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Economies-of-Scale for Real Estate Investment Trusts†

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Abstract. **Using the translog cost function to estimate economies-of-scale for a sample of Real Estate Investment Trusts for the years 1992–1994, we find significant evidence that economies-of-scale exist for REITs for all years examined. The results show that measurement of scale economies is sensitive to the model used for the measurement. Individual characteristics of the REIT, such as type of management and degree of leverage, affect the magnitude of the scale economy. Additional variables accounting for property-type diversification and geographic influences have little additional impact on the measured scale economies. Finally, the measured economies-of-scale for REITs vary considerably over time.**

Introduction

To better understand the way that an industry operates, economists test for efficiencies of production. Economies-of-scale exist for a firm within an industry when larger quantities of the firm's output are produced at a lower average cost than are smaller quantities of output. For securitized real estate, such as Real Estate Investment Trusts (REITs), the outputs are the capitalization of the assets and the dividends paid out to shareholders. Scale economies exist when REITs having larger asset bases or that pay out larger dividends show lower average costs than REITs with smaller asset bases or smaller total dividends.

The sources of cost efficiencies, that can result in an economy-of-scale, can be categorized as either internal or external to the firm. A firm can achieve internal scale economies by specializing. For example, REITs that focus on a single property type or that geographically concentrate their assets would expect cost efficiencies. External economies-of-scale arise when the prices of a firm's inputs are reduced. In the case of REITs, larger REITs may achieve a level of market power, perhaps in financing or management contracts, that results in cost economies unavailable to less capitalized REITs.

In contrast, diseconomies-of-scale result from inefficiencies in operations and from the expense structure of a firm. Generally, differences in management practices can play a large role in explaining why some firms are inefficient in comparison to others. In the case of REITs, the policy for risk management can contribute to a diseconomy-of-scale. If a REIT chooses to diversify its asset base, either the movement away from specialization in a single property type or to geographic concentration may increase average costs.

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Diversification is a primary risk-reduction strategy for institutional investment portfolios, such as REITs. REITs use several means of diversification. A REIT can diversify by mode of investment; that is, investment in equity ownership, mortgages, or combinations of both (hybrid REITs).[1] An investment in mortgages entails a different cost structure than an investment in equity real estate. REITs can also diversify geographically and across property types. Geographic dispersion of properties results in an increased likelihood of contracting for property management and in increases of costs associated with monitoring the dispersed ownerships. Diversification across property types reduces specialization and requires managerial knowledge of diverse asset types within real estate. Because diversification alters the cost structure of the REIT, it is important to test for operational efficiency of REITs in light of these imposed costs.

The issue of whether or not REITs exhibit scale economies has not been addressed in the financial economics literature. Given the large dispersion in the size of REITs, as evidenced by a range in total assets from $2.6 million to $2.0 billion (NAREIT, 1996), the question of whether REITs exhibit size-dependent cost efficiencies is of interest. The purpose of this study is to identify whether REITs become more cost efficient as their size increases or, stated differently, whether economies-of-scale exist for this type of investment company.

Economies-of-Scale and REITS

Prima Facie Evidence

Many real estate practitioners believe that economies-of-scale exist for REITs. In discussing the future of REITs, Philip Scherrer (1995) writes, "The need for capital for growth and the pricing of that capital will create a cycle of REIT mergers and acquisitions in coming years as the more efficient REITs acquire the less efficient and as organizations merge for economies-of-scale and scope."

No research directly addresses the existence of scale economies in REITs. However, because the share price is a measure of output of the REIT, insight into the subject can be gained from previous research observing the response of REIT share price to acquisitions and dispositions. Evidence of positive price reactions to acquisition decisions or negative price reactions to disposition decisions supports the existence of cost efficiencies resulting from changes in the size of the REIT.

Financial research of REITs has generally found no significant wealth effects resulting from property acquisitions by REITs (see Corgel, McIntosh and Ott, 1995, for a review). These results suggest that, if there are any scale economies, the impact is offset by increased costs resulting from diversification. Allen and Sirmans (1987) find significant and positive price effects associated with the acquiring REIT in a merger of two REITs. These gains are attributed to better asset utilization. This result supports the existence of scale economies for REITs.

In examining REITs for the presence of a small-firm effect, McIntosh, Liang and Thompkins (1991) find evidence that, after accounting for risk, small firms earn higher average rates-of-return than large firms. Based on price performance, this result suggests that scale economies may not be present. Finally, it has been shown that a positive and significant price effect exists for REITs that sell off properties (McIntosh, Ott and Liang,

1995). The same study shows an insignificant price effect associated with property acquisitions by REITs. This result shows that the market effects of sales are superior to those of acquisitions and provides additional evidence against scale economies.

The results of existing research are clearly mixed as to empirical support for the existence of scale economies. Logically, the existence and the magnitude of scale economies will differ over time. Year-to-year changes in external factors, asset values and cash flows will affect the measured operating efficiency of a REIT. Specific differences, such as the age and condition of the properties being purchased, may also affect the measurement of scale economies.

Costs and Outputs of REITS

The estimation of scale economies requires cost and output measures. For REITs, we consider two outputs, real estate assets and dividends.[2] Dividends represent the net cash flow to investors from the operation of the REIT. The value of the real estate assets reflects the capitalization of all future expected dividends and any other anticipated benefits resulting from the REIT's equity and mortgage holdings. As a REIT increases in size, its asset base increases and potentially its dividend payout increases. If the costs of asset ownership increase less than the corresponding increase in the output of assets or dividends, a scale economy exists for REITs.

The costs incurred by a REIT depend upon the asset and financing structure of the REIT and the type of management. Costs will vary with differences in geographic location and diversification. For example, because equity REITs own and manage real estate, their costs differ substantially from those of mortgage REITs. Typical expenses associated with an equity REIT include property operating costs, such as property taxes, utilities, insurance, and property management, financing costs, and REIT administration costs. Less frequently incurred costs include those associated with acquisition, disposition and renovation of properties. Mortgage REITs incur limited costs associated with direct operation of real property. Typical costs for a mortgage REIT include asset management fees, generally mortgage servicing and any costs associated with distressed loans, financing costs, and REIT administration costs. Because equity REITs incur different costs than mortgage REITs, equity REITs are expected to experience economies-of-scale differently than mortgage REITs.

Both the type of management and the degree of leverage affect the profitability and the cost levels of a REIT. REITs are managed either internally or externally. Internally managed REITs employ their own acquisition and asset management staffs. When REITs are externally managed, outside advisors perform these services. Differences in the efficiency of REITs may exist because of the type of management. For example, in recent years, the trend of REITs increasingly moving towards internal management of their assets may be motivated, in part, by the perception that self-managed REITs are more efficient. Differences in the amount and cost of debt also affect REIT expenses. For instance, larger REITs may have access to cheaper capital.

Impacts of Diversification

As a REIT expands, decisions on risk management must be made. As a REIT diversifies its asset base, it increases its operating costs. For example, market research and other costs associated with acquisition can increase drastically as a REIT expands into diverse

geographic markets. When a REIT diversifies across property types, managers are required to have a broader range of expertise. A non-diversified REIT acquiring properties of the same type or in the same market can incur lower per unit costs in comparison to a diversified REIT acquiring multiple types of properties or properties in diverse locations. An accurate assessment of scale economies must account for the costs imposed by risk reduction strategies.

The Model and the Data

The most common measure of operating efficiency in economies-of-scale studies is the elasticity of cost with respect to output. When the rate of increase in output exceeds the rate of increase in cost, scale economies characterize the industry. Thus, as firms grow, average unit costs decline. Economies-of-scale are evident when larger firms are more cost efficient than smaller firms.

The Translog Cost Model

Traditional economic theory assumes that a U-shaped average cost function exists for a firm and that a firm will make asset decisions that will move it towards the bottom of the U-shaped curve. That is, a firm will increase its size as long as marginal revenues exceed marginal costs or decrease its size as long as marginal costs exceed marginal revenues. In short, firms will continue expansion until economies-of-scale are no longer available.

In financial economics, the translog cost model is the most pervasive approach to analysis of economies-of-scale.[3] The translog cost model implicitly assumes the U-shaped average cost function. The model offers the advantages of simplicity of interpretation and familiarity due to its common use. However, like most methodologies, it has its shortcomings as well. First, in many cases, the translog cost function is a poor approximation of the true cost function when applied to firms of all sizes (McAllister and McManus, 1993). That is, the technologies and fundamental differences between small and large firms may not be captured in a single model. Also, the results can be distorted if an important factor that varies with firm size is excluded from the model.

For firms, such as REITs, with multiple outputs, scale economies can be estimated either in the aggregate or as product-specific components. In a real estate application, Zumpano and Elder (1994) use a multi-product translog cost function to examine scale economies in the real estate brokerage industry. Whereas many multi-product models treat the outputs as additive, Zumpano and Elder consider that the source of scale economies is affected by the composition of the output rather than just the size of the firm. In the case of REITs, because dividends are a flow measure and real estate assets are a stock measure, the considered outputs are not additive and cannot be aggregated to measure for scale economies.

If the costs of REITs are a function of outputs, namely total assets (A) and total dividends (D), and other factors affecting costs, the translog cost model is:[4]

$$\ln C = \beta_0 + \beta_A \ln A + \frac{1}{2}\beta_{AA}\left(\ln A\right)^2 + \beta_D \ln D + \frac{1}{2}\beta_{DD}\left(\ln D\right)^2 + \beta_{AD}\ln A \ln D + \sum_j \beta_j X_j + e, \quad (1)$$

where:

X_j = other REIT characteristics that may impact costs, namely differences in investments, management characteristics, financing differences, and diversification attributes, and

e = a random error term.

Scale economy measures representing the percentage change in input (expenses) associated with a percentage change in output (average total assets and dividends) are calculated from equation (1). The cost elasticity of each output is found by taking the partial derivative of equation (1) with respect to that output.[5] For an individual REIT, the overall scale economy estimator (SCE_O) is the reciprocal of the sum of estimated cost elasticities of the individual outputs, thus:[6]

$$SCE_O = \frac{1}{\sum\left(\delta_A + \delta_D\right)}, \tag{2}$$

where:

$$\delta_A = \partial \ln C / \partial \ln A = \beta_A + \beta_{AA} \ln A + \beta_{AD} \ln D, \tag{3}$$

and:

$$\delta_D = \partial \ln C / \partial \ln D = \beta_D + \beta_{DD} \ln D + \beta_{AD} \ln A. \tag{4}$$

For any REIT, if the overall scale economy estimator exceeds one, scale economies exist. If the scale economy estimator is less than one, scale diseconomies exist; that is, the marginal cost associated with an additional dollar of output exceeds one dollar. Finally, a result equal to one signifies constant average cost.

Two approaches are used to estimate scale economies once the parameters of equation 1 have been estimated (Noulas, Ray and Miller, 1990). They are the "average" method and the "at mean" method. The "average" method estimates the scale economy measure for each observation and averages across observations to derive the "group" scale economy measure. Thus, the average scale economy estimator, *SCE*, is the average of the individual REIT SCEs for each year's sample. The test statistic:

$$t = \frac{\sum\left(\delta_A + \delta_D\right) - 1}{\sigma / \sqrt{n-1}}, \tag{5}$$

where σ is the standard deviation of the sums of the partial elasticities for the individual sampled firms and n is the sample size, is used to test whether the average scale economy estimator is significantly different from 1. In contrast to the "average" method, the "at mean" method estimates the scale economy at the mean value of the output. This method allows for sensitivity analysis, that is, assessing the expected scale economy for different-sized REITs by evaluating equation (2) at various increments from the mean.

The Data

Data were collected for the years 1992, 1993 and 1994.[7] The original sample is composed of all REITs listed in the *National Association of Real Estate Investment Trusts (NAREIT) Handbook* for each given year. Many observations were incomplete and thus eliminated from the sample. The final sample includes 85 observations from 1992, 113 from 1993, and 146 from 1994. The data are summarized in Exhibit 1.

Cost data are from *Moody's Bank & Finance Manual.* The reported costs include total expenses, interest expense, operating expenses, general and administrative expenses, and management fees. Because the reported total expenses include depreciation, the total cost measure used in this study to estimate scale economies is calculated as the sum of the remaining categories.

Concomitant data were collected from various editions of *Moody's Bank & Finance Manual* and the *NAREIT Handbook*. These data include various diversification measures and dividends. The measures collected include asset and liability information, share data, dollar investment into various asset types, type of property management, and information on the geographic distribution of investments.

The dependent variable for the translog cost model is C, the total costs for the REIT in a given year. The two outputs are D, total dividends for a REIT for a given year, and A, the average total assets for the REIT. The average total assets are reported in the *NAREIT Handbook* on a cost basis. Thus, the measure reflects neither the current market value of the real estate assets nor a current appraised value.[8]

A set of variables are included in the model to control for factors that affect the total costs of a REIT. The debt ratio, defined as total liabilities divided by total assets, accounts for differences in financing between REITs. REITs with a higher debt ratio are expected to incur more costs. Another variable, *Mortgage %*, is the percentage of the REIT's assets invested in mortgages. The model includes two binary variables to account for the impact that managerial differences have on the total costs of REITS. The variable, *Self-Managed*, indicates whether a REIT is internally managed. The variable, *Affiliate Managed*, indicates whether a REIT is managed by a REIT affiliate. All other REITs are managed by a third party.

To account for property-type diversification differences across REITs, a variable, *Propindex*, is included in the model. *Propindex* is calculated as:

$$Propindex = \sum S_i^2, \tag{6}$$

where S_i is the proportion of a REIT's portfolio invested in property type I. This measure is the Hirschman-Herfindahl Index and has been previously used in the analysis of REITs (see Capozza and Lee, 1995).

Finally, to account for geographic differences, the state in which the REIT has the largest market exposure was identified. Four binary variables are created to reflect investment concentration in California, Florida, Texas or New England (defined as Massachusetts, Rhode Island, Connecticut, and New York). These variables reflect geographic cost differentials resulting from legal and market differences between states.

Exhibit 1
Summary of the Data

Variable	Year	Mean	Std Dev.	Min.	Max.	N
Total Costs (*C*)	1992	12,491,000	15,512,000	378,000	84,920,000	85
	1993	14,404,000	20,372,000	177,000	107,100,000	113
	1994	19,607,000	22,876,000	532,000	143,400,000	146
Total Assets (*A*)	1992	155,800,000	174,510,000	7,741,000	1,095,000,000	85
	1993	226,230,000	292,280,000	7,444,000	1,904,000,000	113
	1994	270,500,000	282,500,000	6,823,000	1,848,000,000	146
Total Dividends (*D*)	1992	7,994,000	11,602,000	0	64,889,000	85
	1993	10,392,000	15,651,000	0	83,400,000	113
	1994	16,556,000	2,967,000	0	308,644,000	146
Debtratio	1992	0.465	1.237	0.006	11.460	85
	1993	0.384	0.270	0.000	1.000	113
	1994	0.466	0.305	0.011	2.446	146
Propindex	1992	0.665	0.246	0.236	1	85
	1993	0.733	0.253	0.255	1	113
	1994	0.760	0.246	0.251	1	146
Self-Managed	1992	0.259		0	1	85
	1993	0.319		0	1	113
	1994	0.514		0	1	146
Affiliate Managed	1992	0.459		0	1	85
	1993	0.319		0	1	113
	1994	0.253		0	1	146
Mortgage %	1992	0.143	0.238	0	0.923	85
	1993	0.121	0.237	0	0.975	113
	1994	0.059	0.161	0	0.919	146
California	1992	0.294		0	1	85
	1993	0.257		0	1	113
	1994	0.281		0	1	146
Florida	1992	0.106		0	1	85
	1993	0.133		0	1	113
	1994	0.130		0	1	146
Texas	1992	0.165		0	1	85
	1993	0.106		0	1	113
	1994	0.110		0	1	146
New England	1992	0.082		0	1	85
	1993	0.080		0	1	113
	1994	0.096		0	1	146

Source: Author's calculations

Results

Equation (1) is estimated separately for the years 1992, 1993 and 1994. Also, an aggregate model is estimated using dummy variables to account for the year of the observation. For each year, the dependent variable is the natural logarithm of total costs. Results are generated for the two-asset translog cost model for the base case of no control for costs ($X_j=0$) and for additional other models that control for various factors that affect costs. The second model controls for basic cost factors and includes the variables, *Self-Managed*, *Affiliate Managed*, *Mortgage %*, and *Debtratio*. The third model adds the variable *Propindex* to control for property-type diversification. The final model, controlling for cost factors, property-type diversification and geographic concentration, adds the variables, *California*, *Florida*, *Texas*, and *New England* to the third model. Also, for comparison purposes, a single output model, based upon total assets, is estimated. This model is created by substituting zeroes in place of ln$D$, the excluded output in equation 1.

Scale economy (SCE_O) measures are obtained by using the empirical estimate of equation 1 to estimate the parameters for equation 2 (see Exhibit 2).[9] The overall scale economy estimate for each firm in the sample is calculated. From these estimates, the average scale economy estimator (SCE) and the corresponding t-statistic are calculated. For all cases except one, the calculated t-statistics show that the estimated scale economies are significant at the .99 confidence level. There is sufficient statistical evidence to conclude that, using the translog cost function, REITs exhibit economies-of-scale.

While the data unambiguously supports the existence of economies-of-scale for REITs, the estimated magnitude of the cost efficiencies is difficult to ascertain because of variability in the estimates.[10] However, several conclusions are evident:

- When the translog cost model, equation (1), includes variables that control for individual REIT factors that affect costs, the estimated scale economies generally increase.
- When additional variables are included in the translog cost model to account for differences in property-type diversification or geographic influences, there is little additional impact on the measured scale economies. However, on an individual basis, when diversification variables are included, the model identifies more individual firms that exhibit diseconomies-of-scale.
- The results for the less complex, single-output (total assets) cost model are similar to those of the two-output translog cost model.
- Economies-of-scale for REITs vary considerably over time. Estimated scale economies are largest for the 1993 sample of REITs.[11]

In all cases, the results suggest that economies-of-scale exist for the REIT industry. With one exception, when differences of cost determinants between REITs are controlled by including a set of variables describing basic cost factors, the measured scale economies are greater than those estimated without controlling for costs. This is an expected outcome. For instance, a REIT may incur higher costs because it uses outside management. However, exclusive of the type of management, the REIT may still experience economies-of-scale. Whereas the industry on average evidences scale economies, differences in leverage, management type and the degree of investment in mortgages clearly affect the level of scale economy realized by an individual REIT.

Exhibit 2
Average Scale Economy Estimates*

Basis of Scale Economy Estimate	No Control	Control for Basis Cost Factors	Control for Cost and Property-Type Diversification	Control for Cost Factors, Property-Type Diversification and Geographic Concentration
Panel 1: 1992 Sample				
Assets, only	1.0755 (0.0017)	1.0751 (0.0081)	1.0846 (0.0926)	1.1004 (0.0965)
Assets and Dividends (Overall SCE)	1.0664 (0.0883)	1.0859 (0.1188)	1.0723 (0.1253)	1.1061 (0.1369)
Panel 2: 1993 Sample				
Assets, only	1.1754 (0.0357)	1.2111 (0.1613)	1.1891 (0.0081)	1.1953 (0.0916)
Assets and Dividends (Overall SCE)	1.1511 (0.1213)	1.1958 (0.1528)	1.1795 (0.0446)	1.1874 (0.0603)
Panel 3: 1994 Sample				
Assets, only	1.1368 (0.0865)	1.1947 (0.0895)	1.1573 (0.1674)	1.1754 (0.1634)
Assets and Dividends (Overall SCE)	1.0845 (0.1247)	1.2062 (0.1057)	1.1370 (0.1801)	1.1520 (0.1766)
Panel 4: Aggregate Model				
Assets, only	1.1747 (0.0053)	1.1911 (0.0070)	1.1697 (0.1230)	1.1727 (0.1271)
Assets and Dividends (Overall SCE)	1.1761 (0.0479)	1.1893 (0.0473)	1.1679 (0.1472)	1.1726 (0.1519)

Note: *Standard deviations are in parentheses. These estimates are calculated using the average of the individual scale economy estimates for each sample. The standard deviations reflect the variability of the individual scale economy estimates for each model. All scale economy estimates are statistically different from 1 at a 1% significance level or better.
Source: Author's calculations

Extending the model to account for differences in property-type diversification and geographic concentration generally shows a slight reduction in the overall scale economy measures. With the exception of the 1992 sample, the overall scale economy measures decrease (thus the degree of scale economy decreases) when property type and geography are considered. However, in all cases, the scale economy measures are higher for those estimated without any controls for cost differentials. The results suggest that the impact of diversification on the estimated scale economies is inconsistent. However, as shown in Exhibit 3, although the differences in the "average" scale economy estimates (from

Exhibit 2) are small, there are substantial differences in the numbers of inefficient REITs identified by the model.

Comparing the scale economy measures for the less complex, total asset (single-output) model with those of the two-output model shows the similarity between the results for the two models (see Exhibit 2). This similarity implies that the "total asset" effect is the dominant determinant of the overall scale economy measure in the two-output model. With the exception of the 1994 model which does not control for costs, the estimated scale economies are reasonably close when comparing the results of the two models. Generally, the scale economy estimates from the single-output model are slightly larger than those of the two-output translog model. The practical aspect of this result is that a scale economy measure based upon a single output, that being total assets, is as effective as the one based upon the more complex two-output model.

It is readily apparent that the estimated economies-of-scale are contemporaneously unstable, implying that the cost function itself is unstable over time. Much of this instability is likely due to the nature of the data. Self-reported data often suffers from inconsistency in the reporting of various quantities. For this data, the "at mean" method of evaluating scale economies, basically sensitivity analysis, shows that economies-of-scale disappear for larger REITs in 1992 and 1994. For 1993, they are evident for REITs of all sizes.

Exhibit 4 graphically portrays the differences in estimated scale economies for the three years studied. The graphs are generated by evaluating equation 2, as estimated from the data, across the range of asset sizes.[12] As shown in Exhibits 4a, 4c and 4d (representing 1992, 1994, and the aggregate model, respectively), scale economies decrease with the size of the firm. Thus, the smaller the REIT, the greater the scale economy potential. The results seem to show, on the basis of evidence that scale economies diminish and subsequently disappear, there is an optimal size for REIT cost efficiency. The 1992 and 1994 models show that scale economies disappear at an asset size slightly above the sample average. In contrast, the results for the 1993 sample imply there is no limit to REIT asset expansion beyond which REITs become inefficient.

There are several explanations for the contemporaneous instability of the results. First, as noted in Exhibit 1, the average REIT size is increasing over time. The increase in asset size can be attributed to acquisitions, mergers and newly formed REITs that are larger in size than those observed in a previous year.[13] It is likely that the cost function is unstable over time, especially in light of an increasing asset base. Any cost efficiencies that result from increases in scale may not be observable immediately after an expansion in size. It may take several years for the cost function to stabilize and for any efficiencies to become more apparent.

Conclusions

This study investigates economies-of-scale in REITs. The question of the existence of economies-of-scale, that is, whether REITs can benefit from being larger, is important to REIT managers, analysts and investors. Improving the efficiency of operations is one way to improve the performance of REITs. The results show that: 1) economies-of-scale exist for REITs, 2) measured economies-of-scale differ chronologically, and 3) measuring overall economies-of-scale with the simpler, single-output (total assets) model produces results similar to those of the more complex, two-output (total assets and dividends) model.

The results suggest that there may be an optimal size for REITs. This optimal size

Exhibit 3
Percentage (Number) of Sample Firms Exhibiting Scale Economy Estimates*

Basis of Scale Economy Estimate	No Control	Control for Basis Cost Factors	Control for Cost and Property-Type Diversification	Control for Cost Factors, Property-Type Diversification and Geographic Concentration
Panel 1: 1992 Sample				
Assets, only	100% (84)	100% (84)	78.6% (66)	79.8% (67)
Assets and Dividends (Overall SCE)	88.1% (74)	88.1% (74)	71.4% (60)	86.9% (73)
Panel 2: 1993 Sample				
Assets, only	100% (113)	90.4% (102)	100% (113)	100% (113)
Assets and Dividends (Overall SCE)	84.3% (95)	89.6% (101)	100% (113)	100% (113)
Panel 3: 1994 Sample				
Assets, only	96.6% (141)	98.6% (144)	74.7% (109)	80.8% (118)
Assets and Dividends (Overall SCE)	69.9% (102)	97.3% (142)	68.5% (100)	72.7% (106)
Panel 4: Aggregate Model				
Assets, only	100% (344)	100% (344)	84.9% (292)	84.3% (290)
Assets and Dividends (Overall SCE)	99.7% (343)	100% (344)	80.2% (276)	79.4% (293)

*as estimated from the model
Source: Author's calculations

cannot be delineated because it depends on the characteristics of the individual REIT and varies over time. The implication of diseconomies-of-scale is that oversized REITs can become more efficient by downsizing. This, of course, can be accomplished by spinning off assets. Another option to increase efficiency would be to segment the assets into subgroups that are efficient.

This research is introductory in nature and leaves many unanswered questions. Future research in this area can address the specifics of the cost function for REITs, the specific determinants of scale economies, the impact of the ownership structure of the REIT on the operating efficiency, the impact of management on REIT operating efficiency, and an introspective analysis on the trade-offs between diversification and operating efficiency.

Exhibit 4
Economies-of-Scale for REITs

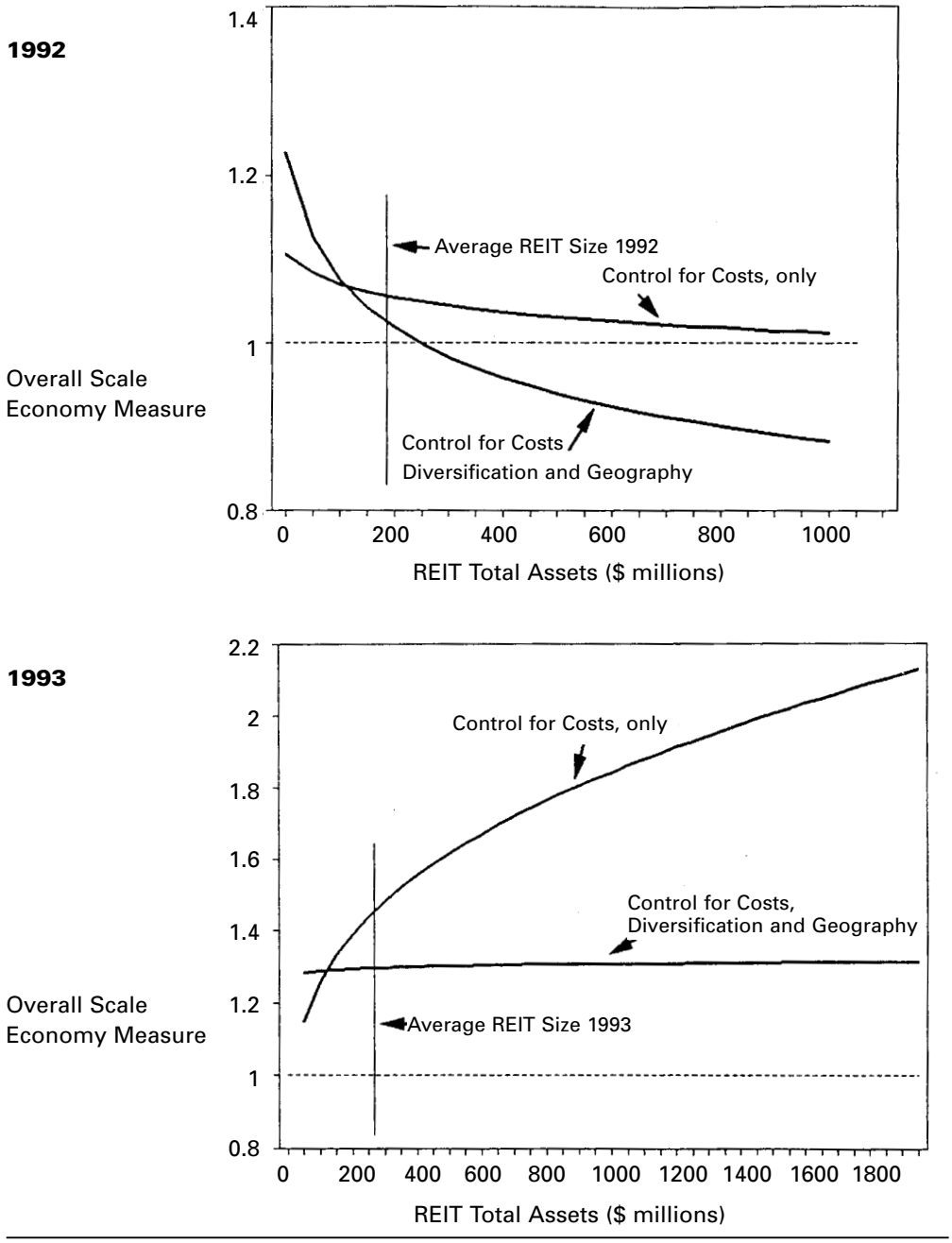
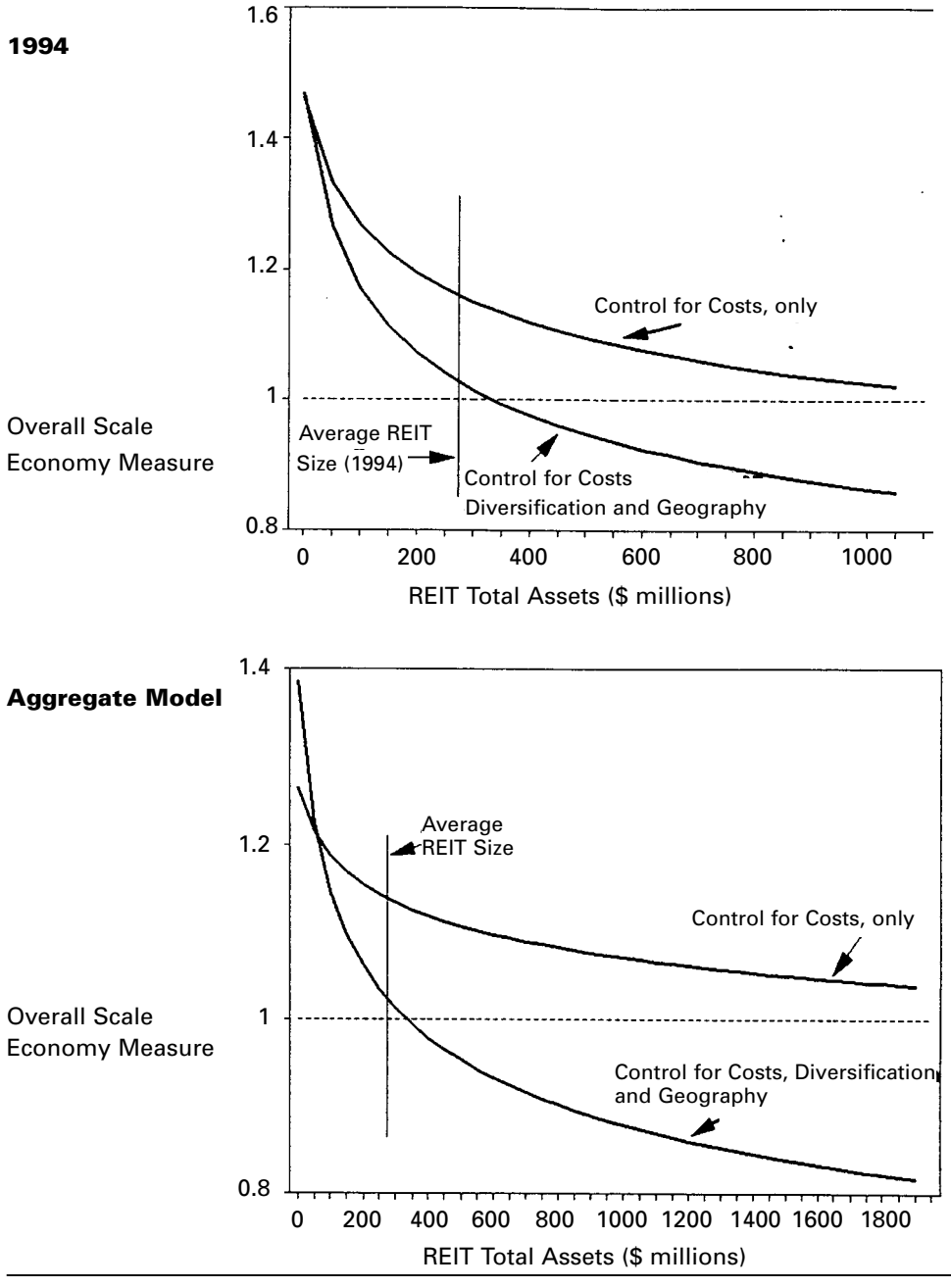


Exhibit 4
Economies-of-Scale for REITs (continued)



Note: These graphs display the overall scale economy measures for each year sampled. Economies-of-scale are present when the scale economy measure exceeds 1.
Source: Author's calculations

Appendix
Estimates of the Cost Elasticities (First Derivative) for Equation 1 (Single-Asset and the Multiple-Output Models)

		(2) Asset and Dividend Model	
	(1) Asset Model	A. Cost Elasticity for Assets	B. Cost Elasticity for Dividends
1992 REIT Data			
No Control for Costs	$0.9582 - 0.0016 \ln A$	$0.5254 + 0.0318 \ln A - 0.0092 \ln D$	$0.2293 - 0.0081 \ln A - 0.0092 \ln D$
Control for Costs	$0.8520 - 0.0052 \ln A$	$0.4453 + 0.0333 \ln A - 0.0055 \ln D$	$0.1287 - 0.0047 \ln A - 0.0055 \ln D$
Control for Costs and Diversification	$-0.8543 + 0.0978 \ln A$	$-1.0857 + 0.1196 \ln A - 0.0116 \ln D$	$0.2099 - 0.0002 \ln A - 0.0116 \ln D$
Control for Costs, Diversification and State	$-0.7831 + 0.0967 \ln A$	$-1.0534 + 0.1193 \ln A - 0.0144 \ln D$	$0.2537 - 0.0009 \ln A - 0.0144 \ln D$
1993 REIT Data			
No Control for Costs	$1.3691 - 0.0298 \ln A$	$0.4555 + 0.0335 \ln A - 0.0134 \ln D$	$0.2864 - 0.0084 \ln D - 0.0134 \ln A$
Control for Costs	$3.2961 - 0.1346 \ln A$	$2.7769 - 0.0973 \ln A - 0.0121 \ln D$	$0.1785 + 0.0031 \ln D - 0.0121 \ln A$
Control for Costs and Diversification	$0.9313 - 0.0068 \ln A$	$0.6167 + 0.0189 \ln A - 0.0122 \ln D$	$0.1770 + 0.0042 \ln D - 0.0122 \ln A$
Control for Costs, Diversification and State	$1.1050 - 0.0163 \ln A$	$0.8069 + 0.0101 \ln A - 0.0153 \ln D$	$0.2286 + 0.0051 \ln D - 0.0153 \ln A$
1994 REIT Data			
No Control for Costs	$-0.5145 + 0.0740 \ln A$	$-1.1127 + 0.1102 \ln A + 0.0046 \ln D$	$-0.0175 - 0.0128 \ln D + 0.0046 \ln A$
Control for Costs	$-0.5384 + 0.0726 \ln A$	$-0.9119 + 0.0975 \ln A + 0.0020 \ln D$	$-0.0244 - 0.0048 \ln D - 0.0020 \ln A$
Control for Costs and Diversification	$-1.7565 + 0.1386 \ln A$	$-2.0413 + 0.1542 \ln A + 0.0051 \ln D$	$-0.0635 - 0.0080 \ln D + 0.0051 \ln A$
Control for Costs, Diversification and State	$-1.6948 + 0.1346 \ln A$	$-2.0116 + 0.1527 \ln A + 0.0040 \ln D$	$-0.0470 - 0.0064 \ln D + 0.0040 \ln A$
Aggregate Model			
No Control for Costs	$0.77933 + 0.0045 \ln A$	$0.0128 + 0.0545 \ln A - 0.0048 \ln D$	$0.1413 - 0.0099 \ln D - 0.0048 \ln A$
Control for Costs	$0.74075 + 0.0060 \ln A$	$0.0390 + 0.0507 \ln A - 0.0033 \ln D$	$0.0952 - 0.0079 \ln D - 0.0033 \ln A$
Control for Costs and Diversification	$-1.1007 + 0.1056 \ln A$	$-1.5512 + 0.1360 \ln A - 0.0033 \ln D$	$0.0864 - 0.0064 \ln D - 0.0033 \ln A$
Control for Costs, Diversification and State	$-1.1677 + 0.1091 \ln A$	$-1.6367 + 0.1409 \ln A - 0.0036 \ln D$	$0.0962 - 0.0068 \ln D - 0.0036 \ln A$

Source: Authors' calculations

Finally, it would be worthwhile to explore data aggregation techniques to estimate scale economies while controlling for time-varying differences.

Notes

[1]Of 201 REITs reporting, 169 are classified as equity REITs. Out of total REIT assets, measured by their market capitalization, 88% are held by equity REITs (NAREIT, 1996).

[2]For the determination of outputs, we considered the output to the owners of the REIT, rather than the outputs of the real estate itself (namely space). In studies of economies-of-scales for financial institutions, total assets or specific assets are often used as outputs. Dividends, as a flow measure, are a viable measure of output; however, as noted by a helpful reviewer, because of variation in dividend payout, a payout ratio may be a better measure of output for the determination of efficiency. Later in this study, it is shown that using dividends as an output measure contributes little to the measurement of scale economies. In the context of the present work, we choose to not pursue the adequacy of alternative dividend measures.

[3]See Berger, Hunter and Timme (1993) for a review of the literature on the efficiency of financial institutions.

[4]The translog cost model also includes input prices. We do not have this type of information and thus omit input prices. This omission is not uncommon to the study of economies-of-scale.

[5]The partial derivatives are called partial scale economies (Noulas et al., 1990); however, as Akhigbe and McNulty (1996) point out, these partial scale economies do not indicate whether economies-of-scale exist for the chosen output. See Akhigbe and McNulty (1996) for information on economies-of-scale measurement issues.

[6]For most studies, the overall scale economy measure is measured as the sum of the estimated cost elasticities. We follow Zumpano and Elder (1994) and use the reciprocal of the typical measure. As we use it, the scale economy measure is more readily interpretable, but direct assessments of the scale economies (% decrease in average costs as assets increase) are not possible. However, given the instability of the results shown later in this study, the loss of the direct assessment of the magnitude of the scale economies is not detrimental.

[7]For the purposes of this study, an extension of the data to 1996 was not feasible because of changes to the format of the NAREIT Handbook. The new format was incompatible to that of the previous three years.

[8]The data allowed two choices for the measurement of this output. Because REITs do not reappraise their properties, total assets, as reported by the REITs, are a book value. The amount of accumulated depreciation on the assets, a function of how long the asset has been held and the size of the individual asset, affects the viability of total assets as a measure of asset value. This effect is offset somewhat by the rapid pace of acquisitions during the study period. The alternative to average total assets is the market capitalization of the REIT, namely the price per share multiplied by the number of shares. Models were run using market capitalization. The results were highly variable and less stable than those using average total assets.

[9]The estimated equations for the first derivative of equation 1 are reported in the Appendix. The coefficients estimated from the model (eq. 1) are not reported. Equation 1 is only necessary for the estimation of the scale economy estimators (SCEs). When equation 1 is differentiated to arrive at the SCE, the coefficients not associated with the outputs fall out of the model.

[10]The impact of outliers was checked by deleting the smallest and largest observations and comparing the results for the remaining sample with that of the full sample. While removal of the outliers changed the magnitudes of the scale economy estimates, there was no substantial impact on the conclusions of the study. In a subsequent study, Anderson, Springer, Fok, and Webb (1998) decompose the sample into smaller (less than median-size) and larger REITs. Their results show that smaller REITs, when compared to larger REITs, are less efficient overall and less scale efficient. However, input utilization, rather than scale, is the larger source of operating inefficiency.

[11]This instability between scale economy measures over time can be interpreted as additional support for the conclusion that the translog model is not the best model for REIT costs. Also, as a reviewer points out, the rapid pace of acquisitions over the study period contributes to the instability of the results. It is possible that accounting for a potential lag effect in the data could stabilize the results.

[12]Exhibit 4 graphs the scale economy function (see the Appendix) as total assets vary and with total dividends held constant at the mean. Because the dividends are held constant, the figures are poor representations of actual REIT characteristics. However, as long as the numerical estimates are not relied upon, the figures fairly portray the fundamental relationships estimated by the translog cost model.

[13]NAREIT (through a personal communication) reports that the number of REIT IPOs peaked in 1993.

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