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Neutrosophic Decision Making Model for Investment Portfolios Selection and Optimizing based on Wide Variety of Investment Opportunities and Many Criteria in Market

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Abstract: Investment portfolio selection is a difficult subject due to the presence of competing factors. Choosing a portfolio for one's investments is a major choice that may have far-reaching effects on one's financial well-being. Risk tolerance, time horizon, investing objectives, asset allocation, and investment selection are only a few of the factors that will be studied in this article. The Stable Preference Ordering Towards Ideal Solution (SPOTIS) technique is the basis for our proposed integrated multi-criteria decision-making (MCDM) model. This paper used the single-valued neutrosophic set as a framework to deal with uncertain data. The purpose of the suggested SPOTIS–Neutrosophic model is to choose the most promising investment possibilities by considering several financial variables. Because of the wide variety of investment opportunities and the many elements (political unpredictability, news, economic circumstances, etc.) that may affect the market, investors often worry about selecting and optimizing their investment portfolios.

Keywords: Decision making; Neutrosophic Set; Investment; Portfolio Section.

1. Introduction

The contemporary portfolio theory was proposed by Markowitz in the 1950s. The goal of this theory is to generate a desired return while limiting exposure to risk via the strategic allocation of a portfolio's resources. The mean-variance approach takes into account the covariance among pairs of assets in addition to the risk-return connection [1, 2].

While the mean-variance approach has gained widespread acceptance, other writers have explored the use of extra variables in portfolio construction by testing out different approaches that consider the large variety of investment opportunities that make up a portfolio and the many criteria that might be taken into consideration. The focus of these research efforts is on improving portfolio optimization and generating returns that are higher than the market reference. Multi-criteria decision-making (MCDM) techniques, which employ various parameters to rank or arrange options according to a mathematical basis for decision-making assistance, are a significant development in investment portfolio choice. In this study, we applied the Stable Preference Ordering Towards Ideal Solution (SPOTIS) method with the single-valued neutrosophic method [3, 4].

When making decisions in a complex setting, fuzzy numbers may be a useful aid. When Zadeh first created fuzzy sets (FSs), he set a precedent for their use in resolving ambiguous problems. Since FSs only store membership levels, they cannot be used to resolve more involved decision issues. Intuitionistic Fuzzy Sets (IFSs) were described by Atanassov, and they are ungraded since they include both membership and non-membership degrees [5, 6].

Despite expanding FSs' application, IFSs are not very precise when dealing with difficulties involving faulty and inconsistent data. Neutrosophic sets (NSs) were first defined by Smarandache in 1999, and they were inspired by IFSs. Non-conventional unit subintervals are used to define the levels of truth, falsehood, and indeterminacy. Wang et al., who also created the theory of single-valued neutrosophic sets (SVNSs), resolved the three functions to an ordinary unit interval subinterval for implementation simplicity [7, 8].

The SPOTIS technique features a straightforward algorithm that, like several MCDM approaches, calls for a decision matrix with options listed across the top and factors down the side, as well as a vector of weights for the criterion and indications of whether they are financially motivated or not. One of the primary premises of this approach is that you must know the upper and lower limits of each criterion's value to appropriately characterize the decision issue. This ensures that every criterion's value is contained inside the limits of the set [9, 10].

The SPOTIS technique uses a normalized distance to determine how far away each option is from the optimal answer. SPOTIS, like Characteristic Objects Method (COMET), makes use of reference items throughout the choice-making process. Thus, like COMET, SPOTIS is a distance-based technique, where alternatives' liking values are calculated based on the distance to the closest characteristic items and the values of those things [11]–[13]. This paper integrated the neutrosophic set with the SPOTIS method to compute the weights of criteria and rank the alternatives.

2. Portfolio Selection and MCDM

Markowitz established the current portfolio theory in 1952. The traditional mean-variance (MV) structure was an early example of portfolio choice. Portfolio choice is the challenge of allocating scarce resources among competing priorities. It is relevant to our daily lives and has promising future uses in fields like stock market investing, energy research, and portfolio management. Portfolio choice has benefited from a variety of academic studies, including those in the fields of behavioral finance, operational research, and smart optimization technology. When selecting a portfolio, traders often consider several different factors or goals, making the MCDM approach a helpful tool [14]–[17].

In operational research, MCDM is a burgeoning topic with the overarching goal of addressing decision-making issues using numerous criteria, particularly those involving choosing a portfolio. The MCDM structure allows for the consideration of various other critical financial factors, such as the return on investment and net profit margin, in addition to the two primary factors of return and risk [18]–[20]. In addition, MCDM benefits from taking individual investor tastes into account. Using the MCDM for the portfolio choice issue may lead to more accurate simulations. Two primary steps make up choosing a portfolio in the MCDM framework: company financial performance analysis and stock allocation [21]–[24].

Financial institutions, such as those who invest in mutual funds, pension plans, and government bonds, are naturally interested in how well companies are doing financially. The concept of value investing is congruent with this attribute. Firm financial ratios are a common measure of financial success. Investors may get valuable insight into the company's financial status, operational outcomes, and investment worth by perusing the financial statement. The financial achievements of businesses may be accurately described by combining all relevant financial parameters. This follows the multi-criteria decision-making paradigm, which makes the distribution of portfolios simpler [25]–[28].

3. SPOTIS Neutrosophic Decision-Making Model

SPOTIS stands for the recently discovered approach of Stable Preference Ordering Towards an Ideal Solution, which is used for formulating multi-criteria decisions. The primary goal of the presented method was to offer a novel approach that does not suffer from rank reversal (the phenomenon of flipping an order while adjusting the number of choices in the given data). The elaborate technique uses distance measuring and the concept of reference objects. The SPOTIS approach necessitates the declaration of data boundaries, compared to other MCDM methods like TOPSIS and VIKOR, where referent objects are formed from a decision matrix. When comparing ISPs with a linear distribution of variations, using data boundaries to find the ISP with the lowest variant count stops rankings from switching places [29, 30]. The SPOTIS is integrated with the single-valued neutrosophic set in this study as shown in Figure 1.

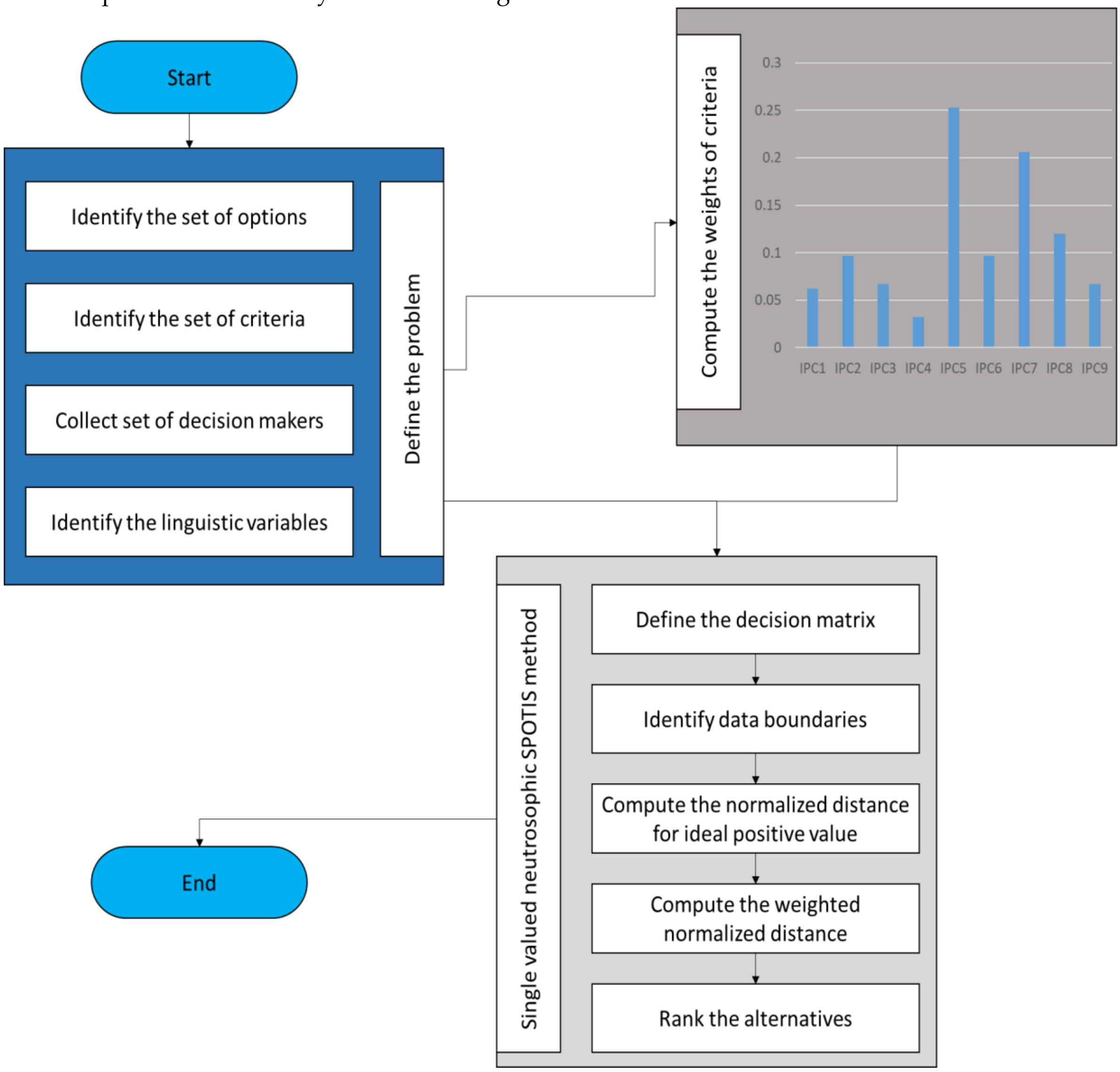

Figure 1. Single valued neutrosophic SPOTIS Methodology.

Step 1. Define the decision matrix. The decision matrix between criteria and alternatives is built by the decision-makers and experts.

Setp 2. Identify data boundaries. The ideal positive value for positive and negative criteria is identified as:

$$f_j^* = f_j^{max} \quad (1)$$

$$f_j^* = f_j^{min} \quad (2)$$

Where $j = 1,2, \ldots n; i = 1,2, \ldots m$ refer to the criteria and alternatives.

Step 3. Compute the normalized distance for the ideal positive value.

$$t_{ij}(X_i, f_j^*) = \frac{|f_{ij} - f_j^*|}{|f_j^{max} - f_j^{min}|} \quad (3)$$

Step 4. Compute the weighted normalized distance

$$t_{ij}(X_i, f^*) = \sum_{j=1}^{N} w_j t_{ij}(X_i, f_j^*) \quad (4)$$

Step 5. Rank the alternatives. The alternatives are ranked based on the lowest value of $t_{ij}(X_i, f^*)$.

4. Application in Investment Portfolio Selection

A person or organization's investment portfolio consists of the many securities it owns, such as stocks, bonds, mutual funds, and other debt and equity instruments. A portfolio of investments is assembled for the dual purposes of spreading out financial exposure and, hopefully, yielding a profit. Investment portfolio advantages consist of:

Management of risk and mitigation of the negative effects of market volatility may be achieved by diversification among diverse types of assets. Possibility of profit Capital appreciation, dividends, and interest all contribute to the ROI potential of a diversified investment portfolio. Investing portfolios are adaptable because their holdings may be changed when market circumstances and personal priorities shift. Effective tax planning allows investors to reduce their tax bill and boost their after-tax earnings.

Investment portfolio nine criteria include:

When putting up a portfolio, it is important to consider the investor's risk tolerance.

When deciding which assets to include in a portfolio, it is important to consider the investor's time horizon.

Portfolio construction should consider the investor's investing objectives, such as income creation or capital appreciation.

Diversification and risk management goals may be accomplished by careful planning of an investment portfolio's asset allocation among several asset classes including stocks, bonds, and cash. Assets, like stocks or mutual funds, should be chosen after careful consideration of their past performance, current management, and associated costs. Volatility and market value are also criteria of the portfolio.

We used nine criteria and ten alternatives in this paper. The experts evaluated the criteria and alternatives to build the decision matrix. Then we replace their opinions by using single-valued neutrosophic numbers. Then compute the normalization decision matrix by using Eq. (3) as shown in Table 1. Then compute the weights of the criteria by using the average method. Then multiply the weights of criteria by the normalization decision matrix to obtain the weighted normalized decision matrix as shown in Table 2. Then rank the alternatives by the distance of the ideal positive value as shown in Table 2. Alternative one is the best and alternative two is the worst.

Table 1. The normalized distance for the ideal positive value.

	IPC_1	IPC_2	IPC_3	IPC_4	IPC_5	IPC_6	IPC_7	IPC_8	IPC_9
IPA_1	0.846768	0.817056	0.844603	0.999181	0	0	0.999733	0	0.950372
IPA_2	0.847985	1	0.844603	0.664393	1	1	0.999966	0.995493	1
IPA_3	0.668109	0	1	0.545703	0.818306	0.849624	0.99991	1	0
IPA_4	0.009467	0.09216	0.710558	0.844611	1	1	0	0.904011	0.997767
IPA_5	0.820936	0.541953	0.844603	0.818554	0.818306	1	0.999966	0.89635	0.950372
IPA_6	1	1	0.829181	0.845839	0.375683	1	0.999966	0.89635	0.997767
IPA_7	0.668109	0.97249	0.836062	0	0.375683	0.75188	0.999966	0.995493	0.957816
IPA_8	0	0.817056	0	0.222374	0.554645	0	1	0.995493	1
IPA_9	0	0.969739	0.844603	1	0.699454	0.834586	0.999826	0.995493	1
IPA_{10}	0.144712	0.149931	0.132859	0.364256	0.553279	0	0.999966	0.995493	0.679901

Table 2. The weighted normalized distance for the ideal positive value.

	IPC_1	IPC_2	IPC_3	IPC_4	IPC_5	IPC_6	IPC_7	IPC_8	IPC_9	Rank Score
IPA_1	0.052452	0.078834	0.056537	0.032292	0	0	0.206252	0	0.063617	0.489984
IPA_2	0.052528	0.096486	0.056537	0.021472	0.253112	0.096486	0.2063	0.118931	0.066939	0.96879
IPA_3	0.041386	0	0.066939	0.017636	0.207123	0.081977	0.206288	0.11947	0	0.740818
IPA_4	0.000586	0.008892	0.047564	0.027297	0.253112	0.096486	0	0.108002	0.066789	0.608727
IPA_5	0.050852	0.052291	0.056537	0.026455	0.207123	0.096486	0.2063	0.107087	0.063617	0.866746
IPA_6	0.061944	0.096486	0.055504	0.027336	0.09509	0.096486	0.2063	0.107087	0.066789	0.813022
IPA_7	0.041386	0.093831	0.055965	0	0.09509	0.072546	0.2063	0.118931	0.064115	0.748163
IPA_8	0	0.078834	0	0.007187	0.140387	0	0.206307	0.118931	0.066939	0.618585
IPA_9	0	0.093566	0.056537	0.032319	0.17704	0.080526	0.206271	0.118931	0.066939	0.832128
IPA_{10}	0.008964	0.014466	0.008893	0.011772	0.140041	0	0.2063	0.118931	0.045512	0.55488

5. Conclusion

Choosing an investing portfolio is an involved procedure that must take many factors into account. Investors may create a balanced and diversified portfolio that meets their specific requirements and goals by considering their risk tolerance, time horizon, investing goals, asset allocation, and investment selection. A well-diversified investment portfolio may help you reach your long-term financial goals by reducing your risk exposure, increasing your earnings potential, giving you more options, and reducing your tax liability. Investors should frequently evaluate their holdings and update better suit their current situation and long-term objectives. This paper analysis the criteria of investment portfolio selection and rank the alternatives based on the MCDM methodology. The paper used the SPOTIS MCDM methodology to rank the alternatives. The SPOTIS method is integrated with the single-valued neutrosophic set to rank the alternatives.

Data availability

The datasets generated during and/or analyzed during the current study are not publicly available due to the privacy-preserving nature of the data but are available from the corresponding author upon reasonable request.

Conflict of interest

The authors declare that there is no conflict of interest in the research.

Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

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