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EFFICIENCY AND PERFORMANCE OF REAL ESTATE INVESTMENT TRUSTS (REITs): AN EMPIRICAL EXAMINATION

by

Can Topuz, B.S., M.B.A., M.S., M.A.

A Dissertation Presented in Partial Fulfillment
of the Requirements for the Degree
Doctor of Business Administration

COLLEGE OF ADMINISTRATION AND BUSINESS
LOUISIANA TECH UNIVERSITY

March 2002

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Date

We hereby recommend that the dissertation prepared under our supervision by Can Topuz entitled Efficiency and Performance of Real Estate Investment Trusts (REITs): An Empirical Investigation be accepted in partial fulfillment of the requirements for the Degree of

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Director of the Graduate School

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ABSTRACT

This study has a threefold purpose. Its first objective is to investigate input and output efficiencies in the Real Estate Investment Trust (REIT) industry. Its second objective is to understand the impact of size, property share, loan production, debt ratio, property and geographic diversification, control and governance variables, overall risk, capital risk, growth rate, and management type on a number of efficiency measures, including profit, cost, allocative, technical, pure technical and scale efficiency. The third objective is to assess the impact of structural and regulatory changes in the industry on REITs' productivity, technology, and efficiency changes.

I have estimated the REITs' efficiency in the period 1989-1999 by employing a nonparametric approach, namely Data Envelopment Analysis (DEA), along with a parametric approach, the Stochastic Frontier Approach (SFA). Results suggest that the average efficiency for all indexes is very low, implying waste of REIT resources and potential profits. Results also indicate that the dominant source of inefficiency in REIT industry is due to technical inefficiency rather than allocative inefficiency. Pure technical inefficiency is generally larger than the scale inefficiency, suggesting that the dominant source of overall technical inefficiency is mainly due to pure technical inefficiency.

Several conclusions emerge from second stage regression analysis, which examines the efficiency variations. First, robust capitalization and higher loan production bear a positive relation to REITs' efficiency. Second, the growth rate in their assets

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impacts positively on cost, technical, pure technical, and scale efficiencies, but negatively on profit efficiency. Third, REITs with more market power (higher property share) experience lower cost, technical, scale, and profit efficiencies. In addition, REIT efficiency decreases with higher debt. Finally, those REITs having separate management (decision) and board (control) structures are more efficient than those REITs with the same management and board.

I also examined the REITs' productivity change relative to both fixed reference technology and successive reference technology. The results suggest that REIT efficiency increases due to both scale efficiencies and better management practices; whereas their productivity generally decreases because of experiencing technical regress. I conclude that greater efficiency and technical improvement could both be achieved by the adoption of appropriate regulations.

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CHAPTER 1

INTRODUCTION

Real Estate Investment Trusts (REITs) were established by the U.S. Congress in 1960 to allow small investors to participate in diversified, large-scale, income-producing real estate enterprises. They are corporations or business trusts managed by boards of directors or trustees. Their shares must be fully transferable, and a minimum one hundred. REITs must have no more than 50% of the shares held by five or fewer individuals during the last half of each taxable year, and at least 75% of their gross income must be derived from real property rents or real estate mortgage interest. They also must invest at least 75% of their assets in real estate equities, mortgages or government equities, and pay dividends on at least 90% of their taxable income. REITs are exempted from both corporate and shareholder level taxation by complying with these restrictions.

REITs have received increased attention in the financial literature due in part to their unique characteristics and increasing popularity among investors. Investors may easily include real-estate-related assets in their investment portfolio by using REITs. An explosion of REIT activity has occurred in the last decade, and REITs have raised substantial amounts of capital for acquiring existing properties and also financing the development of new properties. They have also become a major source of funding for the real estate industry by the rapid increase in their security offerings. According to National

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Association of Real Estate Investment Trusts (NAREIT), the number of equity REITs rose from 56 to 158, and the total market capitalization has increased from $6.8 billion to $134 billion during the period 1989-2000. Operational environment changes and regulatory shifts in the industry have also impacted on the REIT growth. While the average annual number of equity REITs between 1989-1992 was 72.3, the average grew to 166 in the period 1993-2000. Accordingly, average market capitalization for the period of 1993-2000 increased more than 11 times that of the preceding four years. There is a 52% and 30% increase in initial public offerings by equity REITs in the same two periods. The total dollar value of 318 REIT equity offerings (initial and secondary) during 1997 was approximately $32.6 billion.

Along with these tremendous changes in the industry, REITs have also been subject to regulatory processes from time to time in the last decade. The Tax Reform Act of 1986, the Revenue Consolidation Act of 1993, the REIT Simplification Act of 1997, and more recently the REIT Modernization Act in 1999 affected all parties including managers, investment companies, shareholders, and the industry in general. For example, REITs were given permission not only to own but also to operate and manage properties, which in turn generated a new stream of income for their shareholders, better quality controls over the services rendered to tenants, and a more competitive market. Allowing institutional beneficiaries to be considered as individual REIT shareholders enhances the depth of potential REIT capital. Reducing the dividend requirement from 95% to 90% provides REITs with an additional source of income to make payments on outstanding debt.

Not only the REITs but other types of financial institutions have also experienced dramatic operational environment changes over the past several decades. These

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considerable changes have attracted the attention of regulators, managers, investors and researchers. They are all interested in how efficiently a firm uses its expensive inputs to produce its financial products and services. When financial institutions are run efficiently, the improvement in resource allocation benefits the whole society by leading to improved profitability, greater amounts of funds intermediated, better service for consumers, and greater safety and soundness in the financial system.

In an increasingly competitive environment, managers should be more concerned with how efficiently they operate their firms. Otherwise, the capital market penalizes inefficient firms by depressing their share price and subjecting them to takeover. In a perfectly competitive market, under-performing firms face difficulties to survive at all, and ultimately are driven out by more efficient ones.

There are several techniques for calculating the efficiency measures. Until recently, a few REIT efficiency studies focused on how well REITs utilized cost advantages stemming from the scale of production. Scale efficiency refers to whether a REIT is operating at the optimal scale--that is, whether a REIT is providing the most cost-efficient level of outputs. Scope efficiency, on the other hand, refers to whether a REIT is producing the most cost-efficient combination of products. However, the focus has recently switched to another aspect of efficiency, which is called X-efficiency. It measures how close an observed REIT is to an estimated "best-practice" frontier. While scale and scope efficiencies concern a REIT's choice of outputs, the frontier X-efficiency concerns a REIT's use of inputs. For a given level and mix of outputs, if a REIT does not produce its outputs in the least cost way possible, it is either wasting some of the inputs (technical inefficiency), or it is using the wrong combination of inputs to produce its outputs given their input prices (allocative inefficiency), or both of these.

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Frontier (X-efficiency) analysis provides valuable information for decision makers. Numerical efficiency scoring and ranking of firms are of great value because they can be used either to:

1) Inform policy-makers by investigating the impact of deregulation, financial distress, mergers and acquisitions, or market structure on efficiency;
2) Examine research issues by describing the efficiency of an industry, ranking its firms, or checking how measured efficiency may be related to the different efficiency techniques used; or
3) Improve managerial performance by identifying "best performing units" and "worst performing units" within an industry or a firm, and encouraging the "best practices" common in efficient units while discouraging the "worst practices" common in inefficient units.

Berger, Hunter, and Timme (1993) call for financial institution efficiency research, and suggest that results from these studies might explain the impact of various regulatory policies on institutional efficiency. In their international survey, Berger and Humphrey (1997) review 130 frontier (X-) efficiency studies on managerial efficiency of different financial institutions such as banks, savings and loans, credit unions, and insurance companies. However, they report that most of these studies have concentrated on banking industries in developed countries, suggesting that much more research for measuring and comparing efficiency of other financial institutions is called for.

It would be worthwhile to extensively analyze and study the efficiency and productivity of REITs. In the first stage analysis, five different efficiency measures are calculated employing Data Envelopment Analysis (DEA). These are cost efficiency (CE), the proportional reduction in costs that can be attained if the REIT is both allocatively

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and technically efficient; allocative efficiency (AE), the proportional reduction in costs if the REIT chooses the right mix of inputs given the prices; technical efficiency (TE), the proportional reduction in input usage that can be obtained if the REIT operates on the efficient frontier; pure technical efficiency (PTE), proportional reduction in input usage if inputs are not wasted; and scale efficiency, or proportional reduction if the REIT achieves constant returns to scale. This study also employs the stochastic (economic) frontier approach (SFA) to measure nonstandard (alternative) profit efficiency, which accounts for output side errors. Following the studies of Humphrey and Pulley (1997), Berger and Mester (1997) and DeYoung and Hasan (1998), nonstandard (alternative) profit efficiency (PE) is defined as how close a firm is to generating maximum profits given its output levels.

After recovering the efficiency scores from both DEA and SFA analyses, the following variables are used to explain variations in efficiency across REITs in the second stage regression analysis. The ultimate goal of this analysis is to assess how specific variables impact on the REITs' efficiency. These variables are grouped in the following categories:

1.1 Size

In the X-efficiency literature, it is typically argued that firm size should be strongly associated with efficiency. Evanoff and Israilevich (1991), for example, argue that larger firms are likely to have more professional management teams and/or might be more cost conscious, due to greater pressure from shareholders concerning bottom line profits. Because REITs must pay dividends of at least 90 percent of their taxable income, management teams face considerable pressure from owners. On the other hand, Berger *et*

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al. (1993) note that larger firms' ability to achieve optimal output is a matter of gaining size and achieving higher profits over a period of decades, an achievement that cannot be realized by small firms in the short run. However, efficiency might lead to larger size in the sense that more efficient firms compete more effectively and therefore become larger.

Although the direction of size and efficiency is not clear, it seems that the proposed relationship between size and X-efficiency in the literature is not negative. Therefore, the following hypotheses can be stated:

H_o: REIT size is *not* positively related to X-efficiency,

H_a: REIT size is positively related to X-efficiency.

1.2 Property Share

Competitive pressure is one of the most important factors in enhancing a firm's efficiency within an environment characterized by uncertainty and asymmetric information (Hayek, 1945; Hart, 1983). The market power hypothesis states that firms in less competitive markets can charge higher prices for their services and eventually make supernormal profits, and consequently are likely to feel less pressure to control their costs and enjoy a "quiet life". Therefore, the market power hypothesis suggests that the following null hypothesis will be rejected:

H_o: Market power is *not* negatively (positively) related to cost (profit) efficiency,

H_a: Market power is negatively (positively) related to cost (profit) efficiency.

On the other hand, the efficient structure hypothesis posited by Demsetz (1973), Peltzman (1977) and Gale and Branch (1982), among others, states that efficient firms compete more aggressively, generate higher profits, and gain larger market shares due to their low costs of production. Thus, the efficient structure hypothesis suggests that the following null hypothesis will be rejected:

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H_o: Market power is *not* positively (positively) related to cost (profit) efficiency,

H_a: Market power is positively (positively) related to cost (profit) efficiency.

Because a great proportion of equity REITs' income comes from properties, this study captures some aspects of market power with the ratio of REIT properties to the total properties for each year.

1.3 Loan Production

The composition of a REIT's portfolio influences operating costs and in turn may well determine operating efficiency. Since equity REITs might provide loans of up to 25% of their portfolio, it is worthwhile seeing whether there is an association between efficiency and loan production.

1.4 Debt Ratio

In their economies of scale estimation, Bers and Springer (1998a) report that the average scale economy of low-leverage REITs is much higher than that of high-leverage REITs. This result implies that low-leverage REITs acquire more benefit from increasing size than do high-leverage ones. Additionally, REITs using more debt incur greater financial risk and consequently the cost of their debt might be more than low-leverage REITs, for a given size. In their DEA analyses, Anderson *et al.* (1999) find a negative or insignificant relationship between debt ratio and operating efficiency. Thus, the following null hypothesis is expected to be rejected:

H_o: Debt ratio is *not* negatively related to X-efficiency,

H_a: Debt ratio is negatively related to X-efficiency.

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1.5 Concentration

REITs can be classified based on the type of property in which they concentrate their investment, and can also be divided by regions. To account for property-type diversification and geographical-region investment differences across REITs, related Hirschman-Herfindahl indices can be used to examine the impact of property and geographic diversification on REIT efficiency. More diversified REITs require highly skilled management teams knowledgeable about the industry, and are likely to incur more operating costs. Therefore, diversification is expected to be negatively related to efficiency, leading to the following null hypothesis:

H_o: More diversified REITs are *not* less X-efficient,

H_a: More diversified REITs are less X-efficient.

1.6 Corporate Governance and Control

Agency problems cause inefficient firm behavior. Separation of decision management from decision control is one way to alleviate possible agency problems (Fama and Jensen, 1983). CEOs have the most power in the decision management process in terms of preparation and implementation of projects. The board of directors is generally responsible for the greatest decision control, such as approving investments and monitoring implementation. Pi and Timme (1983) state that when the CEO is also the Chairman of the Board, decision management and control of the firm would be one-handed, and therefore the principal-agent problem may get worse. In all probability such a firm is more likely to be run inefficiently. The agency theory suggests the rejection of the following null hypotheses:

H_o: CEO-Chairman affiliation is *not* negatively related to X-efficiency,

H_a: CEO-Chairman affiliation is negatively related to X-efficiency.

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1.7 Overall Risk

If REITs are trading off risk against return, riskier REITs may be more profit efficient. Furthermore, efficient REITs might be good at risk management, suggesting also a negative relationship between cost efficiency and risk. Standard deviation of return on assets (ROA) is used to measure the risk. The following null hypothesis should be rejected:

H_o: REIT risk is *not* negatively (positively) related to cost (profit) efficiency,

H_a: REIT risk is negatively (positively) related to cost (profit) efficiency.

1.8 Capital Risk

Capital risk (the ratio of equity to total assets) is the probability of becoming insolvent. A REIT with more equity is able to take on more and cheaper debt with less chance of becoming insolvent. In the literature, well-capitalized firms are found to be more efficient which is consistent with the moral hazard theory. The theory states that managers with less capital to lose can take on riskier projects, and not necessarily pay attention to efficiency. Another possible reason is that efficient firms have higher profits, which might lead to a higher equity-total assets ratio. Therefore, the following alternative hypothesis should be accepted:

H_o: Well-capitalized REITs are *not* more X-efficient,

H_a: Well-capitalized REITs are more X-efficient.

1.9 Growth

The level of growth rate (change in total assets) is a managerial decision about future investments. Especially after 1994, the focus of REITs shifted to secondary offerings, with more than $7 billion raised in 1995, $11 billion in 1996, $26 billion in

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1997, and $19 billion during 1998. The number of offerings increased from 52 in 1994 to 297 in 1998. Many firms might outgrow their current level of management skills because they may not immediately react to changing market conditions, and may make non-optimal decisions, causing inefficient operations. REITs' management teams should have enough expertise and skill to overcome all operational details.

1.10 Type of Management

There are two forms of management in REITs, self-managed and externally managed firms. Self-managed REITs use their own employees to manage the assets and investments. A third party or a REIT affiliate management firm performs these services for externally managed REITs. By realizing the profit potential in the self-management of the operation, recent trends in the industry indicate that REITs are moving towards internal management, suggesting an increase in operational efficiency (Anderson *et al.*, 1999). Therefore, the following null hypothesis is expected to be rejected:

H_o: Self-managed REITs are *not* positively related to X-efficiency,

H_a: Self-managed REITs are positively related to X-efficiency.

This study also examines the impact of regulatory and structural changes in the industry on REITs' productivity, technology, and efficiency by employing the DEA-type Malmquist total productivity index method. This method allows not only analysis of changes in efficiency among REITs but also changes in technology. It also provides the sources of efficiency change; namely, either change in technical efficiency or change in scale efficiency.

This study contributes to the extant literature in several respects. First, this is the first attempt to measure the efficiencies of equity REITs by applying more than one

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method to the same data set. Second, five different measures of nonstochastic efficiency scores and stochastic alternative profit efficiency are estimated. This study is also the first study to predict and analyze the profit efficiency, cost efficiency, and allocative efficiency of REITs. Third, in addition to size, management type, diversification and leverage variables, this study investigates the impact of market power, risk, growth, and control and governance variables on REIT efficiencies. Additionally, this study examines the REITs' total factor productivity change for the last decade to detect any improvement in performance after regulatory and structural changes. Finally, the study assesses possible efficiency change sources, such as pure technical efficiency change (change in managerial efficiency) and scale efficiency change (change in optimal size).

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CHAPTER 2

TECHNICAL AND SCALE EFFICIENCIES OF REAL ESTATE INVESTMENT TRUSTS (REITs)

2.1 Introduction

Real Estate Investment Trusts (REITs) and other types of financial institutions have experienced considerable operational environment changes over the past several decades. This process is largely the result of legislation, structural change, technological progress and consolidations. These dramatic changes have attracted the attention of regulators, managers, investors and researchers who are interested in the impact on operational efficiency. Efficient institutions, in terms of their sources (inputs) and funds (outputs), have better service, higher profits, and more funds, which, in turn, benefit society.

Berger, Hunter, and Timme (1993) call for financial institution efficiency research, and suggest that results from these studies might explain the impact of various regulatory policies on institutional efficiency. In their international survey, Berger and Humphrey (1997) review 130 frontier (X-) efficiency studies on managerial efficiency of different financial institutions such as banks, savings and loans, credit unions, and insurance companies. However, they report that most of these studies have concentrated on the banking industry in developed countries, suggesting much more research is needed for measuring and comparing efficiency of other financial institutions.

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The Real Estate Investment Trust (REIT) industry has experienced considerable legal and structural changes during the last two decades. The U.S. Congress created REITs in 1960 to enable small investors to make an investment in a diversified, large-scale, income-producing real estate enterprise. REITs have experienced regulatory changes, most notably in 1976, 1986, 1993, 1997, and 1999, allowing them to exercise their business plans and operating systems with more efficiency.

Initially, REITs were subject to a 90% ordinary income distribution test, i.e., they had to distribute 90% of their taxable income to shareholders. This requirement was increased to 95% in January 1, 1980. Until 1986, REITs were required by federal law to hire a manager to operate their properties. Because managers have different economic interests than REIT owners, this situation has created agency problems [see Schulkin, 1971] and affects investment performance [see Solt and Miller, 1995, Hsieh and Sirmans, 1991, Howe and Shilling, 1990]. The Tax Reform Act of 1986 gave REITs permission to own, operate and manage most commercial properties. The Revenue Reconciliation Act of 1993 allowed pension funds to make large dollar investment in REITs, and with the REIT Simplification Act of 1997, their operations were further simplified by the U.S. Congress. Finally, the REIT Modernization Act (RMA), effective in 2001, was signed on December 17, 1999. One of the most important features of the RMA is to reduce the dividend requirement to 90%, providing a valuable source of after-tax incomes to make payments on outstanding debt.

Although REITs have existed in an environment with intense regulation changes, there has been no inquiry into the efficiency of REITs, and its implications.[1]. The purpose of this study is to investigate the efficiency of REITs, and to examine the relationship

[1] The only exception is perhaps an unpublished working paper by Anderson *et al.* (1999).

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between the characteristics and efficiency of REITs. Frontier techniques have been used in order to estimate the efficiency of firms over the past four decades. These techniques are grouped under parametric and nonparametric approaches which entail econometric and mathematical programming methods. Some studies compared different techniques and reported a strong relationship between the findings. (Ferrier and Lovell, 1990; Eisenbeis, Ferrier and Kwan, 1996). However, policy and research issues may be more convincing if several frontier techniques are applied to the same set of data to demonstrate the robustness of the results from both the first and second stage analyses (Berger and Mester, 1997). The nonparametric Data Envelopment Analysis (DEA) and the parametric Stochastic (Economic) Frontier Approach (SFA) are used to investigate the cost and profit efficiencies of REITs. In the SFA, only profit efficiency was calculated due to a data-fitting problem.

Section 2 reviews the existing literature. Section 3 presents the methodology and data. Section 4 reports efficiency measures in general and examines the relationship between efficiency and REIT characteristics. Section 5 concludes the paper.

2.2 Review of the Relevant Literature

The Real Estate literature lacks thorough efficiency analyses. However, there are some economies of scale studies with mixed results. Allen and Sirman (1987) are the first to examine merger and acquisitions of REITs. They investigate the acquiring firm's stock price reaction to merger proposals when both parties are REITs over the period 1977-1983. They find a wealth increase for acquiring REITs, which is attributed to better asset utilization, suggesting scale economies. McIntosh *et al.* (1991) examine the relationship between REIT size and stock price performance over the period 1974-1988. They find

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that smaller REITs have higher returns during the subperiod 1974-1978 and over the entire time period from 1974 to 1988, contradicting the existence of REIT scale economies.

Another issue is the shareholders' wealth effect of transactions involving the sale or purchase of real property and real estate operating entities. Glascock *et al.* (1991) finds that both buyer and seller have significant transaction gains, without identifying the source of these gains. McIntosh *et al.* (1995) extend the research by assessing the real property transactions of tax qualified REITs between 1968 and 1990 to determine shareholder wealth effects. They find that certain REITs experience positive results upon the announcement of sale transactions. Positive price impact for REIT sell-off indicates that there are benefits associated with reductions in size, suggesting additional evidence against scale economies.

The REIT industry experienced a consolidation process in the 1990s. Some observers argue that the number of REITs will diminish and the average REIT size will increase through an ongoing process of mergers and acquisitions, and that there must be a motivating factor such as the presence of economies of scale and efficiency gains. Linneman (1997) suggests that REITs will continue to grow in size and scale as they fully integrate the advantage of capital access, permanent lower capital costs and economies of scale over the long run. Linneman claims that REITs will be able to operate their properties at a lower cost because of their buying power, management infrastructure, and low overhead. Their overall cost of capital is at least 100 basis points lower than the competition because of their access to capital markets, and skill at financial structuring. These advantages will drive their competitors out of business. Hence, merger activity is expected to continue, resulting in domination by a very small number of giant REITs.

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Vogel (1997) counters these views and argues that the consolidation process is based on external, not efficiency related, factors. The argument is made through analogy. If there is a competitive advantage, it lies in management rather than ownership. There is not enough evidence that size gives REITs an operating advantage. He also gives a few examples of fluctuation in the cost of capital from the 1980s, and claims that the cost of capital has no permanent trend. Instead, it depends on the economy, yield curve, or investors' perception about real estate market changes.

Campbell *et al.*, (1998) examine merger activity in the period 1994-1998 to evaluate how each of the above arguments is supported. The population includes 27 mergers in which both the acquirer and the target firms are equity REITs. They measure trading volume responses and price responses by using event study methodology. The results indicate that returns for REIT acquirers are usually negative, and acquired REITs underperform, compared to their non-REIT counterparts. They conclude that if REIT mergers are value enhancing, acquiring firm managers have generally failed to capture the enhancements for their shareholders, suggesting the possible presence of self-dealing in many of these mergers. Furthermore, disappointing gains for acquired firms might dampen enthusiasm for mergers among owners of potential merger targets, and thus make it more difficult for REIT consolidation to occur. They also note that no hostile takeovers occurred during the period, and that most mergers produced either negative or comparably low returns, suggesting that systematic structural problems might prevent widespread consolidation.

An article by Ambrose *et al.* (2000) studies whether or not there are consolidation gains due to economies of scale. Their final sample includes 21 multifamily equity REITs covering the years 1994-1997. To analyze economies of scale, they compare each REIT's

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net operating income (NOI) growth rate in gross number of units to the NOI growth rate for its shadow portfolio, controlling for management ability. The results do not support the hypothesis that large REITs are able to achieve economies of scale through controlling expenses because the efficiency gains come primarily from rental growth rather than through expense control. They conclude that REIT consolidation will not result from cost economies. Furthermore, they find no evidence that REITs engaged in active branding programs generate higher NOI growth, and that geographic concentration generates NOI growth.

Capozza and Seguin (1998) decompose general and administrative (G&A) expenses into a nondiscretionary "structural" component and a discretionary or "style" component to examine the effect of managerial style on firm value. The structural component is associated with the costs of assets and liability management, while style component is, among other things, related to expenses diversifying the portfolio. They study 32 equity REITs with 416 potential observations from 1985 to 1992. The results suggest that greater diversification is associated with higher G&A expenses, and that the nondiscretionary component of G&A expenses increases with size at a decreasing rate, which suggests economies of scale.

Bers and Springer's (1997) study measures economies of scale using translog methodology. Their sample includes 85 observations from 1992, 113 from 1993, and 146 from 1994. Scale economy measures represent the percentage change in input (expenses) associated with a percentage change in output (average total assets and dividends). The authors use the sum of interest expenses, operating expenses, general and administrative expenses, and management fees as inputs while they use total assets and dividends as outputs in the translog cost model. One-output (total assets) and two-output (total assets

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and dividends) translog models produce similar results. This similarity implies that the total asset effect is the dominant determinant of the overall scale economy measure in the two-output model. The results suggest that economies of scale exist for the REIT industry but decrease with firm size. They conclude that there is an optimal size for REIT cost efficiency because of diminishing and subsequently disappearing scale economies. However, optimal size depends on individual REIT characteristics, and is not feasible because of changing the estimated scale economies over time.

Bers and Springer (1998a) extend their research to identify the sources of scale economies. The potential sources are general and administrative (G&A) expenses, management fees, operating expenses, interest expense, and interest expense as a percentage of total liabilities. The sample consists of all publicly traded REITs for the years 1992 through 1996, and include from 303 to 631 observations, depending on the cost category. Cost categories analyses show that except for interest expense, all categories of costs exhibit scale economies, and that G&A expenses are the largest. Although the next-largest source is management fees, operating expenses are not an important economies of scale source. They conclude that G&A expenses and management fees are the more reliable sources of scale economies, and provide the best target for cost control and improved operating efficiency for REITs expanding through merger and acquisition.

As a further extension, Bers and Springer (1988b) classify the REITs according to five attributes: the type of property management, the degree of investment in mortgages, financial leverage, diversification across property types and the property type, and examine differences in scale economies for the 1992 to 1997 time period. The complete data set is comprised of 1274 observations from 345 REITs. The subsamples used to

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estimate the impact of various REIT characteristics on scale economy range from 62 to 711 observations. The translog cost model methodology follows Bers and Springer (1998a). The model is estimated separately for each REIT types. They find that externally managed REITs experience higher scale economies than self managed REITs. This implies that external management passes some of the benefits of scale efficiencies on to the REIT. Estimated scale economies are larger for mortgage REITs which have relatively more administrative costs than equity REITs. Low leverage and well-diversified REITs show larger scale economies than more leveraged and specialized REITs, respectively. Finally, industrial REITs appear to have more scale economies.

Anderson *et al.* (1999) employ a linear-programming technique, Data Envelopment Analyses, to measure scale and technical efficiency of REITs for the period of 1992-1996. Equity REITs have overall efficiency measures ranging from 44% to 66%. Hybrid REITs ranging from 72% to 84% are more efficient. Consistent with Bers and Springer (1997, 1998a,b), most of the REITs are found to be operating at increasing returns to scale in which their efficiency ranges from 74% to 83%. The second stage regression results indicate that debt is negatively related to both overall efficiency and pure technical efficiency between 1992 and 1995. However, there is a positive relationship between debt ratio and scale efficiency in 1994, 1995, and 1996. The authors find mixed results for diversified REITs, and conclude that REIT concentration increases efficiency by allowing more effective input utilization, but reduces the ability to take advantage of scale economies. Finally, internally managed and large REITs appear to be more efficient.

The results of these economies of scale and efficiency studies are derived bycomparing inputs (proxied by costs) to outputs (total assets), and assuming that a REIT

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is a real estate investment. However, there is an implicit problem in choosing the output measures because REITs are also considered as equity and their value changes frequently in the market. In this case, market capitalization seems to be an appropriate output measure. However, Springer (1998) argues that there are drawbacks to these output measures (total assets and market capitalization). The primary criticism for total assets is that they do not represent current measures because they are presented on a cost basis. They may also include additional costs with the purchase of properties. Market capitalization, on the other hand, is not a constant measure, and changes over time. Therefore, it is difficult to measure market capitalization appropriately. Furthermore, it does not reflect what REITs are paying for their properties, but what investors are paying for stock.

There has been considerable debate as to whether REITs are stock investments or real estate investments, with mixed findings. Giliberto and Mengden (1996) compare the performance of REIT (public) and unsecuritized (private) real estate investment performance using the National Association of Real Estate Investment Trusts (NAREIT) Equity REIT Index and the National Council of Real Estate Investment Fiduciaries (NCREIF) Property Index (NPI), respectively. They find that private and public market real estate cash flows are strongly positively correlated, implying that the performance of the underlying real estate assets in publicly traded equity REITs is not fundamentally different from the performance of direct real estate. The results also suggest that differences between private and public market valuation parameters cause most of the observed differences between private real estate and publicly traded REIT performance.

Ghosh *et al.* (1996) argue that findings of similarity between REITs and small-cap stocks are based on pre-1994 data and, in many cases, pre-1992 data. Because the market

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capitalization of the REIT has quadrupled since 1992, results drawn from the previous research may be erroneous. The authors examine the correlation of historic returns, bid-ask spread, institutional ownership, trading volume, and the efficacy of trading rules based on large one-day price changes. Correlations show that REITs are less like other stocks, and provide more diversification. The results also indicate that REITs appear to be less liquid than other comparable-size stocks. Finally, they conclude that REITs are a bit more like direct real estate investment compared to other types of stocks, from the perspective of diversification and liquidity.

Acton and Poutasse (1997) also examine the change in the correlation coefficient between private and public (REIT) markets, employing the NCREIF Property Index, NAREIT Equity REIT index, and a hedged REIT index. They find a positive correlation between the NCREIF Property Index and NAREIT Equity REIT indexes, and also between the NCREIF Property Index and a hedged REIT index, beginning around 1993. They conclude that the returns of the public and private real estate markets are being forced toward similarity because of structural changes that have occurred in the REIT market since 1993, resulting in much greater institutional investment in REITs.

The present study differs from the extant literature in several respects. First, this is the first paper which attempts to measure the efficiencies of equity REITs by applying more than one method to the same data set. Second, five different measures of nonstochastic efficiency scores such as cost efficiency, allocative efficiency, technical efficiency, pure technical efficiency, and scale efficiency are estimated. Stochastic alternative profit efficiency is also estimated to explain REITs' output efficiencies. This is the first study predicting and analyzing the profit efficiency, cost efficiency and allocative efficiencies of REITs. Finally, in addition to size, management type,

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diversification and leverage variables, this study investigates the impact of market power, risk, growth, and control and governance variables on REIT efficiencies.

2.3 Data and Methodology

2.3.1 Data

Efficiency analysis data come from the SNL REIT Quarterly for the years 1989 through 1999, with a total of 1671 observations from 280 equity REITs. This represents a comprehensive set of equity REITs with the necessary input and output variables. Many observations (296) are dropped due to missing information[2]. The final data set is comprised of 1375 observations from 235 equity REITs over the eleven-year study period.

REITs have become a major source of funding for the real estate industry by the rapid increase in security offerings. The distribution of equity REITs and security offerings for all REITs across the years is shown in Table 1. Of particular interest is the large number of initial public offerings in 1993 and 1994, representing the formation of new REITs. There were 191 REITs formed between 1989 and 1999, and 95 of these were formed in 1993 and 1994. The capital raised from initial public offerings was about $16.5 billion in these two years, which was about 53% of the entire period. Total equity capitalization increased from $11 billion at the end of 1992 to $26 billion in 1993. This rapid growth continued during 1994 with more than $38 billion. After 1994, the focus shifted to secondary offerings, with more than $7 billion raised in 1995, $11 billion in 1996, $26 billion in 1997, and $19 billion during 1998. The number of offerings increased from 52 in 1994 to 297 in 1998. All of this growth resulted in a market

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[2] For instance, input prices, for some REITs, could not be determined because correspondent input values were reported as zero.

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Table 1. Distribution of Equity REITs and Equity Offerings Across the Years

Years	Equity REITs			Initial Public Offerings		Secondary Equity Offerings	
	Sample Size	Population	Market Capitalization[1]	Number	Capital Raised[1]	Number	Capital Raised[1]
1989	35	56	6,770	11	1,074	15	722
1990	45	58	5,552	10	882	8	389
1991	71	86	8,785	8	808	20	786
1992	98	89	11,171	8	919	24	1,054
1993	109	135	26,082	50	9,335	50	3,856
1994	168	175	38,812	45	7,176	52	3,944
1995	187	178	49,913	8	922	93	7,321
1996	184	166	78,302	6	1,108	139	11,201
1997	168	176	127,825	26	6,297	292	26,378
1998	159	173	126,904	17	2,129	297	19,378
1999	151	167	118,233	2	292	92	6,343

[1]Market capitalization and capital raised represents in million of dollars.
Source: National Association of Real Estate Investment Trusts

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comprised of 167 equity REITs with a total market capitalization of more than $118 billion.

2.3.1.1 Empirical Design. There are several reasons that this study focuses on equity REIT efficiency. Equity, mortgage, and hybrid REIT forms are totally separate[3]. Their operating environment and goals reflect their proportion of equity or mortgage asset holdings. It is, therefore, inappropriate to combine all three types in the same frontier. Furthermore, efficiency measures from mortgage and hybrid REITs could be biased or missing because of few observations for most years.

There is no consensus among researchers about what constitutes REIT productionor how to measure output[4]. Considering the output measures from other efficiency analyses and following the premise of REIT efficiency studies (Bers and Springer, 1997, 1998a, 1998b, and Anderson *et. al.*, 1999), total asset is deemed the most appropriate output measure. Additionally, Springer (1998) finds three results that validate the total assets as an output variable. First, total assets have a high correlation with market capitalization; second, it has lower variance and yields more consistent results; and third, any bias is conservative[5].

The total assets as a REIT output can be decomposed into three categories: loans, properties, and other assets. These are the value of all real estate loans (L); all properties owned by the company in operation (P); other assets (OA) consist of non-operational

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[3] The National Association of Real Estate Investment Trusts (NAREIT) classifies REITs as equity, mortgage, and hybrid REITs according to their respective holdings of real property or mortgage instruments. To be considered an equity (mortgage) REIT, at least 75% of the REIT investment portfolio must consist of income producing real property (mortgage instruments). Hybrid REITs combine the activities of equity and mortgage REITs.

[4] Possible measures include assets, dividends or FFO, market capitalization and space measures (square footage, number of units, etc.).

[5] Refer to Springer (1998) for a detailed discussion about the justification of possible REIT outputs.

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properties, unconsolidated partnership (which is the value of joint ventures), and all non-real estate investment assets[6]. The outputs are meaningful for the efficiency analysis because income (rent and/or interest) from these outputs depends on the management's decisions regarding where to invest – buying real estate or giving loans.

Input variables are proxied by costs in REIT economies of scale and efficiency studies mentioned in Section 2. Cost variables (interest expense and non-interest expense) have also been used as input variables in some bank efficiency studies such as Ferrier and Lovell (1990), Miller and Noulas (1996), and Avkiran (1999). Similarly, there are two input measures that naturally emerge from the SNL dataset. These are interest expense (IE) and property operating expense (POE)[7]. Interest expense is the cost of debt and other borrowings including the amortization of debt discounts. Property operating expense is associated with rental properties, including maintenance, utilities, property management fees, and real estate taxes. Input prices are proxied for the interest expense and property operating expense inputs, following the same approaches of Mester (1987) and Ferrier and Lovell (1990)[8]. The price of interest expense (PIE) is the interest expense divided by all borrowings, notes, debentures, and repurchase agreements. The price of property operating expense (PPOE) is operating expense divided by rental income.

Table 2 displays summary statistics for outputs, inputs and input prices of the REITs for the years 1989 through 1999. Loan production has a U-shaped pattern,

[6] Non-operational properties include properties under development, land held for development, and property held for sale. Other assets also include unconsolidated partnership which is the value of joint ventures, and all non-real estate investment assets.

[7] The SNL REIT Quarterly also releases "Other Expenses" as an expense item in the related income statements. However, "Other Expenses" was not used as an input variable because of the difficulties of determining the price of this variable.

[8] In their banking and savings and loans studies, they constructed the price of capital as occupancy cost and expenditure on furniture and equipment divided by the level of deposit, and the price of expenditure on materials as expenditure on materials divided by the level of deposit as proxy input prices. Similarly, the present paper employs debt and rental income for the price of interest expense and property operating expense, respectively.

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Table 2. Dollar Value of Selected Statistics (Thousands of dollars)

Variables \ Years	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Outputs											
Loan	18,354 (29,086)[2]	14,362 (24,672)	6,808 (14,051)	4,269 (9,726)	3,458 (8,050)	5,083 (12,940)	6,945 (21,601)	9,581 (29,376)	17,520 (50,445)	23,216 (103,079)	25,507 (99,073)
Properties	137,804 (119,364)	152,055 (125,286)	181,089 (153,388)	209,453 (213,634)	270,023 (263,056)	316,108 (348,615)	416,173 (466,864)	560,573 (667,038)	917,703 (1,258,538)	1,304,573 (1,877,085)	1,465,812 (2,112,635)
Other assets	27,282 (47,856)	22,818 (39,219)	22,189 (43,541)	24,503 (53,136)	34,396 (61,327)	36,695 (60,071)	57,243 (92,003)	72,005 (112,165)	126,407 (213,453)	194,578 (347,445)	243,823 (407,598)
Inputs											
Int. Expense	7,815 (8,563)	6,929 (8,327)	11,705 (12,022)	13,222 (19,038)	12,907 (22,839)	9,182 (16,096)	14,545 (23,714)	16,658 (22,520)	22,618 (32,542)	37,087 (54,998)	50,638 (81,093)
Property Operating Expense	7,179 (7,207)	7,717 (7,254)	10,468 (9,737)	12,047 (14,241)	14,157 (20,193)	15,137 (21,081)	22,974 (35,543)	26,916 (39,712)	40,956 (71,168)	56,013 (86,015)	66,235 (103,100)
Input Prices											
Price of Int. Expense	0.097 (0.024)	0.098 (0.050)	0.088 (0.019)	0.079 (0.023)	0.083 (0.050)	0.064 (0.036)	0.071 (0.027)	0.070 (0.044)	0.064 (0.062)	0.060 (0.017)	0.066 (0.018)
Price of Property Expense	0.370 (0.162)	0.390 (0.132)	0.385 (0.141)	0.386 (0.134)	0.381 (0.135)	0.350 (0.161)	0.346 (0.165)	0.338 (0.242)	0.324 (0.156)	0.304 (0.135)	0.296 (0.122)

[1] **Outputs:** Loans (L) are the value of all real estate loans; properties (P) are all properties in operation owned by the company; other assets (OA) consist of non-operational properties including properties under development, land held for development, and property held for sale, unconsolidated partnership which is the value of joint ventures, and all non-real estate investment assets. **Inputs:** Interest expense (IE) includes interest paid on debt and other borrowings including amortization of debt discounts, property operating expense (POE) are costs associated with operating rental properties including maintenance costs, utilities, property management fees, and real estate taxes. **Input Prices:** Price of interest expense (PIE) and price of property operating expense (PPOE) are defined as interest expense divided by the debt which includes all borrowings, notes, debentures, repurchase agreements and property operating expense divided by rental income which is revenue received from tenants, respectively.
[2] Standard deviations are in parenthesis.

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declining from $18 million in 1989 to the lowest level of $3 million in 1993, and then increasing to $25 million in 1999. However, properties steadily increase over the period, and dominate loans by at least a factor of 7 in 1989 and at most a factor of 78 in 1993. This is mainly because of the interest rate pattern, declining from 7.91% in 1989 to the lowest level of 3.33% in 1993. In this period, REITs preferred purchasing property by using less expensive funds to making loans with low interest rates. Therefore, as is shown in Table 2, REIT interest expenses increased about 100% between 1991 and 1993.

2.3.2 Methodology

This study employs both nonparametric Data Envelopment Analysis (DEA) and the parametric Stochastic (Economic) Frontier Approach (SFA) to measure equity REITs' input efficiencies; cost, allocative, technical, pure technical and scale efficiencies, and profit efficiency over the period 1989-1999.

2.3.2.1 Data Envelopment Analysis (DEA). The DEA is a linear programming technique that maps a piecewise linear convex isoquant (a non-parametric surface frontier) over data points to determine the efficiencies of each Decision Making Unit (DMU) relative to this isoquant. In this application, a DMU is one REIT. The objective of the DEA is to measure relative efficiency among similar organizations (DMUs) that share the same technology (processing procedure) to gain achievements (outputs) through using similar resources (inputs). Cost efficiency (CE) can be decomposed into allocative efficiency (AE) and technical efficiency (TE). The DEA also allows the decomposition of technical efficiency into pure technical efficiency (PTE) and scale efficiency (SE).The efficiency scores of DMUs are bounded between 0 and 1, with the most efficient firms having an efficiency score of 1.

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Several alternative models have been introduced in the DEA literature [see Charnes *et al.*, (1994) for details]. Each of these models seeks to determine which DMUs establishes the best efficiency frontier. The DEA model defines the shape of the efficiency frontier. This study uses the CCR (Charnes, Cooper, and Rhodes, 1978) as well as the BCC (Banker, Charnes, and Cooper, 1984) input oriented models, where the first model assumes constant returns to scale (CRS), but the second assumes variable-returns to scale (VRS). Note that the production frontier changes from a cone shape in the former model to a convex- hull shape in the latter.

2.3.2.1.1 The CRS TE (TE). First, following Charnes *et. al.* (1978), consider N REITs, operating under the CRS and employing two inputs to produce a single output. The following linear programming problem for the technical efficiency (TE) is solved:

$$Min_{TE,w}\ TE_i$$

$$s.t.$$

$$Y . w_i \geq y_i$$

$$X . w_i \leq TE_i . x_i$$

$$w_i \geq 0 \qquad (1)$$

where TE_i, is a scalar and represents the technical efficiency measure (index) for the i-th REIT. w_i is the $1xN$ vector of intensity weights defining the linear combination of efficient REITs to be compared with the i-th REIT. The inequality ($Y . w_i \geq y_i$) implies that the observed outputs must be less than or equal to a linear combination of outputs of the REITs forming the efficient frontier. The inequality ($X . w_i \leq TE . x_i$) assures that the use of inputs at the linear combination of the efficient REITs must be less or equal to the

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use of inputs of the i-th REIT. The formulation requires that $TE_i \leq 1$. An index value of 1 refers to a point on the frontier, and thus to a technically efficient REIT (Farrel, 1957).

2.3.2.1.2 The VRS TE (PTE). The CRS specification biases the TE estimation by confounding scale effects if all REITs do not operate at an optimal scale. In this case, following Banker *et. al.* (1984), the pure technical efficiency (PTE), i.e., TE devoid of the scale effects, can be estimated by the substitution of the CRS with VRS assumption. This can be achieved by adding a convexity constraint $(N_1 \, . \, w_i = 1)$ to (1):

$$Min_{TE,w} \; TE_i$$

$$s.t.$$

$$Y \, . \, w_i \geq y_i$$

$$X \, . \, w_i \leq TE_i \, . \, x_i$$

$$N_1 \, . \, w_i = 1$$

$$w_i \geq 0 \qquad (2)$$

where N_1 is an $1 \times N$ vector of ones. The VRS frontier envelops the data more tightly than the CRS frontier, and thus generates TE scores which are greater than or equal to those obtained from the CRS frontier.

2.3.2.1.3 The SE. Scale inefficiency occurs if there is a difference between the *CRS TE* and the *VRS TE (PTE)* for a specific REIT. Since, $TE = PTE*SE$, then, SE = TE / PTE.

2.3.2.1.4 The Non-IRS TE. An additional linear program is run to determine whether the REIT is operating at increasing returns to scale (IRS) or decreasing returns to scale (DRS). This new constructed frontier allows for only non-

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increasing returns to scale (Non-IRS). This can be accomplished by substituting the constraint $(N_I \,.\, w_i = 1)$ in (2) with $(N_I \,.\, w_i \leq 1)$ as demonstrated below:

$$Min_{TE,w}\ TE_i$$

$$s.t.$$

$$Y \,.\, w_i \geq y_i$$

$$X \,.\, w_i \leq TE_i \,.\, x_i$$

$$N_I \,.\, w_i \leq 1$$

$$w_i \geq 0 \qquad (3)$$

The type of scale inefficiencies (IRS or DRS) for a specific REIT can be determined as follows:

If VRS TE ≠ Non-IRS TE, then the REIT is operating at IRS,

If VRS TE = Non-IRS TE, then the REIT is operating at DRS.

2.3.2.1.5 The Allocative (AE) and Cost Efficiencies (CE). This study also measures both allocative (AE) and overall cost efficiencies (CE) given the input prices p_i and the output levels y_i for the i-th REIT. The product of TE and AE is the overall cost efficiency. Therefore, the cost minimizing vector of input quantities, x^*, should be computed by running the VRS case linear program. Then, the following cost minimization DEA is run:

$$Min_{w,x^*}\ p_i \,.\, x_i^*$$

$$s.t.$$

$$Y \,.\, w_i \geq y_i$$

$$X \,.\, w_i \leq x_i^*$$

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$N_1 . w_i = 1$

$w_i \geq 0$ (4)

The overall cost efficiency (CE) of the *i*-th REIT could be obtained as follows:

$$CE = \frac{p_i' x_i^*}{p_i' x_i} = \frac{minimum\ cost}{observed\ cost}$$

Since CE = AE × TE, then AE can be calculated residually: AE = CE / TE.

2.3.2.2 Stochastic (Economic) Frontier Approach (SFA). Studies concentrating on the banking industry have shown that firms not only err by failing to minimize cost but also err by failing to maximize profitability [see Berger *et al.*, 1993, DeYoung and Nolle, 1996; Akhavein *et al.*, 1997; Berger and Mester, 1997 for details]. Berger *et al.*, (1993) showed that profit inefficiency is more significant than cost inefficiency in determining overall firm efficiency, and that banks lose about 50% of their potential profits from failure to operate on their efficient profit frontier. Anderson *et al.* (2000) found similar results in their residential real estate brokerage efficiency study.

The profit function accounts for the revenue effects of producing at incorrect mixes or levels of outputs, and REITs might err on the output side. A REIT might be input (cost) inefficient, but at the same time output (revenue) efficient or vice versa. For example, higher quality real property (output) needs more expenses (input). In this case, cost efficiency models label REITs as cost inefficient without incorporating the quality of output. However, REITs with higher quality properties have additional revenues, which offset some of their high expenses because customers often pay more for higher quality. Additionally, REIT managers might be more interested in profit efficiency because income is their major source used for debt payments and growth. Furthermore, managers are under pressure of shareholders for higher profits because of the dividend requirement.

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This study employs the stochastic (economic) frontier approach to measure nonstandard (alternative) profit efficiency, which accounts for output side errors. The Stochastic frontier models were first introduced by Aigner *et. al.* (1977) and Meeusen and van den Broeck (1977). Alternative profit function is similar to cost function used in their model. Independent variables are the same, but profit instead of cost is used as a dependent variable. I estimate the following translog profit function:

$$\ln\pi(P,Y)_r = \alpha_0 + \sum_i^3 \beta_i \ln Y_i + \frac{1}{2}\sum_i^3\sum_j^3 \beta_{ij}\ln Y_i \ln Y_j + \sum_k^2 \gamma_k \ln P_k + \frac{1}{2}\sum_l^2\sum_m^2 \gamma_{lm}\ln P_l \ln P_m + \sum_i^3\sum_k^2 \rho_{ik}\ln Y_i \ln P_k + \varepsilon_r \qquad (7)$$

where *ln* is natural logarithm; π is net income of the REIT *r*; *Y* is a vector of outputs; *P* is a vector of input prices. The composite error term for r_{th} REIT ($\varepsilon_r = ln\ u_r + ln\ v_r$) can be decomposed into an identifiable random error, v_r, which is assumed to be independently and identically distributed as $N(0,\sigma_v^2)$, while the other error component, u_r, is derived from a $N(0,\sigma_u^2)$ distribution truncated below zero, which represents controllable inefficiencies. The underlying reason for such a truncated normal distribution assumption is that inefficiencies cannot be negative.

The relative efficiency of a firm can be estimated by means of the ratio, $\lambda = \sigma_u / \sigma_v$ (Jondrow *et al.*, 1982). The u_r, inefficiency measure, of a REIT can be formulated as follows:

$$u_r = [\sigma\lambda/(1+\lambda^2)][-\phi(\varepsilon_r\lambda/\sigma)/\Phi(\varepsilon_r\lambda/\sigma) + (\varepsilon_r\lambda/\sigma)] \qquad (4)$$

where $\sigma = [\sigma_u + \sigma_v]^2$; ϕ is the standard normal density function; Φ is the cumulative normal density function.

Following the studies of Humphrey and Pulley (1997), Berger and Mester (1997)

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and DeYoung and Hasan (1998), nonstandard (alternative) profit efficiency is defined as how close a firm is to generating maximum profits given its output levels. For example, a REIT having 85% profit efficiency suggests that the REIT would earn about 15% more profits than what it was making if it were operating on the efficient frontier[9]. Because of the data-fitting problem, particularly in 1989 and 1999, a frontier is constructed for the period (1989-1999) instead of each year to estimate the profit efficiency scores[10].

2.4 Empirical Results Relating to Efficiency Estimates

The equity REITs efficiency estimates are presented in Table 3. Figures 1 and 2 show that overall efficiency measures generally follow a U-shaped pattern, with a decline in the early years of the sample, 1989-1993, and rising from 1995-1998. Their pattern might be attributed to increasing interest expense (IE) and a decreasing loan (L) amount. An upward trend appears in the interest expense, which rises by 69% from 1989 until 1992 and falls 31% in 1994. The U-shaped pattern of loans is consistent over the same time period, falling by 81% and rising after 1993 (Table 2, Figures 3 and 4).

REITs typically raise debt to finance new property acquisition, and are able to borrow using unsecured corporate lines of credit, which is cheaper and more flexible in terms of prepayment and availability than mortgage loans[11] (Murray, 2000). Lenders generally expect to be repaid from the proceeds of equity and focus on a REIT's access to the capital markets, and raise equity capital. Interestingly, over the sample period, the U.S. economy has experienced a similar U-shaped interest rates pattern. It declined from

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[9] Output prices are used in calculating standard profit efficiency. A detailed description of standard profit efficiency could be found in Berger *et. al.* (1993), DeYoung and Nolle (1996), Akhavein *et al.*, (1997), and Berger and Mester (1997).

[10]The same problem occurred in estimating the stochastic cost efficiency scores for many years, and for a new frontier including the sample period.

[11] REITs cannot obtain mortgage loans at greater than a 40% of loan-to-value, but corporate debt at rates as low as 10-20 basis points over LIBOR (Murray, 2000).

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Table 3, Summary of Equity REITs Efficiency Measures

Efficiencies / Years		CE		AE		TE		PTE		SE	
	Obs.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
1989	35	0.335	0.242	0.660	0.247	0.533	0.303	0.715	0.298	0.772	0.266
1990	45	0.294	0.223	0.594	0.225	0.505	0.267	0.595	0.283	0.869	0.200
1991	71	0.246	0.194	0.654	0.225	0.414	0.282	0.541	0.335	0.827	0.236
1992	98	0.126	0.163	0.694	0.253	0.228	0.267	0.401	0.360	0.680	0.314
1993	109	0.058	0.143	0.633	0.285	0.119	0.221	0.377	0.347	0.366	0.335
1994	168	0.094	0.148	0.536	0.226	0.171	0.202	0.319	0.293	0.620	0.256
1995	187	0.095	0.143	0.832	0.217	0.142	0.215	0.313	0.310	0.572	0.337
1996	184	0.154	0.166	0.701	0.225	0.236	0.235	0.378	0.297	0.690	0.281
1997	168	0.148	0.137	0.828	0.241	0.219	0.236	0.351	0.319	0.732	0.281
1998	159	0.200	0.179	0.510	0.510	0.375	0.228	0.476	0.271	0.829	0.205
1999	151	0.092	0.115	0.450	0.209	0.216	0.199	0.535	0.268	0.420	0.236
All years	1375	0.141	0.171	0.652	0.265	0.243	0.254	0.413	0.320	0.646	0.312

Notes: (CE): Cost Efficiency, (AE): Allocative Efficiency, (TE): Technical Efficiency, (PTE): Pure Technical Efficiency, (SE): Scale Efficiency.
All sample gives the summary statistics for the efficiency measures of the equity REITs over the years 1989 through 1999.

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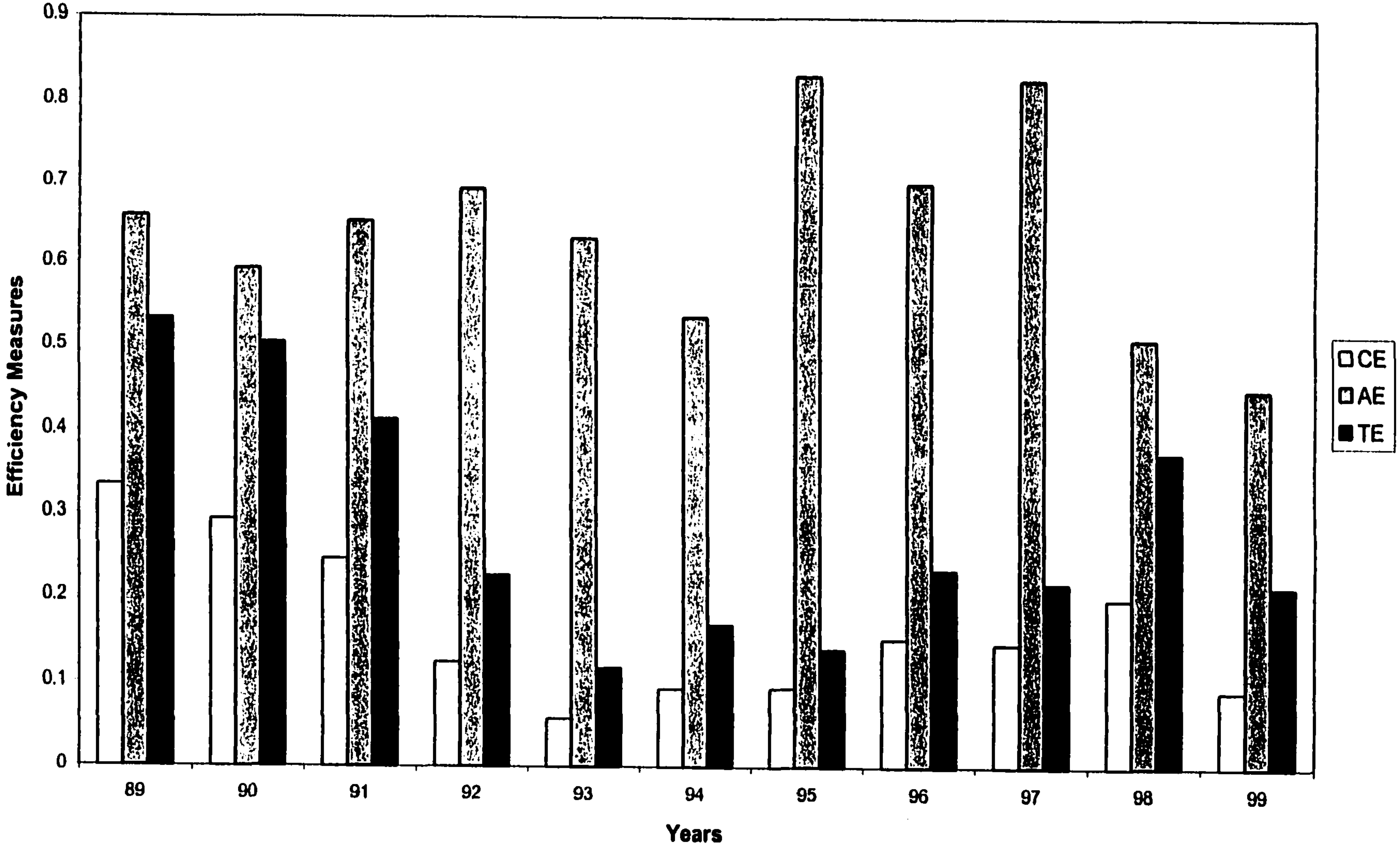

Figure 1. Cost, Allocative, and Technical Efficiencies (1989-1999)

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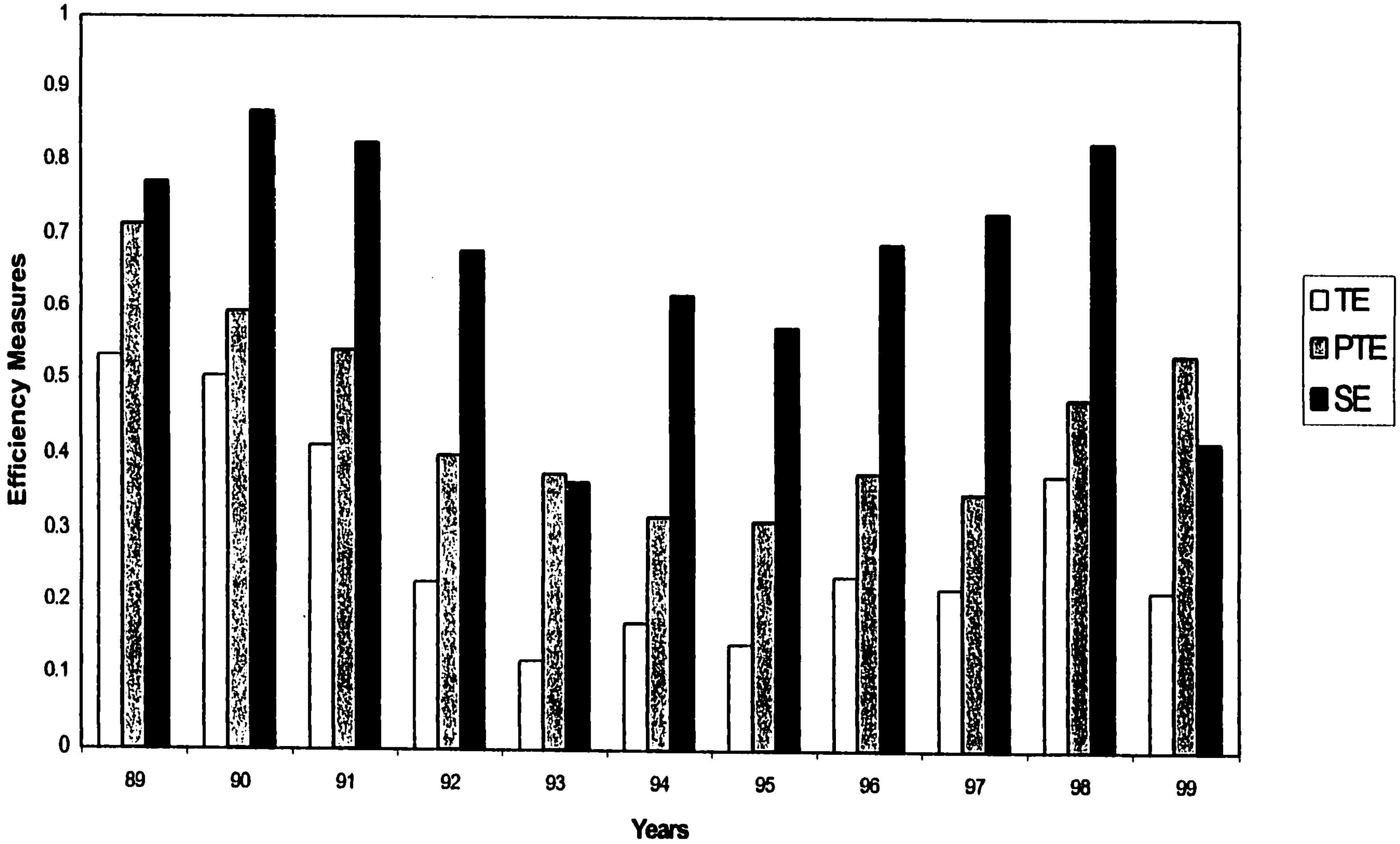

Figure 2. Technical, Pure Technical, and Scale Efficiencies (1989-1999)

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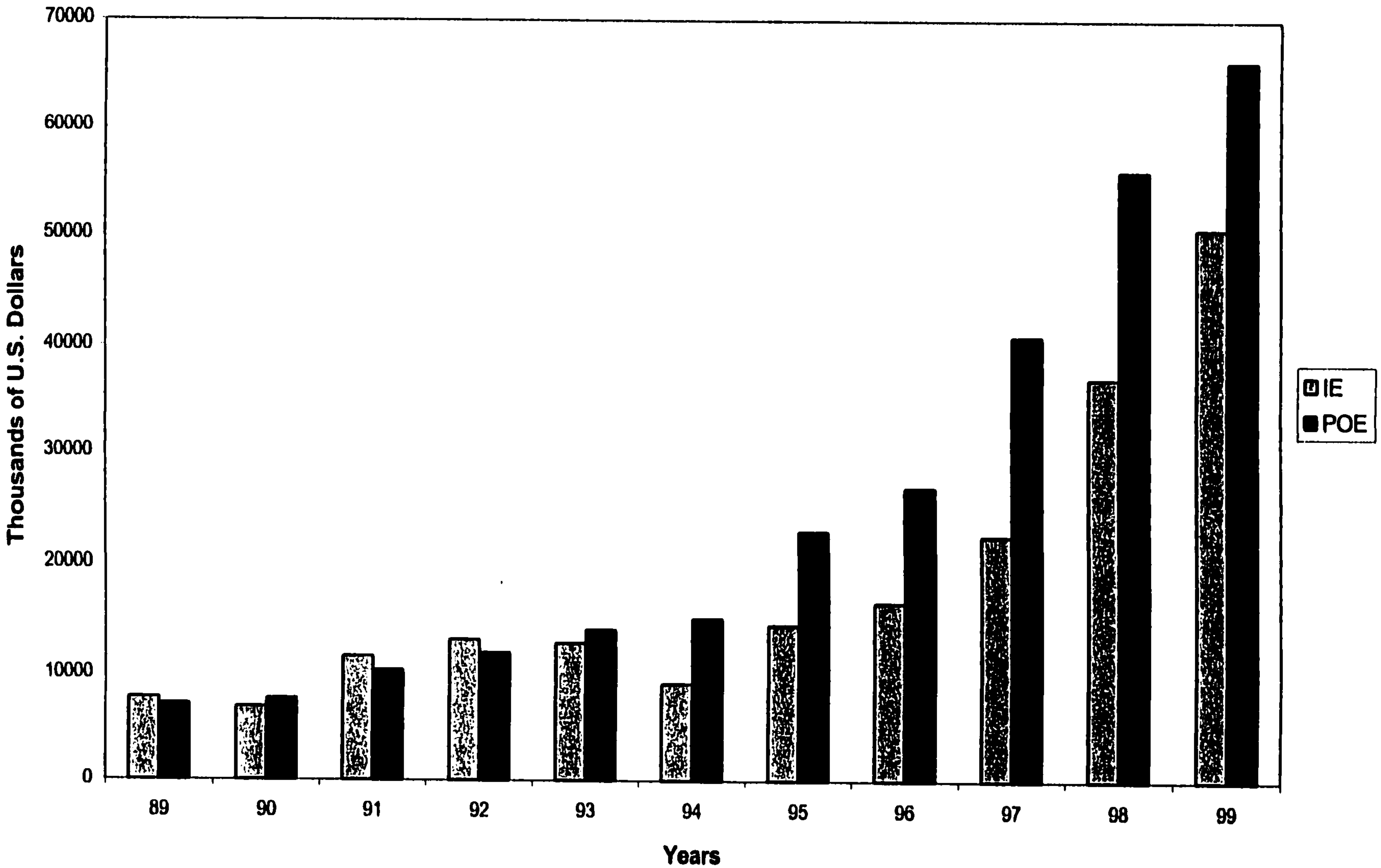

Figure 3. Interest Expense (IE) and Property Operating Expense (POE)

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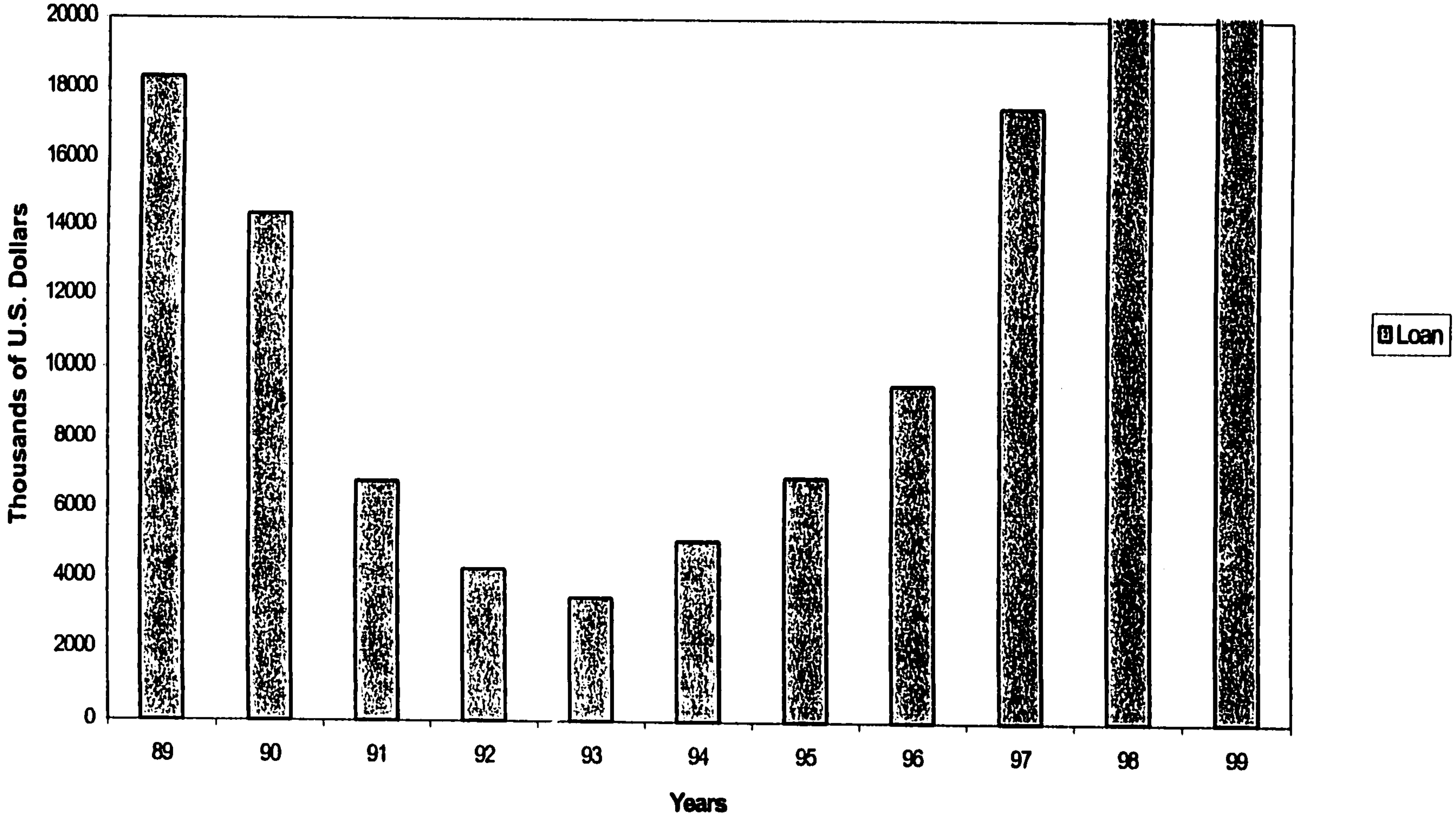

Figure 4. Loan Distributions (1989-1999)

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7.91% in 1989 to the lowest level of 3.33% in 1993, then started rose to 5.36% in 1997, and declined to 4.85% in 1998 and 4.78% in 1999. Therefore, REITs had access to less expensive funds for financing property acquisition instead of making loans in the era of lower interest rates.

Competition among the increasing number of REITs might be the reason for the rise in overall efficiency measures after 1993. Since REITs must pay at least 95% of their taxable income as dividends, debt must be used to finance acquisitions[12]. Liquidity and stock performance is a critical aspect of REIT lending because, as mentioned above, debt is paid by equity proceeds. Positive stock performance is preferred by the highest leveraged firms in order to gain more capital and decrease debt. Stock prices will likely reflect the cost saving results of more efficient firms. The growth in all REIT market capitalization is shown in Table 4. From 1989 through 2000, the number of equity REITs rose from 56 to 158. Of particular interest is the large number of initial public offerings in 1993 and 1994. There is a 52% and 30% increase in equity REITs in these years. The total market capitalization increased from $6.8 billion to $134 billion[13]. The average annual number of equity REITs for the first period is 72.3; for the latter period, the average is 166. Accordingly, there is a substantial increase in market capitalization for the period 1993-2000, averaging more than $87 billion per year, which is more than 11 times that of the preceding four years.

There are several explanations for the growth of REITs in recent years. In early 1990, REIT shares were attractive partially because of declining interest rates, compared to certificates of deposits (CDs). Instead of replacing maturing higher yield CDs with

[12] It is reduced to 90% with the REIT Modernization Act of 1999, effective in 2001.
[13] As noted by the dollar amount, 1993 to the present is significantly different from 1989-92.

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Table 4, Total Equity Capitalization Outstanding (Millions of Dollars at Year End)

REITs / Years	Equity REITs		Mortgage REITs		Hybrid REITs		Composite	
	# of REITs	Market Capitalization	# of REITs	Market Capitalization	# of REITs	Market Capitalization	# of REITs	Market Capitalization
1989	56	6,770	43	3,536	21	1,356	120	11,662
1990	58	5,552	43	2,549	18	636	119	8,737
1991	86	8,785	28	2,586	24	1,596	138	12,968
1992	89	11,171	30	2,773	23	1,968	142	15,912
1993	135	26,082	32	3,398	22	2,678	189	32,159
1994	175	38,812	29	2,503	22	2,991	226	44,306
1995	178	49,913	24	3,395	17	4,233	219	57,541
1996	166	78,302	20	4,779	13	5,696	199	88,776
1997	176	127,825	26	7,370	9	5,338	211	140,534
1998	173	126,904	28	6,481	9	4,916	210	138,301
1999	167	118,233	26	4,442	10	1,587	203	124,262

Notes: To be considered an equity (mortgage) REIT, at least 75% of the REIT investment portfolio must consist of income producing real property (mortgage instruments). Hybrid REITs combine the activities of equity and mortgage REITs.
Source: National Association of Real Estate Investment Trusts

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lower yield CDs, investors bought REIT shares without regard for the possible risk differences between CDs and REIT shares (Etter, 1998). The increasing popularity of REITs caused the creation of new REITs and the expansion of existing ones. In particular, Umbrella Partnership REIT (UPREIT), which first appeared in 1992, spurred the REIT market growth. The UPREIT structure allows real estate partnerships to become a REIT without imposing a tax liability for the individual partners. After creating an UPREIT, the partners have an option to receive units representing their ownership interests in the new trust. The properties' original owners can avoid the taxes by retaining their partnership interests rather than converting them to shares in the UPREIT [see Kleiman, 1993 for more detail]. The UPREIT structure accounts for two- thirds of new outstanding REITs (Ambrose and Linneman, 1998).

The third factor explaining the growth in REITs is the Revenue Reconciliation Act of 1993. Prior to the Act, a REIT's income was taxable if five or fewer individuals owned more than 50%. It was difficult for pension funds to make large investments in a single REIT. After 1993, REIT shares have been considered to be owned by the beneficiaries rather than the institution, allowing pension funds to become REIT owners. Hence, increasing institutional investment helped REITs grow in both primary and secondary markets.

2.4.1 General Efficiency Measures

Table 3 indicates that average allocative efficiency is about 65%, whereas average technical efficiency is about 24%. This means that input (costs) utilization could be reduced if the REITs were on the efficient frontier. Over the sample period, technical efficiency is generally smaller than allocative efficiency, suggesting that the dominant source of cost inefficiency is managerial. REITs are more successful in choosing the

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correct mix of inputs than in properly utilizing the inputs.

Technical efficiency is confounded with scale efficiencies under the assumption of constant returns to scale. The variable returns to scale assumption, on the other hand, provides the measurement of "pure" technical efficiency, which is technical efficiency without the scale efficiency effects. Average scale efficiency and pure technical efficiency are about 65% and 41%, respectively. Pure technical inefficiency is generally larger than the scale inefficiency (Figure 1, Table 3) suggesting that the dominant source of overall technical inefficiency is the pure technical (input related) inefficiency[14].

2.4.2 Returns to Scale Among Real Estate Investment Trust

The scale related nature of the overall technical inefficiency makes the trend in REIT returns to scale interesting. The procedure suggested by Fare, Grosskopf and Lovell (1985) here identifies the sources of scale inefficiency deviation from an optimal standard. Returns to scale is the effect on output that results from increasing all inputs by the same percentage. There are three possible cases: (1) Constant returns to scale (CRS), which arise when the percentage change in input yields the same percentage output change; (2) Decreasing returns to scale (DRS), which occur when percentage change in outputs is less than in inputs; (3) Increasing returns to scale (IRS), which exist when percentage change in output is greater than that of inputs.

The number and percentage of REITs operating at different levels of scale economies is reported in Table 5. As is evident from Figure 5, although scale efficient (i.e., CRS) REITs have declined from 26% to 2% over the 11 years, implying less scale

[14] The allocative efficiency measures the proportional reduction in costs if the REIT chooses the right mix of inputs given the prices, reflecting the firm's regulatory politics. The technical efficiency measures the proportional reduction in input usage which can be reached if the REIT operates on the frontier, reflecting the firm's managerial decision. The pure technical efficiency measures the proportional reduction in input usage if inputs are not wasted, whereas scale efficiency is the proportional reduction if the REIT achieves constant returns to scale.

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Table 5, Returns to Scale (RTS) by Size in Equity REITs

Size[1] \ RTS	#	%	Decreasing RTS #	% col.	% row	Increasing RTS #	% col.	% row	Constant RTS #	% col.	% row	Developments in RTS: RTS	#	%
1989														
Small	14	40	1	7	7	10	91	71	3	33	21	DRS	15	43
Medium	21	60	14	93	67	1	9	5	6	67	29	IRS	11	31
Large	0	0	0	0	0	0	0	0	0	0	0	CRS	9	26
Total	35	100	15	100	43	11	100	31	9	100	26	*Total*	35	100
1990														
Small	18	40	0	0	0	16	57	89	2	22	11	DRS	8	18
Medium	27	60	8	100	30	12	43	44	7	78	26	IRS	28	62
Large	0	0	0	0	0	0	0	0	0	0	0	CRS	9	20
Total	45	100	8	100	18	28	100	62	9	100	20	*Total*	45	100
1991														
Small	28	39	0	0	0	24	59	86	4	50	14	DRS	22	31
Medium	43	61	22	100	51	17	41	40	4	50	9	IRS	40	56
Large	0	0	0	0	0	0	0	0	0	0	0	CRS	9	13
Total	71	100	22	100	31	41	100	58	8	100	11	*Total*	71	100
1992														
Small	34	35	0	0	0	32	58	94	2	29	6	DRS	36	37
Medium	63	64	35	97	56	23	42	37	5	71	8	IRS	55	56
Large	1	1	1	3	100	0	0	0	0	0	0	CRS	7	7
Total	98	100	36	100	37	55	100	56	7	100	7	*Total*	98	100
1993														
Small	32	29	17	19	53	10	100	31	5	63	16	DRS	91	84
Medium	75	69	72	79	96	0	0	0	3	37	4	IRS	10	9
Large	2	2	2	2	100	0	0	0	0	0	0	CRS	8	7
Total	109	100	91	100	83	10	100	9	8	100	7	*Total*	109	100
1994														
Small	54	32	25	19	46	25	89	46	4	40	7	DRS	130	77
Medium	107	64	98	75	92	3	11	3	6	60	6	IRS	28	17
Large	7	4	7	5	100	0	0	0	0	0	0	CRS	10	6
Total	168	100	130	100	77	28	100	17	10	100	6	*Total*	168	100

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Table 5 continued

1995														
Small	47	25	0	0	0	46	55	98	1	6	2	DRS	87	47
Medium	124	66	71	82	57	37	45	30	16	94	13	IRS	83	44
Large	16	9	16	18	100	0	0	0	0	0	0	CRS	17	9
Total	187	100	87	100	47	83	100	44	17	100	9	*Total*	187	100
1996														
Small	38	20	2	2	5	32	71	84	4	27	11	DRS	124	67
Medium	115	63	91	73	79	13	29	11	11	73	10	IRS	45	24
Large	31	17	31	25	100	0	0	0	0	0	0	CRS	15	8
Total	184	100	124	100	67	45	100	24	15	100	8	*Total*	184	100
1997														
Small	26	15	0	0	0	26	26	100	0	0	0	DRS	57	33
Medium	91	55	16	28	18	68	68	75	7	64	8	IRS	100	60
Large	51	30	41	72	80	6	6	12	4	36	8	CRS	11	7
Total	168	100	57	100	34	100	100	60	11	100	7	*Total*	168	100
1998														
Small	20	13	0	0	0	19	23	95	1	6	5	DRS	60	38
Medium	80	50	8	13	10	65	77	81	7	47	9	IRS	84	53
Large	59	37	52	87	88	0	0	0	7	47	12	CRS	15	9
Total	159	100	60	100	38	84	100	53	15	100	9	*Total*	159	100
1999														
Small	22	14	0	0	0	22	81	100	0	0	0	DRS	121	80
Medium	69	46	61	50	88	5	19	7	3	100	4	IRS	27	18
Large	60	40	60	50	100	0	0	0	0	0	0	CRS	3	2
Total	151	100	121	100	80	27	100	18	3	100	2	*Total*	151	100
All sample[3]														
Small	333	24	45	6	13	262	51	79	26	23	8	DRS	751	55
Medium	815	59	496	66	61	244	48	30	75	67	9	IRS	512	37
Large	227	17	210	28	62	6	1	3	11	10	5	CRS	112	8
Total	1375	100	751	100	55	512	100	37	112	100	8	*Total*	1375	1375

[1] It provides the summary of overall returns to scale (RTS) according to size groups for each year in the study. For instance, in 1997, 91 observations (55 % of total 168 obs. = %) belongs to medium REITs, of which 16 (28% of total 57 REITS experiencing DRS = % col., 18% of total 91 medium REITs = % row) experiences DRS.

[2] It presents the trend in the RTS of the REITs by year and sizes. Small REITs: assets < 100; Medium REITs : 100 ≤ assets < 1,000; Large REITs: assets ≥ 1,000 [$ million].

[3] It provides the summary of overall RTS according to size groups for whole sample. For instance, over the years studied, 333 observations (24% of total 1375 obs. = %) belongs to small REITs, of which 45 (6% of total 751 REITs experiencing DRS = % col., 13 % of total 333 small REITs = % row) experiences DRS.

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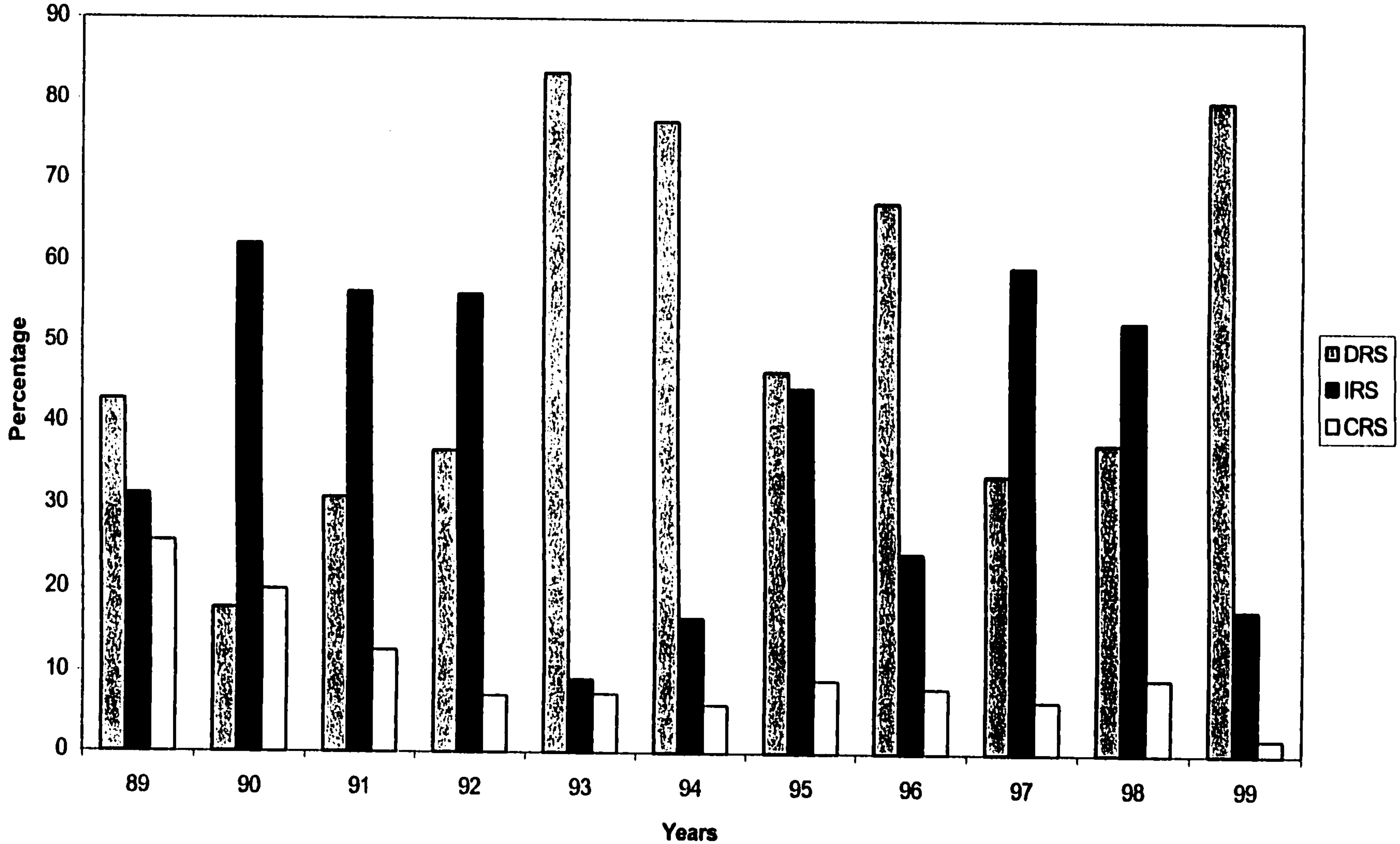

Figure 5. REITs at Different RTS

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efficiency over time, most firms have experienced diseconomies of scale (i.e., DRS), for instance, 43% in 1989, 83% in 1993, and 80% in 1999. The share of the REITs experiencing economies of scale (i.e., IRS) has a different trend over this time. It fell from 62% in 1990 to 9% in 1993 and rose to 60% in 1997, and then fell to 18% in 1999. More intuitive explanations for scale inefficiencies might be obtained by dividing the REITs into different size groups[15]. As Table 5 shows, on the average, 92% of all REITs are scale inefficient (i.e., DRS or IRS) while a small number, 8%, are scale efficient. Of the scale inefficient firms, the share of the REITs experiencing diseconomies of scale and economies of scale is 59% and 41%, respectively. Interestingly, only 6% of the REITs experiencing DRS are small, but the majority (94%) are medium or large. In contrast, only 1% of the REITs experiencing IRS are small. Examining the firms experiencing different modes of scale efficiencies in different sizes shown in Figure 6 further reveals that 92% of all large REITs are experiencing DRS. Of the small REITs, the majority, 79%, are experiencing IRS. The results are clearly consistent with the fact that REITs have been experiencing diseconomies of scale with the dramatic and ongoing merger and acquisition activities since 1995.

2.4.3 Second Stage Regression Analysis

After recovering the efficiency scores from the DEA and SFA analyses, size variables, governance variable, market power and niche variables, risk variables, and other REIT traits were used to explain variations in efficiency across REITs. Table 6 displays definitions, means and standard deviations of the above independent variables and dependent variables, namely cost efficiency (CE), allocative efficiency (AE),

[15] Small size REITs have assets less than 100 million; medium size REITs with assets between 100 million and 1 billion; and large REIT with assets larger than 1 billion.

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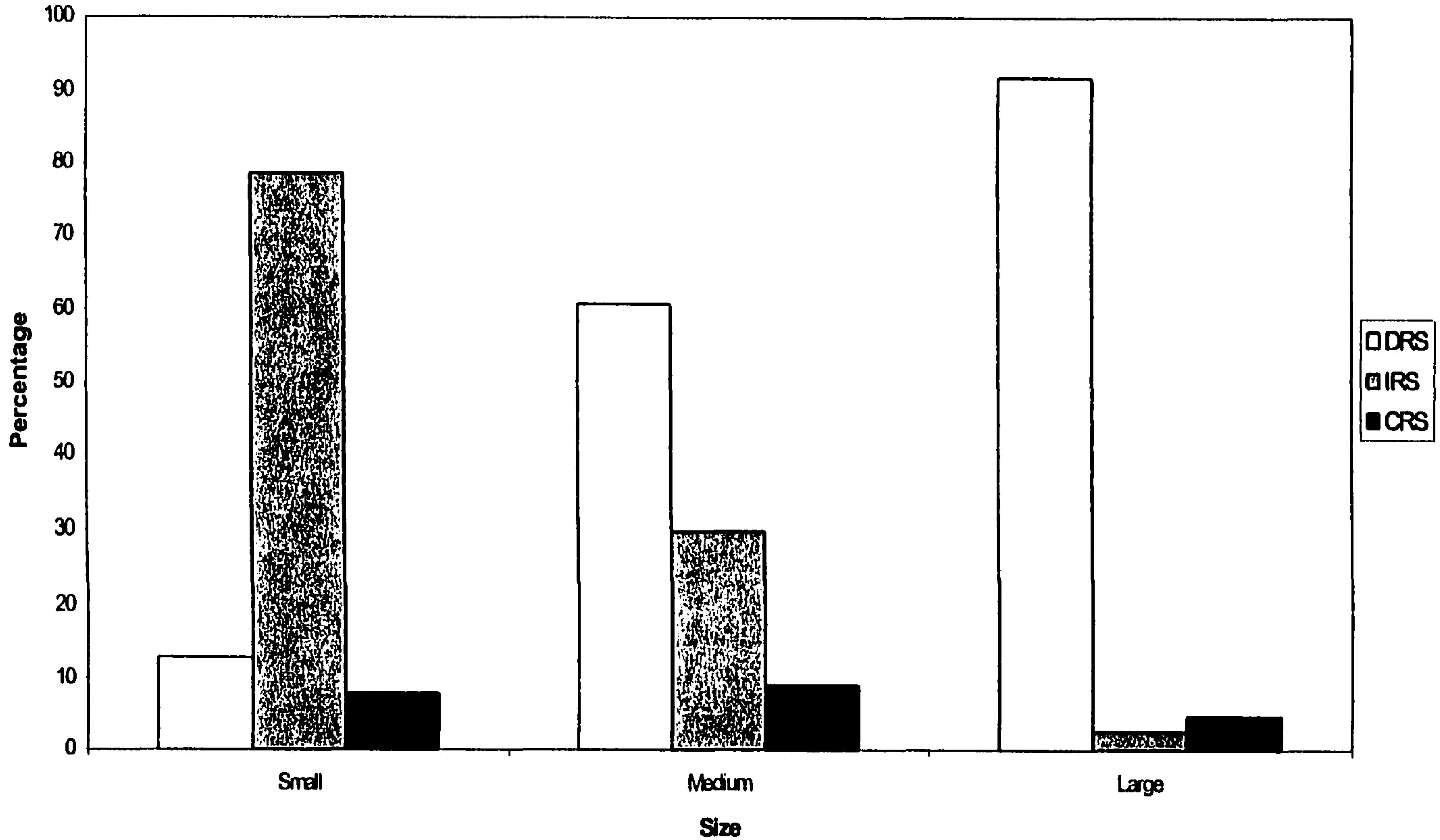

Figure 6. REIT Size and Returns to Scale

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Table 6. Definition and Summary Statistics of the Efficiency Correlates

Variables	Definition of the variables	Mean	Std dev
Dependent variables:			
CE	Cost efficiency, product of technical (TE) and allocative (AE) efficiency, which measures overall input efficiency of a REIT.	0.141	0.171
AE	Allocative efficiency, CE/TE, choosing the right input combinations given input prices (regulation-related).	0.652	0.265
TE	Technical efficiency, CE/AE or PTE*SE, using equal or less of all inputs to produce a given output, as compared to the alternative (under management control, usually driven by strong competition).	0.243	0.254
PTE	Pure technical efficiency, TE/SE, technical efficiency under the variable returns to scale (VRS), i.e., TE which is devoid of scale efficiency effects.	0.413	0.320
SE	Scale efficiency, TE/PTE, whether a REIT has the right size, i.e., whether it produces where the long run average curve (LRAC) is minimum, where constant returns to scale (CRS) is observed.	0.646	0.312
PE	Alternative (nonstandard) profit efficiency, defined as how close a REIT comes to earning maximum profits given its output levels.	0.269	0.097
Independent variables			
Size variables			
SML_REIT	Dummy, equals one if REITs have total assets (TA) below $100 million. Excluded from the regressions as the base case.	0.011	0.020
MED_REIT	Dummy, equals one if REITs have TA of $100 million to $1 billion.	0.592	0.492
LAR_REIT	Dummy, equals one if REITs have TA over $1 billion.	0.165	0.375
Governance variable			
CEO_CHA	Dummy, equals one if the chief executive officer (CEO) of the REIT is also the chairman of the board.	0.313	0.464
Market power and niche variables			
PROPERY SHARE	REIT's share of property in the market.	0.011	0.020
PRO_IND	Property diversity, as measured by the index $\sum_{i=1}^{n} P_i^2$, where n equals the number of property-type invested, and P_i equals the proportion of a REIT's portfolio invested in property-type *i*.	0.783	0.245
GEO_IND	Geographic diversity, as measured by the index $\sum_{i=1}^{n} G_i^2$, where n equals the number of region invested, and G_i equals the proportion of a REIT's portfolio invested in region *i*.	0.556	0.288
LOAN_TA	Loans divided by total assets (TA)	0.029	0.093
TL_TA	Debt ratio, total liability (TL) divided by total assets (TA)	0.585	0.417
Risk variables			
STD_ROA	Standard deviation over time of the REIT's annual return on asset.	0.030	0.047
EQ_TA	Equity divided by TA.	0.406	0.616
Other REIT traits			
SELF MANAGEMENT	Dummy, equals one if REIT is internally managed ones that they use their own employees to manage the assets and investments.	0.678	0.467
GROWTH	The annual growth rate of the total assets.	0.585	2.456

technical efficiency (TE), pure technical efficiency (PTE), scale efficiency (SE) and nonstandard (alternative) profit efficiency (PE). The Generalized Least Square (GLS) multiple regressions are employed rather than standard Ordinary Least Square (OLS) regressions because the dependent variables in the second stage regressions, various efficiency measures, are estimates. Table 7 reports the regression results.

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Table 7. Correlates of the Nonparametric (CE, AE, TE, PTE, & SE) and Parametric (PE) Efficiency Scores[1]

Indep./Dep. Vars	CE	AE	TE	PTE	SE	PE
INTERCEPT	0.093***	0.595***	0.199***	0.323***	0.671***	0.262***
	(3.091)	(7.473)	(3.500)	(3.586)	(8.193)	(8.056)
Size variables:						
MEDIUM	0.011	-0.007	0.012	-0.058	0.102***	0.041***
	(0.536)	(-0.183)	(0.706)	(-1.600)	(2.742)	(2.694)
LARGE	0.034	-0.011**	0.069**	0.124***	-0.018	0.106***
	(1.459)	(-2.329)	(1.964)	(2.887)	(-0.343)	(5.858)
Market power and niche variables:						
PROPERTY SHARE	-2.000***	1.514	-3.997***	12.292***	-17.006***	-3.471***
	(-2.816)	(0.862)	(-3.533)	(7.555)	(-5.193)	(-4.456)
LOAN/TA	0.804***	0.141	0.908***	0.866***	0.412***	0.085**
	(3.577)	(0.613)	(4.751)	(4.596)	(4.433)	(2.305)
TL/TA	-0.071***	0.035	-0.128***	-0.193***	0.034	-0.019
	(-4.244)	(0.573)	(-3.441)	(-2.462)	(0.467)	(-0.773)
PROP_INDEX	0.681×10^{-4}	0.027	-0.016	-0.008	-0.040	0.009
	(0.002)	(0.520)	(-0.383)	(-0.169)	(-0.876)	(0.621)
GEO_INDEX	0.007	0.029	-0.020	-0.016	-0.024	0.002
	(0.371)	(0.702)	(-0.697)	(-0.426)	(-0.607)	(0.134)
Governance variable:						
CEO_CHAIRMAN	-0.021**	-0.061***	-0.021	0.026	-0.095***	0.014**
	(-1.970)	(-2.546)	(-1.276)	(1.312)	(-4.020)	(1.978)
Risk variables:						
Std (ROA)	-0.190	-0.016	-0.437	-0.559	-0.207	0.173
	(-0.665)	(-0.046)	(-1.039)	(-1.401)	(-0.610)	(1.572)
EQUITY/TA	0.119***	0.049	0.195***	0.236***	0.050	0.009
	(4.800)	(0.724)	(4.395)	(2.885)	(0.656)	(0.361)
Other REIT variables:						
GROWTH	0.017**	-0.007	0.027***	0.022**	0.028**	-0.010***
	(2.244)	(-0.645)	(2.654)	(2.089)	(2.134)	(-2.878)
SELF MANAGEMENT	-0.011	0.010	-0.003	-0.038	0.018	-0.024**
	(-0.691)	(0.343)	(-0.120)	(-1.423)	(0.637)	(-2.254)
Model:						
Adjusted R-squared	0.260	0.013	0.222	0.405	0.275	0.095
F-statistics	17.491***	1.628*	14.405***	32.936***	18.862***	5.911***
DW-statistics	1.889	1.294	1.821	1.764	1.618	0.748

[1] CE: Cost Eff.; AE: Allocative Eff.; TE: Technical Eff.; PTE: Pure Technical Eff.; SE: Scale Eff., PE: Stochastic Alternative Profit Eff. The columns report multivariate Generalized Least Squares (GLS) regression coefficients (with t-statistics in parentheses). *,**,*** indicate significance at 10%, 5%, 1% confidence levels, respectively.

2.4.3.1 Size Variables. In the X-efficiency literature, it is typically argued that firm size should be strongly associated with efficiency. The results show that both medium and large REITs have an insignificant positive relationship with cost efficiency. Insignificance implies that REITs are equally competitive or equally able to control costs regardless of their size. Technical and pure technical efficiency, i.e., technical efficiency

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devoid of scale effects, are positively related to large REITs. It seems that large REITs operate more efficiently perhaps because of the ability to produce on a large scale, which exploits the fixed inputs such as administrative and overhead expenses.

The results also indicate that scale efficiency decreases with REIT size. This provides evidence for our earlier findings that the sharing of experiencing decreasing returns to scale for larger REITs (92%) is much more than that for medium (61%) and small (13%) REITs. Highly positive scale efficiency in both small and medium REITs, although all sizes of REITs are experiencing scale inefficiency, implies that decreasing returns to scale has much impact on scale efficiency. However, growth in scale does not harm the small and medium size REITs.

Both large and medium REITs are found to be profit efficient at the 0.01 level. This suggests that larger REITs are more output-oriented and more careful in their production plan. Evanoff and Israilevich (1991) argue that larger firms might be more cost conscious due to greater pressure from shareholders concerning bottom line profits. Since REITs must pay dividends of at least 95% of their taxable income, the management team has more pressure from owners.

2.4.3.2 Property Share. Because a great proportion of equity REITs' income comes from properties, this study captures some aspects of market power with the ratio of REIT properties to the total properties for each year. REITs with more market power have significantly lower cost, technical and scale efficiencies. The result suggests that, as reported earlier, large REITs with more market power suffer from diseconomies of scale, leading to significantly lower scale and technical efficiency. A significant positive relationship, in contrast to other efficiencies, with pure technical efficiency favors this explanation because pure technical efficiency measure is not affected by scale

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inefficiency. Profit efficiency is negatively related to market power, which is contrary to both efficient structure and market power hypothesis.

2.4.3.3 Loan Production (LOAN/TA). Since equity REITs might provide loans of up to 25% of their portfolio, it is worthwhile to see whether there is an association between efficiency and loan production. The results show that loan production is significantly positively related to all efficiency measures except for allocative efficiency. These results overall imply that REITs with higher LOAN/TA tend to have higher cost, technical and scale efficiencies. Profit efficiency is also positively associated with loan production, implying that loans are more highly valued than properties. These results suggest higher operating efficiencies for hybrid REITs, promising further study.

2.4.3.4 Debt Ratio (TL/TA). In their economies of scale estimation, Bers and Springer (1998a) report that the average scale economy of low-leverage REITs is much higher than that of high-leverage REITs. This result implies that low-leverage REITs acquire more benefits from increasing size than do high-leverage ones. In this study, debt ratio, as measured by total liability divided by total asset, is found to be negatively related to cost, technical and pure technical efficiencies. REITs using more debt have more financial risk, and their cost of debt might be more than low-leverage REITs.

2.4.3.5 Concentration (Prop-Index and Geo-Index). REITs can be classified based on the type of property in which they concentrate their investment. These are residential, retail, industrial, office, health care, self-storage, hotel, restaurant, recreation, land, and diversified-other REITs. Properties of REITs can be located in one or different regions through the U.S. They are also divided by regions which are based on the National Council of Real Estate Investment Fiduciares (NCREIF). The regions are

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Northeast, Mideast, Southeast, East North Central, West North Central, Southwest, Mountain, Pacific, and Foreign.

To account for property-type diversification and geographic region investment differences across REITs, related Hirschman-Herfindahl indices were used to examine the impact of property and geographic diversification on REIT efficiency. Property and geographic indexes are calculated as follows:

$$Propindex = \sum_i P_i^2 ,$$

$$Geoindex = \sum_j R_j^2$$

where

P_i = the proportion of a REIT's portfolio invested in property-type i, and

R_j = the proportion of a REIT's portfolio invested in region j.

Propindex and Geoindex measure the concentration of investment into various property types and geographic areas. Higher value indices represent the lower level of diversification for either property type or geographic area. Results for both indexes are insignificant. Positive relationships between both indexes and cost and profit efficiencies favors the hypothesis that more diversified REITs are less cost and profit efficient. However, it seems that property and geographic diversification do not cause inefficient input utilization, implying that REITs have highly skilled and knowledgeable management teams.

2.4.3.6 Corporate Governance and Control (CEO-CHAIRMAN). The theory of the firm assumes that managers try to maximize shareholders' wealth by operating the firm in the most efficient possible manner. However, the agency cost model of the firm

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put forth by Jensen and Meckling (1976) implies that the objectives of stockholders and managers may deviate from each other, resulting in inefficient firm behavior. Managers are likely to maximize their wealth by increasing their perquisites or making non-optimal decisions unless there are external corporate control mechanisms such as compensation packages. Fama and Jensen (1983) state that separation of decision management from decision control is another way to alleviate such possible agency problems.

CEOs have the most power in the decision management process in terms of preparation and implementation of the projects. The board of directors is generally responsible for the most decision control, such as approving investments and monitoring the implementation. When the CEO is also the Chairman of the Board, decision management and control of the firm would be one-handed, and the principal-agent problem might get worse (Pi and Timme, 1993). Examining the efficiency differences between CEO-Chairman and NonCEO-Chairman affiliations in REITs, it is found that CEO-Chairman affiliated firms are negatively related to the cost, allocative and scale efficiencies supporting the agency cost theory[16].

2.4.3.7 Overall Risk [Std(ROA)]. Riskier REITs may be more profit efficient if they are trading off between risk and return. Furthermore, efficient firms might be good at risk management, suggesting a negative relationship between cost efficiency and risk. Employing the standard deviation of return on assets as a direct measure of risk, there is consistent but not significant coefficient signs of cost and profit efficiency. The results suggest that REITs with more variable returns are not different from other REITs.

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[16] In their efficiency studies in banking industry, Pi and Timme (1993) and Isik and Hassan (2001) also found an inverse relationship between efficiency measures and CEO-Chairman affiliated firms.

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2.4.3.8 Capital Risk (EQUITY/TA). Capital risk (equity to total assets) is the probability of becoming insolvent. A REIT with more equity is able to take more and cheaper debt with less chance of becoming insolvent. Accordingly, results indicate that well capitalized REITs have more cost, technical and pure technical efficiencies. Allocative, scale and profit efficiencies are also positively but not significantly associated with higher capitalization. This finding is consistent with the moral hazard theory, from the fact that managers with less capital to lose might take on riskier projects, and not pay attention to the efficiency as necessary. Another possible reason might be that efficient REITs have higher profits, which turns into a higher equity-asset ratio.

2.4.3.9 Growth. There is a significant positive relationship between growth rate (change in total assets) and all input efficiency measures except the allocative efficiency. The results suggest that REITs employ management teams with enough expertise and skill to overcome all operational details, and react to changing market conditions by making optimal decisions. An insignificant but negative relationship with allocative efficiency implies that property operating and interest expenses increase by growing quickly, but probably not in the correct mix. However, profit efficiency reduces with the growth rate, which is consistent with the results reported above. The loan production is positively associated with efficiency measures, including profit efficiency. The significant negative relationship found here might be further evidence that equity REITs mostly focus on properties in growing instead of producing loans.

2.4.3.10 Type of Management. There are several forms of REIT management. Self-managed REITs that are internally managed use their own employees to manage the assets and investments. They can also be externally managed where either a third party or

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a REIT affiliate management firm supplies the services mentioned. By realizing the profit potential in the self-management of the operation, recent trends in the industry indicate that REITs are moving towards internal management, suggesting an increase in operational efficiency (Bers and Springer, 1997). The results do not support this notion to the extent that externally managed REITs are operated with more profit efficiency. Probably, third parties or REIT affiliate management firms still have more experience and skill in real estate operations than a REIT itself.

2.5 Conclusion

This paper has examined the evidence concerning the efficiency of equity REITs from 1989 to 1999. The Data Envelopment Analysis was employed to measure the cost, allocative, technical, pure technical, and scale efficiencies. Alternative (nonstandard) profit efficiency was also measured using the Stochastic (Economic) Frontier Approach. The average efficiency for all indexes is very small. Over the years under study, overall cost and profit efficiencies for the REITs are 14% and 27%, respectively, implying that most of the REIT resources and potential profits are wasted during the REIT operations. The results also suggest that cost inefficiency is mostly caused by technical inefficiency rather than allocative inefficiency, implying that overall inefficiency can be attributed to underutilization or wasting of inputs rather than choosing the incorrect input mix. It seems that managers of REITs are relatively better at choosing the appropriate input mix than utilizing the inputs.

Low technical efficiency does not necessarily imply only "poor management" in terms of utilizing inputs. Further analysis suggests that there is technical inefficiency because of operating off the efficient frontier and due to operating at incorrect scale.

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Consistent with the growth in the REIT industry, REITs have increasingly experienced diseconomies of scale in which the majority (94%) are large. This implies the importance of optimum size for the REIT industry because it incurs more operational costs because of scale inefficiency, which seems to be related more to being a greater, not lower, size than optimal. The result of a negative (positive) relationship between large (small and medium) REITs and scale efficiency is another evidence of going beyond the optimal size limit.

Several conclusions emerge from the second stage regression analysis. First, growing impacts the efficiency of REITs positively because of the fixed administrative and overhead expenses and because of employing experienced management teams concentrating on properties in the real estate industry. Second, good capitalization and higher loan production makes the REITs more efficient. Third, REIT efficiency decreases with higher debt because the cost of low leverage REITs' debt is less than that of high leverage REITs. In addition, large REITs with more market power experience significantly lower scale, technical, and cost efficiencies. Finally, the results indicate that those REITs having separate management (decision) and board (control) structures are more efficient than those REITs with the same management and board.

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CHAPTER 3

TOTAL FACTOR PRODUCTIVITY GROWTH AND REGULATORY CHANGES IN REAL ESTATE INVESTMENT TRUSTS (REITs): AN EMPIRICAL INVESTIGATION

3.1 Introduction

In the last two decades, technological progress, legislation, and consolidations have been important developments in the financial services industry. Dramatic changes have attracted the attention of regulators, managers, investors, and researchers, who are interested in the impact of these developments on operational efficiency. An extensive body of research has examined the performance of banks, thrifts, savings and loans, and insurance companies in the evolving environment and investigated the impact of changes on cost efficiency, technological change, and productivity growth of the financial services industry [e.g., see Berg *et al.*, 1992; Elyasiyani and Mehdian, 1992; Mester, 1993; Fare *et al.*, 1994; Berger and Humphrey, 1997; Wheelock and Wilson, 1999; Cummins *et al.*, 1999; and Isik and Hassan, 2001].

Real Estate Investment Trusts (REITs) have experienced increasing structural and legal changes during the last two decades. In 1960, they were subject to a 90% ordinary income distribution test, i.e., they had to distribute most of their taxable income to shareholders. This requirement was increased to 95% on January 1, 1980. Until 1986, REITs were required to hire managers to operate their properties. This situation

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affected the efficiency since employees have different economic interests than the REITs, leading to an agency problem. The Tax Reform Act of 1986 permitted REITs to operate and manage most commercial properties. Legislation in 1993 removed the restriction on pension plan REIT investment. The REIT Simplification Act of 1997 further simplified their operations. Finally, the REIT Modernization Act (RMA) was also designed to improve REITs' efficiency. One of the most important RMA features is to scale down the dividend requirement to 90%, providing a valuable source of income to make payments on outstanding debt. Such regulatory changes appear necessary to strengthen the REITs' structure to better serve investors and the economy. Since 1990, REITs have grown from a market capitalization of approximately $9 billion to over $139 billion. During 1997, REITs raised over $45 billion in security offerings, reflecting investor recognition of growth prospects.

The literature lacks a detailed study of REITs' total factor productivity change although they do exist in a dynamic environment. This study investigates REITs' performance by assessing technological progress, efficiency change, and productivity growth. The motivation for this study is the debate on the productivity and a need for empirical evidence that can help policy formulations.

Berger and Humphrey (1997) argue that estimation over a longer time period is needed to detect any improvement in performance after regulatory changes. This claim has not been tested. The first contribution of this study is to employ a long chain of ex-post performance indexes. Second, this study assesses the REIT total factor productivity change for the last decade by employing the DEA-type Malmquist Index. Third, the study examines possible efficiency change sources, such as pure technical efficiency change (change in managerial efficiency) and scale efficiency change (change in optimal size).

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This study is organized as follows. Section 2 provides some REIT background information and discusses the regulatory landscape. Section 3 outlines the methodology used. Section 4 discusses data and input-output variables used in the analysis. Section 5 reports the results. Section 6 provides conclusions.

3.2 Background

Congress created Real Estate Investment Trusts (REITs) in 1960 to enable small investors to make investments in diversified, large-scale, income-producing real estate enterprises. REITs are closed-end investment companies that pool the funds of individuals and companies and, much like mutual funds, provide diversified portfolios by investing in real estate, mortgages, or real estate company shares. The difference between closed-end investment companies and mutual funds is in their approach. A REIT, as a closed-end investment company, has a fixed quantity of shares outstanding at any given time, most of which are traded on the financial market.

Congress has refined and improved the REIT laws, most notably in 1976, 1986, 1993, 1997, and 1999, to ensure that REITs can continue to effectively fulfill their mission in a changing economic and business environment, helping shift the focus of real estate investment from the tax-loss orientation of the 1970s and 1980s to the current taxable, income-oriented REIT environment. Such regulatory changes appear necessary to strengthen the REIT structure to better serve investors and the economy.

In 1960, REITs faced the same rules that were then governing regulated investment companies, known as mutual funds, and they had to distribute 90% of their taxable income to shareholders. This requirement was increased to 95%. Since these REIT dividends are mandatory and fully taxable to the shareholders, the tax burden is

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shifted from the company to the shareholders. Until 1986, REITs could own the properties, but were required by Federal law to hire managers or third parties to operate and manage them. REITs were focusing on construction and development rather than on developing long-term income generating properties. The Tax Reform Act of 1986 made fundamental changes in the REIT's operating structure by reducing the deductibility of interest, lengthening depreciation periods, restricting the use of passive losses, and allowing REITs to operate and manage their own properties. The last provision is particularly important to the industry to the extent that Lemieux and Decker (1999) and Ambrose and Linneman (1998), among the others, redefine REITs as "old" or "new." Old REITs still retain an outside advisor or property manager, operating as passive real estate investment vehicles (externally-managed REITs), which concentrate on developing properties for sale. On the other hand, new REITs are fully integrated operating companies, actively engaged in holding and managing their properties (self-advised/self-managed REITs).

Regulatory changes continued in the 1990s. One key difference between the REITs of the 1980s and those of the 1990s was the innovation of the "umbrella partnership REIT" (UPREIT) structure, starting in 1992[1]. This new form of REIT was created to address potential taxes related to the formation of a REIT when various partnerships owning multiple properties were involved. An UPREIT combines a partnership with a traditional REIT. The structure enables real estate partnerships to obtain liquidity, raise equity capital, and defer tax liabilities (Kleiman, 1993, Ambrose

[1] In the typical UPREIT, the partners of the Existing Partnership and the newly formed REIT become partners in a new partnership, termed the Operating Partnership. For their respective interests in the Operating Partnership (Units), the partners contribute the cash proceeds from the public offering. The REIT typically is the general partner and majority owner of the Operating Partnership Units (Source: www.nareit.com).

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and Linneman, 1998). Property owners interested in taking their real estate operations public can do so without incurring prohibitive capital gains taxes that have typically resulted from such transactions in the past (Crain *et al.*, 2000). The REIT benefits by being able to acquire additional assets without having to immediately tap into the capital markets. This structure has been very popular in attracting capital, and more than 75% of new REITs have taken this form since 1992.

Another important regulatory change in the 1990s was the modification of the "five or fewer" rule. This rule disqualifies the REIT status if five or fewer shareholders hold more than 50% of its shares. Although this test is appropriate for the objective of promoting REIT ownership among small investors, it is implausible for institutional investors to invest substantial sums in the shares of individual REITs. For example, pension funds were regarded as a single individual shareholder and could not invest significantly in individual REITs with relatively small market capitalization. The Revenue Reconciliation Act of 1993 alleviated this problem, allowing an institutional beneficiary to be considered an individual REIT shareholder. It was expected that passage of the Act would encourage institutions to increase their investment activity in REIT securities and enhance the depth of available REIT capital. Consistent with this expectation, Chan *et al.* (1998) found an increase in institutional REIT securities ownership.

The Real Estate Investment Trust Simplification Act of 1997 (REITSA) simplified the day-to-day operations of REITs, modernized some of the regulatory structure under the previous tax regime and assisted the continued growth of the industry. Under the old law, income from customary tenant services had been considered rent for

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the purpose of both the 95% and 75% gross income test[2]. However, if non-customary services were given to tenants, income including the underlying rent payments did not qualify as income for these tests. Hence, REITs had to employ independent contractors to provide non-customary services to their tenants without having control over the quality of services. REITSA provides *a de minimis* exception to prior law that rents are not "tainted" with respect to a property, so long as the REIT does not perform nonpermissible services generating 1% of that property's gross income. Thus, providing new services to tenants has three equally compelling benefits. First, new service generates greater loyalty and allows the REIT landlord to remain competitive. Second, it also generates a new stream of income. Finally, the REIT can maintain better quality control over the services rendered to its tenants (NAREIT).

REITSA also repealed the 30% gross income test, which gave small REITs the opportunity to make large profits when they wanted to purchase a property or a package of properties held less than four years[3]. Furthermore, REITs were given permission to retain and pay income tax on net long-term capital gains instead of paying a "capital gain dividend" to their shareholders. This strategy is the least expensive way to promote growth. Finally, REITSA made a technical change in profit calculation for the purpose of assisting newly established REITs. REITs had to distribute all pre-REIT earnings and profits within the first taxable year or lose their status. However, new REITs could fail to comply with this requirement due to unexpected year-end earnings. The REITSA corrected the ordering rules for accumulated earning and profit distributions, eliminating a substantial risk for new REITs.

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[2] REITs must pay dividends of at least 95% of REIT taxable income, and at least 75% of their gross income must be derived from rents from real property or interest on mortgages on real estate property.

[3] REIT looses its status in any year if at least 30% of its gross income is derived from sales of dealer property, real estate is held for less than four years, or securities are held for less than one year.

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The REIT Modernization Act (RMA), which became effective in 2001, creates a more competitive environment and promotes further efficiency. Among the most important provisions is the one about taxable REIT subsidiaries and distribution requirements. The previous legislation had permitted a REIT to earn up to 5% of its income from sources other than rents, capital gains, dividends, and interest. To obtain part of this income, many REITs have invested in non-REIT C corporations, which provide services not allowed to be offered by a REIT. Furthermore, REITs have invested in nonvoting securities of C corporations, the voting stock of which is controlled by other persons (Third Party Subsidiary, or TPS), because they had to comply with the diversification tests[4]. The TPS structure is economically important because it has allowed REITs to use their assets and expertise to provide real estate related services to non-tenants. However, REITs are not allowed to control the subsidiary because of their diversification tests. REIT shareholders cannot be assured that the TPS will always act in their best interests. Income from TPS will accrue to the voting shareholders' benefit, rather than the REIT shareholders (NAREIT). With RMA, REITs will be able to own up to 100% of the stock of a REIT subsidiary that can provide services to REIT tenants without disqualifying the rent received. Additionally, the REIT distribution requirement is reduced to 90% from 95%, providing a valuable source of income to make payments on outstanding debt.

In summary, REITs are required to comply with the following provisions:

1. A REIT must be a corporation, business trust or similar association, and be managed by a board of directors or trustees;

[4] REITs cannot own more than 10% of the voting securities of another company, and the securities of another company cannot exceed 5% of a REIT's total asset value.

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2. REITs must invest at least 75% of their assets in real estate equities, mortgages, or government equities;
3. They must pay dividends of at least 90% of their taxable income;
4. At least 75% of gross income must be derived from real property rents or real estate mortgage interest;
5. There must be a minimum of one hundred shares which are fully transferable;
6. During the last half of each taxable year, REITs must have no more than 50% of the shares held by five or fewer individuals;
7. The trustees, directors, and employees of a REIT are restricted from actively managing or operating REIT property. However, they are permitted to make property decisions related to the business of the REIT.

3.3 Methodology

Three accepted productivity change indexes appear in the literature: the Tornqvist index (Tornqvist, 1936), the Fisher Ideal Index (Fisher, 1922), and the Malmquist index (Malmquist, 1953). The Tornqvist and the Fisher Ideal Indexes can be calculated directly from price and quantity data; hence, no need exists to construct the underlying best practice production frontier by using linear programming technique or stochastic approaches to estimate the parameters of functions characterizing the frontier. These indexes are also consistent with the flexible representations of the frontier, i.e., both are superlative indexes (Caves *et al.*, 1982; Diewert, 1992). The popularity of the Malmquist index stems from three advantages over the Tornqvist and the Fisher Ideal Index. First, it is calculated from quantity data only, a distinct advantage if price information is not available. Second, it does not rest on restrictive behavioral assumptions because it doesn't

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assume cost minimizing or profit maximizing behavior. Finally, the Malmquist index has an informational advantage over the others in the sense that it offers insight into the sources of productivity change, providing a decomposition of productivity change into technological change and technical efficiency change[5]. However, the Tornqvist index presumes that production is always efficient and does not allow for the decomposition of productivity growth into changes in technical efficiency and changes in technology. Consequently, the Malmquist index is employed for the analysis of productivity change.

Sten Malmquist, a Swedish economist and statistician, pioneered the construction of quantity indexes as ratios of distance functions (Malmquist, 1953). In his consumer analysis, Malmquist compares two consumption bundles observed in different time intervals using input distance functions. Caves, Christensen and Diewer (1982a,b) (hereafter, CCD) utilize the same idea in production analysis, exploiting the Shephard concept of distance function. They also show that under certain conditions, the Tornqvist index is equivalent to the geometric mean of two Malmquist output productivity indexes. However, Fare *et al.* (1985) define the Malmquist index by showing the relationship between distance functions and Farrel's (1957) technical efficiency measures.

Following Farrel's (1957) distance functions, Fare *et al.* (1994) defines an output-based Malmquist index of productivity change. Let $x^t = (x_1^t,\dots,x_N^t) \in R_+^N$ and $y^t = (y_1^t,\dots,y_M^t) \in R_+^M$ denote an input vector and an output vector of REITs in the time period $t = 1,\dots,T$. The production function S^t models the transformation of inputs into outputs, i.e., the technology consists of all feasible combinations of input/output vectors.

[5] Under certain conditions the Malmquist and Tornqvist indexes coincide (Caves et al., 1982), and under generally more restrictive conditions, the Malmquist and Fisher Ideal indexes coincide (Fare and Grosskopf, 1994).

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$$S^t = \{(x^t, y^t): x^t \, can \, produce \, y^t\} \qquad (1)$$

S^t is assumed to satisfy certain axioms to define meaningful output distance functions [see Shephard, 1970]. Shephard (1970) defines the output distance function at t as

$$D_o^t(x^t, y^t) = \inf\{\theta: (x^t, y^t / \theta) \in S^t\}. \qquad (2)$$

In an output distance function, the aim is to maximize the proportional expansion of the output vector for a given input vector. To determine the Malmquist index, the distance function is defined with respect to different time periods such as

$$D_o^t(x^{t+1}, y^{t+1}) = \inf\{\theta: (x^{t+1}, y^{t+} / \theta) \in S^{t+1}\}. \qquad (3)$$

This distance function measures the maximal proportional change in outputs to make (x^{t+1}, y^{t+1}) feasible in relation to the technology S^t, i.e., an observed input-output vector produced in the period $t+1$ is compared to the technology in the previous period t. In a similar fashion, the distance function $D_o^{t+1}(x^t, y^t)$ measures the maximal proportional change in output required to make (x^t, y^t) feasible in relation to the technology at $t+1$.

Figure 7 illustrates these concepts. Assume that a REIT is observed in year t and $t+1$ with the combination of (x^t, y^t) and (x^{t+1}, y^{t+1}), which belong to the corresponding frontiers S^t and S^{t+1}. These observations can be either compared to the efficient point on the contemporaneous frontier or to the efficient point on the following year's frontier. For example, the observation (x^t, y^t) is compared to (x^t, y_t^t) or (x^t, y_{t+1}^t); whereas, the observation (x^{t+1}, y^{t+1}) is compared to (x^{t+1}, y_{t+1}^{t+1}) or (x^{t+1}, y_t^{t+1}). The observations (x^t, y^t) and (x^{t+1}, y^{t+1}) are feasible but technically inefficient production points because they are interior to their own frontiers. However, the REIT at $t+1$, (x^{t+1}, y_t^{t+1}) produces more output than the corresponding efficient REIT at t, (x^{t+1}, y_{t+1}^t) with the same level of input.

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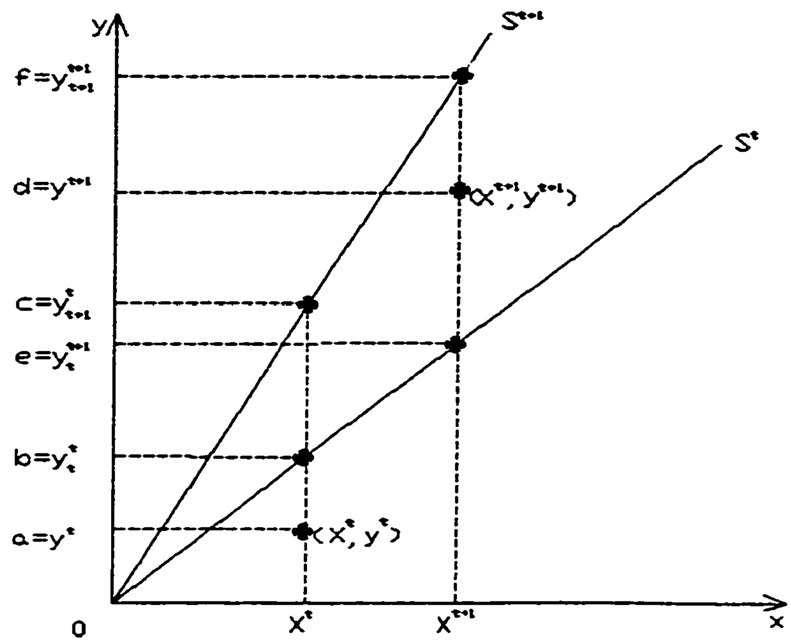

Figure 7. Illustration of the Malmquist Output-Based Productivity Index

CCD define the Malmquist productivity change index based on the reference technology with the period t and $t+1$ as benchmarks,

$$M^t = \frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)} \text{ and } M^{t+1} = \frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^t, y^t)}. \tag{4}$$

M^t is obtained relative to the benchmark technology in period t; whereas, M^{t+1} is calculated relative to the benchmark technology in period $t+1$. Fare *et al.* (1994) specifies the Malmquist productivity change index as the geometric mean of these CCD-type Malmquist productivity indexes to preclude choosing an arbitrary benchmark, as follows:

$$M(x^{t+1}, y^{t+1}, x^t, y^t) = \left[\frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)} x \frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^t, y^t)} \right]^{1/2}. \tag{5}$$

M defines the productivity of the production point (x^{t+1}, y^{t+1}) with respect to the production point (x^t, y^t) according to both years' technologies and calculates the geometric mean of the two ratios. M is greater than, equal to, or less than unity according

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to how the REIT experiences productivity growth, stagnation, or productivity decline between the periods t and $t+1$.

Following Fare *et. al.* (1989, 1992), an equivalent way of stating the Malmquist output-based productivity index is

$$\underbrace{M(x^{t+1},y^{t+1},x^{t},y^{t})}_{TFPCH} = \underbrace{\frac{D_0^{t+1}(x^{t+1},y^{t+1})}{D_0^{t}(x^{t},y^{t})}}_{EFFCH} \; x \; \underbrace{\left[\frac{D_0^{t}(x^{t+1},y^{t+1})}{D_0^{t+1}(x^{t+1},y^{t+1})} \, x \, \frac{D_0^{t}(x^{t},y^{t})}{D_0^{t+1}(x^{t},y^{t})}\right]^{1/2}}_{TECHCH} . \qquad (6)$$

In terms of the distances along the y-axis, the index takes the following form,

$$M(x^{t+1},y^{t+1},x^{t},y^{t}) = \left(\frac{0d}{0f}\right) \; x \; \left(\frac{0b}{0a}\right) \; x \; \left[\left(\frac{0d\,/\,0e}{0d\,/\,0f}\right) \; x \; \left(\frac{0a\,/\,0b}{0a\,/\,0c}\right)\right]^{1/2}$$

$$\underbrace{M(x^{t+1},y^{t+1},x^{t},y^{t})}_{TFPCH} = \underbrace{\left(\frac{0d}{0f}\right) \; x \; \left(\frac{0b}{0a}\right)}_{EFFCH} \; x \; \underbrace{\left[\left(\frac{0f}{0e}\right) \quad x \quad \left(\frac{0c}{0b}\right)\right]^{1/2}}_{TECHCH} \qquad (7)$$

The Total Factor Productivity Change (TFPCH) index, M, is calculated as the product of efficiency change (EFFCH), reflecting how close a REIT is to the efficient frontier (*catching-up effect*) and technological change (TECHCH), reflecting how much the benchmark production frontier shifts at each REIT's input mix (*technical innovation or shock*). Between periods t and $t+1$, EFFCH (*TECHCH*) attains a value of greater than 1, less than 1, or equal to zero, which reflects an efficiency increase (*technical progress*), efficiency decrease (*technical regress*), or no efficiency change (*stagnation*), respectively. These components may be moving in opposite directions; for example, a Malmquist index of 1.25, which signals a productivity growth, could have an efficiency decrease (e.g., 0.5) and a technical progress (e.g., 2.5).

Calculation and decomposition of the Malmquist productivity index requires the

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calculation of four-output distance functions for each REIT in each pair of adjacent time periods. Following Fare *et. al.* (1994), Data Envelopment Analysis (DEA), a linear programming (LP) technique, is employed to measure the productivity change under the assumption of a constant return to scale (CRS) technology, i.e., all REITs are scale efficient. Assume that there are $k = 1,\dots,K$ observations of $n = 1,\dots,N$ inputs $x_n^{k,t}$ in each period $t = 1,\dots,T$, which are employed to produce $k = 1,\dots,K$ observations of $m = 1,\dots,M$ outputs denoted $y_m^{k,t}$ in each period $t = 1,\dots,T$. The technology is described in period t as follows:

$$\begin{aligned} S^t = \{(x^t, y^t): &\sum_{k=1}^{K} \lambda^{k,t} x_n^{k,t} \le x_n^t, \qquad n = 1,\dots,N \\ &\sum_{k=1}^{K} \lambda^{k,t} y_m^{k,t} \le y_m^t, \qquad m = 1,\dots,M \\ &\sum_{k=1}^{K} \lambda^{k,t} \le 1; \quad \lambda^{k,t} \ge 0, \quad k = 1,\dots,K\} \end{aligned} \tag{8}$$

where $\lambda^{k,t}$ is an intensity variable showing the degree of intensity each REIT uses in the production. Intensity variables are restricted to sums of less than or equal to one. Relative to the component distance functions, four linear programming problems are solved for each REIT. These are as follows:

$$\left[D_0^t(x^{k,t}, y^{k,t})\right]^{-1} = \max_{\theta,\lambda} \theta$$

subject to

$$\begin{aligned} &\sum_{k=1}^{K} \lambda^{k,t} x_n^{k,t} \le x_n^{k,t}, \qquad n = 1,\dots,N \\ \phi y_m^{k,t} - &\sum_{k=1}^{K} \lambda^{k,t} y_m^{k,t} \le 0, \qquad m = 1,\dots,M \\ &\sum_{k=1}^{K} \lambda^{k,t} \le 1; \quad \lambda^{k,t} \ge 0, \quad k = 1,\dots,K. \end{aligned} \tag{9}$$

The computation of $D_0^{t+1}(x^{k,t+1}, y^{k,t+1})$ is exactly like (9), where $t+1$ is substituted for t.

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The third problem related to the function $D_0^t(x^{k,t+1}, y^{k,t+1})$ is solved as follows:

$$\left[D_0^t(x^{k,t+1}, y^{k,t+1})\right]^{-1} = \max_{\theta,\lambda} \theta$$

subject to

$$\sum_{k=1}^{K} \lambda^{k,t} x_n^{k,t} \le x_n^{k,t+1}, \qquad n = 1,\dots,N \qquad (10)$$

$$\phi y_m^{k,t+1} - \sum_{k=1}^{K} \lambda^{k,t} y_m^{k,t} \le 0, \qquad m = 1,\dots,M$$

$$\sum_{k=1}^{K} \lambda^{k,t} \le 1; \quad \lambda^{k,t} \ge 0, \qquad k = 1,\dots,K.$$

The last linear programming problem is specified as in (10), but the t and t+1 superscripts are transposed.

Technical efficiency change is decomposed into scale efficiency and pure technical efficiency components (*EFFCH = PEFFCH × SCH*). Decomposition requires the calculation of distance functions under variable returns to scale (*VRS*) (rather than *CRS*) technology by solving two additional LP problems, simply adding the convexity restriction $\sum_{k=1}^{K} \lambda^{k,t} = 1$. The efficiency change is constructed as the ratio of the own-period distance functions in each period satisfying variable returns to scale. The technical change component is calculated relative to the constant returns to scale technology. Scale efficiency is calculated as the ratio of the distance function satisfying constant returns to scale to the function satisfying variable returns to scale.

The Malmquist productivity index has been extensively used in the literature. In particular, it is employed to examine the impacts of deregulation and/or liberalization in industries. For example, an extensive body of research exists in the banking literature. Berg *et. al.* (1992) study the productivity growth of the Norwegian banking industry before and after deregulation over the years 1980-89. Both bank lending volume and the

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lending interest rates are strictly regulated prior to 1984. However, this regulation is gradually lifted from 1984 to 1988. The Malmquist productivity analysis reveals productivity regress in the pre-regulation years because of creating idle capacity with the advent of deregulation. However, the Norwegian banking industry experiences rapid productivity growth in the post-deregulation era. The authors attribute this progress to utilization of capacity. A substantial improvement occurs in the relative efficiency of most banks. The results also reveal that productivity levels of banks become similar, implying increased competition during the deregulated era.

Tatje and Lovell (1996) measure the productivity changes in Spanish savings banks during the post-deregulation period 1986-1991. During this period, great size dispersion occurs among savings banks. While outputs grow from 45% to 90%, inputs grow from 67% to 176%. Hence, this changing environment causes operating problems for savings bank managements, but it also creates opportunities for growth. Two features, particularly after 1989, dominate the savings bank segment of the industry: branching and consolidation through mergers and acquisitions. Results from the Malmquist index approach show a rapid decline in productivity throughout the period and vary within a narrow range of 3.4%-5.5% per year because inputs have grown faster then outputs. They also find that branching does not affect productivity and that the effect of consolidation is inconclusive.

Leightner and Lovell (1998) document the performance of Thai banks during the financial liberalization period 1989-1994. During this period, all interest rate ceilings are gradually removed. All current account foreign exchange and capital account restrictions are relaxed, resulting in a 59% decrease in the spread between commercial bank average lending rates and deposit rates. In contrast, the effective spread between commercial

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banks' lending rates and their cost of funds increases from 2.87% to 3.22% because of the lower cost of funds tapped from foreign sources. The Thai Securities and Exchange Commission is established, and commercial banks are allowed to underwrite and arrange for debt instruments. Thailand's liberalization process also includes the relaxation of certain portfolio restrictions. Banks are no longer required to hold government securities in their portfolio. The authors find a productivity decline for Thai banks but productivity increases for foreign banks. They conclude that deregulation leads to increased competition, higher profits, and economic growth.

Wheelock and Wilson (1999) examine U.S. commercial banks for the period 1984-1993. They find that productivity declines on average but not nearly to the extent of the decline in efficiency. Although U.S. commercial banks experience technological progress, it is not enough to offset the increases in technical and scale inefficiency during 1984-1993. Results further reveal that regulatory changes have different effects on various-sized firms. Small banks experience larger declines in productivity in the first half of the study period, with large banks showing larger declines in the second half.

Avkiran (2000) examines the changes in productivity of the retail-banking sector (four major Australian trading banks and six regional banks) in the deregulated period 1986-1995, using the Malmquist productivity index. Deregulation of the Australian finance sector includes lifting of deposit controls, authorization of savings banks to provide checking facilities, invitation of foreign banks to operate in Australia, and expansion of services by credit unions and building societies. The banks respond to increased competition through such practices, generating revenue from fees rather than from the interest spread, product innovation, or new delivery channels. Findings indicate an overall rise in total productivity (on average, 3.2% per year) driven more by

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technological progress than technical efficiency. Technological innovation reflects the efficiency gains where banks take advantage of new cost-effective technologies and pursue product and market development.

3.4 Data

Data on productivity and efficiency analysis come from the *SNL REIT Quarterly* for the years 1989 through 1999, with a total of 1671 observations from 280 equity REITs. This data set represents a comprehensive set of equity REITs with the necessary input and output variables. Many observations (296) have been dropped due to missing information[6]. The final data set is comprised of 1375 observations from 235 equity REITs over an eleven-year study period.

REITs have become a major source of funding for the real estate industry. The distribution of equity REITs and security offerings for all REITs across the years is shown in Chapter 2, Table 1. A large number of initial public offerings took place in 1993 and 1994, representing the formation of new REITs. There were 191 REITs formed between 1989 and 1999, and 95 of these were formed in 1993 and 1994. The capital raised from initial public offerings was about $16.5 billion in these two years, which was about 53% of the entire period. Total equity capitalization increased from $11 billion at the end of 1992 to $26 billion in 1993. This rapid growth continued during 1994 with an increase of more than $38 billion. After 1994, the focus shifted to secondary offerings, with more than $7 billion raised in 1995, $11 billion in 1996, $26 billion in 1997, and $19 billion during 1998. The number of offerings increased from 52 in 1994 to 297 in

[6] For instance, input prices for some REITs could not be determined because correspondent input values were reported as zero.

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1998. This growth resulted in a market of 167 equity REITs with a total market capitalization of more than $118 billion.

The National Association of Real Estate Investment Trusts (NAREIT) classifies three types of REITs, according to their respective holdings of real property or mortgage instruments, namely: equity, mortgage, and hybrid REITs. To be classified as an equity (mortgage) REIT, at least 75% of the REIT investment portfolio must consist of income producing real property (mortgage instruments). Hybrid REITs combine the activities of equity and mortgage REITs.

This study focuses on equity REITs for two main reasons. First, firms included in the sample should be relatively homogeneous and operate in similar market and regulatory conditions (Oral and Yolalan, 1990). Equity, mortgage, and hybrid REIT firms are totally separate because their managerial goals are different. While rent is the most important source of income for equity REITs, interest is the primary income for mortgage REITs. Additionally, fluctuations in macroeconomic variables (e.g., interest rates) affect operating strategies mostly for mortgage REITs'.

Second, operating under various market conditions could influence the efficiency and performance measures if different REIT forms are pooled in the same sample. Aly *et al.* (1990) suggest constructing different frontiers for each type of firm to measure the efficiencies. In order to pool all firms into a common frontier, differences in mean efficiencies arising from separate frontiers should be insignificant across firms. This finding will allow determination of whether the groups could be pooled and used for the same frontier based on efficiency distributions. However, a few observations of mortgage and hybrid REITs for most years do not allow the construction of different frontiers because efficiency measures could be upwardly biased.

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3.4.1 Input and Output Variables

No consensus exists among researchers, theoretical or otherwise, about what constitutes REIT production or how best to measure output. Possible suggestions include assets, dividends or funds from operations (FFO), market capitalization (or market capitalization less debt), and space measures (square footage, number of units, etc.)[7]. Considering output measures from other efficiency analyses, and following the premise of REIT efficiency studies (Bers and Springer, 1997, 1998a, 1998b, and Anderson *et al.*, 1999), total assets are selected as an output measure. Furthermore, Springer (1998) finds that total assets have a high correlation with market capitalization; it has lower variance and yields more consistent results, and any bias is conservative compared to other alternative output choices.

REIT output is generally in three categories. Loans (L) are the value of all real estate loans; properties (P) are properties in operation owned by the company; and other assets (OA) are non-operational properties[8], unconsolidated partnerships (value of joint ventures), and all non-real estate investment assets. These particular outputs are meaningful for the efficiency analysis because income (rent and/or interest) from them depends on management's investment decisions (whether to buy real estate or give loans). Two REIT input measures emerge naturally from the SNL dataset. These are interest expenses (IE) and property-operating expenses (POE). Interest expense is the cost of debt and other borrowings, including the amortization of debt discounts. Property-operating expense is the cost associated with rental properties, including maintenance,

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[7] For a detailed discussion as to whether REITs are an equity (stock) investment or whether they are a real estate investment and for justification of possible REIT outputs, see Springer (1998).

[8] Non-operational properties include properties under development, land held for development, and property held for sale. Other assets also include unconsolidated partnerships, which are the value of joint ventures and all non-real estate investment assets.

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utilities, property management fees, and real estate taxes.

Table 2 in Chapter 2 reports summary statistics for outputs and inputs of the REITs for the years 1989 through 1999. Loan production has a U-shaped pattern, declining from $18 million in 1989 to the lowest level of $3 million in 1993 and then increasing to $25 million in 1999. However, properties steadily increase over the period and dominate loans by at least a factor of 7 in 1989 and at most a factor of 78 in 1993. This pattern is mainly because of the interest rate, declining from 7.91% in 1989 to the lowest level of 3.33% in 1993. In this period, REITs preferred purchasing property by using less expensive funds to making loans with low interest rates. Therefore, as is shown in Table 2, REIT interest expenses doubled between 1991 and 1993.

3.5 Regulation Impact on Productivity Growth of REITs

In this section, the study analyzes the performance of REITs over an 11-year (1989-1999) regulation period. In such a different period setting, the Malmquist total productivity change indexes and its components must include a technology year of reference (base year). The results shown in Table 8 relate to both a fixed reference technology and a changing reference technology. In the case of fixed reference technology, 1989 is used as a reference year when calculating the productivity and efficiency change during the period because the primary goal is to examine the industry performance after the Tax Reform Act of 1986. Since a relatively long period is needed to bring about a material impact on REITs technology from the regulatory environment, 3 years after the Act is assumed to be adequate to capture any structural change in REITs' performance. Moreover, no significant development or event occurred in 1989, so it can

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Table 8. Average Total Factor Productivity Change in REITs During the Period 1989-1999

Panel A: With respect to fixed reference frontier

Period	# of obs.	effch	tecch	pefch	sech	tfpch
89-90	35	1.090	0.757	0.887	1.228	0.825
89-91	31	1.123	0.790	0.927	1.211	0.887
89-92	30	1.223	0.731	0.946	1.293	0.894
89-93	27	1.237	0.726	0.920	1.345	0.898
89-94	30	1.304	0.486	0.974	1.339	0.634
89-95	24	1.378	0.422	0.970	1.420	0.581
89-96	25	1.408	0.433	1.010	1.394	0.609
89-97	20	1.055	0.654	0.991	1.065	0.690
89-98	17	1.092	0.558	0.963	1.134	0.609
89-99	15	0.929	0.777	0.863	1.076	0.721
Mean						
89-93		1.168	0.751	0.920	1.269	0.876
94-97		1.286	0.499	0.986	1.305	0.629
98-99		1.011	0.668	0.913	1.105	0.665
89-99		1.184	0.633	0.945	1.251	0.735

Panel B: With respect to changing frontier

Period	# of obs.	effch	tecch	pefch	sech	tfpch
89-90	35	1.09	0.757	0.887	1.228	0.825
90-91	40	1.01	0.917	1.062	0.951	0.926
91-92	69	0.446	2.359	0.956	0.467	1.053
92-93	87	1.571	0.757	1.111	1.413	1.189
93-94	93	5.386	0.211	1.164	4.626	1.138
94-95	151	1.559	0.496	1.111	1.403	0.773
95-96	171	1.485	0.695	1.006	1.476	1.033
96-97	154	1.027	1.117	0.849	1.21	1.147
97-98	143	2.37	0.358	1.525	1.554	0.847
98-99	132	1.432	0.619	1.202	1.191	0.887
Mean						
89-93		0.937	1.055	1.000	0.937	0.989
94-97		1.892	0.534	1.025	1.845	1.010
98-99		1.842	0.471	1.354	1.360	0.867
89-99		1.421	0.684	1.073	1.324	0.972

Effch: Efficiency change; Tecch: Technical (technological) change; Pefch: Pure technical efficiency change; Sech: Scale efficiency change; Tfpch: Total productivity change.

safely serve as a control year[9].

[9] Isik and Hassan (2001) assume that a 4-year interval is appropriate to capture any structural change in the performance of Turkish banks.

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Table 8 presents the mean annual values of the Malmquist total factor productivity change (*tfpch*) index with its two mutually exclusive and exhaustive components, changes in technical efficiency (*effch*) and shifts in technology (*tecch*) over time. The two distinct components of the technical efficiency change, pure technical efficiency change (*pefch*) and scale efficiency change (*sech*) are also reported.

3.5.1 Productivity Growth Relative to Fixed Reference Technology

The reference frontier is fixed in 1989 and compared to the years from 1990 to 1999 in the input-output space. The main issue is what the productivity levels are in 1990, 1991, 1992 etc., relative to the 1989 base year. The study examines the same REIT firms throughout the years.

Results in Table 8, Panel A suggest that REITs have experienced increases in efficiency (except in 1999) but decreases in productivity growth and technological regress for all years examined. A dominant source of efficiency improvements is scale efficiency. Pure technical efficiency change is negative over the period (except for 1996). Although productivity deteriorated, it has gradually approached the base year level during the period of 1989-1993. In the following year (1994), the REIT industry faced a significant shock, as reflected in a 33% reduction in the technology index, which turns into a 30% regress in productivity. On the other hand, REITs continued to experience increases in efficiency after 1994. This finding suggests that a significant number of new entrances to the market caused decline from the frontier but helped REITs operate more efficiently because of increasing competition[10].

Results further reveal that REITs maintained their efficiency increase between

[10] Of particular interest is the large number of IPOs in 1993 and 1994. There is a 52% and 30% increase in equity REITs in these two years.

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1994 and 1996. However, they were still suffering from technological regress in that period. The REIT industry seemed to have another shock in 1997. It had a positive impact on technological improvement (an increase of 50%) but a negative impact on the efficiency (a decrease of 25%). Yet, the technological increase was not enough to make the productivity positive.

In the aggregate, relative to the reference year 1989, the average REIT experiences productivity loss in the periods of 1989-1993 (12%), 1994-1997 (37%), and 1998-1999 (34%). The breakdown of total factor productivity change (*tfpch*) into its components suggests that the source of productivity loss is a regress in technology (*tecch*), rather than a decrease in efficiency (*effch*). In fact, efficiency increases in all periods of 17%, 28%, and 1% are due to improvements in scale efficiencies. Overall, in the period 1989-1999, REITs suffered a productivity decline resulting from a regress in technological improvement.

3.5.2 Productivity Growth Relative to Successive Reference Technology

Basically, two problems exist in studying productivity growth relative to a fixed reference technology. First, the base year does not necessarily represent the industry itself. The study requires the use of the same REITs each year when comparing the productivity of the industry. However, it is difficult to hold to this requirement because the number of firms in the industry changes over time due to new entries and exits. Second, a limited number of firms and their performance in the base year (1989) obscure the absolute levels of productivity and its components (Isik and Hassan, 2001). However, successive year technology accounts for a possible survivorship bias and includes more observations from the industry. Table 8, Panel B reports the geometric means of the annual productivity change index and its components.

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The results suggest that REITs experience productivity growth in the periods 1992-1994 and 1996-1997. Actually, the growth trend starts in 1990, improving by 5% for 1992, and reaching a maximum level in 1993 of 19%. In these years, except for 1992, even though technological change exerts a counterbalancing effect on productivity, an enhancement in efficiency offsets this negative impact and causes productivity growth. Throughout the period, productivity follows the same pattern as discussed in the fixed reference technology. REITs generally suffer from technological deterioration during the period.

Results from this analysis show that the technology index is not stable during the entire period. However, the pattern of technology change, as well as the change in efficiency, is similar to the outcomes obtained from the fixed reference frontier. While the REIT efficiency increases about 243% in 1994 compared to 1993, its technological status worsens by 72% in the same year. Hence, the results from the successive reference technology also prove that new entries in the market made the industry operate more efficiently. In 1997, they experience another shock, but in the opposite direction, i.e., their efficiency decreases by 31% but they technologically improve by 61%.

In the aggregate, with respect to successive reference technology, the average REIT experiences productivity loss in the periods of 1989-1993 (1%) and 1998-1999 (13%), but gain in 1994-1997 (34%). After 1993, the source of productivity loss is a regress in technology (*tecch*) rather than a decrease in efficiency (*effch*). Overall, in the period 1989-1999, REITs suffered a productivity decline resulting from a regress in technological improvement.

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3.5.3 Implications for Investors and Regulators

Deregulation is generally undertaken to improve an industry's performance and efficiency. The improvement in resource allocation should benefit society. Price reductions and better services for consumers are also expected if competition is sufficient. Although the ultimate goal of deregulation has been to improve efficiency, the results from depository institutions have been mixed. For example, Berg, Forsund, and Jansen (1992) reports improved efficiency and productivity after deregulation, as do Shyu (1998) for Taiwanese banks, Leightner and Lovell (1998) for Thai banks, and Isik and Hassan (2001) for Turkish banks in a more liberalized financial environment. While U.S. banking efficiency has remained relatively unchanged after the deregulation of the early 1980s (Bauer *et. al.*, 1993; Elyasiani and Mehdian, 1995), the productivity declines during the post-deregulation era (Humphrey, 1993; Grabowski *et. al.*1994; Humphrey and Pulley, 1997; Wheelock and Wilson, 1999).

In some cases, regulatory changes lead to a reduction in measured productivity depending on the industry-type market conditions (Berger and Humphrey, 1997). For instance, Lozano (1995) reports that Spanish banks do not produce the maximum possible output vector due to intense competition for market share following deregulation. Following the interest rate deregulation in the 1980s, great competition arises among U.S. banks in terms of paying higher interest rates on consumer deposits. The productivity benefits that could have been captured by banks are instead passed on to customers because no corresponding reduction occurs in banking services (Berger and Humphrey, 1997).

Starting in 1960, investors have realized the benefits of real estate investments by REIT regulation. Commercial real estate investment has become a viable option for all

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REIT regulation. Commercial real estate investment has become a viable option for all investors because it is an excellent hedge against inflation. Furthermore, REITs eliminate the lack of diversification problem and many of the costs and risks associated with real estate because it is now possible for small investors to purchase a diversified collection of illiquid real estate selected and managed by the professional management in the form of a marketable security. For REITs, an incentive to maximize operating performance also exists, which, in turn, benefits investors due to utilizing resources more efficiently.

In the last decade, changing real estate industry-type market structure resulted from regulatory changes, increasing REIT population and market capitalization have affected REITs' productivity. Examining productivity using different reference technologies gives some clues about determining the effects of new dynamic environment and regulatory changes. Figure 8 shows the REITs' productivity measures from both fixed and successive reference technologies. Although corresponding measures follow the same pattern, their values differ from each other. It is limited to capture all market changes with fixed reference technology due to using only the base year (1989) firms. Much more volatility in the successive reference technology reflects sharp and dramatic changes in the industry because of regulatory changes and new entries to the market. For instance, although REITs suffer from productivity loss for the entire period employing the fixed reference technology, they experience productivity gain for five years (1992-1994 and 1996-1997) using the successive reference technology. The productivity trend generally shows that regulatory changes in 1986 and 1993 have a positive impact on the industry.

Efficiency change appears to be positive for both frontier technologies. However, REITs do not have increase in pure technical efficiency change during the period using

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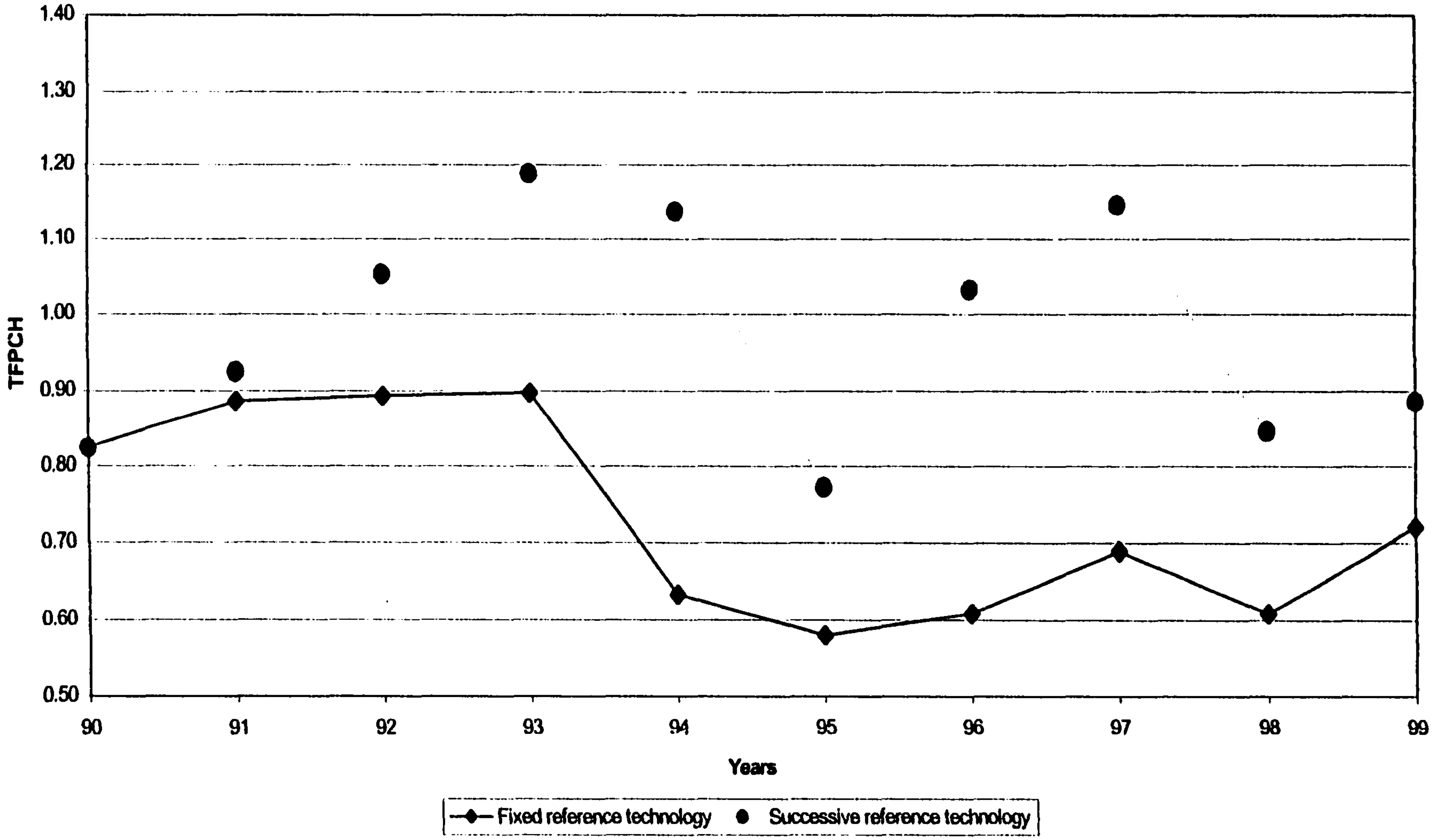

Figure 8. Total Factor Productivity Change in Fixed and Successive Reference Technologies

the fixed reference technology. Using the successive reference technology, REITs experience more increase in efficiency change and, more importantly, increase in pure technical efficiency change (Figure 9). Moreover, sources of increase in efficiency change are generally both scale efficiency and pure technical efficiency change. These findings further imply that investors get benefits from the corresponding regulatory changes and new entries during the period, resulting in competition among REITs, which turns into managerial efficiency.

Although REITs' efficiency increases relative to their frontier, they experience technical (technological) regress in the last decade. Actually, technical regress is the main reason for overall 3% productivity loss. The dividend requirement on REITs might explain the technical regress. The dividend requirement prevents REITs from maintaining current properties and funding future growth. Because REITs are required to pay out 90% of their income to shareholders, they cannot reinvest their earnings. Since REITs have insufficient retained earnings, managers have to look for capital outside of the firm. Raising equity and debt are more costly than using retained earnings. Productivity loss in the last decade might be attributed to the industry's higher cost of capital. In the 1990s, REITs raised equity as a principle source of capital. Their debt ratio also significantly increased after 1992. While their unsecured debt was $1.3 billion, it increased to $10.5 billion in1997, making the industry more risky (NAREIT).

In sum, reshaping the regulatory framework in light of recent developments has been a major concern for policymakers and for REIT managers. The patterns of productivity, efficiency, and technological change seem consistent with what one might expect of an industry living in a dynamic environment. Results suggest that the existing regulatory framework is costly and imposing productivity loss. Removing restrictions

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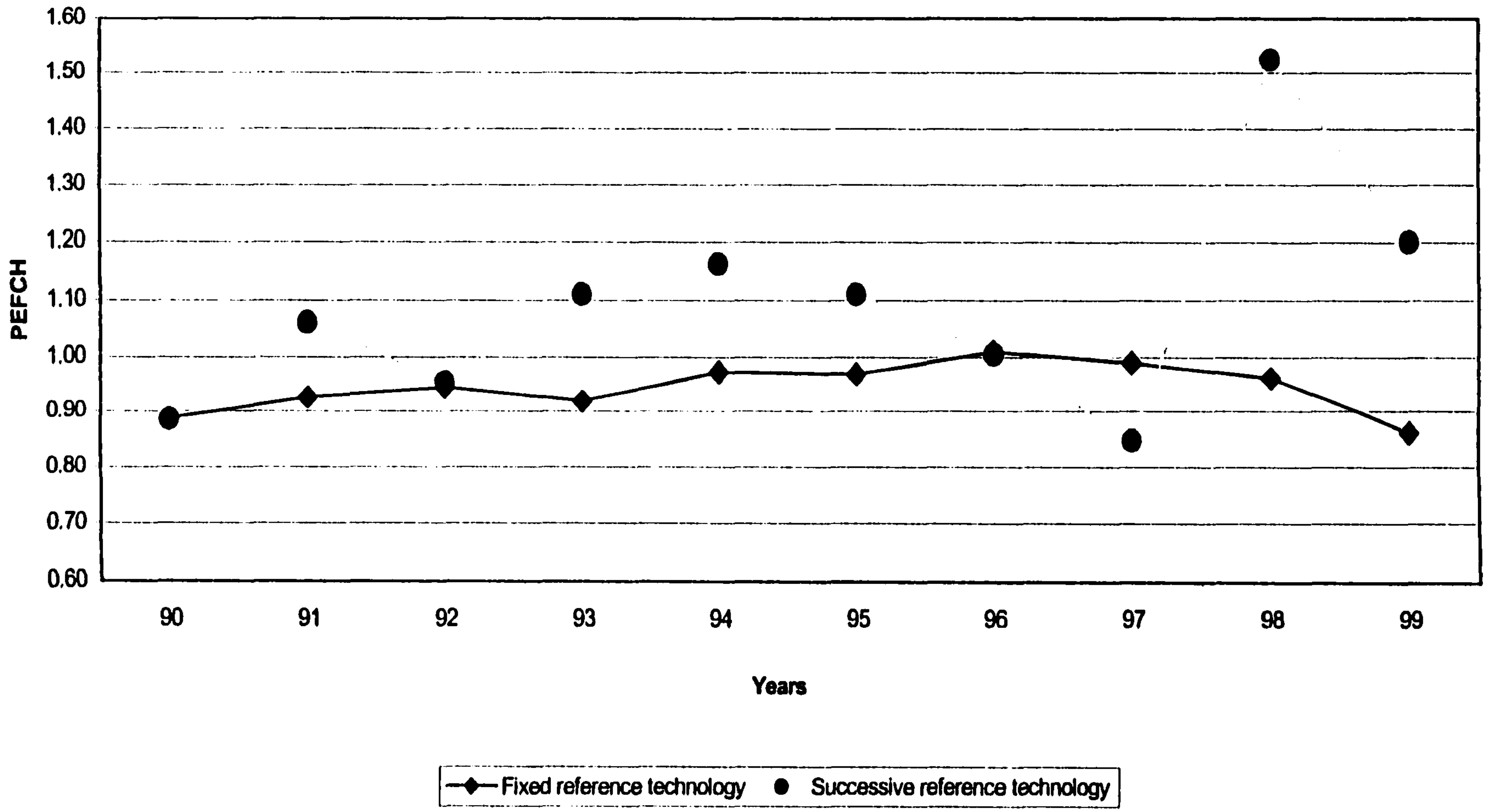

Figure 9. Pure Technical Efficiency Change in Fixed and Successive Reference Technologies

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upon dividends might provide more flexibility and stability for the real estate market.

3.6 Conclusion

This study investigates the impact of regulatory changes, which started in 1986 and continued during the last decade, on the productivity, efficiency, and technology of Real Estate Investment Trusts (REITs) by means of the DEA-type Malmquist Total Factor Productivity Change Index approach. The productivity change is examined relative to the fixed reference technology and to the successive reference technology.

The results suggest that the efficiency of REITs increases during the period of 1989-1999; whereas, their productivity generally decreases because of technical regress. This finding implies that REITs have exerted substantial efforts to gain efficiency rather than improve technically. However, this implication would not be enough to offset the negative impact of technical regress on their productivity.

REITs operate in a highly regulated environment and continuously face dynamic changes in their structure and market. REIT managers should be highly skillful in their decision-making to overcome the difficulties resulting from environmental changes. It seems that recorded efficiency increases are mainly due to both scale efficiencies and to better management practices as reflected in pure efficiency changes. Technological regress, particularly after 1993, can be attributed to higher cost of capital because of increasing capital raised.

Overall, structural and regulatory changes have affected REIT's productivity in different ways. More efficiency and technical improvement could be achieved by appropriate regulations. REITs typically raise debt to finance new property acquisition, using unsecured corporate lines of credit. Lenders generally expect to be repaid from proceeds of equity and focus on REIT's access to the capital markets and on the ability to

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raise equity capital. In this case, the results reveal technical regress leading to productivity loss. In order to reduce such inefficiencies, the dividend requirements could be further reduced to enhance REITs' after-tax income and enable REITs to use retained earnings on investments and make payments on outstanding debt.

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CHAPTER 4

CONCLUSION AND RECOMMENDATIONS FOR FURTHER RESEARCH

This study has examined the evidence concerning the efficiency and productivity of equity REITs from 1989 to 1999. Data Envelopment Analysis was employed to measure the cost, allocative, technical, pure technical, and scale efficiencies of firms. Alternative (nonstandard) profit efficiency was also measured using the Stochastic (Economic) Frontier Approach. The average cost and profit efficiencies for the REITs are 14% and 27%, respectively, implying that most REIT resources and potential profits are wasted during REIT operations. Overall inefficiency can be attributed to underutilization or wasting of inputs rather than choosing the incorrect input mix, because cost inefficiency is mostly caused by technical inefficiency rather than allocative inefficiency.

Low technical efficiency implies not only "poor management" in terms of utilizing inputs but also scale inefficiency because of operating at incorrect scale. REITs have increasingly experienced diseconomies of scale in which the majority (94%) are large. This implies the importance of optimum size for the REIT industry because it incurs greater operational costs because of scale inefficiency, which seems to be related more to being a greater, not lesser, size than optimal. The result of a negative (positive) relationship between large (small and medium) REITs and scale efficiency is further evidence of an industry-wide tendency to go beyond the optimal size limit.

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Several conclusions emerge from the second stage regression analysis. First, growth rate in REITs' assets impacts positively on efficiency measures suggesting that REITs utilize the fixed administrative and overhead expenses, and employ experienced management teams concentrating on properties in the real estate industry. Second, good capitalization and higher loan production make the REITs more efficient. Third, REIT efficiency decreases with higher debt because the cost of low leverage REIT debt is less than that of high leverage REITs. In addition, large REITs with more market power experience significantly lower scale, technical, and cost efficiencies. Finally, the results indicate that CEO-Chairman affiliated firms are generally negatively related to input efficiencies, thereby supporting the agency cost theory.

A DEA-type Malmquist Total Factor Productivity Change Index approach was employed to measure the REITs' productivity over the period 1989-1999. Overall, structural and regulatory changes have affected REITs' productivity in different ways. Although REITs' efficiency increased relative to their frontier, they experienced technical (technological) regress in the last decade, which was the main reason for their overall 3% productivity loss. More efficiency and technical improvement could be achieved by appropriate regulations.

Reshaping the regulatory framework in light of recent developments has been a major concern for both policymakers and REIT managers. The different and volatile patterns of productivity, efficiency, and technological change seem consistent with what one might expect of an industry living in a dynamic environment. Results suggest that the existing regulatory framework is costly and imposes productivity loss. Removing restrictions upon dividends might provide both more flexibility and greater stability for

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the real estate market.There are several directions for further research in REIT operating efficiency. First, other than equity REITs, the efficiency of hybrid REITs and mortgage REITs can also be examined. Second, ownership structure, such as institutional ownership, inside ownership, and beneficial ownership can be examined further to explain the variations of efficiency. Finally, further study can be conducted to investigate the post-merger performance of REITs, which are engaged in acquisition.

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