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A Non-Parametric Examination of Real Estate Mutual Fund Efficiency

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Abstract

Due to the recent lackluster performance in the stock market and low yields in the bond markets, investors have been looking for alternative investment opportunities. Publicly traded real estate investment trusts (REITs) have been a large beneficiary, receiving considerable flows of funds from investors looking for sustained and competitive yields and lower levels of investment risk. Many investors in the REIT market choose to participate via real estate mutual funds (RMFs), yet to date no research has focused on the efficiency in this arena. In this study, we employ data envelopment analysis (DEA), a non-parametric statistical procedure, to assess the relative performance of RMFs for the years 1997–2001. DEA is a procedure that tests whether decision-making units are operating on their efficient frontier, which requires minimum input usage for a given level of output, or vice versa. We find seven RMFs for 1997, three for 1998, three for 1999, four for 2000, and six for 2001 operating on the efficient frontier. Another result that we obtain is that by examining the mean inefficiencies of the input and output values, we determine the main sources of RMF inefficiency.

Key words: real estate; efficiency; REIT; DEA

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1. Introduction

The explosive growth in REITs over the past decade suggests that they provide an important alternative investment vehicle. With this rapid expansion, a growing number of real estate mutual funds (RMFs) began to appear on the market. The growth in the RMF market has been just as dramatic as that of the REIT market, as total RMF net asset value has grown from $1.5 billion in 1994 to almost $13.0 billion in 2001.

RMFs are open-end investment companies that invest almost exclusively in REIT assets. REITs are business trusts that pool together the funds of many investors for the purpose of investing in income-producing real estate or loans secured by real estate. REITs are similar to closed-end mutual funds in that, unlike open-end funds, instead of the fund standing by to redeem shares at the net asset value, REIT shares are traded in secondary markets at prices that may be at a discount or a premium to their net asset values.

REITs are typically divided into three categories based on the type of real estate assets in which they invest. Equity REITs primarily invest in and operate income-producing properties such as apartments, office buildings, shopping centers, and hotels, deriving revenue mainly from rents. Mortgage REITs primarily invest in mortgage loans on commercial and residential property as well as in construction and development loans to real estate developers, deriving revenue mainly from interest on these loans. Hybrid REITs invest in both properties and real estate mortgage loans. There are a limited number of REIT shares, and after the shares are issued to the public in a primary offering, the shares trade like common stock in that trading is conducted between two secondary market participants; the fund itself is no longer involved.

According to National Association of Real Estate Investment Trusts (NAREIT) statistics, equity REITs are by far the largest category, making up approximately 91.75% of total REIT capitalization. The basic reasoning behind the formation of RMFs is that as REITs have become more and more specialized they have lost some of their diversification benefits. RMFs attempt to regain this diversification, while hopefully providing additional returns. RMFs also add a number of expenses, and, from the investor's point of view, the question is one of minimizing those expenses for the value received.

For the last three decades, academics and practitioners have been attempting to measure the investment performance of mutual funds and other types of professionally managed portfolios. In the early years of finance, investors concentrated almost exclusively on the measurement of the rate of return on an investment as an indication of how well the investment performed. In the 1950s studies by Markowitz (1952) and Tobin (1958) suggested a means for investors to measure risk in terms of the variability of the returns. Then in the late 1960s, researchers proposed several alternative measures of portfolio performance based on the capital asset pricing model (CAPM). These new measures encompassed both factors affecting portfolio performance, as they took into account the investment's return component adjusted appropriately for its risk.

The Sharpe Index (Sharpe, 1966), the Treynor Index (Treynor, 1965), and Jensen's Alpha (Jensen, 1968) are the most commonly used of these measures. These performance measures basically try to determine if the activities of a professional fund manager provided additional returns to the fund beyond that of a passive benchmark. These traditional measures have proven to be extremely useful, but they possess potential problems in addressing key factors in evaluating portfolio performance such as identifying the appropriate benchmark and incorporating transaction costs.

Murthi et al. (1997) offer an alternative to the traditional measures by proposing a measure of portfolio performance derived from a technique called data envelopment analysis (DEA, Charnes et al., 1978), which is used extensively in operations management research to compute relative measures of efficiency. Using DEA, investment performance can be gauged by measuring the efficiency of an individual fund relative to all other funds in a sample. DEA accomplishes this by constructing an efficient frontier from a linear combination of the perfectly efficient funds and determines fund deviations from that frontier, which represent performance inefficiencies.

In this research we briefly describe DEA and how it can be used in portfolio performance measurement. We then utilize the DEA technique in measuring the performance of our sample of RMFs. We further examine the DEA inefficiency measures of the individual RMF input and output factors in order to identify the source and extent of any performance inefficiency. By doing this analysis, we can determine what adjustments need to be made in order to make the RMF efficient. By examining the standard deviation of the investments as an input factor, we can also determine whether or not the investments are efficient from a risk perspective.

2. DEA: An Alternative Measure of Investment Performance

Brief Description

Data envelopment analysis (DEA) is an alternative measure of performance that, when used in measuring portfolio performance, can help alleviate some of the problems of the traditional performance measures. DEA is a technique used extensively in operations management research to compute relative measures of efficiency. DEA is a method of non-parametric analysis based on linear programming and is used to analyze production functions through a mapping of the production frontier. As mentioned previously, one of the pitfalls of the traditional performance measures is trying to identify an appropriate benchmark. An advantage of DEA is that because DEA is a non-parametric technique, it does not require any theoretical model such as the CAPM or the arbitrage pricing theory (APT) model to serve as a benchmark. Instead, it measures the relative performance of a fund versus the optimal or most efficient funds.

DEA allows the relationship between multiple inputs and multiple outputs to be described in terms of the most efficient combination of inputs to produce a given output and can be utilized in assessing the relative performance of any person, group, or unit that makes decisions that affect performance or efficiency. These decision makers are commonly called decision making units (DMUs).

DEA can be employed to help an investor in his decision making process. As implied above, another advantage of DEA over the traditional measures is that it can accommodate multiple inputs and/or multiple outputs, which allow transactions costs and other input factors, as well as multiple outputs, to be considered simultaneously in the performance analysis. Furthermore, inputs and outputs can have dissimilar units of measure without requiring any *a priori* tradeoff between the two (Rouse, 1995). This allows for the inclusion of transactions costs, such as expense ratios and loads, as well as other factors such as minimum initial investment and asset size in the analysis.

Essentially, DEA constructs an efficient frontier consisting of a linear combination of the perfectly efficient funds from a sample and determines deviations from that frontier, which represent performance inefficiencies. These deviations from the efficient frontier signify managerial or other inefficiencies that are a function of the failure to minimize inputs and/or maximize outputs.

Seiford and Thrall (1990) contend that DEA is superior to other techniques, such as regression, because it is a measure of relative performance and not of average performance. DEA optimizes on each unit's performance as compared to all others, and then evaluates an individual's performance based on the best performer, while regression performs just one optimization obtaining the average relationship across all units and then compares an individual unit's performance to the average performer. A further advantage of DEA is that, because it can accommodate multiple inputs and multiple outputs with no specification of the functional relationship between them, DEA is not affected by the multicollinearity problems associated with multiple regression models.

Utilizing DEA, we can rank a set of funds from the most efficient to the least efficient and determine how the funds performed on a relative basis. While this may not indicate whether or not the most efficient funds are "adequately" efficient, it does tell us which funds are the best from a given group. DEA also provides results that the traditional measures do not, in that the results can also help indicate what characteristics are causing the inefficiency in the funds. From this, a fund manager can attempt to correct a fund's inefficiencies, or try to emulate an efficient fund in hopes of becoming efficient. If large inefficiencies are found on a wide scale, we might presume that some market imperfection exists that allows funds to operate sub-optimally and still survive.

The DEA Model

Using DEA as a performance measure allows for the fact that distinctive DMUs may value various inputs and outputs differently. The technique allows each unit to define its own set of weights that supplies the most favorable weighting in comparison to the other units. The basic DEA model considers n units ($j = 1, \ldots, n$), each utilizing m factors of production or inputs ($X_{1j}, \ldots, X_{mj}$) to produce s outputs

(Y_{1j}, …, Y_{sj}). The relative efficiency measure, h, of an individual unit is obtained by maximizing the ratio of weighted outputs to weighted inputs subject to the constraint that the corresponding ratios for all units in the relevant data set have an upper bound of 1. Thus, the efficiency of a target unit j_0 can be obtained by solving the following fractional programming model:

$$
\begin{aligned}
\max \quad & h_0 = \frac{\sum_{r=1}^{s} u_r y_{rj_0}}{\sum_{i=1}^{m} v_i x_{ij_0}} \\
\text{s.t.} \quad & \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \le 1, \qquad j = 1, \ldots, n, \\
& u_r,\ v_i \ge 0, \quad r = 1, \ldots, s, \quad i = 1, \ldots, m,
\end{aligned}
\tag{1}
$$

where

u_r = weight attached to output factor r,
v_i = weight attached to input factor i,
y_{rj} = amount of output r by unit j,
x_{ij} = amount of input i of unit j,
S = the number of output factors,
M = the number of input factors,
N = the number of DMUs to be evaluated with respect to each other.

In the solution of the DEA model, weights are assigned to the input and output factors of each unit to make each as efficient as possible subject to the constraint that the efficiency of all units being evaluated have an upper bound of 1. Since the assigned weights maximize efficiency, a unit with an efficiency rating of 1 is deemed efficient relative to the others being evaluated; a unit with an efficiency rating of less than 1 is deemed inefficient. The solution to the above model provides the relative efficiency of the unit and the weights necessary to obtain that efficiency measure. In mapping all of the units' efficiency ratings, we can form an efficient frontier from the units with an efficiency rating of 1; units with an efficiency rating of less than 1 are located inside this frontier. Thus, this efficient frontier "envelops" the units that are deemed to be inefficient. In practice, the fractional DEA program, above, is converted to a linear form so that simple linear programming methods can be applied (Boussofiane et al., 1991).

3. Data Description

DEA is also advantageous in that, in a Pareto efficiency context, efficiency, as evaluated by DEA, can be defined from either an input minimization or output maximization point-of-view. In dealing with input minimization, the objective is to produce a given level of outputs from a minimum amount of inputs. A DMU is considered inefficient from an input perspective if any other DMU or combination of DMUs can produce the same level of outputs while using less of at least one input and no more of any other input. With output maximization, the objective is to produce the maximum amount of outputs from a given level of inputs. A DMU is considered inefficient from an output perspective if any other DMU or combination of DMUs can produce more of at least one output and no less of any other output, from the same level of inputs. The primary objective of this research is to measure the individual performance of RMFs from an investor's point of view using DEA as a measure of performance. 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.

Choosing the appropriate input and output factors to use in the analysis depends largely on the objective of the study. Because this study is being performed from the investor's viewpoint, the input/output choices should be those that would be considered relevant by a typical investor wishing to measure the performance of his portfolio. Therefore, output is defined as the benefit derived by the investor from having the investment, which we interpret as annual returns for RMFs. Inputs are defined as the resources expended by the investor when investing in a RMF. For the RMF investments, the investor incurs certain sales charges to acquire the mutual fund in the form of loads and other expenses of the fund that are passed on to the investor and included in the expense ratio.

A fund's expense ratio refers to the general overall costs incurred by the fund and is typically expressed as a percentage of total assets being managed. We break down the fund's total expense ratio into 12b-1 fees, which are marketing and distribution fees and "other" expenses, which include general and administrative expenses, operating expenses, and advisory fees. We also include the fund's loads (front/deferred), or sales charges, which are not included as part of the expense ratio. We include the standard deviation of the returns as an additional input, as an investment's risk is a vital input consideration for investors and an essential factor when interpreting returns. All of the real estate mutual fund data for the years 1997 to 2001 were obtained from the Morningstar Principia database under the Specialty-Real Estate category. Because a large number of RMFs have emerged only recently, the study period suitable for this research was limited due to the lack of meaningful data prior to 1997.

4. Results

The Basic DEA Results

For all RMFs in the sample, we compute a relative measure of efficiency using the DEA program as described above. For this study, we use a standard input-oriented DEA model, in which an efficiency measure of 1 indicates that the fund is efficient relative to the other funds being evaluated; a DEA measure of less than 1 indicates that the fund is inefficient relative to the others. The difference between the efficiency measure and 1 indicates the magnitude of inefficiency—the larger the difference, the more inefficient the fund.

Table 1 lists sample sizes for each year and the number of efficient RMFs found for each year. From Table 1, we can see that the DEA results identified seven RMFs for 1997, three for 1998, three for 1999, four for 2000, and six RMFs for 2001 as being efficient.

Table 1. Sample Size and Number of Efficient RMFs

	1997	1998	1999	2000	2001
RMF Sample Sizes	28	50	66	94	110
Number of Efficient RMFs	7	3	3	4	6

Table 2 lists these RMFs, along with their input and output attributes. The efficient RMFs have a DEA relative efficiency measure of 1.00, or 100%, and lie on the efficient frontier or what is known as the envelopment surface. These efficient investments require no input reductions or output increases, as their attributes are deemed to be the "best" as compared to all others in the sample. All other RMFs are inefficient relative to these, lying below the efficient frontier, and would need some input/output adjustments in order to become efficient.

For illustrative purposes, in Table 3 we list examples of RMFs that are shown to be DEA inefficient. For example, the 1997 RMF Cohen & Steers has an efficiency score of 0.8909, which indicates that the fund is 89.09% efficient in utilizing its inputs, and in total inefficiency terms it would have to decrease its inputs by 10.91% in order to become efficient. As we can see by the magnitude of the efficiency scores in Table 3, some of the investments require relatively little input reduction in order to become efficient, while others require a great deal. The 1997 RMFs Davis Real Estate A (input efficiency 0.9613), Fidelity Real Estate Investments (input efficiency 0.9748), and Munder Real Estate Y (input efficiency 0.9655) all have efficiency scores that are close to 1.00. RMFs with efficiency scores such as these are often called "near efficient" because their measures are so close to perfect efficiency. As with the traditional measures of performance, one cannot determine if these scores are statistically different from each other or from an efficient fund with a score of 1.00. Thus, one might infer that RMFs with scores that fall within a certain range are "equal." Because funds with efficiency measures such as these require only minor adjustments to their inputs to become efficient, one can

Table 2. DEA Efficient RMFs

	Return (%)	Std Dev (%)	Front Load (%)	Def. Load (%)	12b-1 Fees (%)	Other Exp (%)	DEA Input Efficiency
1997 RMFs							
Crabbe Huson Real Est Prim	18.76	11.94	0.00	0.00	0.25	1.25	1.0000
Davis Real Estate B	23.88	12.93	0.00	4.00	1.00	1.22	1.0000
DFA/AEW Real Estate Secs	19.34	12.14	0.00	0.00	0.00	0.71	1.0000
Evergreen U.S. Real Estate A	55.01	21.10	4.75	0.00	0.75	1.01	1.0000
Evergreen U.S. Real Estate Y	55.42	21.02	0.00	0.00	0.00	1.50	1.0000
Franklin Real Estate Sec I	19.90	11.30	4.50	0.00	0.25	0.73	1.0000
Templeton Global Real Est I	5.24	10.62	5.75	0.00	0.25	1.20	1.0000
Means for Efficient RMFs	28.22	14.44	2.14	0.57	0.36	1.09	1.0000
Means for Full Sample	21.91	14.08	1.61	1.04	0.38	1.35	0.9028
1998 RMFs							
Alpine Intl Real Estate Y	2.64	16.84	0.00	0.00	0.00	1.78	1.0000
Delaware Pooled Real Est	(12.09)	15.23	0.00	0.00	0.00	0.00	1.0000
Fidelity Real Est Hi-Inc	(1.01)	7.24	0.00	0.00	0.00	0.99	1.0000
Means for Efficient RMFs	(3.49)	13.10	0.00	0.00	0.00	0.92	1.0000
Means for Full Sample	(14.82)	15.37	1.36	0.98	0.43	1.16	0.3343
1999 RMFs							
CRA Realty Shares Instl	(2.55)	14.67	0.00	0.00	0.00	0.00	1.0000
Delaware Pooled RE	(2.57)	14.18	0.00	0.00	0.00	0.00	1.0000
Fidelity Real Est Hi-Inc	8.29	6.39	0.00	0.00	0.00	0.89	1.0000
Means for Efficient RMFs	1.06	11.75	0.00	0.00	0.00	0.30	1.0000
Means for Full Sample	(4.55)	14.79	1.23	0.80	0.35	1.17	0.3272
2000 RMFs							
Delaware Pooled Real Est	32.83	14.71	0.00	0.00	0.00	0.00	1.0000
Fidelity Real Est Hi-Inc	17.88	5.32	0.00	0.00	0.00	0.89	1.0000
Fidelity Rel Est Hi-Inc II	33.18	14.57	0.00	0.00	0.00	0.83	1.0000
Security Cap US Real Est	35.84	17.08	0.00	0.00	0.25	0.95	1.0000
Means for Efficient RMFs	29.93	12.92	0.00	0.00	0.06	0.67	1.0000
Means for Full Sample	25.51	15.00	1.12	0.74	0.31	1.26	0.6437
2001 RMFs							
Alpine U.S. Real Estate Eq Y	25.19	25.42	0.00	0.00	0.00	2.57	1.0000
Delaware Pooled Real Est	8.80	14.37	0.00	0.00	0.00	0.00	1.0000
Fidelity Real Est Hi-Inc	12.14	3.50	0.00	0.00	0.00	0.86	1.0000
Hancock Real Estate A	13.05	14.37	5.00	0.00	0.30	0.00	1.0000
Spirit of America Invmt A	28.03	13.66	5.25	0.00	0.30	1.67	1.0000
Stratton Monthly Div REIT	22.98	14.38	0.00	0.00	0.00	1.20	1.0000
Means for Efficient RMFs	18.37	14.28	1.71	0.00	0.10	1.05	1.0000
Means for Full Sample	8.85	14.82	1.07	0.88	0.34	1.24	0.4255

reasonably expect that these changes might be feasible. Others such as Evergreen Global Real Estate (input efficiency 0.5751) and Pioneer Real Estate A (input efficiency 0.7800) are much further from being efficient, and it may be impossible for them to make the needed changes to their inputs to become efficient.

Table 3. Examples of DEA Inefficient RMFs

1997 Inefficient RMF Examples	Return (%)	Standard Deviation (%)	Front Load (%)	Deferred Load (%)	12b-1 Fees (%)	Other Expenses (%)	DEA Input Efficiency
Cohen & Steers Realty Shares	21.16	14.07	0.00	0.00	0.00	1.08	0.8909
Davis Real Estate A	25.08	13.03	4.75	0.00	0.25	1.07	0.9613
Evergreen Glob Real Est Eq Y	4.20	14.38	0.00	0.00	0.00	1.65	0.5751
Fidelity Real Estate Invmnt	21.39	12.94	0.00	0.00	0.00	0.90	0.9748
Flag Inv Real Estate Secs B	20.78	13.42	0.00	4.00	0.75	1.25	0.9097
Munder Real Estate Eq Invt B	21.16	13.13	0.00	5.00	1.00	1.10	0.9319
Munder Real Estate Eq Invt Y	22.40	13.28	0.00	0.00	0.00	1.10	0.9655
Pioneer Real Estate A	19.74	14.65	5.75	0.00	0.25	1.44	0.7800
U.S. Global Inv Real Estate	19.28	12.75	0.00	0.00	0.00	1.80	0.9319
Van Kampen Am Cap Real Est	19.78	12.98	0.00	1.00	1.00	2.38	0.9277

5. Identifying the Source of the Inefficiency

Along with the DEA efficiency scores, the DEA program can also generate other useful results including inefficiency measures, target values, and peer groups. Target values are the values that, if attained, would make the unit efficient. Target values are a convex combination of efficient units that lie on the DEA envelopment surface. The inefficiency measures are the differences between the target input and output values and the unit's actual values. By examining the inefficiency measures of each input and output factor, we can determine the factors that are contributing to the inefficiency and what adjustments need to be made in order to make the RMF efficient.

Table 4 shows the inefficiency measures and target values for the RMFs that are DEA efficient and for some examples of 1997 RMFs that are DEA inefficient.

As we would expect, the efficient RMFs have inefficiency measures of 0 for all input and outputs, and their target values are equal to their actual values. For the inefficient RMFs, the inefficiency measures indicate by how much the fund's inputs need to be decreased and, in some cases, by how much its outputs need to be increased in order to reach the efficient target values. For example, in order for 1997 RMF Cohen & Steers Realty to meet its target values, it would have to reduce its standard deviation by 1.48 and its other expenses by 0.33. Evergreen Global Real Estate Equity Y, on the other hand, is so inefficient that it would need to increase its output attribute, return, by 15.14, as well as decrease some of its inputs. This can occur in an input-oriented model if a fund is highly inefficient.

Table 4. Example DEA Inefficiency Measures and Target Values

INEFFICIENCY MEASURES

1997 Efficient RMFs	Return	Std Dev	Front Load	Def. Load	12b-1	Other
Crabbe Huson Real Est Prim	0.00	0.00	0.00	0.00	0.00	0.00
DFA/AEW Real Estate Secs	0.00	0.00	0.00	0.00	0.00	0.00
Evergreen U.S. RE A	0.00	0.00	0.00	0.00	0.00	0.00
Evergreen U.S. RE Y	0.00	0.00	0.00	0.00	0.00	0.00
Franklin Real Estate Sec I	0.00	0.00	0.00	0.00	0.00	0.00
Templeton Global Real Est I	0.00	0.00	0.00	0.00	0.00	0.00
1997 Inefficient RMF Examples	**Return**	**Std Dev**	**Front Load**	**Def. Load**	**12b-1**	**Other**
Cohen & Steers Realty	0.00	(1.48)	0.00	0.00	0.00	(0.33)
Davis Real Estate A	0.00	(0.31)	(0.91)	0.00	(0.04)	(0.23)
Evergreen Glob R Est Eq Y	15.14	(2.24)	0.00	0.00	0.00	(0.94)
Fidelity Real Estate Invmnt	0.00	(0.30)	0.00	0.00	0.00	(0.15)
Flag Inv Real Estate Secs B	0.00	(1.07)	0.00	(2.50)	(0.26)	(0.10)
Munder R Estate Eq Invt B	0.00	(0.69)	0.00	(3.29)	(0.52)	(0.06)
Munder R Estate Eq Invt Y	0.00	(0.39)	0.00	0.00	0.00	(0.32)
Pioneer Real Estate A	0.00	(3.17)	(2.22)	0.00	(0.05)	(0.71)
U.S. Global Inv Real Estate	0.06	(0.61)	0.00	0.00	0.00	(1.09)
Van Kampen Am Cap RE C	0.00	(0.84)	0.00	(0.20)	(0.60)	(1.14)

TARGET VALUES

1997 Efficient RMFs	Return	Std Dev	Front Load	Def. Load	12b-1	Other
Crabbe Huson Real Est Prim	18.76	36.04	11.94	0.19	0.25	1.25
DFA/AEW Real Estate Secs	23.88	35.75	12.93	0.23	1.00	1.22
Evergreen U.S. RE A	19.34	33.84	12.14	0.20	0.00	0.71
Evergreen U.S. RE Y	55.01	21.88	21.10	0.63	0.75	1.01
Franklin Real Estate Sec I	55.42	22.44	21.02	0.63	0.00	1.50
Templeton Global Real Est I	19.90	32.50	11.30	0.25	0.25	0.73
1997 Inefficient RMF Examples	**Return**	**Std Dev**	**Front Load**	**Def. Load**	**12b-1**	**Other**
Cohen & Steers Realty	21.16	12.59	0.00	0.00	0.00	0.75
Davis Real Estate A	25.08	12.72	3.84	0.00	0.21	0.84
Evergreen Glob R Est Eq Y	19.34	12.14	0.00	0.00	0.00	0.71
Fidelity Real Estate Invmnt	21.39	12.64	0.00	0.00	0.00	0.75
Flag Inv Real Estate Secs B	20.78	12.35	0.00	1.50	0.49	1.15
Munder R Estate Eq Invt B	21.16	12.44	0.00	1.71	0.48	1.04
Munder R Estate Eq Invt Y	22.40	12.89	0.00	0.00	0.00	0.78
Pioneer Real Estate A	19.74	11.48	3.53	0.00	0.20	0.73
U.S. Global Inv Real Estate	19.34	12.14	0.00	0.00	0.00	0.71
Van Kampen Am Cap RE C	19.78	12.14	0.00	0.80	0.40	1.24

Table 5a shows the mean of the inefficiencies in individual inputs and outputs for our sample of RMFs.

Table 5a. Mean Inefficiency Measures

	Return (%)	Standard Deviation (%)	Front Load (%)	Deferred Load (%)	12b-1 Fees (%)	Other Expenses (%)
1997 RMFs	1.8733	(0.9475)	(0.2476)	(0.7147)	(0.1665)	(0.3694)
1998 RMFs	10.9599	(0.2370)	(1.3600)	(0.9800)	(0.4260)	(0.3978)
1999 RMFs	9.6928	(6.1280)	(1.2273)	(0.8030)	(0.3455)	(0.5363)
2000 RMFs	1.4801	(4.1288)	(1.1207)	(0.7434)	(0.3062)	(0.4915)
2001 RMFs	3.0284	(6.9536)	(0.9266)	(0.8805)	(0.3322)	(0.6123)

Table 5b shows the corresponding relative mean inefficiencies, which are calculated by dividing the mean inefficiency of an individual attribute by the mean value of that attribute for the full sample. The contribution of each input or output can be compared by examining its relative mean inefficiencies (Murthi et al., 1997).

Table 5b. Relative Mean Inefficiency Measures—RMFs

	Return	Standard Deviation	Front Load	Deferred Load	12b-1 Fees	Other Expenses
1997 RMFs	0.0855	(0.0673)	(0.1540)	(0.6900)	(0.4338)	(0.2741)
1998 RMFs	(0.7394)	(0.3407)	(1.0000)	(1.0000)	(1.0000)	(0.3415)
1999 RMFs	(2.1287)	(0.4144)	(1.0000)	(1.0000)	(1.0000)	(0.4591)
2000 RMFs	0.0580	(0.2752)	(1.0000)	(1.0000)	(0.9914)	(0.3915)
2001 RMFs	0.3421	(0.4692)	(0.8698)	(1.0000)	(0.9760)	(0.4946)

In an input-oriented DEA model, one would expect the output attribute to show little, if any, inefficiency. Examining the relative mean inefficiency measures we can see that the output attribute, return, had mixed relative inefficiency results. In 1997 and 2000 the returns for RMFs showed very little inefficiency, as these years all experienced significantly positive mean returns. On the other hand, returns were significantly negative for 1998 and 1999. As a result, they displayed large return inefficiencies for those years. Overall, 1997 was an efficient year for RMFs, as the mean efficiency score was quite high at 0.9028 (see Table 5c).

Table 5c. Mean Input Efficiency Scores for Full Sample

Year	RMFs
1997	0.9028
1998	0.3343
1999	0.3272
2000	0.6437
2001	0.4255

Standard deviation relative mean inefficiencies for the RMFs were fairly low in 1998, 1999, 2000, and 2001, ranging from −0.2752 to −0.4692, and extremely low in 1997 at −0.0673. For 1998, 1999, 2000, and 2001, RMF front loads, deferred loads, and the 12b-1 fee portion of the expense ratio all show extremely high relative mean inefficiencies from −0.8698 to −1.0000. Loads and 12b-1 fees for 1997 showed lower relative mean inefficiencies. In contrast to this, the other portion of the expense ratio, "other" expenses, shows low relative mean inefficiency for all years with measures from −0.2741 to −0.4946.

Overall, the main source of inefficiency for the RMFs appears to be the loads and the 12b-1 fees, which exhibit the largest inefficiencies in all years. Loads are fees paid either when buying (front end) or when selling (back end or deferred) a mutual fund. The high relative inefficiency in loads coincides with the popularity of no-load funds, which do not charge such fees. 12b-1 fees stem from Rule 12b-1, which allows mutual funds to pay marketing and distribution expenses directly out of fund assets, which essentially means that these costs are being passed on to the shareholders. The adoption of this rule has been found to be a contributing factor in the increase in the average annual expense ratio of mutual funds (Mack, 1993; McLeod and Malhotra, 1994; Malhotra and McLeod, 1997). Ferris and Chance

(1987) find that funds paying 12b-1 fees not only exhibit higher average annual expenses than funds without 12b-1 fees but may also experience lower average returns. Thus, we can see that 12b-1 fees are a major source of expense for a mutual fund, and as we have shown, a major source of performance inefficiency.

6. Summary and Conclusions

This study employs the operations management research technique of data envelopment analysis as a measurement tool in assessing the relative performance of Real Estate Mutual Funds. We find seven RMFs for 1997, three for 1998, three for 1999, four for 2000, and six RMFs for 2001 operating on the efficient frontier. Another result that we obtain is that by examining the mean inefficiencies of the input and output values, we determine the sources of the inefficiencies. The only consistently significant inefficiencies were found with the RMF's loads and 12b-1 fees for all years except 1997. We also find that for 1997 RMF risk in the form of the standard deviation had only a very low amount of related inefficiency.

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