Optimizing the allocation of private pension funds in Romania (Pillar II)

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Abstract

Recent phenomena on the aging of the population due to the improvement of the quality of life, the decrease of the population, the decrease in the fertility rate and the development of the capital markets have led to the encouragement of private pension funds. The private pension system is essential to any modern and prosperous economy; the competitive allocation of capital under this scheme ensures the maintenance / increase of the purchasing power of future earnings from pensions, as well as the most appropriate way to finance national economic development.

Based on extensive literature on the optimization of financial investment portfolios and efficient management of private pension funds, our main objective is to optimize portfolios of private pension funds in relation to the degree of risk assumed by the managers of these funds. In concrete terms, we report optimal weights for the allocation of pension funds in five asset categories (shares, corporate bonds, participation funds, government securities and bank deposits) by using three optimal portfolios models: equipping, minimizing standard deviation and risk minimization.

The database includes the monthly profitability of the five asset fund categories of pension funds, as well as the VUAN evolution of pension funds and the profitability of pension fund managers for the period from August 2013 to July 2018 (5 years). The results obtained will constitute recommendations for private pension fund managers both in choosing the portfolio optimization model and as choices for choosing the optimal combination of assets at a discounted profitability of the portfolio in relation to the assumed degree of risk by each administrator.

Keywords: private pension system; optimal financial investment portfolios, the Markowitz model (average variance, MV), the average MCVaR model, the unit value of the net asset (VUAN), the profitability of private pension fund managers.

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Introduction

In general, there are two social pension schemes: public (Pillar I), with predetermined pension (defined-benefit plan) and private pension schemes, with mandatory contributions (percentage of salary, Pillar II) and facultative Pillow III). The size of pensions in the public system is determined by the contribution of employees, while the size of private pensions is determined by the return on assets of privately managed pension funds by institutional investors. In the public system, the financial risks related to the demographic and employment trends, the performances of the national economy (low yields on financial markets, recession, inflation, etc.) and the evolution of the average salary are assumed (preponderantly, politically) by the state by modifying the point of pensions. Pillar I aim at alleviating old-age poverty and providing pensioners with a minimum standard.

Particularly, the private system aims to provide retirees with a higher income to provide a desired standard of living[1]. The financial risks related to the performance of pension fund management are assumed by the beneficiaries (future pensioners). Pension fund managers will operate with the most efficient asset allocation optimization models to minimize the risk of volatility of portfolio returns.

The public pension system has a much richer history. Recent phenomena on population aging due to improved quality of life, population decline, declining fertility rates and the development of capital markets have led to the encouragement of the private pension system. "The most important causes of this demographic change are declining natal rates and rising longevity. In short, this means that a growing proportion of a country's population will be retired and will therefore no longer contribute directly to economic output. "(Mercer & CFA Institute, 2018).

The private pension system has both compulsory and optional savings. "On the other hand, there are countries such as those in Western Europe, but also the United States of America that has adopted the occupational pension scheme (as an alternative to the optional pension system), a system that differs from that of private pensions by the fact that they is addressed directly to the employer and the trade unions, these being those who negotiate with the employee the future plan for pensions "(Guzun, 2017).

Regarding Pillar II (with mandatory contributions, whose optimization of fund allocation we follow in this paper), "it is reasonable to suggest that the minimum mandatory contribution level is around 8% of revenue" (Mercer & CFA Institute, 2018). The target for mandatory contributions to Pillar II in Romania is 6% of the 10.5% CAS share. Their evolution from the implementation of Pillar II (2008) is fluctuating:

P II	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Cota anuala contributie (%)	2%	2%	2.50%	3%	3.50%	4%	4.50%	5%	5.10%	5.10%	3.75%

[1] Munnell et al (2014) suggested that the pension income needed to maintain the standard of living before retirement is between 67% and 80% of the pre-retirement gross income, with the highest rate applied to those earning lower incomes.

In the mandatory private pension scheme, participants most often remain captive to the pension fund managers to which they originally joined. They cannot withdraw from the private pension system, but can be transferred to other pension directors in the market. However, as a result of the inertia and lack of understanding of how pension funds are managed (management fees, profitability and the risks of privately managed pension funds), voluntary transfers are very low. This phenomenon leads to reduced competitiveness between pension fund managers. Managing pension funds is characterized by a large component of fixed costs, which increases the inelasticity of voluntary transfers and reduces the competitiveness of the market.

As the future value of private pensions depends on the return on pension fund assets, participants in this pension system may be motivated to target an optimal allocation of the investment portfolio by asset pool of pension funds. The main objective of this paper is to make an optimal selection of investment portfolio for private pension funds.

Pension funds have security and liquidity requirements that are common to all investment funds. In addition, pension funds also have their own characteristics:

• Pension funds have a relatively longer time horizon, so they have a higher risk tolerance. Standard deviation on n years = standard annual deviation × √n.
• the pension fund must maintain purchasing power to ensure the future earnings of pensioners.
• Pension funds are facing regular payments, therefore liquidity is a preoccupation.

The research results on pension investment policies have highlighted the importance of asset allocation so that investment policy explains more than 90% of the variability in performance of pension funds (Brinson, Hood et al., 1986; Ibbotson and Kaplan 2000).

Koegelenberg (2012) in Optimal Asset allocation for South African pension funds ... identifies and uses six investment portfolio optimization models:

1. The traditional Markowitz model, medium ~ variance (Mean-Variance, MV, English);
2. Equally Weighted Portfolio (EW, English);
3. Equally-Weighted Risk Contribution
Portfolio, ERC, in English);
4. Re-sampled Mean-Variance Optimization (RMV), re-sampling;
5. Optimization using Value at Risk as a measure of risk (Optimization using Value at Risk as risk measure);
6. Optimization using nonparametric methods (Optimization using a nonparametric optimization method).

All these models aim to maximize the usefulness function of the final value of the retirement benefit. The utility function is complex and differentiated from investor to investor. Consistent with economic and financial literature, the most useful utility function is the constant aversion to relative risk (aversion in English). Most often, this is expressed as an optimization of the ratio between the expected risk and the expected volatility of the investment portfolio. For the efficient management of mandatory private pension funds (Pillar II), in our paper, we will operate with three models outlined above, namely 1; 2 and 5.

In the first section of our paper we highlighted some of the many researches on three themes: public policies on social pension funds; models for optimizing portfolios of financial

investments and models for optimizing portfolios of pension funds. In the second section we present the normative and methodological framework of privately managed pensions in Romania (Pillar II). The following sections (three and four) were dedicated to the database we analysed, the three models of pension fund optimization (equipped, medium and medium, conditional risk) and the results of applying these models to data series from Romania. Finally, in the final part, we synthesize the findings of the research and the recommendations for private fund managers to optimize their portfolios based on expected returns to a certain degree of risk[2].

1. Specialized literature on the administration of pension funds and efficient allocation of portfolio assets

1.1. Public policies on social pension funds

Robu V. and co-authors (2013) analyse the effect of the degree of concentration of the privately managed private pension market in Romania on the pension income that employees can earn after retirement. In order to estimate future pension income, they use the agent-oriented simulation technique. This type of simulation allows the behaviour of participants in the private pension system to be modelled in terms of the average monthly earnings and growth rate, the level of monthly social security contributions paid to private pension funds and the rate of increase, the pension fund management fee, the rate of return on pension fund assets, the risk-free interest rate on government securities.

The conclusion of their article is that the high degree of concentration on the pensions market in Romania (seven private pension fund managers) affects the pension income that employees will earn after saving. In the short term (for example, five years), small pension funds (with a market share below 30%) offer pensioners a pension income that covers the level of paid contributions, while large funds do not cover contributions. On the contrary, in the long run (for example, 20-30 years), the situation is reversed, large pension funds will determine a future higher pension income as a result of the return on pension funds (increase of the unit value of the net asset). But ... "Under a high administration fee and proportionate to the size of the assets of the pension fund, large pension funds will get into the situation where the participant receives a total pension income under the paid contributions." The negative effect of commissions administration can be countered only through efficient asset management, management that will lead to higher return rates.

R., Shiller (2014) has a fair appreciation of the role of investment managers, namely, to determine the composition of investment portfolios on behalf of their clients, to keep their portfolios safely and to direct them where they will make the best profits, the risk through the creation of widely diversified portfolios, keep their bookkeeping and minimize the taxes paid on investments. For pension funds, investment managers also take into account the long-term objectives of future pensioners to have a pension with a purchasing power greater than

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their contribution to the pension fund. Their role is of fundamental importance in the efficient selection of investment categories and the protection of the purchasing power of our future pensions. Unfortunately, Martin Gruber (1996) found that mutual funds had a performance of about 1.5% less per year than a diversified investment on the stock exchange. Mainly, this underperformance is due to management fees received periodically from their investors, without taking into account subscription or withdrawal fees levied once in investment and withdrawal respectively. We expect, therefore, that the underperformance of mutual fund management is even greater.

In Romania, commissions are fixed by Law 411/2004 as maximum limits (initial commission of 2.5% of contributions and monthly administration fee of 0.05% of assets). All administrators chose to go to the maximum statutory limit for privately managed pension funds (Pillar II). In this respect, A. Mitroi (2018) has a realistic appreciation of the commissions charged on investment: "this initially charged coefficient, lacking professional courtesy, accumulates a significant minus in capitalizing the portfolio ... The Pillar 2 System is an Expensive Business Model and inefficient, comfortable and risk-free, easy to receive ... those assigned and not earned contributions, which he administers prudently after well imposed and controlled by the authorities, but with too high, monopolistic costs. " However, "The private pension system is essential to any modern and prosperous economy; the competitive allocation of capital, the one that the private system manages, proves the most appropriate capacity to finance our development requirements ... ".

Impavido, Gr. (2009) reports to the IMF on two interdependent policy challenges faced by pension fund officers: 1) the promotion of reduced administrative burdens, and 2) the enhancement of long-term asset management performance. The report supports broad consensus on the usefulness of financial knowledge and recognizes the importance of identifying systematic behavioural biases in the decision-making process that can lead to improved expected profitability rates. Consumer inertia and barriers to entry are associated with the market power of private pension fund managers, which in turn reduce the effectiveness of administrative tax cuts. Improving long-term performance is hampered by the low elasticity of participants' demand, generally misinformed about the nature of their savings product. In particular, they are not in a position to monitor the investment performance of fund managers in line with long-term retirement objectives. There are also concerns that fund managers have excessive freedom in strategic asset allocation through tactical decisions, not always consistent with participants' long-term investment objectives.

1.2. Using optimization models for the allocation of financial investment assets

The international literature as well as in Romania is particularly rich in both optimization models of financial investment portfolios in general and in the efficient allocation of private pension funds in particular. From the first category of research we present the study conducted by Miskolczi, P., (2016) on the results of the use of the Markowitz, Medium-Variant (MV) model and the Medium-Conditional Risk Value (MCVaR) model for portfolio optimization on the Hungarian capital market. The average ~ variance (MV) model is very suitable for normal profit distributions, but can lead to incorrect conclusions for distributions different from normal. As a result, many other risk measures have been introduced (semi-variance, variance below a minimum profitability threshold, variance with negative values, etc.). Of all these risk-measurement alternatives, Value-at-Risk (VaR) is the most used in

recent years. However, Value at Risk presents some fundamental issues, ie, does not satisfy the subadditive property (VaR of a portfolio may be higher than the sum of the VaRs of its components) and ignores the severity of losses in the portfolio's profitable distribution queues. Moreover, VaR's non-convexity makes it impossible to use it in portfolio optimization. To overcome these problems, the conditional risk value (CVaR) is used which is more sensitive to larger losses in the thick queues. The author applies the model (MV) and then the M-CVaR on the profitability of seven Hungarian stock exchanges. By applying the two portfolio optimization models, the author answers two questions arising from the use of the two risk measures, (1) Can we have optimal portfolios with different weights? If so, does the solution suggest that the investment decision is different in both cases? The analysis clearly shows that the answer to these questions is yes. Portfolio optimization through the M-CVaR model at different target returns leads to different decisions of optimal allocation relative to the optimal allocation decisions in the MV model.

Bengtsson, P., (2010) also arrives at similar conclusions regarding the use of the two models (MV and MCVaR). The author analyzes, from a very practical perspective, some of the properties of the Medium-Variant (MV) and Medium-Conditional Value-at-Risk (MCVaR) portfolio optimization. In order to capture both positive and negative financial episodes, optimizations were performed on data from two different time periods: 2006 and 2008. 2006 was a period with generally good outcomes, while 2008 was a period dominated by the crisis. The most important conclusion from this study is that under different market conditions there is a difference in the way the two risk measures apply. MV optimization is affected by the general state of financial markets and is therefore superior under favourable market conditions. The reason could be because this model penalizes earnings and losses symmetrically. The most important difference between the two sets of portfolios optimized during the analyzed period (2006 -2008) was that the MCVaR portfolios showed several weeks of high loss and that these losses are higher than those of the MV portfolios. Conditional Risk Value (CVaR) is an alternative measure of the expected loss that was introduced by Uryasev and Rockafellar (1999). This risk measure is considered to be of greater consistency with the VaR and measures the expected loss given that the loss thus estimated is higher than the VaR. Also, the CVaR measure is convex, while the VaR measure is not. Because of this convexity, CVaR can be minimized with respect to the weights of the optimal portfolio (Uryasev and Rockafellar, 1999).

1.3. Using models to optimize investment portfolios of pension funds

Contributory Pension Funds play an essential role in social pension systems. In his study (Zhang, 2014), he starts from the hypothesis that the participants in the mandatory pensions have, in the accumulation phase, a certain motivation in choosing the investment allocation of the pension fund and thus in optimizing the investment portfolio, respectively, maximizing the expected utility of of the final wealth according to the constant aversion to relative risk. The main objective of this paper is to find an optimal selection of investment portfolio for stochastic mandatory pension funds within the medium variance model (MV), which has not been researched in the existing literature. To this end, the author uses a special Riccati equation as a continuous solution (in fact, a viscosity) of the equation[3] to obtain an explicitly

[3] Equation Hamilton-Jacobi-Bellman for continuous dynamic programming.

closed solution of the optimal investment portfolio as well as the efficient border. The utility function is assumed to be a continuous, increasing and strict concave function, such as power, logarithmic, exponential, or quadratic function. For a pension fund, the efficient allocation of assets involves a fairly long period, generally from 20 to 40 years, so it is crucial to take account of wage risk.

Yibing Chen, and co-authors (2017), first analysed some important asset allocation issues for some large-scale companies in the world in managing private pension funds. As an asset allocation methodology, we presented the average variance model and the CVaR constraint model in the real Chinese circumstances. The empirical results show that, in order to maintain the purchasing power of pension funds, certain proportions should be allocated to shares as well as direct equity investments. They also found that the time horizon significantly influences the allocation of pension fund assets. If the time horizon is 5 years (compared to 3 years), higher share and equity investments contribute to improving the performance of pension fund management.

Van Heerden, J.D. and Koegelenberg F.G. (2012) is conducting a comprehensive study of the optimization of South African pension funds in domestic assets and external assets, respectively. In particular, it seeks a response to the intention to invest 25% of the portfolio of external pension funds. In this study the authors assess, first, seven different optimization models to determine the optimal allocation of the asset mix. Thus, we find answer to key optimization issues: what risk measure should be used if parametric or non-parametric optimization should be used and if the average variance model Markowitz is the best model to determine optimal allocation strategies long-term assets. The results obtained from different models have been used to recommend the optimal long-term allocation of assets for a South African pension fund and which would be the most efficient optimization model. In relation to the time horizon, the study found that when only data from the last ten years were used, it would have been optimal to invest only in asset classes in South Africa with statistical differences in return in some cases. Using data from the past 20 years to build optimal portfolios, mixed results were achieved, while over a period of 30 years the result was more in favour of an international portfolio of 25% invested in the foreign asset. The study also revealed that a 20-year data period is optimal for allocating the assets of private pension managers.

Pennacchi, G., and Rastad, M., (2010) present in their paper a dynamic model for the allocation of public pension fund assets and analyze how risk-taking behavior can vary according to the characteristics of a pension plan of a representative taxpayer. To examine the implications of the model, the authors use annual data on the allocation of 125 state pension funds over the period 2000-2009 for eight asset categories: US shares, US non-US shares, US fixed income. and non-US fixed income, real estate, private equity, hedge funds and others. In addition, this includes the rate assumed by each fund for the performance of debts and the total salary for active participants in the pension fund. The authors conclude that the risk of hedging against the change in the market value of investing pension funds is probably a socially optimal policy. The risk is measured by the volatility of the return on the assets portfolio of a fund in relation to the return on the market value of its liabilities. However, the career concerns of pension fund managers may conflict with this objective. Their empirical results seem consistent with the behaviour of investment managers. Attracting pension fund members from the board of directors would be likely to lead to an active allocation rather than to the performance of representative pension funds rather than to immunize the liabilities of their pension plan.

In their study, Xiong X. J., and Idzorek Th. (2011) start from the finding that the returns on pension fund assets are not distributed normally and that investor preferences exceed, in most cases, the averages and variants of normal distributions; however, the implications for choosing the portfolio are not well known. It is therefore necessary to investigate the impact of higher moments (skewness and kurtosis) on the optimal asset allocation policy, respectively, the overall impact on portfolio characteristics. In the case of normally distributed returns, the average variance model (MV) and the average risk-adjusted model (MCVaR) model lead to the same results as the optimal portfolios. Similarly, if the distribution is symmetrical, but with a larger or smaller kurtosis, the weights of the optimal portfolios are very similar. However, when distributions have different levels of skewness and kurtosis, MV and MCVaR lead to significantly different, optimal allocations of assets. Specifically, MCVaR prefers assets with a higher skewness, lower kurtosis, and lower variance.

Understanding the impact of higher moments on asset allocation policy leads to a critical application of modern portfolio theory; What matters is the overall impact on portfolio characteristics. Over the past 20 years, value shares, high yield bonds (but with a lower global credit rating, English), real estate investment (REIT) and US inflation bonds. had a significant negative skewness, while non-US government bonds. had a positive skewness. Kurtosis for high yield bonds, REITs and US inflation bonds are higher than other asset classes. From an analysis of 14 asset classes to the MV model, the MCVAR model leads to higher optimal weights for non-US government bonds, large corporate and non-US REIT shares, and lower optimal weights for US high value, emerging market shares and US REITs.

Hollenwaeger, S., (2017) highlights in his study that the portfolio of pension funds shows major changes in portfolio assets and structure, driven not only by market volatility but also by regulatory requirements with increased emphasis on risk management. Over the past ten years, the most profitable funds have moved on to higher weights in alternative investments on the grounds that they lead to better returns but with higher risks than traditional financial assets. UK pension funds have reduced their bond and equity positions and extended their allocation to alternative investments (OECD, 2015, Talmod & Vasvari, 2014). Over the period 2004-2014, pension managers have increased their portfolio share in alternative assets by more than five percent (Britain's allocation increased by 12.8%, Canadian pension funds increased the share by about 8%, and Brazilian funds by 8.9%). During the same decade, the US increased its 4.5% alternative assets (OECD, 2015). Consequently, their administration requires increasingly skilled skills and knowledge. Significant change to alternative assets leads to qualified concerns about portfolio optimization methods and adequate diversification into alternative assets.

2. The normative and methodological framework of privately managed pensions (Pillar II)

The privately managed pension fund system in Romania is governed by Law 411/2004 on the establishment, organization and operation of pension funds and pension fund managers and other entities involved. For the purposes of our work, Law 411/2004 provides for the rules for calculating the assets of the private pension fund[4]: the total value, the conversion of

[4] Net asset value of the fund = Total asset value - Amount of liabilities;

the contributions into fund units, the number of fund units, the value of the net asset, its unit value, and the administrators' commissions.

To cover biometric risks and / or to ensure financial performance, administrators should maintain an adequate level of assets as technical provisions. These are calculated and certified at 1-3 years by actuaries or by other specialists in the field. In the same direction of protecting the interests of taxpayers and beneficiaries under a special law, the directors contribute to the Private Pensions Guarantee Fund.

From 2018, the mandatory contribution to Pillar II has fallen from 2.5% to 1.7%. By law, management fees are set as maximum limits (2.5% commission originally paid and 0.05% active payroll fee, monthly payable). All pension fund managers have, however, chosen to go to the maximum required by the law (Pillar II).

2.1. The net asset value of the net asset is the support for future earnings of participants and recipients of private pensions

The purchasing power of contributions to pillar II and its maintenance / increase over retirement are determined by the evolution of the unit value of the net asset (VUAN). For a general illustration of the performance of pension fund management, we show that during the analysed period (August 2013 - July 2018) VUAN recorded an annual average of 5.36% with a standard deviation of 3.11%. Over the same period, the inflation rate recorded an annual average of 0.89% and a standard deviation of 1.85%. Compared to the performance of government securities (annual average of 3.16% and standard deviation of 0.26% per year), an efficient management of private pension funds is revealed, as a result of the increase of purchasing power (at the level of the analysed period: 08/2013 - 07/2018, see Table 1).

Table no. 1. The evolution of VUAN pension funds, compared to government bonds and inflation (08/2013 - 07/2018)

Explanations	Annual Average	Standard deviation
VUAN Evolution	5,36%	3,11%
Government securities	3,16%	0,26%
Inflation	0,89%	1,85%

Source: personal calculations based on data from ASF, BNR and INS

Number of fund units = Total number of fund units issued - Total number of fund units cancelled as a result of the payment of the rights of the participant, the transfer of the personal assets or the cancelled in case of his or her disability or death, as well as the regularization carried out by the recording institution, as appropriate;
Converting contributions into base units is made at the latest unit value of the net asset reported and certified by the depositary;
Net asset value of the fund = Total asset value - Amount of liabilities
Net asset value per unit = Net asset value of the fund / No. units of substance.

The purpose of our analysis is to identify the optimal portfolio that will lead to a favourable influence on the performance of the management of private pension funds on the evolution of VUAN, on maintaining / increasing the purchasing power of mandatory private pension contributions. In this respect, it is essential that the allocation of participants' contributions is made into asset categories that provide the best balance between profitability and risk. Therefore, the literature on this subject is interested in identifying the optimal asset portfolio of the pension fund to ensure the highest profitability for the risk profile assumed by the administrator.

According to legal regulations[5] and compliance with the maximum limits[6], depending on the degree of total risk, a privately administered pension fund (Pillar II) may fall into one of the following categories:

a) low risk (less than 10%), respectively, financial investments mainly in fixed income financial instruments;
b) medium risk (between 10% and 25%), respectively, financial placements in a balanced mix of fixed income financial instruments, money market instruments and securities;
c) high risk (between 25% and 50%), respectively, placements with a higher weight in variable income financial instruments (shares, participation securities, etc.)

Six of the seven private pension fund managers in Romania have opted for a medium risk. Only one mandatory pension fund managed by Generali has opted for high risk. The high-risk option is motivated by the expectation of more attractive benefits, but at the same time, with lower chances of achieving the expected profit. On the contrary, the option for medium risk involves a lower-than-expected profit, but with greater chances to reach the hoped-for profit.

2.2. Profitability of the private pension manager versus VUAN

The profitability of the pension fund manager is different from VUAN's evolution, based on revenue from fees charged to participants, the administrator's expenses and net assets[7]. Administrators with very large funds benefit from the size effect (English effect) of reporting management costs to monthly contributions in large volumes.

Indeed, the administrator's expenses are different from one manager to another, but the differences are not significant as they are to revenue. As a result, administrators with very large funds have very good returns and small fund managers have lower returns. One cost item, the one with the technical provision, is almost 100% directly proportional to the size of the fund being managed.

Consequently, VUAN's evolution cannot be compared to the ROI because they have different determinants. The administrator administers a pension fund and its profitability has to be compared to that of other pension / investment / real estate / fund managers.

[5] Norm no. 19/2012 for amending and completing the Norm no. 11/2011 regarding the investment and evaluation of the assets of private pension funds (Official Gazette No. 1 of 03/01/2013);
[6] Law no. 411/2004 on privately managed pension funds
[7] Return rate = Net profit of the pension fund manager / Equity of the pension fund manager

The low influence of the administrator's profitability on VUAN evolution at all seven administrators is illustrated by the correlation coefficient of only 0.23 and the coefficient of determination (R2) of 0.038 in the regression equation: VUAN = - 0.0136 + 1.004 * R_RENTAB.

3. Research methodology

As we mentioned in the introduction to our paper, we will estimate the optimal portfolios of mandatory private pension funds (pillar II) in Romania through three models of Koegelenberg (2012):

• The equally weighted portfolio (EW, English) and, respectively,
• The traditional Markowitz model, medium variance (Mean-Variance, MV, English);
• Optimization using Value at Risk as a measure of risk (Optimization using Value at Risk as risk measure, MCVaR, English).

The optimization of the equipped portfolio is quite simple because it divides 1 in the total number of assets it needs to invest. For our portfolio of pension funds' investments in five relevant asset categories, a 20% share (equity, corporate bonds, participation funds, government securities and bank deposits) would result. However, we have a maximum legal limit of 5% on investing in holding funds, which has led us to redistribute the remaining share to invest in shares (25%), corporate bonds (25%) and government bonds (25%). There is already a maximum limit of 20% for investing in bank deposits. As an intuitive method of optimal allocation of pension fund assets, the portfolio of equipment leads to good results in the medium term (10 years, Koegelenberg, 2012).

With regard to the MV model, it is well known that it selects the optimal portfolio that offers the highest return on the unit of risk measured as standard deviation. The model, however, involves normal distribution of returns and is inappropriate for distributions different from normal. Alternatively, other risk measures (semi-variance, variance below a minimum profitability threshold, variance with negative values, etc.) have been introduced.

In recent years, the most commonly used risk measure is Value-at-Risk (VaR). For reasons that are invoked in the literature (non-additivity, thick tail, non-convexity etc.), the risk-adjusted value (CVaR) is used to optimize the portfolio, much more sensitive to larger losses in thick tails. The MCVaR model is a form of CVaR that incorporates skewness and kurtosis in non-normal distributions.

The MV and MCVaR models show portfolio-friendly results for periods of 10 to 20 years, not until 30 years (Koegelenberg, 2012). Also, in the literature (Xiong XJ, and Idzorek Th., 2011), that if the series of returns have normal distributions, then the MV model and the MCVaR model lead to the same results on the optimal portfolios weights are very similar and if the distribution is symmetrical but with a kurtosis greater than or less than 3 but uniformly. If distributions exhibit different levels of skewness and kurtosis, then MV and MCVaR lead to different asset allocations, ie higher weights for assets with higher skewness, lower kurtosis, and lower variance.

Using multiple optimization models will suggest different optimal weights for the same expected profitability. So, what will be the decision to invest in these cases? To this complex

question, the answer can only be nuanced depending on the degree of risk assumed by the fund managers. For low-risk degrees, the MCVaR model is preferred, for medium risk it is recommended that the portfolio be equiped, and for high risk the MV model would be preferable, the variance being the most widespread risk.

4. Database and results

The Financial Supervisory Authority (ASF) provides us with an exhaustive database on the performance of the administration of pension funds in Romania[8]. Databases of each private pension manager, the Association of Fund Managers in Romania, etc. are also available.

The process of concentrating the private pension market led to the operation of only seven administrators out of the 14 existing in the period from July 2008 to September 2014. In the short term (egg five years), large pension funds (with a market share over 30%) do not provide participants with a pension income to cover the level of contributions paid while small funds cover contributions. On the contrary, in the long run (for example, 20-30 years), the situation is reversed, large pension funds will finance the future pension from the profitability of pension funds obtained by large managers (with a market share of over 30%). Again, it is about the scale effect and the performance of pension fund management (Robu V., 2013).

For the analysis in our paper we used the series of data from August 2013 to July 2018 (5 years) on the investments of pension funds on five relevant categories of assets: shares, corporate bonds, participation funds, government securities and bank deposits. At this stage of the research we studied the average returns of these assets, weighted by the size of the assets of each pension fund. In a future research we will analyse in detail the profitability of each pension fund, even grouped by degrees of risk.

As control variables we used the VUAN evolution and the weighted average return on all private pension funds over the same period. With average weights recently recorded on the five asset categories (19.94%, 3.55%, 5.00%, 64.15% and 7.36% respectively), the asset portfolio of all pension funds has a very close return on the UUA evolution reported by ASF (5.35% versus 5.36%). The weighted average return on fund managers is, of course, 6.67% higher (over the same period)

For the equipped portfolio (25%, 25%, 5%, 25% and 20% respectively) an annual return of 5.96% and a standard deviation of 2.94% are estimated. Compared to the current portfolio, the Equipped portfolio has a higher Sharpe rate, 1.47 versus 1.19. Therefore, the equipment portfolio can be recommended to low risk managers (standard deviation = 2.94%)

[8] https://asfromania.ro/informatii-publice/statistici/statistici-pensii/evolutie-indicatori
https://asfromania.ro/informatii-publice/statistici/statistici-pensii/situatii-financiare

4.1. The Medium Model ~ Variant (MV)

For the MV model, more expected returns on the portfolio were simulated under terms of legal limitation of allocations in each of the five asset categories:

Shares	Corporate bonds	Funds	Government Securities	Deposits
50%	30%	5%	70%	20%

Under these restrictions, the lowest expected return on profit for an optimal portfolio is 3.012% per year, and the highest possible return on return is 9.01% per year. The Sharpe rate is superior to expected returns ranging from 3% to 4%. The highest (4.40%) could be obtained for an estimated return of 3.25%. Prudence of low-risk investment will be accompanied by low returns close to the current inflation rate. Consequently, targeting 3-4% returns for these prudent portfolios' casts doubt on maintaining the purchasing power of the future pension.

For expected returns of 5% and above, bank deposits are eliminated from the composition of the portfolio, but also by declining weights for government securities, otherwise preferable for low returns. Through their profitability and risk parameters, participation funds are always weighted at the maximum.

Expected returns of 5% and above 5% are naturally obtained by increasing the share of corporate bonds and shares up to the maximum legal limit to the maximum possible profitability (50% and 30%, respectively). Table no. 2 shows the recommended weights for some expected returns ranging between 3% and 9%.

Table no. 2. The composition of optimal private pension portfolios, the MV model, at some expected returns, including the standard deviation and the Sharpe rate

Actiuni	Oblig corpor	Fd particip	Titluri stat	Dep b-re	Anuale		
w1	w2	w3	w4	w5	**StDev**	**Media**	**Sharpe Ratio**
0.00%	9.78%	0.22%	70.00%	20.00%	0.57%	3.012%	2.36
2.23%	3.27%	5.00%	70.00%	19.51%	0.36%	3.25%	4.40
3.91%	5.21%	5.00%	70.00%	15.87%	0.53%	3.50%	2.98
7.26%	9.08%	5.00%	70.00%	8.66%	0.91%	4.00%	2.29
10.67%	13.01%	5.00%	70.00%	1.32%	1.31%	4.50%	1.97
15.04%	13.31%	5.00%	66.65%	0.00%	1.76%	5.00%	1.75
19.27%	16.93%	5.00%	58.80%	0.00%	2.24%	5.50%	1.60
23.48%	20.53%	5.00%	50.99%	0.00%	2.73%	6.00%	1.50
27.70%	24.14%	5.00%	43.16%	0.00%	3.21%	6.50%	1.42
31.93%	27.75%	5.00%	35.31%	0.00%	3.70%	7.00%	1.37
36.29%	30.00%	5.00%	28.71%	0.00%	4.19%	7.50%	1.33
40.82%	30.00%	5.00%	24.18%	0.00%	4.68%	8.00%	1.30
45.37%	30.00%	5.00%	19.63%	0.00%	5.19%	8.50%	1.27
49.92%	30.00%	5.00%	15.08%	0.00%	5.70%	9.00%	1.24
50.00%	30.00%	5.00%	15.00%	0.00%	5.70%	9.0083%	1.24

Source: personal calculations in Excel with the Solver subroutine

Chart no. 1 is, moreover, suggestive of illustrating the effective boundary of optimum portfolio portfolios for maximizing profitability at an assumed risk level. Starting with the 3.25% profitability, the risk-return ratio of the optimal portfolios is approximately directly proportional.

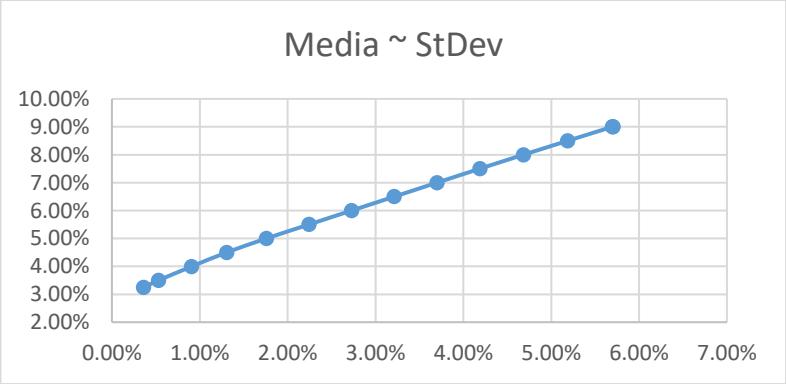

Chart no. 1. Effective boundary of optimal portfolios obtainable at certain expected returns for minimum assumed risk (min StDev, standard deviation)

Source: personal calculations in Excel

In relation to the average portfolio variance criterion, pension fund managers may opt for the best allocation in the five categories of placements to the desired level of expected return. Obviously, the choice of target return is conditional on the degree of risk assumed by the managers.

4.2. Medium Model ~ Condition to Risk (M-CVaR)

M-CVaR is a preferred measure to protect against the risk of loss of a portfolio. Additionality means that the risk of a combination of assets is less than or equal to the sum of the individual risks.

M-CVaR is an optimization model that incorporates skewness and kurtosis of the portfolio's profitability distribution. In this model, optimization can be achieved by maximizing profitability for a certain level of CVaR, or, equivalently, minimizing CVaR for a certain level of expected return. In our work we operate with the second form of optimization: minimizing CVaR for different hopes of portfolio profitability.

Following the same expected returns, as in the MV model, respecting the legal allocation limits and a confidence interval of 10%, the optimal combination with the lowest loss of profitability (CVaR = -2.70%) resulted in an estimated profitability of 3 50%. It recommends zero allocation in shares, maximum legal allocations (30% and 5%) in corporate bonds and participation funds, very large allocation (as expected) in government securities and a minimum allocation (1.32%) in bank deposits.

Obviously, the expected returns above 4% are obtained by increasing the share of shares, corporate bonds (up to the legal maximum, up to 6% expected return) and bank deposits (up to the legal maximum, up to the retentiveness expected by 8%). Estimated returns of 8-9% are obtained with maximum allocation to shares, corporate bonds, participation funds and reduced government securities (see Table 3).

Table no. 3. The composition of optimal private pension portfolios, the MCVaR model, at some expected returns, including standard deviation, VaR and CvaR

Actiuni	Oblig corpor	Fd particip	Titluri stat	Dep b-re	Anuale		Anuale	
w1	w2	w3	w4	w5	**StDev**	**Media**	**VaR**	**CVaR**
0.00%	30.00%	3.26%	46.74%	20.00%	1.67%	3.25%	-2.79%	-2.96%
0.00%	30.00%	5.00%	63.68%	1.32%	1.68%	3.50%	-2.52%	-2.70%
7.12%	30.00%	0.00%	42.88%	20.00%	1.69%	4.00%	-2.90%	-4.06%
11.72%	30.00%	0.00%	38.28%	20.00%	1.90%	4.50%	-3.31%	-5.73%
16.27%	30.00%	0.00%	33.73%	20.00%	2.22%	5.00%	-4.62%	-7.69%
20.83%	30.00%	0.00%	29.17%	20.00%	2.61%	5.50%	-5.09%	-9.82%
25.37%	30.00%	0.00%	24.63%	20.00%	3.05%	6.00%	-6.71%	-11.94%
32.68%	0.00%	0.00%	47.32%	20.00%	3.84%	6.50%	-9.20%	-16.78%
37.24%	0.00%	0.00%	42.76%	20.00%	4.38%	7.00%	-11.03%	-19.48%
41.80%	0.00%	0.00%	38.20%	20.00%	4.91%	7.50%	-12.86%	-22.17%
46.33%	0.00%	0.00%	33.67%	20.00%	5.44%	8.00%	-14.68%	-24.85%
50.00%	0.00%	5.00%	28.36%	16.64%	5.88%	8.50%	-16.21%	-26.96%
50.00%	29.18%	5.00%	15.82%	0.00%	5.70%	9.00%	-15.07%	-25.31%
50.00%	30.00%	5.00%	15.00%	0.00%	5.70%	9.0083%	-15.04%	-25.27%

Source: personal calculations in Excel with the Solver subroutine

As the expected portfolio returns are greater than 3.50%, losses are approximately directly proportional to these expected returns, from - 2.70% to - 26.96%. Within the restrictions mentioned above, the expected, maximum 9% and 9.01% expected returns are accompanied by mitigated losses (around - 25.3%, see Chart 2).

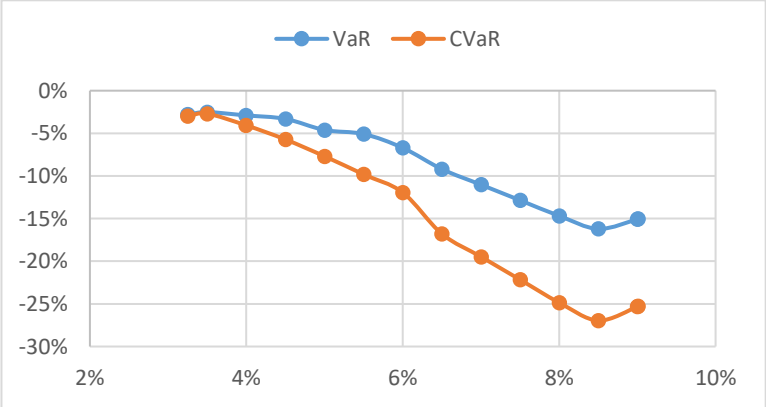

Chart no. 2. Evolution of VaR and CVaR of optimal portfolio at certain expected returns for minimum assumed risk (min CVaR)

Source: personal calculations in Excel

Again, the decision of pension fund managers can focus on the optimal allocations that will lead them to the expected returns in relation to the assumed risk (in this case the risk-adjusted value). Choosing this portfolio optimization criterion (min CVaR) obviously leads to different compositions compared to those recommended by the MV model for the same expected returns. For private pension fund managers, the allocation decision will be determined by the optimization criterion: equipment portfolio, minimum standard deviation or minimum conditional risk.

5. Conclusions

Private pension systems have been motivated by demographic change (population aging, demographic decline in European and American countries, increased average life expectancy), and financial market developments in general. Effective administration of the private pension system determines the maintenance and even increase of the purchasing power of future pension gains, as well as an important source of financing for economic development.

Several portfolios optimization models have been highlighted and used in the literature, for which we have retained three (equipped, medium and medium, conditional risk) for the purposes of our work. There is, moreover, a multitude of studies on the use of the latter two models, both for financial investment in general and for pension funds in particular.

The results of the equipped pro-pension for private pension funds in Romania (5.96% expected return on average, Sharpe rate of 1.47) recommend to administrators who take a low risk (standard deviation = 2.94%). In the average variance model, pension fund managers choose as the optimization criterion for the portfolio to minimize standard deviation. Consequently, they can opt for optimal allocations in the five categories of placements to a desired level of expected return (between 3% and 9%) depending on the degree of risk assumed. In the medium-risk conditional model, administrators are concerned about the cumulative maximum loss that they can record, with a probability of 10%, in portfolio management. As a result, they can opt for an expected return (between 3% and 9%) that minimizes this loss at the level of risk assumed as a pension fund management policy.

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