Volume 10, Issue 1

First Quarter, 2005

The Quarterly Review of Interest Rate Risk

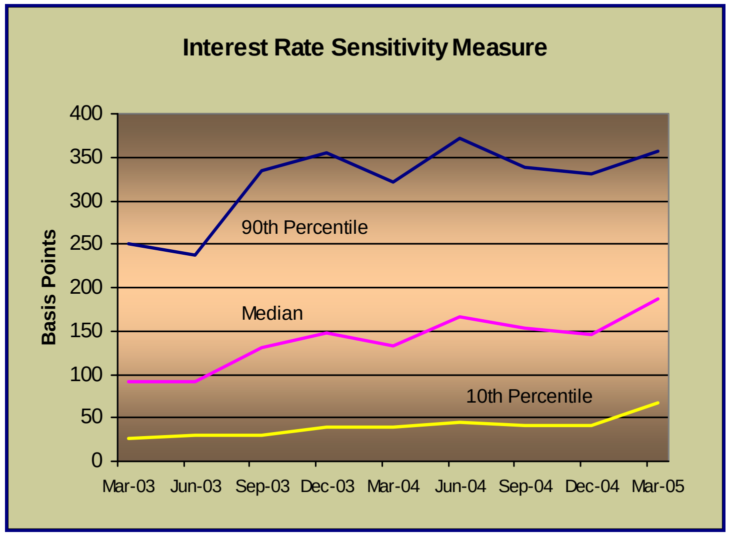
Office of Examinations, Supervision, and Consumer Protection
Risk Modeling and Analysis Division

Special points of interest:

- 30-yr mortgage commitment rate rises
- Treasury yield curve flattens in the first quarter
- First quarter median interest rate sensitivity rises
- Asset duration rises
- Comparative Regional Analysis
- Feature Article on Model Risk

Charts in this issue:

First Quarter Sees Substantial Rise in Sensitivity



First quarter median interest rate sensitivity rose sharply to 187 basis points, up from 145 basis points in the fourth quarter of last year. The increase in sensitivity was due to the change in interest rates in the first quarter that widened the duration gap between assets and liabilities for the industry.

Both the median pre-shock and post-shock Net PortfolioValue (NPV) ratios rose in the first quarter. However, the number of thrifts with post-shock NPV ratios below 4.0 percent remained unchanged at five institutions.

The Treasury yield curve continued to flatten in the first quarter. Between the fourth quarter of 2004 and the first quarter of this year, rates rose for all maturities except for those at the long end of the yield curve. The two-year yield rose by 72 basis points,

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Model Risk

What is model risk? Is it a risk that should concern today's banking institutions as they pursue business plans based on decisions made with computer models? Is it important for an institution to validate models that are used for valuation, hedging, economic capital allocation, and risk management purposes? If an institution ignores, or fails to have internal checks in place to both monitor and manage model risk effectively, can bad things happen?

One does not have to look too hard to find answers to these questions. Recently, a large banking institution has been in the headlines due to model risk. This institution specializes in, among other things, the origination and securitization of non-conforming, fixed-rate, single-family mortgage loans.

As part of its securitization program, this institution historically has retained floating-rate interest-only securities (IOs) whose value is based on the difference between the fixed-rate coupons of the pool of securitized mortgage loans and the three-month LIBOR rate.

The insitution's IOs do not trade in an active security market. As a result, their fair values must be estimated using a computer valuation model.

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Model Risk (continued)

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In theory, the value of the floating-rate IO strips is the present value of the excess spread between the weighted-average fixed coupon of the loans in the mortgage pool and the three-month LIBOR rate paid to investors over the expected life of the loans.

For several years, the insitution's reported IO valuations did not appear to be an issue. In early 2005, however, a flaw was discovered in its IO valuation model after consultations with several financial institutions and valuation experts. Specifically, the institution was incorrectly using a single point-in-time three-month LIBOR rate, instead of using the LIBOR forward curve, when projecting future cash flows for its floating-rate IO portfolio.

This simple mistake substantially overstated the value of the IOs, because in early 2005 investors in similar IO instruments were assuming that the three-month LIBOR rate would rise over time in a manner consistent with the LIBOR forward curve. The institution's modeling assumption that the three-month LIBOR rate would remain constant over the expected life of its floating-rate IOs was inconsistent with market convention and expectations.

As a result of this modeling error, the institution announced that it would have to restate its earnings for 2000 through 2004 to decrease the fair value of its floating-rate IO portfolio by $400 to $600 million.

What happened at the banking institution is a classic example of model risk, where an error was made in one of the valuation model's inputs. Because of this error, senior management at the bank and its shareholders had a dramatically wrong picture of the company's net worth and profitability.

The repercussions for the institution have been severe. Since January 18 of this year, when analysts and investors first became aware that its floating-rate IO strips were substantially overvalued, the firm's stock price has decreased 77 percent.

The losses incurred from the overvaluation of its floating-rate IO portfolio is just the most recent example of the potential risks inherent in using computer-based financial models that are improperly validated or tested. Model risk is an issue that financial institutions cannot afford to ignore given the potential for material losses. Also, the use by banking institutions of models that have not been validated or tested properly is a poor business practice that raises safety and soundness concerns for regulators.

In this article, we address the issue of model risk. Specifically, we examine the components of a typical model and discuss how model risk arises. We also discuss the importance of model risk mitigation and management, and argue that the most effective way for banking institutions to mitigate model risk is through effective model validation.

In this regard, we present the key model validation principles set forth by the Office of the Comptroller of the Currency (OCC) in OCC Bulletin, 2000-16, which addresses risk modeling and model validation.

Model validation increases the reliability of models and also promotes enhancements and a better grasp of the strengths and weaknesses of models among management and user groups.

Overview of Financial Risk Modeling

Financial instruments and the balance sheets of financial institutions have changed dramatically over the last 35 years. Prior to the development of option pricing models by Black and Scholes (1973) and Merton (1973), financial models were simple and relatively few in number.

Since that time, however, the interaction between financial innovation, model development, and advances in computer technology has dramatically increased both the number and sophistication of financial models. These models are typically used for valuation, hedging, risk management, and economic capital allocation.

One needs to look no farther than the banking industry to see how model advancements have shaped the managerial decision-making process. In the 1970s and 1980s, most banks managed their interest rate exposure using a simple gap approach.

In the 1990s, however, as computers became more powerful and less expensive, many banking institutions began using more sophisticated risk modeling techniques, such as duration analysis, net interest income simulation, and option-adjusted spread calculations based on Monte Carlo simulations, to manage their business.

If used properly, these more advanced

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Model Risk (continued)

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models can provide senior management with a better understanding of the risks associated with the options embedded in both on- and off-balance-sheet financial instruments. However, using these models incorrectly can have disastrous consequences.

Valuing mortgage servicing rights, mortgage derivatives, such as POs and IOs, and financial derivatives, such as caps, floors, and swaptions, with computer models can be a very complex process. Clearly, if a model is not fully understood by management, is inappropriately applied, or is incorrectly implemented, decisions made on the basis of its output may be wrong and business plans may fail as a result.

The Basics of Financial Models

A model is an abstract or mathematical representation of something in the real world. There are all kinds of models, ranging from simple, internally developed spreadsheet models in Excel, for example, to complex computer models developed internally in computer languages, such as C++, or by third-party software vendors, such as QRM or Bloomberg.

The types of financial models used by banking institutions typically fall into two major categories, business strategy models and risk management models. Business strategy models provide for income simulation, budgeting, economic value added (EVA) analysis, and profitability forecasting. Risk management models are often used for Asset-Liability Management (ALM), Value-at-Risk (VaR) estimation and credit scoring.

Regardless of what a model is designed to do, all models consist of three basic components: input, processing, and output. The input component consists of the raw data and assumptions that are entered into the model. The processing component consists of the computer code, logic, economic, financial, mathematical and statistical theories, and calculations that are used when the model is run. Finally, the output component consists of the results produced by the model that are used in decision making.

It is important to note that many large models, such as those used by financial institutions to measure and manage their interest rate risk, consist of several different (sub) models. For example, today's basic ALM model will consist of a mortgage prepayment model, an interest rate model, a Monte Carlo model, and a core deposit model, just to name a few.

Any model, whether internally developed or obtained from a third-party, has model risk inherent in its use. For example, the use of Bloomberg models to value a mortgage derivative, such as a CMO, involves model risk, just as a model developed internally for the same purpose does. However, the potential for model risk increases dramatically when using complex models that are themselves made up of models.

Typology of Model Risk

Model risk exposes financial institutions to the risk of incurring unexpected losses because the model's output fails to closely approximate or predict reality. Model risk can take many forms.

It can occur, for example, when an incorrect model is used or a correct model is misspecified. This type of model risk is frequently encountered when models are used to price new complex financial derivatives with unique features that make them path dependent, or dependent on more than one source of risk.

Errors in model implementation, in model calibration, and data entry, or wrong assumptions can also cause model risk. Model risk associated with problems in model calibration, for example, can arise if outliers in the raw data are ignored in estimating a model's parameters.

Finally, model risk can occur when a correct model is misapplied. For example, if a model is estimated and calibrated using raw data that are associated with normal market conditions, the model's predictions can be dramatically wrong if the model is used to price an instrument in a highly volatile market.

Model risk may also arise from something as simple as poor communication in an institution. For example, the lack of well-designed reports that convey important model results to management in an easily understood format can lead to model risk, because incorrect decisions could be made in implementing business plans.

Poor communication exists between different divisions of a company can also create model risk. Accounting and risk management divisions in a banking institution could be valuing the same financial instrument with the same valuation model, but with different assump-

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Model Risk (continued)

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tions.

In using any model, it is important for users to understand the model's technical limitations and to communicate these to management. In order to appreciate what a model can be used for, it is important to know what it cannot be used for.

In and of itself, the existence of model limitations is not really a problem. It only becomes a problem that can lead to model risk when the limitations are not fully grasped and lead to bad decisions.

Mitigation of Model Risk

The best way to mitigate and manage model risk is through effective model validation. The OCC Bulletin 2000-16 highlights three generic procedures that should be applied by a financial institution when validating a model. These procedures are: (1) independent review of the logical and conceptual soundness of the model, (2) comparison of the model's results against the results produced by other models that are used as benchmarks, and (3) comparison of the model's predictions against actual or observed outcomes in the real world. Ideally, these three procedures should be applied to each of the three components that make up a model, that is, the input, processing, and output components.

In order to ensure that model validation and testing is effective, a financial institution should have formal model validation policies. In addition, model validation efforts specified in the policies should be consistent with management's assessment of the proper trade-off between the costs and benefits of model validation.

Elements of Effective Model Validation Policy

The OCC bulletin describes five elements that should make up an institution's formal validation policy. These elements are: (i) independent model review, (ii) defined responsibility, (iii) model documentation, (iv) ongoing model validation, and (v) audit oversight.

Independent Model Review

Model validation should be done by personnel that are as independent as possible from those who developed the model.

At large banking institutions, independent review is often available internally, and can be complemented by external reviewers or internal audit. At smaller institutions, the validation policy should provide for as independent a review as feasible.

When comprehensive independence is not feasible, the validation policy should explicitly provide for effective communication between modelers and decision makers. Moreover, model builders have the responsibility to provide clear and informative descriptions of modeling assumptions and model limitations to senior management.

Defined Responsibility

Model validation responsibility should be formalized and defined just as is the responsibility for model development.

At large banking institutions, policies should specify that, before a model can enter production, (a) the independent model validation unit or external reviewer must document the model validation tests and reasons for concluding the model is valid, and (b) internal audit must verify that no models enter production without formal approval by the validation unit.

At smaller institutions that lack the resources for effective independent review, the validation policy should explicitly require senior management to formally approve all models that are used for pricing or to set risk limits.

Management should approve the conceptual approach and the key assumptions used in such models, and verify that reasonable quality control has been met.

Model Documentation

Model documentation creates a corporate memory when key modeling personnel leave a banking institution. At the corporate level, a catalogue of all models and their applications should be maintained.

Validation policy should also require documentation for specific models that is adequate to facilitate independent review, training of new staff, and clear thinking by the model developer.

The most rigorous validation policies should require documentation that is detailed enough to precisely reproduce the model under review. At a minimum, model documentation should provide summary overviews of the general procedures used and the reasons for choosing those procedures, describe model applications and limitations, identify key personnel and milestone dates in model construction, and

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Model Risk (continued)

(Continued from page 4)
describe validation procedures and results.

Ongoing Model Validation

Most models are frequently changed after going into production in response to changes in the environment or to incorporate improvements in modelers' understanding of what the model is designed to do. Best practices for validation policies require that all changes in the modeling process be documented and submitted for independent review. Model changes should generally be allowed only periodically, and only after independent review and approval by management at the appropriate level in the banking institution.

It is useful for an institution to store multiple copies of model code to facilitate disaster recovery, as well as to monitor assumption changes. Models should be subjected to change-control procedures, so that only approved personnel can make changes to the model code.

Audit Oversight

While large banking institutions may have model validation units with internal audit departments, model validation is frequently outside the scope of audit responsibilities. Nevertheless, the formal validation policy should specify explicitly that internal audit is responsible for ensuring that the model validation and model-validation units adhere to the formal policy.

Conclusion

Financial models are useful in measuring and managing interest rate risk, credit risk, and operational risk, to name just a few of the risks that confront today's banking institutions. However, the growing use and complexity of financial models for valuation, hedging, and risk management increases the potential for model error and model risk.

Model risk occurs because a model's data or assumption inputs, its processes, its outputs, and the interpretation of its output may be flawed in some way.

Mitigating and managing this risk through implementation of a comprehensive system of effective controls is essential to ensure management and the board have reliable information to adjust business plans and strategies as market conditions change.■

First Quarter Sees Substantial Rise in Sensitivity (continued)

(Continued from page 1)
while the 30-year yield fell by 7 basis points.

Evidence of a flatter yield curve is provided by the difference between the two-year and 10-year yields. In December 2004, the difference was 115 basis points. At the end of March 2005, this difference fell to 70 basis points.

The flatter yield curve put downward pressure on the net interest margins of savings institutions. Average net interest margin fell by three basis points to 287 basis points in the first quarter, down from 290 basis points in the prior quarter.

This slight fall in margins was due to a larger quarterly increase in interest expense (15 basis points) relative to the quarterly increase in interest income (13 basis points).

Between December 2004 and March 2005, thrifts increased their portfolio holdings of single-family adjustable-rate mortgages (and mortgage-backed securities (MBS)) from $453.7 billion to $470.9 billion. In percentage terms, thrifts held 65.7 percent of their single-family mortgages in ARMs at the end of March 2005 compared to 64.8 percent at the end of December 2004.

There was also a change in the portfolio mix of adjustable-rate mortgages. Between December 2004 and March 2005, thrift portfolio holdings of non-teaser, lagging index ARMs with a reset frequency of one-month rose 7.5 percent.

Over the same period, thrift portfolio holdings of non-teaser Treasury ARMs with reset frequencies of six months or less and between seven months and two years rose 12.9 percent and 4.5 percent, respectively.

The liabilities side of the balance sheet for thrifts witnessed some changes between the first quarter and the previous quarter. Total variable-rate borrowings rose from $165.8 billion to $186.1 billion. Over the same period, brokered deposits with an original maturity of 12 months or less rose from $26.5 billion to $31.7 billion.

Total thrift industry earnings reached a new record level in the first quarter. Net income rose to $4.0 billion, up from $3.76 billion in the fourth quarter.

Consistent with the rise in earnings, thrift profitability also rose from the previous quarter. The average

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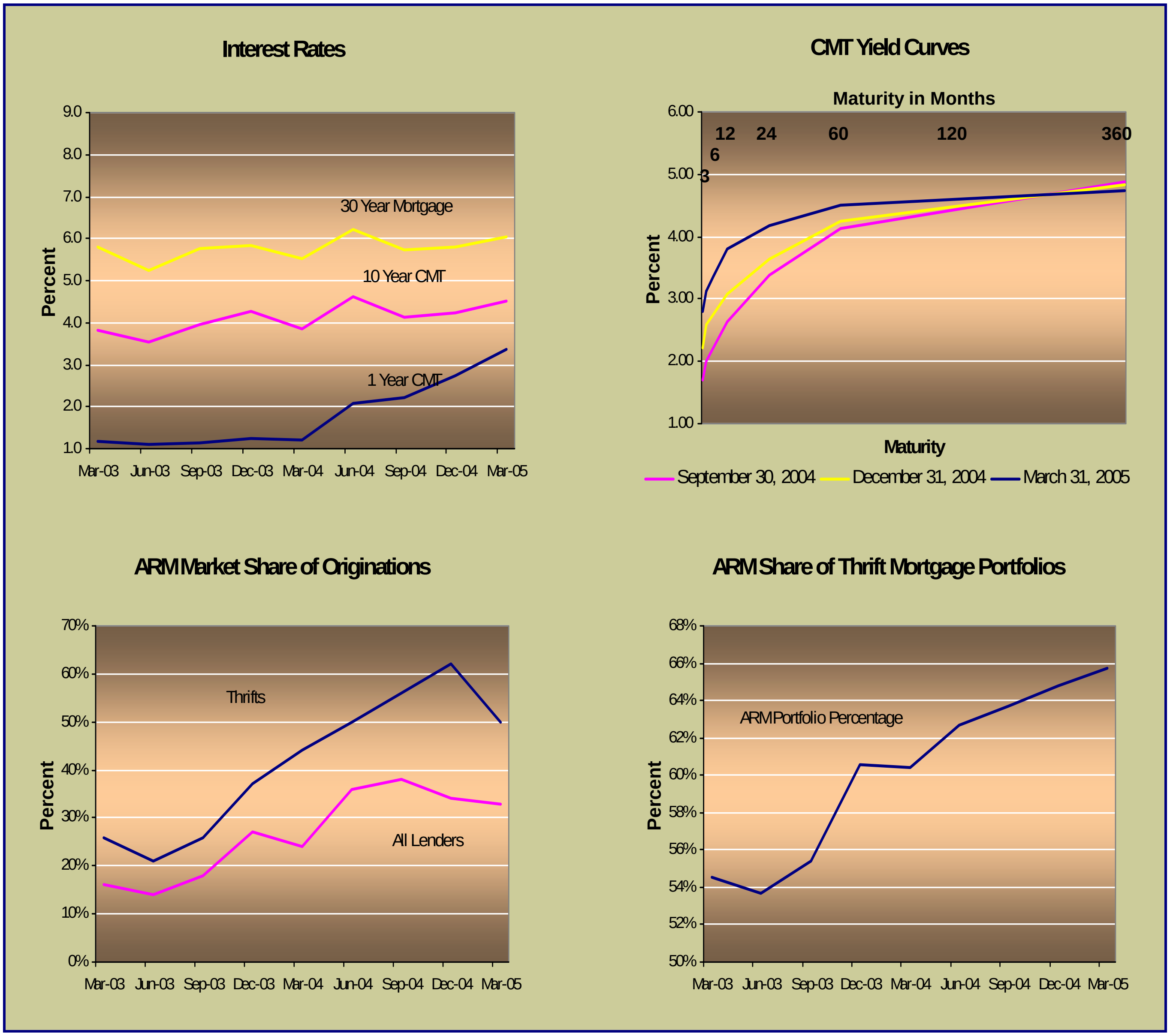
Interest Rates and ARM Market Share



First Quarter Sees Substantial Rise in Sensitivity (continued)

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return on assets (ROA) for the industry rose to 1.22 percent in the fourth quarter, up from 1.17 percent in the fourth quarter. The first quarter improvement in ROA was due to lower loan loss provisions and noninterest expense, and higher mortgage loan servicing fee income.

The 30-year mortgage rate, as measured by the contract interest rate on Freddie Mac commitments for fixed-rate 30-year mortgages, rose to 6.04 percent at the end of the first quarter, up from 5.81 percent from the prior quarter. As a result of the increase in longer-term interest rates in the first quarter, the volume of mortgage refinancing fell.

First-quarter 1-4 family mortgage originations by thrifts fell to $141.1 billion, down from $154.1 billion in the fourth quarter. Total mortgage originations by thrifts in the first quarter were $160.4 billion, down from $176.6 billion in the fourth quarter. The first quarter saw the ARM share of total thrift mortgage originations fall to 50 percent, down from 62 percent in the prior quarter.

Mortgage refinancing activity accounted for 37.2 percent of thrift originations of single-family mortgages in the first quarter, up from 35.8 percent in the previous quarter. This increase is consistent with the mortgage refinancing activity of all lenders, where the proportion rose to 46 per-

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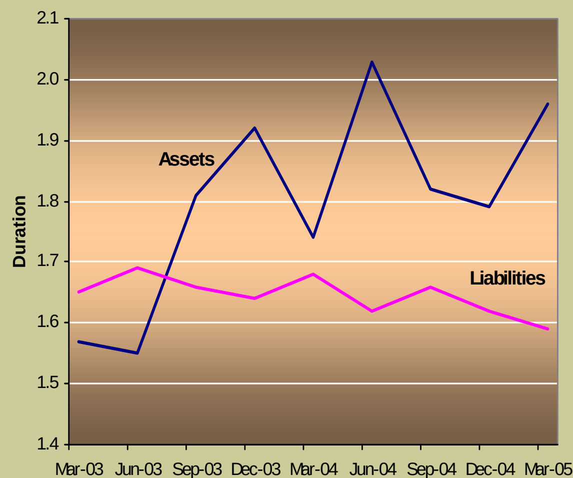
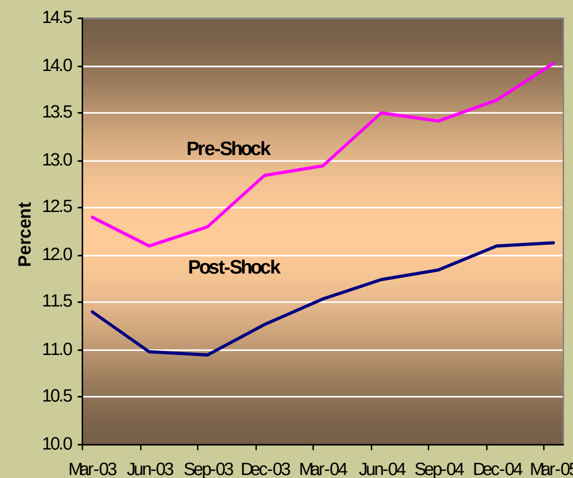
Duration and NPV Sensitivity Measures

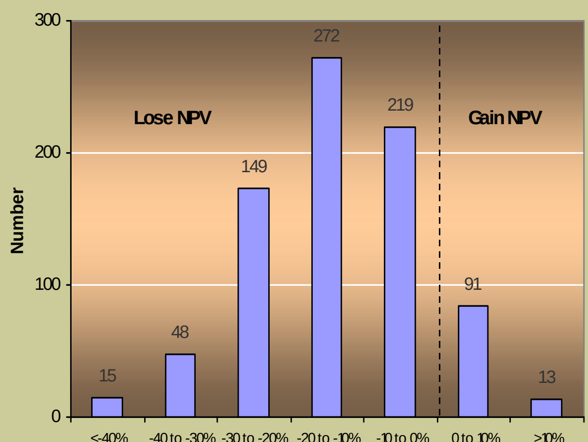
Median Effective Duration



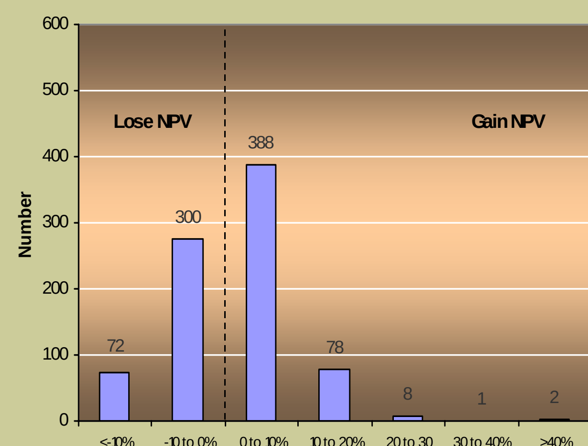
Median Pre- and Post-Shock NPV Ratios



Estimated Change in NPV:
+200bp Rate Change



Estimated Change in NPV:
-200bp Rate Change



First Quarter Sees Substantial Rise in Sensitivity (continued)

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cent from 42 percent.

The industry's median effective duration of assets rose from 1.82 to 1.96 between December 2004 and March 2005. With the increase in interest rates during the first quarter, the rate of mortgage prepayments fell. As a result of the fall in prepayments, the durations of both mortgages and total assets rose.

The industry's median effective duration of liabilities fell from 1.62 to 1.59 in the first quarter.

The median pre-shock NPV ratio for the industry rose to 14.0 percent in the first quarter, up from 13.6 percent in the prior quarter. The median post-shock NPV ratio rose slightly, moving from 12.09 percent in the previous quarter to 12.13 percent in the first quarter. The number of thrifts with a post-shock NPV ratio below 4 percent remained unchanged at five institutions.

For the thrifts filing Schedule CMR in the first quarter, a 200 basis point increase in interest rates would cause the industry's net portfolio value to fall by 15 percent or $23.9 billion. In con-

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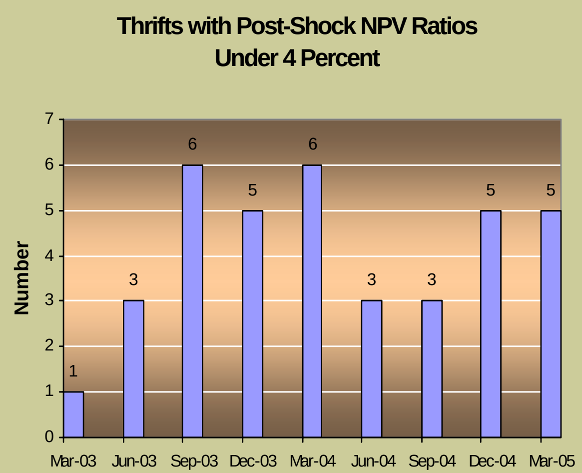
Interest Rate Risk Measures



Interest Rate Risk Measures
Industry Aggregates
Last Two Quarters

	NPV as % of PV of Assets		% Change in NPV	% Change in NPV
	Dec-04	Mar-05	Dec-04	Mar-05
+300	8.48%	9.11%	-28%	-25%
+200	9.70%	10.13%	-16%	-15%
+100	10.67%	10.98%	-7%	-7%
Base	11.29%	11.60%	0%	0%
-100	11.35%	11.80%	1%	2%
-200	N/A	11.43	N/A	-1%
-300	N/A	N/A	N/A	N/A

Post-Shock NPV Ratio and
Sensitivity Measure Matrix
December 2004

	Under 100bp	101-200bp	201-400bp	Over 400bp	Total
Over 10%	240	172	173	22	607
6% to 10%	66	52	74	9	201
4% to 6%	0	0	11	0	11
Below 4%	1	1	1	2	5
Total	307	225	259	33	824

Minimal Moderate Significant High

Post-Shock NPV Ratio and
Sensitivity Measure Matrix
March 2005

	Under 100bp	101-200bp	201-400bp	Over 400bp	Total
Over 10%	150	215	211	36	612
6% to 10%	29	61	94	9	193
4% to 6%	0	1	11	2	14
Below 4%	0	1	2	2	5
Total	179	278	318	49	824

Minimal Moderate Significant High

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trast, a 200 basis point decrease in interest rates would cause the industry's net portfolio value to fall by 1 percent or $797 million.

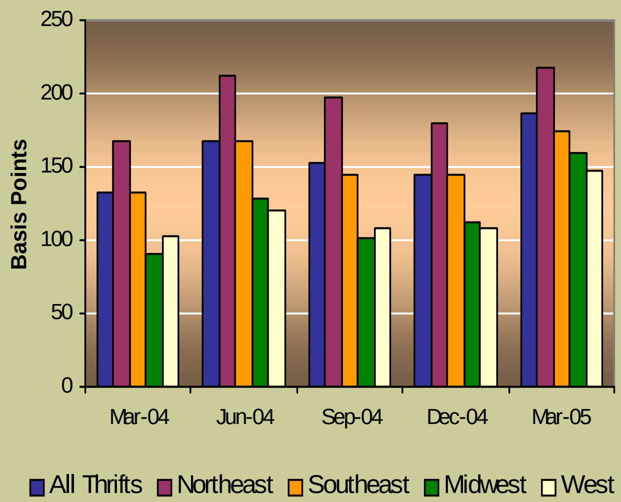
The percentage of thrifts with a post-shock NPV ratio over 6 percent fell in the first quarter. In the first quarter, these thrifts made up 97.7 percent of the industry, compared to 98.1 percent in the previous quarter.

The number of thrifts with a post-shock NPV ratio below 6 percent rose to19 institutions in the first quarter, down from 16 in the prior quarter.

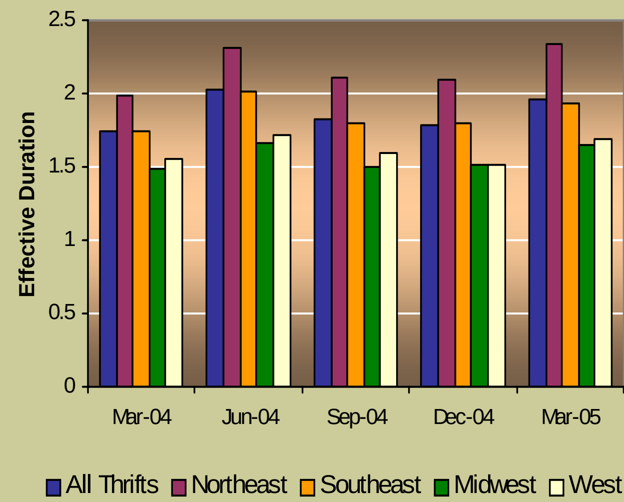
The percentage of thrifts with interest rate sensitivity of 200 basis points or less decreased in the first quarter, falling to 55.5 percent from 64.6 percent in the prior quarter. Finally, the percentage of thrifts with over 400 basis points in interest rate sensitivity rose to 5.9 percent in the first quarter from 4 percent in the prior quarter.■

Comparative Trends in the Four OTS Regions

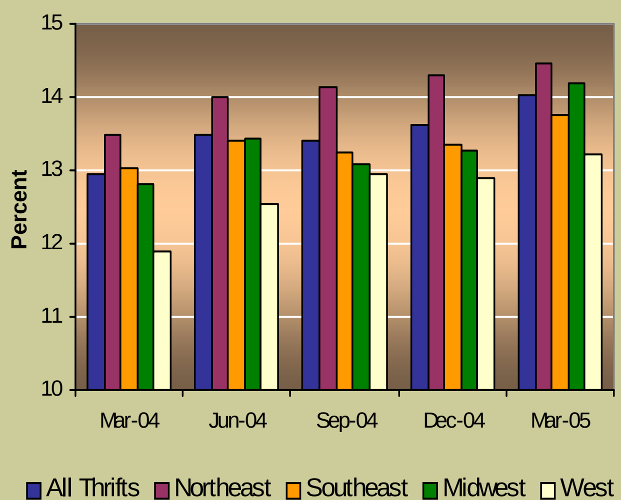
Median Sensitivity by OTS Region



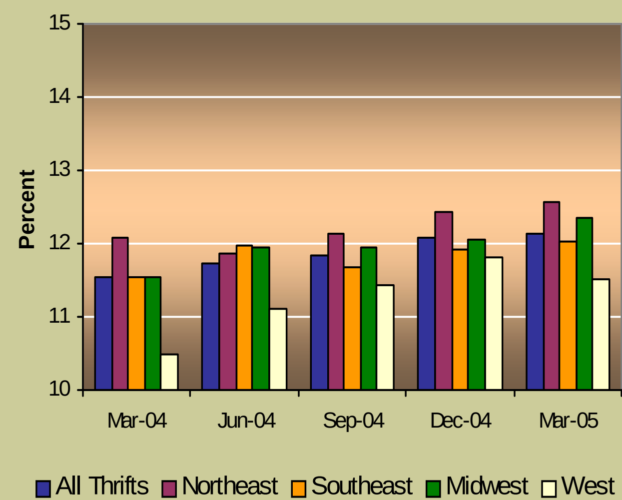
Median Assets Duration by OTS Region



Median Pre-Shock NPV Ratio by OTS Region



Median Post-Shock NPV Ratio by OTS Region



Regional Comparisons

The Northeast Region had the highest median sensitivity, at 218 basis points at the end of the first quarter, while the West Region had the lowest median sensitivity, at 147 basis points.

All OTS regions saw their median sensitivities increase in the first quarter. The Northeast, Southeast, Midwest, and West Regions saw their median sensitivities go up by 15.6 percent, 20.8 percent, 42.9 percent, and 36.1 percent, respectively.

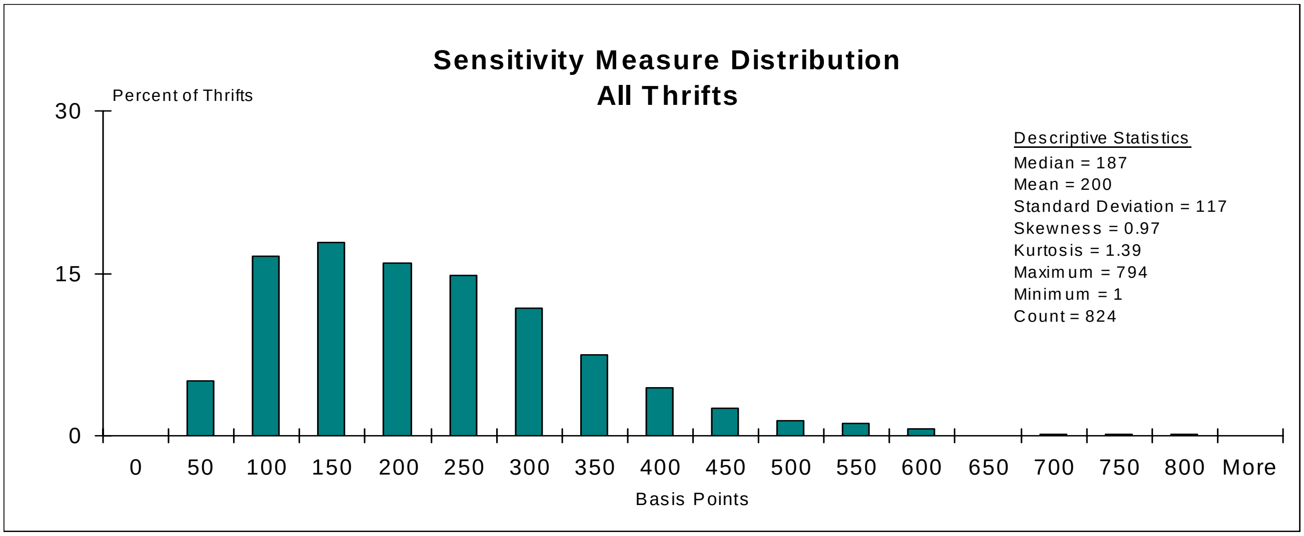
The Northeast Region had the highest median asset duration, at 2.34 at the end of the first quarter. The Southeast, Midwest, and West Regions had median asset durations of 1.93, 1.65, and 1.69, respectively.

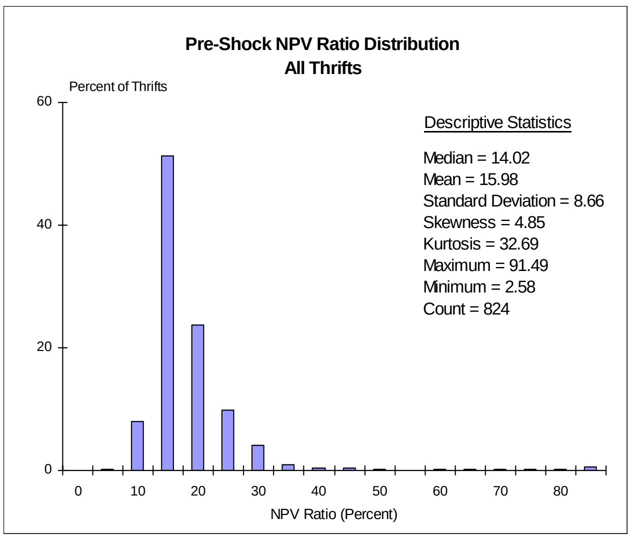
For the first quarter, the Northeast Region had the highest pre-shock NPV ratio at 14.5 percent, while the West Region had the lowest pre-shock NPV ratio at 13.2 percent.

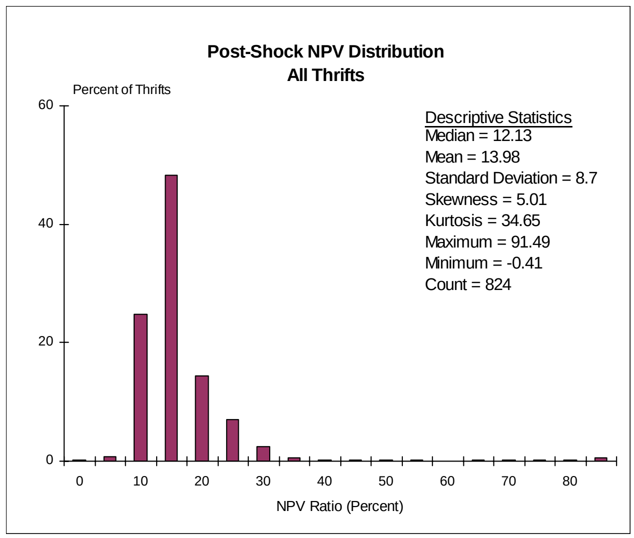
The Northeast, Southeast, and Midwest Regions saw their median post-shock NPV ratios increase, while the West Region experienced a decrease in its median post-shock NPV ratio.

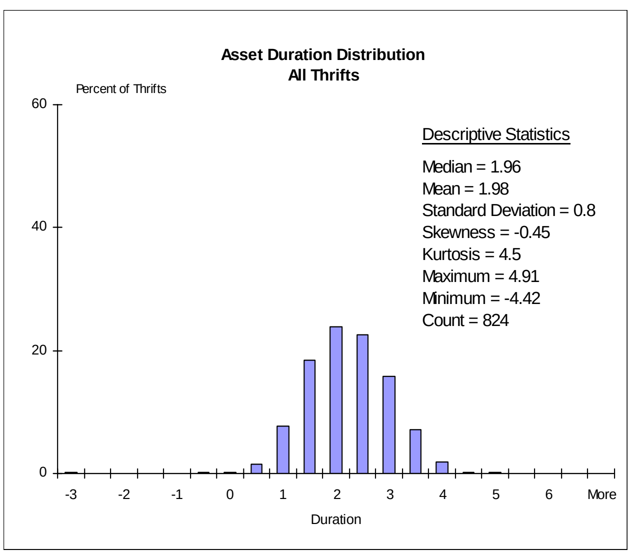
Finally, the median liability duration for the Northeast, Midwest, and West Regions fell, while the median liability duration stayed the same for the Southeast Region in the first quarter.■

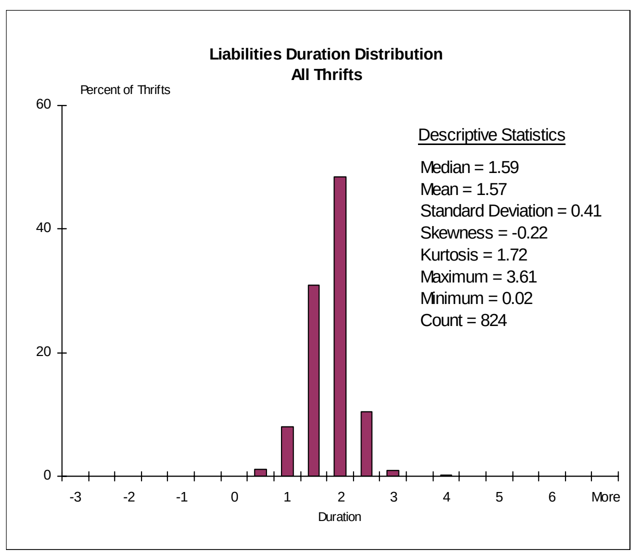
Appendix A — All Thrifts



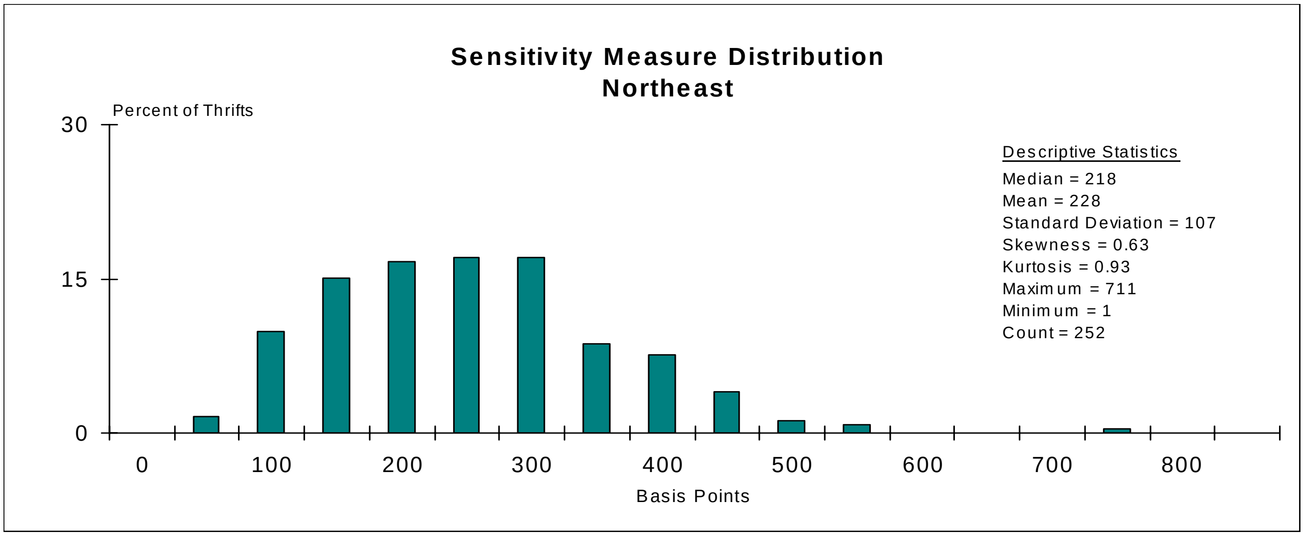


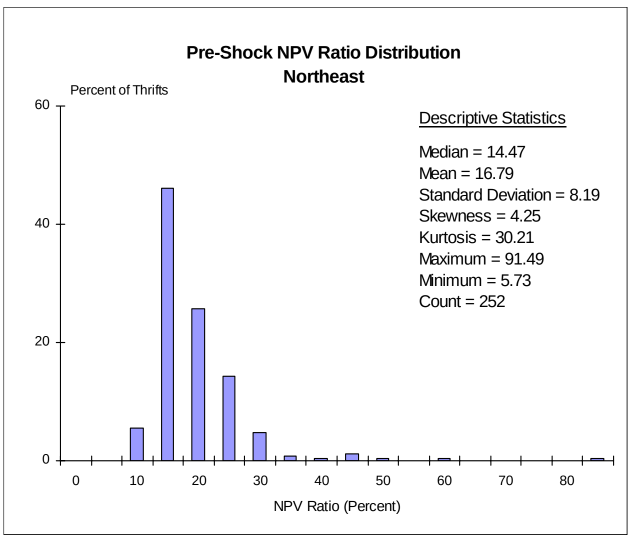


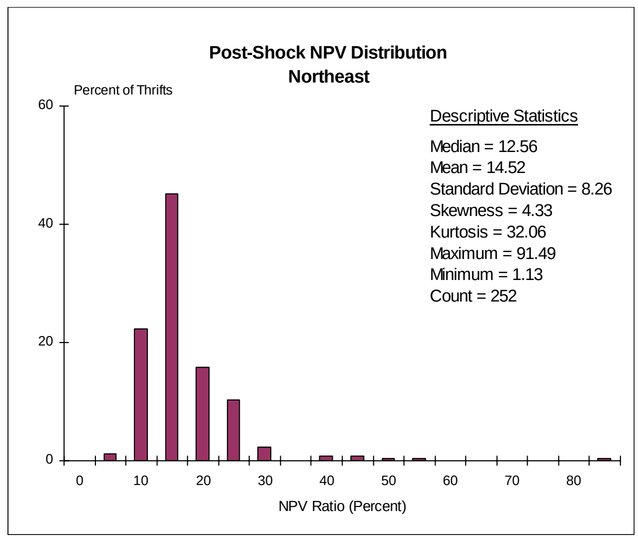


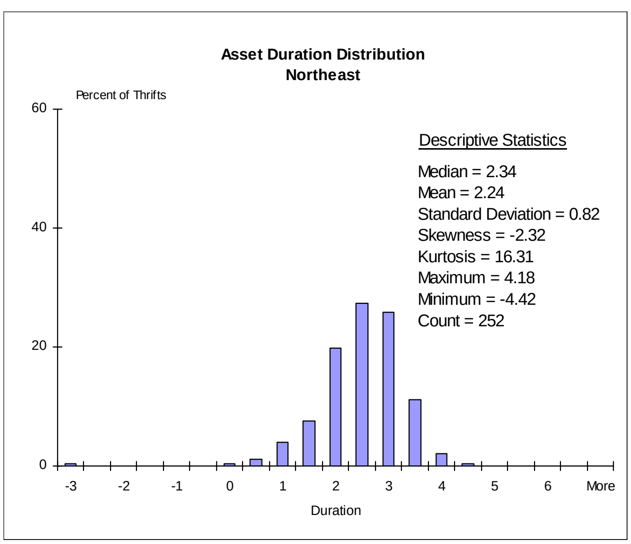


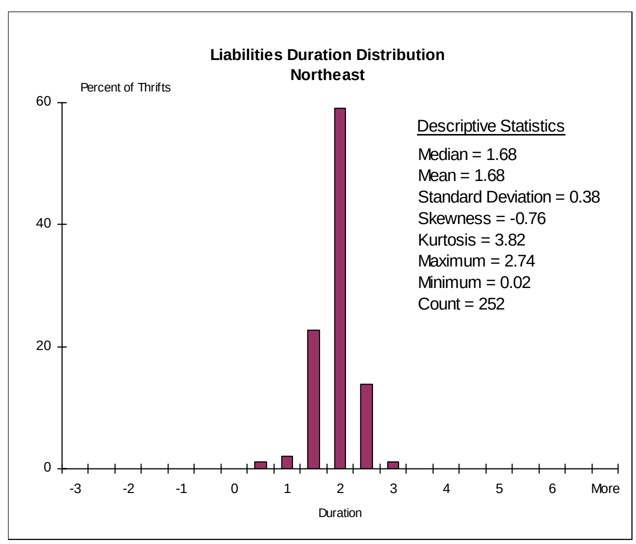
Appendix B — Northeast Region



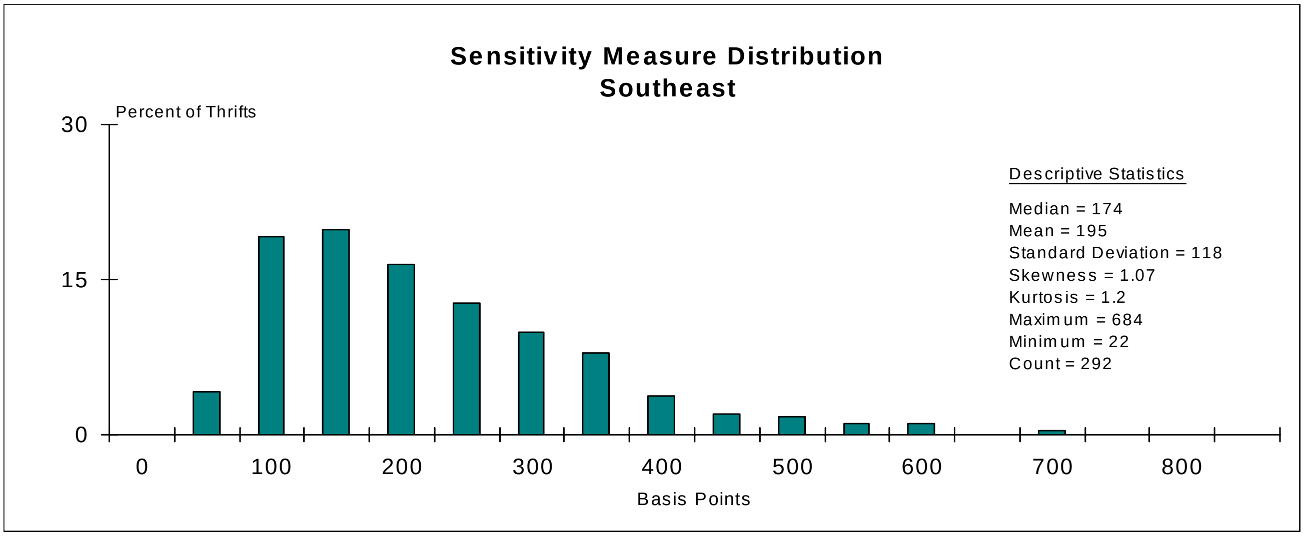


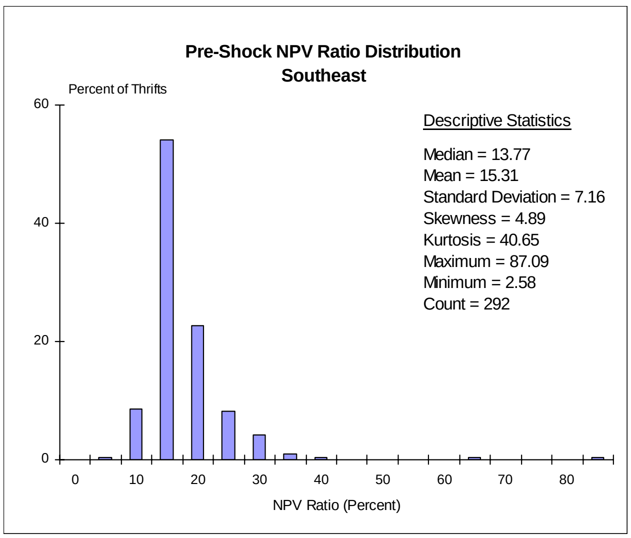


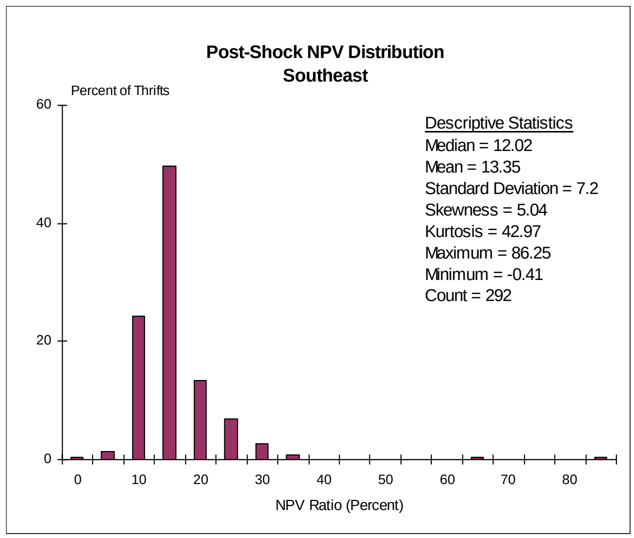


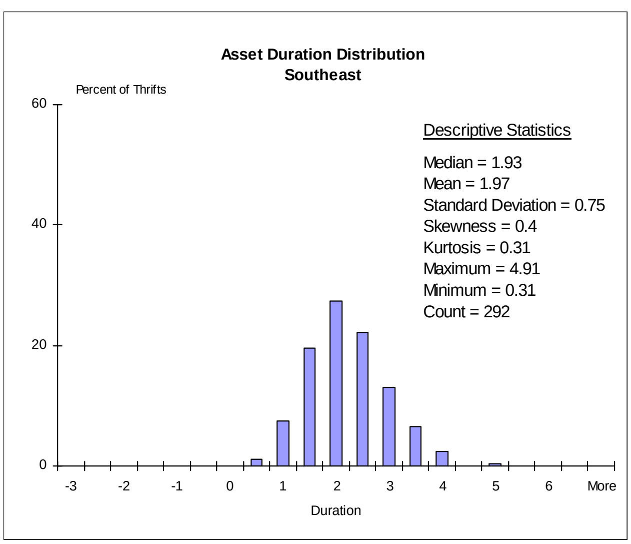


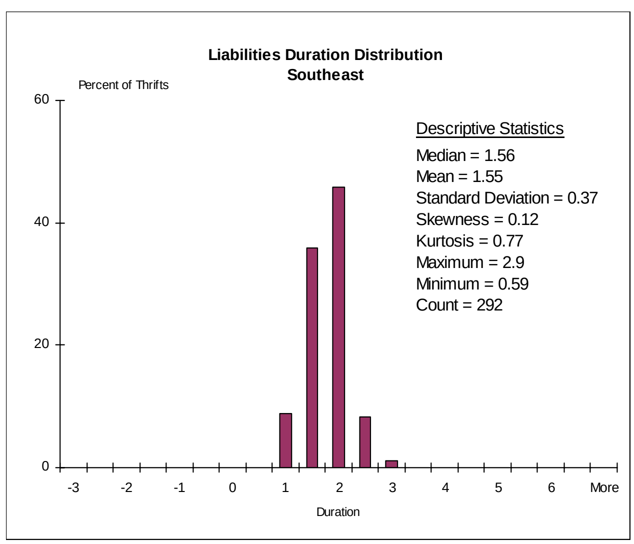
Appendix C — Southeast Region



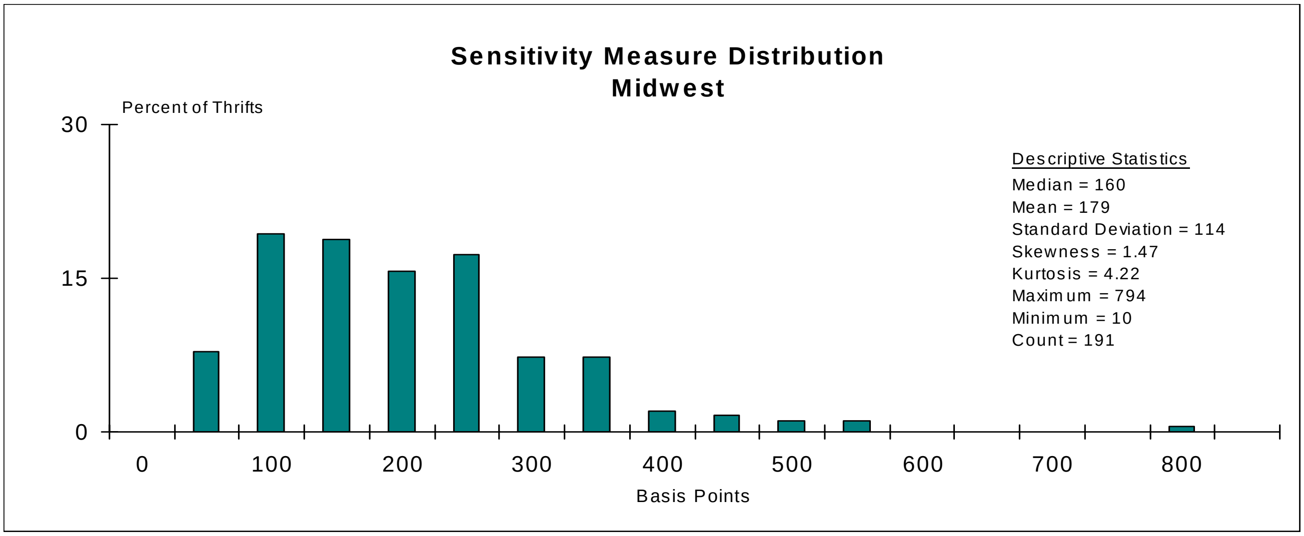


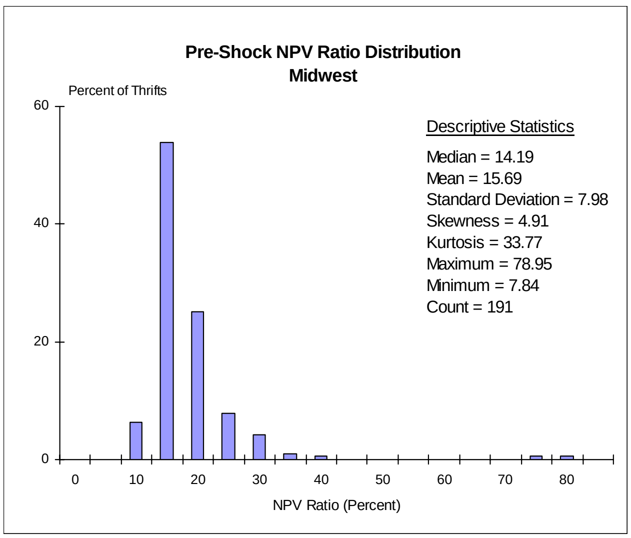


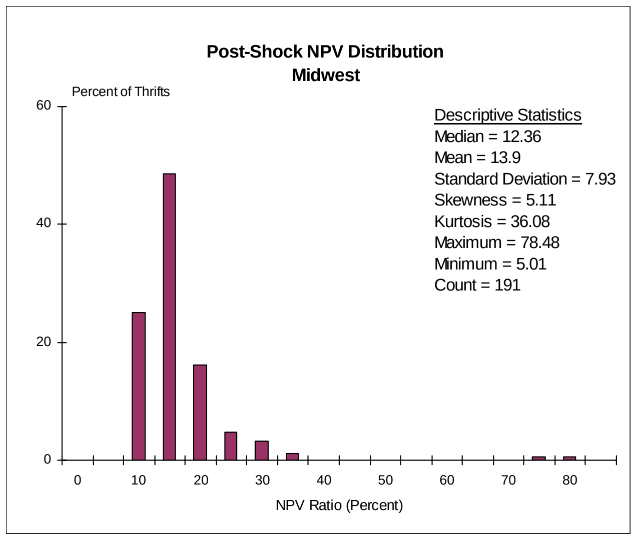


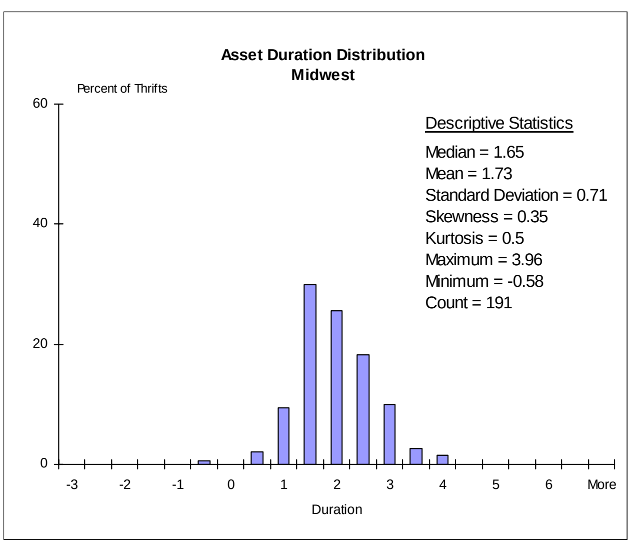


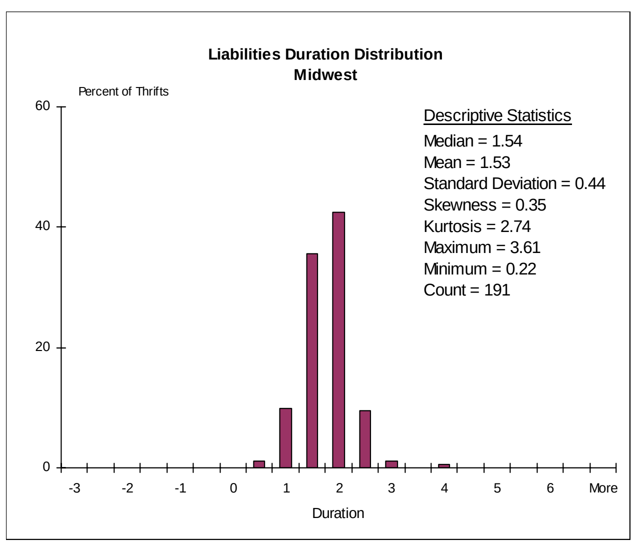
Appendix D — Midwest Region



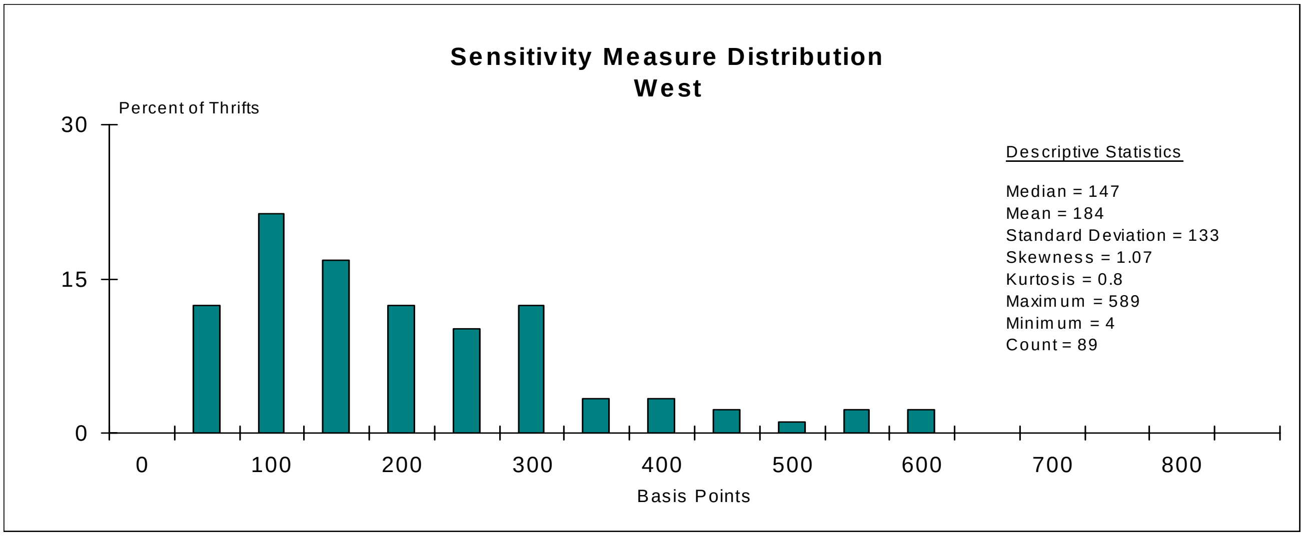


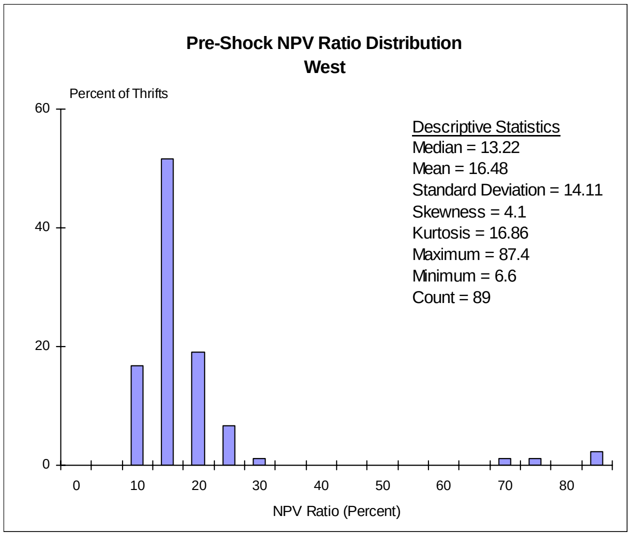


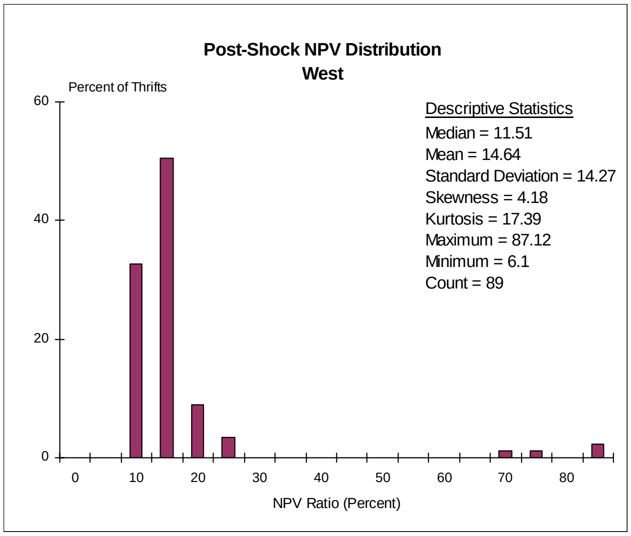


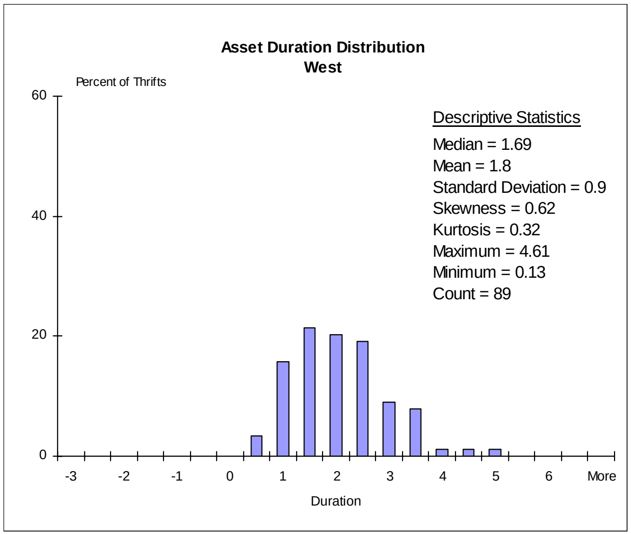


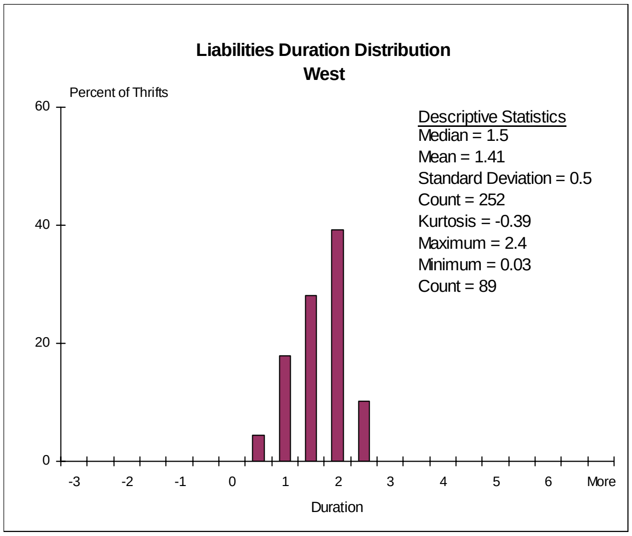
Appendix E — West Region











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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