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Estimating Worksite Mortality—

A Structured Approach

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For the pricing actuary, estimating worksite mortality is a challenging task. This kind of coverage has characteristics of both individual and group insurance because it is an individual policy that is sold at an employee's place of employment. Additionally, life insurance sold in the workplace is a voluntary benefit, meaning participants elect to purchase the coverage and choose the coverage amount. The voluntary nature of this insurance creates the opportunity for antiselection

because individuals in poor health will elect coverage more often than healthy individuals. On the other hand, insurance company underwriters accept or reject the best risks based upon the information contained in the application. The result is two competing forces driving worksite mortality: antiselection by the applicant population and protective selection by the underwriters.

The problem for the pricing actuary is that the two competing forces are compounded by two elements of the product design process: the number of questions on the application used by the underwriters to select the best risks and the minimum required participation level. Agents want to streamline the sales process by removing as many questions from the application as possible. Removing questions from the application reduces the probability that underwriters can identify a substandard individual. Additionally, the worksite group may have differing levels of participation. Participation is the percentage of the employees at the worksite who apply for insurance. The lower the participation rate, the greater the intensity of anti-selection, because a limited number of substandard individuals will be a larger percentage of the insured population. The pricing actuary is often required to answer questions such as:

- "What is the impact on mortality if we streamline the application by removing a question about prescription medication?"

- "If we lower our required participation from 40 percent to 30 percent, how much will our mortality and resulting premiums increase?"

One solution is to divide the actively at work population into risk classes and view each selection decision as a screen that eliminates individuals in each risk class. For this case study the population is divided into three risk classes: standard risk with 100 percent of standard mortality, substandard risk with 300 percent of standard mortality, and HIV positive risk with 2000 percent of standard mortality. An HIV-positive risk is used in this example because this risk represents a "mortality time bomb" that is identifiable through a question or blood test. The first screen in the process is the employee electing to purchase coverage. It is reasonable to assume that substandard individuals will elect coverage more frequently than standard individuals. This screen will skew the applicant population toward the substandard risks. The second screen is the underwriting process that further reduces the applicant pool. In opposition to the application screen, the underwriting screen selects individuals who are standard and weeds out substandard individuals, skewing the insured population back toward the standard risks.

The process involves six steps:

1. Estimate actively at work mortality
2. Estimate the actively-at-work risk class distribution
3. Calculate a standard risk mortality table
4. Estimate the participation rate
5. Estimate the underwriting acceptance rates
6. Calculate the insured mortality table

This process has been used successfully to price worksite products. The following example should be considered illustrative and uses assumptions that do not reflect any particular product or pricing situation. It is critical to develop the assumptions in each stage of the process using professional judgment while considering the impact of the target market and product characteristics.

Step 1: Estimate Actively-at-Work Mortality

One of the key mortality advantages of life insurance sold in the worksite is that all the applicants are actively at work. Employees pass through a powerful screen by showing up for work regularly. Major mortality risk factors such as terminal cancer or serious drug abuse are reduced because it is difficult for these individuals to remain full-time employees.

The problem facing the actuary is selecting an appropriate actively-at-work mortality table. The requirements for this mortality table are that it:

- Reflects current experience
- Is sex and smoker distinct and
- Reflects the actively-at-work selection criteria.

Both the actuary and underwriter must evaluate the target market, evaluate the risks of the target industry and adjust the actively-at-work mortality tables accordingly. This method can be applied equally to insurance for miners or insurance for office workers if the actively-at-work mortality table is adjusted correctly.

Step 2: Estimate Distribution for Actively-at-Work Ratings

The actively-at-work population contains both standard and substandard risks. Substandard risks are more likely to purchase insurance than standard risks in the worksite as they face stricter underwriting standards and higher rates if they decide to purchase insurance as an individual. For this reason is it critical to estimate the number of lives in each risk class.

Input from the underwriting department is critical for this step. Underwriters can use information from fully underwritten applications and industry statistics to estimate the distribution of the actively at work risk class distribution. Table 1 shows the assumed distribution for this case study and how the lives are distributed into the risk classes.

Table 1: Actively-At-Work Risk Class Distribution

Risk Class	Numerical Rating	Actively-at -Work Lives
Standard	100%	950
Substandard	300%	45
HIV Positive	2000%	5

Step 3: Calculate the Standard Mortality

The third step is to calculate the mortality for a standard, 100 percent rated, individual. The conservation of deaths principle says that the actively-at-work population can be broken into risk classes and the result must sum to the population mortality, creating a unique mortality rate each year. The net effect is to have one unknown, the standard mortality rate, per year. Subsequent mortality rates can be estimated by a bootstrapping method. Table 2 illustrates the method.

An important point is that the standard mortality rates calculated in this step are not the mortality rates used for pricing the worksite product. The “standard mortality rate” represents the mortality table for a fully medically underwritten product. The following steps adjust the standard mortality rate for both underwriting selection and participant anti-selection to arrive at an insured mortality table that can be used in product pricing.

Step 4: Estimate the Participation Rate

The fourth step is to estimate how many individuals in each risk category will apply for insurance. For this case study Table 3 shows three scenarios: 20 percent, 40 percent, and 60 percent participation rates. Twenty percent participation means that 20 percent of the standard risk class elects to

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Table 2: Actively At Work Standard Mortality Calculation

Year	qx At Work	At Work	Standard (100%)	Substandard (300%)	HIV+ (2000%)	Qx (100%)
			Number of Lives			
0		1,000.00	950	45	5	
1	0.001185	998.82	950 * (1-q1) =949.05	45 * (1-3 * q1) =44.87	5 * (1-20 * q1) =4.90	0.001
2	0.002366	996.45	947.15	44.60	4.70	0.002
3	0.003538	992.93	944.31	44.19	4.42	0.003
4	0.004695	988.27	940.53	43.66	4.07	0.004
5	0.005833	982.83	935.83	43.01	3.66	0.005

Table 3: Participation Rate

	Standard	Substandard	HIV+	Aggregate
20% Participation	20%	70%	70%	22.5%
40% Participation	40%	80%	80%	42.0%
60% Participation	60%	90%	90%	61.5%

apply for insurance. The substandard risks have a higher participation rate as they know that they are receiving value. However, it is unlikely that every member of a risk class, even severely impaired classes, will apply for insurance. There are some individuals that will not elect to purchase insurance regardless of the economic value. The application rate for impaired risks should be bounded between the standard participation rate and 100 percent.

It is important to note that the 20 percent participation scenario will generate an aggregate participation rate greater than 20 percent because the substandard risks elect to purchase insurance more frequently than the basic 20 percent. If an aggregate participation rate of 20 percent is required, you can solve for the standard rates that will yield a 20 percent aggregate participation rate.

Step 5: Estimate the Underwriting Acceptance Rates

The underwriting acceptance rate is the percentage of applicants who are accepted for life insurance. All the standard individuals should be accepted by the underwriting screen. For substandard individuals there are three ways that they can pass through the underwriting screen:

- The underwriting questions do not identify them as substandard
- The individual knowingly commits fraud
- The individual is ignorant of his/her health conditions

The first situation gives the actuary an interesting basis for dialog with the underwriter. The conversation could go something like this:

Actuary: You say we have a 50 percent chance of identifying and rejecting a substandard individual. What can we change to move that percentage to 70 percent?

Underwriter: Adding an additional question about prescription medications will move that percentage to 70 percent.

Actuary: Our producers are asking for a shorter application. What is the impact of eliminating the question about medical treatment in the last five years?

Underwriter: Given the protective value of the other questions, that change will result in identifying and rejecting 30 percent fewer substandard risks.

Table 4 shows a sample underwriting acceptance rate.

Table 4: Underwriting Acceptance Rate

	Standard	Substandard	HIV+
Guarantee Issue	100%	100%	100%
Simplified Issue without HIV Testing	100%	50%	100%
Simplified Issue with HIV	100%	50%	0%

Table 5: Insured Mortality

Year	Standard lx	Substandard lx	HIV+lx	qx Insured	qx I/qxg
0	950*40%*100% =380	45*80%*50% =18	5*80%100% =4	-	-
1	380*(1-0.001) =379.62	18*(1-0.003) =17.95	4 * (1-0.02) 3.92	0.001279	107.90%
2	378.86	17.84	3.76	0.002550	107.76%
3	377.72	17.68	3.54	0.003803	107.50%
4	376.21	17.47	3.25	0.005028	107.11%
5	374.33	17.20	2.93	0.006219	106.62%

Table 6: First Year Mortality Ratios

	20% Participation	40% Participation	60% Participation
Guarantee Issue	132.96%	114.12%	107.23%
Simplified Issue without HIV Testing	123.91%	107.90%	102.27%
Simplified Issue with HIV Testing	97.31%	92.02%	90.18%

Step 6: Calculate the Insured Mortality Table

Calculating insured mortality involves projecting the number of lives in each risk class and using the total number of lives to construct an insured mortality table, as shown in Table 5.

Expressing the resulting mortality as a percent of the actively-at-work mortality illustrates the combined effect of anti-selection and underwriting selection. A percentage less than 100 percent means that the underwriting selection predominates. A percentage greater than 100 percent means that applicant anti-selection predominates.

Perform What-If Analysis

When pricing worksite products the actuary often has to quantify the answers to “What-if” questions. What if we change the minimum participation requirement? What if we change the level of underwriting? Table 6 illustrates how this process allows the actuary to quantify the impact on mortality of different proposed product designs.

Conclusion

There are many factors that are critical to the success of this process.

- Input from the underwriting department is critical for both estimating the risk distribution of the actively-at-work mortality and the underwriting screen.
- It is critical to recognize that the standard mortality table created in step three is not the table used for pricing the coverage. The table must be adjusted for participation and anti-selection to produce insured mortality.
- Cooperation and understanding between the underwriters and actuaries is critical.
- At the end of the process, the insured mortality must be reasonable. ☐

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