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Mechanisms of Protection from Interest Rate Risk with Reference to the Life Insurance Market in Montenegro

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Abstract: Insurance companies are facing major challenges that point to the need for control process and risk management. Risk management in insurance has a direct impact on solvency, economic security, and overall financial stability of insurance companies. It is very important for insurance companies to adequately calculate risks to which they are exposed. Asset liability management (ALM), as an integrated approach to financial management, requires simultaneous decision-making about categories and values of assets and liabilities in order to establish the optimum volume and the ratio of assets and liabilities, with the understanding of complexity of the financial market in which financial institutions operate. ALM focuses on a significant number of risks, whereby the emphasis in this paper will be on interest rate risk which indicates potential losses that may reflect in a lower interest margin, a lower value of assets or both, in terms of changes in interest rates. In the above context, the aim of this paper is to show how to protect from interest rate changes and how these changes influence the insurance market in Montenegro, both from the theoretical and the practical point of view. The authors consider this to be an interesting and very important topic, especially because the life insurance market in Montenegro is underdeveloped and subject to fluctuations. Also, taking into account the fact that Montenegro is a country that has been making serious efforts to join the EU, it is expected that insurance companies in Montenegro will strengthen their financial position in the market even using the ALM traditional techniques, which is shown in this paper.

Keywords: insurance market, ALM, reserves, interest rate, immunization, life insurance.

JEL: G22, G12, M41

Introduction

The insurance market of SEE countries and thus Montenegro is characterized by significant changes caused by different rates of economic growth and development. Life insurance in the markets of developed countries is leading in overall insurance premium. Due to unfavourable macroeconomic trends in Montenegro as well as inadequate information and lack of trust in the institutions of the financial system in general, the highest share in the total portfolio of the insurance market of Montenegro is of compulsory insurance. It further indicates that the role of the Montenegrin insurance companies as institutional investors is considerably lower compared to those companies that operate in developed markets. However, one should not forget that insurance companies that operate in Montenegro are important institutional investors despite their modest free cash that can be placed on the financial markets.

Borrowed funds or reserves, as future obligations to policyholders, dominate in the structure of liabilities of insurance companies. For this reason, it is important that insurance company estimates its reserves and afterwards invest adequate funds on the financial markets. The estimation of reserves depends on the experience and data held by insurance companies, while equity funds determine the quality and maturity of liabilities. The basic principles of financial operations of insurance company are safety regulation of liabilities to policyholders and maximization of investment returns with acceptable risk level. Also, insurance companies must take into account the balance of maturity funds on the basis of their maturity investments and insurance liabilities. This further means that the structure of invested assets of insurance companies determines the nature and maturity of insurance liabilities.

Asset and liability management of insurance companies, or the ALM technique, is applicable to all insurance companies, but depending on the type of insurance, companies use different ALM instruments. ALM is a set of techniques that analyse the relationship between the assets and liabilities of the company in order to help the company to minimize the interest rate risk. (Sigma, 6/2000)

The aim of this paper is to show that life insurance companies in Montenegro can use static and fundamental deterministic techniques for interest rate risk management and that can make immunization of its investment portfolio in order to eliminate the GAP duration and preserve their own capital, as well as additional measures to preserve liquidity and solvency of the business.

Thus, the fulfilment of the paper objectives demand its structuring into two parts, in addition to the introduction, conclusion and literature. Literature review is given in the first theoretical part where the authors discuss the individual understandings on the issue of ALM and explain the techniques that can be used to measure interest rate risk. The second part contains empirical study in which it is shown how it is possible to manage the interest rate risk using information from financial statements and using basic static ALM techniques in case of a representative insurance company in Montenegro.

The authors of this paper believe that the topic of the paper is interesting and particularly relevant taking into consideration the fact that Montenegro is a country that clearly strives towards the European path and that insurance companies will have to implement various models of risk management according to EU directives, but that this is also an original topic since no similar studies have been conducted so far in Montenegro.

1. Literature review

One general type of financial risk management technique called asset-liability management (ALM) is a process under which institutions analyse the combined impact of risks on both assets and liabilities to determine whether the effects tend to offset or amplify each other. ALM can be defined as the management of net interest margins[1] in order to provide the level of margins and risk that is compatible with the risk of introduction of the institution (Gardner and Mills, 1991). Some authors define the ALM technique as an attempt to stabilize the net interest margin, or the technique that seeks to minimize risk.

Van der Meer and Smink (1993) classify ALM approaches based on several factors, including the degree of ongoing decision-making involved and whether they are based on preserving value or the rate of return. Within the financial services industries, many ALM techniques were initially developed for banks and were later adopted by life insurers.

[1] A critical element of financial management institutions is to control the difference between yields earned on purchased assets and interest cost on financial liabilities. The difference reflects the percentage of total assets called net margin and net interest margin (net interest margin). If net interest margin is high enough, institutions may increase non-interest expenses whilst providing other services. When the margin is negative in a certain period, interest costs are higher than the yield on invested assets, which results in a negative outcome in the total assets of the institution.

Nature of operation and changes in financial markets has caused insurance companies to adjust their ALM strategy to the type of insurance. The application of ALM techniques varies considerably for life and non-life insurance. Life insurance companies focus mainly on interest rate risk on a business line, while non-life insurance company observe a significantly wider range of risks and, therefore, develop special techniques of assets and liabilities management and for multiple lines of businesses. Santomero and Babbel (1997) presented an extensive analysis of financial risk management as performed by insurers.

Baum (1996) explains that decisions and actions taken with respect to assets and liabilities are coordinated in order to ensure effective utilization of company's resources to increase its profitability. The ALM function involves controlling the volatility of net income, net interest margin, capital adequacy, liquidity risk and ensuring an appropriate balance between growth and risk (Guthua, 2003). He explained that ALM involves the management of the total balance sheet dynamics and it involves quantification of risks and conscious decision making with regard to asset liability structure in order to maximize the interest earnings within the framework of perceived risks. The main objective of ALM is to manage risk in a way that the volatility of net interest income is minimized in the short run and economic value of the institution is protected in the long run.

Ferguson (1984) introduced ALM and duration analysis to actuarial literature, applying the standard life insurance tools to P&C loss reserves. Duration is expressed as calculated average maturity of the bond, where we use discounted cash flows for each period (DeMarzo, 2008). Using duration makes it possible to quantify bond sensitivity on interest rate change, maturity, and bond price. The key bond-interest rate relationship is that bond prices are inversely proportional to changes in market interest rates. This means that long-term bonds are more sensitive to interest rate changes than short-term bonds and that low-coupon bonds are more sensitive to interest rate changes than high-coupon bonds. Noris (1985) used the same approach and popularized the term "duration gap of surplus" to reflect the expected change in surplus for a given change in interest rates. Noris recommends fixed-income securities to back loss reserves and equities to back policyholders` surplus. Policyholders` surplus is about a third of P&C insurance company assets, and the recommendation for greater equity investments is echoed by many subsequent ALM studies. Bond convexity can be explained that in the situation of higher duration (longer time to maturity or lower coupon payment), the more convexity will be, and in the situation of higher change in interest change, the more convexity will be (Ivanovski Z. at all, 2013).

Depending on the nature of the business and the characteristics of the product, life insurance companies apply different ALM techniques and strategies. Lamm-

Tennant (1989), Shiu (1993) and Smink (1995) talked in details about the ALM techniques and strategies. Some of the important strategies and techniques of ALM are: projections of assets and liabilities based on simulations; analysis of duration; immunization rates; reinsurance; risk-return analysis; integrated ALM software and more.

Most insurance companies which operate in developed markets manage their assets and liabilities by simulation. A simulation, based on stochastic modelling of variables, includes a large number of random samples with the aim of quantifying the probability distribution of results for a given time horizon. Life insurance companies in developing markets or emerging markets should be even easier to use deterministic techniques of assets and liabilities in order to ensure financial stability and adequate position in the insurance market. The concept of duration and convexity and immunization are certainly fundamental instruments of ALM. (Gajek L. at all, 2005)

2. Measuring of interest rate risk in a life insurance company using the ALM model

Risk measurement may be based on a retrospective analysis of empirical, i.e. realized values; on the basis of a prospective observational assessment involving changes in the market; and on the basis of both estimations.

Nowadays, insurance companies use various techniques of risk measurement and assessment of profitability. When it is not possible to apply hedge, it is important to use a prudent measure of risk which is certainly of great importance for domestic insurance companies. Given the fact that bonds dominate in the structure of portfolio of insurance companies it is necessary to measure how changes in interest rates affect the market value of the portfolio of bonds, or the fair value or the market value of liabilities. Also, it is important to calculate ALM risk[2] for stocks and real estate portfolio which are the part of insurance company's asset.

[2] ALM risk is defined as a potential loss because of fluctuation of interest rate, or value of assets and liabilities. If the influence because of change in interest rate is different on assets and liabilities, then the value of assets and liabilities will change for different amounts so the solvency can be threatened. Assume that PV_A (t) is a value of the company in a time period t, PV_L (t) is the best structure of liabilities in the time period, ρ is a risk measure. If we take into consideration the requirement for solvency in insurance companies, then the difference between the value of assets and liabilities in the time perio t has a negative risk measure, i.e. $\rho(PV_L(T) - PV_A(T)) \leq 0$. Initial value of assets $PV_A(0)$ in the relation $\rho(PV_L(T) - PV_A(T)) = 0$ is a target equity, and the value $\rho(PV_L(T) - PV_A(T))$ is definied as ALM risk.

Liquidity risk is controlled based on the cash flows' adjustment, using immunization technique as deterministic ALM technique, while the interest rate risk is regulated by duration adjustment. Alignment of cash flows is actually a deterministic analysis of cash flow trends during a specified period of time. In the first step, the cash flow profiles of assets and liabilities are examined. Their alignment is performed in the second step when the balancing payment of property is accomplished with payments based on liabilities. Using such procedures, a situation where liquidity is compromised can be easily identified and eliminated.

Synchronizing the average maturity, duration of liabilities is compared against the correspondent investments, so the balance is established due to changes in interest rates on a given date. However, complete immunization gives the possibility of eliminating any changes that may arise from changes in interest rates, which is achieved through partial hedging in the context of conditional immunization. This technique is most often used as a method of planning for fixed income securities. Immunization is less suitable technique for assets and liabilities stochastic character, such as actions or obligations of companies engaged in non-life insurance.

2.1. Duration of bonds

Duration is the most important measure of interest rate risk on securities with fixed revenue and liabilities which are conditioned by interest rates. In essence, everything that involves discounted future cash flows with specific interest rate has its duration. Duration shows the average maturity of securities or it shows the investor the time needed to fully recover its capital invested in certain securities[3].

Mathematical interpretation of duration was given by the mathematician *Frederick Mac Aulay in 1936*:

$$D = \frac{\sum_{t=1}^{n} c_t t(1+i)^{-t}}{PV} \tag{1.1}$$

Wherein D- duration of securities; c_t- cash flow in *t* year; *t*- the time in which the cash flow is realized; *i* – market interest rate; and PV- present value of securities, or their market value.

[3] Duration should distinguish from the maturity of securities. Unlike maturity, duration indicates the time that will restore equity.

The higher the duration of financial instrument, the more time is needed to restore investor`s money and vice versa.

If we look at the present value of future payments as the function of interest rate, then we can calculate the derivative of the function by i and determine the price sensitivity of a financial instrument to interest rate changes. If we select *PV(i)* as present value of financial instrument in the function of interest rate and then by differentiating, we get:

$$\frac{dPV(i)}{di} = - (1+\mathrm{i})^{-1} \sum_{t=1}^{n} c_t t(1+i)^{-t} \tag{1.2}$$

If the formula (1.2) is multiplied by -1 and divided by *PV(i)*, and when we refer to a simple formula of duration (1.1.), we obtain a formula of modified duration which can be mathematically expressed as follows:

$$\mathrm{MD} = - \frac{1}{PV(i)} \frac{dPV(i)}{di} \tag{1.3}$$

So, for any securities, portfolio or liability *S* with the ongoing value of *P*, modified duration *MD* for interest rate i is equal to:

$$\boldsymbol{MDi=Di/(1+i),} \tag{1.4}$$

Formula of modified duration clearly shows how it changes the present value of cash flow due to changes in interest rates. Given that the bonds with a fixed interest rate are the most common types of placements of insurance companies, as well as taking into consider that an increase in market interest rates reduces the market value of the bond, it is clear that the investor, i.e. insurance company, will need more time to recover invested capital. More specifically, the relationship between market interest rates and the average maturity is exactly proportional to the latter case. In order to predict price changes of certain securities (based on changes in interest rates), it is considered that it is better to apply the modified formula of duration compared to the simple formula (1.1).

If the cash flows of securities are generated *m* times during the year, the annual duration is obtained by dividing duration in *m* periods per year , i.e. (Fabozzi, 2004) :

$$\mathbf{D_i = D_{i/m} / m} \tag{1.5}$$

For bonds with k annual interest payments a year and interest rate *i* calculated *k* times a year, modified duration can be calculated as:[4]

$$MD,\ k = D/(1+i/k). \tag{1.6}$$

Observing durations of multiple instruments (bonds), it is clear that we should be forced to do a large number of calculations. Through mathematical analysis of original formula (1.1.), actuaries were able to find a simpler formula for calculating durations of bonds, to avoid computation of Mac Auley duration and then modified duration (Gardner and Mills, 1991):

$$\text{DUR}= \text{N} - \left[\left(\frac{C}{PV}\right)\times\left[N-(1+i)\left(\frac{1-\frac{1}{(1+i)^{N}}}{i}\right)\right]\right] \tag{1.7}$$

Wherein N- maturity of bond; C – sum of cash flows for financial instrument; PV – sum of present values; and *i* – market interest rate.

From the formula of modified duration it can be concluded clearly that the increase in market interest rates reduces the present value of the cash flow and the percentage of duration. For a given change in market yields, the percentage change in the price of assets is proportional to the duration of assets.

Duration of securities portfolio of some financial institutions, and thus the insurance company, is determined on the basis of duration of individual securities and their share in total portfolio, which is also called the contribution to *the portfolio duration* (Fabozzi, 2004).

The portfolio duration is calculated as follows:

$$D_{p\,(i)} = \sum_{j=1}^{n} D_{j(i)} \bullet U_j \tag{1.8}$$

Where $D_p(i)$ is the portfolio duration; U_j- securities share in total portfolio; $D_j(i)$ - duration of *j* security; *i*-interest rate; and *n*- total number of securities.

If, for example, the portfolio consists of two bonds with a negative value - *A* or *B* securities (for example, if instead of investing free funds in securities the

[4] "Professional Actuarial Specialty Guide Asset-Liability Management", Society of Actuaries, 2003 (https://www.soa.org/library/professional-actuarial.../2003/.../spg0308alm.pdf)

company emits bonds in order to raise money), then durations of bonds will be different ($D_A \neq D_B$). Since $U_B = 1- U_A$, the portfolio duration of bonds can be calculated as follows:

$$D_{A+B} = D_A U_A + D_B (1 - U_A) = D_B + U_A (D_A - D_B) \quad (1.9)$$

If D_{A+B} has a negative value, then it is clear that this is a negative cash flow, i.e. this is a negative period when the company will pay an amount of money based on issued securities, but this is not a negative average collection period for invested funds.

Positive duration of securities indicates that the rising of interest rates influences a decrease of market value of instruments, in case of many instruments with fixed return, fixed coupons and liabilities with defined cash flows. Negative duration indicates that the prices of some instrument will increase if there is a rise of interest rate i (for example, if some issued security of 100 units has a duration of 5 years, the value will amount 105 units if the interest rate rises 1%).

Due to the fact that the modified duration indicates the percentage points to the changing prices of securities due to changes in interest rates, securities can be ranked by their modified duration to determine their sensitivity to fluctuations in prices due to changes in market interest rates.

2.2. Convexity

Convexity measures the rate of change of duration in relation to interest rate changes and shows how duration is sensitive to interest rate changes. Positive and negative convexity determine the sensibility of securities values in the parallel shift (change) in interest rates. Insurance companies must calculate and establish the equivalence of the average maturity of assets and liabilities. Even when there is equality of maturity dates, it may happen that some duration in the overall structure is not mutually harmonized. All duration measures actually represent estimates for small changes in yield, and therefore do not include the effect of convexity bonds in its price due to changes in yield for a higher amount. For this reason, the concept of convexity of assets and liabilities is also analysed. Convexity, which is also called the modified convexity (Fabozzi, 2004), is defined as a second copy of PV divided with PV:

$$K = \frac{d^2 PV(i)}{di^2} \frac{1}{PV(i)} = \frac{\sum_{t=1}^{n} c_t t(t+1)(1+i)^{-(t+2)}}{PV(i)} \quad (1.10)$$

If the cash flows are generated *m* times during the year, then the convexity of securities on an annual basis can be expressed through the following formula:

$$\mathbf{K = convexity\ in\ } m \mathbf{\ periods\ a\ year\ /\ m^2} \tag{1.11}$$

In other words, in order to determine the price change of some instrument, there is a need to define a correct factor which is calculated using the following formula:

$$\frac{\Delta PV}{PV} = \frac{K}{2} \bullet (\Delta\, i)^2 \tag{1.12}$$

If we use the duration measure together with convexity measure, it is possible to calculate the actual price change of security influenced by higher changes in returns, i.e. significant changes of interest rate. When interest rate changes for ±2% and more, it is necessary to use not just the measure of duration but also a measure of convexity in order to make to make the estimation of a security`s value change as close as to the actual change.

In the prediction of interest rate sensibility of the securities portfolio of assets and liabilities, there is a greater possibility to make a mistake in the situation when the yield is changing in larger amount. For that reason, and in order to precisely predict the prices of securities, the change of security value (ΔP/P) is calculated by following approximate formula:

$$\frac{\Delta PV}{PV} = \text{-MD} \bullet \Delta i \ + \square \frac{K}{2} \bullet (\Delta\, i)^2 \tag{1.13}$$

All bonds with fixed cash flows have positive duration and convexity. Positive convexity decreases the expected price change in certain securities. Securities with embedded options have a negative or decreased positive convexity. For example, a house mortgage, as well as instruments for repayment, may have negative convexity when rates are at a lower level (which increases the possibility of returning the debt before its maturity). When the convexity is positive due to higher duration and rising interest rates, the change in the value of securities is smaller, which further points to reduced possibility of returning the debt before its maturity. Convexity actually indicates the degree to which the effect of the gain exceeds the losses and equals to the increase or decrease in interest rates at the current level of interest rates.

2.3. GAP duration analysis in the process of ALM

Duration, as an alternative measure of time dimension of assets and liabilities, has an important role in the application of ALM strategy. GAP duration is an instrument of ALM which is used to show total cash flows of some financial institution in a particular period of time. The control of cash flow sensibility on interest rates and maturity of assets and liability of some financial institution is called GAP management (Gardner and Mills, 1991). Comparing weighted average duration of assets and liabilities, it is possible to calculate the risk of interest rate that a financial institution faces, i.e. its potential profit or loss. Harmonization of assets and liabilities duration is one of the GAP management goals. The complexity of calculating GAP duration is particularly expressed when the asset (or liability) with variable rates or interest rate which is payed out of contract maturity is considered.

GAP duration can be calculated using this formula (Saunders and Cornett, 2007):

$$D_{gap} = D_A - w_L D_L \tag{1.14}$$

Wherein:

a) D_{gap} – GAP duration (time period of unadjusted duration of assets and liabilities);

b) D_A – Weighted average duration of asset calculated as:

$$D_A = \sum_{i}^{n} w_i D_{A_i} \tag{1.14.1}$$

wherein: A_i- financial instrument *i*; w_i – share of A_i in total assets; D_{Ai} – duration of A_i instrument; n – total number of financial instruments in the analysed financial institution.

c) D_L - Weighted average duration of liability calculated as:

$$D_L = \sum_{j}^{m} z_j D_{L_j} \tag{1.14. 2}$$

Where L_j is liability *j*; z_j – share of L_j in total liabilities; D_{Lj} – duration of L_j; *m* – total number of liabilities in company.

d) W_L- the percentage of asset which is financed by liabilities, i.e. financial leverage. Financial leverage shows the effect on profitability when a company is financed by liabilities, i.e. the effect on the raise of return on equity (ROE). In other words, W_L shows liabilities which are used to finance assets portfolio.

GAP duration indicates time disproportion in the maturity of assets and liabilities cash flows. If GAP duration is higher in the balance sheet, it is clear that the company is more exposed to the interest rate risk. This measure is used by financial managers to determine the approximate percentage change of net value of a company, i.e. equity, during the change of interest rate or during the constitution of new market value of the company`s assets and liabilities.

From the balance sheet of an insurance company, it is shown that assets (A) are equal to equity (E) (or net value NW), and liabilities (L), i.e. technical reserves which are liabilities of the company. In other words:

$$\mathbf{A = NW + L \rightarrow \ \Delta A = \Delta NW + \Delta L \rightarrow \Delta NW = \Delta A - \Delta L} \tag{1.15}$$

So, when the interest rate is changing on the market, the change of equity is equal to the difference between the changed market value of assets and liabilities. According to the duration model and the abovementioned formula for the financial instrument value change because of interest rate change, the following formula is developed:

$$\Delta NW = -D_{gap} \cdot \frac{\Delta i}{1+i} \cdot A \tag{1.16}$$

Because of the specific balance sheets of insurance companies and because of inconsistency of duration of assets and liabilities, the increase of interest rate influences the decrease of value of guarantee reserve or equity, which influence the decrease of net profit of the company.

2.4. Immunization portfolio

The role of duration measure is also reflected in the enabling immunization or "isolation" of the balance sheet from the interest rate risk. In other words, the duration measure is used within the strategy of immunization portfolio of financial institutions, thus ensuring the immunization from the so-called "illnesses" of interest rates during the period of existence.

Immunization is defined as a strategy of portfolio management that at the end of the period of ownership of the portfolio achieves an annual rate of return equal to or greater than the expected rate of return at the start of the period. In other words, immunization is an investment of free money of insurance company in a way that the existing insurance portfolio becomes insensitive to future changes in interest rates.

Immunization is realized by structuring such a portfolio that will equalize the impact of interest rate changes on the value of liabilities and assets. There are various models of placing funds that allow immunization portfolio, but they are in fact rarely implemented in practice. The reason is that the immunization, the protection against loss, prevents profit-making under conditions favourable changes in interest rates. When actuaries and financial managers are able to identify duration and convexity of its assets and liabilities, it is possible to immunize the investment portfolio and to respect the following three criteria (Babbel, 2001):

1) the net present value of liabilities should be equal to the net present value of invested assets;
2) duration of assets should be equal to the duration of liabilities[5];
3) the convexity of assets should be higher of the convexity of liabilities;

The above mentioned criteria relate to the immunization strategy that is often referred to as multiperiodic immunization, since insurance companies for life insurance can emit insurance policies guaranteeing more payments to customers of insurance during the investment time horizon (Fong and Vasicek, 1990).

3. The application of ALM techniques - the case of insurance company in Montenegro

Insurance companies in Montenegro have a conservative attitude towards loans and investments on the capital market due to a clear lack of regulation and financial market development, but they also lack available skilled personnel. According to the modest investments of Montenegrin insurance companies, the use of expensive programs of ALM that handle highly diversified portfolio and mainly include sophisticated financial instruments and varied contemporary products of life insurance is not expected.

On the other hand, the domestic insurance companies should take into account the compliance of cash flows from assets and liabilities, in addition to regulatory requirements for liquid and solvent business. They should use the basic tools of ALM that are appropriate to our market, including the duration and convexity, gap duration, as well as the technique of immunization. Using the basic instruments of ALM model, the domestic insurance companies could optimize its in-

[5] Assuming that $w_L = 1$ and that total assets are financed from liabilities (technical reserves). If the part of the assets is financed from the part of quarantee reserve, when $w_L < 1$, then: $D_A - wD_L = 0$, tj. $D_A = wD_L$

vestment portfolio which is formed by conservative investment policy, due to legal constraints and underdeveloped financial markets, and thus maximize profit, taking into account the legal provisions and the basic principles of business.

Eleven companies operated in the Montenegrin insurance market in 2015, of which 6 were engaged in life insurance business. In 2015, they achieved a gross premium in the amount close to € 77 billion, with the share of life insurance of about 15%. Based on the financial statements of companies engaged in life insurance in Montenegro,[6] one can see how funds of mathematical reserves are invested, as well as the structure of assets and liabilities of the Montenegrin companies. When solvency and liquidity of operations are identified (based on the known coefficients of performance), an insurance company should be able to deal with the analysis of changes in interest rates in order to identify changes in cash flows due to interest fluctuations.

In order to neutralize the effect of changes in interest rates on cash flows from assets and liabilities, it is necessary to determine the duration of assets and liabilities. Financial reports of one of the leading life insurance company in Montenegro for 2013 and 2014 were used for further analysis. Given that there were no significant changes in interest rates and balance sheet positions in the past two to three years, the calculation of indicators and immunization strategies will be considered for one financial year (2013).

Table 1 provides a synthetic view of the balance sheet positions of the analysed insurance company:

Table 1: Balance sheet of insurance company in Montenegro for 2013 and 2014

Assets (euro)	2013	2014
Intangible assets	0.00	3,137.22
Property and equipment	878,853.35	862,425.09
Long-term financial investments	22,403,487.25	21,851,516.36
Fixed Assets	**23,282,340.60**	**22,717,078.67**
Short-term financial investments	0.00	6,002,737.98
Short-term assets	2,078,839.96	508,693.40
Share of reinsurers in technical reserves	238,784.09	240,481.46
Accruals	1,415,170.74	1,832,235.57
Current Assets	3,732,794.79	8,584,121.41
Total Assets	**27,015,135.39**	**31,301,227.08**

[6] Financial reports are available on the website of the Insurance Supervision Agency in Montenegro, *www.ano.me*

Equity and Liabilities (euro)	2013	2014
Equity	3,000,011.43	3,000,011.43
Reserves	6,377,700.38	7,662,350.77
Total Equity	9,377,711.81	10,662,362.2
Provisions	17,099,287.78	20,076,311.88
Short-term Liabilities	490,771.08	521,343.42
Deferrals	47364.72	41209.58
Total Liabilities	17,637,423.58.	20,638,864.88
Total Equity and Liabilities	27,015,135.39	31,301,227.08

Source: http://www.ano.me/images/stories/2014/revizori_drustava_14/Izvjestaj_Grawe_Osiguranje_-_Eksterna_revizija_2014.pdf

Total liabilities of the company amounted to 17,637,423 € in 2013 and 20,638,864 € in 2014. They mainly related to future payments to insured persons based on realization of the insured case or the purchase of a life insurance policy. Taking into consideration that the company concluded life insurance contracts for different maturity periods, i.e. that portion of the mathematical reserves depends on the duration of each insurance contract, we assume that the average maturity of long-term obligations of the company is 14 years.[7]After examining the financial statements, the mathematical reserve makes up over 96% of total provisions, so the duration of 14 years refers to total long-term liabilities. Short-term liabilities of the company amounted to 490.771 € in 2013 and 521.343 € in 2014. Short-term liabilities have one year maturity, so we assume that the average duration for short-term liabilities is 0.8 years.

Analogous to formula (1.8), total duration of liabilities of the company is equal to the sum of each multiplied liability duration and its share in total liabilities, so for the shown companies we get:

$$D_L = D_k W_k + D_D W_D$$

Wherein:

D_L – duration of total liabilities; D_k– duration of short-term liabilities; W_k– share

[7] Life insurance companies in Montenegro conclude insurance contracts usually for a period of 5 to 25 years. Since the duration is a time when investor money should be paid back, it is clear that duration of technical reserves is equal to time when money is being paid out to policyholders. Due to the impossibility of calculating the maturity of mathematical reserves for each insurance policy individually (companies use special software for determining the amount of the reserve for each policy and to the end of each year), we assume hypothetically that the average maturities of assets covering mathematical reserves (long-term provisions) of the company is 14 years.

of short-term liabilities in total liabilities; D_D– duration of long-term liabilities ; W_D – share of long-term liabilities in total liabilities.

So, duration of liabilities in 2013 equalled:

$$D_L = 0{,}8x0.028 + 14x0.97 \approx 13.6 \text{ years}$$

and in 2014:

$$D_L = 0{,}8x0.025 + 14x0.97 \approx 13.6 \text{ years}$$

The structure of assets of the company[8] in 2013 was[9]:

Table 2: Structure of assets in 2013

Assets	2013
Intangible Assets	0.00
Property and Equipment	878,853.35
Long-term financial investments	22,403,487.25
a. Securities	15,140,294.99
a.1. Bonds of Republic of Montenegro (average maturity of 2 years and average interest rate of 6,5%)	505,272.49
a.2. Bonds of Republic of Montenegro – Eurobonds (average maturity of 3 years and average interest rate of 7%)	14,191,131.25
a.3. Bonds of foreign countries –Eurobonds (average maturity of 20 years and average interest rate of 5%)	443,891.25
b. Long-term deposits and other investments	6,943,137.98
b.1. Term deposits in banks (average maturity of 2 years and average interest rate of 6%)	6,882,737.98
b.2. Other long-term investments (average maturity of 10 years and average interest rate of 7%)	60,400.00
c. Investment property	59,022.34
d. Other long-term investments (loans to policyholders up to 80% of redemption value of policy. Average maturity of 14 years and average interest rate of 8%)	261,031.94
Fixed Assets	23,282,340.60
Short-term financial investments	0.00
a. Short-term deposits	0.00
Short-term assets	2,078,839.96
Share of reinsurers in technical reserves	238,784.09
Accruals	1,415,170.74
Current Assets	3,732,794.79
Total Assets	27,015,135.39

Source: *http://www.ano.me/registri/drustva-za-osiguranje/117-grawe-osiguranje-ad*

[8] In the structure of assets, with the positions for which duration can be calculated, the average maturity was given approximately as well as average interest rate, based on data from the audit and actuarial reports for 2013.

[9] 2013 year is analyzed because of the availability of data from auditing and actuarial reports. In 2014, in the structure of assets there were no significant changes except an increase of short-term investments and a decrease of short-term assets so duration did not change compared to 2013.

Duration of assets according to formulas 1.1. and 1.14.1. (with average interest rate on capital market of 9,36 %[10]), is shown in the following table:

Table 3: Duration of total assets of life insurance company

Type of asset	Assets value	Assets duration[11]	wxD[12]
a.1. Bonds of RoM (Republic of Montenegro)	505,272.49	1.937431	0.036236
a.2. Bonds of RoM – Eurobonds	14,191,131.25	2.80168	1.471731
a.3.Bonds of foreign countries – Eurobonds	443,891.25	11.03755	0.18136
b.1. Term deposits in banks	6,882,737.98	1.941707	0.494695
b.2. Other long-term investments	60,400.00	7.282894	0.016283
c. Investment property	59,022.34	5	0.010924
d. Other long-term financial investments	261,031.94	8.607135	0.083166
Other fixed assets	878,853.35	0	0
Short-term investments	0	0	0
Short-term assets	2,078,839.96	0	0
Share of reinsurers in technical reserves	238,784.09	0	0
Accruals	1,415,170.74	0	0
Total	**27,015,135.39**		**2.294396**
Duration of assets			**≈2.3**

Source: Authors` calculation

The analysis of the structure of assets clearly shows that the average maturity of assets is less than the average maturity of liabilities, so the average duration of liabilities is 13.6 years and the average duration of assets is less than 3 years (2.3). The average duration of assets is 2.3 years because of the fact that the company has invested a small amount in long-term assets with more than 10 years of maturity.

If we look at the formulas for modified duration (1.4. and 1.5), we can see how the market value of assets and liabilities is changing due to changes in interest rates. If interest rate rises from 9.36% to 10.36% then:

$$\%\Delta P_A = - D_A \text{ x } (\Delta i/(1+i))$$

$$\%\Delta P_A = -2,3x(0,01/ (1+0,0936)), \text{ i.e. } \%\Delta P_A = - 0,021 \approx - 2.1\% \text{ and}$$

$$\%\Delta P_L = - D_L \text{ x } (\Delta i/(1+i))$$

$$\%\Delta P_L = -13,6 (0,01/(1+0,0936)), \text{ i.e. } \%\Delta P_L = -0,1244 \approx -12.4\%$$

[10] Interest rates are available on the website of the Central Bank of Montenegro (www.cbcg.me)

[11] Results in the table are calculated in Excel.

[12] Multiplied share of individual asset in total assets and its duration.

In other words, if the interest rates rise by 1% the market value of assets will decreased by 2.1% or 567,317.84€, while the market value for liabilities will decreased by 12.4% or 2,187,040.52€. So, modified duration of assets is 2.1 years and 12.4 years for liabilities.

Knowing that Equity (E) is equal to the difference between total assets and total liabilities, the change will result in the following:

$$\mathbf{E = (27,015,135.39 - 567,317.84) - (17,637,423.58 - 2,187,040.524) = 26,447,817.55 - 15,450,383.06 = 10,997,434.49}$$

so, if the interest rate rose by 1%, equity would decrease by 14% or approximately 1.6 million €. In the opposite situation, if the interest rate decreased by 1%, equity would decrease for the same amount because the market value of assets rose by 2.1% and the market value of liabilities increased by 12.4%.

Using the formula 1.14 for the analysed company, the result is:

$$\mathbf{D_{gap} = D_A - w_l D_L, \text{ tj. } D_{gap} = D_A - (L/A) D_L}$$
$$\mathbf{D_{gap} = 2,3 - (17,637,423.58/27,015,135.39) x 13.6}$$
$$\mathbf{D_{gap} = 2,3 - (0,65 x 13,6); D_{gap} \approx -6.5 \text{ years}}$$

The result shows that 65% of assets are financed by liabilities so the company has a negative GAP duration because the duration of assets is less that the duration of liabilities. In this situation, the change of interest rate reflects higher sensibility of liabilities than assets, which in the case of a rise (a fall) of interest rate will effect in a rise (a fall) of equity of the company X.[13]

If we look at formula 1.16, then:

$$\mathbf{\Delta NW = - D_{gap} (\Delta i/(1+i)) A}$$
$$\mathbf{(\Delta NW) = 6,5(0,01/1,0936)^* 27,015,135.39 \approx 1.6 \text{ million euros}}$$

So, when GAP duration is negative, the value of equity will increase by 1.6 million euros, which is already proven.

Only in situation when GAP duration is 0, the company will eliminate the interest rate risk. This further means that the duration of assets should match the duration of liabilities, which cause the risk of reinvestments.

[13] If interest rate increases, then the value of liabilities will decrease proportionally more than the value of assets.

If we continue to analyse how sensitive duration of assets is on the interest rate change, or to what extent the effect of profit is higher than the effect of loss, in equal changes of interest rate, it is necessary to determine convexity. Convexity of assets should be calculated in order to be able to estimate the sensitivity of the value of assets due to significant changes in yields, i.e. interest rates. Referring to the formula 1.10, the convexity of the assets will be analysed as follows:

Table 4: Convexity of total assets of company X

Type of asset	Value of Asset	Convexity[14]	W*K
a.1. Bonds of RoM (Republic of Montenegro)	505,272.49	4.81	0.089963
a.2. Bonds of RoM – Eurobonds	14,191,131.25	9.15	4.806522
a.3.Bonds of foreign countries – Eurobonds	443,891.25	153.65	2.524655
b.1. Term deposits in banks	6,882,737.98	11.55	2.942633
b.2. Other long-term investments	60,400.00	169.78	0.379591
c. Investment property	59,022.34	25.08	0.054794
d. Other long-term financial investments	261,031.94	96.68	0.934164
Other fixed assets	878,853.35	0	
Short-term investments	0	0	
Short-term assets	2,078,839.96	0	
Share of reinsurers in technical reserves	238,784.09	0	
Accruals	1,415,170.74	0	
Convexity of assets			$K_A \approx 11.7$

Source: Authors` calculation

Due to the impossibility of calculating the maturity of cash flows from mathematical reserves per years, convexity of liabilities cannot be precisely determined. However, as we have assumed that duration of mathematical reserves amounted to 14 yrs., we assume that the total assets of mathematical reserves (recorded in the balance sheet at the end of accounting period) will be paid to average policyholder in 14th year and short-term liabilities will be paid after 10 months (0.8 years).

Reffering to formula of convexity (1.10) the result is[15]:

$$K_{DL} = (17{,}099{,}287.78 \cdot 14 \cdot 15 \cdot (1{,}0936)^{-16}) / 17{,}099{,}287.78$$

[14] Results in the table are calculated in Excel.

[15] Mathematical reserves represent the amount of interest savings premiums. The company reserves the funds of collected premium (charged part of the savings premiums plus the expected return on the market) that at the end of the accounting period is recorded as a mathematical reserve. For this reason, the amount recorded on the liabilities side of the balance sheet represents the present value of liabilities to policyholders, but also the amount of money that will be paid under the contract of insurance in the future, that is cash flow Ct.

$$K_{DL} = (14 \cdot 15)/ (1{,}0936)^{-16} \approx 28.92$$

where K_{DL} is the convexity of long-term liabilities.

Convexity of short-term liabilities K_{KL} using the same formula (1.10) is[16]:

$$K_{kL} = (490{,}771.08 \cdot 1 \cdot 2 \cdot (1{,}0936)^{-3})/ 490{,}771.08$$
$$K_{kL} = (2)/ \cdot (1{,}0936)^{-3} \approx 1.94$$

So the total convexity of the company X (K_L) is:

$$K_L = wK_{DL} + wK_{KL}$$
$$K_L = 0{,}97 \cdot 28.92 + 0{,}028 \cdot 1{,}94 = 28.11$$

In order to determine how it will change the market value of the assets at higher and equal changes in interest rate, or as a result of significant changes in interest yields, it is necessary to include convexity of total assets in the calculation (amounted at 11.7).

Using the formula 1.13 and the fact that the interest rate rises by 3% (from 9.36% to 12.36%), the result for total assets is:

$$\Delta P_A/P_A = -MD_A \, \Delta i + K_A/2 \, (\Delta i)^2$$
$$\Delta P_A/P_A = -2.1^*(0{,}03) + (11{,}7/2)(0{,}03)^2$$
$$-0.063 + 0.005265 = -0.057735$$
$$\Delta P_A = -1{,}559{,}719 \text{ €}$$

If we observe ΔP_A as a result of multiplied modified duration and the interest rate change without convexity, it will show that the value of assets will decrease by 1,701,953 €. Of course, in order to provide more accurate predictions of changes in the market value of the individual or the total assets of the company, it is necessary to calculate its convexity and implement the formula 1.13. That shows a more precise decrease of market value of assets (1,559,719€). The change in equity should be calculated if the correction factor ($(K/2)(\Delta i)^2$) is included.

In this example (change of interest rate of 3%) the change in equity will amount to - 541.422 € (if interest rate rises) or 640.149 € (if interest rate falls). Without the correction factor it would amount to 590,796 €.

[16] Similarly, as in mathematical reserves, the company has short-term liabilities in the amount of 1,000,000 € (present value of current liabilities), which will pay off in one year (cash flow in the period t).

In order to eliminate interest rate risk, it is necessary to achieve the GAP duration at zero level. Assets of the insurance company should comply with maturity and the structure of liabilities, i.e. it is necessary to restructure the assets portfolio in order to make zero GAP duration. In other words:

$$D_A = w_l D_L,\ D_A = 0{,}65 \times 13{,}6$$
$$D_A \approx 8{,}84 \text{ years}$$

Since duration of assets significantly deviate from the values obtained, it is clear that the company must reconstruct its property portfolio and reinvest funds in the form of long-term investments. This strategy can be expensive for the company in the short term period, because the assets must be transformed into money (for example, company need to sell bonds in the market prior to maturity in order to invest in bonds with longer maturities). When a company ensures that the average maturity of its assets is 8.84 years, the interest rate risk will be eliminated because the changes in interest rates will not affect the value of net capital. So with duration of assets of 8.84, a decrease (increase) in market interest rates will not reduce (increase) the market value of their own capital or guarantee reserves of company X.

Further, it should be examined whether the company's investment portfolio X is immunized, i.e. it is necessary to analyse the following criteria:

- The present value of invested assets should be equal to the present value of liabilities.

The present value of the obligation (as at 31st December 2013) amounted to € 17,637,423.58, which means that the present value of assets (assets that are financed from liabilities - technical reserves) must be the same. The company invested technical reserves funds into: a) bonds (15,140,294.99); b) bank (term deposits - 6,882,737.98); c) other long-term financial investments (60,400.00); f) investment property (59,022.34), and g) other long-term financial investments (261,031.94). Due to the difference between the value of invested assets and liabilities in the amount of 4,766 million euros, it is clear that this amount represents a part of the deposit which was funded by the guarantee reserve. More specifically, the company made long-term deposit of about 2 million euros from technical reserves.

- The duration of liabilities should be equal to the duration of assets if the total assets are financed by liabilities.

Because this is not the case in the analysed company, then it should be that $D_A=w_lD_L$, or $D_A\approx$ 8.84 years. In order for duration to be 8.84 years, it is essential that the company invest the part of their assets in long-term financial investments. For further analysis we assume that company needs to reinvest the funds invested in bonds with a maturity of 2 years in new bonds with longer maturities, and to be placed into the form of assets with duration (Dr) and a maturity longer than two years. Accordingly, duration of assets should be as follows:

$$\mathbf{D_i = (505{,}272.49 \cdot 1.937431 + 14{,}191{,}131.25 \cdot D_r + 443{,}891.25 \cdot 11.03755 + 60{,}400.00 \cdot 7.282894 + 59{,}022.34 \cdot 5 + 261{,}031.94 \cdot 8.607135 + 6{,}882{,}737.98 \cdot 1.941707) / 27{,}015{,}135.39 = 8.84}$$

So the duration of reinvested assets in long-term assets equals to:

$$\mathbf{D_r = 216{,}589{,}400.59 / 14{,}191{,}131.25 \approx 15 \text{ yeras}}$$

So, the company should reinvest the assets with maturity of 2 years in the amount of about €14 million in bonds and/or long-term deposits whose total duration is about 15 years, and thus make immunization of its investment portfolio. In this way, duration of total assets amounted to 8.84 which would eliminate the GAP duration and neutralize interest rate risk, as shown in the following table:

Table 5: Duration of total assets after immunization

Type of asset	Value of asset	Duration of asset[17]	wxD[18]
a.1. Bonds of RoM (Republic of Montenegro)	505,272.49	1.937431	0.036236
a.2. Bonds of RoM – Eurobonds	14,191,131.25	15.26	8.016
a.3.Bonds of foreign countries – Eurobonds	443,891.25	11.03755	0.18136
b.1. Term deposits in banks	6,882,737.98	1.941707	0.494695
b.2. Other long-term investments	60,400.00	7.282894	0.016283
c. Investment property	59,022.34	5	0.010924
d. Other long-term financial investments	261,031.94	8.607135	0.083166
Other fixed assets	878,853.35	0	0
Short-term investments	0	0	0
Short-term assets	2,078,839.96	0	0
Share of reinsurers in technical reserves	238,784.09	0	0
Accruals	1,415,170.74	0	0
Total	**27,015,135.39**		**8.84**

Source: Authors` calculation

[17] Results in the table are calculated in Excel.

[18] Multiplied shared of individual asset in total assets and its duration.

- The third condition for a proper immunization of the portfolio is to calculate the convexity of property that must be greater than the convexity of total liabilities. Convexity of total liabilities of an insurance company X is 28.11, suggesting that the convexity property K_A must be greater than 28.11 i.e.:

  (505,272.49·4.81 + 14,191,131.25· Dr + 443,891.25·153.65+ 60,400.00·11.55+59,022.34·25.05+261,031.94·96.68+ 6,882,737.98· 169.78)/ 27,015,135.39>28.11

so:

$$K_R > 572,294,020.61 / 14,191,131.25$$
$$K_R > 40.3$$

So if the company X will immunize investment portfolio or protect its equity due to fluctuations in interest rates, it is necessary to reinvest a part of disbursed funds in the form of longer-term financial assets whose average duration is 15.16 years and convexity at least 40.3.

Conclusion

Model for managing assets and liabilities of an insurance company depends on the development of financial markets and the insurance market of observed country, as well as on the complexity of its assets and liabilities. Analysing the life insurance market in Montenegro, one can conclude that the companies take care of its liquidity and solvency but do not have enough funds in the form of long-term assets. They have a conservative attitude towards the placement of free funds. It is clear that the offer of long-term and relatively safe financial investments in Montenegro is poor and there are no modern market instruments that would encourage the introduction of new and attractive life insurance products. However, if companies operating on the domestic market were led by the principle that the structure of liabilities determines the structure of assets and if they take into account that mathematical reserve funds should be invested in long-term forms of lending, the controlling of duration of assets and liabilities would provide liquidity and profitability, which would certainly have a positive impact on shareholders (through the payment of dividends), but also insured that they would have a higher income based on the right to participate in the profit of company after the implementation of contingency. Such a principle of business would provide greater benefit to policyholders who are saving through insurance, and it

will provide a greater demand for life insurance products. Growth of the insurance market will be achieved, which would have a positive and direct impact on the development of the financial market, as well as on overall economic environment in the country.

In order to eliminate the risk of reducing the equity due to falling interest rates, a company must provide zero GAP duration or increase the average maturity of its assets. Empirical research that is given in the paper shows that a company in Montenegro can use static and deterministic models for managing interest rate risk and that can make the immunization of its investment portfolio in order to eliminate the GAP duration and preservation of its own capital. If the asset is not carried out in accordance with liabilities, changes in interest rate can reduce excess funds, i.e. profit, and thus a part of guarantee funds of insurance companies, which may compromise long-term solvency of the business. For this reason, companies which are operating on the market of Montenegro should at least use traditional ALM instruments in order to preserve their financial power and control of liquidity operations.

Specifically, it is expected that, at some future period, when the capital market and financial institutions and instrument become more developed, insurance companies will divert significant funds to the purchase of bonds and stocks and other financial instruments which characteristic of developed markets. In addition, each insurance company will be forced to create and develop its own strategy and technology for managing assets and liabilities and to implement not only traditional but modern ALM instruments and techniques as well. Also, it is concluded that, using the experience in managing the assets and liabilities of companies that operate in developed markets, the experience of actuaries and financial managers of insurance companies in Montenegro will improve.

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