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Evaluating Greek Equity Funds Using Data Envelopment Analysis

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Abstract

This study assesses the relative performance of Greek equity funds employing a non-parametric method, specifically Data Envelopment Analysis (DEA). Using an original sample of cost and operational attributes we explore the effect of each variable on funds' operational efficiency for an oligopolistic and bank-dominated fund industry. Our results have significant implications for the investors' fund selection process since we are able to identify potential sources of inefficiencies for the funds. The most striking result is that the percentage of assets under management affects performance negatively, a conclusion which may be related to the structure of the domestic stock market. Furthermore, we provide evidence against the notion of funds' mean-variance efficiency.

JEL Classification:G14,G15,G21,G23

Keywords:data envelopment analysis, portfolio efficiency, performance evaluation

1 Introduction

Open-end mutual funds are some of the most successful institutions in modern financial markets worldwide. These are collective investment vehicles that pool money from individual investors to buy the most attractive securities in order to achieve the maximum benefit in terms of risk-adjusted return. Their great popularity is mainly due to the advantages of professional management and risk reduction through portfolio diversification they offer to their shareholders. However, the delegated nature of the fund industry can result in conflicts

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of interest between shareholders who wish to maximize their return and fund managers who seek to maximize their compensation that depends on the fund's assets (Chevallier & Ellison, 1997).

The problem of investor's optimal portfolio selection has received a lot of attention since the pioneering work of Markowitz (1952) and Tobin (1958). In the context of modern portfolio mean-variance theory investors seek to maximize their utility choosing among all possible mean-variance efficient portfolios given their risk preferences. Mean-variance efficiency is defined as the ability of a set of assets to yield the maximum return for a given level of risk or, alternatively, to produce the minimum level of risk for a given expected return.

A related issue to portfolio efficiency is portfolio performance evaluation. The most common criteria are the Sharpe ratio (1966), that measures the excess return of a portfolio adjusted for the variability of its returns measured by their standard deviation, Treynor ratio (1965) and Jensen's alpha (1968), the latter two being based on CAPM theory. In the last three decades, following the equilibrium model of capital market prices of Sharpe (1964) and Lintner (1965), researchers have proposed various parametric measures for portfolio performance assessment.

However, almost all of the employed measures are plagued with two important shortcomings that have been extensively analysed in the relevant literature. The first concerns the choice of a proper benchmark which is closely related to what constitutes normal performance of a portfolio. In the context of modern portfolio theory, benchmark return is defined by a strategy of comparable risk that combines investment in a risk-free asset and in the tangent portfolio that contains all risky assets. Various studies have pinpointed the sensitivity of portfolio performance evaluation to the employed measures (Roll 1977, Lehman & Modest 1987). The second important problem arising from the traditional performance measures is their inability to incorporate the various costs incurred by the mutual fund shareholders. Open-end fund investors face a series of direct and indirect charges which ultimately reduce their received net return. These costs include sales charges (front and back-end loads) and other operational, administrative and marketing costs that are usually proxied by the fund's expense ratio. A series of studies (Malkiel 1995, Carhart 1997, Prather et al 2004, Babalos et al 2009) has examined the impact of costs on fund's returns and detected a negative relationship between fund's performance and various fund's costs.

The inherent disadvantages of traditional performance measures can be effectively alleviated by employing an alternative non-parametric measure that was firstly introduced by Murtrhi et al. (1997). This is obtained using a method known as Data Envelopment Analysis (DEA, Charnes et al., 1978), which is applied extensively in operational management research to compute relative measures of efficiency. The DEA approach allows us to gauge an individual fund's investment performance by measuring its efficiency compared to the peer group funds. DEA accomplishes this by constructing an efficient frontier from a linear combination of the perfectly efficient funds and determining fund deviations from that frontier, which represent performance inefficiencies defined as slacks.

The present study addresses the important topic of portfolio performance evaluation from an operational efficiency perspective using an original dataset. In particular we employ the non-parametric DEA method to measure the performance of a sample of Greek domestic equity funds. We further compute the DEA inefficiency measures of the individual input and output factors in order to identify the source and extent of any performance inefficiency. The oligopostic structure of the Greek mutual fund industry, combined with the small size and illiquidity of the Athens Stock Exchange (ASE), makes the Greek case an interesting one. Specifically, we are able to explore whether the percentage of fund assets under management affects the successful implementation of a fund's investment strategy given the small size and illiquidity of the domestic stock market.

The issue of fund's operational efficiency is crucial for both investors and managers. The former in particular are concerned that the various charges imposed by the funds be used effectively in their best interest, and that funds exploit their available resources in the most efficient way.Our analysis contributes to the existing literature in several ways. Firstly, we provide results for a small, developed European market, with possible implications for other markets of similar size. Secondly, we analyse funds' risk efficiency by examining slacks for the risk input variable. We employ three different measures of performance, namely raw returns, Jensen's alpha (1968) and finally the Carhart's measure of abnormal performance (1997), thus providing a complete assessment of a fund's behaviour. Lastly, we include into our analysis another important operational fund attribute, namely the liquidity ratio, that captures the effect of strategic asset allocation on portfolio performance.

To preview our results, we find that the majority of domestic equity funds for the period under examination exhibit significant inefficiencies. The main inefficiencies lie in the size of the funds, that seems to be a constraint in view of the characteristics of the domestic stock market. Large funds are frequently obliged to invest disproportionally in particular stocks, especially in the case of illiquid stock markets, thereby eroding fund performance.[1] Further, front-end loads are found to play a significant negative role in funds' performance, a finding consistent with other studies and with important implications for shareholders. As for portfolio diversification, domestic equity funds appear not to have eliminated effectively the non-systemic component of their portfolio riskiness since the risk variable exhibits significant inefficiencies (slacks).

The remainder of the paper is organized as follows: in the next section we provide a short review of the relevant literature, while in section 3 we present a brief description of the Greek mutual fund industry. Section 4 provides details of the variables and the sample used, and of the calculation of risk-adjusted returns; Section 5 outlines the DEA method, and Section 6 presents the empirical results. Finally, Section 7 offers some concluding remarks.

2 Literature Review

The literature on the measurement of funds' performance by means of a non-parametric approach is rather limited compared with the numerous studies using the traditional parametric methods such as reward-to-volatility ratios (Treynor 1965, Sharpe 1966) or regression-based abnormal return measures (e.g. Jensen's alpha 1968, Carhart's alpha 1997). Murthi et al. (1997) were the first to apply

[1] See, inter alia, Chen et al (2004).

the DEA method for fund performance evaluation.They employed data for a sample of 2083 US equity mutual funds which were drawn from Morningstar and covered the third quarter of 1993. They detected a significant positive relation between their efficiency index and Jensen's alpha for all categories of funds. The model specification included standard deviation of returns, expense ratio, load and turnover as inputs, and mean gross return as output. Basso & Funari (2001) employed both a single input-output formulation and a generalized version of the DEA approach incorporating as one of the outputs a stochastic dominance criterion. They used several risk measures (standard deviation, standard semi-deviation and beta) and subscription and redemption costs as inputs, and the mean return and the percentage of periods in which the fund was non-dominated as outputs. Their aim was to evaluate the performance of a sample of 47 Italian funds that were classified as equity, bond and balanced funds over the period from 1/1/1997 to 30/6/1999. Their results stressed the importance of the subscription and redemption costs in determining the fund rankings. Murthi & Choi (2001), employing the same inputs and outputs as in Murthi et al. (1997), established a relation between mean-variance and cost-return efficiency by linking their new non-parametric, DEA-based performance measure to the traditional Sharpe index. They applied their new performance measure to a sample of 731 US equity funds belonging to 7 different categories that reported data for the third quarter of 1993. A striking result was that more than 90% of aggressive growth funds exhibited increasing returns to scale. Funds' loads and turnover were identified as major sources of slacks across all funds' categories. Galagadera and Silvapulle (2002) used DEA to assess the relative performance of 257 Australian mutual funds for the period 1995-1999. Minimum initial investment and several time horizons (1,2,3 and 5 years) for the mean return were used as inputs. Their results suggest that scale efficiency is the main source of overall technical efficiency and that both are higher for risk-averse funds with high positive net asset flows. Sengupta (2003) examined the relative performance for a dataset of 60 US fund portfolios from Morningstar for a period of 11 years (1988-1998). He employed raw returns as output and loads, expenses, turnover, risk (standard deviation or beta) and skewness of returns as inputs in his model. More than 70% of the funds were found to be efficient, but with significant deviations depending on the category of funds. The examination of slacks revealed no significant negative effect of the standard deviation on funds' efficiency, providing support for the assertion that funds were mean-variance efficient. The measurement of relative performance of US Real Estate Mutual Funds (RMFs) for the period 1997-2001 was the object of the study of Anderson et al. (2004). The sample size varied substantially from 28 RMFs in 1997 to 110 in 2001 while the source of their data was Morningstar. They employed a series of inputs such as loads, various costs and a standard measure of funds' risk (the standard deviation), and raw return as output. Their results indicated that 12b-1 fees along with the loads are responsible for funds' operating inefficiency. Daraio & Simar (2006) proposed a robust non-parametric performance measure based on the concept of order-m frontier . Their sample consisted of more than 3000 US mutual funds that were collected from Morningstar for the period June 2001- May 2002. They used standard deviation, expense ratio, turnover and fund size as inputs and mean raw return as output. According to their results, most mutual funds did not benefit from the economies of scale resulting from the unique structure of the fund industry such as portfolio management and shareholder services on a variety of securities and customers. More interestingly, the analysis of slacks suggested that for some of the categories mutual funds did not lie on the mean-variance efficiency frontier during the period analyzed. Lozano & Gutierez (2008) performed a relative efficiency analysis for a sample of 108 Spanish funds and a four-year period from January 2002 to December 2005 using six different DEA-like linear programming models that incorporate second-order stochastic dominance and are consistent with a rational, risk-averse investor. The proposed models include mean return as input and various measures of risk as outputs.

3 The Greek fund industry

The domestic fund industry was established in 1972 with the introduction of one equity and one hybrid fund. After 1989, following institutional changes to the Greek capital market, the fund industry experienced rapid growth. While in 1985 there were only two state-controlled funds with nearly 4 billion drachmas under management, by December 2006 there existed 26 fund companies offering 269 funds of all types, 63 of which were domestic equity funds, and managing more than 23.91 billion Euros. The case of Greece is very interesting to examine since the mutual fund industry is oligopolistic with few companies dominating the market while the Athens Stock Exchange (ASE) is relatively small in total capitalization and characterized by illiquidity. The three largest commercial banks, namely the National Bank of Greece, Alpha Bank and Eurobank, control the main Greek fund management companies, holding 75.5% of the total assets under management in December 2006, when their market share of domestic equity funds was as high as 66.03%.

4 Description of data

We have collected data for a sample of 57 Greek domestic equity funds that were in continuous operation during 2006. The primary objective of the analysis is to measure the individual performance of equity funds from an investor's point of view using DEA. From the investors' viewpoint then, the goal is to minimize the inputs for a given level of output; thus, we employ the DEA input-oriented model.

Annual mutual fund data such as total expenses, total net assets in euros and percentage of assets held in cash have been collected from the funds' annual reports. We utilized the Net Asset Value (NAV) of the domestic equity funds, the Athens Stock Exchange (ASE) returns as proxied by the General Index returns, and the risk-free rate as proxied by the 3-month Government Zero Coupons. The source for the funds' NAVs and annual reports is the Association of the Greek Institutional Investors (AGII), while the other series were obtained from Datastream.

In our empirical application of the DEA method we have used multiple inputs such as funds' total expense ratio, front-end loads, total assets at the end of the year, cash holdings and risk (proxied by the standard deviation of returns). A fund's expense ratio refers to the general overall costs including management fees and other operational and administrative costs incurred by the fund and is typically expressed as a ratio over its average net assets for the year. We also include the fund's front-end loads which are paid by shareholders once and are not included as part of the expense ratio. The annualized standard deviation of the returns is included as an additional input, since an investment's risk is a vital input consideration for investors and an essential factor when interpreting returns. Another important fund attribute is the liquidity ratio, that is calculated as the ratio of fund's assets that are invested in cash or cash equivalents to the total assets under management at the end of the year. Funds keep cash reserves in order to meet shareholders redemption needs. The cash percentage can be seen as as an implicit cost for investors since it prevents fund managers from exploiting profitable investment opportunities, especially in cases of booming stock markets.

The first output indicator we employ is the funds' annual raw return,and then we address the issue of proper risk adjustment by employing more sophisticated measures of performance such as annualized Jensen's alpha and Carhart's multi factor model respectively. The latter measure is considered superior compared to Jensen's risk adjusted return, since it adjusts funds' returns for common risk factors (other than market risk) that were found to determine stock returns, such as size, value (Fama & French 1993,1996) and momentum effect (Jegadeesh & Titman 1993). We followed Otten and Bams (2002) in constructing the strategy-mimicking portfolios while all stocks included in the Worldscope for Greek market were utilized. In Table 1 we present some descriptive statistics for the employed variables, such as mean, maximum and minimum values and dispersion.

4.1 Risk-Adjusted Returns

Raw returns of the funds were calculated using the standard formula:

$$R_{pt} = \frac{NAV_{pt} - NAV_{pt-1}}{NAV_{pt-1}} \tag{1}$$

where NAV_{pt} represents Net Asset Value for fund p at time t.

Jensen's alpha measures the ability of a fund manager to generate excess returns over and above the return that would be justified by the exposure of his portfolio to market or systematic risk. Formally, this is given by the intercept α_{pt} of the regression of the fund excess returns on the market index excess returns:

$$R_{pt} = \alpha_p + \beta_p R_{mt} + \varepsilon_{pt} \tag{2}$$

where R_{mt} is the stock market excess return.

In order to capture excess returns generated by tactical asset allocation strategies exploiting the inconsistencies of the CAPM such as size or value strategies we employ a multi-index performance evaluation model. More specifically, we use Carhart's multifactor model which decomposes excess fund returns into excess market returns, returns generated by buying small size stocks and selling big size stocks (Small Minus Big- SMB), returns generated by buying stocks with high book-to-market ratios and selling stocks with low book-to-market ratios (High Minus Low - HML), returns generated by buying and selling stocks with high and low past year's returns (MOM) respectively.

The four-factor model is given by:

$$R_{pt} = \alpha_p + \beta_{p0} R_{mt} + \beta_{p1} SMB + \beta_{p2} HML + \beta_{p3} MOM + \varepsilon_{pt} \tag{3}$$

where
R_{pt} is the fund's excess returns
R_{mt} is the market portfolio excess returns
SMB is the difference in returns between a portfolio of small and big stocks respectively
HML is the difference in returns between a portfolio of high book-to-market and low book-to-market ratio stocks
MOM is the difference in returns between a portfolio of winners and losers stocks during previous year respectively

5 Methodology

In this section we measure relative efficiency of domestic equity funds employing the DEA non-parametric approach used in the estimation of production functions. This method was developed in the pioneering work of Charnes, Cooper and Rhodes (1978) and has been used extensively to measure the relative performance of decision-making units (DMUs) such as social and lately financial institutions which are characterized by multiple objectives and/or multiple inputs structure. DEA estimates the maximum potential output for a given set of inputs. For every decision-making unit it assigns an efficiency measure relative to the best operating unit within a specific group. It consists in computing the optimal weights given a best level of efficiency measure usually set equal to 1, which will be reached only by the most efficient units. The DEA efficiency measure for a decision-making unit j is defined as a ratio of a weighted sum of outputs to a weighted sum of inputs:

$$h = \frac{\sum_{r=1}^{t} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \tag{4}$$

Let us define j=1,2,. . . .,n as the number of decision-making units, r=1,2,. . . .,t as the number of outputs and i=1,2,. . . ..,m as the number of inputs. Additionally, y_{rj} stands for the amount of output r for unit j, x_{ij} the amount of input i for unit j, u_r the weight assigned to output r and v_i the weight assigned to input i.

As already mentioned, the most efficient units are characterized by an efficiency measure equal to 1: at least with the most favourable weights, these units cannot be dominated by the other ones in the set. Thus the DEA method leads to a Pareto efficiency measure in which the efficient units lie on the efficient frontier (see Charnes et al., 1994).

Following Charnes et al.(1994), in order to compute the DEA efficiency measure for a decision-making unit under examination j_0 {1,2,. . . ,n} we must find the optimal solution to the following fractional linear programming problem:

$$\max_{\{v_i,u_r\}} h_0 = \frac{\sum_{r=1}^{t} u_r y_{rj_0}}{\sum_{i=1}^{m} v_i x_{ij_0}} \quad (4.1)$$

$$\text{s.t.} \quad \frac{\sum_{r=1}^{t} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1 \qquad j = 1, ..., n \quad (4.2)$$

$$u_r \geq \varepsilon, \qquad r = 1, ..., t$$
$$v_i \geq \varepsilon, \qquad i = 1, ..., m$$

where ε stands for a sufficient small positive number ensuring that the weights will not take negative values.

The optimal objective function value that is given in 4.1 represents the efficiency measure assigned to the target unit j_0 considered. The efficiency measures of other decision-making units are computed by solving similar problems for each unit in turn.

We can convert the fractional problem defined above into an equivalent linear programming problem; by setting $\sum_{i=1}^{m} v_i x_{ij_0} = 1$ we obtain the so-called input-oriented Charnes, Cooper and Rhodes (CCR) linear model:

$$\max \sum_{r=1}^{t} u_r y_{rj_0} \quad (4.3)$$

$$\text{s.t.} \sum_{i=1}^{m} v_i x_{ij_0} = 1 \quad (4.4)$$

$$\sum_{r=1}^{t} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0, \qquad j = 1, ..., n \quad (4.5)$$

$$-u_r \leq -\varepsilon, \qquad r = 1, ..., t$$
$$-v_i \leq -\varepsilon, \qquad i = 1, ..., m$$

The optimization problem consists in computing the values of $t+m$ variables, that is, the weights u_r and v_i, subject to $n+t+m+1$ constraints. For the estimation we have employed DEA-Solver Pro 5.0.

6 Results

6.1 Basic Results

For all funds in the sample, we have computed a relative measure of efficiency using the DEA program as described above. We employ a typical input-oriented DEA model, in which an efficient fund relative to the other funds being evaluated is indicated with a measure of 1. On the other hand, a DEA measure of less than 1 indicates that the fund is inefficient relative to the others. The magnitude of a fund's inefficiency is calculated as the difference between the efficiency measure and 1 —the larger the difference, the more inefficient the fund.

Table 2 lists the number of efficient funds for every formulation of the DEA model using raw returns, Jensen's and Carhart alpha as output measure as well as the mean efficiency scores. It can be seen that for the raw returns 15 efficient funds are identified; on the basis of Jensen's alpha there are only 8 funds operating on the efficient frontier, and finally when employing the most sophisticated performance measure of Carhart the number of efficient funds is 12. The mean efficiency scores vary depending on the selected output measure, ranging from 0.78 in the case of raw returns to 0.45 in the case of Carhart alpha.

In Table 3 we report some examples of efficient funds along with their attributes for the raw returns output DEA model. All efficient funds exhibit a DEA relative efficiency measure of 1.00, or 100%, and are found on the efficient frontier or what is known as the envelopment surface. No input reductions or output increases are essential for the efficient investments, as they appear to exploit all available resources in the most efficient manner compared with all others in the sample. All other decision-making units are inefficient relative to these, lying below the efficient frontier, and would require some input/output adjustments in order to become efficient.

For illustrative purposes, in Table 4 we present a number of inefficient funds. For example, an efficiency score of 0.9121 indicates that that particular fund is 91.21% efficient in employing its inputs compared with the other funds, and it would have to decrease its inputs by 8.79% in order to be placed on the efficient frontier.

6.2 Sources of inefficiency

In addition to efficiency scores, the DEA method can also provide other useful results including inefficiency measures and projected values. The latter are the values of inputs and outputs required in order for the unit to be efficient. They are a convex combination of efficient units that lie on the DEA efficient frontier. The inefficiency measures or slack variables are the differences between the target input and output values and the unit's actual values. We can determine the attributes that are contributing to the inefficiency and what modifications need to be made in order to make each unit efficient by examining the inefficiency measures of each input and output factor.

Panel A and B of Table 5 report slack variables for funds that are DEA-efficient and inefficient respectively. Similarly, panel A and B of Table 6 present target values for the input and output values of the funds that are relatively efficient or inefficient respectively. Table 6 suggests that, as we would expect, the DEA-efficient funds exhibit inefficiency measures of 0 for all input and outputs, and their target values are equal to their actual values. On the other hand, for the inefficient decision-making units the slack variables indicate the extent to which some inputs need to be decreased or the output variable needs to be increased for the units to lie on the efficient frontier. For example, in order for fund Alico Medium & Small Cap to be efficient it would have to reduce its expense ratio by 0.0030, its front-end load by 0.0268, its cash holding by 0.0435 and its standard deviation by 0.0195. Most importantly, the results indicate that in order to attain the optimal asset size the fund needs to reduce its assets under management by 850819.77 euros.

Following Murthi et al. (1997), we examine the mean of the inefficiencies in individual inputs and outputs for our sample of equity funds. Table 7 lists mean slacks in inputs variables and the relative mean slack, which is defined as the absolute mean slack in input divided by the mean value of inputs for the raw returns output measure[2]. As stated earlier, the examination of slack variables allows to infer whether or not fund managers allocate resources efficiently. A striking result is that the risk of the funds as measured by standard deviation of returns exhibits nonzero slacks for the sample of our funds. This finding contradicts the notion of mean-variance efficiency of funds' portfolios. Of the rest of the input variables, total assets of the funds exhibit the larger slacks, with a relative slack of 0.3823. This is a very important result indicating that the size of the funds acts as a constraint for domestic equity funds, especially in a stock market which is characterized by illiquidity and small capitalization. Another intriguing result is the fact that front-end loads appear to have rather high slacks, which is consistent with the argument of Barber et al. (2005). This means that investors should not include funds that charge high front-end loads (if any) into their selection process.

7 Conclusion

This study has employed the non-parametric DEA method to assess the relative performance of a sample of Greek domestic equity funds. Specifically, it has carried out a cost/benefit non-parametric analysis of the relationship between an output measure proxied either by raw returns or risk-adjusted returns and a series of input variables including cost and other operational attributes such as expense ratio, assets, cash holdings etc.

The empirical findings shed light on some important aspects of the domestic equity fund industry. In particular, only a small percentage of the funds in the

[2]The results for the two other measures are qualitatively the same and are available from the authors upon request.

sample are found to operate on the efficient frontier using any of the three output measures. Another interesting result which can be inferred by examining the slacks for the asset variables is the existence of a negative relationship between fund performance and assets under management. This adverse effect may be attributed to the structure of the domestic stock market, which is characterized by illiquidity and small market capitalization. Additionally, the evidence does not support the notion of mean-variance efficiency for the equity funds in the sample examined. These findings have practical relevance for domestic equity fund shareholders, since investors might take into account some of the funds' characteristics analysed here in their fund selection process. Clearly, one would expect investors to prefer a fund that provides the maximum benefit (return) at a minimum cost (in the form of charges, front-end loads etc.). In particular, investors should pay attention to fund size and front-end loads when selecting an equity fund investing in the domestic stock market since these variables appear to be the source of significant operational inefficiencies.

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Appendix

Table 1
Summary statistics of the employed variables for equity funds

	Mean	Median	Max	Min	St. Dev.
Raw return	0.2647	0.2557	0.5096	0.1455	0.0819
Jensen's alpha	0.0609	0.0523	0.2233	-0.0264	0.0581
Carhart alpha	0.0277	0.0251	0.1223	-0.0419	0.0336
Expense ratio	0.0370	0.0339	0.0753	0.0122	0.0121
Front end load	0.0244	0.0300	0.0500	0.0000	0.0203
Assets (€ millions)	85.24	25.64	558.79	1.30	140.35
Risk	0.1831	0.1797	0.2293	0.1424	0.0190
Cash holdings	0.0842	0.0777	0.2785	0.0109	0.0597

Notes: This Table presents the descriptive statistics for a series of the funds' characteristics over the period under examination. These are the annualized raw returns, the annualized Jensen and Carhart alphas, the Total Expense Ratio, the end period total Assets in € millions, the front-end loads, total risk measured by annualized standard deviation of returns and percentage of assets held in cash.

Table 2
No. of efficient/inefficient funds and mean efficiency scores

	Raw returns	Jensen's alpha	Carhart alpha
No of efficient funds	15	8	12
No of inefficient funds	42	49	45
Mean efficient measure	0.7834	0.4674	0.4454
Total	57	57	57

Notes: This Table lists the number of efficient and inefficient funds according to the three DEA output formulations as well as the mean efficiency scores of the sample of equity funds.

Table 3

Example of efficient funds

FUND	Expense ratio	Front load	Assets (millions €)	St. Deviation	Cash	Return	DEA Input efficiency
ALICO FTSE 20	0.0122	0.0500	24.01	0.1821	0.0131	0.2032	1.0000
ALLIANZ Aggressive strategy	0.0307	0.0350	53.77	0.1879	0.0219	0.3043	1.0000
EUROBANK Mid cap	0.0222	0.0000	121.31	0.2293	0.0359	0.4533	1.0000
Marfin medium	0.0753	0.0500	4.81	0.2009	0.0237	0.2951	1.0000
Marfin premium	0.0597	0.0500	1.42	0.1661	0.0355	0.1666	1.0000
Novabank midcap	0.0461	0.0500	23.89	0.2160	0.0500	0.4283	1.0000
ATE Med & small cap	0.0543	0.0000	3.18	0.2271	0.1009	0.2700	1.0000
Delos Blue chips	0.0346	0.0000	506.32	0.1833	0.0109	0.2571	1.0000

Notes: This Table presents the values of input/output variables for a group of efficient funds in the sample. The definitions of the input/output variables are given in Section 4. The results presented in this table refer to the raw return output DEA model.

Table 4

Example of inefficient funds

FUND	Expense ratio	Front load	Assets (millions €)	St. Deviation	CASH	Return	DEA Input inefficiency
Alico medium & small cap	0.0343	0.0500	9.68	0.1973	0.1192	0.3517	0.9121
Alpha Athens index fund	0.0188	0.0000	56.38	0.1878	0.0184	0.2158	0.9838
Alpha trust	0.0263	0.0200	79.92	0.1424	0.2247	0.2952	0.8957
Alpha aggressive	0.0391	0.0000	32.86	0.1917	0.0777	0.3294	0.8779
Eurobank Insitutional portfolios	0.0452	0.0000	33.26	0.1762	0.1081	0.2261	0.6328
HSBC	0.0308	0.0300	156.51	0.1557	0.0443	0.2714	0.7810
Interamerican Dynamic	0.0371	0.0100	536.52	0.1804	0.0365	0.2111	0.5658
International	0.0608	0.0500	28.85	0.1765	0.0859	0.2101	0.5114

Notes: This Table presents the values of input/output variables for a group of inefficient funds of the sample. The definitions of the input/output variables are given in Section 4. The results presented in this table refer to the raw return output DEA model.

Table 5

Slack variables for efficient/inefficient funds

FUND	Expense ratio	Front load	Assets (millions €)	St. Deviation	Cash	Return
Panel A:Efficient funds						
ALICO FTSE 20	0.00	0.00	0.00	0.00	0.00	0.00
ALLIANZ Aggressive strategy	0.00	0.00	0.00	0.00	0.00	0.00
EUROBANK Mid cap	0.00	0.00	0.00	0.00	0.00	0.00
Marfin medium	0.00	0.00	0.00	0.00	0.00	0.00
Marfin premium	0.00	0.00	0.00	0.00	0.00	0.00
Novabank midcap	0.00	0.00	0.00	0.00	0.00	0.00
ATE Medium & small cap	0.00	0.00	0.00	0.00	0.00	0.00
Delos Blue chips	0.00	0.00	0.00	0.00	0.00	0.00
Panel B:Inefficient funds						
Alico medium & small cap	-0.0030	-0.0268	-0.85	-0.0195	-0.0435	0.0000
Alpha Athens index fund	-0.0075	0.0000	-0.91	-0.0788	-0.0003	0.0000
Alpha trust	-0.0072	-0.0021	-70.91	-0.0149	-0.1816	0.0000
Alpha aggressive	-0.0048	0.0000	-4.01	-0.0285	-0.0254	0.0000
Eurobank Insitutional portfolios	-0.0185	0.0000	-23.38	-0.0647	-0.0678	0.0000
HSBC	-0.0144	-0.0175	-134.42	-0.0341	-0.0097	0.0000
Interamerican Dynamic	-0.0258	-0.0062	-495.19	-0.0783	-0.0158	0.0000
International	-0.0451	-0.0327	-22.15	-0.0862	-0.0420	0.0000

Notes: This Table presents the slack variables for the employed input/output variables. Slacks indicate the extent to which an input (output) needs to be decreased (increased) in order for the fund to achieve a relative efficiency of 1. Panel A presents the results for a group of efficient funds while Panel B presents the corresponding results for a subset of inefficient funds. The results presented in this table refer to the raw return output DEA model.

Table 6

Target values for input/output variables for efficient/inefficient funds

FUND	Expense ratio	Front load	Assets (millions €)	St. Deviation	Cash	Return
Panel A:Efficient funds						
ALICO FTSE 20	0.0122	0.0500	24.01	0.1821	0.0131	0.2032
ALLIANZ Aggressive strategy	0.0307	0.0350	53.77	0.1879	0.0219	0.3043
EUROBANK Mid cap	0.0222	0.0000	121.31	0.2293	0.0359	0.4533
Marfin medium	0.0753	0.0500	4.81	0.2009	0.0237	0.2951
Marfin premium	0.0597	0.0500	1.42	0.1661	0.0355	0.1666
Novabank midcap	0.0461	0.0500	23.89	0.2160	0.0500	0.4283
ATE Medium & small cap	0.0543	0.0000	3.18	0.2271	0.1009	0.2700
Delos Blue chips	0.0346	0.0000	506.32	0.1833	0.0109	0.2571
Panel B:Inefficient funds						
Alico medium & small cap	0.0313	0.0232	8.83	0.1778	0.0757	0.3517
Alpha Athens index fund	0.0113	0.0000	55.46	0.1090	0.0181	0.2158
Alpha trust	0.0190	0.0179	9.01	0.1275	0.0431	0.2952
Alpha aggressive	0.0344	0.0000	28.85	0.1632	0.0523	0.3294
Eurobank Insitutional portfolios	0.0266	0.0000	9.88	0.1115	0.0403	0.2261
HSBC	0.0164	0.0125	22.09	0.1216	0.0346	0.2714
Interamerican Dynamic	0.0113	0.0038	41.33	0.1021	0.0207	0.2111
International	0.0157	0.0173	6.70	0.0903	0.0439	0.2101

Notes: This Table presents target values for the various input/output variables. These are the values that, if attained, would result in a relative efficiency of 1 for the fund. Panel A presents target values for a subset of efficient funds while Panel B shows the corresponding results for a group of inefficient funds. The results presented in this table refer to the raw return output DEA model.

Table 7
Mean slacks in inputs and outputs

	Expense ratio	Front load	Assets (€ millions)	St. Deviation	Cash	Return
Absolute slacks	0.0027	0.0043	32.583	0.0044	0.0199	0.0000
Relative slacks	0.0736	0.1763	0.3823	0.0243	0.2361	0.0000

Notes: This Table summarizes the mean of the absolute slacks and the relative mean slacks which are defined as absolute mean slack in input or output divided by the mean value of the inputs/outputs. The results presented in this table refer to the raw return output DEA model.