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Portfolio Selection using Data Envelopment Analysis (DEA): A Case of Select Indian Investment Companies

Leila Zamani*, Resia Beegam and Samad Borzoian

Kerala University, Kerala, India

***Corresponding author**

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A B S T R A C T

The stock evaluation process plays an important role in portfolio selection because it is the prerequisite for investment and directly influences on the stock allocation. This paper presents a methodology based on Data Envelopment Analysis for portfolio selection, decision making units which can be stocks or other financial assets. First, DMUs efficiencies are computed based on input/output, and then the generation of a portfolio is carried out by a mathematical model. Then the methodology is illustrated numerically on the market of Mumbai stock exchange. Finally, by using AP Model, we determined optimal portfolio stocks for investors in the Mumbai stock exchange.

Introduction

Several portfolio management approaches have been developed for a successful portfolio selection. In the traditional approach, portfolio risk is reduced by over variation and ignoring the correlation among securities, whereas in the modern approach variation is provided by mean-variance model (Markowitz, 1952). This model also emphasizes the drawbacks of inclusion of securities, which are highly correlated in the same portfolio (Markowitz, 1959). Similar to Markowitz's-variance model, mean Roy also developed mean- variance efficiency frontier by examining the relationship between the variance of the returns from the securities of portfolio and the returns from the portfolio (Roy, 1952).In further studies, based on the mean-variance model, portfolio allocation management was improved by adding several factors such as borrowing, loaning, short term selling, transaction cost, to the original model (Tobin, 1958), (Sharpe, 1963), (Lintner, 1965). According to the mean-variance analysis which is the basic of Modern Portfolio Theory, in order to make a decision, the investor should calculate the

estimated return, standard deviations of all stocks and most importantly the covariance between these stocks. In this method, the number of data to be calculated would increase exponentially with the increase in the number stock. This would be complicated. Then there are several models improved to answer the question 'is it possible to all Cocatensequently successfulinthi sports that question by using DEA method for portfolio allocation which is also in used earlier studies for evaluating of portfolio performance (Murthi, Yoon K. Choi, and Preyas Desai, 1997). This method

(DEA) was first developed by Charles, Cooper and Rodes (1978; 1981) to measure and compares the technical efficiency of public corporation. DEA is commonly used to evaluate the relative efficiency of a number of producers. A typical statistical approach is producers. The remainder of the paper is organized as follows. In Section 2, review the background of the study. In section 3, methodology of study is explained and the mathematical formulation of a method for finding portfolio stocks and computing relative efficiency of companies is provided. In Section 4, empirical results and analysis is presented. Finally, Section 5 is conclusion.

Background

Portfolio selection represents one of the most explored topics in finance, both from a theoretical and a practical perspective. The pioneering work on the analysis of wealth allocation is due to Markowitz (1952) that this study laid the foundation of modern portfolio theory with his mean-variance (M-V) model. Modern portfolio theory is based on (i) analysing risk by focusing on the investor's stead portfolio of individual securities, in and (ii) determining and exploiting the E-V efficient frontier, namely, minimizing risk (commonly measured in terms of variance) for every level of expected return. Later, Sharpe (1964) Lintner (1965) and Mossin (1966) proposed a capital asset pricing model (CAPM). Based on their research, many scholars have put forward a number of portfolio performance evaluation methods, such as Treynor index, Sharpe ratio and Jensen index. These performance evaluation methods were popular with investors and widely used in practice. However, these evaluation methods have theoretical flaw.

The traditional methods of portfolio performance evaluation, although are widely used, but there are many limitations on application. First, the returns of portfolio are negative, the traditional indexes can not be used due to conflict with their original meaning; Second, as said before, CAPM-based risk-adjusted indexes have theoretical flaw in itself. Meanwhile, the hypothesis of CAPM model are too strict to meet. So these indexes are not perfect. Although multi-factor models relax the constraints, but it is hard to determine the impact factors. Moreover, the traditional methods do not consider the multi-variable for evaluation of portfolio, which is a very important factor in performance evaluation. To solve these problems, DEA began to be applied in portfolio performance evaluation. Different from the traditional methods, DEA is a non-parametric evaluation method. It does not need the hypothesis of the effectiveness of capital markets and could avoid the impact of the benchmark portfolio on evaluation result. So this approach led to the widespread concern in recent years. Murthi, Choi and Desai (1997) first used DEA to take into account the investment costs in defining a mutual fund performance. McMullen and

Strong (1998) used DEA model to analyze the impact of different time horizon on fund performance. Afterward, Basso and Funari (2001) proposed a new mutual fund performance indexes that take into account a variety of transaction costs and risk measure value in DEA model. Chen and Li (2001) first applied

DEA in China funds performance evaluation. Afterwards, a number of models based on DEA are applied to analyze china funds performance. Ding (2003) applied multiple inputs and multiple outputs DEA model to evaluate performance of investment funds. Deng and Yuan (2007) established the dynamic DEA model. Xu and Zhang (2009) used the input oriented BCC DEA model. In portfolio selection, Murthi et al. (1997), Basso & Funari (2001), Emel et al. (2003), Eilat et al. (2006), Edirisinghe & Zhang (2007), Chen (2008), Ke et al.(2008), Lozano & Gutierrez (2008), Edirisinghe & Zhang (2008) and Amiri et al. (2010) used DEA methodology in order to evaluation or choose assets, stocks, mutual funds etc.

The DEA methodology has its unique advantages which don't need the hypothesis that the selection of the market portfolio and risk-free rate on the evaluation results. The purpose of this paper is to use the DEA methodology to measure relative efficiency of a company by using its financial which statements this model allows us to overcome the first two weaknesses of Markowitz model. DEA aims at comparing the inputs and outputs of a set of decision-making units (DMU) by evaluating their relative efficiency and computing super- efficiency.

Methodology

In this section, we deal with the details of the methodology that would help in portfolio selection in Mumbai stock exchange (BSE). This provides a description of the design and methods that are used. In addition, it explains data used, the procedures methodology related to data collection, population and sample, and selection of variables.

The dual is seeking the efficiency rating weighted sum of the inputs of the other decision making units is less than or equal to the inputs of the decision making unit being evaluated and (b) that the weighted sum of the outputs of the other decision making units is greater than or equal to the decision making unit being evaluated. The weights are the λ(lambda) values. The other decision making units with non-zero λvalues are the units in the efficiency reference set. When the models (1) and (2) are used. Usually more than one efficient DMU is obtained. For ranking efficient units in 1993, a model was introduced by Anderson and Peterson. It should be noted, in this paper that this model is applied to efficient companies are also ranked and calculated coefficient of efficiency which is as shown below. The results will come in the empirical.

Data Collection and Period of Study

The data is used for this work were collected from www.bse.com website. It provides all financial statements of companies for the year 2013. We considered for this paper with application of DEA to assess the efficiency of 43 companies selected from (BSE). This data computing efficiency scores using EMS software, Solver parameters in Microsoft Excel and win4deap. These are linear programming based software.

Table.2 Status of Portfolio Stocks in term of Coefficient Efficiency, Ranks and Shares

N.	The Name of Companies	Coefficient Efficiency Input Orinted (AP Model)	Ranks	The Rank & Share of Companies in the portfolio stock Group		
				Companies Status	Ranks	Shares (%)
1	Shree Cements and Infra Limited (BSE:530977)	6.4344635	1	The First Portfolio Stock 2.0934<x<6.4545	1	32.8
2	Oracle Financial Services Software Limited (BSE:532466)	4.0297291	2		2	20.6
3	Hawkins Cookers Limited (BSE:508486)	3.3750000	3		3	17.2
4	Nestle India Ltd. (BSE:500790)	3.2419127	4		4	16.5
5	GlaxoSmithKline Consumer Healthcare Limited (BSE:500676)	2.5185710	5		5	12.9
6	Page Industries Limited (BSE:532827)	2.0479942	6	The Second Portfolio Stock 1.3909<x<2.0934	1	27.7
7	eClerx Services Limited (BSE:532927)	1.9637720	7		2	26.6
8	MRF Ltd. (BSE:500290)	1.7386911	8		3	23.5
9	Tide Water Oil Co. (India), Ltd. (BSE:590005)	1.6366834	9		4	22.2
10	VST Tillers Tractors Limited (BSE:531266)	1.3673344	10	The Third Portfolio Stock 1<x<1.3909	1	12.8
11	Hero MotoCorp Limited (BSE:500182)	1.3532816	11		2	12.7
12	Bosch Ltd (BSE:500530)	1.2992899	12		3	12.1
13	Fag Bearings India Ltd. (BSE:505790)	1.2624809	13		4	11.8
14	ICICI Bank Ltd. (BSE:532174)	1.2065533	14		5	11.3
15	Disa India Ltd (BSE:500068)	1.0695967	15		6	10.0
16	Bajaj Auto Limited (BSE:532977)	1.0682218	16		7	10.0
17	Infosys Ltd. (BSE:500209)	1.0507359	17		8	9.8
18	Sanofi India Limited (BSE:500674)	1.0167702	18		9	9.5
19	Kirloskar Oil Engines Limited (BSE:533293)	0.9456151	19	The Fourth Group IV 0<x<1	1	7.8
20	The Sandur Manganese & Iron Ores Limited (BSE:504918)	0.9115767	20		2	7.5
21	Pfizer Limited (BSE:500680)	0.8889093	21		3	7.3
22	Abbott India Limited (BSE:500488)	0.8138873	22		4	6.7
23	Borosil Glass Works Limited (BSE:502219)	0.7770755	23		5	6.4
24	Gujarat Apollo Industries Ltd. (BSE:522217)	0.7188528	24		6	5.9
25	Eicher Motors Ltd. (BSE:505200)	0.6748934	25		7	5.5
26	Monsanto India Limited (NSEI:MONSANTO)	0.6321892	26		8	5.2
27	MindTree Limited (BSE:532819)	0.5224235	27		9	4.3
28	PNB Gilts Ltd. (BSE:532366)	0.5046773	28		10	4.1
29	Dr. Reddy's Laboratories Ltd. (BSE:500124)	0.4486672	29		11	3.7
30	Tech Mahindra Limited (BSE:532755)	0.4358038	30		12	3.6
31	Bajaj Finance Limited (BSE:500034)	0.4198347	31		13	3.5
32	AXIS Bank Limited (BSE:532215)	0.4162035	32		14	3.4
33	State Bank of Bikaner & Jaipur (BSE:501061)	0.3879049	33		15	3.2
34	HCL Technologies Ltd. (BSE:532281)	0.3707724	34		16	3.0
35	TTK Prestige Ltd. (BSE:517506)	0.3238066	35		17	2.7
36	CMC Limited (BSE:517326)	0.3130359	36		18	2.6
37	Honeywell Automation India Limited (BSE:517174)	0.2972389	37		19	2.4
38	SMS Pharmaceuticals Limited (BSE:532815)	0.2695042	38		20	2.2
39	Sutlej Textiles and Industries Ltd. (BSE:532782)	0.2603062	39		21	2.1
40	TVS Srichakra (BSE:509243)	0.2495765	40		22	2.1
41	Grasim Industries Limited (BSE:500300)	0.2232887	41		23	1.8
42	Ambika Cotton Mills Ltd. (BSE:531978)	0.2080000	42		24	1.7
43	CEAT Limited (BSE:500878)	0.1527298	43		25	1.3

Input and Output Variables

In this paper, we were selected seven variables for use in the DEA model. Four variables like Return on Equity (ROE), Return on Capital employment (ROCE), Net profit Margin and Earning per share are included as Outputs, and three variable like Beta, Modified 5-year beta and Debt to equity ratio are included as inputs.

Empirical Result and Analysis

This study calculates the relative technical efficiency of companies with high earning per share listed in BSE utilizing an input oriented model, variable returns to scale (VRS) and Anderson &Peterson model in data envelopment analysis (DEA). Since the basic DEA models (CCR, BCC) can only calculate efficiency coefficient equal to one for efficient companies, we introduce the super-efficiency model (AP) as a DEA approach particularly useful for performance evaluation and to estimate efficiency coefficient for all companies. In standard DEA, companies are identified as fully efficient and assigned an efficiency score of unity if they lie on the efficient frontier. Inefficient firms are assigned scores of less than unity. The super-efficient score is to allow the scores for efficient units to exceed unity. Therefore,

the results of the supper efficiency model we have estimated efficiency coefficient for all companies selected (43) that the results obtained, classified and presented in Table (1). The basis of the ranking on companies selected from 18 out of 43 companies shows that the coefficient of efficiency is more than one. The companies are classified into three groups or three portfolio stock, based on the average coefficient of efficiency for the 18 companies with the score efficient more than unit calculated. The first group of companies relate to coefficients of efficiency that are higher than the total average. The second group of companies relate to coefficients that are lower than the average of efficiency. Since we need some different portfolio stocks, then we computed the average coefficient among companies of the second group, that basis on this index (average efficiency) these companies also divided two groups (portfolio stock II&III). According to the results shown in Table (1) companies are divided into four groups. While the first group of companies have the highest coefficient of efficiency, the fourth group has the lowest coefficient among the companies and therefore, this group is not considered in the portfolio selection.

Conclusion

Investors consider several criteria and use several methods to portfolio selection in stock exchange market. In this study, DEA method was used for portfolio allocated. In DEA for calculating the efficiency of different DMUs, by using AP model and computing super-efficiency score that we proposed three portfolio stocks. The first portfolio stock, coefficients of super-efficiency are between 2.0934 and 6.4345. The second portfolio stock, coefficients of super-efficiency range between 1.3909 and 2.0934. The third portfolio stocks, coefficient of super-efficiency companies are range between 1 and 1.3909. The results show that the DEA Super-efficiency scores provide a useful basis for Furthermore, the DEA approach employed in this study can be applied to other stock markets to examine to what extent our results are generalizable.

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