Expert Systems with Applications 38 (2011) 3663–3670

Contents lists available at ScienceDirect

Expert Systems with Applications

journal homepage: www.elsevier.com/locate/eswa

Mutual funds performance evaluation based on endogenous benchmarks

Xiujuan Zhao [a], Shouyang Wang [b], Kin Keung Lai [c,*]

[a] School of Economics and Management, Beijing University of Posts and Telecommunications, Beijing 100876, PR China
[b] Academy of Mathematics and Systems Science, Chinese Academy of Sciences, Beijing 100190, PR China
[c] Department of Management Sciences, City University of Hong Kong, Kowloon, Hong Kong

ARTICLE INFO

Keywords:
Mutual funds
Data envelopment analysis (DEA)
Performance evaluation
Efficiency
Persistence

ABSTRACT

This paper proposes two quadratic-constrained DEA models for evaluation of mutual funds performance, from a perspective of evaluation based on endogenous benchmarks. In comparison to previous studies, this paper decomposes two vital factors for mutual funds performance, i.e. risk and return, in order to define mutual funds' endogenous benchmarks and give insights and suggestions for managements. Of the two quadratic-constrained DEA models, one is a partly controllable quadratic-constrained programming. The approach is illustrated by a sample of twenty-five actual mutual funds operating in the Chinese market. It identifies the root reasons of inefficiency and ways for improving performance. The results show that although the market environment in year 2006 was much better than that in 2005, average efficiency score declines in year 2006 due to relaxing of system risk control. The majority of mutual funds do not show persistence in efficiency ranking. The most important conclusion is that the ranking of mutual funds in China depends mostly on system risk control.

1. Introduction

Mutual funds have become one of the most important investment tools for common people as they enable small investors to take part in diversified investments. Assets managed by mutual funds are increasing as demand is growing and funds are getting diversified. Therefore, how to evaluate funds' performances has become a question of consequence. Since the important work of Markowitz (1952), Sharpe (1964, 1966), Treynor (1965) and Jensen (1968, 1969), numerous studies have been conducted for measuring performance in respect of risk and return, mainly based on the mean-variance (MV) framework. Evaluation results of these studies appear to depend, to a large extent, on exterior benchmarks used (1978).

In the most recent decade, some studies have been based on data envelopment analysis (DEA) methodologies to evaluate mutual funds' performance. Introduced by Charnes, Cooper, and Rhodes (1978), DEA is a mathematical programming method for measuring relative efficiencies of decision making units (DMUs). Since it is a non-parametric method capable of comparative evaluation, it is able to give assessments based on multi-inputs and multi-outputs, and enables managements to benchmark the best-practices of mutual funds by calculating scores denoting their efficiencies.

In order to assess 11 funds engaged in finance and metal industries in International Bargainers Research Database, Wilkens and Zhu (2001) chose standard deviation of returns and the proportion of negative monthly return in the year as inputs, and monthly return, skewness of return distribution and the minimum return in the year as outputs. Murthi, Choi, and Desai (1997) put forward a portfolio performance measurement method based on DEA in 1997, called DEA portfolio efficiency index (DPEI), with standard deviation and transaction loads as inputs, and excess return as output, to investigate performance of 2083 mutual funds in the third quarter of 1993. Choi and Murthi (2001) used the same inputs and outputs but with a different DEA formulation. McMullen and Strong (1998) analyzed and compared the comparative effectiveness of 135 American stock funds with data of the past 1 year, past 3 years and past 5 years, based on the DPEI index. Sedzro and Sardano (1999), on the other hand, analyzed performance of 58 US equity funds in Canada using DEA with annual return, expense ratio, minimum initial investment and a proxy for risk as factors associated with fund performance. Galagedera and Silvapulle (2002) analyzed and measured comparative effectiveness of 257 Australian mutual funds during the years 1995–1999 with different combinations of inputs and outputs. Basso and Funari (2001) used several risk measures (standard deviation, standard semi-deviation and beta) and subscription and redemption costs as inputs, and the mean return and the fraction of periods in which the mutual fund was non-dominated as outputs. Basso and Funari (2003), for assessing ethical funds, substituted the fraction of non-dominated periods for an ethical score of the mutual fund. Luo, Wang, and Tian (2003) used the integrated DEA index to evaluate the comparative performance of 33 closed-end funds which en-

* Corresponding author. Tel.: +852 27888563; fax: +852 27888560.
E-mail addresses: xjzhao@iss.ac.cn (X. Zhao), swang@iss.ac.cn (S. Wang), mskklai@cityu.edu.hk (K.K. Lai).

0957-4174/$ - see front matter © 2010 Elsevier Ltd. All rights reserved.
doi:10.1016/j.eswa.2010.09.022

tered the Chinese market before 2001. He found that the ranking differed much from than that of the Jessen index, which indicates that index selection is very important in funds' performance evaluation. Chang (2004) used a non-standard DEA formulation (based on minimum convex input requirement set) with mean return as output, and standard deviation, beta, total assets and load as inputs. Zhao, Zhang, Lai, and Wang (2007) evaluated Chinese mutual funds in DEA model with value-at-risk (VaR) under asymmetric Laplace distribution, cost and total return, and also investigated their scale efficiencies. Furthermore, Han and Liu (2003), Ma, Wu, and Cheng (2003) also studied the performance of closed-end funds in the Chinese market with an improved DEA model. Chen (2003) summed up DEA models applied in mutual funds performance evaluation.

Most of these researches were based on conventional linear envelopment model; the major differences between them were related to consideration of variables and data samples. As is known to all, DEA approaches provide each inefficient DMU's endogenous benchmark and estimates of the potential improvement that can be made. In mutual funds' evaluation with DEA models, the endogenous benchmarks are portfolios of funds. It is one of the advantages of DEA approaches. However, conventional DEA approaches in the above references do not compute correctly the risk of the target portfolios. These approaches compute the risk measure of the benchmark against which the mutual fund is compared as a linear combination of risk measures of the intervening mutual funds. This does not take into account diversification effects, and the resulting overestimation of the risk measure that usually leads to underestimation of efficiency scores. To make up for this consideration, Morey and Morey (1999) proposed quadratic-constrained DEA models that use a MV approach with variance as input and mean return as output. But there is still space to improve. Their input is total risk and output is total return. This makes sense, but is still not explicit enough in management. A good evaluation should be able to tell the root reason for different performances.

This paper digs the problem deeper and gives two quadratic-constrained envelopment models with information of system risk, non-system risk, excess return from timing and excess return from selecting. Our purpose is to investigate the root reason of each mutual fund's relative efficiency, present its endogenous benchmark, and to give performance improvement suggestions. Considering that the two kinds of risk are a little different from each other, system risk cannot be lowered with diversification, while non-system risk can be, we give a quadratic constraint for non-system risk in the envelopment evaluation model. Constraints of system risk and excess returns then be handled as linear. In addition, since the system risk is an uncontrollable factor, we incorporate the uncontrollable technology factor in our quadratic-constrained DEA models. The two models proposed in this paper are from the perspectives of input and output orientations. With this approach, investors will be able to assess mutual funds better, and shall be able to design better funds portfolios, with their own endogenous benchmarks.

The rest of this paper is organized as follows. Section 2 describes measures of risk and excess return. Section 3 presents the two quadratic-constrained envelopment evaluation models for mutual funds' endogenous benchmarks. Section 4 makes an empirical study of mutual funds in China and Section 5 draws some insightful conclusions.

2. Measures for risk and excess return

2.1. Excess return

Different mutual funds have different proportions allocated to different types of assets. Most existing quantitative researches of asset allocation are based on the framework of Brinson, Hood, and Beebower (1986). Actual allocation is dependent on timing and equity selection, which ultimately defines the original and extended strategic structure of a fund. Then funds adjust proportions of different kinds of assets, including stock, bond and money, dynamically. Asset allocation is the principal step of investment decisions. Decomposing and measuring excess return from differences in asset allocation can help managers find the reasons for performance differences on a running basis, and identify potential for performance improvement in the future.

According to BHB, suppose that there is a market benchmark M with g kinds of assets, and a mutual fund P with the same g kinds of assets. g is a positive integrity. These g kinds may be stock, bond or money, etc. The return of the ith asset in P is denoted as R_{pi} and that in 9i is denoted as R_{mi} ($i = 1,2,\ldots,$ g). The ith asset's proportion in P is denoted as W_{pi} and in M it is denoted as W_{mi}. Then mutual fund P's excess return from timing R_{PT} can be represented as:

$$R_{PT} = \sum_{i=1}^{g} R_{mi} \times (W_{Pi} - W_{mi}). \tag{1}$$

Mutual fund P's excess return from timing R_{PS} can be represented as:

$$R_{PS} = \sum_{i=1}^{g} (R_{pi} - R_{mi}) \times W_{pi}. \tag{2}$$

For practical convenience, the original assets allocation of mutual fund P at the beginning of some given time horizon is regarded as benchmark M's collation proportion. And we assume that the benchmark will not change its asset allocation during this horizon. Therefore, we can investigate mutual fund P's excess return from asset collation adjustment, or we can say, timing, during the given period, via formula (1). However, since it is very hard for us to get the actual return R_{pi}, excess return from selection cannot be computed directly. Here we get a substitute in an indirect way, for selection, by excluding timing, as follows:

$$R_{PQ} = R_P - R_M - R_{PT}, \tag{3}$$

where R_P is mutual fund P's actual total return, and R_M is the benchmark's total return. R_{PQ} can be regarded as the approximate excess return from selection during the given period.

2.2. Risks

Risk is a vital factor affecting return. As a professionally designed financial instrument, one of mutual funds' basic functions is to manage its portfolio's risk. According to the Capital Asset Pricing Model (CAPM), investment risk can be decomposed into system risk and non-system risk. System risk is from market's integral changing, impossible to be controlled by diversification of the portfolio. Non-system risk is the risk that only affects some industry or some company, and which can be countered by diversification of investment. System risk can be computed as follows, according to CAPM:

$$R_P = \alpha_P + \beta_P R_M + \varepsilon_P, \tag{4}$$

where R_P denotes the mutual fund's total return and R_M denotes the benchmark's total return. β_P is a measure of system risk. The bigger the value of β_P is, the higher is the system risk this mutual fund is exposed to. Eq. (4) can be solved by the Least-Squares Method. Standard deviation $\sigma(\varepsilon_P)$ of stochastic error series ε_P is regarded as non-system risk.

Though transaction load is also what investors are concerned about, and it is a necessary payout in mutual fund operations, high initial commission and redemption charges also constitute severe erosions of investment return. Therefore, the transaction load