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Full Length Research Paper

Using the multiple criteria decision making (MCDM) to evaluate the Fama-French three factors model

Shao-Bin Lin and Yi-Fang Hsieh*

Graduate Institute of Technology Management, Chung-Hua University, Hsinchu, Taiwan.

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Fama-French three-factor model indicates the main factors affecting the stock returns for the market factor, the size factor and the book-to-market ratio factor, but did not specify the relative weights of the three factors and what sub-factors make an impact on the three factors. Therefore, in this article, we explore the part that the Fama-French three factor model does explain. By applying the multiple criteria decision making which contains the decision making trial and evaluation laboratory and the analytic network process, we create a network of models and confirm the relationship among these factors based on the model results. The result shows that the three factors have interaction and self-feedback. In the nine evaluation criteria, the price, followed by market returns and dividend growth rate, is the most important factor that affects the stock returns. This result not only confirms the second factor of the Fama-French three-factor model, but also finds out the relative weight of factors.

Key words: Multiple criteria decision making, decision making trial and evaluation laboratory, analytic network process.

INTRODUCTION

Fama-French proposed the Fama-French three factor model in 1993. The study suggested that the major factors which impact the stock returns rate are the market factor, size factor and book-to-market ratio factor, and the model constructed by the three factors can explain most stock return changes. However, the investors not only want to know which factors will impact the returns, but also want to understand the relative weight of various factors' impact level, and which sub-factors will impact these three major factors to provide, as with a reference for making investment decisions. Fama and French (1993) indicated that there are three important factors which will impact the returns, and suggested that the return explanation ability of the book-to-market ratio factor seemed to replace the market factor and size factor, therefore, the paper goes through literature collection and analysis to ensure the sub-factors that impact market factor, size factor and book-to-market ratio factor, and explore the interaction importance between the three factors and sub-factors, to further extend the concept of the Fama-French three factor model.

The paper applied multiple criteria decision making (MCDM) to solve this problem. Kleijnen (2005) indicated that MCDM is a methodology that can consider various decision-attributes, at the same time, it can assist a decision maker with limited feasible options to process ranking, evaluate and select the best option according to each option characteristic attribute. In addition, Saaty (1996) pointed out that analytic network process (ANP) can process the dependence and feedback relations of a problem, and indicated that when practically considering various decision-making criteria, it cannot just apply simple level relations; there may also be interactions between different level criteria. ANP has improved the shortcomings of establishing an evaluation model with a level concept in the past. However, Wang and Hsieh (2009) pointed out that when choosing ANP as the evaluating weight method, whether there are internal and external dependence or feedback relations between criteria and dimension, is the major factor for the entire model to succeed. Therefore, if the connection cannot be confirmed, the accuracy of the evaluation model will be impacted, and Lin and Wu (2008) indicated that decision

*Corresponding author. E-mail: hsiehyifang@gmail.com. Tel: 886-2-28102292/2502. Fax: 886-2-23623693.

making trial and evaluation laboratory (DEMATEL) can process the complicated qualitative problem using a quantitative method, and obtain its direct and indirect relation, therefore, the paper will apply DEMATEL to ensure the connection between dimension and criteria. The findings of Ou Yang et al. (2008) indicated that when processing normalization, the super matrix of current ANP assumed that each cluster has equal quality, however, it neglected that different clusters will have different impact levels; therefore, it proposed combining DEMATEL and ANP to solve this problem. The empirical result found that the method is able to better meet the actual application; therefore, the paper will apply this new MCDM to explore the Fama-French three factor model.

This paper will be processed in three phases, the first phase goes through literature collection and analysis to discover the impact criteria for the market factor, size factor and book-to-market ratio factor; the second phase applies DEMATEL to ensure the impact relation between various dimensions and criteria; the third phase combines DEMATEL and ANP to measure the importance between various factors, and explain the network relation model, to provide investors with a reference criteria.

STOCK RETURNS EVALUATION MODEL

Fama and French (1993) pointed out that stock returns changes will be impacted by the market factor, size factor and book-to-market ratio factor, and reasonable stock returns can be evaluated through the Fama-French three factor model. However, the Fama-French three factor model only explains the three important factors which impact the stock returns changes, but did not clearly describe the sub-factors that impact the three major factors and their relative importance. Therefore, we try to understand what the sub-factors of market factor, size factor and book-to-market ratio factor are, and establish the performance appraisal scale for selecting stocks through the sub-factors.

Market factor refers to market risk premium. According to the studies of Fama (1984), Lewis (1995) and Engel (1996), in the assumption of rational expectation, investors will require risk premium due to holding higher-risk assets. Fama and French (1993) think that risk premium is the risk compensation required by investors due to market anomalies. The capital asset pricing model (CAPM) published by Sharpe (1964), Lintner (1965) and Mossin (1966), pointed out that market risk premium is the part of the market rate of return being higher than the risk-free interest rate. In short, the market risk premium is the difference of the market rate of return and risk-free interest rate, and the risk coefficient of stocks is measured by the β-value. Black et al. (1972), Ross (1976) and Fama and French (1997) also have similar discussions; they think that the risk premium and risk-free rate of return have significant correlations, and the β-value can measure the sensitivity of risk. The study of Duffee (1998) pointed out that the change of risk premium and risk-free interest rate has a negative correlation. Later, many studies have also explored related issues, such as Campbell and Cochrane (1999) pointed out, that the risk aversion coefficient of investors will increase rapidly during economic recession. Brav et al. (2002) indicated that when investors have expectations, the β-value is the prior considered factor, and the study of Chen (2003) found that, there is an over 50% interpretation when applying the β-value to measure risk. It can be known that the risk-free interest rate, market rate of return and β-value seem to have a significant correlation with the market risk premium.

Size effect refers to the investment portfolio constructed by small-size company stocks, and average returns are significantly higher than large-size company stocks with control risk variables. The study of Foster and Gupta (1990) shows that, the size measurement method includes, the production amount, number of employees and number of machines and equipment. Henderson and Cockburn (1996) applied the production amount, number of employees and total assets as the proxy variable of company size. The study of Hossain et al. (1995) and Dechow et al. (1996) defined company scale as the total assets, and later, Ho and Wong (2001) and Cullen and Christopher (2002) also applied this method to define company size. Banz (1981) studied the relationship between company scale and stock returns, with the company market value of equity used as the definition of company size. The studies of Keim (1990), Fama and French (1992, 1993) and Drew et al. (2003) explored the relationships between size effect and stock returns, and it also applied the market value of equity as the measurement standard of company size. Garza-Gomez et al. (1998) studied the proxy variable of size, and found that, sales amount, number of employees, asset book values, and plant and equipment book values, cannot all replace the interpretation ability of the company market value of equity on stock. Therefore, the paper applied the market value of equity as the measurement of company size.

Book-to-market ratio effect refers to the investment portfolio constructed by a high book-to-market ratio, and an average rate of return that is significantly higher than a low book-to-market ratio. After Daniel and Titman (2006) divided the book-to-market ratio, it showed that net worth and stock are the main constructive factors. The Gordon model proposed by Gordon (1962) pointed out that stock changes will be impacted by discount rate, dividend growth rate and expected dividend. The study of Fama (1981) also found that discount rate, expected dividend and dividend growth rate will indeed impact stock, which supports the conclusion of the Gordon model. The studies of Penman (1991) and Fairfield (1994) showed that the current return of equity (ROE) has a significant correlation with the book-to-market ratio, and the return of

Table 1. Criteria explanation.

Dimension	Criteria	Criteria explanation	Supporting scholars
Market factor(D_1)	Market rate of return(C_1)	Returns obtained through market diversified investment	Sharpe, 1964; Lintner, 1965; Mossin, 1966
	Risk-free interest rate(C_2)	Securities or return of investment portfolio that has no default risk and is not related to any Return of the Total Assets Ratio.	Sharpe, 1964; Lintner, 1965; Mossin, 1966; Black et al., 1972; Ross, 1976; Fama and French, 1997; Duffee, 1998
	Beta value(C_3)	Measure of the market risk of stocks with the Beta coefficient	Sharpe, 1964; Lintner, 1965; Mossin, 1966; Brav et al., 2002; Chen, 2003
Size factor(D_2)	Stock(C_4)	Stock's last trading day closing price	Banz, 1981; Keim, 1990; Fama and French, 1992, 1993; Garza-Gomez et al., 1998; Drew et al., 2003
	Outstanding Shares(C_5)	Last trading day outstanding Shares	
Book-to-market ratio factor(D_3)	Net worth(C_6)	The total assets minus total outside liabilities of an individual or a company	Daniel and Titman, 2006; Bernard, 1995
	Expected dividend(C_7)	Expected income for future dividend per share	Gordon, 1962; Fama, 1990; Cutler et al., 1989; Penman, 1991; Fairfield, 1994
	Discount rate(C_8)	Return rate of discounted value of money or time	Gordon, 1962; Fama, 1990; Bernard, 1995
	Dividend growth rate(C_9)	Future dividend growth rate refers to the future profitability	Gordon, 1962; Fama, 1990; Bernard, 1995

equity (ROE) is also the major element for measuring dividend growth rate. The study of Cutler et al. (1989) showed that increased dividends will impact the increase of stock. Bernard (1995) thinks that the change of the book-to-market ratio can be decided by future profitability, net worth change rate and discount rate. It can be known that net worth, expected dividend, discount rate and dividend growth rate seem to have a significant correlation with the book-to-market ratio.

The paper used the three factors proposed by the Fama-French three factor model as a basis for literature review. Stock returns will be impacted by the market factor, size factor and book-to-market ratio factor; the market factor will be impacted by the market rate of return, risk-free interest rate and β-value; the size factor will be impacted by stock and outstanding shares; the book-to-market ratio factor will be impacted by net worth, expected dividend, discount rate and dividend growth rate. Therefore, there are three dimensions and nine criteria. The paper summarized the nine criteria that impacted stock returns in Table 1.

THE CONSTRUCTION OF A NETWORK RELATION MODEL

The paper will apply DEMATEL to ensure the impact relation between various dimensions and criteria, and apply ANP to measure the importance between various factors. This is discussed in three parts; 1) construct network relations through DEMATEL; 2) obtain weight through ANP, and; 3) describe the data collection method.

Apply DEMATEL to construct network relation

To construct a complete decision-making model, the paper must understand whether there is an interaction and self-feedback phenomenon between factors or sub-factors, DEMATEL is often used in MCDM to solve similar problems. DEMATEL is mainly used to solve various complicated problems to clarify the nature of the problem. In recent years, DEMATEL has been very popular in Japan, due to this method being able to effectively understand the complicated casual relationship structure, through checking the impact level between the elements, and applying matrix and related mathematic theory to calculate the causal relationship and impact level between the overall elements. Tzeng et al. (2007) pointed out that DEMATEL can enhance the understanding of specific problems and entangled problem groups, and provide a feasible plan through level structure.

DEMATEL is divided into five steps:

1) to establish evaluation scale, dimension paired comparison is used to evaluate the cognition of each respondent on the impact level of dimension, and the evaluation scale 0, 1, 2, 3, 4 is the measurement standard, which respectively represents no impact (0), low impact (1), medium impact (2), high impact (3) and extreme high impact (4);
2) to calculate the initial matrix, a $n \times n$ original impact matrix Z will be obtained through a paired comparison of the impact level; z_{ij} refers to the impact level of i on j :3) to calculate the normalization impact matrix, the

$$Z=\begin{bmatrix} z_{11} & z_{12} & \cdots & z_{1n} \\ z_{21} & z_{22} & \cdots & z_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ z_{n1} & z_{n2} & \cdots & z_{nn} \end{bmatrix} \quad (1)$$

normalization direct impact matrix can be obtained by applying equations (2) and (3); the matrix diagonal is 0, and the maximum sum of rows and columns is 1:

$$X = s \cdot Z \quad (2)$$

$$s = \min \left[\frac{1}{\max_i \sum_{j=1}^{n} |z_{ij}|}, \frac{1}{\max_j \sum_{i=1}^{n} |z_{ij}|} \right], \quad i, j = 1,2,\cdots,n \quad (3)$$

4) to obtain the total impact relation matrix, the total impact matrix T can be obtained through $\boldsymbol{T}=\boldsymbol{X}+\boldsymbol{X}^2+\boldsymbol{X}^3+\cdots+\boldsymbol{X}^{\boldsymbol{m}}=\boldsymbol{X}(\boldsymbol{I}-\boldsymbol{X})^{-1}$, in which I refers to the unit matrix; 5) to obtain the centrality and cause degree, sum up the rows and columns of the total impact matrix T, and then the sum of rows D and the sum of columns R can be obtained; d_i is assumed to refer to the sum of total impact matrix T's various rows, which is the impact level that directly or indirectly impacts other criteria; r_j refers to the sum of the total impact matrix T's various columns, which is the impact level being impacted by other criteria.

Variable d_i refers to the factor that impacts other factors, r_j refers to the factor being impact by other factors, $d_i + r_j$ refers to the relation intensity between factors, and $d_i - r_j$ refers to the intensity of factors impacting or being impacted; $d_i + r_j$ and $d_i - r_j$ are respectively the centrality and cause degree (Tamura et al., 2002; Tzeng et al., 2007).

Combine DEMATEL and ANP to obtain weight

The paper not only applied DEMATEL to ensure the impact relation between factors, but also hopes to obtain more accurate impact weight at the same time, and ANP can just satisfy the demand of the paper. ANP is proposed by Saaty (1996). Its purpose is to solve a project or the dependent and feedback problem between criteria, so ANP widened the restrictions of analytic hierarchy process (AHP).

In other words, ANP is the generalization of AHP. The greatest difference between the two methods is that ANP is applied in the decision-making of the impact relation between project and criteria; however, AHP ignores the characteristics existing between criteria and project, and assumes it to be an independent relation. Therefore, if there is a feedback relation existing between project and criteria, and is not included in the consideration, the decision-making result may be impacted while making decisions. Therefore, the result obtained by ANP should better meet the actual situation.

The findings of Ou Yang et al. (2008) pointed out that, currently, the super matrix processing normalization method assumes that each group will have the same amount. Although, using this method to normalize the super matrix is very easy, it ignores that different clusters shall have different impact levels, so combing DEMATEL and ANP to solve this problem is proposed. The empirical evidence found that this method can better meet the actual application. Therefore, the paper will apply this method, not the traditional assumption.

The paper divided ANP into four steps:

1) to establish the problem structure, the decision-making problem is ensured, and the problem structure is established. After the problem is clearly described, it will be divided into the network level structure;
2) to establish the un-weighted super matrix, after the level is constructed, the paired comparison between each level element will be processed.

It mainly paired comparisons between various criteria and various criteria. The paired comparison of criteria is also divided into the paired comparison between the same group and the paired comparison between different groups.

The scale is divided into 1 to 9, which refers to the nine levels from equal importance to very important. After the paired comparison matrix is obtained, it can further obtain the eigenvector, and form a super matrix according to the dependency between clusters, which is the un-weighted super matrix (4). Each value in a *W* matrix will be presented with sub-matrix *Wij*. If there is a blank or 0 in the matrix, then it refers that there is no dependency between the elements or groups.

$$\boldsymbol{W} = \begin{array}{c} \\ D_1 \begin{matrix} c_{11} \\ c_{12} \\ \vdots \\ c_{1m_1} \end{matrix} \\ D_2 \begin{matrix} c_{21} \\ c_{22} \\ \vdots \\ c_{2m_2} \end{matrix} \\ \vdots \\ D_n \begin{matrix} c_{n1} \\ c_{n2} \\ \vdots \\ c_{nm_n} \end{matrix} \end{array} \begin{array}{c} \begin{matrix} D_1 \\ c_{11}\cdots c_{1m_1} \end{matrix} \quad \begin{matrix} D_2 \\ c_{21}\cdots c_{2m_2} \end{matrix} \quad \cdots \quad \begin{matrix} D_n \\ c_{n1}\cdots c_{nm_n} \end{matrix} \\ \begin{bmatrix} W_{11} & W_{12} & \cdots & W_{1n} \\ W_{21} & W_{22} & \cdots & W_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ W_{n1} & W_{n2} & \cdots & W_{nn} \end{bmatrix} \end{array} \quad (4)$$

3) To obtain the weighted super matrix, sum up the various dimensions' impact degree of each level of the dimension total impact relation matrix, shown as (5) as normalization:

$$\boldsymbol{T}_D = \begin{bmatrix} t_{11} & \cdots & t_{1j} & \cdots & t_{1n} \\ \vdots & & \vdots & & \vdots \\ t_{i1} & \cdots & t_{ij} & \cdots & t_{in} \\ \vdots & & \vdots & & \vdots \\ t_{n1} & \cdots & t_{nj} & \cdots & t_{nn} \end{bmatrix} \quad (5)$$

Normalize Equation (6) and (7) in dimension total impact relation matrix $\boldsymbol{T}_D$ to obtain $\boldsymbol{T}_D^{\alpha}$:

$$d_i = \sum_{j=1}^{n} t_{ij} \quad (6)$$

$$\boldsymbol{T}_D^{\alpha} = \begin{bmatrix} t_{11}/d_1 & \cdots & t_{1j}/d_1 & \cdots & t_{1n}/d_1 \\ \vdots & & \vdots & & \vdots \\ t_{i1}/d_2 & \cdots & t_{ij}/d_2 & \cdots & t_{in}/d_2 \\ \vdots & & \vdots & & \vdots \\ t_{n1}/d_3 & \cdots & t_{nj}/d_3 & \cdots & t_{nn}/d_3 \end{bmatrix} = \begin{bmatrix} t_{11}^{\alpha} & \cdots & t_{1j}^{\alpha} & \cdots & t_{1n}^{\alpha} \\ \vdots & & \vdots & & \vdots \\ t_{i1}^{\alpha} & \cdots & t_{ij}^{\alpha} & \cdots & t_{in}^{\alpha} \\ \vdots & & \vdots & & \vdots \\ t_{n1}^{\alpha} & \cdots & t_{nj}^{\alpha} & \cdots & t_{nn}^{\alpha} \end{bmatrix} \quad (7)$$

Introduce the normalized dimension total impact relation matrix $\boldsymbol{T}_D^{\alpha}$ in the un-weighted super matrix to obtain the weighted super matrix, shown as (8):

$$\boldsymbol{W} = \begin{bmatrix} t_{11}^{\alpha}\times\boldsymbol{W}^{11} & t_{21}^{\alpha}\times\boldsymbol{W}^{12} & \cdots & \cdots & t_{n1}^{\alpha}\times\boldsymbol{W}^{1n} \\ t_{12}^{\alpha}\times\boldsymbol{W}^{21} & t_{22}^{\alpha}\times\boldsymbol{W}^{22} & \vdots & & \vdots \\ \vdots & \cdots & t_{ji}^{\alpha}\times\boldsymbol{W}^{ij} & \cdots & t_{ni}^{\alpha}\times\boldsymbol{W}^{ni} \\ \vdots & & \vdots & & \vdots \\ t_{1n}^{\alpha}\times\boldsymbol{W}^{n1} & t_{2n}^{\alpha}\times\boldsymbol{W}^{n2} & \cdots & \cdots & t_{nn}^{\alpha}\times\boldsymbol{W}^{nn} \end{bmatrix} \quad (8)$$

4) multiplying the weighted super matrix to obtain the limit super matrix can obtain the weight of various evaluation criteria. $\lim_{z\to\infty} = \boldsymbol{W}^{z}$, in which $\boldsymbol{W}$ is the limit of the super matrix, and z refers to random numbers.

Table 2. Dimension total impact relation matrix T.

Dimension	D_2	D_3	D_4
D_1	3.713	2.911	5.427
D_2	2.506	1.695	3.502
D_3	5.269	3.953	6.993

DATA COLLECTION METHOD

The paper applied experts with financial knowledge and understanding of a certain level of stock investment as the major study objects. They are, financial scholars, stock investment experts and fund managers. Financial scholars must have 2 years of experience in investment, a financial management profession, and university financial teaching courses; stock investment experts must be investment consulting analyzers in a financial holding company, and fund managers must have the experience of helping customers to process various fund investments. The respondents' point of views on various evaluation criteria and the performance of investment projects in various evaluation criteria are obtained through individual in-depth interviews and questionnaires. There are 15 questionnaires issued, which are, 5 each to, financial scholars, stock investment experts and mutual fund managers. The questionnaire survey time is between May and June, 2009 and the interview time for each respondent is about 25 to 50 min, and the questionnaires are retrieved after the interview ends.

Empirical analysis

This explores the consideration factor preference level of financial scholars, stock investment experts and fund managers on choosing stocks to ensure the weight between various factors and find the key factors, and process impact relation description according to the result of the network relation model, and further provides investment reference criteria.

DEMATEL network impact relation verification

The paper applied DEMATEL to ensure the structure of the decision-making problem, and analyzed the impact relation between three dimensions and 9 criteria. The total impact relation matrix T and impact level relation obtained is shown in Tables 2 to 5, and the network impact model is constructed as shown in Figure 1. It can be found from Table 2 that from the cognitions of experts, the 3 dimensions all have impact relations, it can be shown from impact level relation in Table 3 that, compared with other dimensions, the book-to-market ratio factor (D_3) is the most important impact factor; on the contrary, the size factor (D_2) is the factor which has the smallest impact level among all factors. It can be seen from Table 4, that all criteria have impact relations, the impact level relation in Table 5 showed that whether it is a direct or an indirect impact level, compared with other criteria, the market rate of return (C_1) is the most importantly considered criteria; on the contrary, risk-free interest rate (C_2) is the criteria which has the smallest impact level among all. In addition, after observing the impact level of criteria, it can be seen that stock (C_4) is the easiest to be impacted among all criteria and the market rate of return (C_1) has the greatest centrality (d+r), which means that it is the most important criteria for experts.

Table 3. Dimension impact level relation.

Dimension	d (Impact)	r (Impacted)	d+r (Centrality)	d-r (Cause degree)
D_1 market factor	12.051	11.488	23.540	0.563
D_2 size factor	7.703	8.560	16.263	-0.857
D_3 book-to-market ratio factor	16.215	15.922	32.138	0.293

Table 4. Criteria total impact relation matrix T.

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9
C_1	0.484	0.403	0.479	0.629	0.463	0.498	0.531	0.468	0.534
C_2	0.462	0.236	0.377	0.466	0.340	0.372	0.400	0.372	0.405
C_3	0.568	0.351	0.352	0.590	0.424	0.452	0.478	0.436	0.482
C_4	0.576	0.350	0.452	0.480	0.447	0.490	0.505	0.455	0.503
C_5	0.469	0.286	0.373	0.483	0.285	0.379	0.407	0.361	0.401
C_6	0.526	0.333	0.407	0.565	0.412	0.356	0.474	0.405	0.475
C_7	0.556	0.351	0.440	0.576	0.427	0.472	0.394	0.416	0.505
C_8	0.495	0.328	0.394	0.515	0.369	0.416	0.435	0.308	0.427
C_9	0.598	0.377	0.463	0.636	0.453	0.500	0.542	0.449	0.421

Table 5. Criteria impact level relation.

Criteria	d (Impact)	r (Impacted)	d+r (Centrality)	d-r (Cause degree)
C_1 market rate of return	4.487	4.734	9.221	-0.247
C_2 risk-free interest rate	3.432	3.016	6.447	0.416
C_3 market Beta	4.133	3.738	7.871	0.395
C_4 stock	4.258	4.940	9.197	-0.682
C_5 Outstanding Shares	3.445	3.620	7.065	-0.175
C_6 net worth	3.952	3.934	7.886	0.018
C_7 expected dividend	4.137	4.165	8.303	-0.028
C_8 discount rate	3.687	3.671	7.358	0.017
C_9 dividend growth rate	4.439	4.152	8.591	0.287

Risk-free interest rate (C_2) has the greatest cause degree (d-r), which means it can directly impact other criteria the most; the smallest is stock (C_4), which means it is the easiest to be impacted by other criteria.

The paper will further explain the impact relation result of DEMATEL. The result showed that, risk-free interest rate and market β shall be first considered if wanting to judge the buying point of stock, due to that these two criteria will not only directly impact stock changes, but will also impact other criteria changes at the same time, for example, when the risk-free interest rate is slightly lower, it will increase the motive of investors investing in the stock market, once the investors join the stock market, the market liquidity will increase and impact the rise of stock, and the fund market driven by fund proliferation will also impact the change of the net worth, expected dividend, discount rate and dividend growth rate. However, all the changes resulted from low risk-free interest rate. In addition to consider risk-free interest rate and market β, at the same time, dividend growth rate must be considered, due to that the high and low dividend growth rate represents whether the investment subject has the long-term investment value, when the investment subject has no long-term investment value, it will certainly be more difficult to attract investors; therefore, it will be more detrimental for stock development.

Combine DEMATEL and ANP to calculate weight

The major survey target of the paper includes financial scholars, stock investment experts and fund managers. First, the paired comparison matrix was obtained through expert questionnaires, and the eigenvector and un-weighted super matrix can be obtained through calculation. Second, the dimension impact level obtained through DEMATEL was used to obtain the weighted super matrix. Finally, the super matrix is limited to obtain the overall weight, shown as Table 6. The result showed that the three types of experts attach more importance to stock and market rate of return when evaluating stocks, and risk-free interest rate is the criteria with less importance attached. Overall speaking, the focus ranking from the three types of experts for evaluation criteria do not have a significant difference, however in outstanding shares, stock

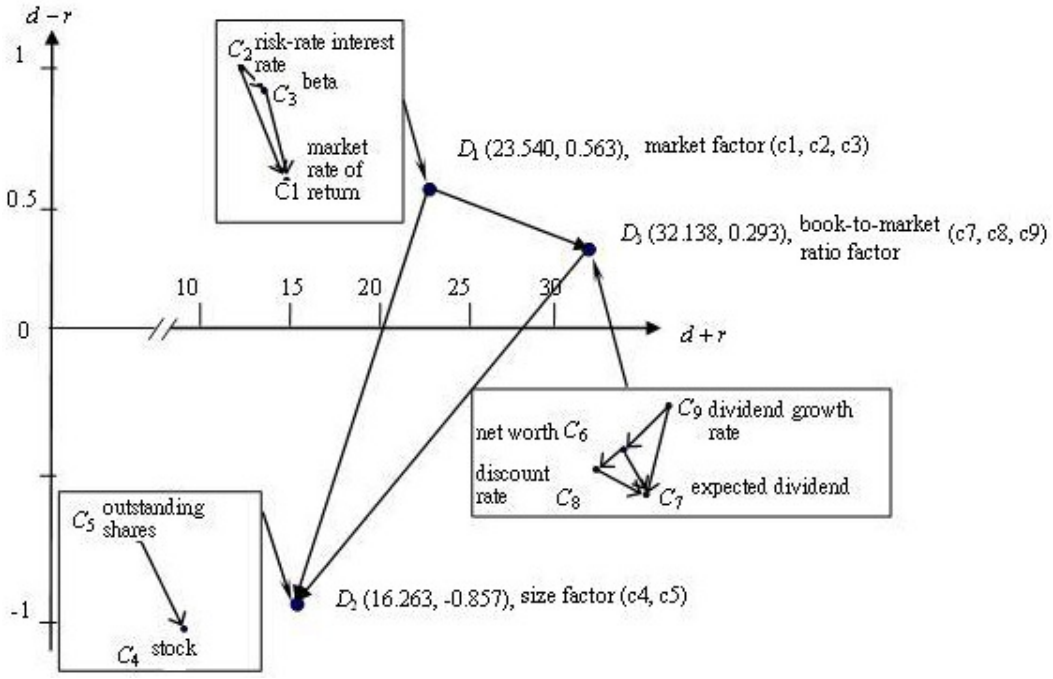

Figure 1. Network impact model.

Table 6. The comparison table of experts and scholars on factor preference.

Dimension	Criteria	Overall experts and scholars		Financial scholars		Stock investment experts		Fund managers	
		Weight	Ranking	Weight	Ranking	Weight	Ranking	Weight	Ranking
Market factor		0.319		0.299		0.323		0.327	
	Market rate of return	0.170	2	0.140	3	0.127	3	0.211	1
	Risk-free interest rate	0.053	9	0.041	9	0.039	9	0.075	6
	Beta value	0.096	6	0.118	4	0.157	2	0.041	8
Size factor		0.237		0.234		0.259		0.221	
	Stock	0.182	1	0.176	2	0.187	1	0.181	2
	Outstanding shares	0.055	8	0.058	8	0.072	8	0.040	9
Book-to-market ratio factor		0.444		0.467		0.418		0.452	
	Net worth	0.124	4	0.087	6	0.109	5	0.152	3
	Expected dividend	0.107	5	0.106	5	0.096	6	0.110	5
	Discount rate	0.071	7	0.076	7	0.088	7	0.055	7
	Dividend growth rate	0.142	3	0.198	1	0.125	4	0.135	4

investment experts uphold a different perspective. Stock investment experts indicated that the amount of outstanding shares do not have a direct impact relation with the high/low and rise/fall speed of stock, so stock investment experts think that evaluating criteria is a very important factor to measure stock returns rate.

After integrating the perspective of experts and scholars on nine criteria, the study found that stock, market rate of return and dividend growth rate have higher importance attached; the importance attached for stock has reached 0.182, which is the most focused evaluation criteria, followed by market rate of return (0.170) and dividend growth rate (0.142). When compared with other criteria, risk-free interest rate has lower importance attached; it is about 0.053. For the perspective of dimension, the more focused evaluation criteria in “market factor” for experts is market rate of return; in “size factor” it is stock, which has a greater difference when compared with the ranking of outstanding shares; and in “book-to-market ratio factor” it is dividend growth rate.

Therefore, after combining the perspectives of the three types of

experts, for the criteria that ranks in the top five, the three factors of book-to-market ratio factor have respectively ranked from 3 to 5. It can be seen that experts and scholars think that "book-to-market ratio factor" is the most important considered factor when investors choose stocks. In addition, when compared with "size factor", although, the focus obtained is lower, it includes the most important considered criteria, "stock", so it doesn't mean that size factor is not important, only that when comparing with other dimensions, its overall importance is lower.

RESULT ANALYSIS AND MANAGEMENT IMPLICATION

The paper explored the empirical result. Firstly, according to the investment model constructed by ANP, it showed that when measuring stock returns rate, the most important evaluation criteria is stock, and the weight is 0.182. The buy and sell price difference of stocks will directly impact stock returns; therefore, the high and low of the stock price are naturally the most focused factors for investors. Moreover, whether it is basic analysis or technical analysis, their final purpose is to look for reasonable stock and further obtain returns. Therefore, the most important factor to measure stock returns rate is stock.

Secondly, market rate of return ranks second in the nine criteria, the weight is 0.170; this is a very important criteria. When the market rate of return is higher than the risk-free interest rate, then the investors will be willing to invest money in the market. Especially, when the market rate of return is far more than the risk-free interest rate, it will largely increase the motive for investors to join the market, so market rate of return is a very important considering factor.

Thirdly, dividend growth rate is also an important criteria, which ranks third among all the evaluation criteria. The weight is 0.142, which refers to when the investors are evaluating investment subjects, they do not only care about the short-term return, but at the same time attach great importance to investment return. Generally speaking, a company with stable operation will have the opportunity to grow, and dividend growth rate is often a very important reference. When a company is making money, it will give the investors more dividends, because this implies that the company stocks have investment value, which will attract more funds to help the company's growth, and investors will also be aware of this, and increase the will to purchase the company stocks, further resulting in stock rise. Therefore, dividend growth rate is a factor that cannot be neglected when measuring the stock returns rate.

Conclusion

The Fama-French three factor model is a very important stock returns evaluation model in the financial field of recent years. The mathematical model explains that market factor, size factor and book-to-market ratio factor will impact the change of stock returns, however, what the sub-factors that impacted these three factors are, is not clearly described, and the interactive impact importance of the three factors on stock returns rate is also not mentioned. If the investors can understand the relative impact importance weight between factors and sub-factors, it will help them in choosing which stock to invest in.

The paper found that the three factors of the Fama-French three factor model have an interactive impact and self feedback relations according to the result of DEMATEL, so the paper applied ANP to calculate the weight of the nine evaluation criteria, and introduced the "dynamic importance relation" of DEMATEL in ANP for calculation. It is found that according to the calculation result, the evaluation criteria that ranks the first is stock, the rest are, market rate of return, dividend growth rate, net worth, expected dividend, market β, discount rate, outstanding shares, and risk-free interest rate respectively. Although, when evaluating stock returns rate, all the possible impact factors must be included in the consideration. However, experts think stock is the most considerable factor when investors are evaluating the stock returns rate according to this factor. In addition, the second important factor is market rate of return, the high and low of market rate of return will impact risk premium. When risk premium is positive, risk adverse investors then will invest in the stock market. The factor that ranks the third is dividend growth rate. A company with stable operation will have the opportunity to grow. Therefore, the dividend issuing amount also have the opportunity to grow; this represents that the company stocks have long-term investment value.

The paper went through literature review to discover the major factors and sub-factors that impact stock returns rate, and applied the new multiple criteria decision making (MCDM) to understand the interactive impact and self feedback relations of factors. The paper combined mathematical theory and experts' subjective judgment, used the concept of the Fama-French three factor model to further analyze and provide investment criteria, and hopes the result will be helpful for investors in making investment decisions.

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