

EXPLOITING THE DECISION-MAKING TECHNIQUE TO EXPLORE THE RELATIONSHIP BETWEEN THE FANCIAL FACTORS AND THE STOCK PREFERECE

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Abstract

When investing in stocks, the investors have to consider a number of financial and nonfinancial factors simultaneously. This fact makes the investors difficult to make a decision on which stocks to invest. Due to the difficulty in obtaining real data, we take the financial factors only into consideration and are concerned with exploring the relationship between the financial factors and the stock preference. To this end, we employed a factor analysis and VARIMAX technique to classify 16 financial factors into several groups and then determined a preference ordering of the stocks listed in KOSPI using Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) which is one of the multiple attribute decision-making techniques for each industry. Since we are restricted to the page numbers, in this paper we will present only one industry case to demonstrate what we would like to intend.

Keywords

Multiple attribute decision-making, TOPSIS, Korean stock price index, preference ordering

1. Introduction

Generally speaking, making a decision on determining which stocks to invest asks an investor to simultaneously take into consideration of a number of financial and nonfinancial factors affecting a stock price. Such an investment decision is to some extent extremely difficult to make. In this paper, we employed the TOPSIS technique with which we considered only the financial factors due to the availability of obtaining relevant data.

The TOPSIS technique is generally to be conceived as one of the powerful decision-making techniques to effectively deal with multiple-attribute decision-making problems. To properly use the technique, we need to classify 16 financial ratios into several groups using a factor analysis. The reason for performing the factor analysis is that the financial ratios usually involve the subordinate relationship among them. For instance, the ratio of net income to net sales which is net income over sales, the total asset turnover ratio which is sales over total asset and the total rate of return which is net income over total asset measures different financial property. However the ratios above have very close correlation and can be formularized as:

$$\text{Total rate of return} = \text{ratio of net income to net sales} \times \text{total asset turnover ratio}$$

With the classified financial ratios which were performed for each industry, we determined the preference ordering of the stocks with the TOPSIS technique. Thereafter, we implemented a comparison analysis for the preference ordering determined by between the general four financial classifications and the TOPSIS technique to explore the relationships involved into them. The four financial classifications are: i) a stability analysis, ii) a profitability analysis, iii) a activity analysis, and iv) a market value analysis. The detail of the four classifications will be described in the following sections.

The next will be organized as followings: In section 2, we describe the decision-making framework for a stock investment. Section 3 focuses on determining the best stock alternative using the TOPSIS technique. Section 4 is oriented with determining the preference ordering of the stocks based on the four financial classifications. In section

5, we compare the TOPSIS results with the financial analysis results. In this section, we intend to explore the relationship between the results of the two analyses.

2. The Decision-Making Framework for a Stock Investment

The decision-making framework for a stock investment that we propose in this paper is to some extent complicated. Figure 1 shows the conceptual framework we will take to determine the preference ordering of a stock investment. The explanation of each step will be omitted here due to a limited number of pages. Figure 2 presents the flowchart about how to progress the comparison of the results of the preference ordering of the stocks determined by the TOPSIS technique and the financial analysis.

For this study, the scope of the work will be confined to the stocks listed in KOSPI more than 5 years. We took 69 out of 105 industry classifications, which include more than 2 companies.

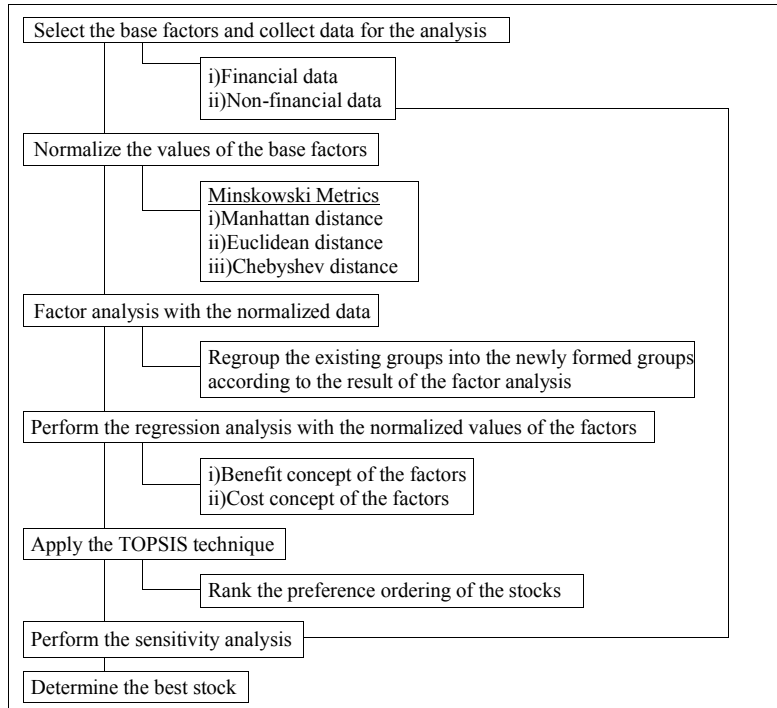


Figure 1: The decision-making framework for a stock investment

• 2.1 The Selection of the Base Factors and Data Collection for the Alternative Analysis

The base factors selected appropriate for the analysis are identified as a group consisting of the factors measured in a monetary term and the other being composed of the non-monetized factors. It is assumed that all the factors including the non-monetized factors can be quantified in a numeric value. The work is required to properly implement the TOPSIS technique which is employed to determine the preference ordering of the stocks.

• 2.2 Transform the Raw Data into the Normalized Data

The data collected has in general a different measuring unit and also conflicts each other, so we need to normalize the raw data such that we may be allowed to compare one with another alternative. To this end, we will use the Minkowski's l_p metrics which is defined between two points x_1 and x_2 in n -dimensional space as

$$d_p = \left\{ \sum_{j=1}^n |x_j^1 - x_j^2|^p \right\}^{1/p}, \quad p \geq 1 \quad (1)$$

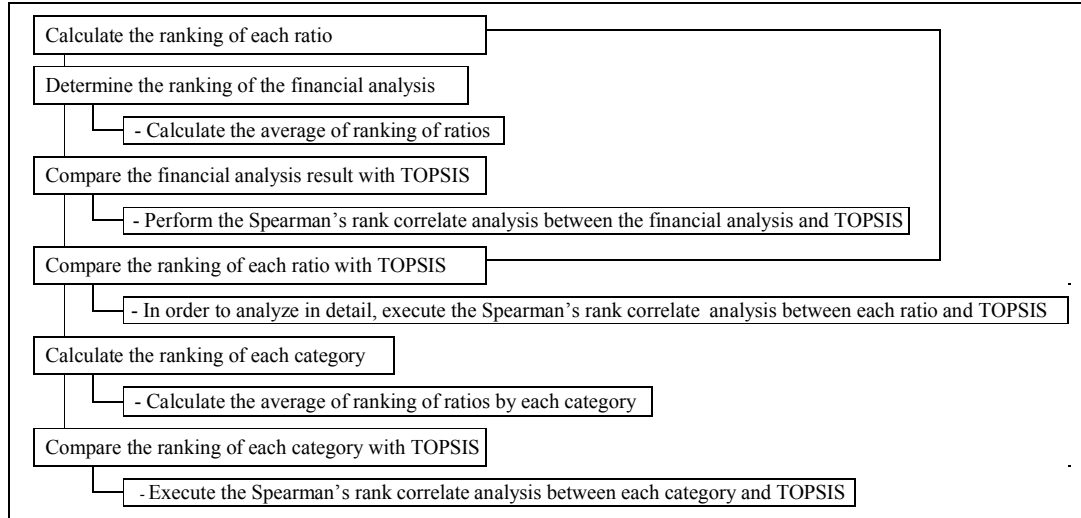


Figure 2: The procedure of comparing results of the two techniques and exploring the relationship between them

In Equation (1), “ p ” may take one among 1, 2 and infinity. Yoon maintains that there is not a confirmed value of “ p ” for a specific decision problem. So, without any conflict, we will take “2” for the value of “ p ” for our purpose of the analysis. So, we obtained the normalized values using

$$r_{ijk} = \frac{x_{ijk}}{\sqrt{\sum_{i=1}^l \sum_{j=2001}^m x_{ijk}^2}} \quad (2)$$

where, i : a company index for $i=1,2,\dots,l$
 j : a year index for $j=1,2,\dots,m$
 k : a base factor index for $k=1,2,\dots,n$
 x_{ijk} : data if the k^{th} factor for company i and period j

• 2.3 A Factor Analysis

Implementing the factor analysis with the normalized values of the factors, we identified the factors having the same effect on the stock price and put them into one group. And the newly calculated value is assigned to the factors. Table 1 shows the result of the factor analysis for the communication and broadcasting equipment manufacturing companies and the right-side of the table indicates six factors whose values of eigenvector are greater than or equal to “1”. Those six factors were newly obtained from 16 independent variables based on the VARIMAX technique.

Table 1: The result of the factor analysis with eigenvector being greater than 1

Component	Initial Eigenvalue			Total Explained Variance			Rotation Sums of Squared Loadings		
	Total	%Variance	%Cumulative	Value	% Variance	%Cumulative	Value	% Variance	%Cumulative
1	4.335	27.091	27.091	4.335	27.091	27.091	3.672	22.953	22.953
2	3.096	19.349	46.440	3.096	19.349	46.440	3.062	19.135	42.088
3	2.118	13.239	59.680	2.118	13.239	59.680	2.150	13.440	55.528
4	1.576	9.851	69.531	1.576	9.851	69.531	2.055	12.841	68.369
5	1.061	6.632	76.163	1.061	6.632	76.163	1.189	7.434	75.803
6	1.014	6.340	82.504	1.014	6.340	82.504	1.072	6.700	82.504
7	.893	5.582	88.086						
8	.612	3.827	91.913						
9	.482	3.014	94.926						
10	.307	1.918	96.844						
11	.271	1.693	98.538						
12	.117	.732	99.270						
13	.070	.440	99.709						
14	.028	.175	99.884						
15	.010	.065	99.949						
16	.008	.051	100.000						

Extraction Method: Principal Component Analysis

• 2.4 Calculate the Factor Value Using a Principal Component Analysis

The new values of the factors were obtained based on the factor analysis with the use of the principal component analysis embedded in SPSS. In more detail, it could be said that the values of the factors was calculated in a linear combination on the basis of the responses of the variables observed. And it is given by (3).

$$x_{ijk} = A_{ij1}Z_{ij1} + A_{ij2}Z_{ij2} + \dots + A_{ijk}Z_{ijk} + U_{ij} \quad (3)$$

where, A_{ijk} : a variable for combining k factors
 Z_{ijk} : k^{th} common factor for the i^{th} company in the j^{th} period
 U_{ij} : a factor related to the variable of x_{ij} only

The values of the factors which were not observed can be derived in a linear combination using (3) and the values of the factor for a specific year of each company can be estimated with (4).

$$F_{ijk} = \sum_{i=1}^l \sum_{j=2001}^m W_{ijk} X_{ijk} \quad (4)$$

where, W_{ijk} : a coefficient of the k^{th} factor for the i^{th} company in the j^{th} period

• 2.5 The Regression Analysis with the Values of the Factors

We performed the regression analysis and reliability test with the new values of the factors which we came by through the factor analysis. The main purpose of the work was to discriminate the factors in the group between a benefit concept and a cost concept. The factor with the positive value represents the benefit concept while one with the negative value does the cost concept.

The non-normalized values of the factors with a positive value might be identified as a factor of the benefit concept to the stock price. On the contrary, the factor with a negative value was regarded as the factors of the cost concept.

The estimating function for a stock price is as in (5).

$$y_{ijk} = \beta_0 + \beta_1 F_{ij1} + \dots + \beta_5 F_{ij5} \quad (5)$$

where,

β_k : a non-normalized value of the k^{th} factor

F_{ijk} : a value of the k^{th} factor for the i^{th} company in the j^{th} period

3. Determine the Best Alternative Using the TOPSIS Technique

We would present how to select the best alternative for the stock investment based on the TOPSIS technique. The TOPSIS was developed based upon the concept that the chosen alternative should have the nearest distance from the ideal solution and the farthest from the negative-ideal solution.

Due to a number of pages limited, we ruled out explaining the procedure of the TOPSIS technique here and presented the results in Table 2. What we did in this paper was to group the factors similarly affecting the stock prices by using the factor analysis for the normalized values of the actors and distinguish the factors into either those with the benefit concept or the cost concept using regression analysis. And finally, we applied the TOPSIS to determine the best stock to invest and also obtained the useful information on the preference ordering of the stocks.

Table 2 shows the result of applying TOPSIS for the stocks of the companies in the communication and broadcasting equipment manufacturing industry. As shown in the table, Samsung Electronics company is ranked as the best stock with the greatest value of $C_i^* = 0.855031$. And the rest of the preference order is as following: (2) LG Electronics, (3) DONGWON SYSTEMS, and Huneed Technologies company in the descending order.

Table 2: The relative closeness value of each company in the communication and broadcasting equipment manufacturing industry (the TOPSIS result)

Number	Company	C_i^*	Ranking	Number	Company	C_i^*	Ranking	Number	Company	C_i^*	Ranking
1	Optimus	0.423826	7	4	Kedcom	0.530545	5	7	Samsung Electronics	0.855031	1
2	DONGWON SYSTEMS	0.567794	3	5	LG Electronics	0.641904	2	8	GS Instruments	0.441609	6
3	DAIDONG ELECTRONICS	0.359001	8	6	Huneed Technologies	0.545985	4				

4. Financial Analysis

The company must announce publicly the financial statements every one year. And the investors evaluate the value of the company from the financial statements to determine the investment alternative.

We analyzed the financial ratios divided to the four categories the followings stability analysis, profitability analysis, activity analysis, market value analysis. Table 3 shows the classification of the financial analysis and presents the definition of the each category. We introduce a short and simple definition of each ratio classification instead of explaining it in detail.

Table 3: The classification of the financial analysis

Basic classification	Definition	Financial affair ratio
Stability analysis	-The measuring indices of the ability of repay the short-term debt	Current ratio, Quick ratio, Debt ratio, Equity ratio
Profitability analysis	-The evaluating indices of the ability of the produce profit.	Return on total assets, Return on equity, Sales margin, Ordinary margin, Net profit margin
Activity analysis	-The measuring indices of the physical utilization of the total asset and inventory etc.	Total asset turnover, Inventory turnover, Fixed asset turnover
Market value analysis	-The ratios which are associated with the share price in stock market. -This ratios can measure the company performance because these reflect both the risk and rate of return.	Book value per share, Earnings per share, Price to equity ratio, Price to earnings ratio

A stability analysis measures the company's ability to repay the short-term debt. Also, this analysis figure out which the company has the enough ability to respond about a business fluctuations or a sudden change in market condition. Company's profitability has been the driving force of the company's continued growth as well as development. The profitability measures to the profitability ratios which are the molecules in the profit items and the denominator in the investment or revenue items. Thus, the profitability ratios are indices to measure some degree of the increase of the operating performance using the raised capitals from the shareholders and creditors. And we can know how the companies effectively perform the activities such as production, sales and financing.

Activity ratios which are calculated to sales by dividing major assets measure that the companies are efficiently using the resources including inventories, current assets and fixed assets. From here, turnover means the physical efficiency which does not indicate monetary result caused by efficient use of assets. Market value ratios express that the company's financial situation and operating performance obtained from the result of the decision making are evaluated how in the stock market. In efficient capital markets, the stock price contains all kinds of available published information, so the market value ratios can be comprehensive indices because the risk and profitability is evenly reflected.

Now, we would present how to select the best alternative for the stock investment based on the financial analysis. To determine the ranking of financial analysis is divided into two steps. First, we determine the preference ordering of stock each affair ratio. Second, we simply calculate the arithmetic mean about these rankings. There is the preference ordering of stock with financial analysis.

Table 4 shows the result of applying financial analysis for the stocks of the companies in the communication and broadcasting equipment manufacturing industry.

Table 4: The ranking of a financial analysis in the communication and broadcasting equipment manufacturing industry

Number	Company	Ranking	Number	Company	Ranking	Number	Company	Ranking
1	Optimus	6	4	Kedcom	8	7	Samsung Electronics	1
2	DONGWON SYSTEMS	4	5	LG Electronics	2	8	GS Instruments	7
3	DAIDONG ELECTRONICS	3	6	Huneed Technologies	5			

5. Compare the TOPSIS Result with the Financial Analysis Result

The companies must announce publicly the financial statement every one year. And the investors evaluate the value of the companies from the financial statement to determine the best investment alternative. The financial analysis is fundamental method which decides the best investment alternative, in the same way TOPSIS is one of the decision-making techniques selecting the best stock. So, we will analyze that the financial analysis compare with the result of TOPSIS.

• 5.1 A Comparisons of the Financial Analysis Result and TOPSIS Result

As shown before, we determined the order of priority of the investment alternative using TOPSIS and financial analysis. In this section, we will make comparison between TOPSIS result and financial analysis result.

First, we drew the histogram about the ranking of the alternatives. Fig. 3 shows the preference ordering of the TOPSIS and the financial analysis. As seen in this figure, the TOPSIS result presents a quite different result from a financial analysis result in the communication and broadcasting equipment manufacturing industry.

We executed the Spearman's rank correlate analysis in order to evaluate measurably the relationship between financial analysis result and TOPSIS result. For more accurate analysis, we executed the Spearman's rank correlate analysis between each category result and TOPSIS result. The Spearman's rank correlation coefficient is used to analyze relationship between two continual variables, if they are the criterion of the rank. The Spearman's rank correlation coefficient can have the values from "-1" to "1". If the value is "1", it means that they have same order of ranking, on the other hand, the value is "-1", it shows that they have completely reversed order.

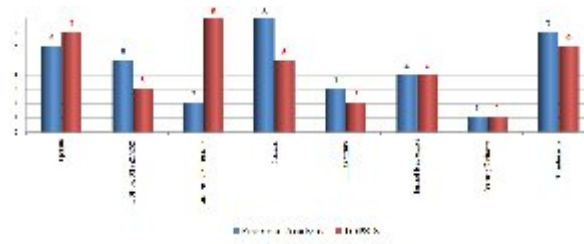


Figure 3: Financial analysis and TOPSIS in the communication and broadcasting equipment manufacturing industry

As mentioned above, we can divide the affair ratios into the four categories which the following: (1) stability analysis, (2) profitability analysis, (3) activity analysis, (4) market value analysis. So, we perform the Spearman's rank correlation analysis to test whether between each category of the financial analysis and TOPSIS have correlation. The procedure is same as correlation analysis with financial analysis and TOPSIS. Namely, we calculate the arithmetic mean about the each category and carry out the Spearman's rank correlation analysis with TOPSIS.

Before the Spearman's rank correlation analysis, we draw the histogram about the each category and TOPSIS. Fig. 4 shows that histograms for the communication and broadcasting equipment manufacturing industry.

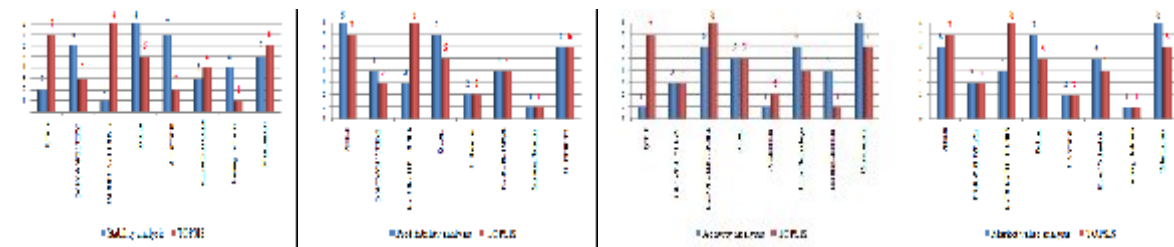


Figure 4: The ranking of each category and TOPSIS in the communication and broadcasting equipment manufacturing industry

Table 5: Spearman's rank correlation coefficient between financial analysis and TOPSIS

	Financial analysis	Stability	Profitability	Activity	Market value
TOPSIS	0.4	-0.4	0.3	0.3	0.5

Table 5 shows the results of Spearman's rank correlation analysis. According to Table 5, the correlate coefficient is "0.4" between financial analysis and TOPSIS. From this figure, we can observe there are scarcely relation between financial analysis result and TOPSIS result. For more accurate analysis, we execute the Spearman's rank correlate analysis between 4 categories and TOPSIS. It appears in Table 5. In all categories, the correlation coefficients are under "0.5". Consequently, all categories have little relation with TOPSIS.

6. The concluding remarks

In this study, we present one unique method when choosing the best-investment-alternative, so called TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) to make a determination of the order of priority between stocks. Then, we compare the financial analysis result with TOPSIS result to figure out the relation between two.

As a result of correlation analysis, we know the financial analysis is low correlation with TOPSIS. It means the ranking of financial analysis is not agree to the ranking of TOPSIS.

We use the same base factors to determine the preference order in the stock market. However, the result of ranking is not equal. We can describe a reason of this. It is caused by how to analyze used financial ratios. Even if the base factors are equal, they go through different steps.

We can explain the differences between two methods through two. First, we can be explained depending on whether we conduct the factor analysis. In case of TOPSIS, we execute the factor analysis to reduce the number of factors by grouping the factors which are same effect on stocks. On the contrary, the financial analysis uses all financial ratios which we selected the base factors. Second, we can describe contingent upon whether to apply

weight value in the stocks. When we carry out the financial analysis, we apply the same weight in each factor. In contrast, to select the best alternative using TOPSIS, we apply different weight according to degree of effect on stock price.

We regrettably can't say which one is better the other, because we can't set up the financial analysis as benchmarking base to compare with others. Thereby we lost the opportunity to help readers more sensibly understand things presented in this paper. So, we need to find out the sound and acceptable benchmarking base which will be the following research. Moreover, it is asked to perform ranking all of the stocks listed in KOSPI with a variety of MADM techniques and adopt estimating a Spearman rank correlation coefficient to test the ability to similarly rank the stocks.

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