ACTUARIAL ESTIMATION OF TECHNICAL PROVISIONS' ADEQUACY IN LIFE INSURANCE COMPANIES

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ABSTRACT:

When considering company doing business quality it is necessary to evaluate the amount of money that company can operate with. Insurance companies, regarding to all specifics of their business, have to evaluate all technical provisions of the company. Technical provisions, as part of the liabilities in insurers' balance sheet, are basic measure of business operations quality and safety (i.e. they are the basic guarantee that all obligations to customers will be settled). Technical reserves are different in dealing with the life insurance business and non-life insurance business. This paper will treat only the means of technical provisions of life insurance. Technical provisions and their requested amount can be determined theoretically by whole range of actuarial methods, but in practice only few of them are identified as the most reliable, and those calculation principles are part of regulation institutions directives. Mentioned directives are different from one country to another, but in this paper special retrospective is given to European Union with appropriate comparisons with other relevant examples. In assessing the quality of insurance business, other that technical provisions' level, it is important to estimate the insurers' solvency margin. Solvency margin primary mission is to ensure sufficient amount of funds so that all insurers' obligations can be reconciled properly. Solvency margin is the ratio between available and required amount of insurance funds. The amount of required funds is quantified measure of risk of all insurance contracts that are active if insurance company portfolio. If technical provision funds are being estimated by reliable actuarial methods, than it is prerequisite that the solvency margin will be determined properly. Appropriate solvency margin is an indicator of safety and good business operations of insurer.

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INTRODUCTION

Insurance is one of the oldest activities in which people were engaged from the creation of civilization. Of human origin, evident are risks that people, their health, life or property were exposed. When human society has reached the intellectual level at which they recognize, not only natural, but also the financial aspects of protection against risks, they developed the first forms of business insurance. In the broadest context, insurance is defined as a form of individual risk management. This claim is justified by the definition of insurance as well. By definition insurance is the method of risk transfer from the insured to the insurer. Premiums, paid by the insured, are the prices of risk defined by the insurer. Insurer assumes the risk that should be the future, an event that is uncertain and independent of the will of the insured or insurer.

Given the primary determinants of insurance, primary insurance division, according to the criteria of the insured risk, is in the life and general insurance. Classical studies have argued that the life insurance provides only one risk, the risk of death. If the insured risk is set in the context of (un)certainty, it is obvious that this was uninsurable risk (the classic statements provide only uncertain, future risks). The risk of death is sure and certain risk (probability is 1). Uncertainty is at the time of onset of risk. In this segment there is a space for life insurance. Thus, life insurance ensures the risk of death, precisely the moment of its realization.

Life Insurance distinguishes two types of insurance: insurance annuities (recurring payments) and insurance of one-off payment. By insuring one-off payment, the risk of death that is being insured can be viewed as a simplified risk of premature death. If the insured's death appears early, it is unlikely that the amount of premium that is paid is enough to pay all obligations of the insurance company. On the other hand, by insurance annuities, the insurance risk of death is reduced to a potentially insured's life is too long. In this case paid premiums are not sufficient to pay the contractual liabilities of insurer. In order to insurance companies could pay the insured all anticipated contract amounts of assets, it is necessary to form the provision. Depending on where exactly the type of life insurance is being thought, differ and reserves.

TECHNICAL PROVISIONS OF INSURANCE COMPANIES

Technical reserves of insurance companies represent the amount of money that will be a guarantee that all obligations of insurers will be reconciled. Determining

the level of technical provisions is very complex job that entrusts the actuaries in insurance companies. Actuaries are generally responsible for assessing the level of risk in insurance companies.

Technical provisions are formed from the payment of premium of the insured. Premiums paid by the insured are calculated to provide risk insurance coverage. Of each premium paid, insurer is mandatory that part of the money set aside as funds of the technical provisions. Formation of technical provisions fund und is required in most national economies, and is defined by legislation. In the countries of the European Union the means of technical provisions, their composition and treatment are defined by EU directives.

Technical provisions vary depending on the type of insurance. Here you will be given an explanation for the technical provisions of life insurance. Differentiation of reserves is a consequence of the different maturity of the contracts in mentioned types of insurance. Life insurance is a type of insurance that is long-term, and also reserves that are formed for this business are long-term reserves. Life insurance technical provisions primarily include mathematical provision of life insurance (whose integral part is provision for unearned premiums which, if necessary, can be expressed separately). Also, the life insurance provisions include provisions for bonuses and discounts in the contract.

Provisions for unearned premiums is formed as the amount of premiums charged that part which relates to insurance coverage for the period of insurance after the accounting period for which is the provision calculated. This provision is calculated by sufficiently cautious actuarial methods. Legal regulation of the EU does not require separate calculations and display of provisions for unearned premiums.

MATHEMATICAL PROVISION

Mathematical provision is the most important part of technical provisions of insurance companies engaged in business of life insurance, as well as for companies whose insurance businesses have savings component.

To understand the essence of the need and importance of the formation of technical provisions, it is necessary to explain the meaning and the emergence of mathematical provision. Premiums paid by the insured in insurance reflect the level of risk. If you are considering life insurance premium, then it is regarded as a reflection of the high risk of death that insured are exposed. Risk assessment is

done on the basis of mortality tables and interest rates provided. According to the above-mentioned definition of the premium, it was quite logical that over the years higher premium should be paid. Biological aging body conditions increase the risk of mortality of the people and in accordance the amounts of pure premiums we pay should increase with age, which still means that in the last year the highest insurance premiums should be paid. It is known that the intensity of work processes in the life expectancy decreases with age. In this context reduces the amount of money at the disposal. Given the nature of cash flows in every human life, the practice of insurance realized that insurance premiums that at all times properly reflect the level of risk of death where a person is exposed to (natural premium) is neither practical nor acceptable. It was concluded with the traditional mindset that is most acceptable to each person paying the same premium over the validity of insurance contracts. This premium is called the average premium and it is calculated as the average value of pure natural premium. It is easy to conclude that at the in the first years of the obligation the average premium is always higher than the natural premiums as at the beginning of the obligation the exposure to risk of death is the smallest (the person is the youngest). After that, the natural premium increases with the increasing age of insured and slowly approaching the value of the average premium. In those years, amount of funds is formed by the insured paid premium, but that fund is currently completely not used to cover the risk. Such is forming the fund reserves, which are called mathematical provisions. In a period of time natural premium was increasing so that becomes equal to the average premium, and after that it becomes even higher. In the second half of the obligation average premium paid by the insured is often insufficient to cover all risk which the insured is exposed, but for these purposes then is used the funds accumulated in previous years - means the mathematical provisions.

Thus, out of the total amount of the premiums established insurance company one part will always be used to cover the risk of death, and the other part, which is not required to cover the risk, will not be used. The first part of the premiums used to cover the risks in this year's risk premium while the second part of the premium is savings. Risk premium increases with age, which is understandable because it increases the likelihood of death, but will never be as high as natural due to premiums and savings components. The insurance company collects a premium from the first year when the contract was concluded, and so form a reserve. So the insurance company bears the risk of only one part of the sum insured for the remaining part of the premium collected is no longer at risk. According to the standard definition

of the mathematical provision it is the difference between the present value of all future obligations of insurance contracts by the assurance of life and the present value of future policyholder obligations on these contracts[1]. This definition is based on the concept of time and is called a prospective definition of the mathematical provision. Except in this way, the mathematical provision can be defined as the difference between payment of insured and payments of insurer under the assumption that all payments due is paid in the accounting year and that all payments are made as to the tables provided[2]. This definition has an accounting character a name and a retrospective definition. Another definition of the mathematical provisions said that provision is to be the sum of the actual, savings premiums with interest rate[3]. Each of these definitions may indicate the use of certain methods for the calculation of provisions. Mathematical provisions can be calculated when necessary, and theoretically it is possible to determine the value of mathematical provision on any day during the business year.

With regard to determining the value of time during one year term insurance mathematical provisions can be divided into: the final, initial or average[4]. The final mathematical provision is a reserve at the end of the year during the period of insurance. Starting or initial mathematical provision is a reserve at the beginning of the year. Starting backup is obtained as the sum of the final reserve at the end of the previous year and annual insurance premiums for the current year. Average provisions are finite and the average value of initial reserves.

When calculating the mathematical provisions, it is important to note that the reserve is calculated for each contract concluded separately.

The theory of insurance and actuarial science identifies a range of net and gross, of individual and group methods of calculating mathematical provisions while the practice and profession adopted the use of only some of which is verified legislation.

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[1] Bylaw on technical provisions, Official Gazette of FBiH, number 80/06

[2] Veselinović V.: Osnovi osiguranja na život, kombinatorike i računa verovatnoće, Prosveta, Belgrade, 1946. p. 94.

[3] Šain Ž.: Optimizacija i upravljanje premijskom rezervom životnog osiguranja, PhD thesis, Ekonomski fakultet u Sarajevu, Sarajevo, 2003. p. 174.

[4] Ćurak M., Jakovčević D.: Osiguranje i rizici, RRiF, Zagreb, 2007., p. 266.

Methods of calculating mathematical provisions are based on the principles of net retrospective and prospective methods. Net based method for calculating take the net premium (i.e., based solely on data from mortality tables and interest rate). Another type of method takes into account costs of insurance and thus the basis for the calculation of gross premiums. Methods based on the principles of the gross premium are reserve premium method (Zillmer method[5]) and methods sufficient premium. Of course it is possible to use different methods with different computational bases of which the most popular Dawson's selection and ultimate methods.

The second division of the mathematical provisions calculation method is on individual and group ones. Within individual methods is possible to differentiate retrospective, prospective, accounting or recursive methods. Group methods of calculation are divided into methods that give an identical result to that which is obtained using individual methods and the methods by which to obtain the approximate result is compared to that which is obtained using individual methods[6].

Retrospective method of calculating mathematical reserves by one insurance contract is defined as the difference between the payments made by the insured until then ($U_d U_d$) and all payments made by the insurer until then ($I_d I_d$). It is important to say that both values should be reduced to a moment in time where the search value of mathematical provision. Can be written that ${}_tV_x = U_d - I_d$ ${}_tV_x = U_d - I_d$ where expression clearly shows that it is a "back view"7. So, for the calculation of mathematical provisions data from the previous period (payment of the insured and insurer payment) are used. With the retrospective method of determining the mathematical provision it is necessary to take into account the time period for which the calculation is done, the premium payment period and sum insured payment period. With this method of calculation for certain insurance models can be derived certain rules (the case with the insurance model based on a single payment of premiums).

Prospective method of calculating mathematical provisions by one insurance contract is defined as the difference between all future payments insurance ($I_b I_b$) and all future payments the policyholder ($U_b U_b$) are reduced to a time when the mathematical provision is calculated. Can be written that ${}_tV_x = I_b - U_b$

[5] Mathematical provision calculating method is named by German actuary Zillmer (1831.-1893.)

[6] Ralević R.: Finansijska i aktuarska matematika, Savremena administracija, Belgrade, 1975. p. 233.

[7] Šain Ž.: Ibidem, p. 175.

$_tV_x = I_b - U_b$ where expression clearly shows that it is a "pre-view" 8. Calculation of reserves by this method is exclusively based on data from future time period (payment of insurance and payment of the insured). As with the retrospective method of determining the mathematical provisions, and here is necessary to look at the time the term for which the calculation is done, the premium payment period and the period of payment of insured amount.

If the same contract shall calculate the mathematical provision at the same time by these two methods results should be identical.

Accounting or recursive method based on calculating the mathematical provisions in the observed time based on data from the previous year. By this method a mathematical provisions at the end of the business year is calculated as the sum of the mathematical provisions of the previous year and all additional premium charged together discounted by interest rate that is used with data from mortality tables. From this sum subtract all payments to insured. This method of calculating mathematical provision is used primarily by insurance where the premium variable and in situations when the reserve is calculated in advance for the entire duration of insurance.

Group methods of calculating mathematical provisions are used for the calculation of the premium reserve for a certain group life insurance. Modern business practices and ways of life imposed by the need for all perform certain tasks faster. In this sense, the individual methods of calculating mathematical provisions are no longer acceptable without the support of modern information technology. Group methods save time by obtaining acceptable results. As already mentioned group methods can be split into two groups: methods which give identical result to that which is obtained using individual methods and those that provide approximate results.

The first group of methods with an identical score includes Karup's method, Altenburger's method (a method of extra numbers), Whiting's methods and Fouret's method.

Karup's method is based on the principle that the group defines the calculation of mathematical provision so as not to deviate from the individual calculations. Therefore, all forms that can be used for individual calculation of mathematical

[8] Ibidem, p. 178.

provision may be by the Karup method used as well with certain adjustments. This method of calculation is very acceptable and satisfactory accurate and is one of the most commonly applied group methods for calculating mathematical provision.

Altenburger's method (a method of extra numbers or methods Zillmer's extra numbers) requires that the general forms for the calculation of provisions modify the way that all elements in these forms, for which is possible, be reduced the age of insured at the time mathematical provision is calculated. All other parameters are displayed through the commutative numbers that remain constant for the entire duration of insurance (this may be a form of insurance, duration of obligation, duration of payment of premiums ...). Commutative numbers used in this method are reduced to the age of insured at the expiration of insurance.

Whiting's method is very similar to the previous. It is important to mention that the method gives accurate results as well as individual methods of a commutative numbers that are used to reduce access to age of insured.

Fouret's method (Recurrent method) resembles the accounting method of calculation because the calculation here is based on data from the previous period. Reserves from the previous period are added to the premium paid and the discounted amount all payments to insured should be deducted. In this method it is necessary to adopt some of the assumptions such as all the insured are born 01. January when the start of all contract is, all insurance premiums are annual, age of insured is expresses as whole numbers, payments are made at the end of the year[9]. Application of this method also gives satisfactory results but it is important to check some of the individual methods of calculating mathematical provisions.

Legislation of EU countries and most countries are on track to become EU members are determined that the mathematical provision is calculated by net prospective method as the difference between the present value of all future obligations under insurance contracts defined conditions and the insurance contract, including contractual amounts and shares in get to the policyholder, either individually or collectively, have the right regardless of whether the guarantee on the amount of bonus, and the present value of future net premium payments.

It is envisioned that the calculation of mathematical provisions can often use other types of actuarial calculations, but only under the condition that they give the same or greater as a result of individual and the calculation of net prospective

[9] Ibidem, p. 185.

method. In the calculations it is possible to obtain a negative value of mathematical provision as in cases where the provisions of the contract pays a premium which is less than the risk premium, the premium which is not accurate enough to cover the amount of risk (such as insurance where the risk of infants death in the first year of extremely high, therefore a high risk premium, the average premium to be paid is not sufficient to cover the risk). In some legislation this value is taken as negative in further calculations and somewhere to set the value of zero (0). Such mathematical provision means a loss for insurance because the premium does not cover the entire risk of the insured and required its own resources to bear uncovered part of the risk.

Taking into account the fact that the determination of the amount of technical provision of life insurance is actuarial valuation, it should be noted that, except for selected calculation techniques, very important elements that are used in calculating are tables of mortality and interest rates. Selection of tables for the calculation of net premiums and mathematical provisions must take into account the relevant trends in the experience of companies and insurance industry as a whole, the expected trends in the insurance policy and other changes that could significantly affect the results. The interest rate used should be reasonably chosen to satisfy certain conditions which are commonly referred to in sub-act country. The rate should be no more than 5%.

SOLVENCY OF THE INSURANCE COMPANY

Estimated level of technical provisions affects the assessment of insurer solvency. Generally speaking, solvency is an indicator of the security of a legal entity, which is reflected in the ratio of assets and liabilities. Solvency of the insurance categories as expressed through the solvency margin and as such gives us a description of the size and condition of the capital adequacy of insurers. Solvency margin is the amount of capital that an insurance company must hold in order to cover expenses that may occur due to occurrence of unexpected events.

Solvency of the company is one of the most sensitive issues when they consider all the calculations in companies engaged in life insurance. Solvency measure, amount of capital needed to make all the obligations of insurers could be settled in their redemption, is calculated as the ratio of the company's credit rating and minimum requirements for solvency. In European countries this ratio is defined as

$$\mathbf{SOL} = \frac{\textbf{available solvency margin}}{\textbf{minimum required solvency margin}}$$

Available solvency margin is viewed as a measure of financial position of the company. Life insurance policies and determination of the required solvency margin amounts are defined by Directive 79/267/EC. According to the above-mentioned approach, Required minimum capital that would represent a solvency margin can be expressed (with two different approaches) as: the amount that is always greater than the limits set out accurately regardless of the size of the portfolio of the company or the amount, which, over exactly defined limits, expressed as a percentage of one or more reference size insurers. In life insurance the calculation takes into account the mathematical provision. By the first approach basis for calculating is the mathematical provision. The first result of high solvency margin is obtained by the sum of gross mathematical provisions, which are formed on the last day of the previous business year, multiplied by a factor of 4% (or 0.04). Thus, the obtained result is multiplied by the ratio of net mathematical provision, which is formed on the last day of the previous business year (which is the mathematical provision net of reinsurance) and gross mathematical provision, which is formed on the last day of the previous business year. The calculating factor in Bosnia and Herzegovina is 4%, while this factor in the Republic of Croatia is 3.6% and 4% in Serbia. The result is obtained in the ratio should be less than 0.85, and if the smaller set to that value.

In some life insurance products factor is determined instead of the coefficient of 0.04 at the level of 0.01 (unit-linked policy where the investment risk to the insured). Thus the amount obtained is not yet a sufficient level of capital. This amount is added to capital ratio and risk ratio for all other potential risks.

With the second results to calculate the solvency margin is taken as the basis of risk capital. Risk capital (capital exposed to risk) is the difference between the insured and the sum collected mathematical provision. Another result is used when calculating the risk capital is negative. Gross amount of risk capital (risk capital which is included and the amount covered by reinsurance) is multiplied by a factor which is the ratio of the net amount of risk capital formed on the last day of the previous business year and the gross amount of risk capital formed on the last day of the previous business year. If the ratio of net and gross capital risk is less than 0.5 then set to that value. So obtained is multiplied by the amount of 0.1% (for contracts in case of death which concluded in the period up to three years), with

0.15% (for contracts in case of death which concluded in a period of three to five years) or 0.3% (for all other contracts in case of death).

CONCLUSION

Mathematical provision is an essential part of technical provisions of insurance. Proper calculation of technical provisions is a prerequisite for an adequate assessment of the amount the insurer's liabilities, the insurer's solvency and capital adequacy. The paper treated only methods for estimating the technical provisions. In order that level of technical reserves is adequately assessed, but the experienced actuary, it is necessary to choose an appropriate method as input to the valuation. In this text, no numerical examples are given, but the comparison is made of all methods for valuating the provisions' adequacy.

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