

Performance evaluation of the Slovak equity mutual funds based on the Data Envelopment Analysis

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Abstract

Investing to the mutual funds is an inseparable part of the effective financial market. The papers are focused on the possibilities of performance quantification of the selected equity mutual funds on the basis of Data Envelopment Analysis. The relevant input and output variables of the model are chosen based on the practical experiences and published studies dealing with this issue. Consequently the model is formed for the ten most important Slovak equity mutual funds over the time period from 1st January 2008 to 30th November 2012. The output of the contribution is the complex performance evaluation of selected mutual funds and providing investments' recommendations for retail investors who the tools of collective investments are primary make up for.

Keywords: mutual funds, efficiency, output variables, input variables, Data Envelopment Analysis (DEA)

1. Introduction

The theoretical fundamentals of the effectiveness analysis were made by Koopmans (1951) who defined the efficiency

as admissible input/output vector in which it is not possible to expand any output (or to reduce any input) without simultaneous reduction of another output (or without expand of another input). Debreau (1951) and later Farrell (1957) derived input oriented indexes of the technical efficiency expressed by the form of equiproportional (radial) reduction of all inputs at the given level of outputs. Charnes, Cooper and Rhodes (CCR DEA model 1978) or Bankerer, Charnes, Cooper (BBC DEA model 1984) built on previous works and put the basis of the Data Envelopment Analysis (DEA). The aim of these DEA methods is to eliminate or exclude the subjectivity by measuring of outputs in relation to invested inputs. Selection process of inputs and outputs, which are given for comparison, modifies the analysis process to objective process and limits subjectivity. The weights are set by the linear mathematical model to the inputs and outputs of the decision making units (in our case these decision making units are mutual funds). The weights represent efficiency of the decision making units. The models evaluated units have the same form but in the case of the different efficiency they have the different values of the weights. The companies are compared and classified ac-

ording to these weights. Regarding to the fact, that weights are proportional numbers, it does not matter in which measures they are expressed.

DEA methodology has become very popular in the calculation of efficiency, because it allows to take the transformation of the various inputs to the various outputs into account in the relatively simple way, it is non-parametric, it does not require the price of the inputs and it is not required to define the type of behaviour of the decision making unit (maximization of the profit or minimization of the costs) in advance.

DEA methodology can be used in the measurement of efficiency or capacity of the mutual funds. Let us to mention some of the studies which dealt with this issue. McMullen and Strong (1998) evaluated efficiency of the 135 equity mutual funds in the USA. Murtha, Choi and Desai (1997) used DEA methodology to quantify the 731 mutual funds. Grinblatt and Titman (1994) studied efficiency of the 335 mutual funds. Galagedera and Silvapulle used DEA to measure the relative efficiency of the 257 mutual funds. Some studies which dealt with this issue are mentioned in the table no. 1.

Authors	Type of model	Inputs	Outputs
Murthi et al. (1997)	CCR	standard deviation, expense ratio, turn-over	mean gross returns
McMullen & Strong (1998)	CCR	standard deviation, minimum investments, expense ratio	one-year, three-year and five-year mean returns
Basso & Funary (2001)	CCR	Beta coefficient, variance, expense ratio	mean returns
Tarim & Karan (2001)	CCR	standard deviation, expense ratio	mean returns
Choi & Murthi (2001)	CCR, BCC	standard deviation, expense ratio, turn-over	mean returns
Sengupta (2003)	BCC	Beta coefficient, expense ratio, turn-over	mean returns, skewness
Gregoriou (2003)	BCC	variance, skewness	mean returns
Gregoriou & Zhu (2005)	CCR, BCC	standard deviation, undesirable standard deviation	mean returns, mean profit, compound return, incremental growth
Gregoriou et al. (2005)	BCC	variance, skewness	mean returns
Kooli et al. (2005)	BCC	variance, skewness	mean returns

Table 1: Study cases of the efficiency evaluation of the mutual funds
Source: self-processed

2. The Basic DEA models

Nowadays there is big number of DEA models, but in general we can classify DEA models as follows:

- according to the orientation:
 - DEA models input oriented
 - DEA models output oriented
- according to the trend of the returns to scale
 - constant returns to scale (CCR DEA models)
 - variable returns to scale (BCC DEA models)

CCR DEA models input and output orientated are applied in our papers.

2.1. CCR DEA model input oriented

This model maximizes the measure of efficiency of the evaluated mutual fund U_q . The measure of efficiency is defined as a ratio of the weighed outputs and weighted inputs under the conditions that the efficiency measures of all other mutual funds are less or equal to zero. The model for mutual fund U_q can be defined as the function of the linear programming as follows:

$$\begin{aligned} \text{maximize} \quad & z = \sum_{i=1}^r u_i y_{iq} \\ \text{subject to} \quad & \sum_{i=1}^r u_i v_{ik} \leq \sum_{j=1}^m v_j x_{jk}, \quad k = 1, 2, 3, \dots, n, \\ & \sum_{j=1}^m v_j x_{jq} = 1, \\ & u_i \geq \varepsilon, \quad i = 1, 2, 3, \dots, m, \\ & v_j \geq \varepsilon, \quad j = 1, 2, 3, \dots, n, \end{aligned} \quad (1)$$

Evaluated mutual fund U_q lies on the CCR effective frontier and it is marked as CCR effective if the optimal value of the efficiency measure, calculated by the equation (1), is equal to zero, i. e. $z^*=1$. The optimal value of the efficiency measure of the ineffective mutual funds is less than one. Model (1) is called primary CCR model input oriented.

2.2. CCR DEA model output oriented

This model maximizes the measure of efficiency of the evaluated mutual fund U_q . The measure of efficiency is defined as a ratio of the weighed outputs and weighted inputs under the conditions that the efficiency measures of all other mutual funds are less or equal to one. The model for mutual fund U_q can be defined as the function of the linear programming as follows:

$$\begin{aligned} \text{minimize} \quad & g = \sum_{j=1}^m v_j x_{jq} \\ \text{subject to} \quad & \sum_{i=1}^r u_i y_{ik} \sum_{j=1}^m v_j x_{jk}, \quad k = 1, 2, 3, \dots, n, \\ & \sum_{i=1}^r u_i y_{ik} = 1, \\ & u_i \frac{x_{iq}}{x_{ij}}, \quad i = 1, 2, 3, \dots, m, \\ & v_j \frac{x_{iq}}{x_{ij}}, \quad j = 1, 2, 3, \dots, n, \end{aligned} \quad (2)$$

The interpretation of the model's results (2) is similar to CCR model input oriented (1). Mutual fund U_q is effective if the optimal value of the objective function g^* is equal to one. If the value is bigger than one, the mutual fund is not operating effectively and optimal value Φq^* expresses the necessity of proportional outputs increasing of the mutual fund. The mutual fund will be operating effectively after increasing.

3. DEA analysis of the Slovak equity mutual funds

We consider the first five indicators as the input variables (standard deviation, Beta coefficient, undesirable skewness, expense ratio and the level of the minimum investments); mean annual returns and mean annual profit are consider as our output variables. Input values of the model for ten equity mutual funds over the period from 1st January 2008 to 30th November 2012 are mentioned in the table no. 2.

The results of efficiency of the equity mutual funds for CCR DEA model input oriented are presented in the table no. 3. The results for CCR DEA model output oriented are presented in the table no. 4.

	Standard deviation	Beta coefficient	Undesirable skewness	Expense ratio [%]	Minimum investment [€]	Mean returns	Mean profit
ČSOB POPF	0,5240	0,7026	-0,0364	5,7000	150,0000	-0,1072	0,9652
DEXIA ELE	0,3010	0,4691	-0,0225	4,2000	170,0000	-0,0380	0,2734
DEXIA QEW	0,2927	0,4557	-0,0241	4,2000	170,0000	-0,0179	0,5429
ESPA SB	0,4303	0,5975	-0,0322	5,8000	996,0000	0,0337	0,6734
ESPA SEE	0,5497	0,8565	-0,0403	5,3000	996,0000	-0,0373	1,1149
ESPA SJ	0,2269	0,2399	-0,0232	5,5000	996,0000	-0,0783	0,4613
KBC EFB	0,5045	0,7016	-0,0304	4,3000	150,0000	-0,0710	0,8054
KBC EFE	0,3212	0,4558	-0,0261	4,3000	150,0000	-0,0699	0,6707
KBC EFF	0,4731	0,5355	-0,0298	4,4000	150,0000	-0,0652	0,6391
KBC EFO	0,2771	0,3299	-0,0285	4,4000	150,0000	0,0570	0,6982

Table 2: Input variables of DEA models for mutual equity funds
Source: self-processed

EQUITY MUTUAL FUND	Efficiency rates	Standard deviation		Beta coefficient		Undesirable skewness		Expense ratio		Minimal investments	
		Original	Adjusted	Original	Adjusted	Original	Adjusted	Original	Adjusted	Original	Adjusted
1.	1,00	0,524	0,524	0,703	0,703	0,014	0,014	5,700	5,700	150	150
2.	0,66	0,301	0,175	0,469	0,208	0,027	0,014	4,200	2,773	170	95
3.	0,79	0,293	0,231	0,456	0,287	0,026	0,016	4,200	3,324	170	135
4.	1,00	0,430	0,423	0,597	0,596	0,018	0,018	5,800	5,149	996	548
5.	1,00	0,550	0,550	0,856	0,856	0,010	0,010	5,300	5,300	996	996
6.	0,91	0,227	0,183	0,240	0,218	0,027	0,014	5,500	2,907	996	99
7.	1,00	0,505	0,505	0,702	0,702	0,020	0,020	4,300	4,300	150	150
8.	0,95	0,321	0,304	0,456	0,382	0,024	0,020	4,300	4,065	150	142
9.	0,84	0,473	0,338	0,535	0,448	0,020	0,017	4,400	3,682	150	126
10.	1,00	0,277	0,277	0,330	0,330	0,022	0,022	4,400	4,400	150	150

Table 3: Efficiency rates of the equity mutual funds input oriented model
Source: self-processed

The funds which values of the objective function are equal to one are effective and vice-versa the funds which ratio of effectiveness is less than one are ineffective. So we can claim, that the funds KBC EFO, KBC EFB, ESPA SEE and ČSOB POPF are all effective and KBC EFF, KBC EFE, ESPA SJ, ESPA SB, DEXIA QEW and DEXIA ELE are ineffective.

The ineffective funds have to reduce

some of the input variables or all of them in order to become effective. For example fund DEXIA ELE has to reduce the risk expressed by standard deviation from the value 0,300969 to the value 0,17462, index Beta from 0,46914 to 0,20787, undesirable skewness from 0,027473 to 0,01355, expense ratio from 4,2 to 2,77 and minimal investments from 170 to 94,53.

EQUITY MUTUAL FUND	Efficiency rates	Mean returns		Mean profit	
		Original	Adjusted	Original	Adjusted
1.	1,00000	0,016745	0,04800	0,10108	0,10109
2.	1,51473	0,068153	0,06815	0,14604	0,14605
3.	1,26360	0,079042	0,07904	0,14556	0,14557
4.	1,00309	0,09246	0,09246	0,30234	0,30235
5.	1,00000	0,009318	0,02322	0,04742	0,04743
6.	1,10066	0,077199	0,07720	0,14172	0,14172
7.	1,00000	0,080497	0,08050	0,16941	0,16941
8.	1,05783	0,067686	0,06769	0,08065	0,08066
9.	1,19505	0,089937	0,08994	0,18737	0,18738
10.	1,00000	0,04711	0,06953	0,15974	0,15975

Table 4: Efficiency rates of the mutual equity funds output oriented model
Source: self-processed

The equity mutual funds which values of the objective function are equal to one are operating effective and on the other hand the funds with the rate of efficiency more than one are ineffective. So we can again claim that funds KBC EFO, KBC EFB, ESPA SEE and ČSOB POPF are effective and equity mutual funds KBC EFF, KBC EFE, ESPA SJ, ESPA SB, DEXIA QEW and DEXIA ELE are consider to be ineffective.

The ineffective funds have to increase some of the output variables or all of them in order to become effective. For example fund DEXIA ELE has to increase mean returns from the value 0,068153 to the value 0,06815 and mean profit from 0,14604 to 0,14605.

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4. References

- [1] BANKER, R.D., CHARNES, A., COOPER, W.W., "Some models for estimating technical and scale inefficiency in data envelopment analysis," *Management Science* 39/10, 1984.
- [2] CHARNES, A., W.W. COOPER, E. RHODES, "Measuring the efficiency of decision making units," *European Journal of Operational Research* 2, pp. 429–444, 1978.

- [3] DEBREAU, G., "The coefficient of resource utilization," *Econometrica* 19, pp. 273-292, 1951.
- [4] FARRELL, M.J., "The measurement of productive efficiency," *Journal of the Royal Statistical Society, Series A* 120, pp. 253-281, 1957
- [5] JABLONSKÝ, J., DLOUHÝ, M., "Modely hodnocení efektivnosti produkčních jednotek," *Professional Publishing*, 2004, ISBN 80-86419-49-5
- [6] KOOPMANS, T.C., "An analysis of production as an efficient combination of activities," *Koopmans, T.C. (Eds.), Activity Analysis of Production and Allocation*. Wiley, New York, 1951.
- [7] ZHU, J., "Quantitative Models for Performance Evaluation and Benchmarking: Data Envelopment Analysis with Spreadsheets and DEA Excel Solver," *Springer*, 2002.
- [8] GREGORIOU, G. N. "Performance appraisal of hedge funds using data envelopment Analysis," *Journal of Wealth Management*, 2003
- [9] GREGORIOU, G.N., SEDZRO, K., ZHU, J., "Hedge fund performance appraisal using data envelopment analysis," *European Journal of Operational Research* Vol 164, No 4, 2005
- [10] KOOLI, M., MORIN, F., SEDZRO, K., "Evaluation des mesures de performance des hedge funds," *Communication at International Conference of the French Association of Finance*, Paris, June 2005. ISBN 9781405156486.
- [11] MURTHI, B. P. S., CHOI, Y. K., & DESAI. P. "Efficiency of mutual funds and portfolio performance measurement: a non-parametric approach," *European Journal of Operational Research*, pp. 98, 1997.
- [12] MCMULLEN, P. R., & STRONG, R. A., "Selection of mutual funds using Data envelopment analysis," *Journal of Business and Economic Studies*, 4, 1998.
- [13] GRINBLATT, M., TITMAN, S., "A study of monthly mutual fund returns and performance evaluation technique," *Journal of Financial Quantitative Analysis*, 29(3), 1994.