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# Leveraging X-factor Testing Techniques in Developing Mortality Assumptions for VM-20

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VM-20 requires prudent estimate assumptions that are based upon a combination of company experience, industry basic tables and prescribed margins. VM-20 has requirements on how company experience is defined, and also requires that additional margins be established if the actuary does not consider the prescribed margins to be adequate. The use of company-based assumptions for statutory valuation and performance of certain tests on that mortality have been in place since Regulation XXX became effective, and some of the tools used within X-factor testing can be leveraged for use with VM-20. In this article, we will connect VM-20 to Regulation XXX and repurpose some of the techniques that actuaries have been using for X-factor testing to aid in setting VM-20 mortality assumptions.

## REVIEW OF VM-20 AND REGULATION XXX

Requirements for Principle-Based Reserves for Life Products (VM-20) took effect for direct writers on Jan. 1, 2017, with the adoption of the Valuation Manual. VM-20 contains a three-year transition period so that by Jan. 1, 2020, all newly issued policies must be valued in accordance with VM-20. Generally speaking, VM-20 implementation is (or will be) a long and strenuous process, requiring a great deal of rigor, judgment and documentation. One of the many challenges companies face is the development of prudent estimate mortality assumptions as required in Section 9.C. In addition to the mechanical requirements, VM-31 (which includes requirements for disclosures of assumptions within the PBR Actuarial Report) and VM-G (which covers corporate governance regarding principle-based reserves) bring assumption-setting for booked statutory reserves under greater scrutiny.

Assuming mortality segments have been defined, the prudent estimate mortality assumption process can be summarized in a few steps, as is done in Section 9.C.1:

1. Develop company experience mortality rates,

2. determine industry basic table to which company experience mortality rates will grade,
3. determine credibility of underlying company experience,
4. determine prescribed margins and
5. blend company experience mortality rates and industry basic table according to grading period determined.

While several aspects of the prudent estimate mortality assumption are prescribed (selection of industry basic table, margins, grading), the process of determining company experience mortality rates according to Section 9.C.2 is less rigidly defined. However, there are several governing requirements outlined within VM-20:

- Annual Assumption Review and Validation via Statistical Testing

From 9.A: “The company shall use its own experience, if relevant and credible, to establish an anticipated experience assumption for any risk factor...”

The appointed actuary shall annually review relevant emerging experience for the purpose of assessing the appropriateness of the anticipated experience assumption. If the results of statistical or other testing indicate that previously anticipated experience for a given factor is inadequate, then the appointed actuary shall set a new, adequate, anticipated experience assumption for the factor.”

- Company Experience Mortality Rates used in VM-20 are at or greater than best estimate

From 9.C.2.c: “The company experience mortality rates shall not be lower than the mortality rates the company expects to emerge which the company can justify and which are disclosed in the PBR Actuarial Report.”

- Further analysis required to determine if the prudent estimate mortality assumption is sufficient

From 9.C.5.d: “The prescribed margin percentages shall be increased, as appropriate, to reflect the level of uncertainty related to situations ...” ASOP 52, Section 3.4.6, further clarifies:

“a. Mortality Margins—Section 9 of VM-20 prescribes the margins that are to be added to the anticipated experience mortality assumptions but also requires the establishment of an additional margin if the prescribed margin is inadequate. The actuary should use professional judgment in determining such additional margin. The guidance in the remainder of this section on determining assumption margins does not



apply to the prescribed mortality assumptions but does apply when determining additional margins for mortality.

“b. Establishing Margins—For each assumption that includes a margin, the actuary should reflect the degree of risk and uncertainty in that assumption in determining the magnitude of such margin. When determining the degree of risk and uncertainty, the actuary should take into account the magnitude and frequency of fluctuations in relevant experience, if available. In doing so, the actuary should consider using statistical methods to assess the potential volatility of the assumption in setting an appropriate margin.”

There are direct connections between the wording of VM-20 and Regulation XXX regarding the assessment of the appropriateness of the company experience assumptions. Section 5B(3)(g)(iii) of Regulation XXX calls for review of continued appropriateness of X-factors taking into account relevant emerging experience, a method generally known as “retrospective testing,” which aligns to the wording in Section 9.A of VM-20. Section 5B(3)(c) of Regulation XXX provides the requirement that mortality rates over a period of time from the valuation date must exceed company best-estimate (which, when combined with other requirements spelled out in Regulation XXX, comprise “prospective testing”), comparable to the wording in

Section 9.C.2.c of VM-20. The retrospective testing might also help the actuary understand the volatility around the company experience mortality rates, which is helpful in understanding the appropriateness of prescribed margins outlined in Section 3.4.6(a) of ASOP 52.

## REVISITING X-FACTOR TESTING TECHNIQUES

In the context of Regulation XXX, retrospective testing provides insight as to whether or not emerging experience supports the use of a particular set of X-factors. Typically, the test involves building a statistical distribution of claims based upon the X-factors being tested and determining whether actual claim experience is an outlier in that distribution, generally at or above the 95th percentile. Similarly, building a statistical distribution of claims may be useful for VM-20. By generating a claim distribution where the expectation is based upon a proposed set of company experience mortality rates, the actuary can benchmark where actual experience lies on the distribution to assess appropriateness of the proposed rates. In addition, the actuary may assess volatility, distinguish fluctuation from a change in trend of emerging experience, or identify the percentile ranking of claims emerging according to the prudent estimate mortality to determine whether additional margins are needed according to Section 9.C.5.d of VM-20.

Two tools, prevalent in X-factor testing, are used to build out the claim distribution. The Panjer recursive method is an algorithm designed to build a distribution based upon grouped data (e.g., face amount bands), and has the advantages of being formulaic and repeatable (which auditors and reviewers appreciate). The distribution is initialized with the probability of zero claims and builds from there. The reader is directed to a pair of write-ups that are of great value: the original article<sup>1</sup> by Harry H. Panjer which develops the method, and a later article<sup>2</sup> by Lloyd Spencer which provides an excellent illustrative example.

The other tool, Monte Carlo simulation, is based on randomly generated numbers and can better emulate the true distribution if given enough trials and seriatim data. For each policy, within a single trial, a random number is drawn between 0 and 1. If the random number is less than the mortality rate for that policy, then a death is assumed to occur, and the sum of the deaths across all policies provides the claims for a single trial. Then, the process is repeated for a particular number of trials, usually a number large enough so that the randomness of the number generation does not materially alter the result (typically 10,000). Results are then ordered and the distribution created. While the Monte Carlo method is possibly a better representation of the true claim distribution, at least if done at a seriatim level to capture individual policy expected mortality, it is calculation-intensive and more challenging to audit due to its random number generation.

Within the Regulation XXX framework, prospective testing is a two-step test to determine if X-factor mortality is at least as great as best estimate. Starting with the in force policies subject to XXX as of a particular date, the following calculations are performed, using both X-factor and best-estimate mortality (without mortality improvement beyond the valuation date):

- Calculate the actuarial present value of future death benefits to the end of the first segment per policy and
- calculate mortality rates without recognition of mortality improvement beyond the valuation date, in each of the first five years after the valuation date.

In both steps, the metric computed using X-factor mortality must exceed the same metric based upon best-estimate. Translating to VM-20, the actuary could perform similar tests, projecting out to the point where the prudent estimate is fully dependent upon the industry-basic table (i.e., after the grading has completed), which could cover the requirement of Section 9.C.2.c of VM-20 by comparing the mortality rates based upon the company experience mortality rates to best-estimates to ensure that the former rates exceed the latter. The actuary could also use this technique to confirm that the prudent estimate mortality rates (post-grading) exceed best-estimate, especially in later projection years, where old-age mortality assumptions are commonly graded to industry averages.

## CONCLUSION

Establishing prudent estimate mortality assumptions under VM-20 is a long and complex process. Having the

ability to generate company experience mortality rates, creating a mechanism to determine the validity of these assumptions, and developing a manner in which to benchmark the prescribed mortality margins for adequacy, will be critical components of the VM-20 process. While still a significant undertaking, techniques from Regulation XXX can be repurposed to address these challenges. ■



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## ENDNOTES

- <sup>1</sup> “The Aggregate Claims Distribution and Stop-Loss Reinsurance” published in the Transactions of the Society of Actuaries, Volume XXXII, 1980, pages 523–545.) <https://www.soa.org/library/research/transactions-of-society-of-actuaries/1980/january/tsa80v3215.pdf>
- <sup>2</sup> “An Overview of the Panjer Method for Deriving the Aggregate Claims Distribution,” Lloyd Spencer [http://www.actuary.org/pdf/external/panjer\\_spencer.pdf](http://www.actuary.org/pdf/external/panjer_spencer.pdf)