Sgt. Pepper Financial Group

Executive Summary

Team 01: Nathan Wei Chan, Derek Younger, Dalton Bassler-Haynes, Beloved Maina

1. Background

Sgt. Pepper Financial Group is considering the launch of a new fixed annuity ("FA") product. However, there are concerns about the flexibility of the current assumption table approach to projecting lapse rates applied to pricing models, given the current crediting market and competitive landscape. A new lapse rate formula is desired to replace the assumption table approach in order to increase the flexibility of the FA pricing models. Nine factors to consider for the formula have been suggested by the Experience Studies division, however the list is not targeted to FA products, and simpler models are preferred for pricing purposes. Therefore it has been requested that four of the nine factors be selected to be used for the lapse rate formula. The formula is also to be used to project future lapse rates as inputs for the pricing models. In addition, possible factors not included in the list given by the Experience Studies division were researched for consideration in the case that a guaranteed living benefit ("GLB") feature is added to the product later.

2. Key Analysis and Methods

To evaluate the factors recommended by the Experience Studies division, the historical data for FA products was fed into an exhaustive search algorithm with lapse rate as the response variable in order to select the four best predicting variables. These variables were used to create a linear regression model to predict lapse rates, which in turn produced the proposed formula. The future data was then plugged into the formula in order to predict future lapse rates. Finally, an additional factor to be considered for the formula if a GLB feature is added to the product is proposed. The formula and additional factor are also supported by research outlined below in the analysis section.

Assumptions

It is assumed that the data provided is credible. For modeling purposes, assumptions about the variables are also made in order to satisfy the requirements for a linear regression model. These include that each predictor variable is independent from all other predictor variables and none of the predictor variables are excessively correlated (besides calendar year and policy year), that all predictor variables have roughly the same variance, that all variables are normally distributed and that there are no outliers.

Methods

With simplicity in mind, linear regression stood out as a potential basis for the formula. RStudio was used to fit a linear regression model to the historical data with lapse rate as the response variable. Calendar year was removed as a variable to prevent redundancy with policy year. Comparison of the resulting model and historical data, alongside the summary of the model's accuracy produced by the software, suggested that linear regression was an appropriate tool to analyze the data. To identify the four key factors requested, the data was fed into a model selection algorithm, which used the exhaustive search method to find the four variables that best predicted the lapse rate for each year. With the variables identified, another linear regression model was created with the historical data, this time omitting the variables not selected by the model selection algorithm. Next, this model was compared to both the first linear regression model and the historical data, and found to match them satisfactorily. The two models were also compared using the Bayesian information criterion ("BIC"), which scores statistical models on accuracy and number of parameters. The resulting BIC values yielded strong evidence in favor of the model with only the selected variables. This model forms the proposed lapse rate formula. With the formula, the data given in the projection template was able to be used to predict lapse rates to be applied to the pricing model.

Analysis

The selection algorithm found that the best predicting variables are mortality rate, crediting rate, 10-year treasury rate and surrender charge. Mortality rate and 10-year treasury rate are positively correlated with lapse rates. Mortality rate impacts lapse rate because when an annuitant dies before the maturity, their policy lapses. The 10-year treasury rate impacts lapse rates because if the treasury rate increases, other investment options have better returns, so policyholders are more likely to lapse and invest their money elsewhere. Meanwhile, the crediting rate and surrender charge are inversely correlated with lapse rates. Crediting rate is the yearly growth of the portfolio determined by the insurance company, so when it is high policyholders are more likely to consider the annuity a good investment and thus are less likely to lapse. The surrender charge impacts lapse rates since people are more likely to lapse when there is a smaller charge on their portfolio if they do lapse. These correlations are reflected in our equation by the signs of the coefficients.

Guaranteed Living Benefits are associated with increased costs, so it is important to investigate additional factors that may impact lapse rates if a GLB is added to a product. Unemployment has been identified as another factor to consider when predicting lapse rates for FA products with guaranteed living benefits. A correlation has been found between unemployment and lapse rates for annuities within the first few years of the annuity. Because of the reduced value of the contract during this time frame, it is recommended that it be investigated whether the effect of unemployment on lapse rates is increased.

Concerns

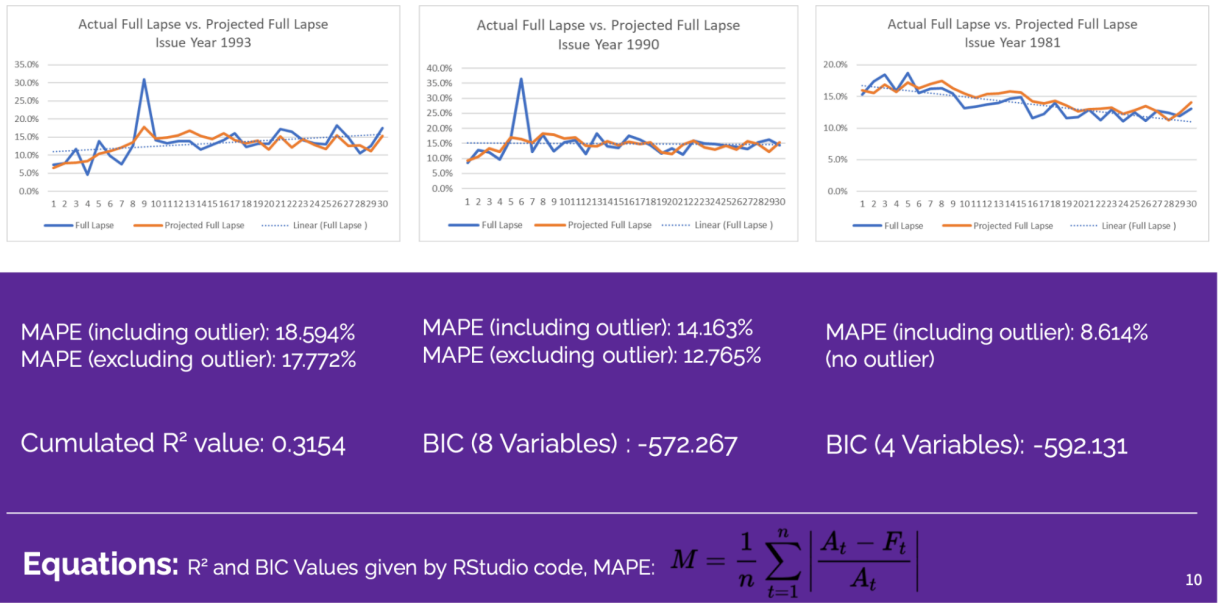
The methodology used to create the formula has two significant limitations. First is that the data was not split into a modeling subset and a testing subset, which reduces confidence that the proposed equation is generalizable. Second is that historical data consistently demonstrates outliers when the surrender charge reaches zero that cannot be predicted by the formula. The average difference between the projected lapse rate using our formula and the true lapse rate when this occurs is 17.09%. These limitations should be considered when applying predictions to the pricing model.

3. Results and Recommendation

It was found by the selection algorithm that the four best factors to use for predicting the lapse rate of the upcoming fixed annuity product are mortality rate, crediting rate, 10-year treasury rate and surrender charge. The linear regression model fit to these variables gave coefficients of 0.516, –0.876, 1.08 and –1.06 respectively and an intercept of 0.1135 to create the proposed lapse rate formula of $f(a, b, c, d) = 0.1135 + 0.516a – 0.876b + 1.08c – 1.06d$ where a = mortality rate, b = crediting rate, c = 10-year treasury rate and d = surrender charge. When applying this formula to the future data, it returned unreasonably low or negative values in some years, so a lower bound of 3% is advised. Results of the projection using this equation are included in the appendix below. To account for the presence of outliers not predicted by the equation when the surrender charge reaches zero, it is also recommended that the projected lapse rate be increased by 17.09% for that year. In the case of a GLB feature being added to the product in the future, it is suggested that monthly unemployment rates be added into the formula for lapse rate projections.

Appendix:

[1] Comparing formula to historical data and BIC values



[2] Table showing results of lapse rate projection

Mortality Rate	Crediting Rate	10 Yr. Treasury Rate	Surrender Charge	Projected Lapse
0.06%	4.50%	3.96%	12%	3.00%
0.46%	4.50%	3.95%	10%	3.00%
1.79%	4.50%	4.00%	10%	3.00%
0.30%	4.70%	4.19%	7%	4.49%
1.05%	4.80%	4.28%	5%	7.02%
1.64%	4.80%	4.93%	4%	9.08%
1.81%	5.00%	5.07%	3%	10.21%
0.34%	5.00%	5.64%	2%	11.13%
0.32%	5.00%	5.80%	0%	13.40%
0.18%	5.20%	5.50%	0%	12.83%
1.77%	5.20%	6.16%	0%	14.37%
0.26%	5.50%	5.90%	0%	13.04%
0.37%	5.50%	7.42%	0%	14.74%
0.78%	5.50%	6.60%	0%	14.07%
0.14%	5.50%	7.00%	0%	14.17%

Information Sources

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