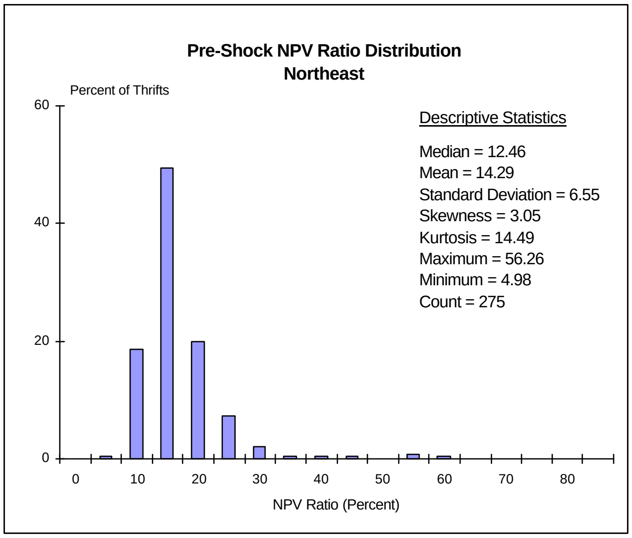


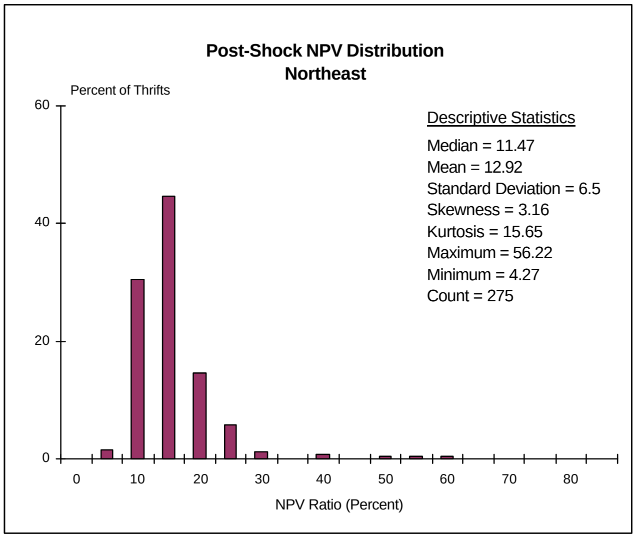


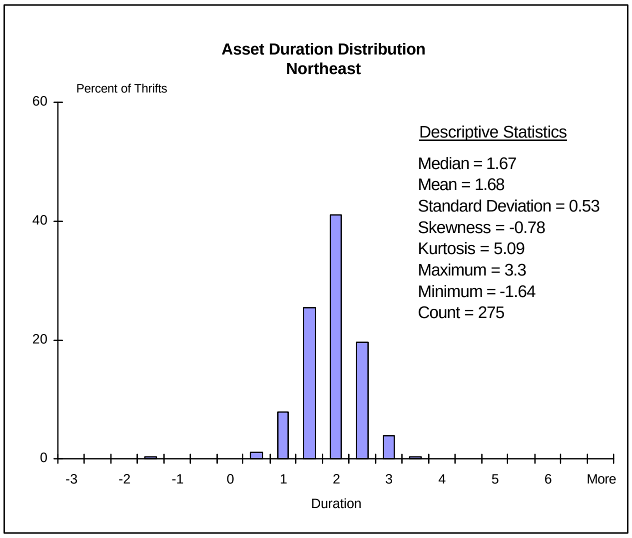


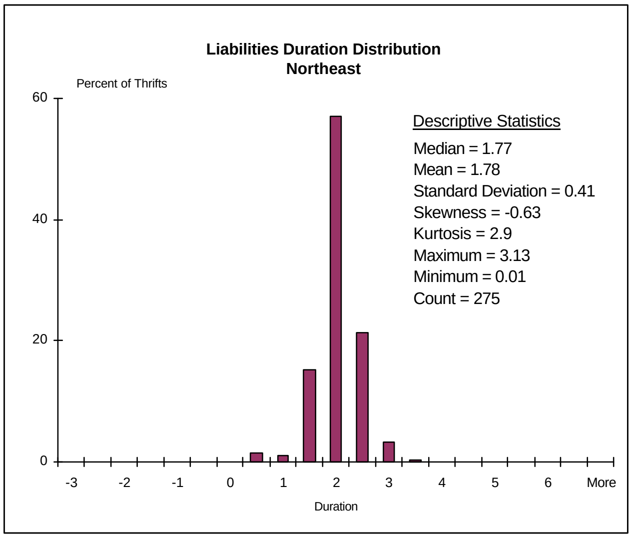
Appendix B — Northeast Region



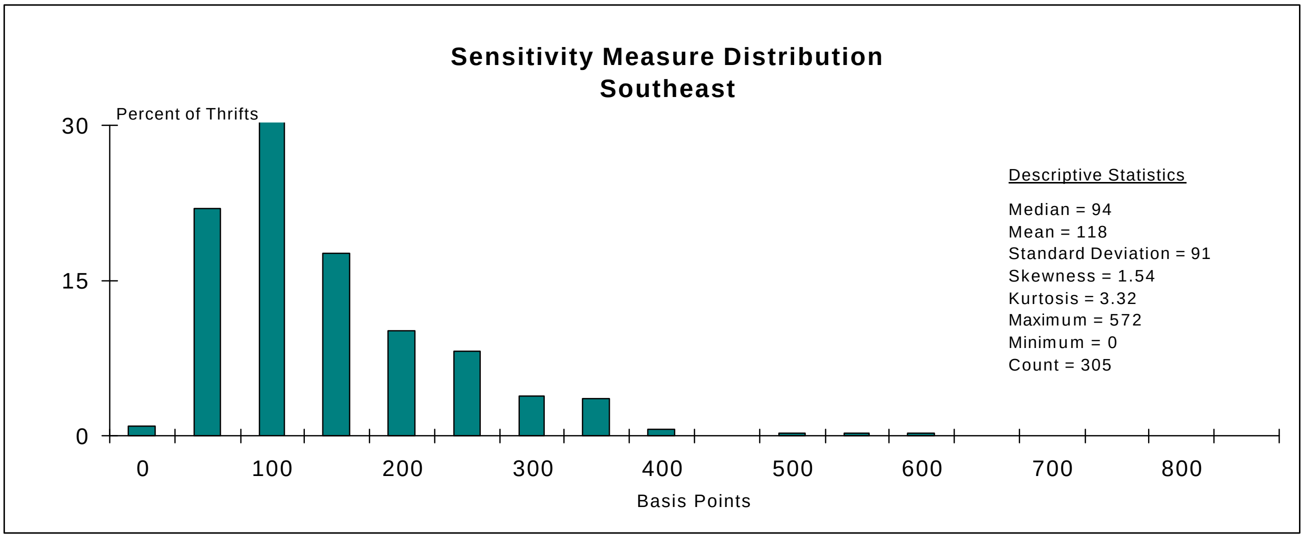


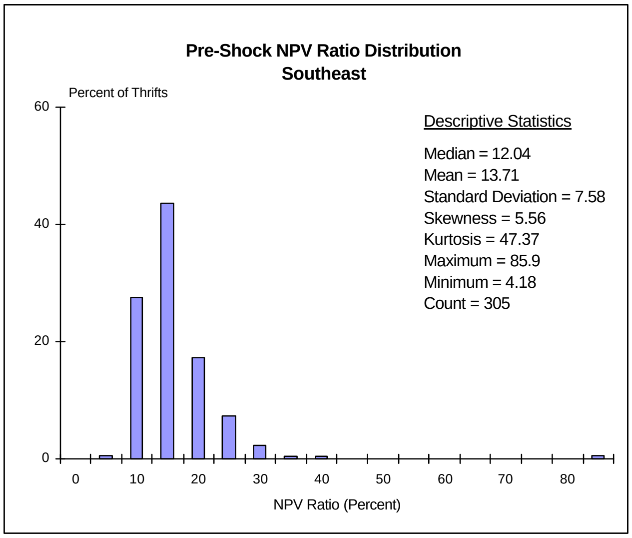


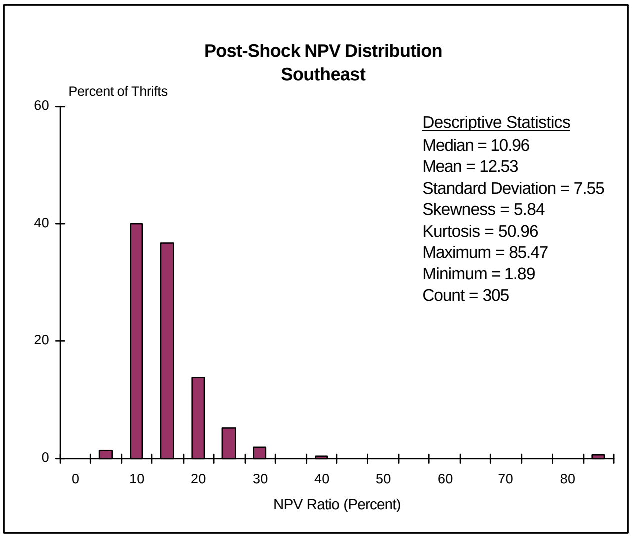


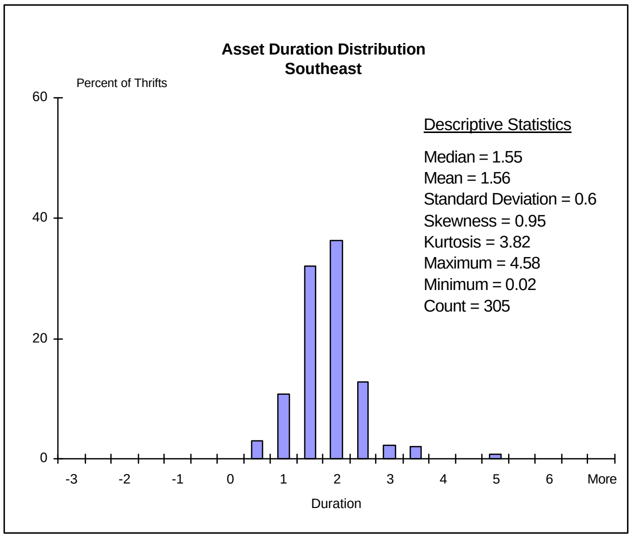


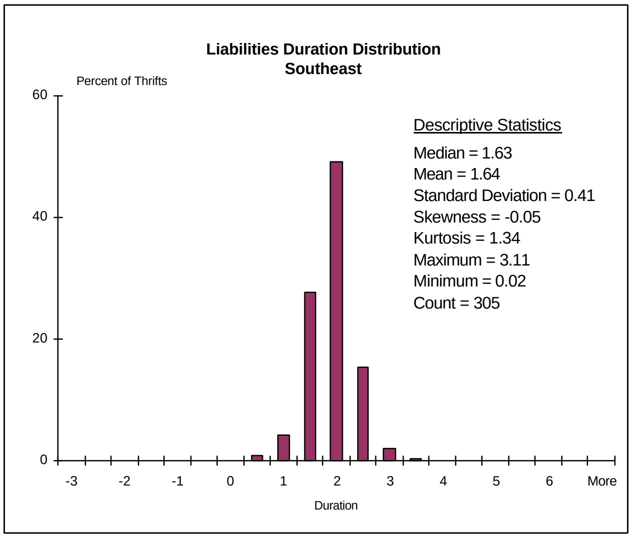
Appendix C — Southeast Region



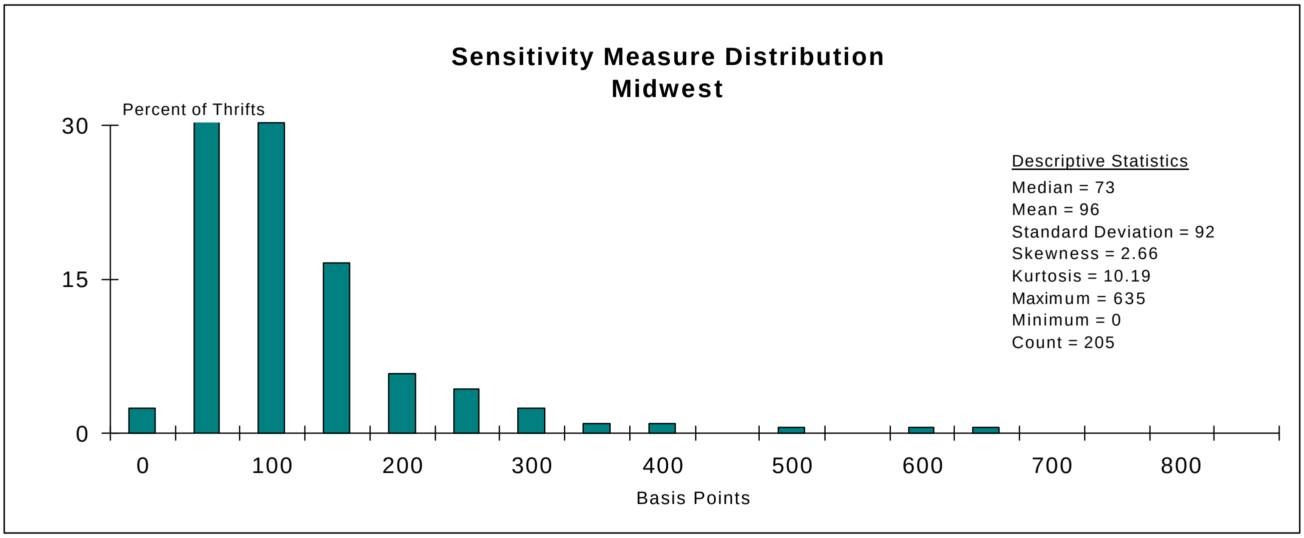


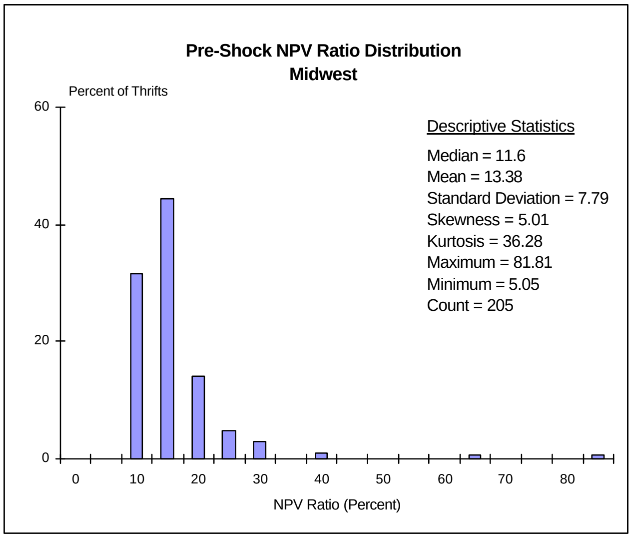


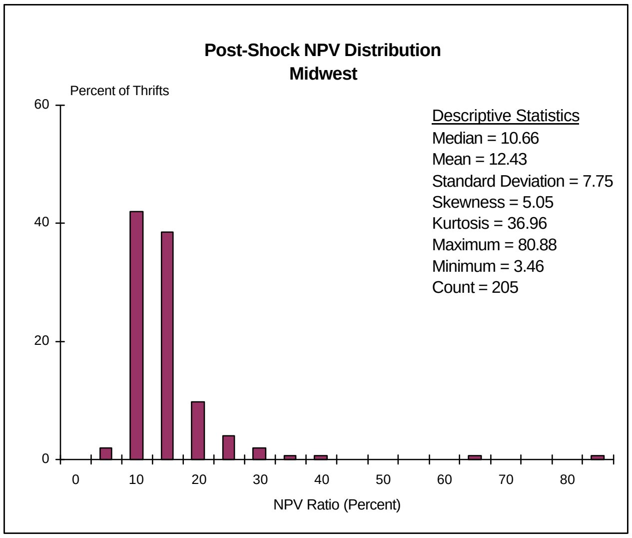


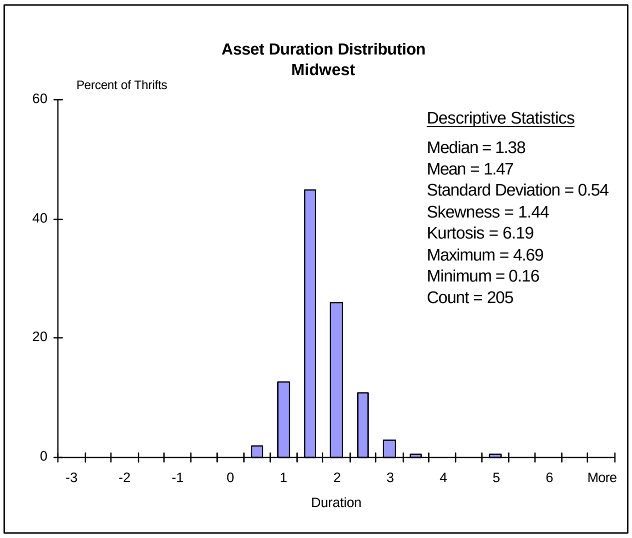


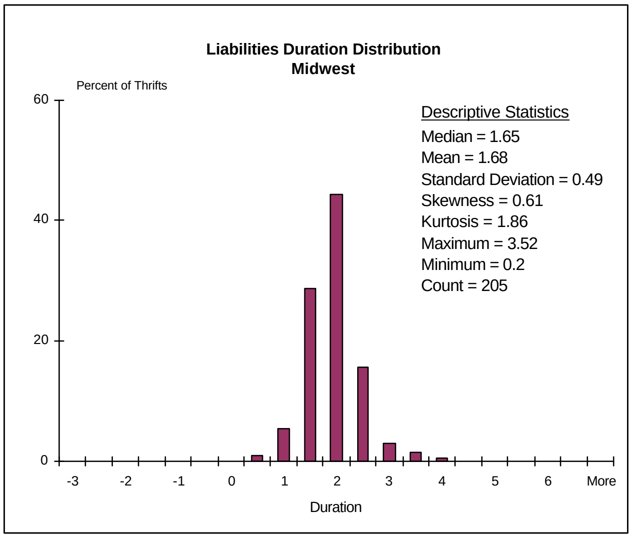
Appendix D — Midwest Region



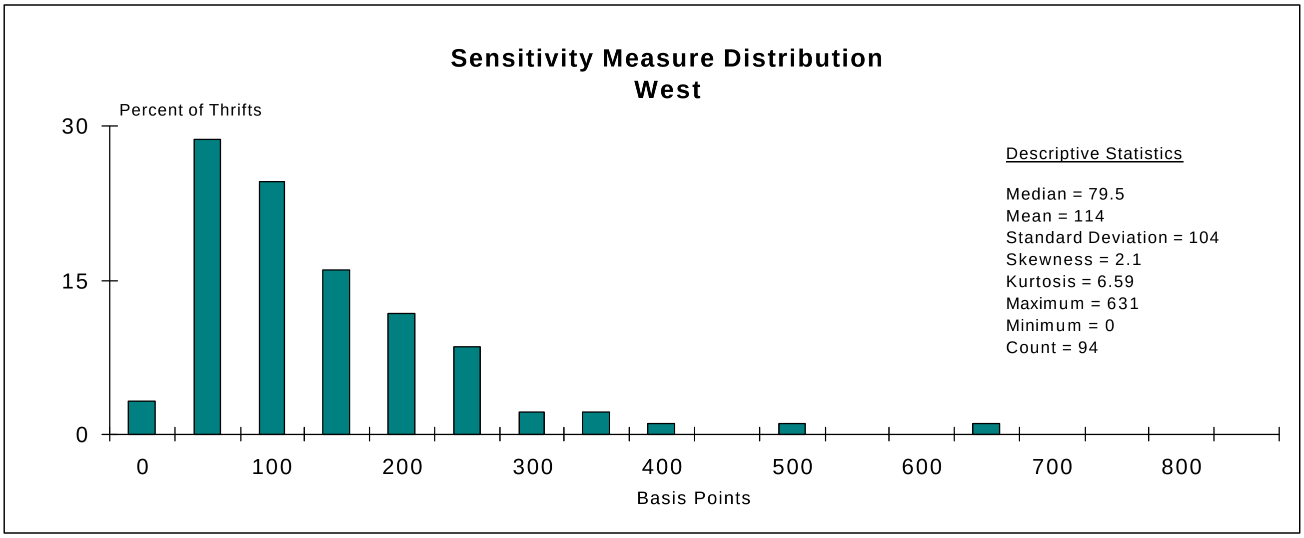


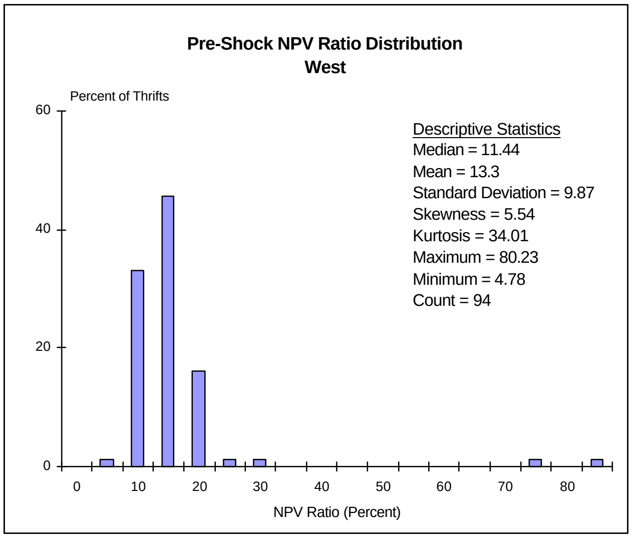


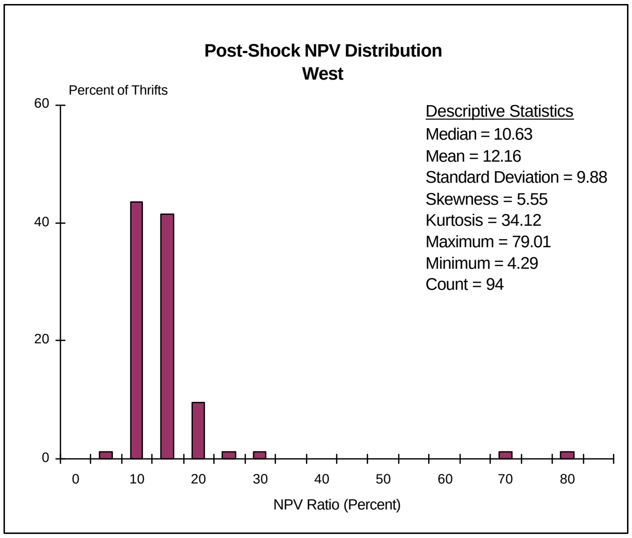


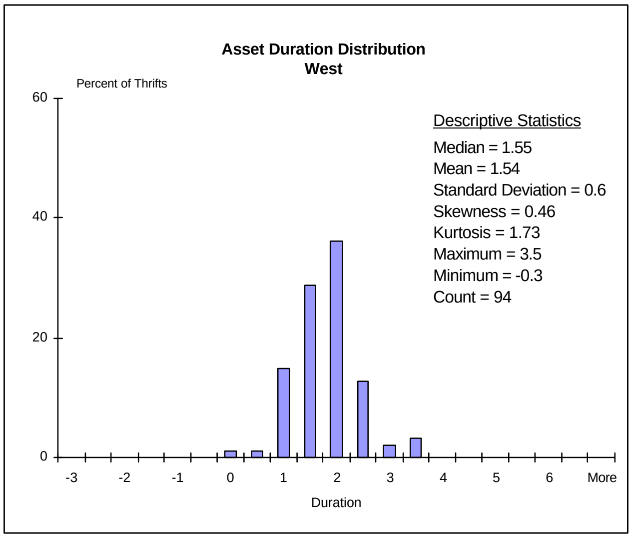


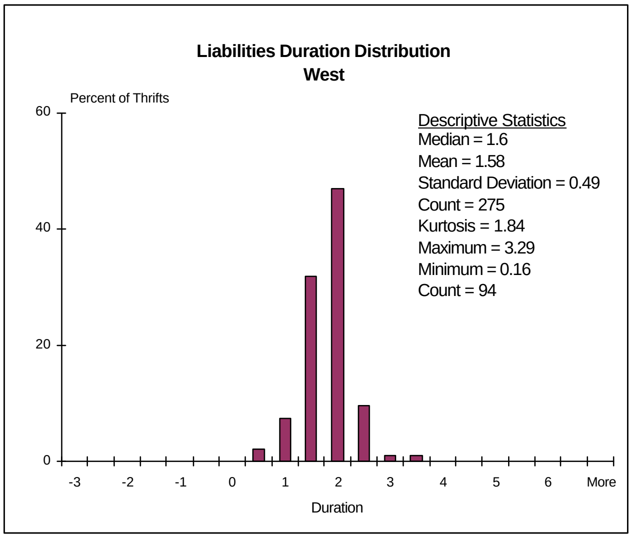
Appendix E — West Region











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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