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What's a Moderately Adverse Interest Rate Scenario, Anyway?

By Mark Alberts

Here's a conversation starter for your next Society of Actuaries (SOA) meeting reception. How often has a 3 percent pop-up[1] in interest rates occurred? How about a 3 percent pop-down? The U.S. valuation and cash flow testing actuaries among us certainly recognize the 3 percent pop-up and pop-down as scenarios #4 and #7 of the New York 7 scenario set (NY7), the most common measure of moderately adverse interest rate conditions for U.S. life companies' cash flow testing. Not surprisingly, as shown in Table 1, the answer is different for short rates and long rates, and also for a pop-up and a pop-down.

Table 1
Interest Rate Pop-Up/Pop-Down Occurrence

Tenor	Data Period	Trading Days	# of Pop-Downs > 2.75%	# of Pop-Ups> 2.75%
90-day	1962-current	~12,000	185	119
20-30-year	1954-current	~15,600	13	0

For short rates, 3 percent pops are rare, with approximately 1 percent frequency for both the pop-up and pop-down. For long rates, excepting a three-week period in mid-1982, they are unheard of.

What does this factoid tell us about moderately adverse conditions for asset adequacy analysis? On its own, perhaps not much. But at a time when asset adequacy margins are squeezed by the ongoing low interest rate environment, appointed actuaries increasingly question the relevance of the NY7, and median stochastic scenario paths increasingly resemble a best-case rather than a best-estimate, this question has become an important one. The appointed actuary must opine on whether the assets backing reserves are adequate under moderately adverse conditions, but has little in the actuarial literature to help him or her evaluate what interest rate conditions are moderately adverse.

Recognizing this gap, the Financial Reporting Section and Smaller Insurance Company Section of the Society of Actuaries have released a new research report, *Modern Deterministic Scenarios for Interest Rates*[2], which attempts to develop a framework for evaluating moderately adverse conditions for interest rates and, further, develops a new set of interest rate scenarios intended to capture moderately adverse conditions for a range of initial interest rate conditions. The methodology and results contribute to the actuarial literature in several ways. First, the report's empirical conditional tail expectation (CTE) analysis methodology provides a way to measure moderately adverse conditions for interest rates that is fundamentally consistent with the CTE70 stochastic standard used in VM-20 and VM-21. Second, we constructed interest rate series for the analysis that go back as far as 1729, which actuaries can use for their own analysis. Finally, the project output includes an Excel tool that can easily be used by practicing actuaries to calculate the deterministic scenario set. In addition to the interest rate research, the report also includes analysis of investment spreads, inflation rates and equity returns to assist the actuary in modeling these elements in a deterministic context.

OVERVIEW OF THE MDS SCENARIO SET

Why deterministic scenarios? The research focused on deterministic scenarios for several reasons. Deterministic scenario sets, specifically the NY7, remain the primary (and in many cases, the only) scenario sets used by appointed actuaries to evaluate asset adequacy. Many companies lack the time or resources for extensive stochastic modeling. Deterministic scenario results are easier to analyze and explain than stochastic results. Some actuaries are also concerned that they lack a reasonable basis for evaluating the range of scenarios produced by their stochastic generators.

The ultimate output of the research was a set of 16 modern deterministic scenarios (MDS). These scenarios are easily calculated using Excel files included as appendices to the report. Scenarios MDS1 through MDS14 are based on the empirical analysis and are calculated using the Excel workbook posted as Appendix J. Scenarios MDS15 and MDS16 are not based on the empirical

Table 2
Descriptions of Scenarios

Scenario Number	Scenario Name	Scenario Description
Reversion Scenarios:		
MDS1	Reversion—High	Grade linearly to an 85HCTE (right tail) reversion target over a 15 year period.
MDS2	Reversion—Low	Grade linearly to an 85LCTE (left tail) reversion target over a 15 year period.
MDS3	Delayed Reversion—High	Long and Short Rates level for 5 years, then grade linearly to CTEH85 reversion target over a 10 year period.
MDS4	Delayed Reversion—Low	Long and Short Rates level for 5 years, then grade linearly to CTEL85 reversion target over a 10 year period.
MDS5	Pop-up with Reversion—High	Initial pop-up, then grade linearly to CTEH85 reversion target by year 15.
MDS6	Pop-down with Reversion—Low	Initial pop-down, then grade linearly to CTEL85 reversion target by year 15.
MDS7	Delayed pop-up with Reversion—High	Long and short rates level for 5 years followed by pop-up, then grade linearly to CTEH85 reversion target by year 15.
MDS8	Delayed pop-down with Reversion—Low	Long and short rates level for 5 years followed by pop-down, then grade linearly to CTEL85 reversion target by year 15.
Rate Change Scenarios		
MDS9	Rate Change CTE—High	Change from initial rate based on CTEH85 (right tail) historical change statistics for the applicable interest rate group.
MDS10	Rate Change CTE—Low	Change from initial rate based on CTEL85 (left tail) historical change statistics for the applicable interest rate group.
MDS11	Rate Change CTE—High with pop-up	Change from initial rate based on CTEH85 (right tail) historical change statistics for the applicable interest rate group, with initial pop-up based on CTEH85 transitional changes.
MDS12	Rate Change CTE—Low with pop-down	Change from initial rate based on CTEL85 (left tail) historical change statistics for the applicable interest rate group, with initial pop-down based on CTEL85 transitional changes.
Interest Rate Cycle Scenarios		
MDS13	Cyclical, 20 year cycle	20 year cycles of interest rates—5 years declining, 10 years flat, 5 years increasing.
MDS14	Cyclical, 40 year cycle	40 year cycles of interest rates—10 years declining, 20 years flat, 10 years increasing.
AIRG Scenarios (See Appendix K; not included in the Scenario Calculator workbook)		
MDS15	AIRG—High	Rates based on 1,000 scenarios from Academy interest rate generator, 85HCTE of cumulative average rates, annualized.
MDS16	AIRG—Low	Rates based on 1,000 scenarios from Academy interest rate generator, 85LCTE of cumulative average rates, annualized.

analysis, but rather are a distillation of a stochastic set generated from the Academy Interest Rate Generator (AIRG) and are calculated using the Excel workbook posted as Appendix K.

Table 2 lists the scenarios with their descriptions. There is not room in this article to describe the scenarios in detail, but some key elements are:

- The scenarios project a long rate and a short rate and use a regression model to complete the yield curve.
- Short and long rates can be projected independently or using one of three yield curve steepness parameters. There are no parallel shifts.
- There are eight high rate and eight low rate scenarios, with each high rate scenario having a low rate counterpart, but these are not symmetric around the starting rate. Low rate and high rate are not synonymous with increasing and decreasing, depending on initial conditions.
- There is no level scenario. We believe it is always appropriate to run a level scenario as a baseline, but that it is not generally a useful measure of moderately adverse conditions.
- Scenarios MDS1 through MDS8 are denoted reversion target scenarios, and revert to either a high- or low-rate target over 15 years using four different reversion patterns—MDS1 and MDS2 revert linearly, while the others incorporate pop-ups/downs and/or delays in the start of reversion. The ultimate target rates are independent of the initial rate and are shown in Table 3.

Table 3
Ultimate Target Rates

Tenor	Low Reversion Target	High Reversion Target
Short rate (90-day)	0.50%	6.25%
Long rate (20/30-yr avg.)	2.60%	7.50%

- Scenarios MDS9 through MDS12 are denoted rate change scenarios and project specified changes in interest rates from the initial rate level—either moderately high or moderately low changes—over 30 years. The projected changes are asymmetric and are dependent on the initial level of interest rates. Scenarios MDS11 and MDS12 incorporate an initial pop-up or pop-down, while MDS9 and MDS10 do not.
- Scenarios MDS13 and MDS14 are cyclical scenarios that assume 20- or 40-year interest rate cycles, respectively. These scenarios are most relevant for longer projection periods and are the only scenarios that require subjective input by the user.
- Scenarios MDS15 and MDS16, computed in a different Excel workbook than the others, use a similar CTE methodology as scenarios MDS9 through MDS12, but applied to a set of 1000 stochastic scenarios generated from the AIRG. These scenarios require the user to run the AIRG and input the scenarios into the Excel workbook. Other stochastic generators could be used as well, but the input is set to accept the AIRG output format.

AUG. 31, 2017, SCENARIOS AND COMPARISON TO THE NY7

Reading the research report will tell you everything you might ever want to know about the development of the scenarios, and more, but what is the upshot? How do the scenarios look today, and how do they compare to the NY7? The report presents the scenarios compared to the NY7 as of Dec. 31, 2015. For this article, we have updated the comparisons to Aug. 31, 2017, for scenarios MDS1 through MDS12, those most comparable to the NY7, but not for scenarios MDS13 through MDS16. To get a sense of the scenarios in other environments, Appendix J to the report can easily be updated to show scenarios for any date going back to 1982.

First, we will review the high/increasing interest rate scenarios. Figures 1 and 2 show, for long interest rates, the MDS high rate scenarios compared to New York scenarios #2 and #4. For long rates, the MDS scenarios reach ultimate rates as high as or higher than the comparable NY7 scenarios, but much more gradually.

Figures 3 and 4 show the same scenario comparisons, but for short rates rather than long rates. The short rates move up much more quickly than the long rates, and also move up more quickly and to higher levels than the comparable NY7 scenarios.

Figure 1
MDS Long Rate–Reversion Target Scenarios–High vs. NY2 and NY4

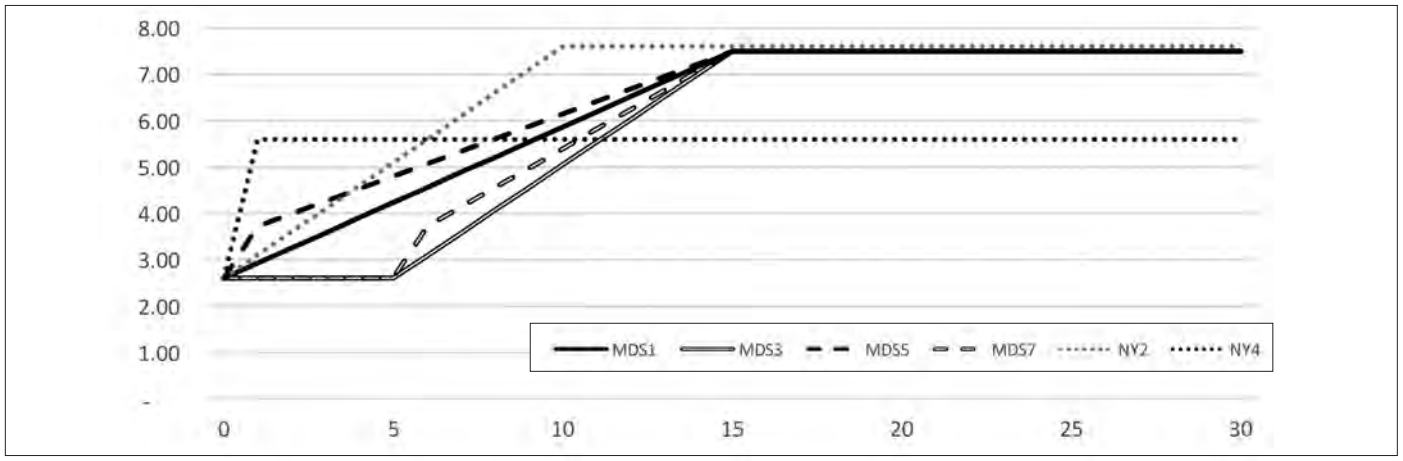


Figure 2
MDS Long Rate–Rate Change CTE Scenarios–High vs. NY2 and NY4

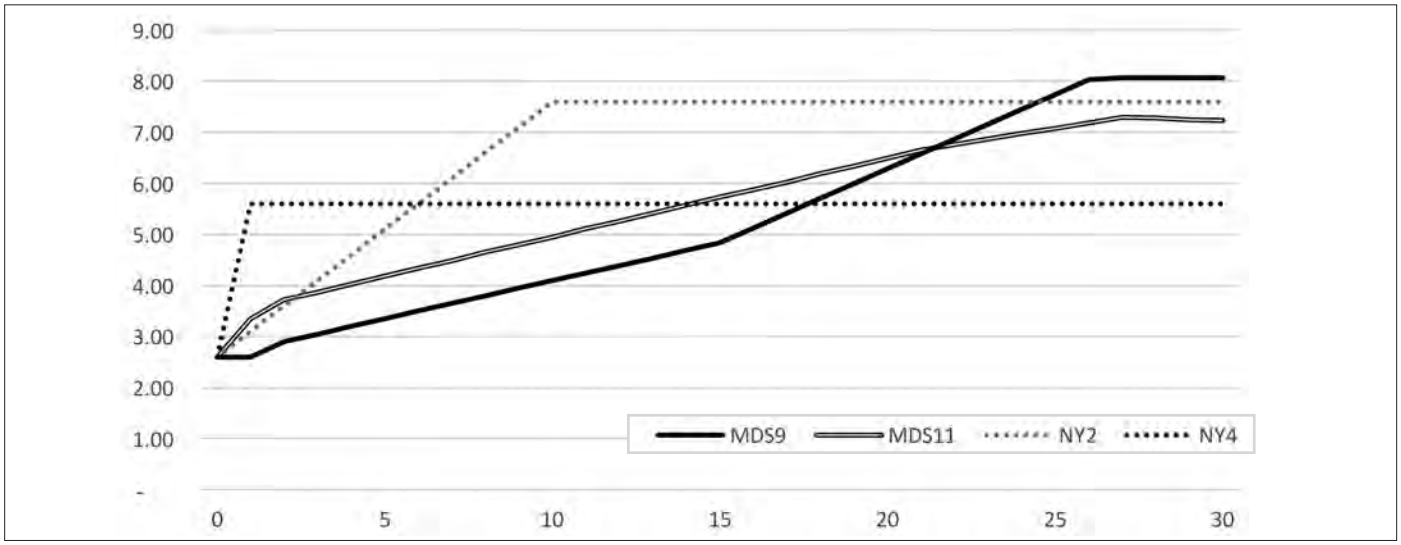


Figure 3
MDS Short Rate–Reversion Target Scenarios–High vs. NY2 and NY4

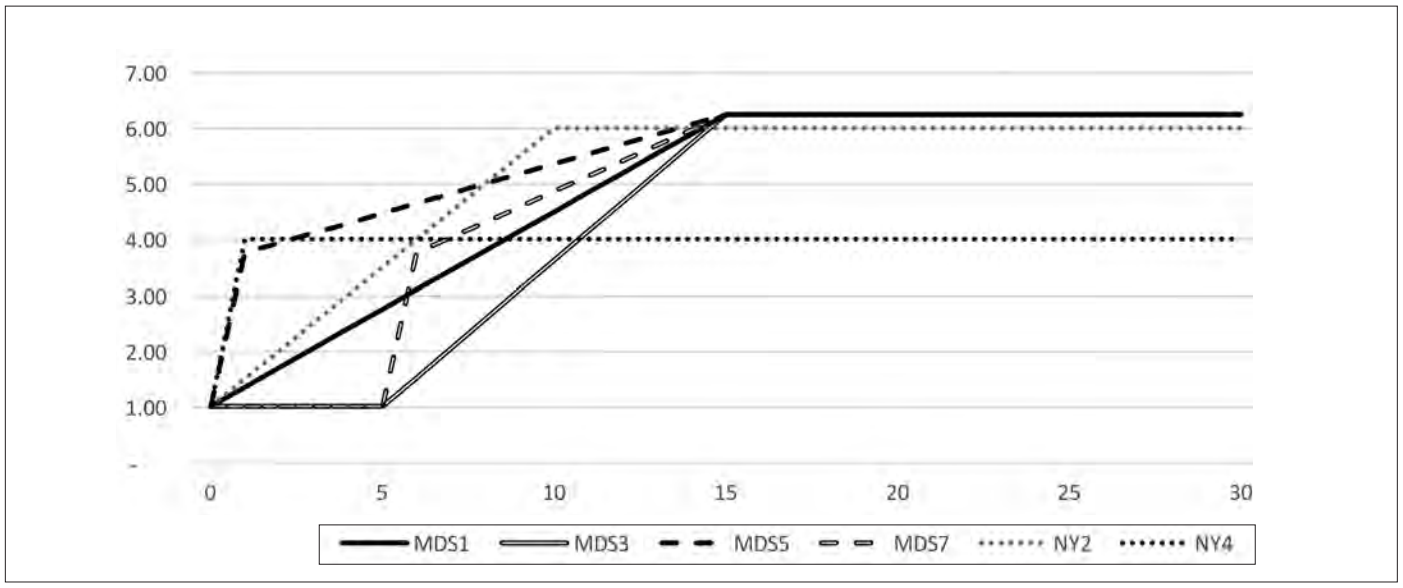


Figure 4
MDS Short Rate–Rate Change CTE Scenarios–High vs. NY2 and NY4

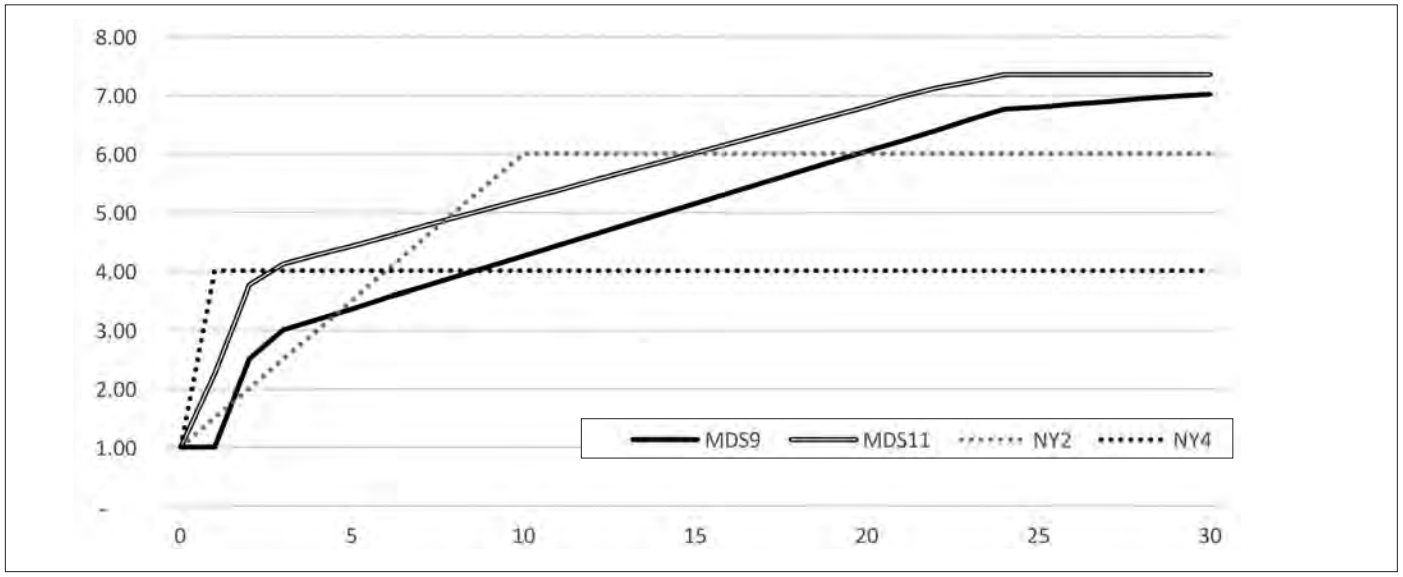


Figure 5
MDS Long Rate–Reversion Target Scenarios–Low vs. NY5 and NY7

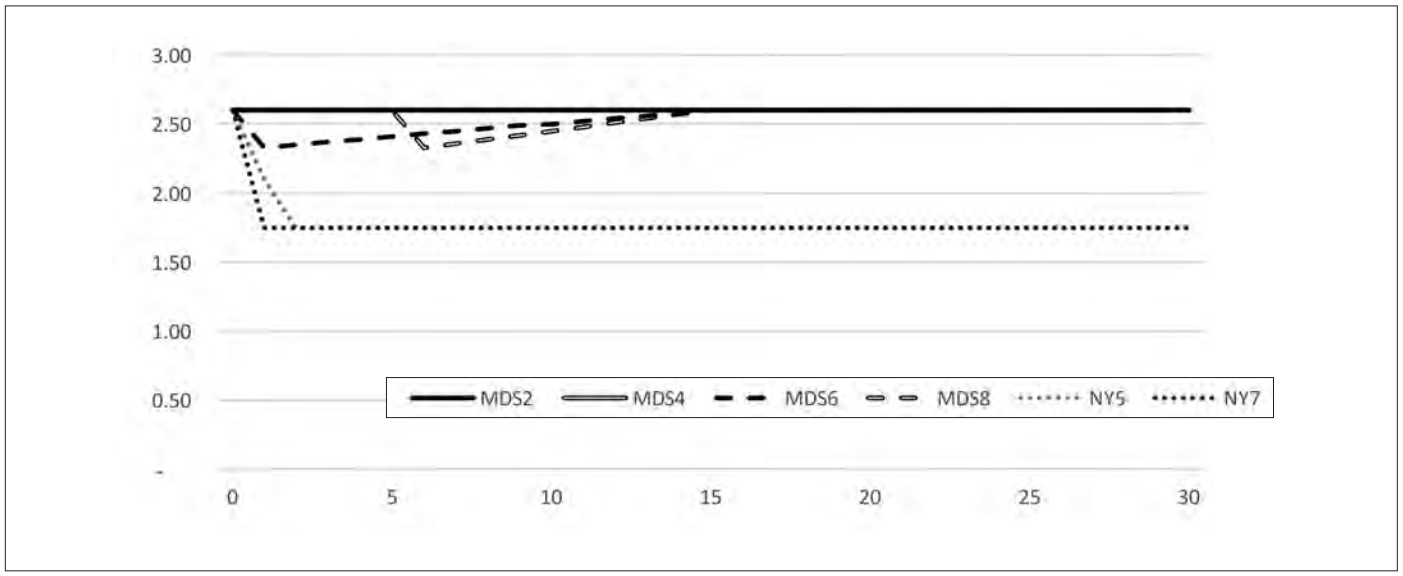
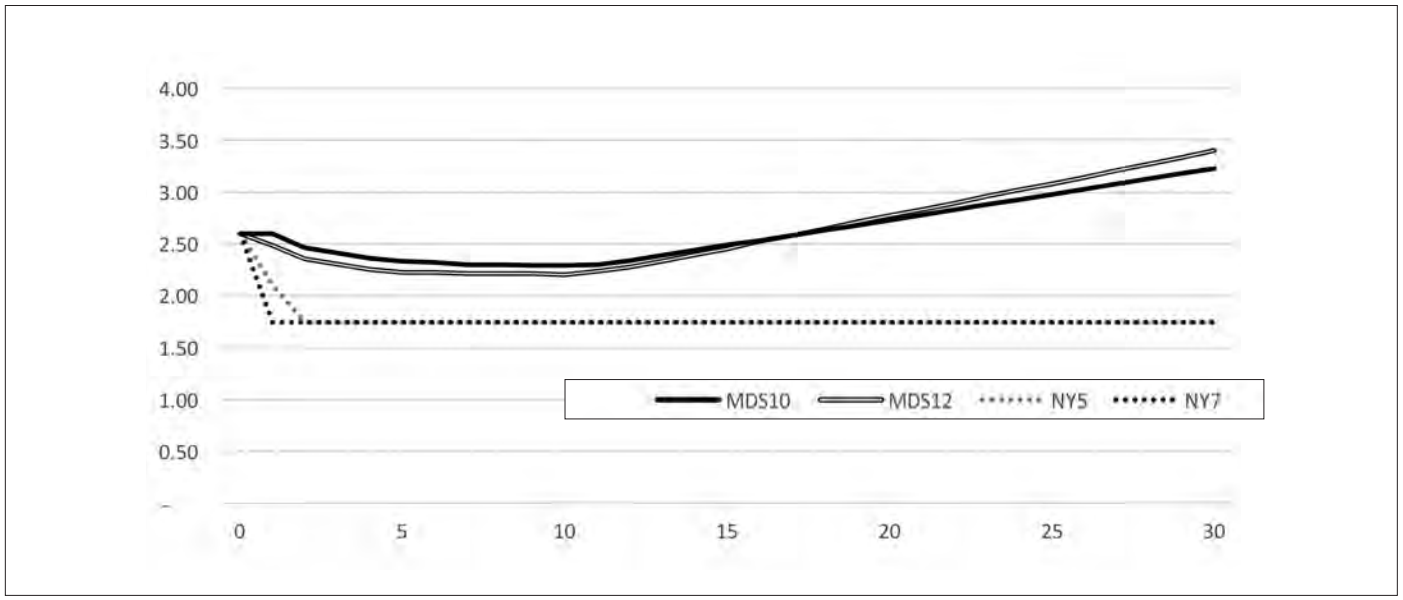


Figure 6
MDS Long Rate–Rate Change CTE Scenarios–Low vs. NY5 and NY7



Now, we will review the low/decreasing interest rate scenarios. Figures 5 and 6 show, for long interest rates, the MDS low rate scenarios compared to NY5 and NY7. The MDS scenarios, consistent with the view that the NY7 decreasing scenarios are beyond moderately adverse in today's conditions, do not decrease as far or as long as the comparable NY7 scenarios. However, these scenarios do reflect decreases in rates from the starting rates that may be significant for some lines of business, and for a substantial period of time. In addition, since the starting rate is very near the reversion target, scenarios MDS2 and MDS4 are indistinguishable, much like NY5 and NY7 after year two.

Figure 7
MDS Short Rate–Reversion Target Scenarios–Low vs. NY5 and NY7

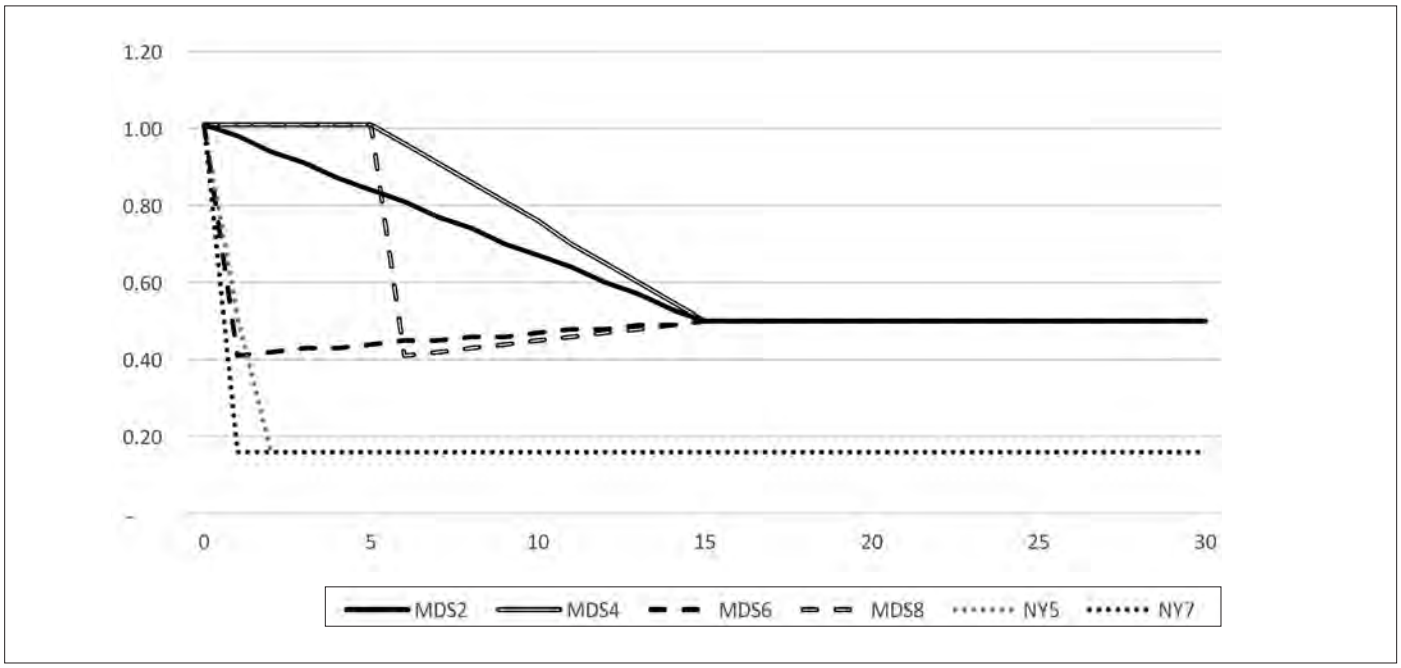
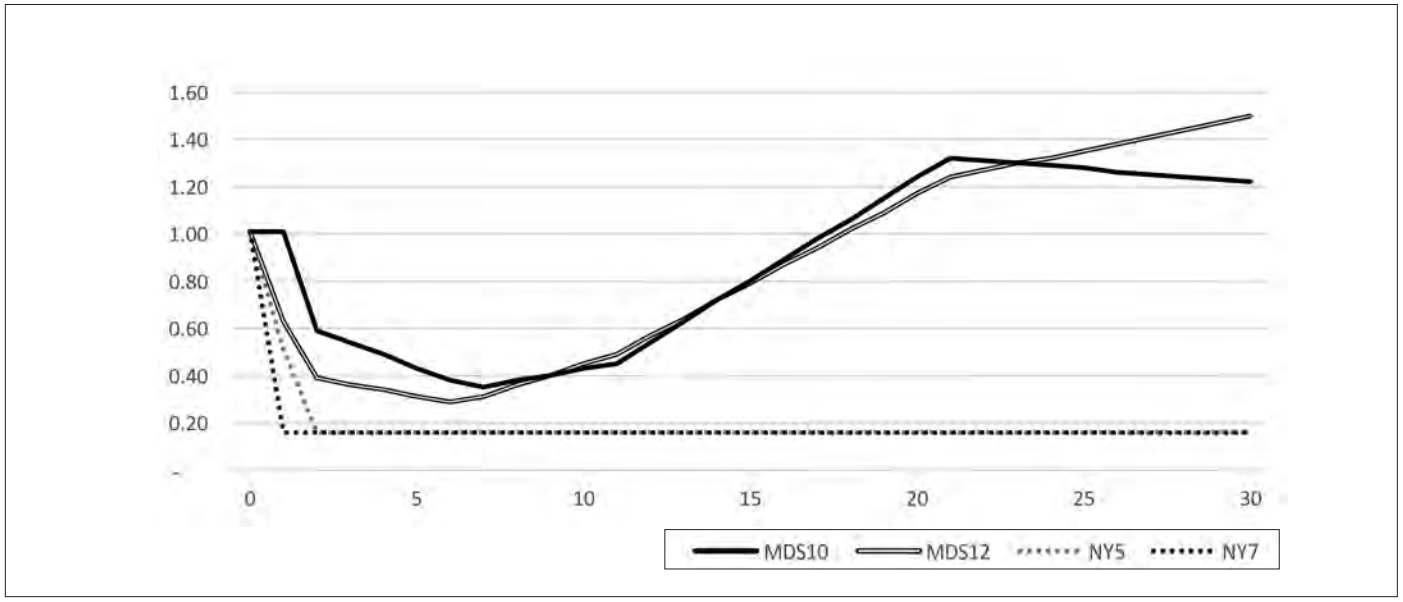


Figure 8
MDS Short Rate–Rate Change CTE Scenarios–Low vs. NY5 and NY7



Figures 7 and 8 show the same scenario comparisons, but for short rates rather than long rates. Similar to the high rate scenarios, the MDS scenarios more closely resemble the NY7 scenarios for short rates than for long rates. Both the reversion scenarios and the rate change scenarios show initial declines comparable to the NY5 and NY7, although the rate change scenarios begin climbing in years five through seven and ultimately end up above the starting point.

OVERVIEW OF THE MDS INTEREST RATE SERIES

I will not describe here the empirical data analysis and the techniques we used to convert the data analysis into scenario calculation algorithms, but refer the interested reader to the report for details of this work. However, a description of the historical interest rate series used as the basis of our analysis is worth a few paragraphs in this article. Much of the prior actuarial literature analyzing interest rates goes back to 1953, the earliest year for which the Federal Reserve maintains detailed treasury rate data. The path of interest rates since then might be likened to a photograph of Mount McKinley—dramatic, but not very helpful for thinking about future interest rate paths, and offering too few annual data points for meaningful analysis. We would need more data, both to increase the number of data points for analysis and to avoid overweighting the extreme high rate period of the 1970s and 1980s.

Unable to find any series of existing interest rate data that met our needs, we constructed our own. Ultimately, we constructed a series of long interest rates going back to 1729 and a series of short interest rates going back to 1825, dubbing them the MDS Interest Rate Series. For recent periods where robust data is maintained by the Federal Reserve, we used the 90-day Treasury for the short rate and the average of 20- and 30-year Treasuries for the long rate. For earlier periods, we selected interest rates from other sources that we believed best represented market interest rates. Most notably, for periods prior to 1920, we selected interest rate data from the United Kingdom, which held the position of economic power now occupied by the United States.

Our decisions to base our analysis on interest rates going back to the 1700s and to use U.K. interest rates as a basis for assessing current and future U.S. interest rates may foster some debate, and we welcome that debate. We believe it was important to use the data sources most relevant to the analysis and as much relevant data as was available. We believe we accomplished that goal.

CONCLUSION

"The work of science is to substitute facts for appearances and demonstrations for impressions." This quote, attributed to Ruskin, is well known to members as the motto of the SOA. Deterministic modeling of interest rates, particularly in the context of moderately adverse conditions, has been sorely lacking in facts and demonstrations. Just in time for 2017 cash flow testing, the SOA offers this new research to advance the state of actuarial practice and to provide appointed actuaries with a new framework for considering moderately adverse interest rate conditions.

In the context of empirical evidence, there are some significant shortcomings to the NY7 scenarios as measures of moderately adverse conditions. Among these: 1) parallel yield curve shifts either understate variability at the short end of the yield curve or overstate variability at the long end, or both; 2) historical data show that the incidence and magnitude of actual rate increases and decreases are asymmetric and are tied to the initial rate level; 3) actual rate changes, particularly for the long end of the curve, are almost never as rapid as the NY7 changes; and 4) over longer modeling horizons, the NY7 maximum increases/decreases may understate the actual range of interest rates.

The MDS scenarios address these shortcomings and are easily computed using the Excel tools accompanying the research report. In the current environment, some actuaries may consider the MDS low rate scenarios to be more moderate than the NY7 decreasing rate scenarios. However, other actuaries who believe that even the level scenario is currently beyond moderately adverse may be dismayed that the MDS scenarios do include decreases from current rate levels.

The appointed actuary is responsible for defining moderately adverse conditions and cannot blindly rely on this, or any other, scenario set. Therefore, perhaps even more important than the scenarios themselves, our research provides actuaries with an empirical data set and an analysis framework that they can use to inform their own view of moderately adverse interest rate conditions. Some elements of the empirical data set or the analysis may prove controversial and will no doubt serve as fodder for future debate. This is debate that we need to have!

Finally, any user of the report must keep in mind that reserves are intended to cover moderately adverse conditions, and capital to cover extreme conditions, and that the context of the report is moderately adverse testing of reserves. While the research could be extended to cover stress testing and extreme conditions, those conditions are not covered by the report and one should take extreme care in trying to apply these analyses or results in a risk management or capital adequacy context. ■

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ENDNOTES

1 Measured as the average rate over the next 12 months less the rate on the start date.

2 *https://www.soa.org/research-reports/2017/2017-modern-deterministic-scenarios/*