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Basics of Life Insurance Development. Construction of Life Continuity Functions

Khamroeva Dilsuz Yakhoevna
PhD student of the Faculty of Economics of the National University of Uzbekistan,
lecturer of Turon Zarmed University.
Email: mohlaroyim261218@gmail.com

Annotation: In this study, protection against unpredictable accidents that occur on the basis of insurance activity planning, reduction of losses from these events, the role of life insurance in the insurance market, table of life expectancy and the necessity of constructing life expectancy functions has been studied.

Keywords: Life insurance, long term and short term life insurance, rent, GDP, GNP, actuarial mathematics, life expectancy curves.

INTRODUCTION.

Today, in our country, it is necessary to further develop the financial market, expand the scope of coverage of the population with quality financial services, support the activities of insurance organizations, create favorable conditions for protecting the rights and legal interests of consumers in this area, as well as , measures to expand insurance types and increase consumer confidence in insurance, thereby increasing insurance income, are being implemented consistently.

As you know, insurance of investments, cash, property, life etc. is a common practice all over the world. The global cataclysms and crises of the last 10-15 years have shown how dangerous this business is and how important this sector is in the social sphere (social security, security, etc.).

Actuarial science studies insurance and its mathematical and theoretical foundations are classified as actuarial mathematics. One of the main tasks of actuarial mathematics is to establish the optimal ratio between the insurance premium (the money the policyholder pays to the insurance company) and the payment (the money the company pays when a certain insured event occurs). Of particular interest is the part of insurance called "personal insurance". This type of insurance includes health and life insurance.

In calculations related to life insurance, as well as in the formation and modeling of insurance and pension schemes, actuaries widely use tables called life tables (TLE-life expectancy tables). For example, using the table, it is possible to determine what reserve the insurance company should have when insuring a homogeneous group of people aged 25-55. An important feature of simple tables is that TLE is compiled as a range of whole values of human age. This, in turn, causes certain inconveniences in actuarial calculations. First, these tables have a large size with many parameters. Secondly, TLE does not have the possibility to be used directly in calculations related to non-integer values of a person's age. For this reason, it is important to construct lifetime functions.

LITERATURE ANALYSIS AND METHODOLOGY.

A number of conditions have been presented regarding the importance and necessity of finding a simple analytical formula to describe population mortality [2]. The main points in this regard are as follows:

1) Like many physical phenomena described by simple formulas, there are several biological arguments in favor of the existence of analytical laws for the process of population extinction;

2) From a practical point of view, it is more convenient to work with a function with several parameters than to deal with TLEs that are large in size;

3) It is often easier to reconstruct the Lifetime Function if there are assumptions about its parameters than to construct the TLE.

Thus, it is natural to consider the problem of finding an adequate analytical law of mortality that fits the data observed in reality. However, when solving such problems, researchers usually follow the following general principles [4]:

1) The principle of theoretical validity. Finding an equation that has theoretical foundations, i.e. connections arising from various theoretical concepts.

2) The principle of universality. The desire to define a general function that applies to the widest range of natural phenomena. In accordance with this principle, the general laws of life span distribution, which apply to various organisms, including humans, are of particular importance.

3) The principle of sufficient approximation with the least number of parameters. The formula that meets this principle gives the most compact view of the data, which allows to restore the distribution with a minimum number of observations.

4) The principle of local description. If the proposed law of distribution of life expectancy is valid only for a limited age range, this is not yet a reason for a critical attitude towards it. The limited application of a law does not show that it is wrong, only that it is a special case of another, more general and as yet unknown law.

Life expectancy curves

The uncertainty or unpredictability of death, illness, or accident is not only a major risk factor but also a source of randomness in life insurance. It allows the use of random events, quantities, processes in mathematical analysis of various aspects of life, health, car insurance, etc. At the same time, the creation of an adequate theory of life insurance should begin with the development of a system of concepts and quantification, which allows making objective conclusions about life expectancy. The main conclusion here is as follows, it is difficult to say anything definite about the death of a person, as a rule. However, if we consider a sufficiently large homogeneous group of people without being interested in the fate of individual people in this group, we are within probability theory as the science of mass random events with the property of frequency stability (for example, normal or Poisson distribution laws approach etc.). Therefore, using the terminology of probability theory, the life expectancy X is entered as a random variable - a random variable.

Let X- denote the life expectancy with $P(X>0)$=1. Distribution function for X tm describing the complete characteristic, nature of X tm

$$F(x)=P(X\leq x) \qquad (1)$$

let it be

In actuarial mathematics, it is common to consider a function that complements (1) and is called the survival function:

$$S(x)=P(X>x)=1-F(x).$$

This is the probability that a person will live to (maturity) x years.

The life expectancy function as an additional function to the distribution function of X has the following characteristic properties:

1) $S(x)$ is not increasing and ;$0 \leq S(x) \leq 1$

2) $S(0)=1, S(+\infty)=0;$

3) $S(x)$ continuous from the right.

However, for the actual process of death, properties 1) and 3) are slightly modified. In fact, the function of life duration must strictly decrease, otherwise there will be a certain period in a person's life, for example, $d_x=x_i-x$, he will not die. Besides, $S(x)$ must be continuous, otherwise in human life it will be the instant of death x_0 with non-zero probability:

$DR=S(x_{0-})-S(x),$

$$S(x_{0-}) = \lim_{x\to x_{0-}} S(x),$$

$$S(x_0) = \lim_{x\to x_{0+}} S(x).$$

Also, since X has a limited real life span, it is usually assumed to be finite at age a (as a rule, a=100, 120 years), so $S(x)$ $x>a$ for $S(x)=0$.

The lifetime S(x) has a simple statistical meaning. It is equal to the average percentage of a certain constant group of newborns who survive to the age of x [6].

According to the general property of probability theory, according to the stochastic nature of a continuous random variable, its density is . $f(x)$

$$f(x) = F'(x) = -S'(x)$$

The intensity of death (life expectancy) is determined as follows:

$$\mu_x = \frac{f(x)}{1-F(x)} = \frac{f(x)}{S(x)} = -d\ln(S(x)).$$

Obviously, it has the following properties [7]:

$1)\mu_x \geq 0$

$2).\int_0^\infty \mu_u du=+\infty$

Together, these functions are commonly referred to as the mortality (life expectancy) curve. Since mortality curves provide a general description of the decline of a given group of observations in a population, great importance is attached to finding an adequate model [6]. These types of curves are hypothesized based on demographic hypotheses.

Some analytical laws of death have been studied in several works,

$S(x) = 1 - \frac{x}{\alpha}$ De Moivre Model (1729)

$S(x) = \exp[-B(e^{\alpha x} - 1)/\alpha]$- Gomperts model (1825)

$S(x) = \exp[-\mathrm{A}x - B(e^{\alpha x} - 1)/\alpha]$ Makeham Model (1860)

$S(x) = \exp[-\mathrm{A}x - \mathrm{H}x^2/2 - B(e^{\alpha x} - 1)/\alpha]$ Makeham model 2

$S(x) = \exp[-\mathrm{k}x^{\beta}/(\beta)]$- Weibull model

$S(x) = \exp[-(x/\alpha)^{\beta(x)} - \text{Veon modeli}$ (2003)

Life expectancy functions have been proposed in various forms by Perks (Perks, 1932), Beard (Beard, 1959-71), Vaupel (Vaupel et al., 1979), Bras (Le Bras, 1976) and Cannisto (Cannisto, 1992). proposed models [1].

DISCUSSION AND RESULTS.

We model the distribution of random variable life expectancy X on the basis of life expectancy tables compiled for the general population of Uzbekistan (men and women). In this case, it is taken as *a*=100. in cases where it is a constant and a function of time, the parameter b is considered separately.

In the first case, β≈0.445. If is a function of time, then the corresponding curve is: β

$$\beta_n(x) = \frac{-0.00000029x^5 + 0.0000674x^4 - 0.00516x^3 + 0.1674x^2 - 2.197x + 12.09}{x + 7.45923}$$

where are the corresponding coefficients of the rational polynomial $\beta_n(x)$ found by the method of least squares. A joint representation of the corresponding analytical model and the empirical distribution functions of the observations is as follows (Figure 1).

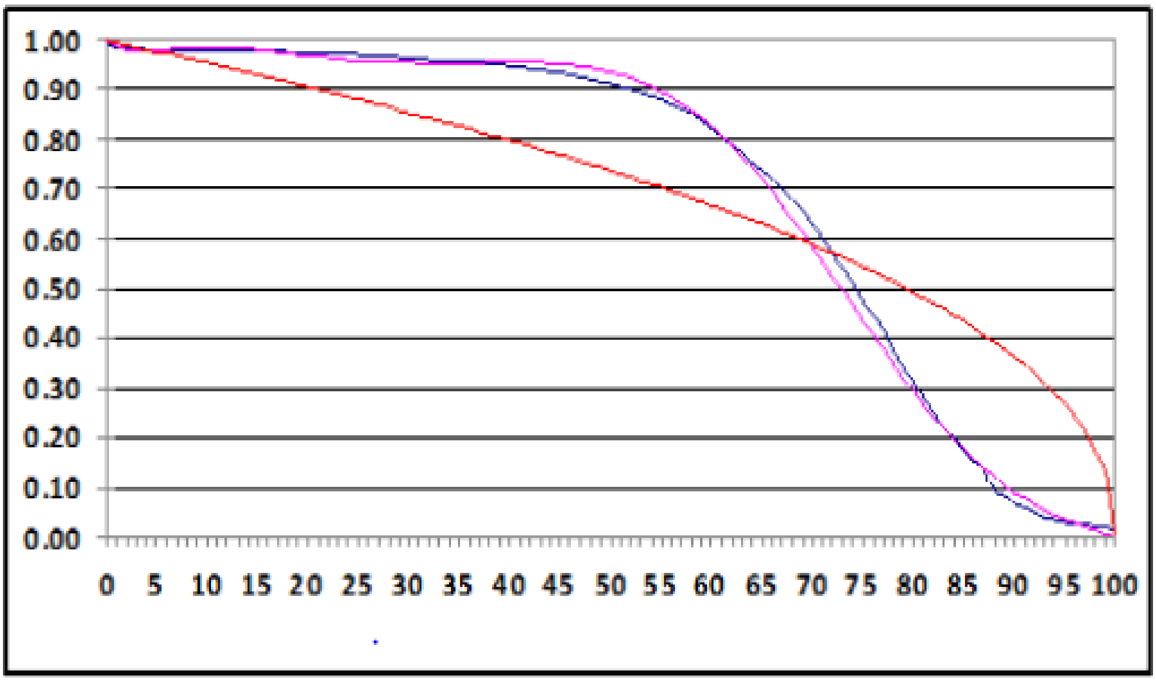

Figure 1. Joint plot of the constructed model and empirical life expectancy distribution function.

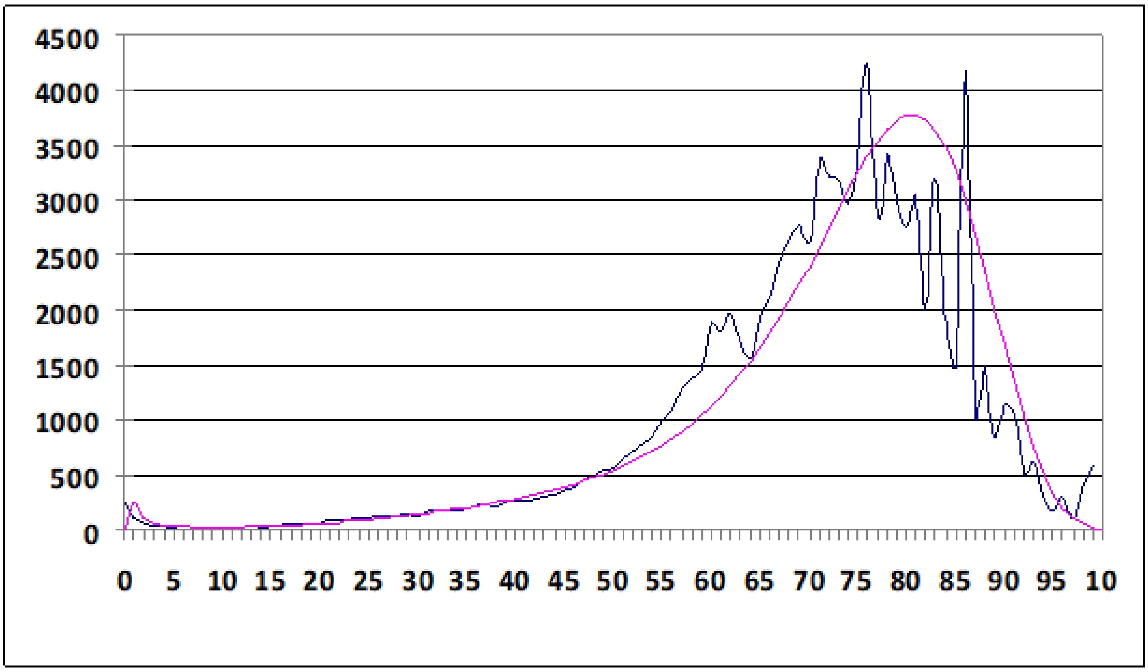

Figure 2. Combined observation histogram and model density plot.

CONCLUSION.

Actuarial-friendly life expectancy functions provide solutions to a wide range of problems in life insurance calculations. This is much more convenient than Life Duration Tables. TLE cannot be used directly in calculations involving non-integer values of a person's age. For this reason, it is important to construct lifetime functions.

Through the above results, it is possible to use this model not only in economics and mathematics, but also in demography and biology. Life expectancy curves are of great importance in finding an adequate model, as they provide a general description of the decline of a given set of population observations.

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