

PORTFOLIO ALLOCATION USING DATA ENVELOPMENT ANALYSIS (DEA)-An Empirical Study on Istanbul Stock Exchange Market (ISE)

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ABSTRACT

Purpose_ this paper compares the returns between the portfolio constructed by using Data Envelopment Analysis (DEA) method and the market index

Design/ methodology/ approach_ the efficiency of all the financial sector stocks in Istanbul Stock Exchange Market (ISE) was determined by applying DEA for period 01.01.2002-09.31.2005. According to the results of DEA, the efficient stocks were used to construct the portfolio. The portfolio and their actual market returns were analyzed. Additionally it was emphasized that DEA technique is applicable to portfolio allocation.

Findings_ quarterly returns of 14 portfolios were 9.44, while the returns of ISE National-100, ISE National-50 and ISE National-30, 1.84, 1.88, 1.87 respectively for period 2002-2005. The return of portfolio constructed by using DEA was higher than the market return.

Research limitations/implications_ this study was applied to all the financial sector stocks listed on ISE for period 01.31.2002-09.31.2005

Keywords Portfolio Allocation, Financial Sector, ISE, Data Envelopment Analysis.

Paper type_ Research paper

Introduction

Several portfolio management approaches have been developed for a successful portfolio allocation. 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 mean-variance model, Roy also developed a 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 allocate successful portfolio using with less input and information?' Consequently in this study looks for an answer of 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 characterized as a central tendency approach and it evaluates producers relative to an average producer. In contrast, DEA is an extreme point method and compares each producer with only the "best" producers.

In CCR-model (Input oriented) used in the study, the efficiency measure for Decision Making Unit (DMU_j) can be calculated by solving the following mathematical programming problem:

$$\text{Max } \theta_j(u, v) = \frac{\sum_{r=1}^s u_r y_{rj}}{\sum_{i=1}^m v_i x_{ij}} \quad [\text{Equation (1)}]$$

Subject to

$$\text{Max } \theta_j(u, v) = \frac{\sum_{r=1}^s u_r y_{rj}}{\sum_{i=1}^m v_i x_{ij}} \leq 1, j= 1,2,\dots,\dots,n \quad [\text{Equation (2)}]$$

$$u_r \geq 0, r = 1, 2, \dots, s \text{ [Equation (3)]}$$

$$v_i \geq 0, i = 1, 2, \dots, m \text{ [Equation (4)]}$$

where x_{ij} = the observed amount of input of the i_{th} type of j_{th} DMU ($x_{ij} > 0$, $i = 1, 2, \dots, m$, $j = 1, 2, \dots, n$) and y_{rj} = the observed amount of output of the r_{th} type of j_{th} DMU ($y_{rj} > 0$, $r = 1, 2, \dots, s$, $j = 1, 2, \dots, n$)

θ is the efficiency score for the particular DMU $_j$ and efficiency score for all of them are obtained by repeating them for each DMU $_j$, $j = 1, 2, \dots, n$. The value of θ is always less than or equal to unity DMUs for which $\theta < 1$ are relatively inefficient and those for which $\theta = 1$ are relatively efficient.

Research method and data

In this study the data for the period 2002-2005 are provided from ISE, and the study covers all stocks in the ISE financial sector. First, performance measurement was made by using the DEA method, then the stocks that are found to be effective in the result of DEA were allocated.

The inputs of DEA are market values, equity capital, price / earnings ratio, price / cash flow ratio, Market value per share / Book value per share, trading volume. The output of DEA is net profit. EMS (Efficiency Measurement System) was used for DEA. The return for a period is calculated as follows

$R = (F_{t+1} - F_t) / F_t$, F_t = close price of the t_{th} period, F_{t+1} = close price of the $t+1_{th}$ period.

Research restrictions

In order to apply DEA, all inputs and outputs should have numeric and positive values, Therefore, DMUs which doesn't meet this requirement (negative values) were revised. Furthermore, unlisted stocks were simply ignored.

Research findings

Table 1 Portfolio1 (03.31.2002)

(DMU)	Efficient DMU ($\alpha = 1$)	Return (06.31.2002)	Index Return (06.31.2002)	
F6	İş Bankası (A)	0,34	ISE National-100	-0,196
F7	İş Bankası (B)	-0,25	ISE National-50	-0,197
F9	Sınai Yatırım Bankası	-0,02	ISE National-30	-0,201
F10	Şekerbank	-0,23		
F22	Yapı Kredi Sigorta	-0,63		
F45	Koç Holding	-0,52		
F51	Vakıf Risk	-0,16		
F55	Egs Gmyo	0,00		
F57	İhlas Gmyo	-0,53		
F58	İş Gmyo	-0,25		
F60	Vakıf Gmyo	-0,12		
F61	Yapı Kredi Koray Gmyo	-0,35		
F64	Ata Yat.Ort.	-0,41		
F65	Atlantis Yat. Ort.	-0,24		
F68	Bumerang Yat.Ort.	0,00		
F70	Eczacıbaşı Yat. Ort.	-0,14		
Total Return of Portfolio		-0,219		

On March 31, 2002, 85 financial DMUs¹ listed on ISE were included in to the efficiency analysis. According to the result of input-oriented DEA, the portfolio was constructed by using 18 DMUs whose efficiency scores equal to 1 ($\alpha = 1$)

Table 2 Portfolio2 (06.31.2002)

(DMU)	Efficient DMU ($\alpha = 1$)	Return (09.31.2002)	Index Return (09.31.2002)	
F2	Alternatifbank	-0,19	ISE National-100	-0,0572
F6	İş Bankası (A)	-0,09	ISE National-50	-0,0655
F7	İş Bankası (B)	0,02	ISE National-30	-0,0818
F11	T.S.K.B.	0,06		
F24	Finans Fin. Kir.	0,00		
F27	İş Fin.Kir.	-0,11		
F54	Egs Gmyo	-0,41		
F67	Bumerang Yat.Ort.	-0,01		
F76	M. Yılmaz Yat.Ort.	-0,09		
F77	Syb Yat. Ort.	-0,11		
F83	Alfa Menkul Değ.	-0,03		
Total Return of Portfolio		-0,0871		

On June 31, 2002, 84 financial DMUs listed on ISE were included in to the efficiency analysis. According to the result of input-oriented DEA, the portfolio was constructed by using 11 DMUs whose efficiency scores equal to 1 ($\alpha = 1$)

¹ In Financial sector each stock is regarded as one DMUs and definition the variable "F" that changes from F1 to F85

Table 3 Portfolio3 (09.31.2002)

(DMU)	Efficient DMU($\alpha =1$)	Return (12.31.2002)		
F6	İş Bankası (A)	-0,18519		
F7	İş Bankası (B)	0,150943		
F22	Finans Fin. Kir.	0,311475		
F40	Mazhar Zorlu Holding	0,333333		
F48	Garanti Gmyo	0,26		
F57	Atlantis Yat. Ort.	0,259259		
F60	Bumerang Yat.Ort.	0,230769		
F61	Deniz Yat. Ort.	0,02		
F65	Garanti Yat. Ort.	0,568182		
F68	M. Yılmaz Yat.Ort.	0,095238		
F69	Syb Yat. Ort.	0,421875		
F74	Alfa Menkul Değ.	-0,33582		
Total Return of Portfolio		0,177506		
			Index Return (12.31.2002)	
			ISE National-100	0,172
			ISE National-50	0,175
			ISE National-30	0,180

On September 31, 2002, 76 financial DMUs listed on ISE were included in to the efficiency analysis. According to the result of input-oriented DEA, the portfolio was constructed by using 10 DMUs whose efficiency scores equal to 1 ($\alpha = 1$)

Table 4 Portfolio4 (12.31.2002)

(DMU)	Efficient DMU ($\alpha =1$)	Return (03.31.2003)		
F6	İş Bankası (A)	0,169697		
F7	İş Bankası (B)	-0,06557		
F9	Şekerbank	-0,05195		
F10	T. Kalkınma Bank.	-0,06667		
F22	Finans Fin. Kir.	-0,1375		
F25	Öz Finans Fact.	-0,03415		
F40	Mazhar Zorlu Holding	-0,23529		
F45	Yazıcılar Holding	-0,91273		
F51	Nurol Gmyo	-0,14286		
F55	Alternatif Yat.Ort.	-0,18333		
F57	Atlantis Yat. Ort.	-0,18627		
F58	Atlas Yat. Ort.	-0,03509		
F60	Bumerang Yat.Ort.	-0,10417		
F61	Deniz Yat. Ort.	0,098039		
F64	Finans Yat. Ort.	0,04		
F65	Garanti Yat. Ort.	0,275362		
F68	M. Yılmaz Yat.Ort.	-0,13043		
F69	Syb Yat. Ort.	-0,05495		
F70	Taç Yat. Ort.	-0,28169		
Total Return of Portfolio		-0,10734		
			Index Return (03.31.2003)	
			ISE National-100	-0,0862
			ISE National-50	-0,0891
			ISE National-30	-0,0861

On December 31, 2002, 84 financial DMUs listed on ISE were included in to the efficiency analysis. According to the result of input-oriented DEA, the portfolio was constructed by using 11 DMUs whose efficiency scores equal to 1 ($\alpha = 1$)

Table 5 Portfolio5 (03.31.2003)

(DMU)	Efficient DMU ($\alpha = 1$)	Return (06.31.2003)	Index Return (06.31.2003)	
F6	İş Bankası (A)	-0,09326	ISE National-100	0,148
F22	Finans Fin. Kir.	0,327536	ISE National-50	0,150
F56	Ata Yat.Ort.	0,520408	ISE National-30	0,147
F57	Atlantis Yat. Ort.	0,240964		
F58	Atlas Yat. Ort.	0,04		
F60	Bumerang Yat.Ort.	0,265116		
F68	M. Yılmaz Yat.Ort.	0,575		
F70	Taç Yat. Ort.	0,545098		
Total Return of Portfolio		0,302607		

On March 31, 2003, 76 financial DMUs listed on ISE were included in to the efficiency analysis. According to the result of input-oriented DEA, the portfolio was constructed by using 8 DMUs whose efficiency scores equal to 1 ($\alpha = 1$)

Table 6 Portfolio6 (06.31.2003)

(DMU)	Efficient DMU ($\alpha = 1$)	Return (09.31.2003)	Index Return (09.31.2003)	
F1	Akbank	0,321429	ISE National-100	0,199
F3	Dışbank	-0,21698	ISE National-50	0,221
F6	İş Bankası (A)	0,11881	ISE National-30	0,238
F13	Tekstilbank	-0,13636		
F14	Yapı Ve Kredi Bank.	0,045455		
F22	Finans Fin. Kir.	-0,11354		
F26	Tekstil Fin. Kir.	0,1875		
F28	Toprak Fin. Kir.	-0,05941		
F46	Alarko Gmyo	-0,01681		
F47	Atakule Gmyo	0,026316		
F54	Ak Yat.Ort.	0,243243		
F56	Ata Yat.Ort.	0,053691		
F57	Atlantis Yat. Ort.	0,15534		
F58	Atlas Yat. Ort.	-0,02797		
F60	Bumerang Yat.Ort.	0,161765		
F61	Deniz Yat. Ort.	-0,03896		
F63	Evren Yat. Ort.	0,138889		
F64	Finans Yat. Ort.	0,067797		
F68	M. Yılmaz Yat.Ort.	-0,09524		
F69	Taç Yat. Ort.	0,28934		
F72	Varlık Yat.Ort.	-0,02041		
F73	Yapı Kredi Yat.Ort.	0,240964		
Total Return of Portfolio		0,060221		

On June 31, 2003, 75 financial DMUs listed on ISE were included in to the efficiency analysis. According to the result of input-oriented DEA, the portfolio was constructed by using 22 DMUs whose efficiency scores equal to 1 ($\alpha = 1$)

Table 7 Portfolio7 (09.31.2003)

(DMU)	Efficient DMU ($\alpha = 1$)	Return(12.31.2003)	Index Return (12.31.2003)	
F3	Dışbank	0,954545	ISE National-100	0,426
F6	İş Bankası (A)	-0,10619	ISE National-50	0,429
F13	Tekstilbank	0,184211	ISE National-30	0,452
F14	Yapı Ve Kredi Bank.	0,801242		
F18	Commercial Un. Sig.	0,45283		
F22	Finans Fin. Kir.	0,724138		
F26	Tekstil Fin. Kir.	0,326316		
F51	Nurol Gmyo	0,783333		
F57	Atlantis Yat. Ort.	0,907563		
F58	Atlas Yat. Ort.	0,697842		
F60	Bumerang Yat.Ort.	0,322785		
F61	Deniz Yat. Ort.	2,175676		
F64	Finans Yat. Ort.	0,666667		
F68	M. Yılmaz Yat.Ort.	1,140351		
F72	Varlık Yat.Ort.	0,479167		
Total Return of Portfolio		0,700698		

On September 31, 2003, 75 financial DMUs listed on ISE were included in to the efficiency analysis. According to the result of input-oriented DEA, the portfolio was constructed by using 20 DMUs whose efficiency scores equal to 1 ($\alpha = 1$)

Table 8 Portfolio8 (12.31.2003)

(DMU)	Efficient DMU ($\alpha = 1$)	Return (03.31.2004)	Index Return (03.31.2004)	
F56	Alternatif Yat.Ort.	0,131783	ISE National-100	0,084
F57	Ata Yat.Ort.	0,6	ISE National-50	0,0789
F58	Atlantis Yat. Ort.	0,497797	ISE National-30	0,0653
F59	Atlas Yat. Ort.	0,25		
F60	Avrasya Yat.Ort.	0,020833		
F61	Bumerang Yat.Ort.	1,368421		
F62	Deniz Yat. Ort.	0,457447		
F63	Eczacıbaşı Yat. Ort.	0,19863		
F64	Evren Yat. Ort.	0,329545		
F65	Finans Yat. Ort.	0,27619		
F66	Garanti Yat. Ort.	0,572816		
F67	Global Yat. Ort.	0,251701		
F68	İş Yat. Ort.	0,403743		
F69	M. Yılmaz Yat.Ort.	2,954918		
F70	Taç Yat. Ort.	0,291667		
F71	Tskb Yat. Ort.	1,01005		
F72	Vakıf Yat. Ort.	0,293103		
F73	Varlık Yat.Ort.	0,450704		
F74	Yapı Kredi Yat.Ort.	-0,00556		
F75	Global Menkul Değ.	-0,02817		
Total Return of Portfolio		0,516281		

On December 31, 2003, 76 financial DMUs listed on ISE were included in to the efficiency analysis. According to the result of input-oriented DEA, the portfolio was constructed by using 20 DMUs whose efficiency scores equal to 1 ($\alpha = 1$)

Table 9 Portfolio9 (03.31.2004)

(DMU)	Efficient DMU ($\alpha = 1$)	Return(06.31.2004)	Index Return (06.31.2004)	
F1	Akbank	-0,22143	ISE National-100	-0,11
F3	Dışbank	-0,05	ISE National-50	-0,107
F6	İş Bankası (A)	-0,16435	ISE National-30	-0,111
F11	T.S.K.B.	-0,12069		
F12	T.Ekonomi Bank.	-0,13021		
F18	Commercial Un. Sig.	-0,02685		
F26	Tekstil Fin. Kir.	-0,32886		
F28	Toprak Fin. Kir.	0,389706		
F30	Yapı Kredi Fin.Kir.	0,189873		
F41	Mazhar Zorlu Holding	-0,22353		
F45	Vakıf Risk	-0,05833		
F53	Vakıf Gmyo	-0,15556		
F58	Atlantis Yat. Ort.	-0,05882		
F59	Atlas Yat. Ort.	-0,0678		
F61	Bumerang Yat.Ort.	-0,59596		
F70	M. Yılmaz Yat.Ort.	-0,66425		
F73	Vakıf Yat. Ort.	-0,11238		
F74	Varlık Yat.Ort.	-0,14563		
Total Return of Portfolio		-0,14139		

On March 31, 2004, 77 financial DMUs listed on ISE were included in to the efficiency analysis. According to the result of input-oriented DEA, the portfolio was constructed by using 18 DMUs whose efficiency scores equal to 1 ($\alpha = 1$)

Table 10 Portfolio10 (06.31.2004)

(DMU)	Efficient DMU ($\alpha = 1$)	Return (09.31.2003)	Index Return (09.31.2004)	
F1	Akbank	0,247706	ISE National-100	0,221
F6	İş Bankası (A)	0,186047	ISE National-50	0,222
F11	T.S.K.B.	0,127451	ISE National-30	0,217
F18	Commercial Un. Sig.	1,57931		
F20	Ray Sigorta	0,284211		
F26	Öz Finans Fact.	0,262857		
F27	Tekstil Fin. Kir.	0,34		
F30	Yapı Kredi Fin.Kir.	-0,31915		
F41	Mazhar Zorlu Holding	0,159091		
F45	Vakıf Risk	0,336283		
F53	Vakıf Gmyo	0,295547		
F57	Ata Yat.Ort.	0,236364		
F58	Atlantis Yat. Ort.	-0,00781		
F59	Atlas Yat. Ort.	0,081818		
F60	Avrasya Yat.Ort.	0,189655		
F61	Bumerang Yat.Ort.	0,2625		
F64	Evren Yat. Ort.	0,203947		
F67	Global Yat. Ort.	0,493333		
F68	İnfo Yat. Ort.	0,235772		
F70	M. Yılmaz Yat.Ort.	0,469136		
F72	Tskb Yat. Ort.	-0,19014		
F74	Varlık Yat.Ort.	0,119318		
Total Return of Portfolio		0,254238		

On June 31, 2004, 77 financial DMUs listed on ISE were included in to the efficiency analysis. According to the result of input-oriented DEA, the portfolio was constructed by using 22 DMUs whose efficiency scores equal to 1 ($\alpha = 1$)

Table 11 Portfolio11 (09.31.2004)

(DMU)	Efficient DMU ($\alpha = 1$)	Return (12.31.2004)	Index Return (12.31.2004)	
F6	İş Bankası (A)	0,108683	ISE National-100	0,137
F21	Yapı Kredi Sigorta	0,137255	ISE National-50	0,141
F23	Finans Fin. Kir.	0,128834	ISE National-30	0,147
F26	Öz Finans Fact.	-0,0905		
F27	Tekstil Fin. Kir.	-0,3806		
F41	Mazhar Zorlu Holding	-0,15686		
F53	Vakıf Gmyo	0,44375		
F57	Ata Yat.Ort.	0,102941		
F58	Atlantis Yat. Ort.	-0,37008		
F59	Atlas Yat. Ort.	0,478992		
F60	Avrasya Yat.Ort.	-0,03623		
F61	Bumerang Yat.Ort.	-0,49307		
F74	Varlık Yat.Ort.	0,15736		
Total Return of Portfolio		0,002344		

On September 31, 2004, 77 financial DMUs listed on ISE were included in to the efficiency analysis. According to the result of input-oriented DEA, the portfolio was constructed by using 13 DMUs whose efficiency scores equal to 1 ($\alpha = 1$)

Table 12 Portfolio12 (12.31.2004)

(DMU)	Efficient DMU ($\alpha = 1$)	Return (03.31.2005)	Index Return (03.31.2005)	
F1	Akbank	-0,21557	ISE National-100	0,023
F7	İş Bankası (A)	0,263264	ISE National-50	0,02
F12	T.S.K.B.	1,259542	ISE National-30	0,012
F18	Anadolu Sigorta	-0,04294		
F19	Aviva Sigorta	0,364486		
F22	Yapı Kredi Sigorta	0,298851		
F24	Finans Fin. Kir.	0,456522		
F27	Öz Finans Fact.	-0,16915		
F28	Tekstil Fin. Kir.	-0,06024		
F29	Toprak Fin. Kir.	0,14966		
F44	Mazhar Zorlu Holding	-0,06977		
F48	Vakıf Girişim	0,152778		
F56	Vakıf Gmyo	0,277056		
F58	Ak Yat.Ort.	-0,07519		
F60	Ata Yat.Ort.	-0,06667		
F61	Atlantis Yat. Ort.	0,153465		
F62	Atlas Yat. Ort.	-0,02727		
F64	Bumerang Yat.Ort.	-0,09375		
F76	Vakıf Yat. Ort.	-0,00671		
F77	Varlık Yat.Ort.	-0,19298		
Total Return of Portfolio		0,117769		

On December 31, 2004, 79 financial DMUs listed on ISE were included in to the efficiency analysis. According to the result of input-oriented DEA, the portfolio was constructed by using 20 DMUs whose efficiency scores equal to 1 ($\alpha = 1$)

Table 13 Portfolio13 (03.31.2005)

(DMU)	Efficient DMU ($\alpha = 1$)	Return (06.31.2005)	Index Return (06.31.2005)	
F7	İş Bankası (A)	-0,168	ISE National-100	0,0547
F27	Öz Finans Fact.	-0,01796	ISE National-50	0,0581
F44	Mazhar Zorlu Holding	-0,45833	ISE National-30	0,0587
F60	Ata Yat.Ort.	-0,06429		
F64	Bumerang Yat.Ort.	-0,11207		
F66	Eczacıbaşı Yat. Ort.	0,009174		
F77	Varlık Yat.Ort.	0,119565		
F79	Yatırım Fin. Yat.Ort.	0,42029		
Total Return of Portfolio		-0,03395		

On March 31, 2005, 80 financial DMUs listed on ISE were included in to the efficiency analysis. According to the result of input-oriented DEA, the portfolio was constructed by using 8 DMUs whose efficiency scores equal to 1 ($\alpha = 1$)

Table 14 Portfolio14 (06.31.2005)

(DMU)	Efficient DMU ($\alpha = 1$)	Return (09.31.2003)	Index Return (09.31.2005)	
F1	Akbank	0,162338		
F7	İş Bankası (A)	0,125	ISE National-100	0,236
F8	İş Bankası (B)	-0,00625	ISE National-50	0,234
F23	Factotürk Faktoring	0,628743	ISE National-30	0,245
F27	Öz Finans Fact.	0,006098		
F28	Tekstil Fin. Kir.	0,3875		
F29	Toprak Fin. Kir.	0,949686		
F44	Mazhar Zorlu Holding	0,052632		
F46	Şişe Cam	0,097436		
F61	Ata Yat.Ort.	-0,76031		
F62	Atlantis Yat. Ort.	-0,03571		
F65	Bumerang Yat.Ort.	0,203883		
F67	Eczacıbaşı Yat. Ort.	0,154545		
F68	Evren Yat. Ort.	0,101449		
F72	İnfotrend Yat.Ort.	-0,24576		
F76	Taç Yat. Ort.	0,136364		
F78	Vakıf Yat. Ort.	0,088757		
F79	Varlık Yat.Ort.	0,737864		
Total Return of Portfolio		0,154681		

On June 31, 2005, 82 financial DMUs listed on ISE were included in to the efficiency analysis. According to the result of input-oriented DEA, the portfolio was constructed by using 18 DMUs whose efficiency scores equal to 1 ($\alpha = 1$)

Table 15 Compare with the Return of Portfolio (03.31.2002-09.31.2005)

Portfolio-DAE	ISE National-100	ISE National-50	ISE National-30
-0,219	-0,1969	-0,1979	-0,2018
-0,0871	-0,057	-0,065	-0,081
0,177506	0,172	0,175	0,180
-0,10734	-0,0862	-0,0891	-0,0861
0,302607	0,148	0,1503	0,147
0,060221	0,199	0,221	0,238
0,700698	0,426	0,429	0,452
0,516281	0,084	0,0789	0,0653
-0,14139	-0,110	-0,107	-0,111
0,254238	0,221	0,222	0,217
0,002344	0,137	0,141	0,147
0,117769	0,023	0,020	0,012
1,812767	0,0547	0,0581	0,0587
0,154681	0,236	0,234	0,245
9,458772²	1,843539	1,8823	1,876134

² Total Return for 14 period = $[\prod_{i=1}^k (1 + YGi) - 1]$ where;

YG_i = Returns of one period

k = Number of period

Conclusion

Investors consider several criteria and use several methods to allocate portfolio in stock exchange market.

In this study, DEA method was used for portfolio allocation and the return of this portfolio was compared with the return of Index. From 2002 to 2005 14 portfolios for each quarterly period were allocated and returns of these portfolios were compared with the return of the index for the same period. As a result, In 6 of these 14 periods (09.31.2002; 03.31.2003; 31.09.2003; 12.31.2003; 06.31.2004; 03.31.2005), the return from the portfolio allocated according to DEA was higher than the market return.

The total return from portfolio is 9, 44 whereas the total return from index remind 1, 84; 1, 88; 1, 87 respectively. From 2002 to 2005 this results suggest that DEA method can be used for portfolio allocation by investors.

This model may give opportunity for earning abnormal return to investors. Moreover if this model can be turned into a dynamic software packet, it might be a very useful instrument for portfolio allocation.

In further studies potential recovery rate which shows what portion of input and output should be changed can be calculated for the stocks that are not included in the portfolio. This could enable those stocks to be included in the portfolio by taking into account their potential recovery rate.

Furthermore, it can be investigated whether the portfolio allocation model by using DEA is an alternative portfolio allocation technique. Other portfolio allocation method can be applied for the same period and the returns of the constructed portfolios can be compared.

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