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POSSIBILITIES OF CREATING OPTIMAL INVESTMENT PORTFOLIO OF INSURANCE COMPANIES IN SERBIA*

Mogućnosti kreiranja optimalnog investicionog portfolija osiguravajućih kompanija u Srbiji

Abstract

Owing the time gap between the premium collection and the benefit payments, insurance companies invest temporarily free funds of technical reserves and thus fulfill an important role of institutional investors. The paper deals with the analysis of the investment possibilities of insurance companies in Serbia in terms of the existing regulatory constraints and the financial market development level. The optimal portfolio of assets used to cover technical reserves of non-life insurers is constructed on the basis of the Markowitz portfolio theory. The results of the research support the hypothesis that quantitative investment rules lead to a narrowing of an efficient set of insurer's investment opportunities and to a deterioration of risk-return trade-off of their investments. Recommendations for improving the investment performance of non-life insurers are generated through the analysis of real investment portfolio at the level of the entire insurance sector, as well as of a specific insurance company. It is concluded that the availability of financial instruments and trends in their prices and yields primarily determine investment decisions of insurers in Serbia.

Key words: *investments, technical reserves, risk, return, investment portfolio*

Sažetak

Zahvaljujući vremenskoj nepodudarnosti između naplata premija i isplata naknada za štete, osiguravajuće kompanije ulažu privremeno slobodna sredstva tehničkih rezervi i time ostvaruju važnu ulogu institucionalnih investitora. U radu se analiziraju mogućnosti investiranja osiguravajućih kompanija u Srbiji pri postojećim regulatornim ograničenjima i stepenu razvijenosti finansijskog tržišta. Na osnovama Markovićeve portfolio teorije, konstruisan je optimalan portfolio imovine koja služi za pokriće tehničkih rezervi neživotnih osiguravača. Rezultati istraživanja dokazuju hipotezu da kvantitativna ograničenja investicija dovode do sužavanja efikasnog skupa investicionih mogućnosti osiguravača i pogoršanja odnosa prinosa i rizika njihovih investicija. Kroz analizu realnog investicionog portfolija na nivou celokupnog sektora osiguranja, kao i konkretne osiguravajuće kompanije, generisane su preporuke za poboljšanje investicionih performansi neživotnih osiguravača. Zaključuje se da raspoloživost finansijskih instrumenata i kretanja njihovih cena i prinosa primarno opredeljuju investicione odluke osiguravača u Srbiji.

Ključne reči: *investicije, tehničke rezerve, rizik, prinos, investicioni portfolio*

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Introduction

Insurance companies are specific market participants whose activity differs from the activity of other economic entities. As opposed to other types of business in which an enterprise usually makes certain investments in the process of production of goods (services) and only after that realizes financial effects of the sale of such goods to customers, the policyholder in insurance "credits" the insurer, paying him in advance premium for the insurance service. The realization of insurance service is conditioned by the probability of the realization of insured risk. A mismatch between cash inflows and outflows in the insurance allows the insurer to dispose temporarily free funds, which form the technical reserves, and to achieve extra yield through their investments, in addition to profit from insurance business. Insurance companies transform passive funds, obtained on the basis of a large number of smaller amounts of insurance premiums, into the active capital invested on financial markets. The concentration of these funds in the form of technical reserves ensures that insurance companies have an important place among institutional investors. Investing of temporarily free technical reserve funds is usually strictly regulated by the state, since the policyholders, receiving compensation from these reserves in the event of the insured risk realization, are objectively deprived of the opportunity to control how efficiently and safely insurance companies invest these funds.

Bearing in mind the stochastic character of insured risks and, consequently, of insurance indemnities, as contractual obligations of insurers, it is very important to create such an investment portfolio that will provide the best balance between the risks taken and the return that can be achieved, while respecting current investment rules at the same time. Therefore, this paper deals with the possibilities of investing funds of insurance companies in Serbia under the existing limiting factors. The aim of the paper is to create an optimal investment portfolio of non-life insurers, taking into account the nature of their liabilities to policyholders, the regulatory constraints in effect, but also the level of development of the domestic financial market.

The first section of the paper explaines the main funding sources of insurance companies, after which specific factors that determine the structure of their investment portfolio will be elaborated. A review of results of previous studies of investment regulation effects on insurers` investment performance is followed by description of the methodology and data used in this study. Derived hypothetical optimal portfolio in the spirit of the *Markowitz* portfolio theory, which could be achieved in Serbia assuming investing in securities only, as well as the average real investment portfolio of insurers on the domestic insurance market will be presented in the sequel. Investment portfolio of a specific insurance company will also be discussed for comparison with the previous two and drawing recommendations for optimization of the investment portfolio of insurance companies in our country.

Insurance companies` funding sources

A specific manner of the insurance mechanism functioning allows insurance companies to initially collect and accumulate premiums from policyholders, while compensation payments are realized subsequently, after the actual occurrence of an insured event. Payment of sums insured in life insurance can occur after ten or more years from the contract conclusion while the periods of realization of the risks covered by non-life insurance are considerably shorter, usually up to one year. In any case there is a time gap between the inflows of premiums and outflows from compensations during which the insurance company has at its disposal certain funds that can be used to achieve additional return through their investment. Thus, investment opportunities of insurers are influenced by the very nature of insurance business.

The significance of an insurance company on the financial market depends on its investment potential. Insurer`s investment potential includes the total funds that are temporarily available and as such can be invested to earn yield, but considering the safety of investments, since most of that funds should cover future liabilities to policyholders. Therefore, insurance company can invest only a portion of available funds relating to the insurance fund (external capital) and guarantee reserves (equity).

Prior to its use for payments of insurance indemnities, temporarily released funds represent technical reserves, or insurance fund. Depending on the amount and timing of insurance indemnities, technical reserves condition significant changes in insurer`s investment potential. As regards the own capital which represents a guarantee reserve or available solvency margin, it is rarely and shortly used for covering insurance liabilities, and for this reason legal restrictions on its investing are not necessary. Equity is used for covering insurance liabilities only in the case of shortcomings of technical reserves. Its volume can be planned with a high degree of probability and in a much lesser extent impacts the changes in investment potential.

Investment potential of the insurance company is an integral part of its financial potential. It represents the portion of financial potential remaining after deduction of the insurance expenses, borrowed funds and the insurance indemnities. If these deductibles are increased to a greater extent than the amount of guarantee and technical reserves, that will result in the investment potential reduction, despite the growing financial potential of the insurer. Investment potential is a variable affected by a number of factors from which the most important are the volume of collected premiums, the structure of the insurance portfolio, the operating loss or profit, legislation relating to the formation and investment of insurance funds, duration of insurance contracts and the amount of own capital.

Insurance companies` investment portfolio structure

The three most important directions of insurance companies` investments are investing in real estate directly or approving mortgage loans, buying securities and depositing funds with banks and other financial institutions [17, p. 328]. The proportions of specified investment forms within the insurers` assets are conditioned by several factors, such as the purpose of insurance business, the level of financial market developmet, the type of insurance that the concrete company deals with and the legal framework.

Each investment of an insurance company must meet two basic principles: providing a high level of protection against risks underwritten and achieving a high return on funds invested. The overall insurer`s investment policy is based on the principles of safety, profitability and liquidity. However, the purpose of the insurance business determines the relative importance, i.e. priorities among these principles. Due to its basic function of ensuring policyholders` security, each insurance company must primarily take into account the safety principle when making investment decisions. Consequently, the primary direction of placing technical reserve funds of insurance companies should be conditionally risky assets, in the sense of government bonds, long-term bonds of state companies and bank deposits. In addition, the principle of safety is achieved through the diversification and dispersion of investments, as well as maintaining solvency margin at the prescribed level when investing the funds in order to prevent possible erosion of the company's capital [15, p. 14].

To what extent will the insurance company really be able to realize its function of institutional investor primarily depends on the depth and breadth of the financial market. Insurer`s ability to directly and indirectly meet the expectations of shareholders, supervisors, policyholders and other stakeholders through the investment activities is limited if the offer of financial instruments is scarce. In terms of underdeveloped capital market, insurance companies mainly appear on the money market, which adversely affects their investment profitability, particularly in case of life insurers, whose liabilities require high-quality long-term investments [16, p. 147].

Types of assets in which insurance companies invest their funds, as well as the maturity of these placements, are determined by the properties of funding sources and liabilities, in terms of their predictability and duration. In this respect, there is a significant difference between companies engaged in life and non-life insurance. The premium, as the most important source of financing, is known upon the conclusion of the contract in both types of insurance. However, the ability to predict future liabilities to policyholders in terms of their amount and timing is considerably higher in life insurance. Sums insured in this type of insurance are predetermined and fixed, while the indemnity in non-life insurance depends on many factors. Likewise, the moment of occurrence of the insured event is relatively predictable or even

defined within the life insurance contract whereas in non-life insurance it is quite uncertain if and when will the damage occur. Ultimately the difference in the maturity of funding sources and liabilities stems from the fact that contracts in non-life insurance usually cover a period of one year, while the contracts in life insurance refer to multi-year periods.

Following explained features of funding sources and liabilities, companies dealing with life insurance have a notably wider range of investment opportunities and a longer investment horizon as opposed to non-life insurers. Based on the investment portfolio of life insurers in developed countries, it can be argued that those companies hold most of their assets in bonds, as securities characterized by lower yields and lower risk relative to equity instruments. In order to maximize safety of investments and to achieve certain tax reliefs, these companies are particularly interested in investing in government bonds. Due to yield stability, real estate also represents an attractive investment alternative for life insurers. Non-life insurers, on the other hand, hold relatively larger share of their assets in cash, cash equivalents and short-term securities (primarily commercial papers and treasury bills). In addition, these companies invest relatively more in shares thus achieving protection against the inflation risk in the so-called long-tail lines of business (see Table 1).

Finally, the structure of the investment portfolio of insurance companies is determined by the legislation, which is primarily related to investment of technical reserves (particularly of the mathematical reserve immanent to life insurance). The goal of the legislator is to preserve the real value of insurance funds in contemporary unstable investment environment and rapid changes in the value of money, as well as to maintain the insurer`s ability to settle its liabilities to policyholders at any given time. Thereby there are two alternative approaches of the regulator. "Prudent person rules" are qualitative standards requiring from investors to act with caution and to follow the general principles of the investment portfolio diversification and asset-liability matching. "Quantitative portfolio regulations", on the other hand, impose explicit limits on holdings of assets with relatively volatile nominal returns, low liquidity or high credit risk [6, p. 20].

Literature review

Optimization of investment portfolio of insurance companies is based on modern portfolio theory and asset-liability management principles, but respecting relatively larger number of limitations in relation to other types of investors. In an effort to exploit as much as possible the potential of insurance for encouraging the economic development of the country, the way in which investment regulations impact behaviour of insurance companies as institutional investors has become an area that has gained increasing attention [25, p. 4]. Therefore, the effects of investment regulations on the structure and performance of insurers` investment portfolios are examined through theoretical and empirical researches.

Table 1: Life and non-life insurers' portfolio allocation in selected OECD countries (in %)

Country	Life insurance			Non-life insurance		
	Bonds	Shares	Other	Bonds	Shares	Other
Austria	72.9	9.5	17.5	29.3	41.2	27.2
France	75.9	19.5	4.6	60.1	25.8	14.1
Germany	38.7	3.7	57.6	38.5	10.2	51.3
Italy	89.6	4.0	6.4	77.7	6.8	15.5
Japan	68.4	7.0	24.6	35.5	25.4	39.1
Spain	75.1	3.4	21.5	50.9	12.0	37.1
Switzerland	62.3	1.9	35.8	37.3	3.8	58.9
United Kingdom	60.9	14.5	24.6	36.8	9.2	54.0
United States	74.0	3.8	22.2	63.7	23.9	12.4

Source: [24, pp. 27-28]

Still in 1968, *Lawrence D. Jones* [14] analyzed the impact of internal investment objectives and external restrictions on insurers` investment decisions. The effect of statutory investment rules in the form of limiting investment risk taking was identified on the aggregate database of life insurance companies in the United States from the period 1946-1964 and it was concluded that the proportion of shares in insurers` investment portfolio would be considerable higher in the absence of such restrictions. Although *Hershman* [12] pointed out that the effective impact of statutory limits is smaller, since most insurers in the practice invest in risky forms of assets to a much lesser extent than is permissible, he noted that the requirements for technical reserve coverage discourage investment in equity and thus limit yielding possibilities of insurers. Ussing regression analysis on the data of 55 US life insurance companies during the period 1988-1995, *Henebry & Diamond* [11] proved a significant decline in the share of stocks and mortgages in the investment portfolio of these companies as a result of artificial non-market restrictions imposed by regulators.

The *European Commission* [9] generally argues against the quantitative regulatory rules for institutional investors stressing that they lead to a sub-optimal return and risk taking. More precisely, quantitative rules impede appreciation of liabilities duration when making investment decisions, hamper the use of appropriate techniques of immunization and asset-liability matching, force selection of portfolio that is below the efficient frontier, limit the use of financial derivatives for risk hedging and with excessive focus on individual risky assets underestimate the possibilities to reduce overall risk of the portfolio through diversification. Due to their rigidity, they can not fast enough adapt to changes in macroeconomic conditions and trends on financial and real estate markets [6, p. 167]. On the example of the OECD countries over the period 1980-1995, *Davis* [5] has shown that life insurers in countries applying the "prudent person rules" on average realized higher investment returns compared with those whose investments are subject to quantitative rules. Through a panel data econometric model, *Bijapur et al.* [3] proved in the case of life insurers from seven EU countries observed over the period 1995-2004 that explicit limits on investments constrain portfolio diversification and distort portfolio choice, thus imposing a cost for insurance companies (and their customers) in terms of risk-adjusted returns.

Observing the investment portfolio structure of life insurers in developing countries, *Kong & Singh* [18] identified a strong bias for fixed income securities since most regulators explicitly restrict the proportion of investments in shares, real estate and international instruments. The authors emphasize that such a stringent investment guidelines not only restrict asset allocation, but also may be counterproductive, leading to increased exposure to interest rate risk. Similarly, the results of research conducted on the example of the insurance sector in China show that investment rules constrain investment opportunities for insurance companies and potentially reduce their investment performance [10]. Although similar studies have not been conducted for insurance companies operating in Serbia, *Beronja* [2] proved in the case of voluntary pension funds that the investment restrictions imposed by domestic regulator cause the efficient frontier shift and lead to the investment portfolio sub-optimality.

Data and methodology of analysis

The research hypothesis according to which investment restrictions adopted by the regulator lead to a narrowing of the efficient set of investment opportunities and to a worsening of risk-return trade-off for insurance companies in Serbia is formulated on the basis of previous research results. However, bearing in mind the low development level of the financial market, it can be assumed that primary factors that determine investment decisions of the insurers in Serbia are not regulatory constraints, but the availability of financial instruments and trends in their prices and yields.

The mean-variance analysis of *H. Markowitz* [19] represents a methodological framework for testing the first hypothesis. In general, the overriding investment goal is to achieve an optimal trade-off between risk and return, by allocation of the portfolio to appropriately diversified combinations of assets [5, p. 4]. The *Markowitz* portfolio

selection model includes the identification of available risk-return combinations from a set of risky assets, construction of the optimal portfolio of risky assets and, then, the selection of the complete portfolio by combining a risk-free assets and optimal risky portfolio [4, p. 240]. Within this process it is necessary at first to derive the minimum-variance frontier of risky assets that presents the lowest possible level of risk that may be taken at a given level of expected return of the portfolio. Part of this hypothetical boundary above the global minimum variance portfolio is the efficient frontier of risky assets at which it is not possible to increase return without increasing risk, or to reduce risk without reducing return. Theoretically, the optimal risky portfolio is located in the tangency point of the capital allocation line (CAL) with the highest slope (showing all possible combinations of risk and return as a result of the distribution of the entire portfolio between a particular risky portfolio and the risk-free assets) to the efficient frontier. Finally, a selection of the complete portfolio is conditioned by the objectives and preferences of investors as well as the constraints they encounter.

The subject of optimization in this paper is a portfolio made up of assets used to cover technical reserves of non-life insurance companies in Serbia. It is assumed that the coverage of technical reserves is complete. The minimum variance frontier is carried out on the basis of available historical data on risky assets returns, by solving quadratic programming problem with an objective function:

$$\min \sigma_p^2 = \sum_{i=1}^{n} w_i^2 \sigma_i^2 + \sum_{i=1}^{n} \sum_{j=1}^{n} w_i w_j Cov_{ij},\ i \neq j \quad (1)$$

while satisfying a set of linear constraints:

$$\begin{gathered} \sum_{i=1}^{n} w_i = 1 \\ w_i \geq 0, i = 1,2,..., n \\ E(r_p) = r_p^D \end{gathered} \quad (2)$$

where:

σ_p^2- portfolio variance,

w_i, w_j - weights of individual securities,

σ_i^2- variance of the rate of return on individual securities,

Cov_{ij}- covariance of returns on two securities,

$E(r_p)$- expected return of the portfolio,

r_p^D- given expected return of the portfolio,

n - number of securities observed.

The model further assumes that insurance companies cannot perform "short sales" which is why the negative values of weights of individual securities are not permitted. Solutions to the problem are weights w_i, $i = 1,...,n$ at which the lowest level of portfolio variance for a given expected return of the portfolio is achieved. Portfolio optimization criterion can be the Sharpe ratio maximization, so that the objective function (1) is replaced by the expression (3):

$$\max S_p = \frac{E(r_p) - r_f}{\sigma_p} \quad (3)$$

where:

S_p- Sharpe ratio,

r_f- risk-free rate of return,

$E(r_p) - r_f$- portfolio risk premium.

Calculated weights of individual securities determine the optimal risky portfolio offering the highest yield per unit of risk, i.e. having the highest reward-to-variability-ratio, which is the slope of the capital allocation line. Given the optimal risky portfolio and the CAL generated by the combination of this portfolio and the risk-free assets, the individual investor's degree of risk aversion could be used in order to find the optimal complete portfolio in the absence of other constraints [4, p. 238].

In order to take into account investment rules that apply to insurance companies in the construction of their investment portfolio, it is necessary to introduce additional restrictions into formulated algorithm of quadratic programming. Types of assets that may serve to cover technical reserves of insurers in Serbia and limitations on the overall and individual investments in those types which are considered risky are defined within the current law [13, article 131] and subordinate legislation [7, article 3] (see Table 2).

Having regard to the outlined investment rules, data availability and general characteristics of the investment portfolio of non-life insurers, the hypothetical risky portfolio can be composed exclusively of shares subject to trading on the regulated market. Since their total share in relation to technical reserves cannot be greater than 25%, shares issued by a single issuer cannot participate

Table 2: Types of assets that may serve to cover the technical reserves of insurance companies in Serbia

Types of assets		Limitations in relation to technical reserves	
		Individual investments	Total investments
Securities issued by (or guaranteed by) a state, EU or OECD member states, or their central banks		Without limitations	
Securities issued by the international financial organizations whose member is the Republic of Serbia		Without limitations	
Securities issued by (or guaranteed by) the autonomous provinces and local government units		≤ 35%	≤ 10%
Debt securities traded within the organized stock market in the country		≤ 35%	≤ 5%
Debt securities not traded within the organized stock market, provided that they are issued by a domestic legal entity		≤ 3%	≤ 0.5%
Shares traded within the organized stock market in the country		≤ 25%	≤ 5%
Shares not traded within the organized stock market, provided that they are issued by a domestic legal entity		≤ 5%	≤ 1%
Equity shares in companies based in the Republic of Serbia		≤ 5%	≤ 1%
Investment units of investment funds (only for life insurance linked with units of investment funds)		≤ 100%	≤ 25%
Real estate and other real legal rights to real estate	life	≤ 30%	≤ 10%
	non-life	≤ 20%	≤ 7%
Deposits in banks in the Republic of Serbia		≤ 20%	≤ 5%
Cash in currency and coin or in bank accounts	life	≤ 7%	≤ 5%
	non-life	≤ 10%	

Source: Prepared according to [13, article 131] and [7, article 3]

in the risky portfolio with more than 20%, which satisfies the requirement that their share in the complete portfolio does not exceed 5%. The remaining 75% of the complete portfolio may be formed by risk-free instruments, i.e. Treasury bills.[1] Additional constraint can be represented as follows:

$$wi \leq 0.20, i = 1,2,..., n \quad (4)$$

As for the standard deviation of risk-free returns stands $\sigma_f = 0$, it follows that $Cov_{p,f} = \rho\sigma_p\sigma_f = 0$. Taking into account stated limitations, after construction of the optimal risky portfolio with the expected return $E(r_p^*)$ and standard deviation σ_p^*, the expected return of the complete portfolio $E(r_p^c)$ can be calculated on the basis of:

$$E(r_p^c) = 0.75\, r_f + 0.25E(r_p^*) = r_f + 0.25\,[E(r_p^*) - r_f] \quad (5)$$

while the standard deviation of the complete portfolio (σ_p^c) is equal to:

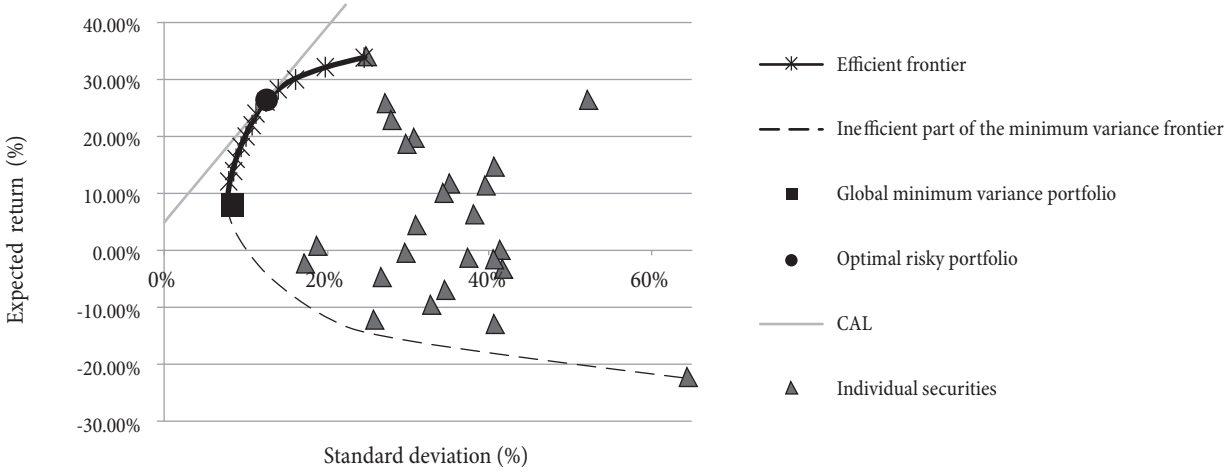
$$\sigma_p^c = 0.25\sigma_p^* \quad (6)$$

The analysis was conducted on the basis of data on prices of 25 shares traded by continuous trading method with the highest turnover on the Belgrade Stock Exchange in 2015, taken from the web site of the stock exchange [1]. Change in share prices was observed on a monthly basis during the period January 2011 - October 2015, thus obtaining 57 observations on the monthly returns of each share. The weighted average interest rate on Treasury bills denominated in RSD of 4.89% in October 2015 (according to a report on interest rates on the securities as a part of the official statistics of the National Bank of Serbia [23]) is taken for a risk-free rate of return. Data on average interest rates on long-term government bonds are taken from the same source.

The second hypothesis was tested by analyzing the real structure of assets used to cover technical reserves of non-life insurers in Serbia. Data on the structure of these assets at the level of the entire insurance sector were taken from the annual reports of the National Bank of Serbia insurance supervision department [21, 22]. The preview of the structure of technical reserves coverage in the case of a specific non-life insurance company is prepared on the basis of notes to the financial statements of that company for 2014, which are publicly available on the web site of the Business Registers Agency of the Republic of Serbia [26]. Data on the rates of return on the government debt securities held by the selected insurer are taken from

1 Long-term bonds are not included in the constructed portfolio since that there is only one old foreign currency savings bond maturing on 2016 and there are no corporate debt securities on the organized market at the moment. As of November 2015 long-term debt securities issued by the Republic of Serbia are added on the Belgrade Stock Exchange (secondary trading in government bonds has so far been performed on the OTC market through the bilateral investor contracts).

Figure 1: The minimum variance frontier of risky assets with the optimal CAL without constraints



Source: Authors' calculations on the basis of [1] and [23]

the auctioning reports of the Treasury of the Ministry of Finance of the Republic of Serbia [27].

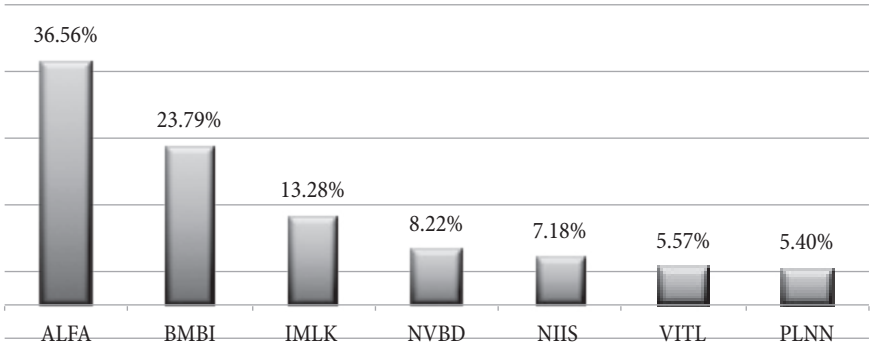
Discussion of results

The mean value and standard deviation of annualized returns on each of the observed shares (see Annex 1), as well as the covariance between shares, as necessary inputs for determining the portfolio return and standard deviation are calculated on the basis of obtained data on monthly returns. The minimum variance frontier is derived by applying the steps (1) and (2) of the explained algorithm (see Figure 1). By introducing risk-free assets, through the further optimization process based on the steps (3) and (2), we determined an optimal risky portfolio, which is located in the point of tangency between the efficient frontier and capital allocation line with the highest slope.[2] More specifically, the Sharpe ratio of 1.7 indicates that any increase in risk, or portfolio standard deviation by one percentage point leads to an increase in the portfolio return of 1.7%.

Figure 2 shows the structure of the optimal risky portfolio in the absence of regulatory constraints. The expected return on the optimal risky portfolio is 26.03% per annum and its standard deviation is 12.42%. In any particular case, the preferences of insurer's portfolio managers and the nature of liabilities to policyholders will determine the structure of the complete portfolio on the given capital allocation line.

Introduction of regulatory constraints in the form of expression (4) has caused a shift of the efficient frontier of risky assets and a narrowing of the efficient set (see Figure 3). The slope of the capital allocation line is reduced

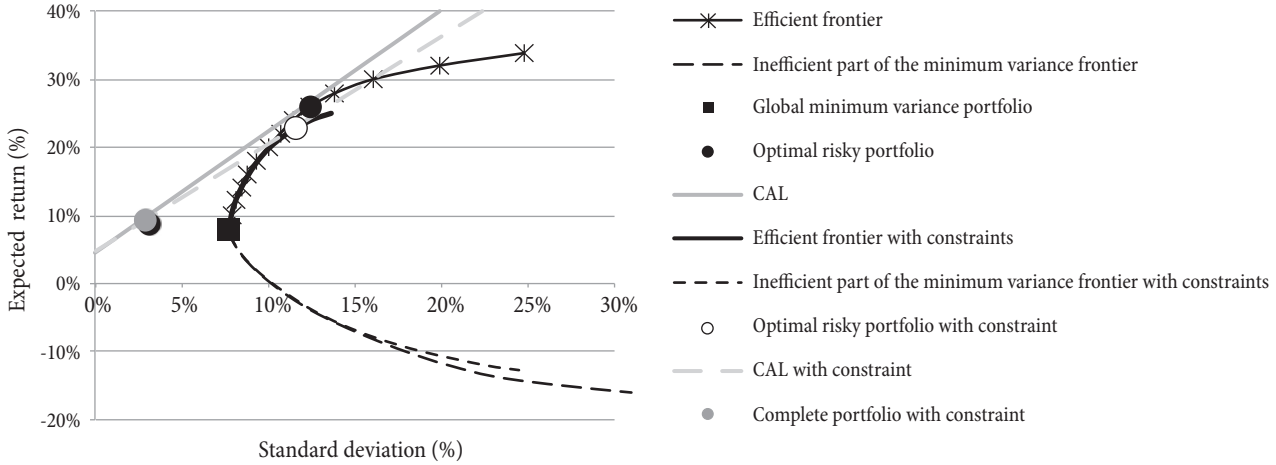
Figure 2: The structure of the optimal risky portfolio without constraints



Source: Authors' calculations on the basis of [1]

2 The optimization was performed using the Solver tool in Microsoft Excel.

Figure 3: The minimum variance frontier of risky assets with the optimal CAL with and without constraints



Source: Authors' calculations on the basis of [1], [23] and [7]

so that the newly created optimal risky will provide a smaller expected return (22.84%) at approximately the same level of risk (standard deviation of 11.60%). Being located below the original *Markowitz* efficient frontier, such a portfolio is sub-optimal, which is consistent with previous findings [2, p. 262].

Regulatory restrictions will be reflected in the structure of the complete portfolio also, in which shares cannot participate with more than 25%. If the rest of the assets used to cover technical reserves were invested in 1-year Treasury bills, expected return of the complete portfolio would be only 9.38%, and its standard deviation would be 2.90% (see Table 3).

However, there is still a possibility to increase the expected return of the portfolio. Instead of in 1-year Treasury bills, part of the complete portfolio can be invested in long-term government bonds, whose share is also not subject to regulatory limitations. For example, the weighted average interest rate on government bonds denominated in RSD with a maturity of 5 years amounted to 6.50% in October 2015 [23]. Bearing in mind the need to preserve liquidity of non-life insurers` investment portfolio, 30% of the portfolio may be invested in 1-year Treasury bills, 25% in the optimal risky portfolio made up of shares and the rest in long-term government bonds. Such an investment portfolio would provide expected return equal to:
$0.3 \cdot 0.0489 + 0.25 \cdot 0.2284 + 0.45 \cdot 0.065 = 10.10\%$

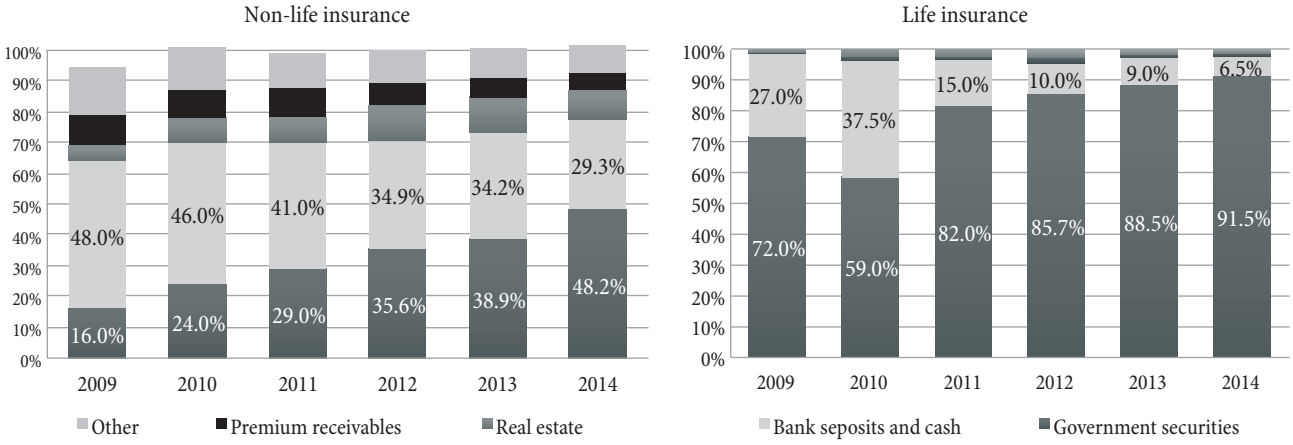
It is interesting to compare the obtained optimal portfolio with the actual structure of assets used to cover technical reserves of the average non-life insurer in Serbia. According to the report of the National Bank of Serbia, coverage of non-life insurers` technical reserves by prescribed types of assets was complete in 2014 (101.4%). Technical reserves were for the most part covered by government securities (48.2%), bank deposits and cash (29.3%), investment real estate (9.3%) and insurance premium receivables (5.8%) [22, p. 16]. Such a structure of the investment portfolio indicates the prevailing conservative investment policy in the domestic insurance sector. In comparison with the structure of assets covering technical reserves of life insurers (which is dominated by government bonds with a share of 91.5%), it can be concluded that non-life insurers invest funds over shorter time periods in line with the maturity of their liabilities (see Figure 4).

Table 3: Comparison of portfolios with and without constraints

Portfolio	Expected return	Standard deviation	Risk-free rate	Sharpe ratio
Optimal risky portfolio without constraints	26.03%	12.42%	4.89%	1.70
Optimal risky portfolio with constraints	22.84%	11.60%	4.89%	1.55
Complete portfolio with constraints	9.38%	2.90%		

Source: Authors' calculations on the basis of [1], [23] and [7]

Figure 4: Structure of technical reserve coverage of insurance companies in Serbia



Source: [21] and [22]

Over the course of time there is a visible increase in the share of government securities and decrease in the share of bank deposits in the portfolio of non-life insurers, contributing to improvement of their investment performance. However, the investment potential is not sufficiently utilized for the purpose of increasing overall business profitability, since the share of stocks in the observed portfolio was less than 5% in 2014. This result can be explained by the insufficient depth and breadth of domestic capital market, as well as with the decline and stagnation of stock exchange indices after the onset of the global financial crisis of 2008/09. The financial market in Serbia is characterized by a poor supply of financial instruments and the low level of investment activity. Given the relative scarcity of local government bonds and the virtual non-existence of corporate bonds, investors are faced with rather limited options regarding valorisation of available funds and diversification of risks taken [16, p. 147]. At the same time, the number of shares that are being traded daily is small, liquidity of the regular turnover is low and volatility of prices and trading costs are high. Immediately before the onset of the crisis in 2007 as much as 20% of technical reserves of non-life insurers were covered by shares traded on the organized market [20, p. 15]. At the end of the same year BELEXline index, which represents the capitalization-weighted portfolio of shares traded on the Belgrade Stock Exchange, reached the value of 3,830.84, while its value by the end of October 2015 was only 1,304.30 [1]. Having regard to the unfavorable market trends, the investment rules for insurers were also tightened during the observed period. Namely, there were no limitations on the total, but only on individual investments in shares traded on the organized market (amounting to 5% of technical reserves) in the previous legislation [8, article 4]. However, given the fact that the actual participation of shares in the structure of technical reserve coverage is on average significantly below the limit, it can be concluded that the conservative investment behavior of insurers on the domestic insurance market has been determined by the available investment instruments and trends in their prices, rather than by a restrictive regulator`s approach.

The portfolio of assets covering technical reserves in case of a specific insurance company engaged in non-life insurance in Serbia was, by its structure, aligned with the average portfolio at the sectoral level in 2014. The largest share in the portfolio of 46.91% refers to government bonds, with equal representation of long-term (two-year and three-year) bonds and bonds with maturities up to one year. Investments in long-term bonds generated an average return of 7.29%. The average rate of return on short-term bonds was slightly higher (7.84%), because the company invested mainly in Treasury bills denominated in dinars, while long-term bonds were mostly denominated in euros. Paying attention to investment dispersion, the company deposits its funds in seven banks in the country achieving an average rate of return on deposits of 4.67%. Finally, the company achieved income from renting its own investment properties of 2.76% in 2014 (see Table 4).

Table 4: Structure of technical reserve coverage in case of specific non-life insurance company

Type of assets	Share in assets covering technical reserves	Weighted average interest rate
Long-term government bonds	23.87%	7.29%
Treasury bills	23.04%	7.84%
Bank deposits	29.90%	4.67%
Investment real estate	9.25%	2.76%
Cash	6.85%	-
Insurance premium receivables	3.41%	-
Unearned premium and claim reserves recoverable from coinsurance and reinsurance	3.67%	-

Source: Prepared according to notes to the financial statements of the observed insurance company for 2014 [26] and [27]

Technical reserves of this undertaking were fully covered by the prescribed types of assets in 2014 (108.07%). The company has invested funds intended for future payment of liabilities to policyholders in accordance with the principles of safety and liquidity. However, the realized weighted average rate of return of the observed portfolio of 5.19% is twice lower compared to the expected return of the proposed complete portfolio (10.10%). In addition, a significant drop in average interest rates on government debt securities denominated in RSD was recorded during the past year should be noted. The weighted average interest rate on 1-year T-bills, for example, has declined from 8.00% in December 2014 to only 4.89% in October of the current year [23]. In other words, the same portfolio structure would bring even lower return at the end of 2015. The profitability of the portfolio can be increased by investing in shares traded within the organized market which were not used at all for covering technical reserves of the company in 2014. Of course, in order to preserve the security of investments, this recommendation relates primarily to liquid shares of issuers of high creditworthiness, especially those that are listed at the stock exchange.

Conclusion

In an attempt to fulfil their primary function of protection from the risks in the best possible manner, insurance companies perform maturity transformation of funds collected from the premiums paid by policyholders. Part of these funds that will be used for settlement of liabilities to policyholders in the future is available for investment until maturity of these obligations and is allocated in the form of technical reserves of insurers. Thanks to the forming and investing of technical reserve funds onto the financial market, insurance companies appear in the role of leading institutional investors in developed countries. By investing the temporarily available funds, insurance companies are trying to obtain an adequate return in the form of interest and capital gain at as little risk as possible. The structure of their investment portfolio is conditioned by the purpose of insurance business, the level of development of the financial market, the types of insurance that the specific company is involved in and the current legislation.

The paper analysed possibilities of investing funds of insurance companies in Serbia in terms of the existing limiting factors. The optimal risky and complete investment portfolios of non-life insurers were created using the *Markowitz* portfolio selection model on the basis of data on prices and yields of available instruments on the domestic financial market. A quadratic programming approach is used to generate efficient frontier of risky assets in the presence of quantitative investment rules. The study confirmed the hypothesis according to which investment constraints adopted by the regulator lead to a narrowing of the efficient set of investment opportunities and to a worsening of risk-return trade-off for insurance companies in Serbia. Quantitative portfolio regulations do not only prevent insurance companies from reaching through proper asset allocation the point on the efficiency frontier that is compatible with their liabilities, but can force them to keep inefficient portfolio that is below the efficient frontier.

With the introduction of a new legal framework in 2014, the more restrictive investment rules for insurers in relation to the previous period were established. Such an approach of domestic regulator is in contrast with current trends in terms of regulating investment activities of insurance companies in the European Union. The Solvency II concept, as an upcoming regulatory framework for the insurance sector in the EU, includes the replacement of the current quantitative constraints with prudential investment regulation. Assets used to cover technical reserves should be invested in a manner that is consistent with the nature and duration of insurers` liabilities. Member states will not be able to require insurers to invest in specific types of assets, as it would distort the free movement of capital. Indispensable prerequisite for this approach is the introduction of the risk-based solvency evaluation methodology (including investment risks), instead of the existing fixed coefficient model (taking into account only insurance risks), which will still remain applicable in Serbia.

Insight into the real structure of the assets used to cover technical reserves of the average and specific non-life insurer, on the other hand, indicates a pronounced conservative investment policy in the domestic insurance sector. However, the investment potential is not sufficiently used to improve the overall insurers` profitability. The proportion of shares traded on the organized market in the coverage of technical reserves has recorded a dramatic decline after the onset of the financial crisis of 2008/09 and is significantly less than the permitted. Hence it can be concluded that the primary factors that determine investment decisions of the insurers in Serbia are not regulatory constraints, but the availability of financial instruments and trends in their prices and yields. In terms of underdeveloped financial market, insurance companies cannot fulfil the important function of financial accumulation, which diminishes their contribution to the economic development of the country.

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Annex 1.

Data on issuers, average annualized returns and standard deviations for the observed shares (January 2011 - October 2015)

Issuer	Symbol	Average return (%)	Standard deviation (%)
AIK banka a.d., Beograd	AIKB	-12.02	26.07
NIS a.d., Novi Sad	NIIS	11.39	35.10
Energoprojekt holding a.d., Beograd	ENHL	4.43	30.97
Aerodrom Nikola Tesla a.d., Beograd	AERO	19.58	30.76
AIK banka a.d., Beograd	AIKBPB	-4.94	26.87
Komercijalna banka a.d., Beograd	KMBN	-6.78	34.45
Alfa plam a.d., Vranje	ALFA	33.86	25.04
Metalac a.d., Gornji Milanovac	MTLC	0.50	18.77
Messer Tehnogas a.d., Beograd	TGAS	9.86	34.40
Imlek a.d., Beograd	IMLK	22.98	28.06
Jubmes banka a.d., Beograd	JMBN	-13.12	40.64
Galenika Fitofarmacija a.d., Zemun	FITO	0.12	41.38
Nova Budućnost a.d., Žarkovac	NVBD	25.90	52.14
Bambi a.d., Požarevac	BMBI	25.39	27.15
Jedinstvo a.d., Sevojno	JESV	-2.68	17.44
Sojaprotein a.d., Bečej	SJPT	-3.57	41.60
Planinka a.d., Kuršumlija	PLNN	18.43	29.74
Montinvest a.d., Beograd	MOIN	14.45	40.44
Philip Morris Operations a.d., Niš	DINNPB	6.25	38.13
Vital a.d., Vrbas	VITL	11.11	39.60
Goša montaža a.d., Velika Plana	GMON	-9.36	33.05
Veterinarski zavod Subotica a.d., Subotica	VZAS	-1.24	40.86
Radijator a.d., Beograd	RDJZ	-1.48	37.60
Tigar a.d., Pirot	TIGR	-22.28	64.48
Energoprojekt industrija a.d., Beograd	EPIN	-0.33	29.54

Source: Authors' calculations on the basis of [1]

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