EPRA RESEARCH
European Public Real Estate Association

# ASSESSING SIZE EFFECTS AND ECONOMIES OF SCALE IN EUROPEAN REAL ESTATE COMPANIES

## Research Paper Summary

### 1. Why is this an area of interest to EPRA members?

If larger firms are able to achieve substantial economies of scale then this should flow through to returns and provides a justification for M&A activity in the sector.

### 2. What was the focus of your research?

The research used data on listed real estate companies to analyse the impact of scale and robustness of any effects by examining the potential causes of scale effects.

### 3. Describe key conclusions for market practitioners

The research finds economies of scale exist for European real estate companies - larger companies have lower costs and higher profitability. However, the benefits of increasing scale are greater for small companies than larger companies. Furthermore, there appears to be no evidence that M&A activity in and of itself leads to efficiencies from scale suggesting that the benefits of economies of scale with size come from internal growth.

## Research summary

This research investigates scale economies in listed European real estate companies. As such it is likely to be most of interest to those managing listed real estate companies and those investing in listed real estate companies but the issues raised in the paper are also likely to be of interest to those operating in private real estate markets.

The expectation is that costs should fall as firms grow as they can share fixed costs over more assets and have access to more sources of capital lowering the cost of capital. The study examines 236 European (both in listing and where investing) real estate companies over the period 2001 to 2015. The research examines size effects on revenue, expense, profitability and capital costs and finds that larger real estate companies are more profitable as a result of being able to operate with lower costs. Our finding of economies of scale is robust to the choice of analytical approach used in measurement. Both methods of analysis suggest that the marginal effect of increasing scale is greater for smaller firms than larger firms – for small firms getting bigger makes a substantial difference to costs and profitability whilst the impact of getting bigger on a larger firm is more modest. Pre- and post- merger analysis shows no evidence of synergies or efficiencies feeding through to lower costs or higher returns. Merged firms have significantly lower returns and higher costs of debt relative to industry averages compared with the pre-merger period. Thus, it appears that costs and loss of focus (increased diversification) from buying other companies typically outweigh the potential benefits.

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# Assessing Size Effects and Economies of Scale in European Real Estate Companies

## Content table




**Nick Mansley**
**Brent Ambrose**
**Franz Fuerst**
**Zilong Wang**






Nick Mansley, Executive Director, Real Estate Research Centre (RERC), University of Cambridge
Professor Brent Ambrose, Smeal Professor of Real Estate, Pennsylvania State University
Dr Franz Fuerst, Reader in Real Estate Finance, RERC, Department of Land Economy, University of Cambridge
Dr Zilong Wang, RERC, Department of Land Economy, University of Cambridge


**Contact**


Nick Mansley,
nm558@cam.ac.uk

Ali Zaidi, EPRA Indices & Research Director:
a.zaidi@epra.com


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# Assessing Size Effects and Economies of Scale in European Real Estate Companies

## Abstract

This study investigates scale economies in European real estate companies. We examine the size effects on revenue, expense, profitability and capital costs by panel regression, we find that larger real estate companies are more profitable and have lower costs. Further evidence from stochastic frontier analysis suggests that economies of scale exist. Both methods of analysis suggest that these economies of scale are greater for smaller firms than larger firms. However, pre- and post- merger analysis shows no evidence of synergies. Merged firms have significantly lower returns and higher costs of debt relative to industry averages compared with the pre-merger period.

## Introduction

As with many other industries there is an expectation that average costs for real estate companies should fall with size. The classic "economies of scale" argument is that as firms grow the incremental cost of management of additional properties should fall (Ambrose, Highfield, & Linneman, 2005; Kim, 1986). This argument arises from the observation that there are fixed elements of cost that can be shared across properties, as well as increased bargaining power of being a bigger agent in a fragmented market. In addition, larger property companies could also have access to better debt terms and a lower cost of capital, as they have access to more finance sources (Barclay & Smith, 1995; Titman & Wessels, 1988). In the narrow sense "economies of scale" assume production or organisation of operations is optimised at any scale and hence the "economies of scale" come predominantly from efficiencies as volumes (or values) increase.

Many studies that have looked at "economies of scale" in manufacturing (Pratten, 1965, Silbertson 1972) and the service sector (e.g. retailing (Drucker, 1975), financial services (Building Societies - Drake and Simper, 2001; Banking – Altunbas and Molyneux, 1993) as well as studies specifically focusing on real estate companies (Ambrose et al, 2000 and 2005). Most of these studies have found scale effects but also highlighted some of the measurement and identification challenges.

Real estate companies with larger property portfolios should demonstrate efficiencies. As firms grow and add properties, costs will not rise in line with the increase in assets under management. If true, then larger real estate companies should exhibit higher returns providing a rationale for mergers and acquisitions. However, isolating the effects of scale is challenging, as it is necessary to control for a variety of characteristics. Inevitably, it is not possible to incorporate all the many factors that may drive differences in expenses across companies (e.g. older properties may incur more expenditure, distance between management and their property portfolios may lead to inefficiencies or lower returns, companies differ in the extent to which development activities are part of their business model and in the extent that operational management is resourced internally, externally or in joint ventures etc.) However, this study takes a systematic approach to the estimation of the effect of scale by taking into account country, sector and other potential drivers of differences across firms (to the extent that data is available).

Whilst there are strong arguments that scale should offer benefits in terms of spreading of costs and improved access to capital/cheaper financing, counter arguments suggest that as firms get bigger they may experience diseconomies of scale. For example, they may face upward pressure on labour costs as companies grow – a large company effect – reflecting peer benchmarking, the challenges of recruiting into larger firms where it may be harder to identify personal contributions. They may find specialist resources spread too thinly – leading to poorer decision-making etc. Larger companies also find additional resources are required to co-ordinate activities with the costs associated with them. Larger companies may find they are "conflicted out" of operating in certain markets. Finally, larger companies may find it hard to maintain the same passion, drive and incentivisation that smaller organisations can achieve. Consequently, whilst in some areas we expect to find that scale brings efficiency savings it is far from clear that there will be a strong relationship between size and performance.

This report briefly summarises some of the previous research on economies of scale and the issues arising from it. It then considers European real estate companies specifically using a benchmark panel estimation. We then perform stochastic frontier analysis and pre and post-merger analysis as robustness checks.

## Literature Review

The limitations of the size of the REIT/real estate company universe mean that early studies based on the 1970s and 1980s struggled to find any meaningful economies of scale. However, this is not uncommon fact or limited to real estate firms. As Ambrose, Highfield, and Linneman (2000) point out, the ability to econometrically measure economies of scale often eludes the technology and data at hand. Indeed early studies of US REITs suggested there may be a "small firm effect" in REITs, with smaller REITs earning

higher average returns than large firms (Willard & Youguo, 1991) in contradiction of the economies of scale argument. Yet, numerous examples from a variety of industries dating back to the industrial revolutions in the United Kingdom and the United States demonstrate the potential for efficiency to increase in production and operations as firm size grows. Ambrose, Highfield, and Linneman (2000) give examples of economies of scale arising through industry consolidation and firm size in industries such as railroads, airlines, cement, steel, brewing, and oil and gas exploration. The growth in the real estate industry in the 1990s and 2000s points to a similar rise in the scale of real estate companies.

Economies of scale can arise from a variety of factors. First, and probably foremost, scale economies exist in firm costs of capital. For example, larger firms often issue equity and debt in greater amounts leading to lower underwriting spreads (Hansen and Torregrosa, 1992) and theoretical work links increased REIT liquidity with lower required rates of return and thus higher firm values (Goodman, 1999). However, finding scale economies with respect to capital costs is not new. Studies dating back to the 1960s document that larger firms have lower costs of raising new capital (Archer and Faerber, 1966). Thus, it should be no surprise that larger real estate firms command greater economies of scale with respect to capital raising costs.

Second, scale economies are associated with greater operating efficiency and profitability. Although larger firms may have an advantage in raising capital, this advantage will dissipate unless they generate greater operating efficiency. In support of the role of operating efficiencies, studies have shown that economies of scale in operations often result from horizontal consolidation within industries (Eckbo, 1992) implying that size leads to lower operation costs. In the real estate industry, Ambrose, et al (2000) report that large REITs have higher net operating income (NOI) growth than average size REITs. In addition, Bers and Springer (1998) and Capozza and Seguin (1998) report evidence consistent with scale economies existing in REIT general and administrative (G&A) costs. For example, Capozza and Seguin (1998) note that REITs with increases in property-level G&A expenses have lower returns, suggesting the market penalizes firms without sufficient scale economies. Ambrose, Highfield and Linneman (2005) also report evidence supporting a link between firm profitability and firm size. Additionally, they identified that large REITs are able to increase growth prospects while succeeding at lowering costs. Their evidence from the stochastic frontier analysis points to further efficiency gains from continued growth and consolidation in REITs.

One of the problems with identifying economies of scale in empirical studies is that the econometric techniques and data are often not sufficient to uncover the effect (Ambrose, Highfield, and Linneman, 2000). For example, Ambrose et al (2000) report that their observed link between NOI growth and firm size is weak. Furthermore, Capozza and Seguin (1999) find results that are inconsistent with scale economies in G&A expenses, in contradiction to their earlier study (Capozza and Seguin, 1998). Although previous research seems to imply that economies of scale exist with respect to capital costs, Bers and Springer (1998) find small diseconomies of scale with interest expense. Yet, in contrast, Capozza and Seguin (1999) report a weak negative relation between interest expense and firm size. Thus, the question of the existence of economies of scale remains an important question.

Research from later in the 1990s and early 2000s using data from the 1990s such as Bers and Springer (1997), Capozza and Seguin (1998) and Ambrose and Linneman (2001) found evidence of scale economies. These studies made the distinction between economies of scale in expenses and the impact of size on capital costs and scale effects on earnings growth potential. In terms of the various expense items (general and administrative (G&A), interest costs, management fees, other operating expenses), economies of scale are more evident in smaller expense items and so these studies concluded that the gains from economies of scale were modest. Indeed Yang (2001), suggested that the non-linear nature of economies of scale suggested that there may be diseconomies of scale for larger real estate companies. However, Ambrose, Highfield and Linneman (2005) found evidence to support a link between firm profitability and firm size. Additionally, they identified that large REITs are increasing growth prospects while succeeding at lowering costs. Their evidence from the stochastic frontier analysis points to further efficiency gains from continued growth and consolidation in REITs. However, Miller, Clauritie and Springer (2006) looking over similar time periods found little evidence of scale economies in REITs.

Whilst differences in costs can be observed across companies, what is of course not known is whether each firm is as efficient as it can be and hence any cost function derived for the industry could potentially be biased by these inefficiencies – as summarized in Anderson, Lewis, and Springer (2000). Any estimate

of inefficiency faces the challenges of recognising the heterogeneity of businesses and underlying real estate – avoiding mistaking inefficiency for operating in a market where more inputs are required for the same level of revenue. If some companies (REITs) are sufficiently large to influence (output) prices, neoclassical theory predicts that they will set prices above marginal cost to maximise profits. However, empirical tests of this hypothesis are inconclusive. For example, Ambrose et al (2000) find limited ability for REITs to influence rents.

As REITs and companies merge, the costs of subsequent integration normally occur in the first year or so, while efficiencies are realized largely subsequently. Campbell, Ghosh and Sirmans, 2001 examined REIT mergers in the mid-1990s and found this pattern of target returns positive whilst acquirer returns are slightly negative. They highlighted that whilst there may be scale economies geographical diversification arising from mergers can dissipate some of these benefits. This impact of distance from assets has recently been researched by Eichholtz, Holtermans and Yonder (2015) again in a US context where they found that, particularly for lower quality office property, proximity matters with higher effective rents/occupancy rates achieved by investors close to their occupiers. Furthermore, real estate is a capital intensive business and previous research in the US has highlighted that larger firms are able to benefit from capital cost savings as highlighted by Linneman (1997) as a motivation for consolidation in the industry.

The issues of how to estimate and distinguish economies of scale have been a subject of debate both with respect to real estate and in other industries. The banking industry for example has seen numerous studies of costs and profitability functions and their functional form. Berger and Mester note that a translog form is popular and other more flexible forms may provide better fits to the data (as one would expect). The implication is that a linear form is likely to be overly restrictive.

As previous studies have noted, there are issues in terms of what is used to measure scale – output, revenue, floorspace and total assets are all possibilities. The measurement of real estate services output by statistical authorities is derived as revenue less inputs from other industries and services Allcoat (2014). This captures the revenue impact of higher value property (requiring more capital) and a broader service offer (requiring more labour and possibly more capital). Total assets or the value of real estate is another potential measure of scale. Valuation based measures across Europe make this method possible in a way it is less so in the US where assets are more commonly just recorded at book value. The amount of space available for lease can also be seen as having relevance to scale economies but has the drawback of not adjusting for quality (location, building quality, height etc.) even if adjusting for sector. Our analysis follows previous work - Altinkhe and Hansen, 2001 and Ambrose et al, 2005 - in estimating the effect of firm size across multiple dimensions of revenue, cost and profitability factors.

In reviewing private real estate managers and mandates there is evidence that costs fall with size. Put simply the average cost of a large real estate mandate e.g. £4bn is likely to be significantly below that for a £200m mandate. Estimated fees for the former are c30bps p.a. whilst the median fee for a £200m mandate was 70bps (LCP Investment Management Fees Survey, 2015)

In a study of private real estate funds, Krautz and Fuerst, 2015 examined the relationship between size and success, noting market concentration in real estate funds is “above average relative to the finance industry and comparable to industries that require extensive capital investments in large-scale machinery, equipment, and technology”. Previous research indicates that performance is typically not sustained and in many cases the performance of previous funds is not clearly established. It is therefore believed that size, in accordance with signalling theory, is taken as a proxy for reputation and the ability to manage large pools of capital. In addition given the more developed networks that larger managers have this enables larger managers to raise capital more successfully. This study did not find evidence that larger managers were able to turn this capital raising advantage into out-performance.

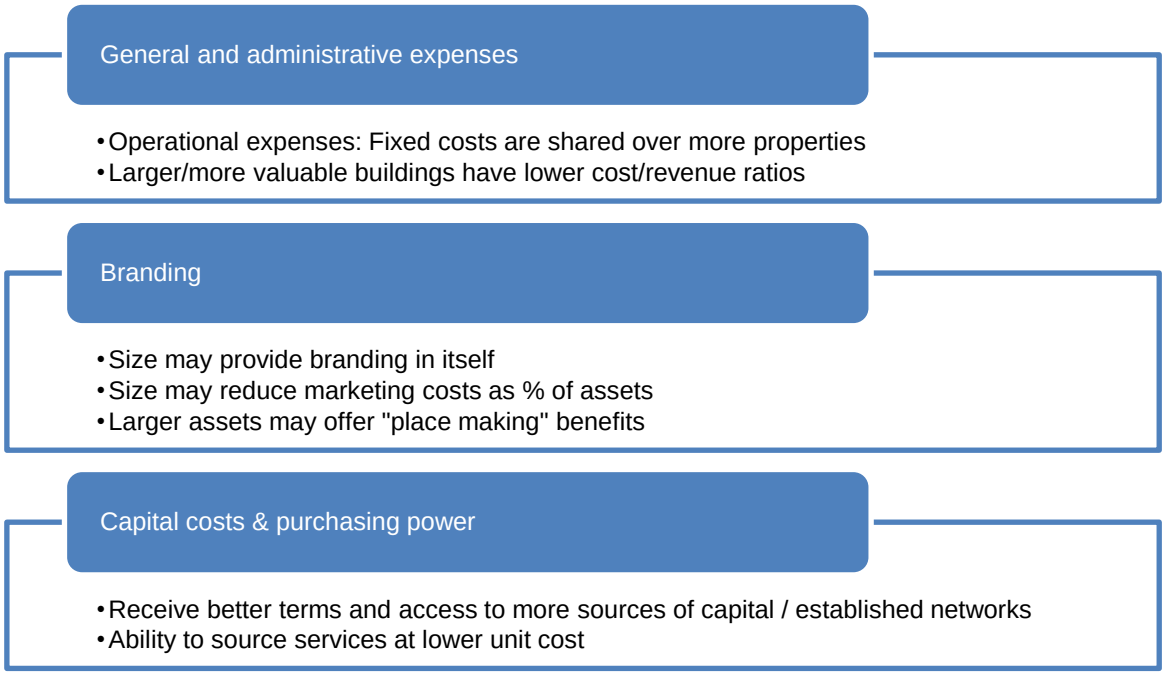
Whilst there is some disagreement, studies of US REITs have generally indicated the following:

- G&A expenses / revenue fall for larger firms – consistent with operational efficiencies from scale.

- Rental revenue as % of sales is not affected by size – there is little evidence of fundamentally different business models by size.
- NOI/revenue increases as firms grow (FFO growth, total debt and property focus also important) but at slowing rate – reflecting that operational efficiency feeds through to net income.
- Lower cap rates on larger firms – increased valuation of larger firms.
- Larger firms have higher payout ratios (lower leverage firms also)
- ROE is higher for larger firms – profitability increases with size
- Larger firms have lower WACC and lower systematic risk

There has not been a recent study of European real estate companies to establish the extent to which these findings apply in a European context. Figure 1 shows an overview of potential size factors as reported in the literature. These factors can be grouped into the three areas general and administrative expenses, branding and cost of capital and purchasing power factors.

**Figure 1: Summary of factors relating real estate company size to cost & performance**




The benefits of scale are likely to be reflected in greater operational efficiency (lower expense ratios), lower financing costs or an ability to drive higher revenue growth.

## Data and Methodology

This study focuses on European real estate companies and investigates the following questions:

- The impact of firm size on expense
- The impact of firm size on capital cost
- The impact of firm size on revenue
- The impact of firm size on return
- Do economies of scales exist in European real estate companies
- How does firm perform after merger and acquisition

We restrict our sample to European real estate companies with financial data available from the SNL REIT database and employ several selection criteria to capture companies with similar business models. First, we exclude housebuilders, hotel groups and debt investment companies since their business model is

different from investor companies. Secondly, we exclude companies based in Europe that invest primarily in markets outside the European Economic Area (e.g. investing in Russia, Turkey and India etc.). Lastly, we exclude new start-up companies or companies that had their IPO during 2015/2016 creating a sample of 236 real estate companies/ REITs across Europe over the period 2001 to 2015.

Previous studies on economies of scale assume firms produce homogenous products and the output is identifiable and quantifiable. In the case of REITs or real estate companies, firms invest in real estate and generate income and profits through the leasing of space. However, real estate is not homogenous and the diversity of activity across sectors and markets combined with a lack of comprehensive data on underlying portfolios makes comparison by volume of space owned or leased problematic. Thus, we employ three proxies for output: total enterprise value, total assets and total revenue.

In order to study the size effect of REITs and economies of scale we employ panel regression analysis, the choice of fixed or random effect[1] is guided by the Hausman test. The summary statistics for our variables of interest are shown in Table 1.

Table 1: Summary Statistics

| Variable | Mean | SD | N |
|---|---|---|---|
| Log(EV) | 6.67 | 1.51 | 2150 |
| Log(Asset) | 13.70 | 1.48 | 2236 |
| Log(Revenue) | 11.61 | 1.59 | 1826 |
| ROAE (%) | 6.05 | 14.28 | 1888 |
| ROAA (%) | 2.55 | 7.31 | 1976 |
| NOI/Market Cap (%) | 9.55 | 29.07 | 1859 |
| NOI/Revenue (%) | 29.99 | 25.51 | 1747 |
| Rental Revenue/Revenue (%) | 49.14 | 26.61 | 1631 |
| SG&A Expenses/Total Asset (%) | 1.74 | 2.28 | 2220 |
| SG&A Expenses/Rental Revenue (%) | 41.65 | 76.24 | 1831 |
| Total Debt/ Total Cap (%) | 50.51 | 21.28 | 1849 |
| ST Debt/ Debt (%) | 18.51 | 24.35 | 1839 |
| Asset Growth (%) | 16.55 | 58.99 | 1716 |
| Interest Expense/Asset (%) | 4.47 | 2.42 | 1934 |
| WAIR (%) | 4.41 | 1.24 | 1423 |
| WACC (%) | 4.12 | 1.88 | 1766 |
| Total Cost / Asset (%) | 5.04 | 2.75 | 1801 |
| MABidder (Binary) | 0.08 | 0.27 | 2236 |

Note: The sample contains 236 firms and 2236 firm year observations between 2001 and 2015. See Appendix A for variable definitions.

Property investments across time, sectors and countries differ in terms of their historic development, lease structures, services offer and regulations. We control the regressions with year, sector and country dummies. The distribution of our sample across time is shown in Figure 2, most of our sample is between 2006 and 2015. Our sample consists of companies based in 17 European countries with the UK comprising around 40% of observations. Figures 3 and 4 show the distribution of our sample across countries and property type, respectively. We note that most of the European REITs or real estate companies are diversified across property type, unlike in United States where there are a substantial number of companies who are focused on one property type. We further control for leverage and growth. Growth is captured by asset growth rate, whereas leverage is captured by total debt as a percentage of total capitalization and short-term debt as a percentage of total debt. The real estate industry is not static as merger and acquisition (M&A) activities occur over time. Firms could acquire assets or other real estate companies to achieve economies of scale. We control for acquiring activity by a dummy variable which

[1] Ordinary Least Square (OLS) is ruled out since it cannot deal with unobserved heterogeneity.

equals to 1 if the company is a bidder for (i.e. purchaser of) shares of other real estate companies (including private companies). Figure 5 shows the distribution of the 170 acquisition cases across time.

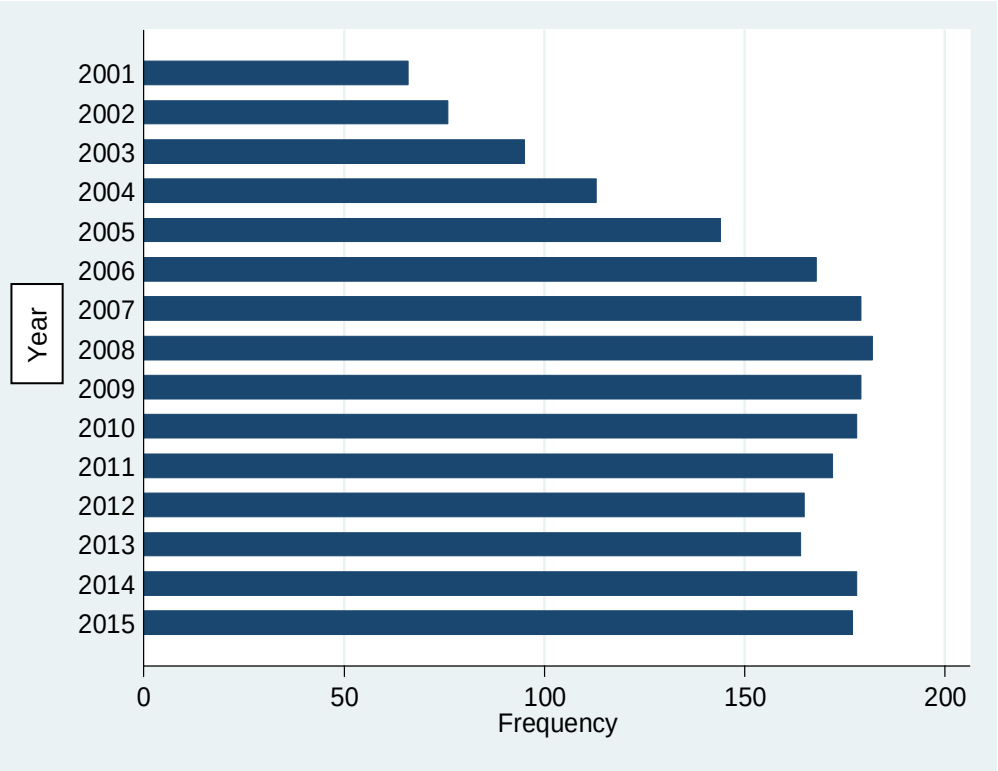



**Figure 2: Sample distribution of companies across time**

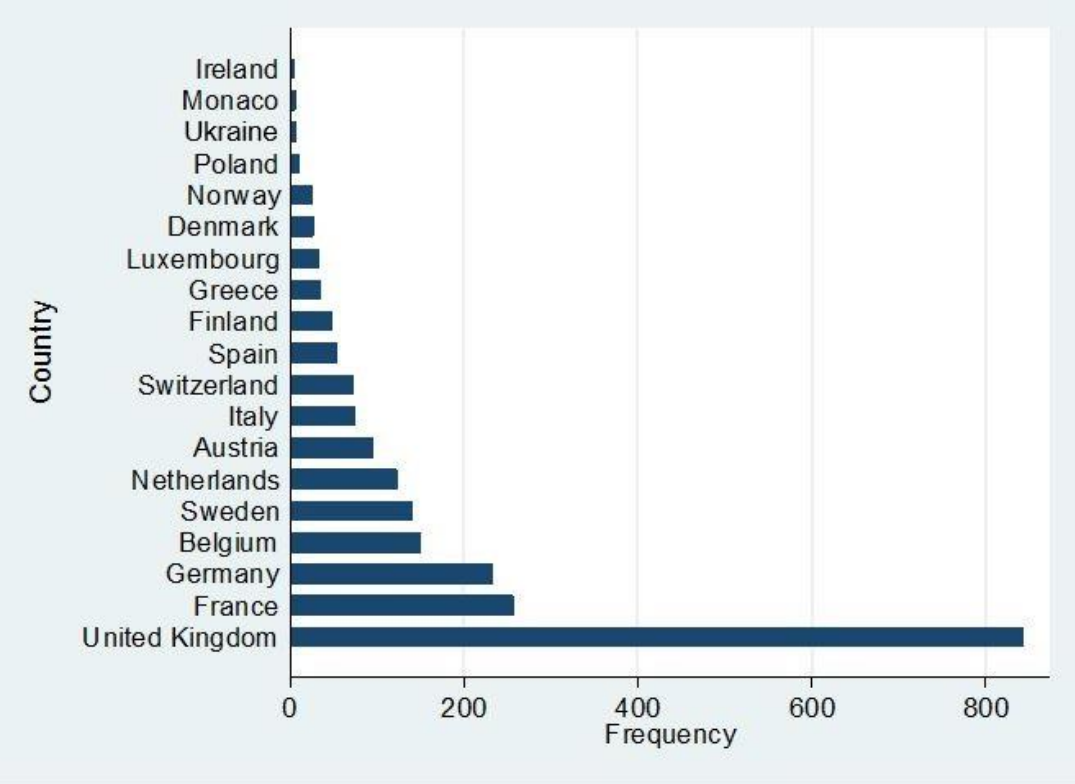



**Figure 3: Sample distribution of company years by country**

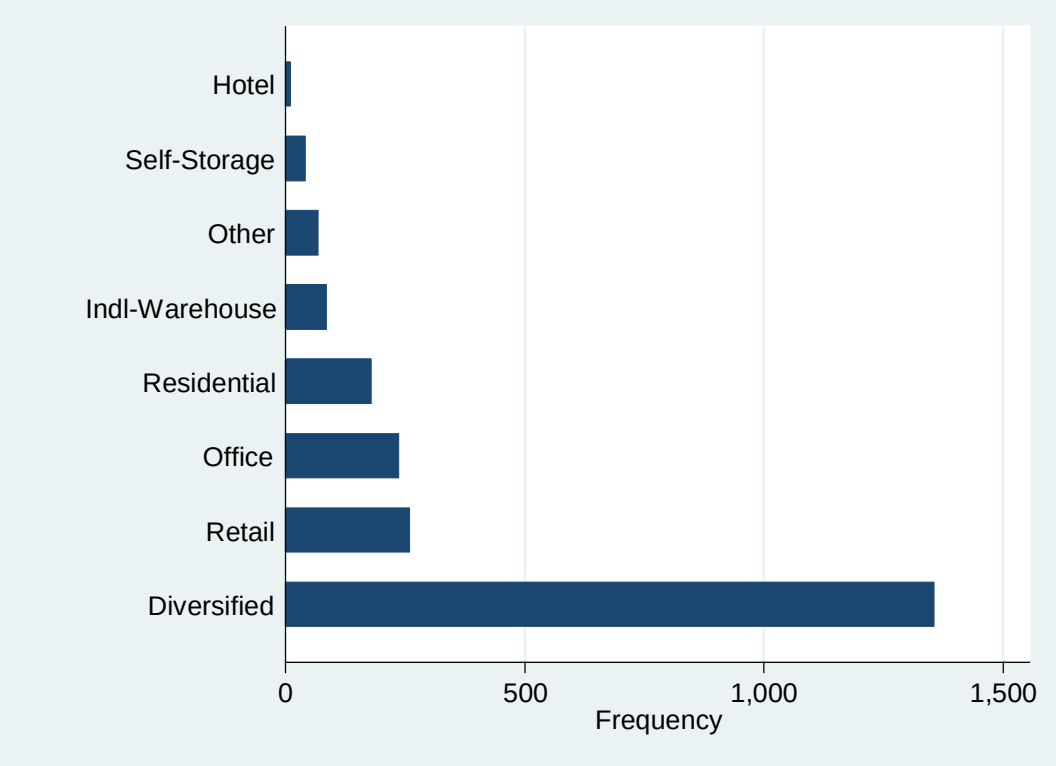



**Figure 4: Sample distribution across sectors**

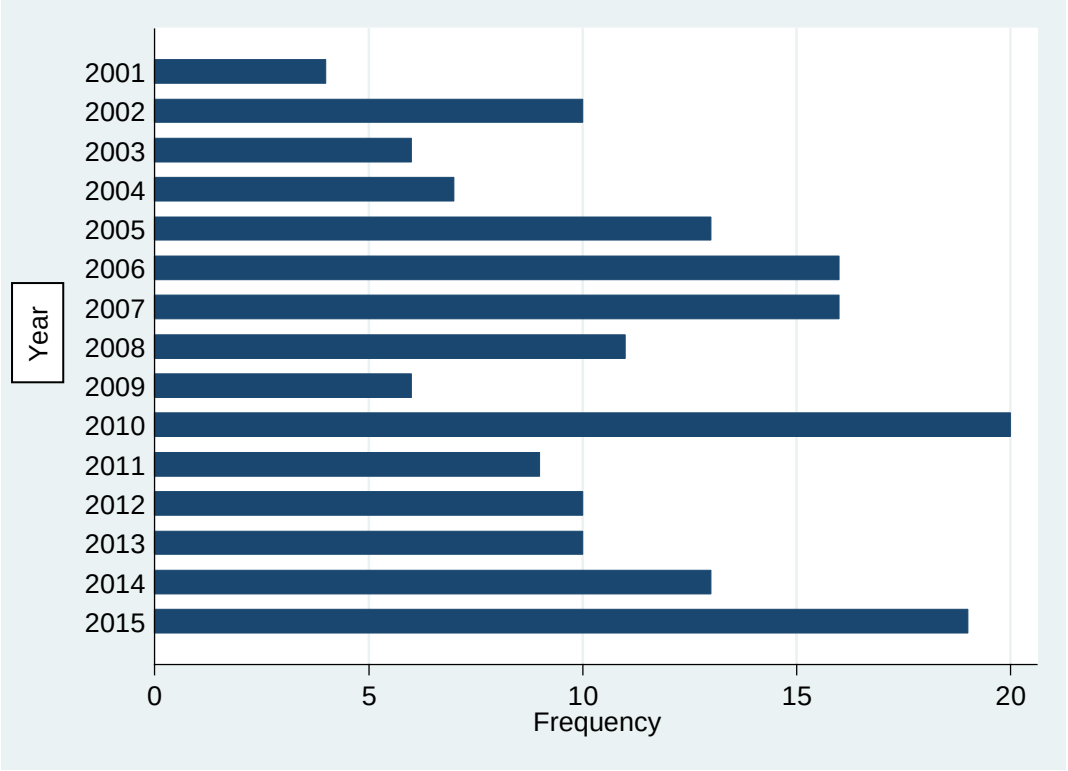



**Figure 5: Acquisition activities across time**

We include net operating income (NOI) as a percentage of market capitalization, NOI as a percentage of total revenue, and rental revenue as a percentage of total revenue to examine the revenues of real estate companies. We also include selling, general and administration (SG&A) expenses as a percentage of total assets, SG&A expenses as a percentage of rental revenue and total cost[2] as a percentage of assets to examine the expenses of REITs. If there is evidence of economies of scale in real estate companies, we should find that both revenue measures increasing while expense measures decline as size increases. Figure 6 shows the average SG&A expense ratio by size decile[3] and clearly indicates that the SG&A expense ratio declines with the company size, especially from the first decile to the second decile. We observe that firms with assets above 121 million euros have substantially lower SG&A expenses as a percentage of total assets.

We include return on average equity (ROAE) and return on average assets (ROAA) to examine the profitability of real estate companies. If there is evidence of economies of scale in real estate companies, we should find that return increases with size.

[2] Total cost is the sum of SG&A expenses, operating rental expenses and interest expenses
[3] Decline are based on total enterprise value adjusted by inflation

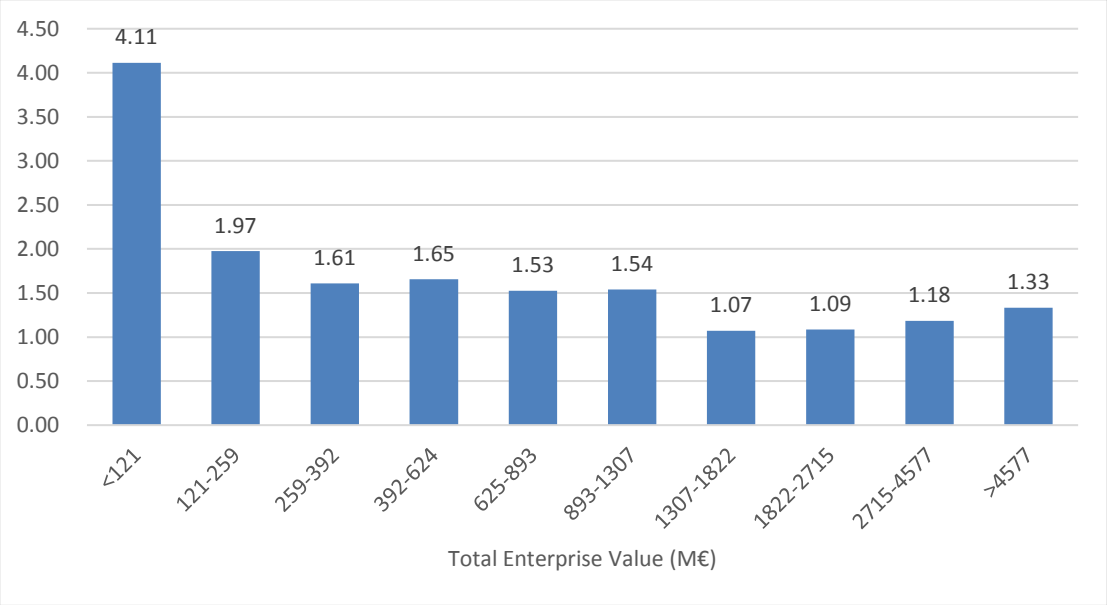



**Figure 6: SG&A Expense to Total Assets Ratio**

Since real estate is a capital intensive industry, the cost of capital could be an important factor that determines the performance of the real estate companies. We employed three measurements for the cost of capital: interest expenses as a percentage of total debt, weighted average interest rate, and weighted average cost of capital (WACC). If there is evidence of economies of scale in real estate companies, we should find that cost of capital decreases as size increases. WACC is estimated as follows[4]:

$$WACC = k_d\left(\frac{D}{D+E}\right) + k_s\left(\frac{E}{D+E}\right) \quad (1)$$

Where $k_d$ and $k_s$ represent the cost of debt (D) and the cost of equity (E), respectively. We estimate the cost of debt as the ratio of interest expenses to book value of debt (D). The market value of equity (E) is the company's market capitalization. Regarding the estimation of the cost of equity, given the relatively short period of many real estate companies or REITs have traded publicly, obtaining sufficient returns data to calculate a stable beta is problematic. Furthermore, we found significant number of negative betas by using available historical returns. Thus we estimate the cost of equity using a version of the dividend growth model:

$$k_s = \frac{DIV}{S} + g \quad (2)$$

Where $DIV$ represents the total dividends declared, $S$ is the market capitalization, and g is the projected growth rate. In order to proxy for the projected growth rate, we average the previous two years dividend growth rate, and the previous year's dividend growth rate is estimated by the weighted average dividend growth rate over all companies which pay dividend in our sample[5].

[4] Due to the poor coverage of preferred stock dividend for the European real estate companies, we assume here company only issue common stock and debt.
[5] For example, the projected dividend growth rate for year 2006 is estimated by averaging of the weighted average dividend growth rate for 2004 and 2005 for all real estate companies.

## Regression Results

Table 2 provides the panel regression results for the impact of size on the expense ratios of real estate companies. We use three measures of expense: SG&A expense as a percentage of total assets, SG&A expense as a percentage of revenue and total cost as a percentage of total assets. When total assets is used as a denominator for the expense measurements, only total enterprise value and total assets are used for size measurements. Overall, the results show evidence of economies of scale for SG&A expenses, but not significantly for total costs. For the SG&A/Assets regression, we find a negative and significant coefficient for firm size and a significantly positive coefficient for the quadratic effect when total enterprise value is used as size measurement. This indicates that SG&A/Assets and SG&A/Revenue decrease with firm size but at a decreasing rate as firm size increases. The results are similar for SG&A/Revenue when total enterprise value and total assets are used as size measures. The existence of economies of scale in the expense measures is consistent with evidence from US REITs presented in Ambrose, Highfield and Linneman (2005). The predicted SG&A Expenses/Assets ratio from the regression is illustrated in Figure 7 below.

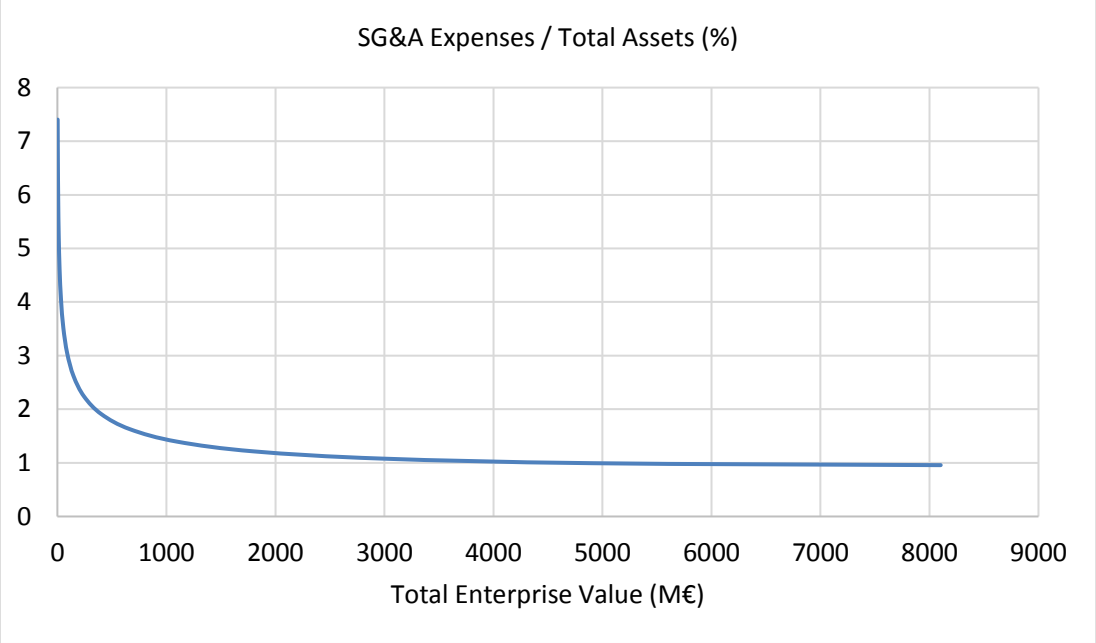



**Figure 7: Predicted SG&A Expenses/Total Assets by Size of Firm**

For the impact of acquisition, we find evidence that acquisitions in the current or previous year increase SG&A expense to total assets ratio. However, we did not find any effect of acquisition on SG&A/Revenue and Total Cost/Assets. SG&A expense ratios decrease with the total debt to total capitalization ratio. This indicates that more highly leveraged firms operate more efficiently - perhaps, given the pressure from debt servicing, they have more focus on SG&A expense. The total cost to total assets ratio increases with leverage, measured by the total debt to total capitalization ratio. The short-term debt to total debt ratio, perhaps surprisingly given the fall in interest rates over the period, is associated with lower total cost to total assets ratios. Interest expense is one of the components in total cost and it is expected that interest expense increases with leverage. Combining the results, we conclude that although high leverage firms operate more efficiently by reducing SG&A expense, the increases in interest expense offset the benefit from efficiency and lead to an increase in the total cost. Finally, asset growth is associated with a decrease in SG&A expense and total cost. Faster growing companies appear to be better able to control costs. The results on total costs/total assets are not significant in terms of the impact of firm size but the predicted ratio from the regression is shown in Figure 8 below.

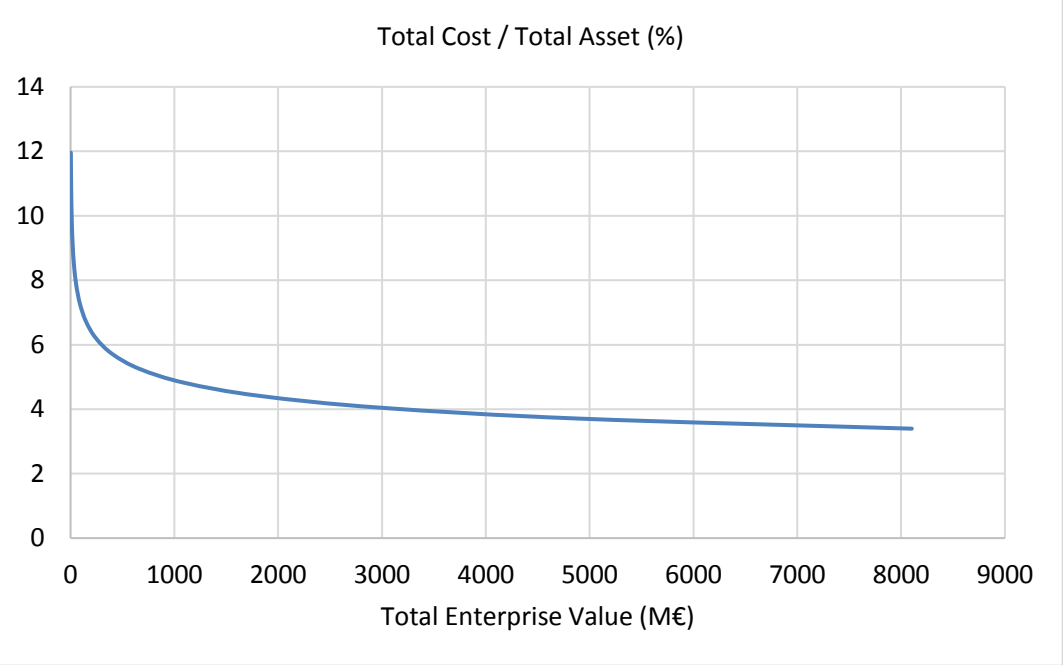



**Figure 8: Predicted Total Costs/Total Assets by Size of Firm**

Table 3 provides the panel regression results for the impact of size on the cost of capital. Three measurements of cost of capital are used: interest expense to total debt ratio, weighted average interest rate and weighted average cost of capital. Overall, the results show no evidence economies of scale for cost of capital. Intuitively, we expect that larger firms have lower cost of debt given their access to a broader range of sources of debt capital, but 5 out of 6 regressions show insignificant coefficient for firm size. This result coincides with Bers and Springer (1998) who find small diseconomies of scale with interest expense. Interestingly, interest expense to total debt ratio increases with the firm's revenue[6]. One possible explanation is that our sample includes companies using different accounting standards and thus revenue may not fully capture the size of the company. Similarly, we expect larger firms to have lower weighted average cost of capital since larger firms are less risky. But none of our regressions show this correlation. Furthermore, interest expense to total debt ratio decreases with higher asset growth.

Table 4 provides the panel regression results for the impact of size on three revenue related metrics of real estate companies: NOI as a percentage of market capitalization, NOI as a percentage of revenue and rental revenue as a percentage of revenue. When revenue is used as a denominator for the revenue measurements, only total enterprise value and total assets are used for size measurements. Overall, the results show evidence of economies of scale. For the NOI/Market Cap regression, we find positive and significant coefficients for all three firm size measurements and a significantly negative coefficient for the quadratic effect. Larger companies have higher NOI/market cap ratios and NOI/Market Cap increases at a decreasing rate as firm size increases. This result can either be interpreted as larger firms having a lower valuation (higher cap rate) reflecting market views of growth prospects or that larger firms are better able to deliver NOI and/or are less dependent on trading and development to deliver income to shareholders. We also examined NOI/Revenue and Rental Revenue/Revenue. We only find significant coefficients for firm size when total enterprise value is used as a proxy for size and NOI/Revenue shows an insignificant quadratic effect.

[6] When we re-run the regression with additional controls such as fixed rate debt to total debt ratio and secured debt to total debt ratio, the sign and significance for the coefficient of size does not change. Results are available on request.

For the impact of acquisition, $MABidder_{t-1}$ shows positive significant coefficients for all three NOI/Market Cap regressions, this indicates that this ratio increases one year after acquisition. Three out of seven regressions show negative and significant coefficients for MABidder, indicating that NOI/market cap decreases during the year of acquisition. We also find NOI/market cap increases with total debt to total capitalization ratio and decreases with asset growth (as expected if NOI/market cap seen as a valuation yield – faster growth is associated with a lower capitalisation rate).

Table 5 provides the panel regression results for the impact of size on the return of the real estate companies. Two measurements of return are used: return on average equity and return on average assets. For the return on average asset regressions, only total enterprise value and revenue are used as size measurement. Overall, the results show evidence of economies of scale for return. We find positive and significant coefficients for firm size and significantly negative coefficients for the quadratic effect except when revenue is used as size measurement. This indicates that return increases at a decreasing rate as firm size increases. The result shows that acquisition in current or previous year has no significant effect on the return. Return decreases with leverage as measured by the total debt to total capitalization ratio - more highly leveraged firms deliver lower returns on equity – a result consistent with other studies. Return also decreases with the short-term debt to total debt ratio i.e. longer time financing is associated with higher returns. Finally, asset growth is associated with higher returns.

In conclusion, we find evidence for economies of scale for real estate companies. Whilst we did not find evidence that larger firms have lower debt servicing costs, larger firms are able to generate higher returns and have lower SG&A expenses.

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Table 2: Expense Measures

| | (1) SG&A/Asset | (2) SG&A/Asset | (3) SG&A/Rental Revenue | (4) SG&A/Rental Revenue | (5) SG&A/Rental Revenue | (6) Total Cost/Asset | (7) Total Cost/Asset |
|---|---|---|---|---|---|---|---|
| Log(EV) | -1.716*** | | -50.528*** | | | -0.411 | |
| | (-4.02) | | (-2.62) | | | (-0.55) | |
| $Log(EV)^2$ | 0.091*** | | 2.500* | | | -0.025 | |
| | (2.87) | | (1.88) | | | (-0.47) | |
| Log(Asset) | | | | -99.760** | | | |
| | | | | 3.051** | | | |
| $Log(Asset)^2$ | | | | (2.09) | | | |
| Log(Revenue) | | -0.298 | | | -17.489 | | 0.699 |
| | | (-0.95) | | | (-1.04) | | (1.19) |
| $Log(Revenue)^2$ | | 0.011 | | | 0.578 | | -0.030 |
| | | (0.78) | | | (0.78) | | (-1.18) |
| MABidder | 0.184** | 0.140 | 5.857 | 5.466 | 4.751 | -0.038 | -0.103 |
| | (1.98) | (1.36) | (1.37) | (1.27) | (1.11) | (-0.25) | (-0.66) |
| $MABidder_{t-1}$ | 0.228** | 0.208* | 6.649 | 6.419 | 5.919 | 0.313** | 0.185 |
| | (2.17) | (1.90) | (1.48) | (1.41) | (1.27) | (2.22) | (1.31) |
| Total Debt/ Total Cap | -0.014*** | -0.015*** | -0.459*** | -0.346** | -0.450*** | 0.014*** | 0.012** |
| | (-3.97) | (-3.89) | (-3.00) | (-2.12) | (-2.72) | (2.81) | (2.37) |
| ST Debt/ Debt | 0.003 | 0.003 | 0.169 | 0.167 | 0.213 | 0.005* | 0.006** |
| | (1.39) | (1.36) | (1.25) | (1.23) | (1.47) | (1.80) | (2.10) |
| Asset Growth | -0.004*** | -0.004*** | 0.026 | 0.023 | 0.011 | -0.008*** | -0.008*** |
| | (-4.51) | (-4.54) | (0.86) | (0.73) | (0.31) | (-6.62) | (-6.24) |
| Intercept | 12.040*** | 6.758*** | 293.104*** | 855.172*** | 191.033* | 11.055*** | 3.148 |
| | (8.26) | (3.67) | (4.09) | (2.83) | (1.94) | (4.00) | (0.93) |
| Year Control | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Sector Control | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Country Control | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *N* | 1624 | 1555 | 1582 | 1589 | 1514 | 1344 | 1624 |
| Adj. $R^2$ | 0.755 | 0.744 | 0.694 | 0.693 | 0.679 | 0.749 | 0.755 |
| Hausman Test | 28.75* | 39.58*** | 51.27*** | 48.85*** | 46.73*** | 43.59*** | 38.85*** |

Note: See Appendix A. All regressions are estimated by fixed effect.
t statistics in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01

**Assessing Size Effects and Economies of Scale in European Real Estate Companies**

Table 3: Capital Cost Measures

| | (1) Interest Expense/Debt | (2) Interest Expense/Debt | (3) Interest Expense/Debt | (4) WAIR | (5) WAIR | (6) WAIR | (7) WACC | (8) WACC | (9) WACC |
|---|---|---|---|---|---|---|---|---|---|
| Log(EV) | 0.190 | | | 0.438 | | | 0.239 | | |
| | (0.30) | | | (1.31) | | | (0.48) | | |
| $Log(EV)^2$ | -0.037 | | | -0.031 | | | -0.028 | | |
| | (-0.82) | | | (-1.37) | | | (-0.77) | | |
| Log(Asset) | | 0.898 | | | 0.574 | | | 1.164 | |
| | | (0.57) | | | (0.89) | | | (0.86) | |
| $Log(Asset)^2$ | | -0.040 | | | -0.019 | | | -0.045 | |
| | | (-0.72) | | | (-0.87) | | | (-0.94) | |
| Log(Revenue) | | | 1.562*** | | | 0.169 | | | 0.223 |
| | | | (2.61) | | | (0.80) | | | (0.45) |
| $Log(Revenue)^2$ | | | -0.059** | | | -0.005 | | | -0.001 |
| | | | (-2.25) | | | (-0.51) | | | (-0.06) |
| MABidder | -0.114 | -0.122 | -0.144 | 0.037 | 0.029 | -0.003 | -0.053 | -0.053 | -0.084 |
| | (-0.91) | (-0.97) | (-1.15) | (0.52) | (0.41) | (-0.04) | (-0.45) | (-0.47) | (-0.75) |
| $MABidder_{t-1}$ | 0.255* | 0.253* | 0.179 | 0.032 | 0.025 | -0.005 | 0.161 | 0.165 | 0.121 |
| | (1.86) | (1.82) | (1.36) | (0.42) | (0.33) | (-0.07) | (1.45) | (1.50) | (1.16) |
| Total Debt/ Total Cap | -0.015* | -0.014* | -0.016* | 0.003 | 0.003 | 0.004 | 0.025*** | 0.026*** | 0.022*** |
| | (-1.88) | (-1.74) | (-1.85) | (0.99) | (0.98) | (1.45) | (5.20) | (5.43) | (4.32) |
| ST Debt/ Debt | -0.002 | -0.002 | -0.004 | -0.002 | -0.002 | -0.001 | 0.003 | 0.003 | -0.000 |
| | (-0.30) | (-0.32) | (-0.71) | (-0.85) | (-0.79) | (-0.69) | (0.90) | (0.91) | (-0.03) |
| Asset Growth | -0.008*** | -0.008*** | -0.008*** | -0.001 | -0.001 | -0.001 | -0.006*** | -0.006*** | -0.005*** |
| | (-4.44) | (-4.57) | (-4.56) | (-1.34) | (-1.31) | (-1.29) | (-4.30) | (-4.33) | (-4.28) |
| Intercept | 6.728*** | 1.402 | -3.774 | 3.658*** | 0.936 | 3.727*** | 2.950 | -4.243 | 1.006 |
| | (2.80) | (0.12) | (-1.07) | (3.00) | (0.20) | (2.96) | (1.60) | (-0.44) | (0.35) |
| Year Control | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Sector Control | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Country Control | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *N* | 1423 | 1429 | 1365 | 1119 | 1123 | 1072 | 1369 | 1375 | 1310 |
| Adj. $R^2$ | 0.354 | 0.355 | 0.378 | 0.544 | 0.544 | 0.553 | 0.493 | 0.493 | 0.492 |
| Hausman Test | 31.52** | 30.99* | 61.97*** | 22.43 | 24.47 | 19.53 | 36.78*** | 36.48*** | 46.61*** |

Note: See Appendix A. Regressions (1),(2),(3),(7),(8) and (9) are estimated by fixed effect. Regressions (4),(5) and (6) are estimated by random effect.
t statistics in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01

**Assessing Size Effects and Economies of Scale in European Real Estate Companies**

Table 4: Revenue Measures

| | (1) NOI/ Market Cap | (2) NOI/ Market Cap | (3) NOI/ Market Cap | (4) NOI/ Revenue | (5) NOI/ Revenue | (6) Rental Revenue/ Revenue | (7) Rental Revenue/ Revenue |
|---|---|---|---|---|---|---|---|
| Log(EV) | 25.557*** | | | 15.438*** | | 11.595** | |
| | (3.17) | | | (2.63) | | (2.44) | |
| $Log(EV)^2$ | -1.726*** | | | -0.569 | | -0.742** | |
| | (-2.98) | | | (-1.33) | | (-2.10) | |
| Log(Asset) | | 33.629* | | | 12.926 | | 10.770 |
| | | (1.83) | | | (1.08) | | (0.93) |
| $Log(Asset)^2$ | | -1.064* | | | -0.220 | | -0.408 |
| | | (-1.67) | | | (-0.51) | | (-0.98) |
| Log(Revenue) | | | 40.638*** | | | | |
| | | | (3.25) | | | | |
| $Log(Revenue)^2$ | | | -1.583*** | | | | |
| | | | (-3.05) | | | | |
| MABidder | -4.471 | -5.063* | -4.209 | -2.248 | -2.321* | -2.696* | -2.446 |
| | (-1.59) | (-1.76) | (-1.62) | (-1.59) | (-1.65) | (-1.68) | (-1.51) |
| $MABidder_{t-1}$ | 3.960** | 3.472** | 3.209** | 1.320 | 1.182 | -1.545 | -1.359 |
| | (2.49) | (2.21) | (2.31) | (0.78) | (0.68) | (-0.90) | (-0.79) |
| Total Debt/ Total Cap | 0.090 | 0.072 | 0.084 | 0.099* | 0.054 | 0.305*** | 0.305*** |
| | (0.81) | (0.63) | (0.73) | (1.91) | (1.02) | (6.76) | (6.64) |
| ST Debt/ Debt | 0.073 | 0.070 | 0.057 | -0.029 | -0.034 | -0.038 | -0.041 |
| | (0.69) | (0.66) | (0.54) | (-1.05) | (-1.22) | (-1.31) | (-1.41) |
| Asset Growth | -0.004 | -0.001 | 0.001 | -0.019** | -0.015* | -0.035*** | -0.033*** |
| | (-0.53) | (-0.13) | (0.10) | (-2.18) | (-1.74) | (-4.09) | (-3.93) |
| Intercept | -86.691*** | -254.470* | -251.031*** | -53.924** | -110.129 | 7.976 | -18.657 |
| | (-3.11) | (-1.93) | (-3.44) | (-2.55) | (-1.30) | (0.46) | (-0.23) |
| Year Control | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Sector Control | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Country Control | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *N* | 1630 | 1637 | 1562 | 1490 | 1495 | 1402 | 1406 |
| Adj. $R^2$ | 0.348 | 0.346 | 0.348 | 0.562 | 0.555 | 0.653 | 0.651 |
| Hausman Test | 37.41** | 32.48** | 40.06*** | 54.42*** | 48.09*** | 45.60*** | 41.87*** |

Note: See Appendix A. All regressions are estimated by fixed effect.
t statistics in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01

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Table 5: Return Measures

| | (1) ROAE | (2) ROAE | (3) ROAE | (4) ROAA | (5) ROAA |
|---|---|---|---|---|---|
| Log(EV) | 11.341*** | | | 6.077*** | |
| | (3.11) | | | (2.89) | |
| $Log(EV)^2$ | -0.500* | | | -0.287* | |
| | (-1.84) | | | (-1.91) | |
| Log(Asset) | | 22.093*** | | | |
| | | (2.71) | | | |
| $Log(Asset)^2$ | | -0.634** | | | |
| | | (-2.17) | | | |
| Log(Revenue) | | | -3.050 | | -0.509 |
| | | | (-0.88) | | (-0.32) |
| $Log(Revenue)^2$ | | | 0.463*** | | 0.169** |
| | | | (3.01) | | (2.37) |
| MABidder | 1.451 | 1.440 | -0.067 | 0.377 | -0.274 |
| | (1.39) | (1.38) | (-0.07) | (0.89) | (-0.77) |
| $MABidder_{t-1}$ | 0.232 | 0.258 | -1.176 | 0.060 | -0.607 |
| | (0.23) | (0.26) | (-1.35) | (0.14) | (-1.56) |
| Total Debt/ Total Cap | -0.286*** | -0.321*** | -0.246*** | -0.138*** | -0.125*** |
| | (-9.08) | (-9.72) | (-9.26) | (-9.14) | (-10.67) |
| ST Debt/ Debt | -0.052*** | -0.053*** | -0.059*** | -0.015* | -0.018** |
| | (-2.73) | (-2.78) | (-3.47) | (-1.85) | (-2.50) |
| Asset Growth | 0.044*** | 0.045*** | 0.046*** | 0.018*** | 0.018*** |
| | (3.53) | (3.58) | (4.05) | (3.50) | (4.02) |
| Intercept | -41.156*** | -169.576*** | -19.025 | -23.333*** | -13.921 |
| | (-3.20) | (-2.96) | (-0.96) | (-3.08) | (-1.52) |
| Year Control | Yes | Yes | Yes | Yes | Yes |
| Sector Control | Yes | Yes | Yes | Yes | Yes |
| Country Control | Yes | Yes | Yes | Yes | Yes |
| *N* | 1555 | 1561 | 1509 | 1555 | 1509 |
| Adj. $R^2$ | 0.469 | 0.468 | 0.560 | 0.485 | 0.615 |
| Hausman Test | 77.52*** | 77.64*** | 208.85*** | 53.33*** | 173.13*** |

Note: See Appendix A. All regressions are estimated by fixed effect.
t statistics in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01

## Stochastic Frontier Analysis

Examinations of economies of scale on cost by standard panel regression do not allow for the possibility of inefficient production. We further test economies of scale by using a stochastic frontier model. The model was first introduced by Aigner et al. (1977) and Meeusen and Van den Brock (1977). The model includes two error terms, one captures a stochastic shock that is outside the company's control, and the other is a one-sided error that captures inefficiency. A firm can lie on or within the frontier and the distance between actual output and the frontier output represents the technical inefficiency. In the case of real estate companies, we assume firms use inputs (operations and capital) to produce output which is defined earlier. We estimate a translog variable cost function which is shown below (we drop firm and time subscripts to simplify):

$$lnC = \alpha_0 + \sum_{i=1}^{m} \alpha_i lnq_i + \sum_{j=1}^{n} \beta_j ln(1+p_j) + \sum_{i=1}^{m}\sum_{r=1}^{m} \pi_{ir} lnq_i lnq_r \quad (3)$$

Where $lnC$ is the natural logarithm of the cost; $lnq_i$ is the natural logarithm of the ith output (i-1,…,m); $\ln(1+p_j)$ is the natural logarithm of one plus the jth input price (j=1,…,n); $v \approx N(0,\sigma^2)$ and $u \approx N(m,\sigma_u^2)$, a truncated normal; $m = \theta_0 + \sum_{s=1}^{q} \theta_s x_s + w$; the $x_s$ are alternative control variables; $w$ is a two-sided, symmetric random error, approximately $N(0,\sigma_u^2)$; and $\alpha, \beta, \pi$ and $\theta$ are coefficients. Since there are a few observations for $p_j$ equal 0, we took the natural logarithm of $1+p_j$ in order to not lose those observations.

The technical efficiency (TE) index for each firm in the sample is given as follows (Battese and Coelli; 1995; Coelli, 1996):

$$\mathrm{TE} = \exp(\mathrm{u}) = \exp(\theta_0 + \sum_{s=1}^{q} \theta_s x_s + w) \quad (4)$$

We use two inputs including cost of capital and the sum of operating SG&A expense and operating rental expense. We define the input prices as follows: the weighted average cost of capital (average price of capital, *i*) and the average of other expenses per euro of assets (average price of other inputs, *r*). The dependent variable equals total cost(Cost), which is the sum of operating SG&A expense, operating rental expense and interest expense. We use three alternative measurements for output: total enterprise value, total assets and revenue. Only one measurement of output will be used for each regression. From our panel regression analysis, the results show that a higher leverage company faces higher total costs, on average. Thus we use debt to assets ratio as an extra control variable since it shifts the cost frontier. Following Miller et al. (2006), we add two variables to explain changes in efficiency. One, a time variable determines whether real estate companies become more or less cost efficient over the sample period. We define Time=1,2,…15 for year 2001, 2002, …2015, respectively. Two, we use the debt to assets ratio to determine whether higher leveraged firm exhibits worse efficiency. The summary statistics for the stochastic frontier analysis are shown in Table 6.

Table 6: Summary Statistics for Stochastic Frontier Analysis

| Variable | Mean | SD | Max | Min | N |
|---|---|---|---|---|---|
| lnCost | 10.69 | 1.42 | 14.49 | 4.17 | 1745 |
| lnEV | 6.69 | 1.51 | 10.63 | 0.59 | 2079 |
| lnAsset | 13.72 | 1.48 | 17.46 | 3.91 | 2163 |
| lnRevenue | 11.64 | 1.56 | 15.53 | 3.22 | 1774 |
| ln(1+i) | 0.04 | 0.02 | 0.17 | 0.01 | 1705 |
| ln(1+r) | 0.03 | 0.03 | 0.36 | -0.02 | 1965 |
| Debt ratio | 45.11 | 17.653 | 99.01 | 0.00 | 2147 |
| Time | 8.88 | 3.94 | 15.00 | 1.00 | 2163 |

Note: The sample contains 236 firms and 2163 firm year observations between 2001 and 2015. lnCost is the natural log of the total cost. lnEV is the natural log of total enterprise value. lnAsset is the natural log of total assets. lnRevenue is the natural log of total revenue. ln(1+i) is the natural log of 1 plus weighted average cost of capital. ln(1+r) is the average of other expenses per euro of assets. Debt ratio is debt to assets ratio. Time is a continuous variable to capture the year.

After defining input price and output, we precise estimating equations emerge from equations (3) and (4) as follows:

$$lnCost = \alpha_0^1 + \alpha_1^1 lnEV + \pi_{11}^1 lnEV * lnEV + \beta_1^1 ln(1+i) + \beta_2^1 (1+r) + \gamma_1^1 Debt\ ratio + v^1 + u^1 \quad (5)$$

$$lnCost = \alpha_0^2 + \alpha_1^2 lnAsset + \pi_{11}^2 lnAsset * lnAsset + \beta_1^2 ln(1+i) + \beta_1^2 (1+r) + \gamma_1^2 Debt\ ratio + v^2 + u^2 \quad (6)$$

$$lnCost = \alpha_0^3 + \alpha_1^3 lnRevenue + \pi_{11}^3 lnRevenue * lnRevenue + \beta_1^3 ln(1+i) + \beta_2^3 (1+r) + \gamma_1^3 Debt\ ratio + v^3 + u^3 \quad (7)$$

$$TE^i = \exp(u^i) = \exp\left(\theta_0^i + \theta_1^i Time + \theta_1^i Debt\ ratio + w^i\right) \text{ where i} = 1 \text{ to } 3 \quad (8)$$

We link the appropriate error specification in equation (8) to their counterparts in equations (5), (6) and (7) and perform a stochastic frontier estimation. The estimation allows the calculation of economies or diseconomies of scale. The measurement of economies or diseconomies of scale equals the cost elasticity with respect to output. If the cost elasticity is larger than 1, this implies diseconomies of scale. If the cost elasticity equals to 1, this implies constant economies of scale. If the cost elasticity is smaller than 1, this implies economies of scale. Specifically, the cost elasticity respect to total enterprise value, total assets and total revenue are given by following relation:

$$\frac{\partial lnCost}{\partial EV} = \alpha_1^1 + 2 * \pi_{11}^1 lnEV \quad (9)$$

$$\frac{\partial lnCost}{\partial Asset} = \alpha_1^2 + 2 * \pi_{11}^2 lnAsset \quad (10)$$

$$\frac{\partial lnCost}{\partial Revenue} = \alpha_1^3 + 2 * \pi_{11}^3 lnRevenue \quad (11)$$

Table 7 provides the estimation results for the stochastic frontier. Column (1) is estimated from equations (5) and (8) where total enterprise value is used as output. Column (2) is estimated from equations (6) and (8) where total assets is used as output. Column (3) is estimated from equations (7) and (8) where total revenue is used as output.

Using the coefficient from Table 7 and equations (9), (10) and (11), we calculate the cost elasticity respect to the firm's output. The results show evidence of economies of scale for all three measurements of firm's output. This result coincides with our finding in the panel regressions section. This result also coincides with Ambrose, Highfield and Linneman (2005) and Miller et al. (2006). Furthermore, we break down the

sample into four quartiles based on total assets adjusted for inflation. We expected that smaller firms have more opportunity to gain efficiency by taking advantage of scale economies. In other words, smaller firms could benefit more through expansion. The results of all three output measurements confirm our expectation. Especially, when total assets is used as output, the top quartile shows constant economies of scale. The results are consistent with our conclusion from the panel regressions, larger firms can operate more efficiently and reduce the expense ratios. The frontier is illustrated in Figure 9 below.

Considering our control variables on the level of inefficiency, we only find evidence that inefficiency of real estate companies changes over time and leverage of firms when we use total assets as output. This is the joint estimation of equation (6) and (8). From both equations, $\exp(u^2)$ is the measurement of inefficiency, the higher the $\exp(u^2)$, the larger the cost incurs with the firm, thus the firm is operating more inefficiently. The coefficients for Time and Debt ratio are significant and with value -0.017 and -0.004, respectively. This indicates that higher leveraged firms are operating more efficiently, we found similar results from the panel regression. Our results also suggest that firms operating more efficiently over time, this coincides with our expectation, since improved methods of operation should lower the cost.

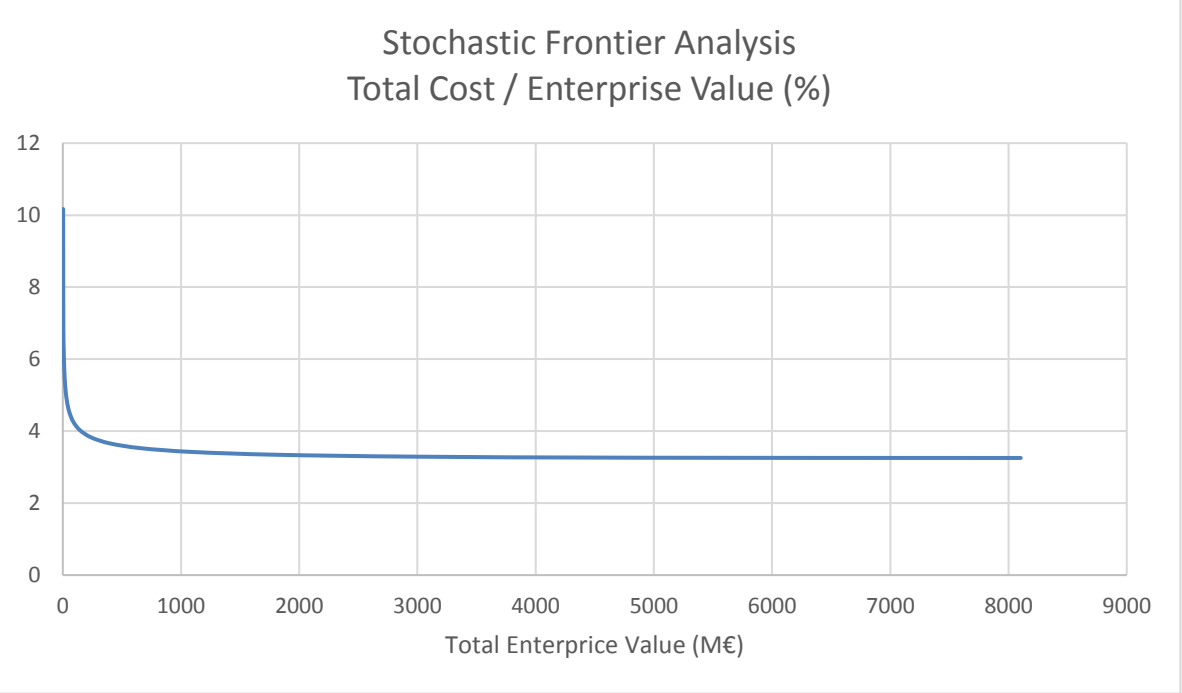


**Figure 9: Cost Frontier - Total Costs/EV by Size of Firm**

Table 7: Stochastic Frontier Estimation

| | (1) | (2) | (3) |
|---|---|---|---|
| | lnCost | lnCost | lnCost |
| lnEV | 0.754*** | | |
| | (19.97) | | |
| lnEV*lnEV | 0.014*** | | |
| | (4.84) | | |
| lnAsset | | 0.900*** | |
| | | (15.31) | |
| lnAsset*lnAsset | | 0.003 | |
| | | (1.50) | |
| lnRevenue | | | 0.482*** |
| | | | (4.34) |
| lnRevenue*lnRevenue | | | 0.015*** |
| | | | (3.16) |
| Debt ratio | 0.013*** | 0.012*** | 0.017*** |
| | (15.85) | (13.72) | (11.89) |
| ln(1+i) | 6.253*** | 3.716*** | 5.150*** |
| | (11.98) | (10.22) | (5.76) |
| ln(1+r) | 15.525*** | 16.791*** | 7.834*** |
| | (39.74) | (61.20) | (13.41) |
| Constant 1 | 3.545*** | -3.636*** | 1.487** |
| | (27.01) | (-8.97) | (2.33) |
| One-sided error (inefficiency) estimates | | | |
| Time | -0.175 | -0.017*** | -3.987 |
| | (-0.74) | (-3.04) | (-0.96) |
| Debt ratio | -0.072 | -0.004** | 0.671 |
| | (-0.79) | (-2.57) | (0.51) |
| Constant 2 | 1.019 | 0.357*** | -331.388** |
| | (1.41) | (4.51) | (-2.00) |
| Sigma2 | 0.538 | 0.058*** | 118.68*** |
| Gamma | 0.812 | 0.081*** | 0.999*** |
| Economies of scale | | | |
| All observations | 0.9388*** | 0.9889*** | 0.8323*** |
| Total assets smallest quartile | 0.8842*** | 0.9765*** | 0.7762*** |
| Total assets second quartile | 0.9279*** | 0.9867*** | 0.8189*** |
| Total assets third quartile | 0.9538*** | 0.9925*** | 0.8464*** |
| Total assets largest quartile | 0.9861*** | 1.0001 | 0.8815*** |
| N | 1557 | 1566 | 1290 |

Note: See Table 7. We specify the cost frontier as a translog function where the debt ratio shifts the intercept. Sigma$^2$($\sigma^2$) equals $\sigma_v^2 + \sigma_u^2$ and gamma equals $\sigma_u^2/\sigma^2$). The null hypothesis for the coefficient are coefficient equals to zero. The null hypothesis for economies of scale are economies of scale equals to one. The sample for economies of scale are full sample and four quantiles based on total assets adjusted for inflation.
t statistics in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01

## Pre and Post Merger Analysis

This section analyses the operating performance before and after the acquisition. For this section we restrict the sample to cases where the bidder acquired the target and the target delisted from the exchange. We also choose the acquisition such that we have at least 2 years of accounting data before acquisition for both bidder and target and 2 years of accounting data after acquisition for the bidder. Since our sample period is 2001-2015, this implies that we drop acquisition events before 2003 and after 2013. Finally, we only keep the companies where there is no other major merger and acquisition 3 years before and after the acquisition we are analysing. After the sample selection process, we were left with 6 acquisition cases which are shown in Table 8.

Table 8: Acquisition Event

| Bidder | Target | Year |
|---|---|---|
| Derwent London Plc | London Merchant Securities Plc | 2006 |
| Conygar Investment Company Plc | Advantage Property Income | 2009 |
| Conwert Immobilien Invest SE | ECO Business-Immobilien | 2010 |
| Picton Property Income Limited | Rugby Estates Investment Trust Plc | 2010 |
| NSI N.V. | Vastned Offices/Indl N.V. | 2011 |
| Affine | AffiParis | 2012 |

We use 10 indicators to measure operating performance: NOI as a percentage of market capitalization, NOI as a percentage of revenue, rental revenue as a percentage of revenue, SG&A expense as a percentage of assets and SG&A revenue as a percentage of rental revenue, total cost as a percentage of total assets, return on average equity, return on average assets, interest expense as a percentage of total debt and weighted average interest rate.

We aggregate performance data of the target and bidder before the acquisition to obtain the pro forma pre-merger performance of the combined firms[7]. Comparing the post-merger performance and this pre-merger benchmark provides a measure of the change in performance. But the difference in performance before and after merger could be caused by other factors such as changes in economic condition and industry condition. Thus, we use industry-adjusted performance as our measurements to evaluate pre-merger and post-merger performance. For each year and firm, industry-adjusted performance measures are calculated by subtracting the industry median from the sample firm value. The companies involved in our acquisition events are excluded when calculating the industry median.

We choose two event windows in this study: 2 years and 3 years. In case of 2 years event window, for each performance indicator and firm, we calculate the 2 years average industry-adjusted performance before the acquisition and 2 years average industry-adjusted performance, then calculate the difference. In order to test whether the differences are different from zero, t-tests are performed. A similar process is used when the event window is 3 years. Accounting data during the year of acquisition is excluded. Performance indicators are affected by one-time merger cost incurred during that year, making it difficult to compare them with results from other year.

Table 9 provides the results when we choose 2 years event window. The second column shows the mean of the difference between 2 years average pre-merger performance and 2 years average post-merger performance. The mean of the difference between pre- and post-merger are significantly negative for ROAE and ROAA, this indicates that return drops significantly for the merged firm in the post-merger period. The mean of the difference between pre- and post-merger are significantly positive for Interest Expense/Debt and WAIR, this indicates that the cost of debt increases significantly for the merged firm in the post-merger period. Table 10 provides the results when we use a 3 years event window. The second column shows the mean of the difference between 3 years average pre-merger performance and 3 years average post-merger performance. We get similar results with the 2 years event window, the results

[7] For example, the pro forma premerger NOI to market capitalization ratio for companies A and B is calculated by $\frac{NOI_A+NOI_B}{Market\ Cap_A+Market\ Cap_B}$

indicate that return drops and cost of debt increases significantly for the merged firm in the post-merger period. From our results, there is no evidence shows that there are synergies generated by merger and acquisition. Instead, the merged firm's performance is worse than the two firms running separately.

Table 9: Pre and Post-Merger Analysis for 2 Years Event Window

| Performance Indicator | Mean of the difference between pre and post-merger | N |
|---|---|---|
| NOI/Market Cap | -17.27a | 1 |
| NOI/Revenue | -9.35a | 1 |
| Rental Revenue/Revenue | 0.36a | 1 |
| SG&A/Asset | 0.41 | 5 |
| SG&A/Rental Revenue | 36.56a | 1 |
| Total Cost/Asset | 1.32 | 3 |
| ROAE | -12.39** | 5 |
| ROAA | -5.52** | 5 |
| Interest Expense/Debt | 2.40* | 4 |
| WAIR | 1.98** | 4 |

Note: See Appendix A. If the number of observation is one, t test cannot be performed.
[a] cannot do t test, * p < 0.10, ** p < 0.05, *** p < 0.01

Table 10: Pre and Post-Merger Analysis for 3 Years Event Window

| Performance Indicator | Mean of the difference between pre and post-merger | N |
|---|---|---|
| NOI/Market Cap | -9.34a | 1 |
| NOI/Revenue | -8.07a | 1 |
| Rental Revenue/Revenue | -4.08a | 1 |
| SG&A/Asset | 0.42 | 5 |
| SG&A/Rental Revenue | 28.73a | 1 |
| Total Cost/Asset | 1.46 | 3 |
| ROAE | -9.89* | 5 |
| ROAA | -4.36* | 5 |
| Interest Expense/Debt | 2.49** | 4 |
| WAIR | 2.17* | 3 |

Note: See Appendix A. If the number of observation is one, t test cannot be performed.
[a] cannot do t test, * p < 0.10, ** p < 0.05, *** p < 0.01

# Conclusions

This study investigates scale economies in European real estate companies, specifically, we test the size effect on revenue, expense, profitability and capital cost ratios of real estate companies. We utilize real estate company data from SNL database and focus on Europe based companies who invest primarily in Europe. Our sample consists of 236 real estate companies over the period 2001 to 2015.

By running panel regressions controlling for country, time and property type effects, we find that larger real estate companies are more profitable and at the same time incur lower costs. NOI ratios increase and SG&A expense ratios decrease with the size of the company. We did not find evidence that larger companies have lower cost of debt or weighted average cost of capital. Neither interest expense to total debt ratios nor weighted average interest rates fall with size.

Stochastic frontier analysis again suggests that economies of scale exist for European real estate companies. We examined whether the inefficiency of the firm varies by time and debt to assets ratio but neither time nor debt to assets ratios appeared to have an effect.

Despite strong evidence for the economies of scale from panel regression and stochastic frontier analysis, our results from pre- and post-merger analysis suggesting that no synergy is created by this M&A activity. Instead, the merged firm's performance compared to the industry deteriorates compared to the two firms running separately. In particular, merged firms show significantly lower returns and higher cost of debt compared with the pre-merger period.

Although there is clear evidence for the economies of scale, this result suggests consolidation in the sector does not necessarily produce efficiencies. Growing a company by buying other companies does not appear to lead to improved performance, it takes effort and time to integrate prior to the realization of the benefit. Acquiring other real estate companies may also lead to increased diversification (geographically or by property type) and this may also limit opportunities for economies of scale.

# Appendix A: Variable definition

| Variable Name | Definition |
|---|---|
| Log(EV) | Natural log of the total enterprise value (Market capitalisation of ongoing operations, including common capitalisation at market value and all non-common equity, debt, and mezzanine at book value, less cash and cash equivalents at book value) |
| Log(Asset) | Natural log of total assets |
| Log(Revenue | Natural log of total revenue. ROAE is return on equity defined as net income as a percentage of average equity |
| ROAA | ROAE is return on equity defined as net income as a percentage of average equity |
| ROAA | Return on assets defined as net income as a percentage of average assets |
| NOI/Market Cap | Net operating income as a percentage of market capitalization |
| NOI/Revenue | Net operating income as a percentage of revenue |
| Rental Revenue/Revenue | Rental revenue as a percentage of revenue |
| SG&A Expenses/Total Asset | Selling, general and administrative expense as a percentage of total assets |
| SG&A Expenses/Rental Revenue | Selling, general and administrative expense as a percentage of Rental Revenue |
| Total Debt/ Total Cap | The book value of total debt expressed as a percentage of the total capitalization |
| ST Debt/ Debt | The ratio of the book value of short-term debt to the book value of the total debt |
| Asset Growth | The growth in the book value of total assets over the previous year |
| Interest Expense/Debt | Interest expenses as a percentage of total debt |
| WAIR | Weighted average interest rate of debt |
| WACC | Weighted average cost of capital |
| Total Cost / Asset | Total cost (operating rental expenses + operating SG&A expenses + interest expenses) expressed as a percentage of total assets |
| MABidder | Dummy variable equal to 1 if the company is a bidder |

## Appendix B: More Balanced Panel Regression with shorter period

Our sample includes both current and historical companies and consequently one problem with our sample is that the number of companies varies across different periods. There are companies that entered in the middle of our sample period and there are companies that failed. In order to assess the extent to which this is a problem, we re-estimated our model using a balanced panel regression, so that it can capture more on the time series variation of our sample. From Figure 2, it shows that most of our sample observations are distributed between 2006 and 2015. In order to make a balanced panel without losing too many firms, our sample in this section is restricted to the 2006-15 period. Across the whole 10 years period of our sample, for each regression, we only include firms with at least 8 years of data for all the variables we are using in the regression.

Table B.1 shows the balanced panel regression for the expense measurements. The results confirm our conclusion from the benchmark regression, larger firm is able to reduce SG&A cost. Table B.2 shows the balanced panel regression for the cost of capital measurements. The results for WACC is the same as our benchmark regression, WACC has no relationship with the firm size. But the results for the balanced panel regressions show that cost of debt is higher with larger firm[8]. This result is against our expectation and is counter intuitive. One possible explanation could be the quiet life hypothesis. Larger firms are able to operate in a more relaxed environment and thus put less effort in negotiating the terms of the loan. Table B.3 shows the balanced panel regression for the revenue measurements. The results also confirm our conclusion from the benchmark regression, larger firm is able to increase revenue. Lastly, table B.4 shows the balanced panel regression for the return measurements. The economies of scale for return disappeared. Again, the reduction in return for the larger firm might be caused by the higher cost of debt. ROAA even shows diseconomies of scale when the size is measured by revenue. Similar possible problem with revenue measurement, because of the manipulation and accounting standard, revenue might not able to fully capture the size of the company.

[8] We re-estimated the regression with additional control such as fixed rate debt to total debt ratio and secured debt to total debt ratio, the sign and significance for the coefficient of size does not change. Results are available on request.

**Assessing Size Effects and Economies of Scale in European Real Estate Companies**

Table B.1: Expense Measures – Balanced Panel

| | (1) SG&A/Asset | (2) SG&A/Asset | (3) SG&A/Rental Revenue | (4) SG&A/Rental Revenue | (5) SG&A/Rental Revenue | (6) Total Cost/Asset | (7) Total Cost/Asset |
|---|---|---|---|---|---|---|---|
| Log(EV) | -1.153*** | | -42.777*** | | | -0.751 | |
| | (-3.04) | | (-2.92) | | | (-1.19) | |
| $Log(EV)^2$ | 0.048* | | 2.123** | | | 0.017 | |
| | (1.67) | | (2.27) | | | (0.37) | |
| Log(Asset) | | | | -88.787** | | | |
| | | | | (-2.42) | | | |
| $Log(Asset)^2$ | | | | 2.749** | | | |
| | | | | (2.25) | | | |
| Log(Revenue) | | -0.163 | | | -2.245 | | 0.086 |
| | | (-0.56) | | | (-0.14) | | (0.10) |
| $Log(Revenue)^2$ | | 0.005 | | | -0.005 | | -0.003 |
| | | (0.36) | | | (-0.01) | | (-0.09) |
| MABidder | 0.142 | 0.099 | 3.732 | 3.362 | 3.034 | -0.003 | -0.098 |
| | (1.33) | (0.82) | (0.84) | (0.76) | (0.68) | (-0.02) | (-0.61) |
| $MABidder_{t-1}$ | 0.187 | 0.155 | 3.449 | 3.193 | 3.022 | 0.114 | 0.013 |
| | (1.48) | (1.16) | (0.69) | (0.64) | (0.57) | (0.64) | (0.07) |
| Total Debt/ Total Cap | -0.015*** | -0.014*** | -0.640*** | -0.537*** | -0.566*** | 0.023*** | 0.027*** |
| | (-3.60) | (-2.79) | (-3.56) | (-3.11) | (-2.81) | (3.51) | (3.93) |
| ST Debt/ Debt | -0.001 | -0.002 | 0.011 | 0.009 | 0.048 | 0.003 | 0.002 |
| | (-0.23) | (-0.88) | (0.08) | (0.06) | (0.30) | (0.83) | (0.68) |
| Asset Growth | -0.003*** | -0.004*** | 0.056 | 0.054 | 0.070 | -0.008*** | -0.008*** |
| | (-3.20) | (-3.13) | (1.15) | (1.10) | (1.37) | (-4.88) | (-4.52) |
| Intercept | 12.472*** | 8.502*** | 459.434*** | 964.046*** | 300.335*** | 9.510*** | 3.867 |
| | (9.03) | (4.83) | (6.70) | (3.46) | (3.16) | (3.83) | (0.85) |
| Year Control | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Sector Control | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Country Control | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *N* | 1139 | 1047 | 1115 | 1126 | 1025 | 873 | 798 |
| Adj. $R^2$ | 0.798 | 0.795 | 0.762 | 0.762 | 0.752 | 0.375 | 0.362 |
| Hausman Test | 28.60** | 40.88*** | 41.67*** | 40.96*** | 58.52*** | 17.86 | 16.98 |

Note: See Appendix A. Regressions (1)-(5) are estimated by fixed effect and regression (6) and (7) are estimated by random effect.
t statistics in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01

**Assessing Size Effects and Economies of Scale in European Real Estate Companies**

Table B.2: Capital Cost Measures – Balanced Panel

| | (1) Interest Expense/Debt | (2) Interest Expense/Debt | (3) Interest Expense/Debt | (4) WAIR | (5) WAIR | (6) WAIR | (7) WACC | (8) WACC | (9) WACC |
|---|---|---|---|---|---|---|---|---|---|
| Log(EV) | 1.306** | | | 3.010*** | | | 0.353 | | |
| | (2.53) | | | (5.29) | | | (0.67) | | |
| $Log(EV)^2$ | -0.110*** | | | -0.204*** | | | -0.029 | | |
| | (-2.69) | | | (-5.44) | | | (-0.66) | | |
| Log(Asset) | | 3.954*** | | | 7.177*** | | | 0.235 | |
| | | (2.68) | | | (4.36) | | | (0.13) | |
| $Log(Asset)^2$ | | -0.149*** | | | -0.244*** | | | -0.007 | |
| | | (-2.78) | | | (-4.39) | | | (-0.09) | |
| Log(Revenue) | | | -0.022 | | | 0.476 | | | -1.149 |
| | | | (-0.03) | | | (0.91) | | | (-1.46) |
| $Log(Revenue)^2$ | | | 0.004 | | | -0.018 | | | 0.052 |
| | | | (0.14) | | | (-0.81) | | | (1.46) |
| MABidder | 0.109 | 0.088 | 0.030 | 0.045 | 0.033 | -0.037 | 0.293** | 0.261* | 0.138 |
| | (0.76) | (0.61) | (0.22) | (0.52) | (0.38) | (-0.43) | (2.14) | (1.96) | (1.23) |
| $MABidder_{t-1}$ | 0.250* | 0.262* | 0.095 | 0.200** | 0.210** | 0.155* | 0.323** | 0.319** | 0.193 |
| | (1.75) | (1.84) | (0.69) | (2.36) | (2.46) | (1.83) | (2.31) | (2.28) | (1.65) |
| Total Debt/ Total Cap | -0.010 | -0.008 | -0.002 | -0.006 | -0.008* | -0.008* | 0.039*** | 0.039*** | 0.038*** |
| | (-1.63) | (-1.48) | (-0.42) | (-1.42) | (-1.78) | (-1.85) | (6.98) | (6.93) | (8.30) |
| ST Debt/ Debt | -0.006* | -0.006* | -0.011*** | -0.004 | -0.004 | -0.006* | 0.003 | 0.003 | -0.001 |
| | (-1.92) | (-1.93) | (-4.73) | (-1.29) | (-1.45) | (-1.94) | (0.81) | (0.76) | (-0.32) |
| Asset Growth | -0.014*** | -0.014*** | -0.014*** | -0.002 | -0.002 | -0.002 | -0.010*** | -0.010*** | -0.007*** |
| | (-3.98) | (-4.06) | (-3.72) | (-1.30) | (-1.39) | (-1.45) | (-4.40) | (-4.31) | (-3.54) |
| Intercept | 2.003 | -20.535** | 5.233 | -4.926** | -46.228*** | 3.410 | 0.305 | -0.638 | 7.623* |
| | (1.12) | (-2.01) | (1.32) | (-2.19) | (-3.79) | (1.09) | (0.18) | (-0.05) | (1.81) |
| Year Control | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Sector Control | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Country Control | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *N* | 769 | 780 | 719 | 604 | 604 | 579 | 766 | 777 | 717 |
| Adj. $R^2$ | 0.554 | 0.555 | 0.330 | 0.736 | 0.731 | 0.727 | 0.646 | 0.646 | 0.678 |
| Hausman Test | 28.37** | 23.70* | 14.61 | 48.18*** | 49.07*** | 31.03*** | 45.84*** | 46.88*** | 45.75*** |

Note: See Appendix A. All regressions are estimated by fixed effect except regression (3) is estimated by random effect.
t statistics in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01

**Assessing Size Effects and Economies of Scale in European Real Estate Companies**

Table B.3: Revenue Measures – Balanced Panel

| | (1) NOI/Market Cap | (2) NOI/Market Cap | (3) NOI/Market Cap | (4) NOI/Revenue | (5) NOI/Revenue | (6) Rental Revenue/Revenue | (7) Rental Revenue/Revenue |
|---|---|---|---|---|---|---|---|
| Log(EV) | 25.050** | | | 22.750*** | | 22.015*** | |
| | (2.35) | | | (2.76) | | (3.17) | |
| $Log(EV)^2$ | -1.657** | | | -1.219** | | -1.550*** | |
| | (-2.27) | | | (-2.02) | | (-3.05) | |
| Log(Asset) | | 51.342* | | | 44.621** | | 44.207** |
| | | (1.67) | | | (2.34) | | (2.24) |
| $Log(Asset)^2$ | | -1.684 | | | -1.443** | | -1.637** |
| | | (-1.62) | | | (-2.12) | | (-2.32) |
| Log(Revenue) | | | 65.239*** | | | | |
| | | | (3.92) | | | | |
| $Log(Revenue)^2$ | | | -2.681*** | | | | |
| | | | (-3.86) | | | | |
| MABidder | -5.220* | -5.512* | -4.029 | -2.972* | -2.809* | -2.942* | -2.503 |
| | (-1.67) | (-1.71) | (-1.38) | (-1.82) | (-1.72) | (-1.70) | (-1.42) |
| $MABidder_{t-1}$ | 4.583** | 4.383** | 4.344** | 0.342 | 0.426 | -2.373 | -2.095 |
| | (2.16) | (2.11) | (2.45) | (0.20) | (0.23) | (-1.40) | (-1.22) |
| Total Debt/ Total Cap | 0.027 | 0.011 | -0.006 | 0.053 | 0.014 | 0.337*** | 0.326*** |
| | (0.18) | (0.07) | (-0.04) | (0.74) | (0.19) | (6.01) | (5.98) |
| ST Debt/ Debt | 0.118 | 0.117 | 0.135 | -0.045 | -0.055 | -0.020 | -0.024 |
| | (0.76) | (0.75) | (0.84) | (-1.21) | (-1.45) | (-0.61) | (-0.74) |
| Asset Growth | -0.013 | -0.012 | -0.008 | -0.024** | -0.018* | -0.017* | -0.017* |
| | (-1.39) | (-1.34) | (-0.82) | (-2.35) | (-1.95) | (-1.82) | (-1.72) |
| Intercept | -62.769* | -354.905 | -367.476*** | -80.193*** | -321.974** | -102.455*** | -324.202** |
| | (-1.68) | (-1.59) | (-3.80) | (-2.69) | (-2.38) | (-4.04) | (-2.33) |
| Year Control | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Sector Control | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Country Control | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *N* | 1142 | 1153 | 1051 | 988 | 996 | 931 | 938 |
| Adj. $R^2$ | 0.370 | 0.371 | 0.395 | 0.552 | 0.543 | 0.664 | 0.662 |
| Hausman Test | 23.19* | 21.37* | 50.00*** | 35.72*** | 32.60*** | 37.91*** | 36.74*** |

Note: See Appendix A. All the regressions are estimated by fixed effect.
t statistics in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01

**Assessing Size Effects and Economies of Scale in European Real Estate Companies**

Table B.4: Return Measures – Balanced Panel

| | (1) ROAE | (2) ROAE | (3) ROAE | (4) ROAA | (5) ROAA |
|---|---|---|---|---|---|
| Log(EV) | 2.931 | | | 3.644 | |
| | (0.60) | | | (1.58) | |
| $Log(EV)^2$ | 0.221 | | | -0.085 | |
| | (0.60) | | | (-0.47) | |
| Log(Asset) | | 11.113 | | | |
| | | (0.92) | | | |
| $Log(Asset)^2$ | | -0.168 | | | |
| | | (-0.38) | | | |
| Log(Revenue) | | | -11.343** | | -3.022 |
| | | | (-2.57) | | (-1.40) |
| $Log(Revenue)^2$ | | | 0.859*** | | 0.297*** |
| | | | (4.43) | | (3.11) |
| MABidder | 2.136* | 2.094* | 0.453 | 0.757 | -0.106 |
| | (1.79) | (1.77) | (0.48) | (1.43) | (-0.26) |
| $MABidder_{t-1}$ | -0.224 | -0.286 | -1.713* | 0.298 | -0.639 |
| | (-0.20) | (-0.25) | (-1.78) | (0.55) | (-1.35) |
| Total Debt/ Total Cap | -0.316*** | -0.362*** | -0.215*** | -0.187*** | -0.119*** |
| | (-7.03) | (-8.08) | (-6.04) | (-9.06) | (-7.06) |
| ST Debt/ Debt | -0.052** | -0.050** | -0.065*** | -0.026** | -0.020** |
| | (-2.27) | (-2.19) | (-3.04) | (-2.05) | (-2.07) |
| Asset Growth | 0.035** | 0.036** | 0.031** | 0.015*** | 0.012** |
| | (2.17) | (2.33) | (2.43) | (2.85) | (2.47) |
| Intercept | 16.830 | -71.295 | 45.247* | 1.634 | 7.643 |
| | (0.98) | (-0.85) | (1.76) | (0.21) | (0.61) |
| Year Control | Yes | Yes | Yes | Yes | Yes |
| Sector Control | Yes | Yes | Yes | Yes | Yes |
| Country Control | Yes | Yes | Yes | Yes | Yes |
| *N* | 1075 | 1085 | 1002 | 1126 | 1009 |
| Adj. $R^2$ | 0.485 | 0.486 | 0.595 | 0.541 | 0.639 |
| Hausman Test | 74.34*** | 72.54*** | 177.12*** | 64.06*** | 156.72*** |

Note: See Appendix A. All the regressions are estimated by fixed effect.
t statistics in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01

# Appendix C: Data Envelopment Analysis (DEA)

Three are several techniques are available for analysing X-efficiencies, we have used stochastic frontier analysis in the main body of the study. In this section, we are going to use data envelopment analysis (DEA), the main advantage of DEA is that we can estimate efficiency and economies of scale without specifying the functional form. On the other hand, the disadvantage of DEA is that it does not allow for deviation from the efficient frontier to be a function of random error. As a result, DEA can produce results that are sensitive to outliers, model specification and data errors. Thus, we exclude both top and bottom 1 percentile data for each variable that we employ in the section. In the context of DEA, there are three measurements of efficiency. The overall technical efficiency (OTC) is the product of the deviation from the efficient cost frontier due to inefficient input utilization (pure technical inefficiency) and the deviation from failure to operate at constant returns to scale (scale inefficiency).

In this section, we only use total assets as output. We use three inputs: SG&A expense, rental expense and interest expense. Table C.1 reports the summarised results of the DEA estimation of real estate company operating efficiency. The mean OTE measure ranges from a low of 36% in year 2005 to a high of 73% in year 2003. These results imply that, on average, the input usage of the average real estate company could have been reduced by 27% to 64%. The large standard deviation associated with the estimated mean OTE measures suggest that the efficiency levels of the individual company differ substantially. Furthermore, the efficiency shows a decreasing trend over time. Since we have small sample before 2006 and the companies in the sample differ across year, thus the efficiency before 2006 may not comparable with the efficiency after 2006. Focus on efficiency after 2006, there is no trend over time for the efficiency.

As we mentioned earlier, OTC is the product of pure technical inefficiency (PTE) and scale inefficiency (SE). the mean PTE measure ranges from 51% in 2012 to 80% in 2001. SE measures are generally lower, the mean range from 67% in 2005 to 91% in both 2001 and 2002. The results suggest there is more opportunity for efficiency gain from better utilization of existing resources than taking advantage of scale economies.

We further examine the nature of scale efficiencies by determining the number firms operating under constant, increasing, and decreasing returns to scale (see Table C.2). The results show that the majority of the real estate companies in our sample are experiencing decreasing return to scale, suggesting that these real estate companies could increase operating efficiency through contraction. On the other hand, the number of real estate companies who are experiencing increasing return to scale range from 14 (22% of the sample) in 2003 to 54(39%) in 2012. Those companies could increase operating efficiency through expansion

Table C.3 compares efficiency differences between larger and smaller real estate companies for each year studies. For most of the years, the OTE measures show that larger real estate companies are overall efficient overall than smaller real estate companies. PTE shows the similar pattern as OTE, larger real estate companies are technical efficient than smaller real estate companies. This suggesting that larger real estate companies can better utilize their resources. Focus on SE, smaller real estate companies are scale efficient than larger real estate companies in most of the years. Combine the results from Table C.2, the results might suggest that most of the large real estate companies in our sample are experiencing decreasing return to scale.

Table C.1: Data Envelopment analysis (DEA) efficiency estimates (2001-2015)

| Measure | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|
| OTC | | | | | | | | |
| Mean | 0.73 | 0.68 | 0.59 | 0.65 | 0.36 | 0.52 | 0.42 | 0.50 |
| S.D. | (0.26) | (0.24) | (0.24) | (0.23) | (0.20) | (0.23) | (0.22) | (0.23) |
| Min-max. | [0.23-1.00] | [0.27-1.00] | [0.20-1.00] | [0.23-1.00] | [0.09-1.00] | [0.10-1.00] | [0.12-1.00] | [0.09-1.00] |
| PTE | | | | | | | | |
| Mean | 0.80 | 0.76 | 0.69 | 0.75 | 0.58 | 0.65 | 0.63 | 0.62 |
| S.D. | (0.24) | (0.23) | (0.25) | (0.25) | (0.28) | (0.25) | (0.26) | (0.27) |
| Min-max. | [0.29-1.00] | [0.29-1.00] | [0.25-1.00] | [0.27-1.00] | [0.09-1.00] | [0.16-1.00] | [0.16-1.00] | [0.15-1.00] |
| SE | | | | | | | | |
| Mean | 0.91 | 0.91 | 0.87 | 0.88 | 0.67 | 0.80 | 0.68 | 0.83 |
| S.D. | (0.14) | (0.13) | (0.16) | (0.15) | (0.22) | (0.17) | (0.21) | (0.19) |
| Min-max. | [0.29-1.00] | [0.28-1.00] | [0.33-1.00] | [0.38-1.00] | [0.25-1.00] | [0.16-1.00] | [0.24-1.00] | [0.28-1.00] |

| Measure | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|
| OTC | | | | | | | |
| Mean | 0.53 | 0.45 | 0.41 | 0.37 | 0.35 | 0.39 | 0.40 |
| S.D. | (0.24) | (0.25) | (0.24) | (0.24) | (0.23) | (0.25) | (0.25) |
| Min-max. | [0.14-1.00] | [0.11-1.00] | [0.06-1.00] | [0.05-1.00] | [0.04-1.00] | [0.06-1.00] | [0.04-1.00] |
| PTE | | | | | | | |
| Mean | 0.60 | 0.52 | 0.54 | 0.51 | 0.52 | 0.55 | 0.52 |
| S.D. | (0.26) | (0.27) | (0.28) | (0.29) | (0.29) | (0.29) | (0.28) |
| Min-max. | [0.17-1.00] | [0.13-1.00] | [0.14-1.00] | [0.11-1.05] | [0.13-1.00] | [0.14-1.00] | [0.15-1.00] |
| SE | | | | | | | |
| Mean | 0.90 | 0.88 | 0.79 | 0.76 | 0.72 | 0.74 | 0.77 |
| S.D. | (0.15) | (0.15) | (0.20) | (0.23) | (0.21) | (0.25) | (0.20) |
| Min-max. | [0.30-1.00] | [0.31-1.00] | [0.23-1.00] | [0.15-1.00] | [0.10-1.00] | [0.14-1.00] | [0.12-1.00] |

Table C.2: Number (percent) of real estate companies experiencing increasing, decreasing or constant return to scale

| | Decreasing return to scale | Constant return to scale | Increasing return to scale | Total |
|---|---|---|---|---|
| 2001 | 11(21%) | 20(38%) | 22(42%) | 53 |
| 2002 | 20(36%) | 14(25%) | 22(39%) | 56 |
| 2003 | 39(60%) | 12(18%) | 14(22%) | 65 |
| 2004 | 25(28%) | 24(27%) | 41(46%) | 90 |
| 2005 | 52(50%) | 14(14%) | 37(36%) | 103 |
| 2006 | 67(57%) | 21(18%) | 30(25%) | 118 |
| 2007 | 85(60%) | 25(18%) | 32(23%) | 142 |
| 2008 | 80(56%) | 27(19%) | 36(25%) | 143 |
| 2009 | 94(64%) | 23(16%) | 31(21%) | 148 |
| 2010 | 80(58%) | 19(14%) | 40(29%) | 139 |
| 2011 | 78(57%) | 18(13%) | 42(30%) | 138 |
| 2012 | 67(48%) | 18(13%) | 54(39%) | 139 |
| 2013 | 80(58%) | 18(13%) | 41(29%) | 139 |
| 2014 | 77(51%) | 26(17%) | 48(32%) | 151 |
| 2015 | 79(54%) | 25(17%) | 42(29%) | 146 |

Note: Percentages may not add to 1 because of rounding

Table C.3: A comparison of efficiency results (mean efficiency score) for smaller real estate companies and larger real estate companies (2001-2015)

| Measure | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|
| OTC | | | | | | | | |
| Smaller | 0.709 | 0.596 | 0.561 | 0.626 | 0.376 | 0.519 | 0.415 | 0.486 |
| Larger | 0.749 | 0.773 | 0.624 | 0.674 | 0.351 | 0.519 | 0.416 | 0.516 |
| PTE | | | | | | | | |
| Smaller | 0.825 | 0.675 | 0.601 | 0.718 | 0.506 | 0.622 | 0.562 | 0.587 |
| Larger | 0.776 | 0.839 | 0.769 | 0.778 | 0.652 | 0.686 | 0.694 | 0.662 |
| SE | | | | | | | | |
| Smaller | 0.864 | 0.897 | 0.931 | 0.878 | 0.766 | 0.836 | 0.757 | 0.853 |
| Larger | 0.959 | 0.915 | 0.808 | 0.883 | 0.570 | 0.766 | 0.602 | 0.798 |

| Measure | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|
| OTC | | | | | | | |
| Smaller | 0.486 | 0.439 | 0.384 | 0.347 | 0.324 | 0.357 | 0.363 |
| Larger | 0.567 | 0.469 | 0.442 | 0.399 | 0.387 | 0.432 | 0.429 |
| PTE | | | | | | | |
| Smaller | 0.545 | 0.488 | 0.468 | 0.462 | 0.451 | 0.515 | 0.446 |
| Larger | 0.651 | 0.561 | 0.608 | 0.565 | 0.585 | 0.593 | 0.589 |
| SE | | | | | | | |
| Smaller | 0.911 | 0.914 | 0.836 | 0.774 | 0.756 | 0.714 | 0.812 |
| Larger | 0.882 | 0.849 | 0.749 | 0.745 | 0.678 | 0.774 | 0.735 |

Note: Smaller real estate companies are identified as those being smaller than the median total assets for the given year. Larger real estate companies are identified as those being larger than the median total assets for the given year

# Appendix D: The Effect of Market Power

This section will examine the market power hypothesis, firms in a concentrated market may exercise market power in pricing and earn supernormal profits. In order to measure market concentration, we will focus on real estate companies who are operating in single sector only. We further exclude companies in other sector since this category consists of a combination of different sectors. We also exclude hotel since only 1 company in our sample is in this sector. Thus, it left us with companies in four sectors: industrial-warehouse, office, residential, retail and self-storage. We use Herfindahl-Hirschman index (HERF) to measure market concentration.

$$HERF = \sum_{i=1}^{N} s_i^2 \qquad (12)$$

Where $s_i$ is the market share of firm i in the market, and $N$ is the number of firms. For each sector and each year, we assume that the company in our sample are the universe of the sector and we use market capitalisation to calculate market share. The summary statistics of HERF index for each sector is shown in Table D.1 Self-Storage shows the highest market concentration whereas retail shows the lowest market concentration.

Table D.1: Summar statistics for HERF index

| Sector | Mean | SD |
|---|---|---|
| Industrial-Warehouse | 0.30 | 0.08 |
| Office | 0.23 | 0.06 |
| Residential | 0.24 | 0.15 |
| Retail | 0.17 | 0.02 |
| Self-Storage | 0.60 | 0.14 |

Table D.2 provides the regression results for the effect of market concentration on expense, revenue, return and cost of capital of real estate companies. We do not find any evidence that supports the market power hypothesis. Market power has no effect on revenue, return and capital costs. However regression (4) shows that total cost to assets ratio is higher in a more concentrated market. This result can be explained by the quiet life hypothesis, firms with greater market power are less efficient due to a relaxed environment and thus put less effort in minimising cost.

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Table D.2: Effect of HERF

| | (1) NOI/Market Cap | (2) NOI/Revenue | (3) SG&A/Asset | (4) Total Cost/Asset | (5) ROAE | (6) ROAA | (7) Interest Expense/Debt | (8) WACC |
|---|---|---|---|---|---|---|---|---|
| Log(EV) | 54.308*** | 33.088*** | -2.647*** | -0.724 | 6.020 | 2.518 | 0.374 | 1.538** |
| | (3.62) | (3.33) | (-2.73) | (-0.50) | (1.00) | (0.72) | (0.38) | (2.10) |
| $Log(EV)^2$ | -4.026*** | -2.505*** | 0.162** | -0.031 | -0.170 | -0.017 | -0.078 | -0.172*** |
| | (-3.74) | (-3.44) | (2.27) | (-0.30) | (-0.38) | (-0.07) | (-0.99) | (-3.00) |
| HERF | 18.160 | -16.916 | 3.979 | 3.477*** | 3.970 | 1.012 | -1.990 | -0.062 |
| | (1.14) | (-1.41) | (1.26) | (3.38) | (0.54) | (0.29) | (-1.47) | (-0.05) |
| MABidder | -2.421 | -1.970 | 0.004 | -0.293 | 2.204 | 0.618 | -0.220 | 0.049 |
| | (-1.01) | (-0.75) | (0.05) | (-1.29) | (1.49) | (0.88) | (-1.33) | (0.24) |
| $MABidder_{t-1}$ | 7.133* | 4.794 | 0.177 | 0.430* | -2.113 | -1.409* | 0.317 | 0.600*** |
| | (1.81) | (1.32) | (1.21) | (1.76) | (-1.43) | (-1.78) | (1.43) | (2.64) |
| Total Debt/ Total Cap | -0.080 | 0.239*** | -0.014* | -0.004 | -0.426*** | -0.231*** | -0.029* | 0.019** |
| | (-0.36) | (2.65) | (-1.94) | (-0.58) | (-8.37) | (-10.62) | (-1.95) | (2.19) |
| ST Debt/ Debt | 0.057 | -0.082 | -0.002 | -0.003 | -0.055 | -0.024 | 0.007 | -0.005 |
| | (0.52) | (-1.53) | (-0.36) | (-0.54) | (-1.49) | (-1.60) | (0.47) | (-0.65) |
| Asset Growth | -0.007 | -0.033*** | -0.003*** | -0.007*** | 0.042** | 0.022*** | -0.007*** | -0.004*** |
| | (-0.55) | (-3.03) | (-2.86) | (-5.23) | (2.07) | (2.98) | (-3.21) | (-3.24) |
| Intercept | -172.842*** | -104.027*** | 13.269*** | 15.365*** | -7.940 | -2.745 | 9.130*** | 1.051 |
| | (-3.67) | (-3.03) | (4.22) | (2.87) | (-0.37) | (-0.22) | (3.22) | (0.44) |
| Country Control | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *N* | 554 | 515 | 554 | 476 | 530 | 548 | 505 | 481 |
| Adj. $R^2$ | 0.460 | 0.598 | 0.371 | 0.770 | 0.337 | 0.469 | 0.116 | 0.407 |
| Hausman Test | 21.43*** | 18.36** | 4.29 | 18.01** | 34.92*** | 22.17*** | 11.73 | 22.85*** |

Note: See Appendix A. Regressions (1),(2),(4),(5),(6)and (8) are estimated by fixed effect. Regressions (3) and (7) are estimated by random effect.
t statistics in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01

## References


- Aigner, D. J., Lovell, C. A. K. and Schmidt, P. (1977). 'Formulation and Estimation of Stochastic Frontier Function Models', *Journal of Econometrics*, Vol. 6, pp. 21–37.
- Ambrose, B. W., Highfield, M. J., & Linneman, P. D. (2005). Real estate and economies of scale: the case of REITs. *Real Estate Economics*, *33*(2), 323.
- Ambrose, Brent W., and Peter Linneman, "Organizational Structure and REIT Operating Characteristics," *The Journal of Real Estate Research* 21:3 (2001) 141-162.
- Ambrose, Brent W., Steven R. Ehrlich, William T. Hughes, and Susan M. Wachter, "REIT Economies of Scale: Fact or Fiction," *The Journal of Real Estate Finance and Economics,* 20:2 (2000) 211-224.
- Barclay, M. J., & Smith, C. W. (1995). The maturity structure of corporate debt. *The Journal of Finance*, *50*(2), 609–631.
- Battese, G. E. and Coelli, T. J. (1995). 'A Model of Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data', *Empirical Economics*, Vol. 20, pp. 325–332.
- Berger, A. N., Hanweck, G. A., & Humphrey, D. B. (1987a). Competitive viability in banking. *Journal of Monetary Economics*, *20*(3), 501–520. http://doi.org/10.1016/0304-3932(87)90039-0
- Berger, A. N., Hanweck, G. A., & Humphrey, D. B. (1987b). Competitive viability in banking: Scale, scope, and product mix economies. *Journal of Monetary Economics*, *20*(3), 501–520.
- Berger, A. N., & Mester, L. J. (1997). Inside the black box: What explains differences in the efficiencies of financial institutions?. *Journal of banking & finance,* 21(7), 895-947.
- Busching, T. (2007). Germany enters the REIT universe with a big bang. *Journal of Retail & Leisure Property*, *6*(3), 181–187.
- Campbell, R. D., & Sirmans, C. F. (2002). Policy implications of structural options in the development of real estate investment trusts in Europe: Lessons from the American experience. *Journal of Property Investment & Finance*, *20*(4), 388–405.
- Coelli, T. J. (1996). 'A Guide to FRONTIER Version 4.1: a Computer Program for Stochastic Frontier Production and Cost Function Estimation', *CEPA Working Paper 97/07*, Center for Efficiency and Productivity Analysis, University of New England, Armidale.
- Eichholtz, P., & Kok, N. (2007). The EU Reit and the internal market for real estate. *Available at SSRN 1081198*.
- Eichholtz, P. Holtermans, Rogier and Yönder, Erkan, (2015), The Economic Effects of Owner Distance and Local Property Management in U.S. Office Markets (May 27, 2015). Forthcoming in the *Journal of Economic Geography*. Available at SSRN: http://ssrn.com/abstract=2498547 or http://dx.doi.org/10.2139/ssrn.2498547
- Fuerst, F.; Matysiak, G.A. (2013): Analyzing the Performance of Non-Listed Real Estate Funds: A Panel Data Analysis. *Applied Economics.*45/14, 1777-1788.
- Gilligan, T., Smirlock, M., & Marshall, W. (1984). Scale and scope economies in the multi-product banking firm. *Journal of Monetary Economics*, *13*(3), 393–405.
- Kim, H. Y. (1986). Economies of scale and economies of scope in multiproduct financial institutions: Further evidence from credit unions. *Journal of Money, Credit and Banking*, *18*(2), 220–226.
- Krautz, S.; Fuerst, F., (2015): Size Signals Success: Evidence from Real Estate Private Equity, *Journal of Portfolio Management*, Real Estate Special Issue 2015 1-9.
- Krugman, P. (1980). Scale economies, product differentiation, and the pattern of trade. *The American Economic Review*, 70(5), 950–959.
- Meeusen, W. and van den Broek, J. (1977). 'Efficiency Estimation from Cobb–Douglas Production Functions with Composite Errors', *International Economic Review*, Vol. 18, pp. 435–444
- Miller, S. M., Clauretie, T. M., & Springer, T. M. (2006). Economies of scale and cost efficiencies: A panel-data stochastic frontier analysis of real estate investment trusts.*The Manchester School*, 74(4), 483-499.
- Titman, S., & Wessels, R. (1988). The determinants of capital structure choice. *The Journal of Finance*, *43*(1), 1–19.
- Willard, M., & Youguo, L. (1991). An examination of the small-firm effect within the REIT industry. *Journal of Real Estate Research*, *6*(1), 9–17.