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Analysis of Private Pension Companies in Turkey by EATWOS

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Abstract
One problem that nations face in the progress of their economies is individuals not knowing how to save. Private Pension System (PPS) is one way to help a nation's economy by encouraging individuals to save on voluntary basis. There are many companies in Turkey operating in PPS, which are called Private Pension Companies (PPC). The more funds they collect, the longer these companies can sustain and the more they can contribute to the economy. Therefore PPCs need to pursue ways to improve themselves in order to keep operating with a high performance.The aim of this study is to demonstrate the performances of 19 PPCs operating in Turkey between 2010 and 2014. The performances of the PPCs were analyzed by applying Efficiency Analysis Technique with Output Satisficing (EATWOS) in 3 different ways. The inputs used in the study are "number of staff employed", "total assets", and "total shareholders' equity" while the criteria outputs have been determined as "premium production" and "pension contracts". The first application of the method revealed that ANADOLU, VAKIF and ZIRAAT were the top 3 companies working with high efficiency. The second application resulted that ALLIANZ, ANADOLU, AVIVASA, CIGNA, GARANTI, VAKIF and ZIRAAT showed better performances than the rest. The third application demonstrated that ALLIANZ, AVIVASA, GARANTI, and VAKIF were the most efficient companies
Keywords: Private Pension, Efficiency Analysis, EATWOS

1. Introduction

Private Pension System (PPS) basically aims to improve the welfare of people during retirement by encouraging them to make long-term savings. This way, people having retired from the system are provided with a regular income that can improve their welfare during retirement. Individual retirement saving and investment system is a private pension system that leads to an improvement in welfare of people as a second retirement income, while it also helps the governments to create new job and employment opportunities by providing more funds for infrastructure and long-term investments. It increases the social security coverage while reducing the social security burden of governments. It makes the financial sector operate more efficiently by helping to increase the number of long-term funds. It also helps the economy to keep a stable growth by helping to fight against inflation. It allows deepening of capital markets and contributes to the reduction of fluctuations and speculations in the market with institutional investment strategies (Bireysel Emeklilik Sistemi Gelişim Raporu, 2014). PPS plays an important role in the regulation of the relationship between savings and investments in both micro and macro levels. Therefore, Private Pension Companies (PPCs) have to conduct their activities efficiently so that they can raise the individual savings to the desired level and turn these savings into the appropriate investments in financial markets.

Financial institutions are important actors playing an important role in the development and growth of the national economy, continuation of the stability and distribution of the resources. Financial institutions operating in the sector are not uniform. In other words, there are various types of financial institutions in the sector. The most notable examples are banks, insurance companies, intermediaries and PPCs. PPCs are relatively newer than others. They basically manage the savings provided by the participants on voluntary basis. PPCs, like general insurance companies, offers funds to investors through the capital market while keeping a portion of the premiums they collect as collateral. Mediating between savers and investors in need of funds is one of the services the sector provides.

The average annual growth rate of pension fund assets was 8,2% through 2009-13, which was a better performance than 4,1% of insurance companies during the same period, and 6,7% of investment funds (for which assets slightly declined between 2010 and 2011 (Pension Markets in Focus, 2014).

According to OECD statistics, total value of pension fund assets was 26.1 trillion US dollars in 2013. The United States, followed by UK (10%), Japan (7%) and the Netherlands (6%), held more than half of that with 55%.

As Figure 1 shows, in 2013, only five OECD countries reached asset-to-GDP ratios higher than 100% – the Netherlands (166,3%), Iceland (148,7%), Switzerland (119%), Australia (103,3%) and the United Kingdom (100,7%). This is 83% in the USA, and 4,9% in Turkey, which is quite low compared to other OECD countries. Overall, the simple average of the share of PPS in GDP in OECD countries is 36,6% , and the weighted average is 84,2% (OECD, 2014). The size of total funds and the share in the GDP proves the importance of PPS to the economies.

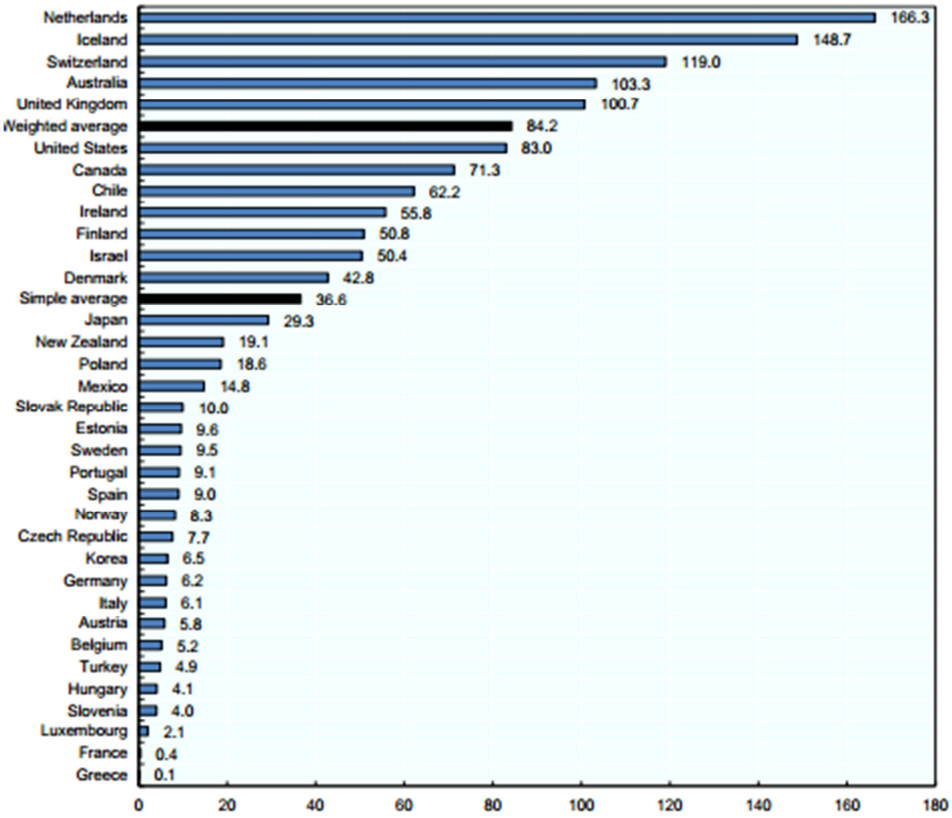

Figure 1. Importance of pension funds relative to the size of the economy in the OECD, 2013 as a percentage of GDP

Source: http://www.oecd.org/daf/fin/private-pensions/Pension-Markets-in-Focus-2014.pdf

As the financial performances of PPCs directly or indirectly affect many parties in the economy, monitoring and improving the financial structure of PPCs is not only important for these institutions themselves but also for the overall economy. While PPCs with a poor financial performance have a negative effect on the economy, those with a high performance make positive contribution. That is why the efficiency of PPCs also, as of other financial institutions, should be measured at regular intervals. Studies related to performance measurement in the Turkish financial sector, notably in banking, are very common. However, there are not many studies related to insurance sector and PPCs. As there are many factors affecting the performance of PPCs, there are so many criteria to be taken into consideration in measuring the performance of these institutions. There are very different methods used to assess the efficiency of PPCs operating in the financial sector.

The performances from 2010 to 2014 of 19 PPCs operating in Turkey were measured in this study. It can be very difficult to determine inputs and outputs in the measurement of the efficiency of PPCs, as in other fields. In the light of the literature review, the inputs were determined as “Number of Staff Employed”, “Total Assets”, and “Total Shareholders' Equity” while “Premium Production” and “Pension Contracts” were taken as the outputs. EATWOS was applied for the performance measurement in 3 different ways: EATWOS without satisficing Level (SL), EATWOS considering only 1 output, and EATWOS considering 2 outputs.

The second part of the study deals with PPS in Turkey, while the third part focuses on the literature review. The fourth part tells about EATWOS, and the fifth describes the application of the method, and deals with analysis of the results. The final part discusses the three ways of application of the method overall and separately.

2. Private Pension System in Turkey

Individual Retirement Savings and Investment System Act was passed by the Turkish Parliament on 28 March 2001, and published on 7 April 2001 in the Official Gazette numbered 24366. The law was put into force on 7 October 2001, 6 months after the date of publication. The legislation aimed to make the system work effectively in a legal framework necessary for the implementation. Pension companies have been in operation since October 27, 2003. Several amendments have been made to the Act for different purposes.

PPS was established as a complement to the existing public social security system. The main purpose of PSS is to help individuals to use their savings properly guiding them to investments so that they can lead a comfortable life during retirement as they do while working. PSS operates on voluntary basis and is open to

individuals from all fractions. The savings accumulated in the system are used in pension funds created within the framework of the Capital Markets Board of Turkey (CMB) by the private pension companies established under supervision of the Undersecretariat of Treasury (UT). In our country, Turkey, there are already 19 PPCs, the activities of which are taken into public control mechanisms by the CMB and UT.

The number of contracts in force between late 2003 and 31.12.2014 in PSS was 5.807.319. The number of participants exceeded 5 million with an approximate 23% growth compared to 2013. The size of pension funds in the same period increased by 38%, and reached 12.650 million dollars (1 USD = 2,75 TL). The government's contribution increased by 162%, compared to the year 2013, and reached 1.098 million dollars. As of 31.12.2014, there are 4.242.733 individual contracts, 1.185.852 group individual contracts, and 378.734 employer group pension insurance contracts. The total value of individual contracts is 9,3 billion dollars; the total value of group individual contracts is 2,86 billion dollars; and the total value of employer group pension contracts is 0,5 billion dollars (Individual Pension System Progress Report 2014, 10-12).

3. Literature Review

Mansor and Radam (2000) employed Malmquist Productivity Index (MPI) method to measure the efficiency of PPCs in Malaysia and found that technical efficiency and technical development are the two most important factors that affect a company's performance. Assessing the performance of insurance companies in Taiwan between 1997 and 1999 using Stochastic Frontier Analysis (SFA), Hao and Chou (2005) suggested that a company's efficiency is directly proportional to its market share, product differentiation, and scale efficiency. Fuentes et al. (2005) divided the insurance companies into different branches, and evaluating each branch in itself by MPI, they demonstrated that health insurance companies have the highest values of efficiency. Barrientos and Boussofiane (2005) measured the performances of PPCs in Chili by Data Envelopment Analysis (DEA). It was a two stage process. DEA efficiency scores were calculated in the first stage, and in the second, regression analysis was employed. The outputs for the DEA method were "total income" and "participants", while the inputs were "marketing, sales and distribution expenses", "number of employees", and "general administrative expenses". Karim and Jhantasana (2005) suggested that there is no relation between the longevity of a company and its efficiency by measuring the efficiency of the insurance companies in Thailand using SFA. Barros and Garcia (2006) assessed the efficiency of private pension companies in Argentina from 1994 to 2003. The inputs of the model they used were "the number of employees", "fixed assets", and "payments" while the outputs were "the number of funds", "the total value of the funds" and "premiums". The methods used in the analysis were Constant Return to Scale (CRS) and Variable Return to Scale (VRS). Hao (2007) studied the performances of Taiwan insurance companies and demonstrated that those with a higher market share were more efficient. Then, the same sample was restudied by Barros and Garcia (2007) in terms of technical efficiency using SFA method. They concluded that there can be significant reductions in the costs of companies when complementary technologies are used for both closed-end and open-end funds. Barros et al. (2008) investigated the efficiency of private pension companies in Argentina between 1996 and 2007 by using SFA with panel data and Deterministic Frontier Models (DFM) together. While "operating expenses" were taken as the dependent variables, "the average wage of employees", "average management costs", "average costs of fixed assets", "payments to the participants", "the fund value and market share" were used as the independent variables. The study revealed that there was an increase in the costs during the studied period. While the "market share" decreased the costs, all the other variables caused an increase in the costs. So there was no improvement in the performance of the companies; on the contrary, there was also a continuous performance loss in the sector because of the poor performance of the companies. Zanghieri (2008) found that profitability and cost are two important factors in the efficiency of the companies by measuring the efficiency of the European insurance companies between 1997 and 2006 by SFA method. Tsai et al. (2008) measured the performances of the insurance companies in Taiwan by an integrated model combining Modified Delphi Method (MDM), Analytic Network Process (ANP) and Technique for Ordering Preference by Similarity to the Ideal Solution (TOPSIS). Investigating efficiency and competitive behavior on the Dutch life insurance market, Bikker and Van Leuvensteijn (2008) earned a new method for measuring the effects of competition on efficiency known as the Boone indicator. Fan and Cheng (2009) measured the performances of Taiwan insurance companies by using Analytic Hierarchy Process (AHP) and TOPSIS. Teresa and Garcia (2010) assessed the efficiency of private pension companies in Portugal by MPI based on DEA covering the period from 1994 to 2007. The outputs of the model were "number of participants, the number of funds, value of the funds and profit" while the inputs were "payments to the beneficiaries", "the number of employees", "total assets", and "contributions received". Barros et al. (2010), using the CRS efficiency score for the period 1994-2003, ranked the insurance companies in Greece. Eling and Luhnen (2010) studied the efficiency of 6462 insurers from 36 countries for the period 2002–2006 by DEA and SFA, revealing that the technical and cost efficiency growths were steady for international insurance markets but there were large differences across countries. Tzung-Ming and Chaang-Yung (2011) used Grey Relational Analysis in their study the subjects of which were 15 larger-scale Taiwanese insurance

companies. The study adopted 24 different categories of financial ratios as the variables which were used to measure business performance for insurance companies through five business indexes including capital structure, profitability, debt-paying ability, business performance, and capital employment. Wang et al. (2011) employed the DEA method to compare the efficiency and evaluate the performance of 25 property and casualty insurance companies in 2007. Al-Amri et al. (2012), by analyzing the technical efficiency of 39 insurance firms in Gulf Cooperation Council (GCC) by DEA methodology and MPI, demonstrated that the insurance sector in GCC countries is moderately efficient and it is likely to grow. Akotey et al. (2013) analyzed the profitability of 10 life insurance companies in Ghana for the period 2000-2010 by panel regression method. Bawa and Chattha (2013) investigated the effect of variables on the profitability of 18 life insurance companies in India for the period 2007-2012. They employed the Multiple Linear Regression Model, and the results show that return on assets ratio is positively affected by liquidity and the size of the company, while it is negatively affected by the shareholders' equity. Burca and Batrînca (2014) studied the effect of 13 variables on return on assets ratio in the investigation of the factors that affect the performances of 21 Romanian insurance companies for the period 2008-2012. Huang and Eling (2013) measured the efficiency of non-life insurance companies in Brazil, Russia, India, and China by using DEA. Rahmani et al. (2014) assessed the efficiency and performance of Iranian insurance companies using non-parametric frontier analysis (FA) models. They used DEA and free disposal hull methods to distinguish the efficient companies from the inefficient ones. They also employed two well-known super efficiency analysis models to rank the efficient units. Chen and Lu (2014) employed fuzzy AHP and the improved fuzzy modified TOPSIS to measure the marketing performance of 4 leading companies in Taiwan. Biener et al. (2015) investigated the efficiency and productivity of Swiss insurance companies in the life, property/casualty, and reinsurance sectors from 1997 to 2013 by frontier efficiency methodologies. Sinha (2015) used a dynamic slacks-based DEA model proposed by Tone and Tsutsui (2010) to measure the performance of 15 in-sample life insurance companies for a period of seven years (2005–2006 to 2011–2012) in India.

Kısakesen (2010) tried to determine the efficient and inefficient companies in Turkey from 2005 to 2008 by DEA. The input variables of the research were “equity”, “the total contributions” and “technical costs” while the output variables were “technical incomes” and “premiums collected”. Another study from Turkey is by Köseoğlu (2009), who investigated the efficiency of PPCs from 2004 to 2008 by using DEA. The inputs were “equity”, “technical pension expenses”, and “the company's total liabilities of pension activities”, while the outputs were “administrative expense fees” and “admission fee revenues”. Bakırtaş et al. (2010) calculated the efficiency of pension companies in Turkey from 2006 to 2009 by DEA and MPI methods. The results of the two methods were compared. “Labor”, “resources from pension operations” and “equity” were taken as inputs while “technical incomes” and “investment earnings” were used as outputs. Ozturk (2010) studied the efficiency of PPCs operating in PES (2006-2008), using the DEA and MPI methods. “Equity”, “total debts from pension activities” and “labor” were inputs while “technical pension incomes” and “investment incomes” were used as outputs. Among other studies carried out to determine the relative efficiency of insurance companies in Turkey are Bülbül and Akhisar (2004), Kılıçkaplan and Karpat (2004), Bülbül and Akhisar (2005), Kılıçkaplan and Baştürk (2005), Kayalı (2007), Turgutlu et al. (2007), Altan (2010) and Özcan (2011). DEA is the most common method used in these studies.

4. Method

4.1 Efficiency Analysis Technique with Output Satisficing

EATWOS is an efficiency analysis method allowing for satisfying solutions rather than optimum solutions while, like DEA and Operational Competitiveness Rating (OCRA), it is also employed to assess the maximum profit between output and input quantities. Being relatively a new technique developed by Peters and Zelewski (2006), it is based upon "satisficing" concept, which partly brought the Nobel Prize to Herbert A. Simon in economics. (Simon, 1979). According to this “satisficing” concept, individuals seek satisfactory solutions rather than optimal ones. The idea suggests that an output quantity meeting a certain satisficing level (SL) can be considered to be as good as an output quantity exceeding this SL. Furthermore, in some cases the proposed efficiency analysis technique is capable of identifying efficiency improvement potentials (Peters & Zelewski, 2006).

This method was used by the developers in measuring the efficiency of heat treatment furnaces and supply change (Peters & Zelewski 2006; Peters et al., 2012). It was also used by Bansal et al. (2014) in the evaluation of vendors, by Özbek (2015) in efficiency analysis of non-governmental organizations based in Turkey, and again by Özbek (2015) in efficiency analysis of the Turkish Red Crescent.

The general EATWOS procedure is described as below (Peters & Zelewski, 2006)

Determination of the inputs and outputs to be taken into account is the first step. In addition, the Decision Making Units (DMU) to be measured should be determined by the decision maker. Next, as the EATWOS requires, the decision maker has to establish the output quantities y_{ij} as well as the input quantities x_{ik} for all DMUs. So, the quantities y_{ij} of all outputs j ($j = 1, \dots, J$) of all DMUs i ($i = 1, \dots, I$) have to be entered into the output matrix $\underline{Y}$.

$$\underline{Y} = \begin{bmatrix} y_{11} & y_{12} & \cdots & y_{1J} \\ y_{21} & y_{22} & \cdots & y_{2J} \\ \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots \\ y_{I1} & y_{I2} & \cdots & y_{IJ} \end{bmatrix} \; with\; y_{ij} \in R_{\geq 0} \quad \forall i = 1, \dots I, \quad \forall j = 1, \dots, J \tag{1}$$

As each column of this output matrix $\underline{Y}$ corresponds to an output j, each row corresponds to a DMU i. The way the input matrix $\underline{X}$ is established is the same.

$$\underline{X} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1K} \\ x_{21} & x_{22} & \cdots & x_{2K} \\ \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots \\ x_{I1} & x_{I2} & \cdots & x_{IK} \end{bmatrix} \; with\; x_{ik} \in R_{\geq 0}, \forall i = 1, \dots I, \forall k = 1, \dots, K \tag{2}$$

Similar to the process followed for the output matrix, each column of this input matrix $\underline{X}$ corresponds to an input k $(k = 1, \dots, K)$, and each row corresponds to a DMU. Inputs and outputs must be cardinal measures, as EATWOS requires.

EATWOS provides the chance to consider SLs for outputs. This means that the decision maker is capable of determining a SL_j for each output j. In addition, the exogenous assessment of the relative importance weights v_j of the outputs as well as the relative importance weights w_k of the inputs must be carried out, as EATWOS requires (Peters & Zelewski, 2006). A scoring technique or Analytic Hierarchy Process (AHP) can also help to determine the importance weights (Saaty, 2004).

Application of EATWOS without consideration of Satisficing Levels (Peters & Zelewski, 2006)

As the next step, EATWOS is applied without consideration of SLs. This way, SLs are ignored for all outputs. The output quantities y_{ij} are normalized first. The normalization of the output quantities takes place as in TOPSIS (Hwang & Yoon, 1981).

$$\exists i \quad \exists j \quad y_{ij} \neq 0: \quad r_{ij} = \frac{y_{ij}}{\sqrt{\sum_{i=1}^{I} y_{ij}^2}} \quad \forall i = 1, \dots, I \quad \forall j = 1, \dots, J \tag{3a}$$

$$\forall i = 1, \dots, I \quad \forall j = 1, \dots, J \quad y_{ij} = 0:, \quad r_{ij} = 0 \tag{3b}$$

The normalization process gives the normalized output matrix $\underline{R}$:

$$\underline{R} = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1J} \\ r_{21} & r_{22} & \cdots & r_{2J} \\ \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots \\ r_{I1} & r_{I2} & \cdots & r_{IJ} \end{bmatrix} \tag{4}$$

Then, for each output j, the maximum normalized output quantity y_j^* is determined on basis of the column vectors of $\vec{r_j}$ of the normalized output matrix $\underline{R}$.

$$r_j^* = \max_i \{\vec{r_j}\} \tag{5}$$

The calculation of the distance measures op_{ij} for the outputs can be carried out on the basis of the matrix $\underline{R}$ and the maximum normalized output quantities r_j^*.

$$op_{ij} = 1 - \left(r_j^* - r_{ij}\right), \forall i = 1, \dots, I, \forall j = 1, \dots, J \tag{6}$$

The distance measure op_{ij} suggests that the smaller the distance of r_{ij} to r_j^*, the closer op_{ij} is to one. This distance measure is taken as output score.

The normalization of the input quantities is the next step. This process is a similar one to the normalization of the output quantities.

$$\exists i \quad \exists k \quad x_{ik} \neq 0:, \quad s_{ik} = \frac{x_{ik}}{\sqrt{\sum_{i=1}^{I} x_{ik}^2}} \quad \forall i = 1, \dots, I \quad \forall K = 1, \dots, K \tag{7a}$$

$$\forall i = 1, \dots, I \quad \forall k = 1, \dots, K \quad x = 0: \quad s = 0 \tag{7b}$$

So, the way the normalized input matrix $\underline{S}$ is calculated is similar to way of the normalization of the output matrix.

$$\underline{S} = \begin{bmatrix} s_{11} & s_{12} & \cdots & s_{1K} \\ s_{21} & s_{22} & \cdots & s_{2K} \\ \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots \\ s_{I1} & s_{I2} & \cdots & s_{IK} \end{bmatrix} \tag{8}$$

The determination of the minimum normalized input quantity s_k^* for each input k on basis of the column vectors $\overrightarrow{s_k}$ of the normalized input matrix $\underline{S}$ is the following step.

$$s_k^* = \min_i\{\overrightarrow{s_k}\} \qquad \forall k = 1, \dots, K \tag{9}$$

The calculation of the distance measure for inputs can be done, then, by adding the respective value s_{ik} from the matrix $\underline{S}$ to 1 and subtracting the minimum normalized input quantity s_k^*.

$$ip_{ik} = 1 + s_{ik} - s_k^* \quad \forall i = 1, \dots, I \qquad \forall k = 1, \dots, K \tag{12}$$

It can be concluded from this distance measure that the smaller the distance of s_{ik} to s_k^*, the closer ip_{ik} is to one. The distance measure ip_{ik} must not be zero, so the value 1 is added. The distance measure ip_{ik} is taken as input score, as it is done in the output score.

In order to obtain an efficiency score for each DMU, the input distance measures (input score) and the output distance measures (output score) can be used.

$$E_i = \frac{\sum_{j=1}^{J} v_j * op_{ij}}{\sum_{k=1}^{K} w_k * ip_{ik}} \qquad \forall i = 1, \dots, I \tag{13}$$

When E_i of a DMU i is low, this means the efficiency is relatively lower than the other DMUs, while E_i is high the efficiency is high. These efficiency scores allow preparing a rank order R of the efficiency of the DMUs by sorting the efficiency scores from high to low.

Application of EATWOS with consideration Satisficing Levels (Peters & Zelewski, 2006)

In this step, EATWOS with consideration of SL_j is applied for at least one of the outputs j with $j \in \{1, \dots, J\}$. The way the outputs without SLs are treated is the same as described in the previous section.

This model uses five logical constraints. This idea belongs to from Yan, Yu, and Cheng (2003). The following five constraints are applied for all outputs for which the decision maker determines SLs:

$$\left(\frac{SL_j - y_{ij}}{SL_j}\right) + z_1 \leq 1 \tag{14a}$$

$$\left(\frac{SL_j - y_{ij}}{SL_j}\right) * z_2 \geq 0 \tag{14b}$$

$$z_1, z_2 \in \{0; 1\} \tag{15}$$

$$z_1 + z_2 = 1 \tag{16}$$

$$a_{ij} = \frac{y_{ij}}{SL_j} * z_2 + 1 * z_1 = f(y_{ij}) \tag{17}$$

The constraints (14a) and (14b) are used to restrict the possible values of the logical variables. Constraint (15) describes the logical variables z1, z2 as binary variables. The duty of constraint (16) is that, in connection with constraint (15), only one of the logical variables can take the value one, while the other one takes the value zero. The possible values of the logical variables in constraint (17) are determined by using the constraints (14a), (14b), (15), and (16).

If a SL_j is determined for the respective output, the normalized output quantities a_{ij} are obtained by applying the constraints (14a), (14b), (15), (16), and (17). These quantities are necessary for making up the normalized output matrix $\underline{A}$. However, if no SL is established for an output j, the respective column vector $\vec{a}_j$ in the matrix $\underline{A}$ is equal to the column vector $\vec{r}_j$ in the matrix $\underline{R}$.

$$\underline{A} = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1J} \\ a_{21} & a_{22} & \cdots & a_{2J} \\ \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots \\ a_{I1} & a_{I2} & \cdots & a_{IJ} \end{bmatrix} \tag{18}$$

Next, the determination of the maximum normalized output quantity a_j^* is realized for each output j by taking the maximum value of each column vector $\overrightarrow{a_j}$.

$$a_j^* = \max_i\{\overrightarrow{a_j}\} \qquad \forall j = 1, \dots, J \tag{19}$$

The maximum normalized output quantity a_j^* is used to calculate the distance measures for outputs. This distance measure is calculated for all DMUs i and for all outputs j.

$$op_{ij}^{SL} = 1 - \left(a_j^* - a_{ij}\right) \qquad \forall i = 1, \dots, I \qquad \forall j = 1, \dots, J \tag{20}$$

An efficiency score is calculated for each DMU, as before. But this time, E_i^{SL} incorporates the distance measures op_{ij}^{SL} in order for the SLs for the outputs to be considered.

$$E_i^{SL} = \frac{\sum_{j=1}^{J} v_j * op_{ij}^{SL}}{\sum_{k=1}^{K} w_k * ip_{ik}} \qquad \forall i = 1, \dots, I \tag{21}$$

By sorting the efficiency scores E_i^{SL} from high to low, a rank order R^{SL} of the efficiency of the DMUs can be obtained once again.

5. Data and Discussion

In this study, the efficiency of 19 PPCs in operation in Turkey between 2010 and 2014 was analyzed. These PPCs were taken as DMUs in the study. Efficiency measurement for each company was carried out for each year separately. The companies that did not operate in the year for which the measurement was done were ignored in the analysis of the relevant year. The input criteria were determined to be “Number of Staff Employed”, “Total Assets”, and “Total Shareholders' Equity”, while the output criteria were taken as “Premium Production” and “Pension Contracts. Criteria weights were determined by considering the importance of the criteria. As EATWOS requires that the total weight of the input criteria be 1, the input criteria were weighted as follows: "Number of Staff Employed" 0,2 ; "Total Assets" 0,4; and "Total Shareholders' Equity" 0,4. Since the same is also true for the output criteria, they were weighted as follows: “Premium Production” 0,5 and “Pension Contracts” 0,5. The data used in the study was obtained from the website of the Undersecretariat of Treasury (www.hazine.gov.tr). The flow diagram of the study is presented in detail in Figure 2 below.

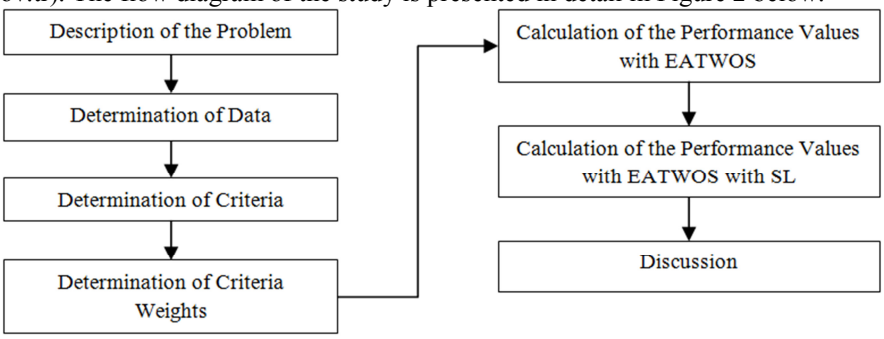

Figure 2. Flow Chart

The Application of the EATWOS Method without consideration of Satisficing Levels

Obtained from the website of the Undersecretariat of Treasury, the data of 2010-2014 related to the companies was evaluated by EATWOS. The application did not consider the SLs. The results obtained from the application are shown in Table 1 below.

Table 1. The efficiency scores (ES) of PPCs between 2010 and 2014 (EATWOS without SLs)

		2010		2011		2012		2013		2014	
No	Name of the Company	ES	Rank	ES	Rank	ES	Rank	ES	Rank	ES	Rank
1	AEGON	0,3884	11	0,3141	12	0,4183	12	0,4209	13	0,5011	11
2	ALLIANZ	0,3983	10	0,3282	11	0,4300	11	0,4266	11	0,4884	14
3	ALLIANZ Y	0,5134	4	0,4135	5	0,5152	5	0,5069	6	0,6112	2
4	ANADOLU	0,6173	2	0,4840	2	0,6517	2	0,5382	2	0,5877	4
5	ASYA					0,4040	14	0,4344	10	0,4929	12
6	AVIVASA	0,5420	3	0,4315	4	0,5388	4	0,5354	4	0,6005	3
7	AXA					0,4034	16	0,4096	15	0,4486	19
8	BNP PARIBAS CARDIF	0,3742	13	0,3615	8	0,3880	17	0,3953	17	0,4860	15
9	CIGNA FINANS	0,4434	7	0,3066	13	0,4777	7	0,4680	8	0,5279	8
10	ERGO	0,3849	12	0,4780	3	0,4052	13	0,3963	16	0,4550	16
11	FIBA							0,3852	18	0,4493	18
12	GARANTI	0,6277	1	0,3324	10	0,5615	3	0,5379	3	0,5797	5
13	GROUPAMA	0,4052	9	0,3486	9	0,4359	10	0,4205	14	0,4906	13
14	HALK					0,4734	8	0,5008	7	0,5543	6
15	KATILIM									0,4502	17
16	METLIFE	0,4277	8	0,3731	7	0,4035	15	0,4218	12	0,5033	10
17	NN	0,4503	6	0,3963	6	0,4653	9	0,4558	9	0,5203	9
18	VAKIF	0,4715	5	0,6399	1	0,5028	6	0,5161	5	0,5325	7
19	ZIRAAT			0,2938	14	0,6682	1	0,6864	1	0,7171	1

As can be seen from Table 1, ASYA, AXA, FIBA, HALK, KATILIM and ZIRAAT were not in continuous operation during this period. This is taken into account in the evaluation of Table 1 and Chart 1. A holistic evaluation of the whole period all the years included exhibits that the companies with the highest performances are ANADOLU, AVIVASA, GARANTI, VAKIF and ALLIANZ Y, as shown in Chart 1. When the year 2010 is ignored, ZIRAAT, ANADOLU, VAKIF, AVIVASA and ALLIANZ Y are found to be the best companies. When only 2012-2014 is considered, ZIRAAT, ANADOLU, GARANTI, AVIVASA and ALLIANZ Y found to be the top 5 companies. ASYA, AXA, FIBA and KATILIM are found to be the least efficient companies though they operated continuously during the whole period.

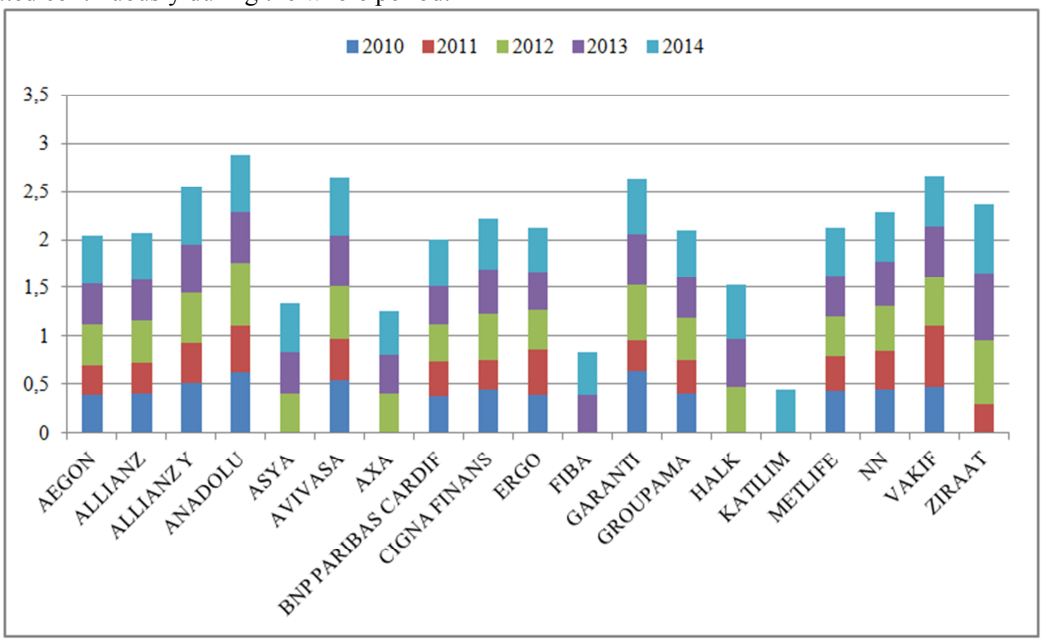

Chart 1. Graphical representation of the performances of the PPCs between 2010 and 2014

The Application of the EATWOS Method with consideration of Satisficing Levels

With the data used in the previous application, EATWOS was applied once more for the output "Premium

Production" with consideration of SLs this time. First of all, the logical constraints, presented in Equation (14a), (14b), (15), (16) and (17), have to be applied to the output maximum "Premium Production". SLs were determined separately for each year as follows: $SL_{2010,1} = 100.000$ for 2010; $SL_{2011,1} = 120.000$, for 2011; $SL_{2012,1} = 140.000$, for 2012; $SL_{2013,1} = 160.000$ for 2013; $SL_{2014,1} = 180.000$ for 2014. The resulsts are shown in Table 2. The graphical presentation can also be seen in Chart 2.

If 2014 is considered only, the top 3 companies are ALLIANZ Y, AVIVASA and ZIRAAT. In 2013, AVIVASA, CIGNA and VAKIF are the most efficient ones. When it comes to 2012, the ranking changes as ANADOLU, AVIVASA and CIGNA. In 2011, CIGNA, METLIFE and ZIRAAT worked more efficiently than the others.

If the whole period 2010-2014 is evaluated holistically, ALLIANZ Y, ANADOLU, AVIVASA, CIGNA, GARANTI, HALK, METLIFE, VAKIF and ZIRAAT are found to have been working more efficiently than the others.

Table 2. The Performance of PPCs between 2010 and 2014 (EATWOS with SL)

		2010		2011		2012		2013		2014	
Nr	Name of the Company	ES	Rank	ES	Rank	ES	Rank	ES	Rank	ES	Rank
1	AEGON	0,3026	13	0,3368	13	0,4184	14	0,5113	13	0,6025	10
2	ALLIANZ	0,5176	8	0,5254	9	0,5284	11	0,5414	11	0,5344	13
3	ALLIANZ Y	0,7168	2	0,6629	6	0,6799	7	0,6967	5	0,7162	3
4	ANADOLU	0,6173	5	0,6340	8	0,7451	1	0,6571	8	0,6692	8
5	ASYA					0,2370	17	0,2937	16	0,3018	16
6	AVIVASA	0,6938	3	0,6784	4	0,7032	3	0,7234	2	0,7306	1
7	AXA					0,4238	13	0,5244	12	0,3352	15
8	BNP PARIBAS CARDIF	0,3122	12	0,2652	14	0,3831	15	0,4433	15	0,5788	11
9	CIGNA FINANS	0,6166	6	0,6949	3	0,7041	2	0,7126	3	0,7071	6
10	ERGO	0,3405	11	0,4015	12	0,3070	16	0,2897	17	0,2749	17
11	FIBA							0,2614	18	0,2690	18
12	GARANTI	0,7197	1	0,6662	5	0,6917	5	0,6932	6	0,6790	7
13	GROUPAMA	0,4516	9	0,5101	10	0,5415	10	0,5586	10	0,5666	12
14	HALK					0,6875	6	0,7082	4	0,7152	4
15	KATILIM									0,2586	19
16	METLIFE	0,5541	7	0,7053	2	0,5876	9	0,6227	9	0,6470	9
17	NN	0,3865	10	0,4042	11	0,4597	12	0,4925	14	0,4959	14
18	VAKIF	0,6544	4	0,6399	7	0,7029	4	0,7407	1	0,7097	5
19	ZIRAAT			0,7088	1	0,6682	8	0,6864	7	0,7171	2

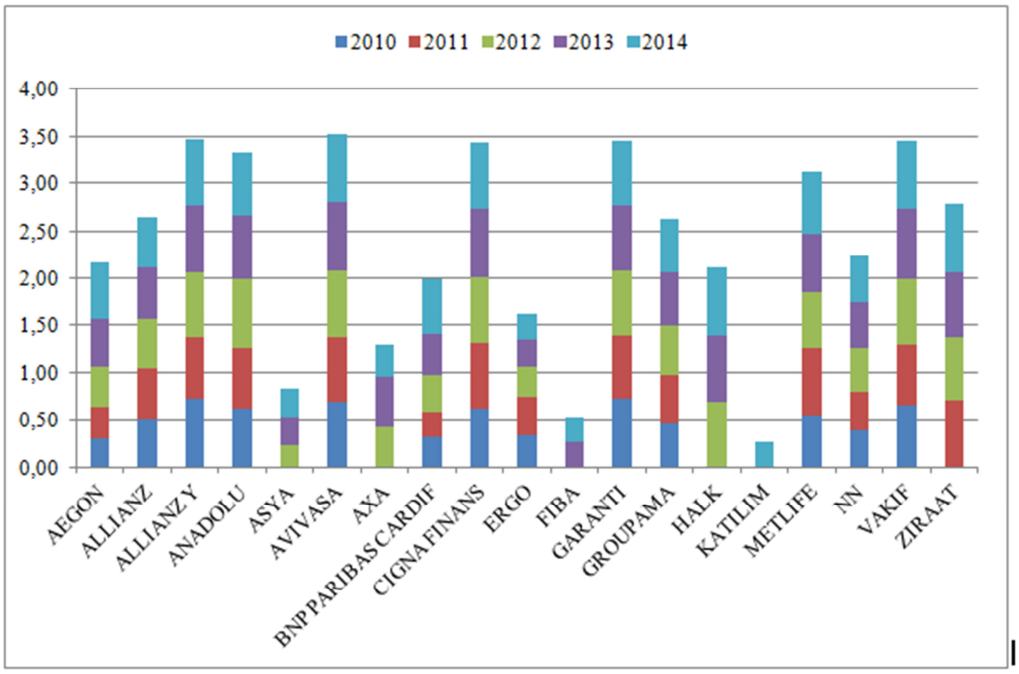

Chart 2. Graphical representation of the performances of the PPCs between 2010-2014

As the next step, the method was once more applied having determined the SLs for "Premium Production" and "Pension Contract" for each year separately. The SLs used for the "Premium Production" factor were the same as used in the previous application. This time SLs for "Pension Contract" were added as follows: $SL_{2010,2} = 200.000$ for 2010; $SL_{2011,2} = 210.000$, for 2011; $SL_{2012,2} = 220.000$ for 2012; $SL_{2013,2} = 260.000$ for 2013, and $SL_{2014,2} = 310.000$ for 2014. The results are shown in Table 3 and Chart 3.

Table 3. The Performance of PPCs between 2010 and 2014 (EATWOS with SL)

		2010		2011		2012		2013		2014	
		ES	Rank	ES	Rank	ES	Rank	ES	Rank	ES	Rank
1	AEGON	0,2295	12	0,2550	13	0,3119	14	0,3876	15	0,4344	14
2	ALLIANZ	0,4643	8	0,4635	11	0,4456	12	0,4993	13	0,4641	12
3	ALLIANZ Y	0,8216	1	0,7675	3	0,7726	2	0,7669	3	0,7738	4
4	ANADOLU	0,6173	5	0,6340	6	0,7451	3	0,6571	8	0,6692	7
5	ASYA					0,0925	17	0,4270	14	0,3561	15
6	AVIVASA	0,7507	3	0,7283	4	0,7419	4	0,7442	4	0,7492	5
7	AXA					0,2182	15	0,3158	16	0,1281	16
8	BNP PARIBAS CARDIF	0,2741	11	0,2555	12	0,3989	13	0,5234	11	0,6028	11
9	CIGNA FINANS	0,4962	7	0,6375	5	0,6387	6	0,7033	6	0,6483	9
10	ERGO	0,1638	13	0,1148	14	0,1649	16	0,1474	17	0,0883	17
11	FIBA							0,0231	18	0,0331	19
12	GARANTI	0,7460	4	0,8874	2	0,7050	5	0,6942	7	0,6871	6
13	GROUPAMA	0,4327	9	0,4962	10	0,4880	11	0,5050	12	0,4542	13
14	HALK					0,5688	8	0,7772	2	0,8279	3
15	KATILIM									0,0625	18
16	METLIFE	0,4139	10	0,5525	7	0,5402	10	0,6496	9	0,6296	10
17	NN	0,5330	6	0,5343	8	0,6358	7	0,6493	10	0,6546	8
18	VAKIF	0,7725	2	0,8985	1	0,8506	1	0,8782	1	0,8483	1
19	ZIRAAT			0,5174	9	0,5419	9	0,7399	5	0,8364	2

The top 3 companies in 2014 were found to be HALK, VAKIF and ZIRAAT, while AXA, ERGO,

FIBA and KATILIM were the least efficient. ALLIANZ Y, AVIVASA, HALK, GARANTI and VAKIF were the leading ones in efficiency in 2013, while AXA, ERGO and FIBA were again the least efficient. In 2012, the top companies were ALLIANZ Y, ANADOLU, AVIVASA, GARANTI and VAKIF, while ASYA, AXA and ERGO were at the bottom of the list. The companies with the best performance in 2011 were ALLIANZ Y, AVIVASA, GARANTI and VAKIF. In the same year, the least efficient ones were AEGON, BNP and ERGO. ALLIANZ Y, AVIVASA, GARANTI and VAKIF showed the best performance in 2010, while AEGON and ERGO were the least efficient. When the period 2010-2014 is considered as a whole, VAKIF, ALLIANZ Y, AVIVASA and GARANTI were found to be top 4 companies, while ASYA, AXA, ERGO, FIBA and KATILIM were found to have been operating the least efficiently.

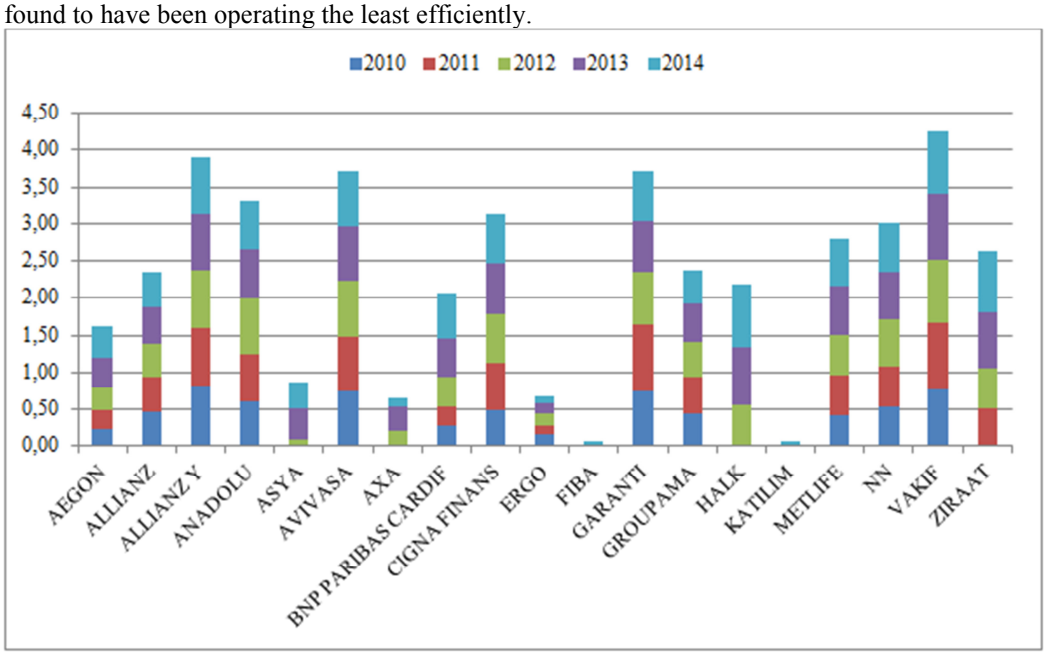

Chart 3. Graphical representation of the performances of the PPCs between 2010 and 2014

6. Conclusion

PPS is a system that aims to provide an extra income for people in addition to the regular retirement pay by encouraging them to make long-term savings. This system plays an important role in both macro and micro level in the regulation of the relationship between savings and investments. In order to function properly, PPCs should raise the savings to the desired level and find proper investments in the financial markets. Therefore, the efficiency of PPCs needs to be measured regularly, and if there is something wrong with the performance, they should seek ways to improve their efficiency. Otherwise, they would be a burden for both the national economy and savers.

This study aims to measure the efficiency of 19 PPCs in Turkey from 2010 to 2014 by applying EATWOS method in 3 different ways. The input criteria are taken as “Number of Staff Employed”, “Total Assets”, and “Total Shareholders' Equity” while the outputs are taken as “Premium Production” and “Pension Contracts”.

The first application of EATWOS revealed that ALLIANZ Y, ANADOLU, AVIVASA, GARANTI, VAKIF and ZIRAAT exhibited the best performance in general in the overall period from 2010 to 2014, while AEGON, ALLIANZ, ASYA, AXA, BNP, ERGO, FIBA and KATILIM were less efficient. GARANTI, GROUPAMA and NN were the companies that showed a gradual performance loss over the years.

The second application of EATWOS with SL for “Premium Production” revealed, when the results were analyzed as a whole for the period 2010-2014, that ALLIANZ Y, ANADOLU, AVIVASA, CIGNA, GARANTI, VAKIF and ZIRAAT were operating with better efficiency, while AEGON, ASYA, AXA, BNP, ERGO, FIBA and KATILIM showed a weak performance. ALLIANZ, ERGO, GARANTI, GROUPAMA and NN exhibited a little performance loss while AVIVASA improved its performance continuously over these years.

The third application of EATWOS was realized with SLs for “Premium Production” and “Pension Contracts”. The result for the whole period 2010-2014 was as follows: ALLIANZ Y, AVIVASA, GARANTI and VAKIF were the top companies while AEGON, ASYA, AXA, ERGO, FIBA and KATILIM were found to be the least efficient. ALLIANZ, ERGO, and GARANTI lost performance over the years while HALK, VAKIF and ZIRAAT improved their performances during the same period.

The study as a whole with all 3 applications of EATWOS reveals that ALLIANZ Y, ANADOLU, AVIVASA, GARANTI and VAKIF showed a continuous and efficient performance while AEGON, ASYA,

AXA, ERGO, FIBA and KATILIM exhibited a poor performance.

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