Efficiency evaluation of Greek equity funds

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Abstract

This study assesses the relative performance of Greek equity funds employing a non-parametric method, namely Data Envelopment Analysis (DEA). Specifically, we evaluate the funds' total productivity change using the DEA-based Malmquist Index. Our results reveal significant losses in funds' productivity for the period of 2003-2009, which calls for the attention of domestic policy makers and market regulators. Significant implications for the investors' fund selection process arise from our analysis since we are able to identify potential sources of operational inefficiencies. Employing a panel logit model we document a significant negative relationship between the probability of being efficient and funds' size, a finding which may be related to the microstructure 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, operational efficiency, equity funds, DEA-Malmquist productivity index

1. Introduction

Open-end mutual funds are one 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 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.

Another issue related 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 the 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 the employed measures are plagued with two important shortcomings that have been extensively analyzed 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 combining financial as well as operational dimensions. In particular, we employ the non-parametric DEA method to measure the performance of a sample of Greek domestic equity funds. We further evaluate the funds' total productivity change using Malmquist index. The DEA method allows us to compute inefficiency measures of the individual input and output factors in order to identify the source and extent of any performance inefficiency. The oligopolistic 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 capitalization and illiquidity of the domestic stock market.

The issue of funds' operational efficiency is crucial for both investors and managers. Investors, in particular, are concerned that the various charges imposed by the funds are used effectively in their best interest and that funds exploit their available resources in the most productive manner. On the other hand, managers are also concerned about funds' efficiency since long-term success of the delegated nature of active management depends crucially on adopting practices that serve effectively clients' investment purposes.

Our analysis contributes to the existing literature in several ways. To our knowledge, this study constitutes the first attempt to measure relative efficiency of the Greek equity funds. We provide results for a small, developed and bank-dominated European market, with possible implications for other markets of similar size and institutional characteristics. At the same time we examine the impact on the efficiency of the domestic equity funds industry of a significant legislation change that took place in 2004 (Law 3283/2004). We use the Malmquist index in order to assess shifts in funds' total productivity whereas we employ for the first time in the relevant literature Carhart's (1997) risk-adjusted return as an output measure.

As part of the sensitivity analysis, we extend our work to investigate the relationship between fund and its size as in Coelli et al. (1998). Following previous work of Grinblatt & Titman (1989) and Murthi et al. (1997) we explore the interaction between fund's efficiency and asset size in the context of a capital market with unique characteristics such as small capitalization and illiquidity.

To preview our results, we find that the majority of domestic equity funds for the period under examination exhibit significant operational inefficiencies. Inefficiency is mainly driven by funds' expenses that inevitably reduce investor's wealth. As for portfolio diversification, domestic equity funds appear not to have eliminated effectively the non-systematic component of their portfolio riskiness since the risk variable exhibits significant inefficiencies (slacks). With respect to total productivity change we document a substantial productivity loss that is mainly driven by lack of technological advances. The second-stage evaluation of DEA efficiency scores reveal interesting aspects of funds' inadequacies. A higher probability of being efficient is associated with a smaller fund size. A large asset base seems to be a constraint in view of the microstructure 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].

The remainder of the paper is organized as follows: in the next section we provide a description of the main hypotheses we test in our study. Section 3 reviews the relevant literature, while in section 4 we present a brief description of the Greek mutual fund industry. Section 5 provides details of the variables and the sample used, and of the calculation of risk-adjusted returns; Section 6 outlines the DEA method, and Section 7 presents the empirical results. Finally, Section 8 offers some concluding remarks and possible policy implications.

2. Hypotheses to be tested

Below we specify the various hypotheses tested in the present study.

Hypothesis 1

Total productivity of domestic equity funds has improved following a series of institutional changes

Productivity shift of a fund can be measured by comparing its efficiency over two successive periods. In particular, we opt for evaluating the industry's relative efficiency by employing a number of variables to measure inputs and outputs that integrate operational as well as financial characteristics. Productivity can be decomposed into two components, namely

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

technical efficiency change and technological change, allowing robust inference regarding how privately managed funds should be organized and operated. As the fund management process is the key determinant of returns to shareholders, it has been the subject of numerous studies in the context of delegated portfolio management since the seminal paper of Jensen (1968), with the evidence suggesting funds' underperformance relative to known benchmarks. Given the multi-dimensional process of the fund management process (that involves collecting money from investors, investing assets in a range of financial products and providing a range of supporting services). it is rather crucial to evaluate technical efficiency at a fund level. Moreover, because of the prominent role of collective investment schemes in the well-functioning of the financial system regulatory and supervisory advancements are important for more transparency and better governance of the fund management industry. Garcia (2010) has concluded that despite significant legislation amendments conducted in the Portuguese pension fund industry there was still room for improvement in order to achieve operational efficiency.

Hypothesis 2

Domestic equity funds' portfolios are mean variance efficient

The mean variance theory established by the pioneering work of Markowitz (1952, 1959) states that investors employing the benefits of diversification can construct mean variance efficient portfolios that provide the maximum expected return for a given level of risk measured by its variance of returns. In other words, an investor can reduce the risk of his investment by allocating effectively his wealth in a variety of assets, diversification eliminating idiosyncratic risk. Hence mutual funds are an attractive form of investment for those individuals who do not possess enough wealth to construct a fully diversified portfolio.
One of the major advantages of the non-parametric data envelopment analysis technique is the identification of sources of inefficiency by means of the slack variables. By definition, slack variables indicate whether portfolio managers use resources inefficiently. Therefore, examining the slacks of the employed risk variable we can infer if domestic equity funds hold mean variance efficient portfolios (Murthi et al., 1997).

Hypothesis 3

An increase in a fund's size causes an increase in the probability of the fund being efficient

Despite the contradictory evidence this hypothesis is central to our perception of the role of mutual funds in the economy, i.e. of the economies of scale in the active management industry. A better understanding of this issue would naturally be useful for investors, especially in light of the significant outflows that domestic funds have experienced in the recent past. Moreover, the scale-ability of investment funds is strongly related to the persistence of fund performance (see, e.g., Gruber, 1996; Berk and Green, 2004). Given the delegated nature of active management the existence of economies of scale in the industry may also have implications for the agency relationship between managers and shareholders and the best compensation contract between them. A positive relationship between fund size and performance would be indicative of economies of scale such as more resources for research and lower expense ratios (see, e.g., Otten & Bams 2002).

On the other hand, there is a belief that a large fund size may have a detrimental effect on fund performance due to trading costs associated with liquidity or price impact (Andre Perold & Robert S. Salomon 1991, Roger Lowenstein 1997). In other words, smaller funds have an advantage over larger funds because trading can be done without any significant impact on securities prices. As Chen et al. (2004) pointed out, while a small fund can easily invest all of its money in its best ideas, a lack of liquidity forces a large fund to invest in its not-so-good ideas and take larger positions per stock than is optimal, resulting in inferior performance. Grinblatt & Titman (1989) and more recently Prather et al. (2004) examined the effect of fund size on performance and found that the mutual funds with the smallest net asset values exhibit the best performance.

3. A Brief 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. Treynor & Mazuy model 1966, Jensen's alpha 1968, Carhart's alpha 1997) as in Romacho & Cortez (2006). Murthi et al. (1997) were the first to apply 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 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.

4. The case of Greece

The Greek mutual fund industry is a quite an interesting case to examine because it is oligopolistic while the Athens Stock Exchange (ASE) is relatively small in total capitalization and characterized by illiquidity. During the period we examine, Greece was an emerging market growing to maturity, now part of EMU and fully integrated in the international financial system. Domestic market is currently regulated by the provisions of Law 3283/2004 which amends previous Law 1969/91. Law 3283/2004 combined with a series of supplementary acts incorporates into Greek legislation important directives stipulated by European Parliament 2001/107 & 2001/108) that regulate crucial issues with regard to UCITS (Undertaking for Collective Investment in Transferable Securities). Among other things, it introduces creation of UCITS established in another EU member country, clearly defined asset allocation limits of each fund category, mandatory disclosure of fund' operational costs etc that provide greater transparency and enhanced protection of shareholders' interests.

The growth of the domestic mutual fund industry was remarkable. While there were only two stately controlled funds managing 4 billion drachmas in 1985 (252.9 million drachmas, Base date=2009), by December 2004 there existed 262 funds of all types managing more than 31.65 billion Euros (an equivalent of 10.7 trillion drachmas or 122 billion drachmas, Base date=2009). However, following the adverse effects of the global financial crisis the size of the domestic fund industry by December 2009 declined to 10.68 billion euros.

Regarding the domestic equity funds, there existed only 27 funds in 1998, while in 2004 their number rose to 63 managing 3.94 billion euros. The decline in asset prices combined with the prolonged volatility in the stock market led to significant outflows from equity funds.

Therefore, by the end of December 2009 there were 46 equity funds[2] with 1.87 billion under management.

Panel A of Table 1 presents some interesting figures regarding the evolution of the domestic equity fund industry such as number of funds, total assets under management and fund median size while Panel B reports the same useful information for our sample funds.

Please insert Table 1 here

5. Data sources and description

Efficiency frontier estimation requires data on various inputs and outputs for the employed decision making units (DMUs). Data for a sample of 31 Greek domestic equity funds during period 2003-2009 have been collected. The time period along with the number of funds analyzed was determined by data availability. The primary objective of the analysis is to measure the individual performance of equity funds from an investor's point of view using Data Envelopment Analysis (DEA). From the investors' viewpoint, the goal is to minimize the inputs for a given level of output; thus, we employ the DEA input-oriented model. Next, employing a balanced panel data on Greek equity funds (31 funds x 7 years=207 observations) we attempt to identify changes in funds' total productivity through the estimation of the Malmquist index.

A common problem encountered in the DEA financial literature is the presence of negative values in the input or output variables which contradicts the non-negativity assumption of the basic DEA models. For this purpose, a number of alternative solutions have been suggested - see, inter alias, Ali & Seiford (1990), Basso & Funari (2005). A transformation of the original data along with the use of a translation-invariant DEA model such as the additive model has been the most popular methods of tackling the negative data problem. With regard to this issue, we employ an output measure which is always non-negative and is financially meaningful, that is:

$$W=1+R_j \qquad (1)$$

where R_j stands for the actual return achieved by the mutual fund j during the investment period and is proxied by the annualized risk adjusted return from a multi factor model,

[2] We exclude from our analysis domestic equity funds that are domiciled in Luxembourg.

namely the Carhart model. Therefore, W expresses the terminal value at the end of the investment period of one unit $C_0 = 1$ invested in the mutual fund.

Annual mutual fund data such as total expenses, age and total net assets in euros 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, capital invested 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 to its average net assets for the year. It should be noted that Hellenic Market Commission introduced (Law 3283/2004) mandatory disclosure of costs related information of funds' portfolios from 2005 and onwards. 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. Finally, since output is measured by the terminal value of the investment, we must include among the inputs the initial capital invested in the mutual fund. In the context of our analysis, it is assumed that the same initial outlay $C_0 = 1$ is invested in all the funds under examination.

Table 2 provides some useful descriptive statistics of the employed variables. It shows that the average fund exhibits a slight underperformance (-0.4% p.a.) relative to known benchmarks, while it charges 3.6% p.a. of its total assets as expenses which is substantially higher than international standards[3]. Moreover, we observe that there is much heterogeneity among the funds analysed with a standard deviation higher than the mean for the majority of listed variables.

Please insert Table 2 here

5.1 Risk-Adjusted Returns

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

[3] Babalos et al (2009)

$$R_{pt} = (NAV_{pt} - NAV_{pt-1}) / NAV_{pt-1} \tag{2}$$

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

It is a common practice for fund management companies to advertise their funds' high raw returns in the financial press in order to attract new investors. However, raw returns are not indicative of managerial ability since they do not take into account the funds' different exposures to systematic risk sources. Jensen (1968) suggested a risk-adjusted return measure that is rooted in the CAPM and is widely employed. However, 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 (1997) 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 (value) and selling stocks with low book-to-market ratios (Growth) returns generated by buying and selling stocks with high and low past year's returns (MOM) respectively. The four-factor abnormal return is given by the intercept of the following regression:

$$R_{pt} = \alpha_{pt} + \beta_{0p} R_{mt} + \beta_{1p} SMB + \beta_{2p} HML + \beta_{3p} MOM + \varepsilon_{pt} \tag{3}$$

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

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 the previous year

6.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:

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

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 favorable 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:

$$\max_{\{v_i, u_r\}} h_0 = \frac{\sum_{r=1}^{t} u_r y_{rj_0}}{\sum_{i=1}^{m} v_i x_{ij_0}} \qquad (5)$$

s.t. $\dfrac{\sum_{r=1}^{t} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1$ j=1,...,n (6)

$u_r \geq \varepsilon$ r=1,...,t (6.1)

$v_i \geq \varepsilon$ i=1,...,m (6.2)

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 (5) 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:

$$\max \sum_{r=1}^{t} u_r y_{rj_0} \quad (7)$$

$$s.t. \sum_{i=1}^{m} v_i x_{ij_0} \quad (8)$$

$$\sum_{r=1}^{t} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0 \qquad j=1,2,\ldots n \quad (9)$$

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.

7.Results

7.1 Basic Results

For all funds in the sample and for each year we have computed a relative measure of efficiency using the DEA method 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.

In Graph 1 we show the evolution of the funds' mean efficiency during the period under examination. It is clear that the average efficiency of Greek equity funds is at relatively high levels (consistently above 0.90), while exhibiting a significant variation. Specifically, mean efficiency ranges from 0.9 in 2003 to 0.95 in 2009 confirming a long-term upward trend. Moreover, it can be seen that, during 2008, funds have experienced a significant drop in their efficiency levels resulting from the effects of the global financial crisis.

Please insert Graph 1 here

Table 3 lists individual DEA efficiency scores for the sample funds for each year separately. We can see that the number of efficient funds is rather low, ranging from 1 to 8 funds. In other words, the majority of funds operate away from the efficiency frontier indicating sources of inefficiencies among domestic equity funds that will be analyzed in detail later.

Please insert Table 3 here

In addition to efficiency scores, the DEA method allows the estimation of inefficiency measures or slack variables which are defined as the difference between the target input and output values and the unit's actual values. We can determine the key factors that are responsible for fund's inefficiency and what modifications need to be made in order to make each fund efficient by examining the inefficiency measures of each input factor. Therefore, Panel A of Table 4 reports mean values of slack variables for our sample funds. Following Murthi et al. (1997), we examine the mean of the inefficiencies in individual inputs. In particular, we attempt to measure the degree of inefficient use by portfolio managers of certain cost and risk variables. Mutual funds are probably the preferred investment vehicle for individuals because they provide a low cost access to a professionally managed and highly diversified portfolio. A fund's expense ratio gauges the overall costs associated with running and managing a fund, including management fees and other operational and administrative costs, and is defined as the ratio of a fund's total expenses to its average net assets for each year. A number of possible explanations have been put forward regarding the relationship between costs and fund performance. Acting in an informationally inefficient framework as in Grossman & Stiglitz (1980) informed investors should be rewarded with higher returns than uninformed investors (Ippolito 1989). However, the various expenses are deducted from funds' assets, inevitably leading to performance erosion (Carhart 1997,Chen et al. 2004, Babalos et al 2009). With respect to portfolio diversification we examine another important input variable, that is fund's total investment risk. The evidence in Table 4 suggests that both the expense ratio and the risk variable measured by the standard deviation of returns exhibit substantial slacks throughout the analyzed period. For example, in 2006 a fund characterised as inefficient needed to reduce its expenses by 0.010 units (or 27.5%) and its risk levels by 0.038 units (or 20.8%) in order to operate on the efficient frontier.

Please insert Table 4 here

Panel B of Table 4 presents relative mean slacks, which is defined as the absolute mean slack in input divided by the mean value of inputs. Employing the relative slacks it is possible to evaluate the marginal impact of each input variable on funds' efficiency.

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 the 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. Among the other input variables, total expenses exhibit the larger slacks with a relative slack of 0.134 confirming previous evidence (Babalos et al., 2009) that expenses might in effect erode fund's performance.

7.2 Further results

7.2.1 Malmquist productivity index

In order to gain additional insights into the domestic equity funds' market we rank funds according to the change in total productivity for the period 2003-2009. For our analysis, we have adopted the non-parametric efficient frontier approach that allows estimating the Malmquist productivity index (Malmquist, 1953) based on data envelopment analysis. There are various formulations of the Malmquist index according to Caves et al (1982) and Fare et al. (1992). In line with similar studies, we estimate an output-oriented Malmquist productivity index based on DEA. Output-oriented models aim at identifying technical inefficiency in the form of a proportional reduction in input usage.

Results from the estimation of funds' total productivity change scores are presented in Table 5. Fund's total productivity change can be decomposed into a technical efficient change (catch-up or diffusion term) which measures the degree a fund improves or worsens its efficiency, and a technological efficient change (innovation or frontier-shift term) that reflects the change in the estimated frontiers between two periods. Technological change (column (2)) in the active management industry is the consequence of innovation such as investing in new methods, practices and techniques with the objective of achieving superior risk-adjusted returns. Additionally, we break down technical efficient change into pure efficient change (column (3)) and scale-efficient change (column (4)) which is related to fund size. The change in pure technical efficiency could be a sign of enhanced managerial skills or even of upgraded management structure resulting in a better balance between inputs and outputs, accurate reporting, effective decision making and so on. With respect to the frontier-shift term, a value larger than one indicates an improvement in the employed technology. Domestic equity funds are ranked according to the values of the Malmquist total productivity index reported in column (5) of Table 5. Values of the Malmquist index larger than one indicate total productivity gains for the relevant fund.

Please insert Table 5 here

The results suggest that Greek domestic equity funds experienced an average annual decrease in total productivity of 4.2% for the period 2003-2009. This indicates that innovation deteriorated in the analyzed period for our sample of equity funds leading us to conclude that there was no investment in new technologies and in comparable managerial skills upgrades. In general, domestic equity funds experienced a substantial productivity loss for the period 2003-2009, which should represent a major concern on the part of domestic policy makers.

The total productivity decrease is mainly driven by the adverse technological change undergone by the majority of our sample funds. In particular, the average annual technological regression is 5.2% while the average technical efficiency change, though positive, is low, at only 1% percent per year. For the period of analysis, 14 out of 31 funds exhibited a positive technically efficiency change indicating an improvement of technical efficiency in the period of interest. Decomposing technically efficiency change into pure technically efficiency change and scale efficiency change that is related to fund size reveals substantial gains for 14 out of 31 funds only in one area. The scale efficiency is equal to one for all our funds indicating that there was no growth in technical efficiency associated with scale.

7.2.2 Determinants of efficiency

As a next step in our analysis we opt for exploring potential factors responsible for funds' efficiency by means of a two-step approach, as suggested by Coelli et al. (1998). Our method is based on a conditional Logit probability model that seeks to establish a relation between the probabilities of a fund being efficient and various funds' operational characteristics such as assets and age. A logistic regression coefficients indicate the change (increase when $\beta_i>0$, decrease when $\beta_i<0$) in the predicted logged odds of having a characteristic of interest for a one-unit change in the independent variables. Therefore, we estimate the following regression employing a balanced panel and assuming random effects:

$$Eff_{it} = \beta_0 + \beta_1 Assets_{it} + \beta_2 Age_{it} + v_i + \varepsilon_{it} \quad i=1,\ldots\ldots,N\ ,t=1,\ldots\ldots,T \qquad (10)$$

where

Eff is a binary variable that takes value 1 if fund i is efficient and 0 if otherwise

Assets is the fund's i total assets at the end of the year expressed in millions of euros

Age is the fund's i age measured in years from its inception

Please insert Table 6 here

A first conclusion is that fund's size contributes negatively to the probability of being efficient. In other words, the bigger a fund is the lower its efficiency. This is a very important result probably linked with the domestic stock market's microstructure 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. The latter is reinforced by the statistics regarding the Athens Stock Exchange that are presented in the following Table 7 and Table 8. Finally, age seems to have a positive although insignificant influence on the probability of being efficient. It seems that older funds might have developed better management techniques, more effective organizational structure or even better understanding of the financial environment in general.

Please insert Table 7 here

Please insert Table 8 here

7.2.3 Predictive power of the proposed performance measure

Studies examining the predictive power of various performance measures are numerous, dating back to Jensen (1968), Grinblatt & Titman (1992), Malkiel (1995), Gruber (1996), Carhart (1997) and more recently to Bollen & Busse (2005), Fama & French (2010) for US funds. However, the results regarding mutual fund performance persistence are still inconclusive. Currently, a series of papers testing the predictive power of different performance measures for international fund markets has emerged – see, inter alia, Cortez, Paxson, and Rocha (1999) for Portuguese funds, Fletcher and Forbes (2002) for UK fund industry, Otten & Bams (2004) for 5 European markets, Ferruz, Vicente, and Andreu (2007) for the Spanish and the German equity funds. With regard to the domestic equity funds Babalos et al (2007,2008) reported weak evidence of performance persistence that is sensitive to the selection of the appropriate performance measure.

Despite the numerous studies on the predictive power of the traditional performance measures, namely raw returns, regression-based measures the literature on testing the practical relevance of relative performance measures similar to ours is scarce. Hence, we opt for employing the Spearman rank correlation coefficient in order to examine the degree of association between fund rankings based on the proposed measure over one-year horizons during the period 2003-2009. The results are presented in Table 9 indicating the absence of significant correlation between fund rankings. In other words, the proposed performance measure carries no predictive power over time. However, further research on the robustness of our findings would be useful.

Please insert Table 9 here

8. Conclusions

The purpose of the present study is twofold. Firstly, we attempted to measure operational efficiency for a sample of Greek domestic equity funds between 2003 and 2009 by means of the non-parametric Data Envelopment Analysis (DEA) method. With regard to efficiency measurement, we have employed an original dataset spanning cost and risk characteristics of the funds analyzed, whereas a sophisticated risk-adjusted return measure, namely Carhart's alpha (1997), was employed as the output measure. 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 sample are found to operate on the efficient frontier. Another interesting result which can be inferred by examining the slacks is the negative effect that expenses exert on funds' operational efficiency. More interestingly, the evidence does not support the notion of mean-variance efficiency for the equity funds in our sample.

Examining total productivity change through estimation of a DEA-based Malmquist index provides some interesting evidence with respect to the diffusion of best-practice technology in the domestic fund industry. In particular, we observed a substantial productivity loss for domestic equity funds for the period analyzed. The lack of investments in leading technologies and related management techniques by fund management companies appears to have caused a significant technological regression. With regard to the determinants of funds' operational inadequacies and as a part of a sensitivity analysis, we have employed a second-stage panel logit regression that documented the existence of a negative relationship between the probability of being efficient and assets under management. This adverse effect may be attributed to microstructure features of the domestic stock market, which is characterized by illiquidity and small market capitalization.

These results have practical relevance for domestic equity fund shareholders, since investors might take into account some of the funds' characteristics analyzed 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 expenses when selecting an equity fund investing in the domestic stock market since these variables appear to be the source of significant operational inefficiencies. Additional analysis points to a lack of predictive power of the proposed measure of performance evaluation, although further research on the robustness of this result would be advisable.

However, we reckon that there is potential for upgrading funds' operational efficiency mainly through two different channels. Firstly, fund management companies exhibiting the poorest performances should adopt a more efficient, incentive-oriented managerial policy that would allow them to cover the distance from the efficient frontier. In particular, fund companies should minimise the costs charged to shareholders exploiting in more effective ways the economies of scale and scope of the industry. The objective of achieving better levels of diversification in their managed portfolios should remain high in managers' agenda. Secondly, their effort towards improvement should rest on technological innovations in terms of methods, techniques, launching new products and so on. Moreover, improvements in the efficiency of domestic equity funds depend indisputably on the actions of market regulatory authorities such as (1) reinforcing the implementation of its regulatory obligations, (2) requiring the disclosure of funds' detailed operational information in order to establish greater transparency into the market, (3) providing favorable tax treatment for fund management companies and fund investors and (4) implementing 'best practices' introduced by other regulatory authorities in preserving investors' best interest.

Finally, technical inefficiency measures can be used for competitive benchmarking (''yardstick competition'') in which management fees are dependent on the costs of similar (in terms of input mix) but more efficient funds. Such a framework can (1) enhance the fund managers' incentives to achieve efficiency and (2) reduce the informational asymmetry between fund managers (the agent) and regulators and investors (the principal).

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References

Anderson R., Brockman C., Giannikos C & McLeod R., 2004, "A non-parametric examination of Real Estate mutual fund efficiency", Int. J. Bus. Econ. 3, pp. 225-238.

Babalos V., Kostakis, A. and Philippas, N, 2007, “Spurious results in testing mutual fund performance persistence: evidence from the Greek market”, Appl. Finan. Econ. Letters 3, pp. 103-108

Babalos, V. Caporale, G.M. Kostakis, A. and Philippas, N., 2008, “Testing for persistence in mutual fund performance and the ex-post verification problem: evidence from the Greek market”, Europ. J. Finance 14,pp. 735-753

Babalos V., Kostakis A. & Philippas N., 2009, "Managing mutual funds or managing expense ratios? Evidence from the Greek fund industry", J. Mult. Financ. Manag. 19, pp. 256-272

Barber B.M, Odean T.& Zheng L., 2005," Out of sight, out of mind: The effect of expenses on mutual fund flows", J. Bus. 78, pp. 2095-2120.

Basso Antonella & Stefania Funari, 2001, "A data envelopment analysis approach to measure the mutual fund performance.", Eur. J. Oper. Res. 135 , pp. 477-492.

Bollen N. P. B. , Busse J. A., 2005, “Short term persistence in mutual fund performance”, Rev. Finan. Stud. 18, pp 569-597.

Brau J. C., Rodríguez J., 2009, ‘An empirical analysis of Mexican and US closed-end mutual fund IPOs’, Res Int Bus Finance 23, pp. 1-17

Carhart, M., 1997, "On persistence in mutual fund performance", J. Financ. 52, pp. 52-82.

Caves D.W., Christensen L.R., Diewert W.E., 1982a, ‘Multilateral comparisons of output, input and productivity using superlative index numbers’., Economic Journal, Royal Economic Society 92, pp. 73-86

Caves D.W., Christensen L.R., Diewert W.E., 1982b, ‘The economic theory of index numbers and the measurement of input, output and productivity, Econometrica 50,pp. 1393-1414

Charnes A, Cooper W. & Rhodes E., 1978, "Measuring the efficiency of decision making units", Eur. J. Oper. Res. 2, pp. 429-444.

Charnes A, Cooper W., Lewin A.Y & Seiford L.M., 1994," Data envelopment analysis: Theory, methodology and application." Kluwer, Boston

Chen J.,Hong H., Huang M. & Kubik J., 2004, "Does fund size erode performance? The role of liquidity and organization ", Am. Econ. Rev. 94, pp.1276--1302

Chevallier J. & Ellison G, 1997, "Risk taking by mutual funds as a response to incentives", J. Polit. Econ. 105, pp. 1167-1200.

Coelli T.J., Rao P., Battese G.E. 1998, 'An Introduction to Efficiency and Productivity Analysis, Kluwer Academic Press

Cooper, W, Seiford L & Tone K., 2007,"Data envelopment analysis: A comprehensive text with models, applications, references and DEA-Solver software", Springer Science-Business Media

Cortez R., M., Paxson, D. A. & Rocha M. J., 1999, "Persistence in Portuguese mutual fund performance", Europ. J. Finance 5, pp. 342-365.

Daraio C & Simar L., 2006, "A robust nonparametric approach to evaluate and explain the performance of mutual funds", Eur. J. Oper. Res. 175, pp.516-542.

Fama, E. F. & French, K. R, 1993, "Common risk factors in the returns on bonds and stocks ", J. Financ. Econ. 33, pp 3-53.

Fama, E. F. & French, K. R., 1996, "Multifactor explanations of asset pricing anomalies", J. Financ. 51, pp 55-84

Fama E & French K., 2010, "Luck versus Skill in the Cross Section of Mutual Fund Returns", J. Financ. 65, pp. 1725-54

Ferruz, L., J.L. Sarto, and L. Andreu. 2007, "A comparison between German and Spanish equity fund markets", Journal of Asset Management 8, pp. 147–151.

Fletcher, J. Forbes D., 2002, "An exploration of the persistence of UK unit trust performance", J. Empirical Finance 9, pp. 475-493.

Garcia M.T.M, 2010, 'Efficiency evaluation of the Portuguese pension funds management companies', J. Int. Financ. Mark. Instit. Money 20, pp. 259-266

Grinblatt, M., and Titman S., 1989, "Mutual fund performance: An analysis of quarterly portfolio holdings", J. Bus. 62, pp. 393-416.

Grinblatt, M., and Titman S., 1992, "The Persistence of mutual fund performance", J. Financ. 47, pp. 1977-1984.

Grossman, S. & Stiglitz S., 1980, "On the impossibility of informational efficient markets", Am. Econ. Rev. 70, pp. 393-408

Gruber, M. J., 1996, "Another puzzle: The growth in actively managed mutual funds," J. Financ. 51, pp. 783-810.

Huang M. Y., Lin J. B., 2011, ‘Do ETFs provide effective international diversification?’, Res Int Bus Finance 25, pp. 335-344

Ippolito, Richard A., 1989, “Efficiency with costly information: A study of mutual fund performance 1965-1984”, Q. J. Econ. 104, pp. 1-22

Jegadeesh N. and Titman S., 1993, "Returns to buying winners and selling losers: Implications for stock market efficiency", J. Financ. 48, pp. 65-91.

Jensen, M., 1968, "The performance of mutual funds in the period 1945-64," J. Financ. 23, pp. 389-416.

Lehman B. & Modest D., 1987, "Mutual fund performance evaluation:A comparison of benchmarks and benchmark comparisons" , J. Financ. 42, pp. 233-26

Lintner J., 1965. "The Valuation of risky Assets and the selection of risky investments in stock portfolios and capital budgets." Rev. Econ. Stat. 47, pp. 13-37.

Lozano S. & Gutierez E., 2008, "Data envelopment analysis of mutual funds based on second-order stochastic dominance", Eur. J. Oper. Res. 189, pp. 230-244.

Malkiel B., 1995," Returns from investing in equity mutual funds 1971-1991", J. Financ. 50, pp. 549-572.

Malmquist S.,1953, ‘ Index numbers and indifference surfaces’, Trabajos de Estatistica 4, pp. 209-242

Markowitz H. , 1952, "Portfolio selection ", J. Financ. 7, pp. 77-91.

Murthi, B. P. S., Yoon K. Choi, Preyas Desai,1997,"Efficiency of mutual funds and portfolio performance measurement: A non-parametric approach.", Eur. J. Oper. Res. 98, pp. 408-418.

Murthi, B. P. S. & Choi. Y, 2001, "Relative performance evaluation of mutual funds: A non-parametric approach.", J. Bus. Financ. Account. 28, pp.853-876.

Otten R. & Bams D., 2002, "European mutual fund performance," Eur. Financ. Manag. 8, pp.75-101.

Prather, L., Bertin, W.J, Henker, T., 2004, "Mutual fund characteristics, managerial attributes, and fund performance ", Rev. Financ. Econ. 13, pp. 305-326.

Romacho J.C. Cortez M. C., 2006, ‘Timing and selectivity in Portuguese mutual fund performance’, Res Int Bus Finance 20, pp. 348-368

Roll R., 1977, "A critique of the Asset Pricing Theory's Tests: Part I: On past and potential testability of the theory", J. Financ. Econ., pp. 129-176.

Sengupta J., 2003, "Efficiency tests for mutual fund portfolios", Appl. Financ. Econ. 13, pp. 869-876

Sharpe, W. F. ,1966, "Mutual fund performance", J. Bus. 39, pp. 119-38.

Sharpe W.F, 1964, "Capital asset prices: A theory of market equilibrium under conditions of risk", J. Financ. 19, pp. 425-442.

Tobin J., 1958, "Liquidity preference as behavior towards risk", Rev. Econ. Stud. 25, pp. 65-86.

Treynor J. ,1965, "How to rate management of Investment Funds;", Harvard Bus. Rev., pp. 63-75.

Zera S.P., Madura J., 2001, 'The empirical relationship between mutual fund size and operational efficiency', Appl. Financ. Econ. 11, pp. 243-251.

Appendix

Table 1
Evolution of domestic equity fund industry

Year	No of funds	Total Assets (billion €)	Fund Median Size (million €)
Panel A: Whole market			
2003	66	3.85	12.27
2004	63	3.94	15.84
2005	55	4.4	23.14
2006	57	4.65	25.64
2007	51	4.15	33.95
2008	52	1.54	12.41
2009	46	1.87	17.02
Panel B: Sample funds			
2003	31	2.93	32.37
2004	31	3.14	34.29
2005	31	3.73	41.43
2006	31	3.95	44.94
2007	31	3.49	43.07
2008	31	1.33	16.01
2009	31	1.65	22.05

Note: This table reports domestic equity fund industry figures such as number of funds, total assets and median size. Data are reported for each year during the period January 2003-December 2009. Panel A reports data for all domestic equity funds while Panel B reports data only for the sample funds. Index funds and equity funds domiciled in Luxembourg are excluded. The data were obtained from the Association of Greek Institutional Investors (AGII).

Table 2

Characteristics of the variables for the period 2003-2009

	Mean	Maximum	Minimum	Std. Dev.
Carhart alpha (%)	-0.4	18.1	-26.9	6.5
Total expense ratio	0.036	0.081	0.005	0.01
Age (in years)	9.945	19.68	1.11	4.472
Assets (mil. euros)	93.204	575.165	1.14	136.705
Risk	0.197	0.465	0.096	0.071

Notes: This table presents the descriptive statistics for a series of the funds' characteristics over the period under examination. These are the annualized Carhart alphas, the Total Expense Ratio, the end period total Assets in € millions, total risk measured by annualized standard deviation of returns and age of funds measured in years from inception.

Graph 1
Mean efficiency score for period 2003-2009

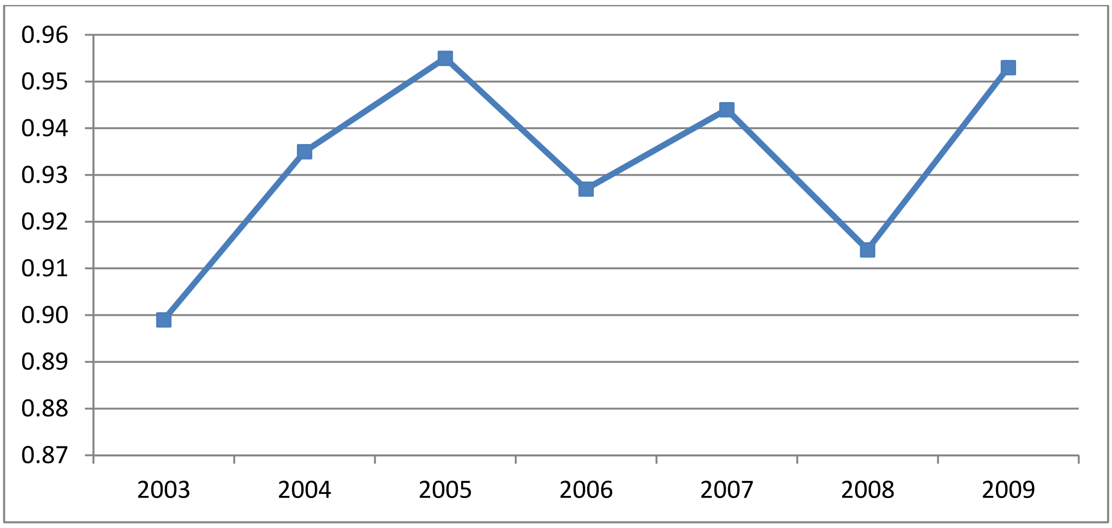

Table 3

Individual efficiency scores

FUND	2003	2004	2005	2006	2007	2008	2009
1	0.766	0.882	0.985	0.933	0.971	1.000	0.968
2	0.896	0.918	0.951	0.902	0.936	1.000	1.000
3	0.888	0.995	0.944	0.968	0.913	0.885	0.973
4	0.888	0.971	0.953	0.960	0.894	0.861	0.933
5	0.935	0.965	0.952	0.918	0.976	0.943	0.945
6	0.923	0.995	0.954	0.918	0.976	0.936	0.945
7	0.883	1.000	0.969	1.000	1.000	1.000	1.000
8	0.907	1.000	1.000	0.917	1.000	1.000	0.913
9	0.887	0.966	0.960	0.943	0.912	0.902	0.907
10	0.866	0.910	1.000	0.956	0.982	0.725	0.914
11	0.883	0.944	0.952	0.875	0.949	0.903	0.934
12	0.853	0.963	0.941	0.916	0.906	0.959	0.937
13	1.000	0.957	0.933	0.960	1.000	1.000	0.995
14	1.000	0.967	1.000	0.905	1.000	0.920	0.985
15	0.905	0.900	0.922	0.911	0.913	0.841	0.954
16	0.851	0.989	0.869	0.942	0.958	0.771	0.971
17	0.808	0.990	0.911	0.904	0.909	0.870	0.894
18	0.859	0.823	0.970	0.954	0.928	0.960	0.900
19	1.000	0.859	0.947	0.912	0.894	0.973	0.955
20	0.929	0.985	0.933	0.891	0.899	0.967	0.951
21	0.845	0.897	0.950	0.901	0.897	0.976	0.967
22	0.931	0.997	1.000	0.891	0.913	0.974	0.999
23	0.857	0.946	0.939	0.954	0.923	0.992	0.974
24	0.879	0.901	0.960	0.987	0.975	0.758	0.957
25	0.976	0.874	0.976	0.952	0.965	0.857	0.954
26	0.950	0.941	0.947	0.924	0.875	1.000	0.878
27	1.000	0.852	1.000	0.955	0.952	0.834	0.965
28	0.847	0.929	0.904	0.841	0.948	0.799	0.953
29	0.918	0.797	0.983	0.915	0.991	0.734	0.975
30	0.836	0.940	0.960	0.925	0.921	1.000	0.948
31	0.891	0.947	0.942	0.898	1.000	1.000	1.000
No of efficient funds	4	2	5	1	5	8	3

No of inefficient funds	27	29	26	30	26	23	28

Notes: This table reports DEA-CRS annual efficiency scores for funds for the period 2003-2009. The number of efficient (inefficient) funds is reported at the bottom of the table.

Table 4

Mean slacks in inputs

Panel A:Mean absolute slacks			
Year	**Capital**	**Expenses**	**Risk**
2003	0	0	0.026
2004	0.002	0.004	0.016
2005	0	0.009	0.018
2006	0	0.01	0.038
2007	0	0.005	0.002
2008	0	0.001	0.003
2009	0	0.005	0.003
Mean	0	0.005	0.015

Panel B:Relative slacks (absolute slack/mean value of inputs)			
Year	**Capital**	**Expenses**	**Risk**
2003	0	0	0.141
2004	0.002	0.113	0.114
2005	0	0.262	0.144
2006	0	0.275	0.208
2007	0	0.129	0.013
2008	0	0.028	0.01
2009	0	0.127	0.011
Mean	0	0.134	0.091

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. 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 the estimated mean absolute slacks while Panel B reports computed relative slacks.

Table 5

Average technically efficient change and technological change of domestic equity funds: 2003-2009

	Fund	Technically efficient change	Technological change	Pure technical efficiency change	Scale efficiency change	Malmquist index (TFP change)
1	Interamerican Developing Companies	1.022	0.969	1.022	1.000	0.990
2	ATE Small & Medium Cap	1.020	0.971	1.020	1.000	0.990
3	Geniki Selected Values	1.040	0.938	1.040	1.000	0.976
4	Hermis Pionneer	1.014	0.962	1.014	1.000	0.975
5	Probank	1.019	0.955	1.019	1.000	0.973
6	ALLIANZ	1.015	0.957	1.015	1.000	0.971
7	Attikis	1.023	0.950	1.023	1.000	0.971
8	Alico	1.019	0.952	1.019	1.000	0.970
9	Eur. Reliance Growth	1.009	0.958	1.009	1.000	0.967
10	Interamerican Dynamic	1.009	0.959	1.009	1.000	0.967
11	Alico Small & Medium Cap	1.010	0.956	1.010	1.000	0.966
12	KYPROU Hellenic Dynamic	0.996	0.969	0.996	1.000	0.965
13	Eurobank Institutional Portfolios	1.021	0.945	1.021	1.000	0.965
14	ALLIANZ Aggressive Strategy	1.008	0.956	1.008	1.000	0.964
15	Hermis Dynamic	1.016	0.949	1.016	1.000	0.964
16	Delos Top-30	1.021	0.943	1.021	1.000	0.963
17	HSBC Medium & Small Cap	0.997	0.964	0.997	1.000	0.961
18	ALPHA TRUST Growth	1.021	0.940	1.021	1.000	0.960
19	Millenium Mid cap	0.994	0.965	0.994	1.000	0.959
20	ATE	1.004	0.953	1.004	1.000	0.957
21	Delos Blue Chips	1.004	0.952	1.004	1.000	0.956
22	International Selection	1.008	0.945	1.008	1.000	0.953
23	CitiFund Equity	1.012	0.942	1.012	1.000	0.953
24	Delos Small Cap	1.009	0.943	1.009	1.000	0.952
25	ALPHA TRUST New Companies	1.001	0.950	1.001	1.000	0.951
26	International Growth	1.017	0.934	1.017	1.000	0.950
27	ALPHA Blue Chips	1.004	0.945	1.004	1.000	0.948
28	HSBC Growth	0.999	0.945	1.000	0.999	0.944

29	ALPHA	1.002	0.941	1.002	1.000	0.943
30	Millenium Blue Chips	0.987	0.953	0.987	1.000	0.940
31	KYPROU Hellenic	0.992	0.837	0.992	1.000	0.831
Mean		**1.010**	**0.948**	**1.010**	**1.000**	**0.958**

Notes: This table presents results of the estimated output-oriented Malmquist index for the period 2003-2009. Column (3) reports the results for technically efficiency change while column (4) reports the results of technological change. In columns (5) and (6) we present pure technically efficiency change and scale efficiency change respectively. Total factor productivity change (Malmquist index) is presented in column (7). All Malmquist index averages are geometric means.

Table 6

Conditional Logit panel regression

Period	**2003-2009 (217 observations)**
β_0	-3.04
t-statistic	-3.50***
β_1	-0.011
t-statistic	-1.68*
β_2	0.11
t-statistic	1.39

Notes: This table reports estimated regression coefficients from the conditional, random effects logit model for the period 2003-2009.

*** (*) denotes statistical significance at 1% (10%)

Table 7

Summary statistics of Athens Stock Exchange

Year	**Capitalization**				**Avg no of trades**		
	Large Capitalization	Medium & Small Capitalization	Other	**Total**	Large Capitalization	Medium & Small Capitalization	Other
2006	143.78	10.70	3.44	157.93	28602.76	12457.29	0.04
2007	166.22	15.12	14.16	195.5	26630.88	11613.72	295.24
2008	55.28	6.68	6.17	68.12	24200.9	2894.1	447.95
2009	70.44	5.59	7.42	83.45	32186.64	4519.06	589.75
Year	**Volume of trades**						
	Large Capitalization	Medium & Small Capitalization	Other				
2006	382.78	241.40	21.23				
2007	544.11	136.18	46.93				
2008	646.34	50.36	32.98				
2009	703.18	101.84	37.00				

Notes: This table presents capitalization (billion of €), average daily number of trades and volume of trades (millions of shares) of Athens Stock Exchange. Daily average of trades is without block of trades while volume of trades refers to trades recorded in December of each year. Data are available only after 2006 since January of 2006 the internationally known sector classification FTSE Dow Jones Industry Classification Benchmark (ICB) is applied in Athex. Data were collected from Athens Stock Exchange

Table 8

Average trade spread in Athens Stock Exchange

Year	Trade spread
2005	1.77
2006	1.36
2007	1.23
2008	2.35
2009	2.79

Notes: This table reports average trade spread for the whole market for the period 2005-2009. The spread is defined as the ratio of the difference between the best ask and the best bid price over the average of the sum of the two prices. Average trade spread is the weighted, by traded value, average or the spreads corresponding to these trades. The spread that corresponds to a trade is the one experienced exactly before the trade. Data were retrieved from Athens Stock Exchange.

Table 9
Predictive power of fund's performance measure

Period	Spearman Correlation coefficient
2003-04	0.027
	(0.14)
2004-05	-0.131
	(-0.71)
2005-06	0.255
	(1.42)
2006-07	0.224
	(1.24)
2007-08	0.008
	(0.04)
2008-09	0.231
	(1.28)

Note: This table reports Spearman rank correlation coefficient for fund rankings in the specified period while in brackets we report the associated t-statistic.