Performance Evaluation of Mutual Funds Via Single Valued Neutrosophic Set (SVNS) Perspective: A Case Study in Turkey

Serpil Altınırmak [1], Yavuz Gül [2], Basil Oluoch Okoth[3] Çağlar Karamaşa[4]

[1] Eskişehir Vocational School, Anadolu University, Yunus Emre Campus, Eskişehir, 26470, Turkey. E-mail: saltinirmak@anadolu.edu.tr

[2] Graduate School of Social Sciences, Anadolu University, Yunus Emre Campus, Eskişehir, 26470, Turkey. E-mail: yavuzgul@anadolu.edu.tr

[3] Graduate School of Social Sciences, Anadolu University, Yunus Emre Campus, Eskişehir, 26470, Turkey. E-mail: basils.okoth@yahoo.com

[4] Faculty of Business, Anadolu University, Yunus Emre Campus, Eskişehir, 26470, Turkey. E-mail: ckaramasa@anadolu.edu.tr

Abstract.

The aim of this study was to use the Single-Valued Neutrosophic Set (SVNS) to analyze 58 mutual funds, traded at the Istanbul Stock Exchange, under incomplete, indeterminate and inconsistent information. To this end, the performance of the funds was first evaluated using the most commonly preferred criteria like the Morningstar rating, Sharpe ratio, Treynor ratio, and Jensen ratio. Following these criteria, SVNS based entropy was used to rank the funds. The results of the entropy weights revealed Morningstar rating to be the most important evaluation criterion followed by Treynor, Sharpe and Jensen ratios respectively. Yapı Kredi Asset Management Foreign Technology Sector Equity Fund was found to be the most successful fund, while İş Asset Management BIST Technology Capped Index Share Fund (Equity Intensive) Fund was the least successful fund.

Keywords: Performance Evaluation, Mutual Funds, Neutrosophic Set, Single valued neutrosophic set based entropy

1 Introduction

A feedback based on the performance evaluation of an investment is quite significant for the success of any investment. It is important to determine whether the portfolios created for the purpose of risk distribution, either by institutional or individual investors, have the capacity to create the desired benefit or if the there exists a healthy risk-return relationship.

Evaluations of the performance of investment funds, managed by professionals, and composed of various securities (just as a portfolio), will have an impact on the success of the investment fund. When fund managers determine the assets that they intend to invest in, it is extremely important to measure the fund performance by considering the return and risk on the assets alongside other indicators. When determining the fund performance, another important point is to determine whether or not the performance realized is the result of any chance factor. The right decisions by the fund managers will lead to the selection of the right securities for the fund as well as the inclusion to the fund of securities that move in tandem with an emerging market. They are also able to make changes to the securities making up the fund in time by including securities that change slower than the market in case of declining markets.

2 Fund Performance Evaluation

When determining fund performance, the basic emphasis should be on risk and return. The total return expected from the fund should be compared to the level of risk that the fund is exposed to. The first thing that should be done therefore is the determination of the risk and return of the fund. The risk and return of the fund will vary according to the risks and returns of the assets in the fund pool.

2.1 Calculating the Morningstar Return

The Morningstar system is fundamentally made of two parts; while the first part works out the 'Morningstar Return', the second part determines the 'Morningstar Risk'. In calculating the Morningstar Return in the first stage, the monthly returns used should be calculated from the monthly closing price per share of selected funds. This simple calculation of the return can be expressed as:

$$Rp = (Vt - Vt\text{-}1) / (Vt\text{-}1) \qquad (1)$$

Where Rp is the monthly return of the fund, Vt is the monthly closing price per share, V-t is the monthly closing price per share for the previous month.

After calculating of the monthly returns of the fund, Morningstar obtains the value for 'adjusted return' for each month by subtracting, from the monthly returns, the monthly costs charged on the fund, such as commissions, expenses, and management fees among others. The monthly excess return for each fund is thus calculated based on the adjusted returns. In other words, the additional earnings by the fund above the risk-free rate. Since Morningstar always presents investors with investment alternatives to the risk-free assets, the excess return earned by a fund is now understood better as either above or below the risk-free rate. Consequently, the return of the fund is calculated by subtracting the risk-free interest rate for that month from the adjusted monthly return.

$$ERp = \text{Adjusted Fund Return- } Rf \qquad (2)$$

Where ERp is the monthly excess return of the fund and Rf is risk-free rate.

In the next stage, Morningstar divides the funds into categories. When Morningstar initially put forward this system, it grouped the funds into the four basic asset classes, as mentioned earlier, and classified (assigned) the funds structures into one of these asset classes according to the investment strategies. However, these asset classes were later revised to allow better evaluation and to avoid the comparison of apples and oranges. In 1996, Morningstar introduced categories that grouped funds into narrower classes. However, these categories were not integrated into the Morningstar Star Rating System until mid-2002. With the initial being 48 categories, this number rose to 64, and 81 by August 2009, and finally to 122 in April 2016. After the fund categories have been defined, the monthly 'category average return' for every fund category is calculated. To do this, the adjusted monthly returns of all the funds in the category are added and divided by the number of funds in the category, resulting into the determination of the monthly category average return for that fund category. After this is done, Morningstar compares the category average return to the risk-free rate, resulting in the Morningstar Return.

$$\text{Morningstar Return} = ERp / (\text{category average return} - Rf) \text{ or } Rf \qquad (3)$$

As can be seen, the ERp obtained by subtracting the risk-free rate-based return from the adjusted monthly return of the fund forms the numerator of the equation and is divided by the greater of the (category average return - Rf) or Rf. Also, it will be noticed that while the numerator essentially shows the excess return of the fund, the denominator shows a comparison of the average excess return of the category in which the fund is found and the risk-free rate. Thus, the denominator of this equation may change from month to month, i.e., it may be the category average return – Rf expression in some months and only made of the risk-free return for other months. Morningstar divides the result by one of these two variables to avoid distortions due to low or negative average excess returns in the denominator of equation [7].

2.2 Calculating the Morningstar Risk

Once the Morningstar return has been calculated, the fund's Morningstar risk should be determined. In this regard, it should be noted that Morningstar is not based on the risk values obtained using measures of risk such as the standard deviation or beta coefficient, but it is determined on the basis of the downward risk to investors, which is the financial risk associated with losses, and which is believed to be investors' biggest fear. For this operation, first, the fund's adjusted monthly return and the risk-free interest rate are compared. At this point, months with reported negative monthly excess returns are identified. These negative returns are then summed up and divided by the total number of months in the period. The aim here is to determine the opportunity cost incurred by the investors in terms of monthly average (the monthly average loss) as a result of not investing at the risk-free rate. The same method is then applied to the fund category.

The average return of the category is compared with the risk-free interest rate, the months in which the monthly excess returns of the category in which the fund is found are reported as negative are determined, and these negative returns are summed and divided by the total number of months in the period. The average monthly loss of the category of funds, i.e. category risk, is calculated. The Morningstar risk of the fund is expressed as follows:

$$\text{Morningstar Risk} = AMLp / AMLc \qquad (4)$$

Where AMLp is the Average Monthly Loss of the fund and AMLc is the Average Monthly Loss of the category in which the fund is found.

2.3 Calculation of Raw Return

After obtaining the required data on Morningstar return and the Morningstar risk the next step is the calculation of the Morningstar raw return for each fund. This value is obtained by subtracting the Morningstar risk from the Morningstar return of the fund.

Raw Return = Morningstar return - Morningstar risk   (5)

2.4 Treynor Ratio

The Treynor Ratio (Index) introduced by Jack Treynor in 1965 measures portfolio performance using the beta coefficient, which measures the systematic risk, instead of the standard deviation which measures the total risk. The beta coefficient indicates how sensate the securities or portfolio are to the market. Treynor argued that although non-systematic risks could be eliminated through portfolio diversification, systematic risk cannot be removed in any way [8]. Treynor thus divided the investment risk on a diversifiable portfolio into two parts: general market fluctuations, and fluctuations in securities within the portfolio. Treynor argued that the first risk is valid for all stocks and that it cannot be eliminated while the second risk can be eliminated or reduced by appropriately diversifying the portfolio. Just like in the Sharpe Ratio, the risk premium is also calculated here. However, unlike the Sharpe Ratio, the premium calculated here is based on the beta coefficient and not standard deviation. In this way, there is a residual return for every unit of systematic risk assumed, i.e. earning above the risk-free rate of return. The Treynor ratio can be expressed as follow [11]:

$$T_m = (R_m - R_f)/\beta_m \qquad (6)$$

Where T_m = Treynor Ratio

$\qquad\quad R_f$ = Risk Free Rate

$\qquad\quad R_m$ = Return of Fund

$\qquad\quad B_m$ = Beta coefficient of the fund.

    Treynor explained his portfolio performance based on the Security Market Line (SML), not the Capital Market Line (CML) used by Sharpe [24]. If the evaluated portfolio is above this level, then it has performed worse than the market, a performance below this line implies it is better than the market.

2.5 Sharpe Ratio

The Sharpe Ratio which measures portfolio performance based on the total risk was developed by William Forsyth Sharpe in 1966. This is one of the most commonly used and simplest methods for measuring portfolio performance. The idea that it is necessary for investors to invest in the index funds through the market portfolio in order to avoid the non-systematic risks that have been forecast by the Sharpe Ratio rests on the assumption that it would be erroneous to try to obtain more returns from the market, as stocks in active markets always reflect the prices correctly [22].

In his study, Sharpe tried to subject the measures presented by Treynor to the empirical test by evaluating their predictive powers. He also sought to advance Treynor's work, as well as make more explicit the relationship between the recent developments in capital theory and alternative models of investment fund performance and then subjecting these alternative models to more empirical tests. He analysed the annual return rates of 34 open-end investment funds between 1954 and 1963. In the study, the performance of 23 investment funds was found to be lower than the Dow Jones Industrial Average (DJIA), which was considered as the indicator. On the other hand, when relatively poorly diversified portfolios are considered, the Treynor Index, due to its diversification weakness and failure to address some of the variables, may lead the results to vary considerably. This led the conclusion by Sharpe that, whereas it may be a good measure for predicting future performance, the same reasons make it a poor measure for past performance [19].

The model introduced by Sharpe shows the extra return over the risk-free rate that the investor seeks to achieve for the amount of total risk undertaken, i.e. the additional return expected for every unit of total risk. The Sharpe Ratio is based on the Capital Market Line (CML) and assumes that the investment fund affects the portfolio [26]. The Capital Market Line can thus be said to be the indicator. When the Sharpe Ratio calculated for the portfolio that an investor holds is found to be greater than the Sharpe Ratio of the market portfolio, it can be concluded that the portfolio has performed better than the market [4].

The calculation of the Sharpe Ratio which is based on the total portfolio risk can be expressed as follows [22]:

$$S = (R_m + R_f)/\sigma_m \qquad (7)$$

Where S = Sharpe Ratio,

R_p = Return of Fund

R_f = Risk-Free Rate

σ_p = Standard Deviation of the Fund (Total Risk of the Fund)

The difference between the return on the portfolio and the risk-free interest rate, the numerator of the equation, is known as the risk premium. This premium shows the reward or the residual return (excess return, return on risk-free interest rate) that the investor gets for undertaking risk. The denominator of the function indicates the total risk made of both systematic and non-systematic risks.

2.6 Jensen Ratio

This ratio was developed by Michael Cole Jensen in 1968 and uses just a single value in measuring portfolio performance. The Jensen Ratio measures the deviation of any portfolio from the Securities Market Line [18].

The Ratio based on the Capital Assets Pricing Model (CAPM) is the difference between the realized return of the portfolio and the expected return (with assumptions) above the Securities Market Line. This ratio also acts as an examination of the skills of the portfolio manager in formulating the portfolio. Since Jensen expressed the difference mentioned in terms of Alpha Coefficient, the ratio is also known as the Jensen Alpha. This ratio can also be defined as the supernormal return above the expected return according to the CAPM.

In his study, Jensen asserted that he had created a method (criterion) that measures the predictive skills of portfolio managers as well as their contribution to the returns of the funds known as the Jensen Alpha. He sought to measure the predictive skills of 115 mutual fund managers between 1945 and 1964. He noted that the performance of the 115 mutual funds, and by extension the skills of the managers in predicting the stock prices did not exceed the average by much [10].

The Jensen Ratio is expressed as follows [1]:

$$\alpha_m = R_m - [R_f + \beta_m (R_m - R_f)] \qquad (8)$$

Where α_m = Jensen (Alpha) Ratio of the fund

R_p = Return of the Fund

R_m = Return of the Indicator Index (Market)

R_f = Risk Free Rate

β_m = Beta coefficient of the fund.

3 Methodology

3.1 Neutrosophic Set

Neutrosophic Sets (NS) is proposed by Smarandache (1998) having with degree of truth, indeterminacy and falsity membership functions in which all of them are totally independent [20,21]. Let U be a universe of discourse and $x \in U$. The neutrosophic set (NS) N can be expressed by a truth membership function $T_N(x)$, an indeterminacy membership function $I_N(x)$ and a falsity membership function $F_N(x)$, and is represented as $N = \{< x : T_N(x), I_N(x), F_N(x) >, x \in U\}$. Also the functions of $T_N(x)$, $I_N(x)$ and $F_N(x)$ are real standard or real nonstandard subsets of $]0^-, 1^+[$, and can be presented as $T, I, F : U \rightarrow]0^-, 1^+[$. There is not any restriction on the sum of the functions of $T_N(x)$, $I_N(x)$ and $F_N(x)$, so:

$$0^- \leq \sup T_N(x) + \sup I_N(x) + \sup F_N(x) \leq 3^+ \qquad (9)$$

The complement of a NS N is represented by N^C and described as below [6]:

$$T_N^C(x) = 1^+ \ominus T_N(x) \qquad (10)$$

$$I_N^C(x) = 1^+ \ominus I_N(x) \qquad (11)$$

$$F_N^C(x) = 1^+ \ominus F_N(x) \quad \text{for all } x \in U \quad (12)$$

There are applications of the neutrosophic set such as MCDM problems of supplier selection [1], strategic planning [2], logistic center location selection [17], teacher recruitment in higher education [13] and school choice [14].

3.2 Single Valued Neutrosophic Sets (SVNS)

Single-Valued Neutrosophic Set (SVNS) which is a case of NS was developed by Smarandache (1998) and Wang, Smarandache, Zhang, and Sunderraman (2010) in order to deal with indeterminate, inconsistent and incomplete information. The interval $[0,1]$ was considered rather than $\left]0^-, 1^+\right[$ for better representation and application to real-world problems. Let U be a universe of discourse and $x \in U$. A single-valued neutrosophic set B in U is described by a truth membership function $T_B(x)$, an indeterminacy membership function $I_B(x)$ and a falsity membership function $F_B(x)$. When U is continuous, an SVNS B is depicted as

$$B = \int_x \frac{<T_B(x), I_B(x), F_B(x)>}{x} : x \in U .$$ When U is discrete an SVNS B can be represented as

$$B = \sum_{i=1}^n \frac{<T_B(x_i), I_B(x_i), F_B(x_i)>}{x_i} : x_i \in U$$ [15]. The functions of $T_B(x)$, $I_B(x)$ and $F_B(x)$ are real

standard subsets of $[0,1]$ that is $T_B(x) : U \to [0,1]$, $I_B(x) : U \to [0,1]$ and $F_B(x) : U \to [0,1]$. Also, the sum of $T_B(x)$, $I_B(x)$ and $F_B(x)$ are in $[0,3]$ that $0 \leq T_B(x) + I_B(x) + F_B(x) \leq 3$ [5].

For simplicity two SVNSs such as $B_1 = (t_1, \iota_1, f_1)$ and $B_2 = (t_2, \iota_2, f_2)$ then summation between B_1 and B_2 can be described as below:

$$B_1 \oplus B_2 = (t_1 + t_2 - t_1 t_2, \iota_1 \iota_2, f_1 f_2) \qquad (13)$$

Two SVNSs such as $B_1 = (t_1, \iota_1, f_1)$ and $B_2 = (t_2, \iota_2, f_2)$ then multiplication between B_1 and B_2 can be described as below:

$$B_1 \otimes B_2 = (t_1 t_2, \iota_1 + \iota_2 - \iota_1 \iota_2, f_1 + f_2 - f_1 f_2) \qquad (14)$$

For an SVNS as $B = (t, \iota, f)$ and $\lambda \in \Re$ an arbitrary positive real number then,

$$\lambda B = (1 - (1-t)^\lambda, \iota^\lambda, f^\lambda), \lambda > 0 \qquad (15)$$

The complement of an SVNS B is represented by $_C(B)$ and is described as follow [9]:

$$T_C(B)(x) = F(B)(x) \qquad (16)$$

$$I_C(B)(x) = 1 - I(B)(x) \qquad (17)$$

$$F_C(B)(x) = T(B)(x) \text{ for all } x \in U \qquad (18)$$

The union of two SVNS namely B_1 and B_2 is an SVNS B_3 denoted by $B_3 = B_1 \cup B_2$ and its truth, indeterminacy and falsity membership functions are shown below [23]:

$$T(B_3)(x) = \max(T(B_1)(x), T(B_2)(x)) \qquad (19)$$

$$I(B_3)(x) = \min(I(B_1)(x), I(B_2)(x)) \qquad (20)$$

$$F(B_3)(x) = \min(F(B_1)(x), F(B_2)(x)) \text{ for all } x \in U \qquad (21)$$

The intersection of two SVNS namely B_1 and B_2 is an SVNS B_3 denoted by $B_3 = B_1 \cap B_2$ and its truth, indeterminacy and falsity membership functions are shown below [12]:

$$T(B_3)(x) = \min\big(T(B_1)(x), T(B_2)(x)\big) \qquad (22)$$

$$I(B_3)(x) = \max(I(B_1)(x), I(B_2)(x)) \qquad (23)$$

$$F(B_3)(x) = \max(F(B_1)(x), F(B_2)(x)) \text{ for all } x \in U \qquad (24)$$

3.3 Single Valued Neutrosophic Sets (SVNS) Entropy Based Decision Making

A new single-valued neutrosophic sets (SVNS) entropy based multi-attribute decision making (MADM) was proposed by Nirmal and Bhatt (2016) and composed of steps seen as follows [16]:

1-Type of decision problem (ranking, evaluation, sorting etc.) is identified in the first step.

2-Then alternatives with regard to criteria having qualitative or quantitative values are identified.

3-Decision matrix involving criteria and alternatives with respect to decision-making problem is constructed.

4-Qualitative information is transformed into fuzzy numbers by means of matrix normalization techniques shown as Table 1:

Normalization technique	Normalized beneficial value	Normalized non-beneficial value
Linear scale transformation max method	$N_{ij} = \dfrac{x_{ij}}{x_{i\,max}}$	$N_{ij} = \dfrac{x_{i\,min}}{x_{ij}}$
Linear scale transformation max-min method	$N_{ij} = \dfrac{x_{ij} - \min x_{ij}}{\max x_{ij} - \min x_{ij}}$	$N_{ij} = \dfrac{\max x_{ij} - x_{ij}}{\max x_{ij} - \min x_{ij}}$
Linear scale transformation sum method	$N_{ij} = \dfrac{x_{ij}}{\sum\limits_{i=1}^{m} x_i}$	$N_{ij} = 1 - \dfrac{x_{ij}}{\sum\limits_{i=1}^{m} x_i}$
Vector normalization method	$N_{ij} = \dfrac{x_{ij}}{\sqrt{\sum\limits_{i=1}^{m} x_{ij}^2}}$	$N_{ij} = 1 - \dfrac{x_{ij}}{\sqrt{\sum\limits_{i=1}^{m} x_{ij}^2}}$

Table 1. Matrix normalization techniques

5-Elements of input matrix in the classic or fuzzy set are conversed to single-valued neutrosophic sets by means of conversion rule for beneficial and non-beneficial criteria explained as below:

a) For beneficial criteria: Positive ideal solution (PIS) is constructed as $< T_{max}^*(x), I_{min}^*(x), F_{min}^*(x) >$.

Normalized input matrix beneficial criteria are created as the degree of truthness $T_L(x)$, the degree of indeterminacy and degree of falsehood are considered as $I_L(x) = F_L(x) = 1 - T_L(x)$ respectively.

b) For non-beneficial criteria: Negative ideal solution (NIS) is constructed as $< T_{min}^{*}(x), I_{max}^{*}(x), F_{max}^{*}(x) >$.
Normalized input matrix non-beneficial criteria are created as the degree of indeterminacy and falsehood as $I_{L}(x) = F_{L}(x)$, the degree of truthness is considered as $T_{L}(x) = 1 - I_{L}(x) = 1 - F_{L}(x)$.

c)Entropy value for the jth attribute is calculated according to Eq.(25) as shown below:

$$E_{j} = 1 - \frac{1}{m} \left[\sum_{i=1}^{m} \left(T_{ij}(x_{i}) + F_{ij}(x_{i}) \right) \left| 2 \left(I_{ij}(x_{i}) \right) - 1 \right| \right] \qquad (25)$$

6-Entropy weight for the jth attribute is calculated as below [24]:

$$W_{j} = \frac{1 - E_{j}}{\sum_{j=1}^{n} \left(1 - E_{j} \right)} \qquad (26)$$

Weight vector $W = \left(w_{1}, w_{2}, w_{3}, \ldots, w_{n} \right)^{T}$ of attributes, $K = \left\{ K_{j}, j = 1, 2, \ldots, n \right\}$ with $W_{j} \geq 0$ and

$$\sum_{j=1}^{n} W_{j} = 1.$$

7-Value of each alternative is calculated as follows:

$$L_{w} = \sum_{j=1}^{n} W_{j} * \left((T_{ij}(x) * T_{ij}^{*}(x)) + (I_{ij}(x) * I_{ij}^{*}(x)) + (F_{ij}(x) * F_{ij}^{*}(x)) \right) \qquad (27)$$

Where for beneficial attribute PIS=$< T_{max}^{*}(x), I_{min}^{*}(x), F_{min}^{*}(x) >=<1,0,0>$, and for non-beneficial attribute NIS=$< T_{min}^{*}(x), I_{max}^{*}(x), F_{max}^{*}(x) >=<0,1,1>$.

8- Each alternative is ranked according to the descending order of L_{w}.

4 Data Set

This study investigated mutual funds which operated continuously and without merging with any other funds for the five-year period between 2012 and 2016, and found security funds that could be grouped under 58 "equity umbrella funds" according to the established criterion. Data from the relevant pages of the Turkish Capital Markets Board website were utilized in the determination of these funds. The unit share price, and consequently the total portfolio value of one of the funds- Alkhair Portfolio Participating Equity Fund (Equity intensive fund)- on 31.07.2013 was found to be zero. Since this had the potential to affect the return and risk of the fund, this fund was removed from the study, leaving only 57 funds for analysis. These crisp data are converted to neutrosophic values because of the superiority of neutrosophy over crisp ones.

5 Analysis

A decision matrix was constructed for crisp data drawn from the equity funds and within the framework of the four criteria (Morningstarrating, Sharpe ration, Treynor ratio, and Jensen ratio) as seen in Table 2.

Equity Funds	Morningstar weighted point	Sharpe weighted point	Treynor weighted point	Jensen weighted point
Ak Asset Management America Foreign Equity Fund	0,692148	0,228627	-0,0363502	0,0096924
Ak Asset Management Europe Foreign Equity Fund	-0,24477	0,113154	-0,0522	0,004424

Ak Asset Management Asia Foreign Equity Fund	-1,447455	-0,001768	-0,000950	0,0000765
Ak Asset Management BIST 30 Index Equity Fund (Equity Intensive Fund)	-3,683878	0,008855	0,000668	0,000955
Ak Asset Management BIST Banks Index Equity Fund (Equity Intensive Fund)	-3,82955	-0,03114	-0,00174	0,00126
Ak Asset Management BRIC Countries Foreign Equity Fund	-1,730383	0,035271	0,0076763	0,0019280
Ak Asset Management Equity Fund (Equity Intensive Fund)	-3,50801	-0,01854	-0,00094	-0,00049
Ak Asset Management Foreign Equity Fund	-0,120508	0,169739	-0,093322	0,0071872
Ata Portfolio First Equity Fund (Equity Intensive Fund)	-3,113982	0,089787	0,0056179	0,005439
Azimut PYŞ First Equity Fund (Equity Intensive Fund)	-2,553792	0,045385	0,0035996	0,002600
Bizim Portfolio Energy Sector Participation Equity Fund (Equity Intensive Fund)	-2,432883	-0,095570	-0,010140	-0,0036231
Bizim Portfolio Construction Industry Participation Equity Fund (Equity Intensive Fund)	-3,161174	0,039539	0,0027570	0,0024940
Deniz Portfolio BIST 100 Index Equity Fund (Equity Intensive Fund)	-3,694172	0,004020	0,000370	0,0006699
Deniz Portfolio Equity Fund (Equity Intensive Fund)	-3,517794	0,010906	0,000791	0,0009917
Finans Portfolio BIST 30 Index Equity Intensive Fund Exchange Traded Fund	-3,907524	0,021992	0,001424	0,001816
Finans Asset Management First Equity Fund	-3,296607	0,052358	0,0034596	0,0032420
Finans Asset Management Dow Jones İstanbul 20 (Equity Intensive) Exchange Traded Fund	-3,799676	0,0257993	0,0016396	0,0019916
Finans Asset Management Second Equity Fund	-3,479966	0,0508895	0,0031856	0,0032607
Finans Asset Management Turkey Large-Cap Banks (Equity Intensive) Exchange Traded Fund	-5,244110	-0,0010259	0,0000074	0,000465
Fokus Asset Management Equity Fund (Equity Intensive Fund)	-2,486771	0,041656	0,0028337	0,0020580
Garanti Asset Management BIST 30 Index Equity Fund (Equity Intensive Fund)	-3,877312	-0,000583	0,0000974	0,000431
Garanti Asset Management Equity Fund (Equity Intensive Fund)	-3,378613	0,040647	0,0025761	0,0026067
Gedik Asset Management First Equity Fund (Equity Intensive Fund)	-3,148063	-0,010759	-0,000589	-0,0001846
Gedik Asset Management G-20 Countries Foreign Securities (Equity Intensive Fund)	-0,604129	0,107282	0,120414	0,0041053
Gedik Asset Management Second Equity Fund (Equity Intensive Fund)	-1,946579	0,121667	0,0103163	0,0058834
Global MD Asset Management First Equity Fund (Equity Intensive Fund)	-3,418733	-0,042653	-0,0025318	-0,0016431
Global MD Asset Management Second Equity Fund (Equity Intensive Fund)	-3,266048	-0,063557	-0,0037824	-0,0024167
Halk Asset Management Equity Fund (Equity Intensive Fund)	-3,673393	0,0238852	0,0015849	0,0018096
HSBC Asset Management BIST 30 Index Equity Fund (Equity Intensive Fund)	-3,819283	-0,0068613	-0,000271	0,000007
HSBC Asset Management Equity Fund (Equity Intensive Fund)	-3,818957	0,036008	0,0022634	0,0026858
ING Asset Management First Equity Fund (Equity Intensive Fund)	-3,510678	-0,0138847	-0,000641	-0,00026
İş Asset Management Dividend Paying Corporations Share Fund (Equity Intensive Fund)	-3,380190	-0,012627	-0,000613	-0,000216
İstanbul Portfolio Equity Intensive Fund (Equity Intensive Fund)	-1,818028	-0,092841	-0,006290	-0,0022918
İş Asset Management BIST-30 Index Share Fund (Equity Intensive Fund)	-3,798493	-0,0012180	0,0000549	0,0003845

İş Asset Management BIST 30 equity intensive Exchange investment fund	-3,871759	0,0208728	0,00137201	0,0017460
İş Asset Management BIST Bank Index Share Fund (Equity Intensive Fund)	-4,291139	-0,0092844	-0,000475	-0,0001311
İş Asset Management BIST Technology Capped Index Share Fund (Equity Intensive Fund)	-0,875815	0,283976	0,034661	0,0166801
İş Asset Management Share Fund (Equity Intensive Fund)	-3,407564	-0,014655	-0,000716	-0,000307
İş Asset Management İş Bank Subsidiaries Fund (Equity Intensive Fund)	-2,531887	0,0536240	0,0037697	0,0025575
İş Asset Management Participation Share Fund (Equity Intensive Fund)	-1,323817	-0,0959215	-0,0099110	-0,0022049
İş Portfolio Banking Private Equity Fund (Equity Intensive Fund)	-3,334418	-0,0018027	0,0000289	0,000307
Kare Asset Management Equity Fund (Equity Intensive Fund)	-2,874745	0,143354	0,0088840	0,0087556
Qinvest Asset Management Equity Fund (Equity Intensive Fund)	-2,518660	0,0033631	0,000253	0,000378
Strateji Asset Management Second Equity Fund (Equity Intensive Fund)	-2,653906	0,117171	0,0081913	0,006719
Strateji Asset Management Second Equity Fund (Equity Intensive Fund)	-0,999745	0,074355	0,0089824	0,0021746
Şeker Asset Management Equity Fund (Equity Intensive Fund)	-2,965969	0,005848	0,000374	0,00060018
Tacirler Asset Management Equity Fund (Equity Intensive Fund)	-1,524716	0,041657	0,00270103	0,0011679
TEB Asset Management Equity Fund (Equity Intensive Fund)	-3,568576	0,024865	0,00166	0,0018599
Vakıf Asset Management BIST 30 Index Equity Fund (Equity Intensive Fund)	-3,749163	-0,0009460	0,0000723	0,000391
Yapı Kredi Asset Management BIST 30 Index Equity Fund (Equity Intensive Fund)	-3,688064	0,0097042	0,000707	0,000994
Yapı Kredi Asset Management BIST 100 Index Equity Fund (Equity Intensive Fund)	-3,602030	0,00260078	0,000302	0,000586
Yapı Kredi Asset Management First Equity Fund (Equity Intensive Fund)	-3,445713	0,0078333	0,000610	0,000827
Yapı Kredi Asset Management Koc Holding Affiliate and Equity Fund (Equity Intensive Fund)	-2,185636	0,1336988	0,0085835	0,0066485
Yapı Kredi Asset Management Foreign Technology Sector Equity Fund	0,152437	0,239112	-1,015735	0,0091293
Ziraat Asset Management BIST 30 Index Equity Fund (Equity Intensive Fund)	-3,734672	0,0036299	0,000338	0,000647
Ziraat Asset Management Equity Fund (Equity Intensive Fund)	-3,091296	-0,008640	-0,000496	0,0000372
Ziraat Asset Management Dividend Paying Corporations Equity Fund (Equity Intensive Fund)	-2,095050	0,0000948	0,0000245	0,00027349

Table 2. Decision matrix for crisp data in terms of equity funds

After the decision matrix for crisp data, vector normalization process was implemented to obtain the normalized decision matrix. After that, the normalized decision matrix was transformed into the SVNS decision matrix comprised of the degree of truthness $T_L(x)$, indeterminacy $I_L(x)$, and falsehood $F_L(x)$ using the conversion rule for beneficial and non-beneficial criteria. This step is shown in Table 3.

Equity Funds	Morningstar weighted point	Sharpe weighted point	Treynor weighted point	Jensen weighted point
Ak Asset Management America Foreign Equity Fund	(0.0299,0.97,0.97)	(0.37,0.6299,0.6299)	(-0.035,1.035,1.035)	(0.323,0.676,0.676)
Ak Asset Management Europe Foreign Equity Fund	(-0.01,1.010,1.01	(0.183,0.816,0.816)	(-0.05,1.05,1.05)	(0.147,0.852,0.852)

	0)			
Ak Asset Management Asia Foreign Equity Fund	(-0.062,1.062,1.062)	(-0.002,1.002,1.002)	(-0.00092,1.00092,1.00092)	(-0.0025,1.0025,1.0025)
Ak Asset Management BIST 30 Index Equity Fund (Equity Intensive Fund)	(-0.159,1.159,1.159)	(0.014,0.985,0.985)	(0.00064,0.999,0.999)	(0.0318,0.968,0.968)
Ak Asset Management BIST Banks Index Equity Fund (Equity Intensive Fund)	(-0.165,1.165,1.165)	(-0.05,1.05,1.05)	(-0.00169,1.00169,1.00169)	(-0.042,1.042,1.042)
Ak Asset Management BRIC Countries Foreign Equity Fund	(-0.07484,1.074,1.074)	(0.057,0.942,0.942)	(0.00745,0.992,0.992)	(0.0642,0.935,0.935)
Ak Asset Management Equity Fund (Equity Intensive Fund)	(-0.151,1.151,1.151)	(-0.03,1.03,1.03)	(-0.00091,1.00091,1.00091)	(-0.016,1.016,1.016)
Ak Asset Management Foreign Equity Fund	(0.00521,1.005,1.005)	(0.274,0.725,0.725)	(-0.0905,1.0905,1.0905)	(0.239,0.76,0,.76)
Ata Portfolio First Equity Fund (Equity Intensive Fund)	(-0.134,1.134,1.134)	(0.145,0.854,0.854)	(0.005,0.994,0.994)	(0.181,0.818,0.818)
Azimut PYŞ First Equity Fund (Equity Intensive Fund)	(-0.11,1.11,1.11)	(0.07,0.926,0.926)	(0.003,0.996,0.996)	(0.086,0.913,0.913)
Bizim Portfolio Energy Sector Participation Equity Fund (Equity Intensive Fund)	(-0.105,1.105,1.105)	(-0.154,1.154,1.154)	(-0.0098,1.0098,1.0098)	(-0,12,1.12,1.12)
Bizim Portfolio Construction Industry Participation Equity Fund (Equity Intensive Fund)	(-0.136,1.136,1.136)	(0.063,0.936,0.936)	(0.0026,0.997,0.997)	(0.083,0.916,0.916)
Deniz Portfolio BIST 100 Index Equity Fund (Equity Intensive Fund)	(-0.159,1.159,1.159)	(0.006,0.993,0.993)	(0.00035,0.999,0.999)	(0.022,0.977,0.977)
Deniz Portfolio Equity Fund (Equity Intensive Fund)	(-0.152,1.152,1.152)	(0.017,0.982,0.982)	(0.00076,0.999,0.999)	(0.033,0.966,0.966)
Finans Portfolio BIST 30 Index Equity Intensive Fund Exchange Traded Fund	(-0.169,1.169,1.169)	(0.035,0.964,0.964)	(0.0013,0.998,0.998)	(0.06,0.939,0.939)
Finans Asset Management First Equity Fund	(-0.142,1.142,1.142)	(0.084,0.915,0.915)	(0.0033,0.996,0.996)	(0.108,0.891,0.891)
Finans Asset Management Dow Jones İstanbul 20 (Equity Intensive) Exchange Traded Fund	(-0.164,1.164,1.164)	(0.041,0.958,0.958)	(0.0015,0.998,0.998)	(0.066,0.933,0.933)
Finans Asset Management Second Equity Fund	(-0.15,1.15,1.15)	(0.082,0.917,0.917)	(0.003,0.996,0.996)	(0.108,0.891,0.891)
Finans Asset Management Turkey Large-Cap Banks (Equity Intensive) Exchange Traded Fund	(-0.226,1.226,1.226)	(-0.001,1.001,1.001)	(0.00000722,0.999,0.999)	(0.015,0.984,0.984)
Fokus Asset Management Equity Fund (Equity Intensive Fund)	(-0.107,1.107,1.107)	(0.067,0.932,0.932)	(0.0027,0.997,0.997)	(0.068,0.931,0.931)
Garanti Asset Management BIST 30 Index Equity Fund (Equity Intensive Fund)	(-0.167,1.167,1.167)	(-0.00095,1.0009,1.0009)	(0.0000946,0.999,0.999)	(0.0144,0.985,0.985)
Garanti Asset Management Equity Fund (Equity Intensive Fund)	(-0.146,1.146,1.146)	(0.065,0.934,0.934)	(0.0025,0.997,0.997)	(0.086,0.913,0.913)
Gedik Asset Management First Equity Fund (Equity Intensive Fund)	(-0.136,1.136,1.136)	(-0.017,1.017,1.017)	(-0.00057,1.00057,1.00057)	(-0.006,1.006,1.006)
Gedik Asset Management G-20 Countries Foreign Securities (Equity Intensive Fund)	(-0.026,1.026,1.0	(0.173,0.826,0.826)	(0.116,0.883,0.883)	(0.136,0.863,0.863)

	26)			
Gedik Asset Management Second Equity Fund (Equity Intensive Fund)	(-0.0841,1.084,1.084)	(0.196,0.803,0.803)	(0.01,0.989,0.989)	(0.196,0.803,0.803)
Global MD Asset Management First Equity Fund (Equity Intensive Fund)	(-0.147,1.147,1.147)	(-0.069,1.069,1.069)	(-0.0024,1.0024,1.0024)	(-0.054,1.054,1.054)
Global MD Asset Management Second Equity Fund (Equity Intensive Fund)	(-0.141,1.141,1.141)	(-0.102,1.102,1.102)	(-0.0036,1.0036,1.0036)	(-0.08,1.08,1.08)
Halk Asset Management Equity Fund (Equity Intensive Fund)	(-0.158,1.158,1.158)	(0.038,0.961,0.961)	(0.0015,0.998,0.998)	(0.0603,0.939,0.939)
HSBC Asset Management BIST 30 Index Equity Fund (Equity Intensive Fund)	(-0.165,1.165,1.165)	(-0.011,1.011,1.011)	(-0.00026,1.00026,1.00026)	(0.002,0.997,0.997)
HSBC Asset Management Equity Fund (Equity Intensive Fund)	(-0.165,1.165,1.165)	(0.058,0.941,0.941)	(0.00219,0.997,0.997)	(0.089,0.91,0.91)
ING Asset Management First Equity Fund (Equity Intensive Fund)	(-0.151,1.151,1.151)	(-0.022,1.022,1.022)	(-0.00062,1.00062,1.00062)	(-0.008,1.008,1.008)
İş Asset Management Dividend Paying Corporations Share Fund (Equity Intensive Fund)	(-0.146,1.146,1.146)	(-0.0204,1.0204,1.0204)	(-0.00059,1.00059,1.00059)	(-0.0072,1.0072,1.0072)
İstanbul Portfolio Equity Intensive Fund (Equity Intensive Fund)	(-0.078,1.078,1.078)	(-0.15,1.15,1.15)	(-0.0061,1.0061,1.0061)	(-0.076,1.076,1.076)
İş Asset Management BIST-30 Index Share Fund (Equity Intensive Fund)	(-0.164,1.164,1.164)	(-0.0019,1.0019,1.0019)	(0.0000533,0.999,0.999)	(0.0128,0.987,0.987)
İş Asset Management BIST 30 equity intensive Exchange investment fund	(-0.167,1.167,1.167)	(0.033,0.966,0.966)	(0.00133,0.998,0.998)	(0.058,0.941,0.941)
İş Asset Management BIST Bank Index Share Fund (Equity Intensive Fund)	(-0.185,1.185,1.185)	(-0.015,1.015,1.015)	(-0.00046,1.00046,1.00046)	(-0.0043,1.0043,1.0043)
İş Asset Management BIST Technology Capped Index Share Fund (Equity Intensive Fund)	(-0.037,1.037,1.037)	(0.459,0.54,0.54)	(0.033,0.966,0.966)	(0.556,0.443,0.443)
İş Asset Management Share Fund (Equity Intensive Fund)	(-0.147,1.147,1.147)	(-0.023,1.023,1.023)	(-0.00069,1.00069,1.00069)	(-0.01,1.01,1.01)
İş Asset Management İş Bank Subsidiaries Fund (Equity Intensive Fund)	(-0.109,1.109,1.109)	(0.086,0.913,0.913)	(0.0036,0.996,0.996)	(0.0852,0.914,0.914)
İş Asset Management Participation Share Fund (Equity Intensive Fund)	(-0.057,1.057,1.057)	(-0.155,1.155,1.155)	(-0.0096,1.0096,1.0096)	(-0.0735,1.0735,1.0735)
İş Portfolio Banking Private Equity Fund (Equity Intensive Fund)	(-0.144,1.144,1.144)	(-0.0029,1.0029,1.0029)	(0.0000281,0.999,0.999)	(0.01,0.989,0.989)
Kare Asset Management Equity Fund (Equity Intensive Fund)	(-0.124,1.124,1.124)	(0.232,0.767,0.767)	(0.0086,0.991,0.991)	(0.291,0.708,0.708)
Qinvest Asset Management Equity Fund (Equity Intensive Fund)	(-0.108,1.108,1.108)	(0.0054,0.994,0.994)	(0.00024,0.999,0.999)	(0.012,0.987,0.987)
Strateji Asset Management Second Equity Fund (Equity Intensive Fund)	(-0.114,1.114,1.114)	(0.189,0.81,0.81)	(0.0079,0.992,0.992)	(0.224,0.775,0.775)
Strateji Asset Management Second Equity Fund (Equity Intensive Fund)	(-0.043,1.043,1.043)	(0.12,0.879,0.879)	(0.0087,0.991,0.991)	(0.0725,0.927,0.927)

Şeker Asset Management Equity Fund (Equity Intensive Fund)	(-0.128,1.128,1.128)	(0.0094,0.99,0.99)	(0.00036,0.999,0.999)	(0.02,0.979,0.979)
Tacirler Asset Management Equity Fund (Equity Intensive Fund)	(-0.065,1.065,1.065)	(0.067,0.932,0.932)	(0.00262,0.997,0.997)	(0.0389,0.961,0.961)
TEB Asset Management Equity Fund (Equity Intensive Fund)	(-0.154,1.154,1.154)	(0.04,0.959,0.959)	(0.00161,0.998,0.998)	(0.062,0.937,0.937)
Vakıf Asset Management BIST 30 Index Equity Fund (Equity Intensive Fund)	(-0.162,1.162,1.162)	(-0.00153,1.00153,1.00153)	(0.0000702,0.999,0.999)	(0.013,0.986,0.986)
Yapı Kredi Asset Management BIST 30 Index Equity Fund (Equity Intensive Fund)	(-0.159,1.159,1.159)	(0.015,0.984,0.984)	(0.00068,0.999,0.999)	(0.033,0.966,0.966)
Yapı Kredi Asset Management BIST 100 Index Equity Fund (Equity Intensive Fund)	(-0.155,1.155,1.155)	(0.004,0.995,0.995)	(0.00029,0.999,0.999)	(0.019,0.98,0.98)
Yapı Kredi Asset Management First Equity Fund (Equity Intensive Fund)	(-0.149,1.149,1.149)	(0.012,0.987,0.987)	(0.00059,0.999,0.999)	(0.0275,0.972,0.972)
Yapı Kredi Asset Management Koc Holding Affiliate and Equity Fund (Equity Intensive Fund)	(-0.094,1.094,1.094)	(0.216,0.783,0.783)	(0.0083,0.991,0.991)	(0.221,0.778,0.778)
Yapı Kredi Asset Management Foreign Technology Sector Equity Fund	(0.0065,0.993,0.993)	(0.387,0.612,0.612)	(-0.986,1.986,1.986)	(0.304,0.695,0.695)
Ziraat Asset Management BIST 30 Index Equity Fund (Equity Intensive Fund)	(-0.161,1.161,1.161)	(0.005,0.994,0.994)	(0.00032,0.999,0.999)	(0.021,0.978,0.978)
Ziraat Asset Management Equity Fund (Equity Intensive Fund)	(-0.133,1.133,1.133)	(-0.013,1.013,1.013)	(-0.00048,1.00048,1.00048)	(0.0012,0.998,0.998)
Ziraat Asset Management Dividend Paying Corporations Equity Fund (Equity Intensive Fund)	(-0.09,1.09,1.09)	(0.000154,0.999,0.999)	(0.0000238,0.999,0.999)	(0.009,0.99,0.99)

Table 3. SVNS Decision Matrix

After constructing SVNS decision matrix, entropy values $\left(E_j\right)$ and weights $\left(W_j\right)$ for each criterion werecalculated as shown in Table 4.

Criteria	Entropy value $\left(E_j\right)$	Entropy weight $\left(W_j\right)$
Morningstar weighted point	1.243136	0.307845
Sharpe weighted point	0.891585	0.220789
Treynor weighted point	1.033546	0.255943
Jensen weighted point	0.869916	0.215422

Table 4. Entropy values $\left(E_j\right)$ and weights $\left(W_j\right)$ for each evaluation criteria

The findings presented in Table 4 above show that the entropy weights based on the different evaluation criteria were close to each other. The weights based on the Morningstar rating system were found to be the highest leading to the assumption of Morningstar as the most significant evaluation criteria. Jensen ratio was found to have the least weights prompting assumption of its weakness as evaluation criteria for equity funds. Finally, the value of each equity fund $\left(L_w\right)$ was computed and ranked as highlighted in Table 5 below.

Equity Funds	Value $\left(L_w\right)$	Ranking
Ak Asset Management America Foreign Equity Fund	1,402621	56
Ak Asset Management Europe Foreign Equity Fund	1,471126	53
Ak Asset Management Asia Foreign Equity Fund	1,516942	45

Ak Asset Management BIST 30 Index Equity Fund (Equity Intensive Fund)	1,568346	20
Ak Asset Management BIST Banks Index Equity Fund (Equity Intensive Fund)	1,587197	4
Ak Asset Management BRIC Countries Foreign Equity Fund	1,507607	46
Ak Asset Management Equity Fund (Equity Intensive Fund)	1,574065	11
Ak Asset Management Foreign Equity Fund	1,465676	54
Ata Portfolio First Equity Fund (Equity Intensive Fund)	1,523178	44
Azimut PYŞ First Equity Fund (Equity Intensive Fund)	1,526375	42
Bizim Portfolio Energy Sector Participation Equity Fund (Equity Intensive Fund)	1,57504	10
Bizim Portfolio Construction Industry Participation Equity Fund (Equity Intensive Fund)	1,54372	36
Deniz Portfolio BIST 100 Index Equity Fund (Equity Intensive Fund)	1,570483	15
Deniz Portfolio Equity Fund (Equity Intensive Fund)	1,563529	25
Finans Portfolio BIST 30 Index Equity Intensive Fund Exchange Traded Fund	1,56876	17
Finans Asset Management First Equity Fund	1,542249	38
Finans Asset Management Dow Jones İstanbul 20 (Equity Intensive) Exchange Traded Fund	1,564664	23
Finans Asset Management Second Equity Fund	1,547307	35
Finans Asset Management Turkey Large-Cap Banks (Equity Intensive) Exchange Traded Fund	1,611662	2
Fokus Asset Management Equity Fund (Equity Intensive Fund)	1,527103	41
Garanti Asset Management BIST 30 Index Equity Fund (Equity Intensive Fund)	1,576842	8
Garanti Asset Management Equity Fund (Equity Intensive Fund)	1,54881	34
Gedik Asset Management First Equity Fund (Equity Intensive Fund)	1,562302	28
Gedik Asset Management G-20 Countries Foreign Securities (Equity Intensive Fund)	1,41159	55
Gedik Asset Management Second Equity Fund (Equity Intensive Fund)	1,483426	51
Global MD Asset Management First Equity Fund (Equity Intensive Fund)	1,580536	6
Global MD Asset Management Second Equity Fund (Equity Intensive Fund)	1,583647	5
Halk Asset Management Equity Fund (Equity Intensive Fund)	1,562333	27
HSBC Asset Management BIST 30 Index Equity Fund (Equity Intensive Fund)	1,577772	7
HSBC Asset Management Equity Fund (Equity Intensive Fund)	1,56098	29
ING Asset Management First Equity Fund (Equity Intensive Fund)	1,57242	13
İş Asset Management Dividend Paying Corporations Share Fund (Equity Intensive Fund)	1,568706	18
İstanbul Portfolio Equity Intensive Fund (Equity Intensive Fund)	1,554046	32
İş Asset Management BIST-30 Index Share Fund (Equity Intensive Fund)	1,575108	9
İş Asset Management BIST 30 equity intensive Exchange investment fund	1,568286	21

İş Asset Management BIST Bank Index Share Fund (Equity Intensive Fund)	1,590875	3
İş Asset Management BIST Technology Capped Index Share Fund (Equity Intensive Fund)	1,384472	57
İş Asset Management Share Fund (Equity Intensive Fund)	1,570112	16
İş Asset Management İş Bank Subsidiaries Fund (Equity Intensive Fund)	1,524021	43
İş Asset Management Participation Share Fund (Equity Intensive Fund)	1,543436	37
İş Portfolio Banking Private Equity Fund (Equity Intensive Fund)	1,563628	24
Kare Asset Management Equity Fund (Equity Intensive Fund)	1,495966	49
Qinvest Asset Management Equity Fund (Equity Intensive Fund)	1,54147	39
Strateji Asset Management Second Equity Fund (Equity Intensive Fund)	1,501294	48
Strateji Asset Management Second Equity Fund (Equity Intensive Fund)	1,479225	52
Şeker Asset Management Equity Fund (Equity Intensive Fund)	1,55172	33
Tacirler Asset Management Equity Fund (Equity Intensive Fund)	1,504807	47
TEB Asset Management Equity Fund (Equity Intensive Fund)	1,559298	31
Vakıf Asset Management BIST 30 Index Equity Fund (Equity Intensive Fund)	1,573768	12
Yapı Kredi Asset Management BIST 30 Index Equity Fund (Equity Intensive Fund)	1,568154	22
Yapı Kredi Asset Management BIST 100 Index Equity Fund (Equity Intensive Fund)	1,568682	19
Yapı Kredi Asset Management First Equity Fund (Equity Intensive Fund)	1,562843	26
Yapı Kredi Asset Management Koc Holding Affiliate and Equity Fund (Equity Intensive Fund)	1,485724	50
Yapı Kredi Asset Management Foreign Technology Sector Equity Fund	1,816721	1
Ziraat Asset Management BIST 30 Index Equity Fund (Equity Intensive Fund)	1,571666	14
Ziraat Asset Management Equity Fund (Equity Intensive Fund)	1,559821	30
Ziraat Asset Management Dividend Paying Corporations Equity Fund (Equity Intensive Fund)	1,531766	40

Table 5. Value of each equity funds $\left(L_w \right)$ and ranking

According to the findings in Table 5, Yapı Kredi Asset Management Foreign Technology Sector Equity Funds had the highest L_w value and ranked in the first position followed, respectively, by Finans Asset Management Turkey Large-Cap Banks (Equity Intensive) Exchange Traded Fund and İş Asset Management BIST Bank Index Share Fund (Equity Intensive Fund). On the other hand, İş Asset Management BIST Technology Capped Index Share Fund (Equity Intensive) Fund had the lowest L_w value and ranked in the last position.

Conclusion

In this study, SVNS entropy-based decision making is used to rank equity funds traded in Turkey under incomplete, indeterminate and inconsistent information by using four evaluation criteria. To the best of our knowledge, it is the first study in evaluating equity funds traded in Turkey from the neutrosophic set perspective. According to the entropy weights results, Morningstar rating was found to be the most significant evaluation criteria. This indicates the importance of Morningstar weighted scores for equity funds traded in Turkey. On the contrary, Jensen-based weighting was found to be the least significant evaluation criteria for equity funds. Yapı Kredi Asset

Management Foreign Technology Sector Equity Fund had the highest L_w value and ranked first, followed by Finans Asset Management Turkey Large-Cap Banks (Equity Intensive) Exchange Traded Fund and İş Asset Management BIST Bank Index Share Fund (Equity Intensive Fund). On the other hand, İş Asset Management BIST Technology Capped Index Share Fund (Equity Intensive) Fund had the lowest L_w value and ranked in the last position.

In future studies we suggest the use of other neutrosophic logic-based techniques and normalization methods (out of vector normalization) to analyze this concept. SVNS based entropy technique may also be applied in evaluating equity funds of different countries by considering other criteria. This methodology may also be applied to different sectors.

References

[1] Abdel-Basset, M., Manogaran, G., Gamal, A. and Smarandache, F. (2018). A hybrid approach of neutrosophic sets and DEMATEL method for developing supplier selection criteria, Design Automation for Embedded Systems, 1-22.

[2] Abdel-Basset, M., Mohamed, M. and Smarandache, F. An extension of neutrosophic AHP-SWOT analysis for strategic planning and decision making, Symmetry, 10(4),116

[3] Altıntaş, K.M. Türk özel emeklilik fonlarının risk odaklı yönetim performansı: 2004-2006 dönemine ilişkin bir analiz. Anadolu Üniversitesi Sosyal Bilimler Dergisi, 8(2008), 85-110.

[4] Bayramoğlu, M.F., and Yayalar, N. Portföy Seçiminde Toplam Riski Temel Alan Portföy Performans Ölçütlerinin Değerlendirilmesi. Abant İzzet Baysal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 17(2017), 1-28.

[5] Biswas, P., Pramanik, S., and Giri, B.C. Some Distance Measures of Single Valued Neutrosophic Hesitant Fuzzy Sets and Their Applications to Multiple Attribute Decision Making, In New Trends in Neutrosophic Theory and Applications, F. Smarandache and S. Pramanik (Ed.), Pons Publishing House, Brussels, (2016a), 27-34.

[6] Biswas, P., Pramanik, S. and Giri, B.C. TOPSIS method for multi-attribute group decision making under single-valued neutrosophic environment. Neural Computing and Applications, 27(2016b), 727-737.

[7] Blake, C.R. and Morey, M.R. Morningstar ratings and mutual fund performance. The Journal of Financial and Quantitative Analysis, 35(2000), 451-483.

[8] Gökgöz, F. and Günel, M.O. Türk yatırım fonlarının portföy performanslarının analizi. Ankara Üniversitesi Sosyal Bilimler Dergisi, 3(2012), 3-25.

[9] Hussain, A.N., Mohamed, M., Abdel-Baset, M. and Smarandache, F. Neutrosophic Linear Programming Problems, In Neutrosophic Operational Research, F. Smarandache, M. Abdel-Baset and Y.Q. Zhou (Ed.), Volume 1, Pons Publishing House, Brussels, (2017), 15-27.

[10] Jensen, M.C. The performance of mutual funds in the period 1945-1964. The Journal of Finance, 23(1968), 389-416.

[11] Kök, D., and Erikçi, M.E. Türkiye'de A tipi yatırım fonlarının performansı: 2004-2013 dönemi analizi. Pamukkale İşletme ve Bilişim Yönetimi Dergisi, 2(2015), 15-26.

[12] Liu, P., and Wang, Y. Multiple attribute decision making method based on single-valued neutrosophic normalized weighted Bonferroni mean. Neural Computing and Applications, 25(2014), 2001-2010.

[13] Mondal, K. and Pramanik, S. Multi-criteria group decision making approach for teacher recruitment in higher education under simplified Neutrosophic environment. Neutrosophic Sets and Systems, 6 (2014), 28-34.

[14] Mondal, K. and Pramanik, S. Neutrosophic decision making model of school choice. Neutrosophic Sets and Systems, 7 (2015), 62-68.

[15] Mondal, K., Pramanik, S., and Smarandache, F. Several Trigonometric Hamming Similarity Measures of Rough Neutrosophic Sets and their Applications in Decision Making, In New Trends in Neutrosophic Theory and Applications, F. Smarandache and S. Pramanik (Ed.), Pons Publishing House, Brussels, (2016), 93-103.

[16] Nirmal, N.P., and Bhatt, M.G. Selection of Automated Guided Vehicle Using Single Valued Neutrosophic Entropy Based Novel Multi Attribute Decision Making, In New Trends in Neutrosophic Theory and Applications, F. Smarandache and S. Pramanik (Ed.), Pons Publishing House, Brussels, (2016), 105-114.

[17] Pramanik, S., Dalapati, S., and Roy, T.K. Neutrosophic multi-attribute group decision making strategy for logistic center location selection. In Neutrosophic Theory and Applications, F. Smarandache, M. A. Basset & V. Chang (Eds.), Vol. III. Pons Asbl, Brussels, 2018, 13-32.

[18] Seçme, O., Aksoy, M., and Uysal, Ö. Katılım Endeksi Getiri, Performans ve Oynaklığının Karşılaştırmalı Analizi. Muhasebe ve Finansman Dergisi, (2016), 107-128.

[19] Sharpe, W.F. Mutual fund performance. The Journal of Business, 39(1966), 119-138.

[20] Smarandache, F. A unifying field in logics, neutrosophy: neutrosophic probability, set and logic. American Research Press, Rehoboth, (1998).

[21] Smarandache, F. and Pramanik, S. (Eds). New trends in neutrosophic theory and applications. Vol 2, Brussels: Pons Editions, (2018).

[22] Uyar, U., and Gökçe, A. 2008 küresel ekonomik krizinin bankacılık hisse senetleri performansı üzerine etkisi. Finansal Araştırmalar ve Çalışmalar Dergisi, 7(2015), 209-225.

[23] Wang, H., Smarandache, F., Zhang, Y.Q., and Sunderraman, R. Single valued neutrosophic sets. Multispace and Multistructure, 4 (2010), 410-413.

[24] Wang, J., and Zhang, Z. Multi-criteria decision making method with incomplete certain information based on intuitionistic fuzzy number. Control and Decision, 24(2009), 226-230.

[25] Yıldız, A. Yatırım fonları performansının veri zarflama analizi yöntemiyle değerlendirilmesi. Ankara Üniversitesi SBF Dergisi, 61(2006), 211-234.

[26] Yolsal, H. A tipi yatırım fonlarının performansı: Banka ve aracı kurum fonları üzerine bir inceleme. Marmara Üniversitesi İktisadi ve İdari Bilimler Dergisi, 32(2012), 343-364.