

# The Messenger

Risk Management Newsletter

## 2001 VBT – Caution: Steep Hill Ahead

In my role as a Research Actuary, I am often asked to perform mortality experience studies using the SOA 2001 Valuation Basic Tables (VBT) as an expected basis. I never gave this much thought until a question arose about the possibility that a fair amount of anti-selective policyholder behavior may be embedded into the slope of this table. If true, then trend studies using actual-to-expected (A/E) ratios based upon the VBT may be presenting biased results. In this article I demonstrate how much anti-selection could be incorporated into the table by employing a Dukes-MacDonald<sup>1</sup> selective lapsation model.

### Lapse Rates during the 2001 VBT Experience Era

The 2001 VBT is based upon intercompany mortality experience from 1990 through 1995. During that era, lapse rates for both term and permanent business were very high compared to current levels. Figure 1 shows the results of a LIMRA 1986-87 Long-Term Ordinary Lapse Survey<sup>2</sup>. Today, lapse rates for level term insurance are about one-third of those shown in the figure and about one-half for permanent insurance. There is a possibility the slope of the 2001 VBT is overly steep because of the selective lapsation that can occur when lapse rates are inordinately high. Current mortality patterns may be flatter than the VBT because lapse rates are much lower today, resulting in less anti-selective behavior on the part of policyholders.

### Dukes-MacDonald Selective Lapsation Model

The Dukes-MacDonald selective lapsation model assumes that policy lapsation in excess of a baseline set of rates is anti-selective. The total of the expected deaths from the cohort in the excess lapse group (the “reverters”) and the expected deaths from the cohort continuing their insurance (the “persisters”) must equal the expected deaths arising from the original cohort using the baseline lapses. This is the conservation of death principle.

Dukes-MacDonald assumes that the mortality for the reverters follows the select mortality of a newly underwritten attained-issue-age group. Then, conservation of deaths is used to mathematically solve for the mortality of the persisters. As long as there are excess lapse rates, this process is repeated year



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Figure 1: Historical 1986-87 Lapse Rates

Policy Year	Traditional		Level Term	
	Whole Life	YRT	Other	
1	17.7%	16.8%	17.2%	
2	11.1%	16.6%	21.8%	
3-5	11.7%	15.6%	17.8%	
6-10	11.7%	14.2%	13.6%	
11+	8.4%	11.1%	10.0%	

Lapse rates during the experience period for 2001 VBT were very high compared to today's lapse rates. (LIMRA)

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**Figure 2: Male Nonsmoker Age 40, Exposure Years 2000-2009**

Duration	Baseline Mortality Rate	Baseline Lapse Rate	Normalized 2001 VBT	Lapse Rates For 1986-87 Era
1	0.32	6.5%	0.32	18.0%
2	0.38	6.5%	0.39	15.0%
3	0.44	6.0%	0.47	15.0%
4	0.52	5.5%	0.56	15.0%
5	0.61	5.0%	0.67	15.0%
6	0.71	4.5%	0.81	12.0%
7	0.83	4.0%	0.97	12.0%
8	0.97	4.0%	1.17	12.0%
9	1.13	4.0%	1.40	12.0%

Baseline mortality exhibits little selective lapsation while normalized 2001 VBT mortality shows significant lapse-related anti-selection.

after year as the persisting cohort continues to be divided into new reverters and new persisters.

The theory also allows for only some portion (the “effectiveness rate”) of the reverters to follow attained-issue-age mortality. In classic Dukes-MacDonald theory, the remainder, while still lapsing, follows the anti-selective mortality of the persisting cohort. However, I use a modification whereby the remainder follows the point-in-scale mortality of the original cohort. The sum of the attained-issue-age deaths plus the point-in-scale deaths plus the persisters anti-selective deaths must equal the original cohort deaths.

### Determining Baseline Rates

In order to effectively apply the Dukes-MacDonald model, baseline mortality and lapse rates must theoretically be free from anti-selective influences. Starting with SCOR’s proprietary reinsurance experience database, I applied the following filters:

- Male nonsmoker
- 3 and 4 class underwriting structures
- Issue years 2000-2009
- Exposure years 2004-2009
- Original face amounts \$100,000+
- No substandard ratings
- Exposures and decrements based upon policy count

The intent of restricting the issue years, risk classes and face amounts was to extract experience on a homogeneous set of policies that best represented modern underwriting selection methods. The issue year constraint limited my analysis to only Durations 1-9. Applying multivariate predictive modeling techniques to various sub-segments of the data, it was determined that very little correlation existed between current levels of mortality and lapse. That is, given today’s experience, a higher lapse rate did not necessarily indicate a higher mortality rate, and a lower lapse rate did not indicate a lower mortality rate. Therefore, it is reasonable to assume the slope of current mortality contains very little anti-selection due to selective lapsation. Likewise, current lapse rates are a good proxy for the baseline required by Dukes-MacDonald.

For mortality, an exponential model was created from the experience and used to calculate baseline mortality for the various issue ages needed as input to Dukes-MacDonald. A similar exponential model was created for the 2001 VBT and normalized by setting the mortality rate in Duration One equal to the baseline. Figure 2 shows the baseline model mortality and lapse rates for male nonsmoker issue age 40. It also includes the 2001 VBT model mortality and the lapse rates used to approximate the level of the 1986-87 era.

### Results of the Experiment

The experiment uses multiple cohorts to adjust baseline mortality by successively lapsing a new group of

**Figure 3: Dukes-MacDonald Anti-selective Mortality Factors**

eff = 90%

Policy	Ratio of Cohort Mortality to Original Issue Group							
Year	1st Cohort	2nd Cohort	3rd Cohort	4th Cohort	5th Cohort	6th Cohort	7th Cohort	8th Cohort
1	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
2	101.0%	101.0%	101.0%	101.0%	101.0%	101.0%	101.0%	101.0%
3	100.7%	102.0%	102.0%	102.0%	102.0%	102.0%	102.0%	102.0%
4	100.5%	101.4%	103.6%	103.6%	103.6%	103.6%	103.6%	103.6%
5	100.5%	101.3%	103.3%	106.7%	106.7%	106.7%	106.7%	106.7%
6	100.6%	101.5%	103.4%	106.5%	110.8%	110.8%	110.8%	110.8%
7	100.6%	101.5%	103.2%	106.2%	110.5%	114.4%	114.4%	114.4%
8	100.7%	101.8%	103.6%	106.6%	111.0%	115.0%	119.8%	119.8%
9	100.8%	101.9%	103.8%	106.7%	110.9%	114.9%	119.9%	125.4%

The Dukes-MacDonald Model predicts a general pattern of deterioration in mortality due to selective lapsation.

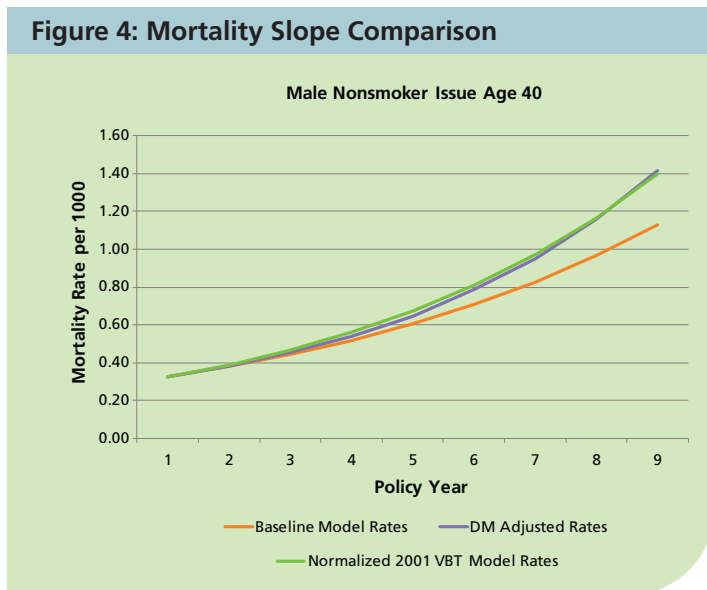
reverters from the prior group of persisters. Due to the complexity of the calculations, I limited the analysis to male nonsmoker issue age 40, where a large portion of our reinsurance inforce resides. Figure 3 illustrates the progression of results as the original cohort exhibits increasingly anti-selective mortality when the better risks lapse off year after year.

The last column shows how the relative slope of mortality has changed after eight years of selective lapsation behavior. It is a measure of the amount of anti-selection possibly built into the 2001 VBT (at least for male nonsmoker issue age 40). I tested several effectiveness rates and chose 90% as the factor that best reproduced the perceived behavior of the VBT population. This result is displayed graphically in Figure 4 as a comparison of original baseline model mortality, Dukes-MacDonald adjusted mortality, and normalized VBT model mortality.

#### References

<sup>1</sup>Dukes, Jeffrey, and Andrew W. MacDonald. "Pricing a Select and Ultimate Renewable Term Product." *Transactions of Society of Actuaries* Vol. 32 (1980): 547-584.

<sup>2</sup>Society of Actuaries. *TSA 1985-87 Reports. LIMRA. 1986-87 Long-Term Ordinary Lapse Survey*, 266.



Backing out Dukes-MacDonald effects can be used to adjust the 2001 VBT's mortality slope to contemporary slope experience.

### Conclusion

The SOA 2001 VBT appears to have some level of selective lapsation implicitly built into the slope of early duration rates when compared to current patterns of mortality. To be fair, there could be some alternative explanation for the flatter slope of current mortality, such as a greater persistence of preferred underwriting selection. However, the ability to mimic the slope of the VBT given current mortality as a starting point using a Dukes-MacDonald model lends some credence to the former viewpoint. In either case, it is important to understand that there may be a bias in the results of any A/E mortality analysis that uses the 2001 VBT as an expected basis. ∞