Insurance Pricing: from theory to reality

Rahim Mahmoudvand¹
Bu-Ali Sina University, Hamedan, Iran

Abstract

Risk is an inevitable part of the world that can be found in different forms around us. We may be able to control the negative effect of some risks. But, insurance is an appropriate method that can be used for treating many different types of risks.

Insurance pricing is a pivot in insurance industry as it is associated to all stakeholders. Insured, insurers and other stakeholders of the insurance industry follow up insurance pricing carefully. However, in most cases, the insurers implement insurance pricing. The price of insurance is normally a function of the cost of production. Unlike of many products, the costs of insurance products are not fixed and depend on a range of factors.

In this paper, I have investigated the mechanisms by which these factors associate with insurance pricing. Then, I tried to identify drawbacks of these mechanisms.

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1 Introduction

We all understand the meaning of risk but surprisingly there is no definition for risk that is agreed by all researchers. A relatively common definition for risk says that it is a condition in which there is a possibility of an adverse deviation from a desired outcome that is expected or hoped for; see Voughan and Voughan (2013).

Core feature of insurance is sharing risk in exchange for payment. Insurance pricing is a methodology for determining the price of risk for insured. An appropriate pricing ensure that insurance company set fair and adequate premium given the competitive nature. Simplicity and stability are two other criteria that assumed to be satisfied in insurance pricing. In my opinion, an important question in insurance pricing is about the meaning of “fairness”. Our understanding by fairness is driven by both culture and legislation. From viewpoint of insurers, the fairness tied up with cost of the insurance product. In this paper, I want to discuss about the cost of the insurance product

2 Main results

Let me start with the list of costs in insurance pricing. There might be a long list for the cost of insurance, but these are categorized as below:

- Losses and loss adjustment expenses,
- Acquisition expenses,
- Administrative expenses,
- Taxes,
- Profits and contingencies.

Actuaries commonly focus on the first item. This can be understood from main actuarial journals. For instance, I checked four famous actuarial journals (see Table 1). First, I found the total number of publications from Scopus (https://www.scopus.com/sources?zone=TopNavBar&origin=sourceinfo) for each journal. Then, I decided to see all publications in each journal. Unfortunately, I couldn’t access to all contents so I just tried to look at their recent publications. My conclusion is that the main focus of the publications is on losses and loss adjustment expenses. One can complete this checking to find an exact estimate of the percentage of the publications on losses and loss adjustment expenses.

Table 1: A sample of actuarial journals

<table>
<thead>
<tr>
<th>Journal</th>
<th>Starting year</th>
<th>Number of papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scandinavian Actuarial Journal</td>
<td>1918</td>
<td>1964</td>
</tr>
<tr>
<td>ASTIN Bulletin</td>
<td>1958</td>
<td>1247</td>
</tr>
<tr>
<td>Insurance Mathematics and Economics</td>
<td>1992</td>
<td>2051</td>
</tr>
<tr>
<td>North Actuarial American Journal</td>
<td>1997</td>
<td>959</td>
</tr>
</tbody>
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The other sources of theories are books. I also checked several books in the area of actuarial science. Figure 1 shows four famous actuarial books. Again the conclusion was similar to the results that I got by review of the journals.

Figure 1: A sample actuarial book

Let us to see what theories we use for insurance pricing. Denote by random variable $X$ the total incurred losses with an insurable risk. Then, $\pi_X$, that is called “premium”, will be defined as below:

$$\pi_X : S_X \rightarrow \mathbb{R}^+,$$

(2)

where $S_X$ is the support of r.v. $X$. Finding $\pi_X$ is based on the assumption that a contingent claim expenses can be compensated by fixed payments which is indeed the premium. Several common forms for $\pi_X$ are given in Table 2.

<table>
<thead>
<tr>
<th>Name</th>
<th>Formula</th>
<th>condition</th>
</tr>
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<tbody>
<tr>
<td>Expected value principle</td>
<td>$(1 + \rho) \times E(X)$</td>
<td>$\rho &gt; 0$</td>
</tr>
<tr>
<td>Standard deviation principle</td>
<td>$E(X) + \alpha \times \sigma(X)$</td>
<td>$\alpha &gt; 0$</td>
</tr>
<tr>
<td>Variance principle</td>
<td>$E(X) + \beta \times \sigma^2(X)$</td>
<td>$\beta &gt; 0$</td>
</tr>
<tr>
<td>Zero utility principle</td>
<td>$\pi_X = \pi$; where $E[u(\pi - X)] = u(0)$</td>
<td></td>
</tr>
</tbody>
</table>

In these approaches, mean and variance of $X$ cover incurred losses and parameters $\rho, \alpha$ and $\beta$ applied to capture other costs of the insurance product (items 2-5 in above mentioned list). In order to find mean, variance and higher
moments of $X$, we require knowing loss distribution. There is a vast literature on this topic. The above mentioned books include many good references. Studies on determining $\pi_X$ can be divided into two categories:

- Structural form of $\pi_X$ and their characteristics,
- Computational issues.

Theoretically, a premium principle is desirable for insurer if it develops an adequate premium return. However, literature shows that most of business lines prefer to use expected value principle. Almost all life insurance products use expected value principle. Posterior rate making such as Bonus-Malus Systems are indeed based on the expected value principle. I think the main reason for this choice is the challenges that we have in practice when we want to use other principles. By the way, simplicity and flexibility of expected value principle provide several advantages. For instance, using GLM and Bayes theorem one can improve the level of fairness with this principle. These tools can be used to model variability of losses by risk factors. Such aims can be indeed achieved when we have access to data. Nevertheless, the problem of the creditability of insurance data is one of the most fundamental problems for the non-life actuary. But in the last few years, the impact of big data on the assessment of individual risks results in a growing debate on what is a fair actuarial price; see. e.g. Martinez et al, 2016.

Now, let me give a brief discussion about other sources of insurance cost. Acquisition expenses are agent’s commission which is very common in life insurance. This cost is not stochastic, but it could be reduced by new technologies partly. Administrative expenses include costs other than losses and acquisitions and seem to be fixed. But in practice these costs depends on the quality of insurer’s workforce. Taxes are percentage of the total premium, so higher costs produce higher taxes. The last item is a hoped-for return on capital.

Let come back again to the expected value principle. The parameter $\rho$ included in this premium principle to capture all costs other than losses and adjustment losses. The above discussion on the insurance costs show that $\rho$ vary by company for the same insurable risk. So, the total premium for a unique risk may differ dramatically and this is in contradiction with fairness.

References


Email: r.mahmodvand@gmail.com