ACTA UNIVERSITATIS AGRICULTURAE ET SILVICULTURAE MENDELIANAE BRUNENSIS

Volume 63 215 Number 6, 2015
http://dx.doi.org/10.11118/actaun201563061987

THE INFLUENCE OF THE SHARPE RATIO ON APPRECIATION SAVINGS INTENDED FOR THE PAYMENT OF LIFETIME PENSIONS

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Abstract

KUPČÍK PETR, GOTTWALD PAVEL. 2015. The Influence of the Sharpe Ratio on Appreciation Savings Intended for the Payment of Lifetime Pensions. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis,* 63(6): 1987–1993.

The paper focuses on the payment of lifetime pensions paid by pension companies based on the selected mortality table of the Czech Statistical Office. We assume different input values depending on the size of the Sharpe ratio pension companies from selected countries. This paper aims to identify and assess the impact of the Sharpe ratio on the payment of lifetime pensions in postproduction period. We used data of nominal appreciation of pension companies from the Visegrad countries and Sweden, Switzerland and the Netherlands in the period 2005–2013. In the empirical analysis we additionally distinguished between guaranteed and non-guaranteed pension funds. For the purpose of calculating lifetime pensions, we used the formula early paid pension by the pension company on the Czech market down in its her pension plan with an expected median payment period of r years. We found link between the value of the Sharpe ratio and the size of lifetime pensions. Conclusion of the paper shows the effects of low performance of pension funds on lifetime pension with a focus on the Czech Republic. The scientific paper describes partial results reached within the project no. 54/2014 of the Internal Grant Agency of the Faculty of Business and Economics of the Mendel University in Brno following the aims and methodology of the given project.

Keywords: sharpe ratio, efficiency, pension fund, lifetime pensions

INTRODUCTION

The ageing population is a major problem for pension systems in many European countries. The 2012 Ageing Report indicates that these risks are very topical in the countries of Central Europe, especially in Poland, Slovakia and the Czech Republic. There is a reasonable assumption that these countries should have an independent system to demographic aging which would provide income in postproduction period (Part, 2012).

Pension systems are divided into several pillars. The first pillar functions mainly as a pay as you go system (so called „PAYG system“). Private pension companies are part of the second and third pillar, which are based on the accumulation of assets of participants and their assets are invested by pension companies in the financial markets.

Investments of pension companies are very specific because their assets are intended for the payment of pensions. It represents a very long investment horizon corresponding to the certain risk profile of investments. For this reason, the authors of the paper decided to focus on the investment performance of pension companies in selected countries. Authors used a method of the Sharpe ratio in order to compare investment performance of pension funds.

OBJECTIVES AND METHODOLOGY

The main objective of this paper is to estimate the influence of the Sharpe ratio of pension companies on the payment of lifetime pensions in postproduction period.

The secondary objective of this paper is to highlight the differences in performance of pension funds from the Visegrad countries and Switzerland, Sweden and the Netherlands.

The first step in the project was to collect data on investment performance of pension funds in selected countries in the period 2005–2013. We focused on the Visegrad countries (the Czech Republic, Slovakia, Poland and Hungary) and Sweden, Switzerland and the Netherlands. Sweden, Switzerland and the Netherlands were added to analysis, because we wanted to show the differences between a developed and less developed fully funded system (the Visegrad countries). Summary of input data is in Tab. I.

We determined economic status of an individual pension system according to the international Melbourne Mercer Global Pension Index. The Melbourne Mercer Global Pension Index evaluates the Netherlands pension system as one of the best pension systems in the World. The Netherlands pension system has a rating B plus with Australia in 2014. Sweden and Switzerland have a rating B, Poland has a rating C. Slovakia, Hungary and the Czech Republic havea rating E. Melbourne Mercer Global Pension Index indicates the country with the evaluation of E as a country with a poor pension system that may be in the early stages of development or a non-existent system (Mercer, 2014).

Data have been obtained also for the risk-free interest rate in the time series 2005–2013 in selected countries. The paper is using two alternative specifications for the risk free asset: a short-term local rate (SIR) and a long-term local rate (LIR) (Eurostat, 2014).

We obtained pivotal data from these associations and governmental organizations:

- Association of pension companies in the Czech Republic (APF CR, 2014).
- Hungarian Financial Supervisory Authority (HFSA, 2014).
- Investments office (Investments office, 2014).
- Pensioenfonds ABP (PensioenfondsABP, 2014).
- The Organisation for Economic Co-operation and Development (OECD, 2013).
- Ministry of the Treasury in Poland (Steindl, 2013).
- Swedish National Pension Fund – AP1, AP2, AP3 (Swedish National Pension Fund – AP1, AP2, AP3, 2014).

The second step in the project was to estimate the Sharpe ratio. The Sharpe ratio (SR) is the average rate of return minus the risk-free return, divided by the standard deviation of the return. The Sharpe ratio is determined according to the following formula No. 1.

$$SR=\frac{R-R_f}{\delta}, \quad (1)$$

R.....nominal rate of return,
R_f.....risk-free interest rate,
δ.....standard deviation of return (upside and downside volatility).

Frank A. Sortino made the adjustment of the Sharpe ratio and a new indicator called The Sortino ratio (Vovk, 2011). The Sortino ratio penalizes only downside volatility below target return. The Sharpe ratio penalizes both upside and downside volatility. The Sortino ratio (So) is calculated as:

$$So=\frac{R-R_f}{\delta_D}, \quad (2)$$

R.....nominal rate of return,
R_f.....risk-free interest rate,
δ_D.....standard deviation of return (downside volatility).

Authors Bohl, Lischewski and Voronkova (2010) use the Sharpe ratio as a measure of performance evaluation in their Working paper "Pension funds' performance in strongly regulated industries in Central Europe: Evidence from Poland and Hungary". For the evaluation of investment performance authors also used the Treynor ratio. While the Sharpe ratio considers the total risk of a portfolio, the Treynor ratio takes the systematic risk into account.

The authors decided to use an indicator called the Sharpe ratio which was used by a number of authors in scientific studies (e.g. Hlaváč and Schneider, 2011; Walker and Iglesias, 2007). The authors focused on the Sharpe ratio instead of the Sortino ratio because we decided to examine a comprehensive volatility of investments pension fund. It is investments with

I: *Overview of the input data for the period 2005–2013*

Countries	Number of Pension companies	Average rate of return in %	Standard deviation rate of return
Czech Republic	11	2.05	0.80
Slovakia	6	2.16	2.24
Poland	13	7.38	9.72
Hungary	17	4.45	12.90
Switzerland	10	4.14	6.70
Sweden	4	7.08	11.26
The Netherlands	2	7.33	10.77

Sources: Local associations of pension companies

a long time horizon because we take into account the up side and downside volatility. The authors did not use the Treynor ratio due to the large volume of data and parameter settings. The authors consider the Treynor ratio as a possible way for further research.

Performance of pension funds is monitored and evaluated by the World Bank and The Organisation for Economic Co-operation and Development (OECD). The method of the Sharpe ratio was used in the publication OECD: Financial Performance of Pension Fund Systems around the World: An Exploratory Study. In this study multiple tools are compared to assess the performance and it is recommended to use the Sharpe ratio (Walker and Iglesias, 2007).

The performance of pension companies was explored using the Sharpe ratio by researchers CERGE-EI, Mr. Schneider and Mr. Hlavac. They identified large differences in the performance of pension companies in Central Europe (Hlaváč, Schneider, 2011).

The Sharpe ratio is a measure of performance, which includes the risk profile of the investment. It is one of the modern methods of measuring portfolio performance of Pension companies (Musílek, 2011). It is an indicator of absolute return without setting a benchmark (Elton, Gruber, Brown *et al.*, 2007).

If the Sharpe ratio is negative, it means that the pension company does not even reach the nominal appreciation of the underlying assets (the risk-free interest rate). This is a very bad result for pension companies (Brown, Reilly, 2009).

The methodology of the calculation of the Sharpe ratio is the same as was used by the above-mentioned authors, however, the results are different because our time period contains a credit crunch. Furthermore, we have decided to focus on and highlight the differences in performance between guaranteed and unguaranteed pension funds and we identified the influence of the Sharpe ratio on lifetime pension for the Czech Republic. The last part is very important because the PAYG pension systems in Central Europe have limits of their capabilities and the amount of annuity of these systems is very uncertain. The importance of The Sharpe ratio of pension companies on the amount of lifetime pensions has not been examined.

Results of performance of pension funds were divided into two groups: non-guaranteed and guaranteed funds. Guaranteed funds (GF) include a portfolio which is very conservative and consists mainly of bonds and treasury bills. These are usually the funds that are managed by strict regulations. Non-guaranteed funds (NF) represent investment portfolio with a high percentage of shares, usually in combination with bonds.

We determined values of the Sharpe ratio for individual countries, groups of countries (the Visegrad countries vs. countries with developed fully funded pension systems) and for guaranteed and non-guaranteed pension funds. The results of the Sharpe ratio represent a certain degree of effectiveness investing the assets of pension companies. Based on this assumption, we recalculated the nominal rate of return of Czech pension funds. We calculated the potential rate of return, which would achieve with the same efficiency investment assets such as pension funds in selected countries. We used the following equation No. 3.

$$SR = \frac{x - 2.84}{0.8}, \tag{3}$$

SR .....sharpe ratio of selected countries,
x .....potentional performance of Czech pension company,
2.84.....risk-free interest rate in the Czech Republic,
0.8.....standard deviation of Czech pension companies.

We determined accumulated amount of money through equation No. 4 of long-term savings. Prerequisites were to determine the monthly deposits in the amount of 2 000 CZK and time savings of a potential participant for 40 years (Joshi, 2008).

$$s = m \times v \times \frac{(1+i)^n - 1}{i}, \tag{4}$$

s .....accumulated amount of financial resources,
m .....number of deposits in one year,
i .....annual interest rate,
v.....regular deposit amount,
n .....time period of saving.

Based on the amount of accumulated financial resources of potential participants, we determined the amount of lifetime pensions. Lifetime pensions are paid in a base period and in a period after the base period until the end of life of the potential participant. The basic period is the time taken to reach the upper age limit. The upper age limit for the potential participant is determined based on reaching retirement age in the Czech Republic. The upper age limit is unchanged. As the upper age limit was used median life expectancy according to mortality tables of the Czech Statistical Office. These mortality tables are the basic parameters for creating the mortality tables of pension funds (Czech Statistical Office, 2014)

We used the formula of early paid pension by the pension companies on the Czech market with an expected median payment period of r years.

We used the selected formula No. 5 from the pension plan IV of a pension company AXA. The reason was that the pension company AXA is a multinational company operating in several selected countries and the calculation of pensions in the Czech pension companies are on a similar basis because pension plans must be approved by the Czech National Bank. This formula is used to define the annual old-age, retirement and disability

pensions throughout the basic period as of the date of commencement of disbursement and every year when a new calculation is carried out, once shares have been credited. (AXA pension company, 2014).

$$P = \left(\frac{(1+j)^n}{1+0.5j}\right) \times \left(\frac{j}{(1+j)^n - 1}\right) \times C, \quad (5)$$

C.....the total amount of financial resources,
j .....the minimum of appreciation,
n .....the period of draw pensions.

The authors used these simplifying assumptions. The retirement age of the potential participant is 67 years and the technical interest rate is 1%. Life expectancy is set in accordance with the mortality tables of the Czech Statistical Office which are valid for the year 2013. The authors used the mortality tables for men because men have a shorter life expectancy and the differences in the amount of life annuity will be reflected more.

RESULTS

Sharpe Ratio

This section discusses the main results of a portfolio performance analysis of pension funds that consists in estimating the Sharpe ratio. An overview of the results of the Sharpe ratio is in Tab. II.

The authors described in the article: *Reform of the third pillar of the pension system in the Czech Republic after 1 year of operation* (Gottwald and Kupčík, 2014) the position of the pension system in the Czech Republic. We have noted that the new pension participant funds contain very few participants and their assets are not invested in accordance with their statutes. For this reason, the results of the Sharpe ratio in the Czech Republic do not include data of non-guaranteed pension funds.

The Sharpe ratio of guaranteed funds (–0.82) is lower than the Sharpe ratio of non-guaranteed funds (0.17). This is due to strong restrictions on the investment of pension funds and very conservative investments mainly in government bonds. The Sharpe ratio of guaranteed funds (the Czech Republic, Hungary and Slovakia) in comparison with domestic government bonds with a maturity of 10 years is negative. Savings and investments for retirement should have a long-term horizon, for this reason, it is a very bad result for pension companies.

The results are better in non-guaranteed funds only with the exception of Slovakia and Hungary, where this is caused by the negative political influences. It is very important to highlight the excellent results of non-guaranteed pension funds in Poland (0.24), Sweden (0.41), Switzerland (0.41) and the Netherlands (0.44). Pension funds from these countries overcame the interest rate of government domestic bonds with a maturity of 10 years.

Hungarian pension funds have even the worst performance of all selected countries. Polish pension funds have worse performance than Swedish pension funds, but it must be said that Polish pension funds have the best performance from the Visegrad countries. The countries with developed fully funded system have higher Sharpe ratio (0.42) than the Visegrad countries (–0.45). The large difference is mainly due to several reasons. Especially, small investment limits, progressive investment portfolios, other culture and mentality people and investors. The Netherlands (0.44) achieves the best results of all selected countries.

The Influence of the Sharpe Ratio on the Lifetime Pensions

The amount of the lifetime pensions is illustrated in Tab. III. The highest monthly lifetime pension was achieved by developed pension systems in Switzerland (7,999 CZK), Sweden (8,004 CZK) and the Netherlands (8,050 CZK). The worst results of the Visegrad countries were achieved by the Czech Republic (6,180 CZK). The results demonstrate the potential yield of Czech pension funds if they invested efficiently as pension funds in selected countries.

We have focused on identifying the impact of the Sharpe ratio of the amount on the lifetime pensions. We adjusted the baseline results and used only data of positive Sharpe ratio for identifying the impact on lifetime pensions. The interpretation of

II: *Sharpe ratio (SR) of Pension funds*

Selected countries	SR LIR	SR SIR	SR NF	SR GF	Average SR	Average SR
Czech Republic	–2.09	0.11	x	–0.99	–0.99	–0.45
Slovakia	–1.19	0.10	–0.34	–0.75	–0.55	
Poland	0.20	0.29	0.24	x	0.24	
Hungary*	–0.45	–0.40	–0.12	–0.72	–0.42	
Switzerland	0.33	0.48	0.41	x	0.41	0.42
Sweden	0.36	0.47	0.41	x	0.41	
The Netherlands	0.38	0.49	0.44	x	0.44	
Average SR			0.17	–0.82		

* Second pillar was closed in 2010
Source: own research

III: *Local Sharpe ratio, achieved appreciation and monthly lifetime pension by monitored countries*

Country	Local Sharpe ratio	Achieved appreciation of Czech pension funds with the performance of local pension companies in %	The amount of the monthly lifetime pension in CZK
The Czech Republic	–0.99	2.05	6,180.00
Non-guaranteed fund	0.12	2.97	7,540.00
Poland	0.24	3.03	7,734.00
Switzerland	0.41	3.17	7,999.00
Sweden	0.41	3.17	8,004.00
Sweden + Switzerland + + The Netherlands	0.42	3.17	8,017.00
The Netherlands	0.44	3.19	8,050.00

Source: own research

negative Sharpe ratio is specific for each country. Therefore, we decided to focus on only one country. For the foregoing reasons, we decided to identify the impact of the Sharpe ratio of Czech pension funds on the amount of lifetime pensions.

The following formula No. 6 shows the relationship between the Sharpe ratio and monthly lifetime pension. We used the exponential equation:

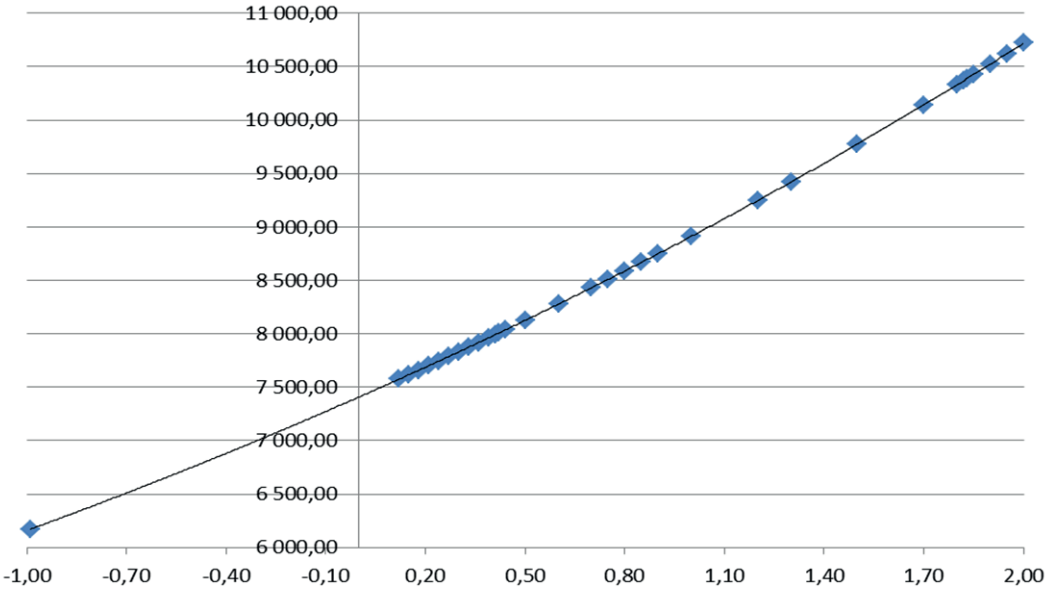
$$y = 7408{,}8e^{0{,}1847x}. \quad (6)$$

From the Fig. 1 is evident that the Sharpe ratio is less sensitive in the Czech Republic, because the volatility of investment in pension funds is small. Low risk of this investment is typical for a very conservative investor.

Generally, the amount of lifetime pensions depends mainly on the size of the nominal appreciation of the assets which are reached by pension funds if the interest rate increases by 1%, so monthly lifetime pension is increased by 25.1% and the Sharpe ratio will increase by 1.23 point. It is necessary to control the performance of pension funds. A small change in interest rates causes a large change in monthly lifetime pension.

DISCUSSION

Walker and Iglesias (2007) in article: *Financial Performance of Pension Fund Systems around the World:* An Exploratory Study described performance of pension funds on Latin American countries, Central and East European countries. They had identified a comparable performance of pension funds in the Netherlands (Sharpe ratio – SIR 0.39; Sharpe ratio – LIR 0.14) in accordance with our research. Different results were achieved by pension funds in Hungary (Sharpe ratio – SIR 0.3; Sharpe ratio – LIR 0.43). Data of Hungarian pension funds are from the time period 1998–2007. The financial crisis affected investments of pension funds in 2008 (the size of the nominal appreciation of conservative funds –1.1%,



1: *The relationship between the Sharpe ratio (x-axis) and monthly lifetime pension in CZK (y-axis) of the monitored countries (the Czech Republic, Poland, Switzerland, Sweden, The Netherlands, Non-guaranteed Funds)*
Source: own research

balanced funds –11.9%, dynamic funds –21.5%). It is obvious that Hungarian pension funds under pressure from bad investment results and negative political influence got into a difficult situation. This situation culminated when 95% of participants in pension savings returned to the PAYG system in 2010.

Hlaváč and Schneider (2011) in article: *Financial Performance Pension Funds in Central Europe: Why are Czech funds the worst?* described performance of pension funds in the Czech Republic, Hungary, Bulgaria, Croatia, Poland and Slovakia in various time periods. What they identified from selected countries was the highest performance of Polish pension funds in the time period 2000–2010 (Sharpe ratio – SIR 0.13; Sharpe ratio – LIR 0.15). The results are badly compared, because they are for the different periods of time, however, there is an obvious tendency of Polish pension funds that they achieve the best performance of the Visegrad countries.

One of the determinants of the Sharpe Ratio is a risk-free interest rate. We estimate a problem in defining the risk-free rate because, in our opinion, on the current financial market risk-free asset does not exist. For purposes of comparison the performance of pension funds across different countries, we used bonds as a riskless assets of local government because they express a certain degree of credibility and they can be used as a common denominator for all selected countries.

CONCLUSION

The Sharpe ratio is a good support indicator for the evaluation of pension companies. The indicator allowed the authors to compare the performance of individual pension systems in the countries studied. In the case of the Netherlands, the portfolio mainly consists of a combination of bonds and equities, similar portfolios are used in Sweden and Switzerland. The Netherlands, Sweden and Switzerland show very similar results. E.g. in a period of significant decline in revenues in the financial markets in 2008 (The Netherlands –21.69%; Switzerland –12.56%; Sweden –21.69%) and worse results in 2011, pension funds managed an appropriate choice to avoid significant portfolio decline in the value for clients. The pension funds achieved a good long-term appreciation of clients' deposits.

The Sharpe ratio is one of the possible tools for assessing the performance of the funds and the indicator of a correct setting of the pension system.

If the results show negative values of the Sharpe ratio, the system indicates either a problem or errors in the system settings. The more the value of the Sharpe ratio approaches zero, the worse is result. The example of Hungary and Slovakia showed negative state interference. The Czech Republic is again characterized by strong regulation. This regulation does not allow for pension schemes to achieve better results.

These countries, especially the pension system in the Netherlands, are among the highest rated in accordance with Melbourne Mercer Global Pension Index, which is confirmed by previous claims about the value for clients.

Pension schemes in the Netherlands, Switzerland and Sweden operate on much greater involvement of employers in this system than in the Czech Republic. This ensures sufficient funds in the pension system. Employees are automatically insured and they eliminate unwanted demographic and social impacts and the absence of clients in the pension system. In the Czech Republic, the system is primarily based on the clients themselves and they are motivated by a state contribution. Looking at a long-term evolution of the average monthly contribution for the client in the Czech Republic, it is clear that this motivation does not work in a long time horizon. Subject to further examination may be its influence on the return achieved in the financial markets. Or in this case, it may be the impact on lifetime pension in post-life period of a client.

From the regular monthly lifetime pension there are clearly visible differences generated by the total amount of saved money. The higher the Sharpe ratio indicates, the higher amount of saved money in account, and thus a higher absolute value of the lifetime pension.

The Sharpe ratio can be seen as one of a number of possible indicators for evaluating the quality of pension systems. However, it can also serve as a benchmark for assessing individual pension systems in the European Union. It can create the conditions for the creation of a uniform and compatible pension system in the European Union.

Acknowledgement

The scientific paper describes partial results reached within the project No. 54/2014 of the Internal Grant Agency of the Faculty of Business and Economics of the Mendel University in Brno following the aims and methodology of the given project.

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