Option Pricing under Stochastic Volatility of US REITs

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Abstract

Margrabe (1978) developed the first option pricing model to value the exchange of two financial assets. One of its main applications is the pricing of M&A activities. In the real estate industry, however, the development of some sector-specific measures and the (real) nature of underlying assets require an adaption of the Margrabe (1978) model to study M&A activities for the REIT (Real Estate Investment Trust) industry. We argue that an application to this specific equity sector allows us to study the impact of internal and external funding more carefully because of the presence of a specific measure of funds created internally (FFO) and assets used to guarantee lenders. Both external and internal funds are treated as additional items to the existing capital structure of the company/project, with the latter being treated as cash flows of the project and the former as additional value to the project NPV.

The empirical study demonstrates that there is an emerging optionality when one REIT takes over another. Moreover, consideration of funding for expansion should lead to a REIT trading at a premium to its NAV and the introduction of a stochastic volatility should increase the option value. Finally, we show that our model explains the behaviour of M&A pricing better than any traditional method and that an appropriate calibration enhances the pricing capabilities of the model under different scenarios.

Keywords: Exchange Options, M&A, REITs and Stochastic Volatility

JEL: C4, C5, G1 and G3.

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1 Background

This empirical study analyses a compound option that emerged when one REIT took over o merged another REIT. Although not much literature has been written on analysing REITs using option pricing under stochastic volatility, it seems in practice there are emerging optionalities within REITs industry. Due to limited or non-availability of literature on option pricing under stochastic volatility of REITS, the literature for this empirical study will be drawn from option pricing, asset pricing, stochastic volatility, stochastic calculus, real options option and real estate finance. Furthermore, it is assumed that empirical study is undertaken under complete markets as sample data is on listed real estate funds.

According to Clayton *et al.* 2007, there are three valuation methods that are used by academicians and practitioners to value REITs; discounted cash flows (DCFs), earnings based valuation done either through dividend discount model (DDM) or adjusted funds from operations (AAFO) and net asset value (NAV) methods. Although, earnings based valuations are very robust but there is of debate on which items should or not be adjusted when using earnings based valuations such mark to market premium on derivatives (hedges) and mark to market on debt instruments (loans). Therefore, debate around which items to include or not to include leads to earnings based valuation being subjective. As such, homogeneity amoung different markets and REITs is not captured accurately when using earnings based valuations. NAV, despite of being simplest technique, it does capture similar items amoung different markets and funds; therefore, NAV is a reliable valuation method. The NAV measure the difference between the assets and liabilities of the company and the difference is divided by number of outstanding shares, usually the long-term ones. From Sharpe's (1969) empirical study, it can inferred that NAV is gives a better insight about the value of the evaluated company as long term investments, assets and liabilities are better indicator of the true of the company.

So far, one of the widely used model for valuating an option to exchange one asset for another is Margrabe (1978) model. One key advantage of Margrabe (1978) model is its flexibility including adjustment of option variables of the model. Margrabe (1978:177) stated that "thus, the formula for the European option is also valid for its American counterpart". Margrabe's (1978) empirical study assumes that cash flows of two merging entities are swapped for one another and the model calculates the exchange option based of share price of two merging companies. Both the share price and NAV represent "value" of companies except that the share price is more "noisy" than NAV. The NAV is driven mainly by the balance sheet items of the REIT. Advantages of

NAVs includes working well when the asset base is stable and asset base of most real estate funds are stable. Therefore, it is proposed that a "new" Margrabe (1978) model on REITs should incorporate NAVs as opposed to share prices in the original Margrabe (1978).

Furthermore, sometimes REITs' share price trade away from their NAV as explored by Clayton and McKinnon (2000), leading to questions like between NAV and share prices of REITS which one gives fair valuations. Interestingly, the issue of REITs trading away from their NAV has been majorly debated academicians and real estate finance practitioners will little or no consensus at all. However, some empirical studies such as ones by Campbell *et al.* 2001, Campbell *et al.* 2005, Anderson *et al.* 2002, and Born *et al.* 1989, explicitly illustrate after the announcement to Mergers and Acquisitions (M&As) until some time after the M&A transaction happened, REITs' share prices trade away from their NAVs. Intuitively, when stocks trade higher than their NAVs, then there should be an extra value embedded in share prices.

The rest of the paper is organised as follows; section 2 explores M&As within REITs industry, section 3 outlines data collection and possible assumption on that data, section 4 is on the development of "new" Margrabe (1978) REIt model, section 5 is on behaviour of REITs' share prices, section 6 is on stochastic volatilities, section 7 outlines empirical results of asymmetric Generalised Autoregressive Conditional Heteroskedasticity [GARCH (1;1)] and option pricing, and final section concludes the empirical study.

2 M&As within REITs Industry

It seems that most M&As within REITs industry took place from the mid-1990s and they were fuelled mainly by either real estate companies going public or consolidation that was underpinned by desire to achieve economies of scale as illustrated by empirical studies such as ones by Gordon (1998), Mueller (1998), Mooradian and Yang (2001) and Born *et al.* 1989. During the same period, value of REITs reached exceptional high levels. Clayton *et al.* (2007: 588) state that "starting in 1992, however, the equity REIT market experienced tremendous growth, increasing from a market capitalisation of less than \$9 billion to nearly \$128 billion by 1997".

Gordon (1998) explored the best possible way of managing a REIT when an investment manager has an option of treating a REIT either as direct investment portfolios (DIPs) or stock investment portfolios (SIPs). The major difference between DIPs and SIPs is that DIPs are managed by an outsider while the 'true' owners maintain the investment rights while SIPs are managed internally by 'true' owners. In principle, Gordon (1998) was investigating the best value adding strategy. The empirical study was based on what happened in REIT industry in 1990s in the United States of America (USA). During the same period, returns earned by most REITs were decreasing and investors acknowledged that alternative investment routes needed to explore in order maximise REITs returns. One of the ways that was confirmed to be a suitable returns enhancing strategy was acquisitions of other REITs or related real estate funds. Born, *et al.* 1989's empirical study illustrated that returns of REITs when M&As deals are announced tend to be positive and statistically significant; however, the mean return was positive but statistically insignificant. Acquisitions lead to an increase in economies of scale of most REITs in 1990s in USA. Furthermore, the empirical study advocates internal active management of REITs in order to improve overall returns which in theory support the notion that REITs should be treated as SIPs. Anderson *et al.* (2002:611) stated that "the results indicate that internal REIT management increases all measures of efficiency while increasing the debt ratio reduces the pure technical efficiency (i.e. PTE).

Mueller (1998) analysed whether the increase in REITs' total earnings and size sustains REITs' growth in the long run. According to Mueller (1998) the marathon of growing REITs started in 1992 in the USA as well. Furthermore, Mueller (1998) grouped REITs into different sizes; *small-cap*, *mid-cap*, *large-cap* and *mega-cap*. Despite of the economics of scale that was achieved through M&As, the funds from operations (FFO) of REITs were found to be decreasing with an increase in asset base. Mueller (1998:150) states that "as REITs grow bigger, they need a larger acquisition dollar appetite or must find more profitable investments to maintain the same FFO per share growth rate, or they must convince investors to accept lower dividend yield". Mooradian and Yang (2001) stated that REITs investor should be encouraged to accept lower dividends payout in order for the left money to be re-invested in the company. Results illustrated that operating efficiencies through M&As were higher for small-cap REITs than mega-cap REITs. Interestingly, the large-cap REITs were effective in decreasing debt and equity capital costs. In addition, large-cap and mega-cap REITs mainly benefitted from going public at metamorphosis phase and their stocks were placed on stock exchange mostly at premium to their NAVs. Although, the reason why REITs benefited from funding opportunities, it seems that when REITs with a large balance and market capitalisation apply for funding, they (large-cap REITs) tend to get better re-financing terms than small-cap REITs. As tax payments of earnings generated from REITs are taxed within individual investors; therefore, there are no tax savings benefits. However, announcement of taking debt by REITs is regarded as being positive financial markets. "Thus, the positive REIT stock price response to new debt announcements was interpreted by the authors as an investor response to a signal of future profitability", [Born, McIntosh and Officer (1989: 143)]. Other REITs used venture capital to grow which is highly risky than going through M&As; however, the option values that are generated in venture capital projects (VCPs) tend be to higher due to massive capital and higher risks associated VCPs as shown by Ahnefeld and Mehler-Bicher (2002), and Davis *et al.* 2004.

In conclusion, Mueller's (1998) empirical study illustrates that it easier and safer for small-caps, mid-caps and to some extant large-caps to grow through acquisitions; however, mega-caps benefit a lot by going public. Furthermore, investor should distinguish from growth of assets base and FFOs as they are not intertwined. Mooradian and Yang (2001) asserted that growth in assets base of REITs is normally associated with an increase in debt-to-book value of companies.

Campbell *et al.* 2005 explored any value creation benefits due to REITs merging. Like most empirical studies on REITS in USA, the sample study is based of M&A transactions that were record between 1994 and 2009. Prior to Campbell *et al. 2005*, there was a similar study by Campbell *et al. 2001* except the 2001's emphasis was on the information content within M&A activity in REITs. During the same time, REITs although denominated in different terms and they were infancy stages in many countries throughout the world. According to Campbell *et al. 2005*, main sources of value creation within REITs industry were selling equity units within REITs and REITs companies going public. Despite of benefits that were brought by growth of M&As transactions in REITs, there contentious issues such managing REITs and corporate control. In USA, the established of "Umbrella Partnership REIT" (UPREIT) was instrumental in driving M&As deals in REITs industry. Campbell *et al.* 2001 illustrated that information had a big influence on listed REITs confirming that, *ceteris paribus*, the target firm's share price tend to decline after the announcement of the merger or takeover. Normally, the financial markets interprets that one REIT is being taken over by another because of target REIT's inefficiencies. The fundamental idea behind UPREIT was conversation of REITs and related real estate funds into shares of REITs or equivalent market prices on stock exchange. Therefore, there was an extra option value generated through established of UPREIT by stating that REITs should held for sometime before the actual conversation taking place. Anderson *et al.* 2002, conquer with Campbell *et al.* 2005 that proper re-structuring of REITs improved efficiency lead to higher returns. Furthermore, Anderson *et al.* 2002, state that prior REIT re-structured, between 1992 and 1996, there were a lot of inefficiencies with REITs industry. The sample included 53 public-private merges in which a private held REIT is being taken over by a public trading REIT.

Campbell *et al.* 2005 excluded any merger were the target REIT was acquired for $50 million or less. In general, there were returns for most transactions; however, most benefits were realised when the taken over REIT's management formed part of the new merged entity and lowest return when none of acquired management were retained. Furthermore, benefits of the mergers was not solely to the shareholders but included the REIT industry as well in terms of consolidation and availability of information increased. Other *ex post* benefits that were found that are normally questionable with most M&As transactions include effective company structures. M&As deals that took place within mid-1990s were necessarily and idea in bringing efficiency within REITs industry according Anderson *et al.* 2002. Campbell *et al. 2001*, just like Campbell *et al. 2005*, confirmed that in case of public-private merger, the returns are significantly positive especially those accruing to the acquirer in the long run.

3 Data

The data sample consists of thirty-seven (37) completed REITs M&A deals that took place in United States of America (US) between mid-1990s and late-2000s. The original sample is made up of eighty-six (86) completed REITs M&A deal; however, because of poor shortage of some data on some REITs M&A deals, thirty-eight (38) were deleted by from final sample as results with from incomplete of 38 REITs M&A deals will create inconsistence in results. The data was extracted from SNL Financials database. Only mergers between one REITs and another were analysed. Mergers between REITs and real estate operating companies (REOCs) were left out as data on REOCs was either poorly recorded or non-existent.

The NAV of the all REITs and listed real estate funds were calculated by taking the difference of each organisation's total assets and liabilities divided by organisation's outstanding ordinary shares.

All the transactions are listed in alphabetical order as per the name of the acquirer of the transaction. In some cases where the acquirer merged with more than one REIT at different times, the acquirer ticker will be represented by its ticker with a numerical number as from the merger to the last one in order to illustrate different mergers by one acquirer and different targets.

4 REITs Magrabe (1978) Model

Margrabe (1978) and Sebehela (2008) illustrated that a call option of Margrabe (1978) model can be written as:

$$C[S_1, S_2, (T-\tau)] = S_1 e^{-\gamma_1(T-\tau)} N(d_1) - S_2 e^{-\gamma_2(T-\tau)} N(d_2) \quad (1)$$

where
$$d_1 = \frac{\ln(S_1/S_2) + (\gamma_1 - \gamma_2 + \sigma_p^2/2) * (T-\tau)}{\sigma_p \sqrt{T-\tau}}, \quad (2)$$

$$d_2 = \frac{\ln(S_1/S_2) + (\gamma_1 - \gamma_2\, \sigma_p^2/2) * (T-\tau)}{\sigma_p \sqrt{T-\tau}} \text{ or } d_2 = d_1 - \sigma_p \sqrt{T-\tau} \quad (3)$$

and $\sigma_p = \sqrt{\sigma_1^2 + \sigma_2^2 - 2\rho_{1,2}\sigma_1\sigma_2}$

The call option is represented by C, S_1 is the exchanged asset for another one, S_2 is the acquired asset, $T-\tau$ is time to expiration (in this case time to expiration starts when the merger is announced till when the deal is closed), γ_1 and γ_2 are cost of carries for assets one and two respectively, σ_1 and σ_2 are volatilities of assets one and two respectively, σ_p is the combined volatility of assets one and two, $\rho_{1,2}$ is the correlation coefficient between assets one and two, d_1 and d_2 are probabilities of being in the money when risk-free interest is numeraire, $N(d_1)$ and $N(d_2)$ are cumulative normal density functions of d_1 and d_2 respectively. Although, the share price of any listed company should reflect all available information about that company under efficient market hypothesis (EMH) as it can be inferred from Fama *et al. 1969*; however, there is a time lagging effect in REITs that leads to information being priced in later than expected. A good example of a time lagging effect would where properties owned by a REIT are re-evaluated and the stock market will be informed about the new values after re-evaluation has been completed. One of the leading property appraisers, Investment Property Databank (IPD) does most valuations on properties and release the valuation reports once per year leading to time lagging effect on pricing information in REITs' share price, although ultimately the new information will be priced in after some time.

For reasons stated earlier, S_1 and S_2 will be replaced by NAV_1 and NAV_2 respectively. Furthermore, the funding (either external or internal) that acquirer sometimes uses in order to acquire the targeted firm, will be added to the acquirer's NAV. Ahnefeld, Mehler-Bicher (2002), Davis *et al.* 2004, Jaimungal and Lawryshyn (2009), and Rose (1998) illustrated that when funds are used to expand existing project, those injected funds are treated as an extra 'value' to the existing project's value. The extra 'value' will be represented by *lambda* (λ). In order for the 'extra' value, lambda to be to be consistent with the NAV calculation, the lambda will be divided by the number of outstanding shares.

Therefore, it proposed that the call option of REITs Margrabe (1978) model should be written as follows:

$$C[NAV_1, NAV_2, (T-\tau)] = NAV_1 e^{-\gamma_1(T-\tau)} N(d_1) - NAV_2 e^{-\gamma_2(T-\tau)} N(d_2) \quad (4)$$

where
$$d_1 = \frac{\ln(NAV_1 / NAV_2) + (\gamma_1 - \gamma_2 + \sigma_p^2/2) * (T-\tau)}{\sigma_p \sqrt{T-\tau}} \quad (5)$$

and d_2 and σ_p are still the same as in the original Margrabe (1978) model.

When funding was used for acquisitions, the call option of REITs Margrabe (1978) model expands into:

$$C[(NAV_1 + \lambda), NAV_2, (T-\tau)] = (NAV_1 + \lambda) e^{-\gamma_1(T-\tau)} N(d_1) - NAV_2 e^{-\gamma_2(T-\tau)} N(d_2) \quad (6)$$

where
$$d_1 = \frac{\ln[(NAV_1 + \lambda) / NAV_2] + (\gamma_1 - \gamma_2 + \sigma_p^2/2) * (T-\tau)}{\sigma \sqrt{T-\tau}} \quad (7)$$

and d_2 and σ_p are still the same as in the original Margrabe (1978) model.

5 Behaviour of REITs' Share Prices

More and more empirical studies on REITs and related real estate products show that listed real estate funds are increasing becoming integrated into capital markets as illustrated by Clayton and MacKinnon (2001), Myer and Terris (1995), and Okunew *et al.* 2000, although REITs are fairly low risk securities as compared to other capital market securities. Clayton *et al.* (2004: 621) states that "in general, REITs are low-beta stocks, but they are certainly not zero-beta assets". Furthermore, the prices of tradable securities follow a Geometric Brownian Motion (GBM) as demonstrated by Alexander (2008) and inferred from Kasznik and McNichols (2002), and Praetz (1972). Therefore, REITs' share price just like most tradable securities should follow a random walk (RW); however, in this empirical study REITs' share prices are replaced by their NAVs. Any stochastic process that follows a Brownian Motion (BM) should be a martingale.

A stochastic process is called a martingale if for all $s \leq t$ holds and its expectation should be represented as follows; $\mathrm{E}[X_t - X_s | (X_\tau)_{\tau \leq s}] = 0$, where X is the share price of a stock. Given an earlier statement that demonstrated that share prices and NAVs are similar as both measure "value" of REIT; therefore, X can be replaced by NAV. Furthermore, the following characteristics should hold:

- Interpretation: no drift, no trend.
- For i.i.d. if $\int NAV \mu_t(nav) dnav = m = 0$.
- Markov process: $\int_{\Re} NAV_1 p(t, s, nav_0, dnav_1) = 0$.
- Brownian motion is a martingale.
- Can have very complicated dependence on the past.

It also assumed that the final process is a natural filtration of some previous process. In order for a future stochastic process to be naturally filtrated by some prior process, the following should hold:

- Encoding of knowledge.
- F_t is a σ-algebra; describes knowledge of agent at time t.
- Collection $(F_t)_{t \in I}$ is called filtration if for all $s \leq t$ holds $F_s \subset F_t$.
- A stochastic process is called adapted if NAV_t is F_t measurable.
- Natural filtration of a process $(NAV_t)_{t \geq 0}$: F_t is the σ-algebra generated by $(NAV_s)_{s \leq t}$.
- Any process is adapted w.r.t. its own filtration.
- A stochastic process $(Y_t)_t$ is adapted w.r.t. the natural filtration of process $(NAV_t)_t$ if Y_t is a function only of $(NAV_s)_{s \leq t}$.

Taking into account that NAV flows BM and the future process can be filtrated w.r.t. its past process (f_s), then the following can be proven that the excepted value of a random process, NAV_t at future time ***t***, given that its present time ***s***, taking the whole history of the Brownian Motion (BM) process is $\mathrm{E}[NAV_t / f_s \mathrm{N} \ s < t]$, where E represents the expectation. Decomposing NAV_t into known value NAV_s and the random increment is $[NAV_t - NAV_s]$. That gives:

$$\mathrm{E}[NAV_t | F_s] = \mathrm{E}[NAV_s + NAV_t - NAV_s | F_s] \quad (8)$$

$$= \mathrm{E}[NAV_s | F_s] + \mathrm{E}[NAV_t - NAV_s | F_s] \quad (9)$$

$$= NAV_s + \mathrm{E}[NAV_t - NAV_s | F_s] \quad (10)$$

The value NAV_s given the history to time ***s*** is not a random variable but the known value NAV_s, so $\mathrm{E}[NAV_s | F_s] = NAV_s$, which proves that the process is a martingale. Furthermore, any martingale process follows BM. Then $NAV_t - NAV_s$ equation is an increment from ***s*** to ***t*** and it is an independent of the value of BM at time ***s*** or earlier and the unconditional expectation of $\mathrm{E}[NAV_t - NAV_s | F_s] = \mathrm{E}[NAV_t - NAV_s] = 0$.

6 Stochastic Volatility

The spot volatility will be based on the returns of the acquirer as prior the actual merger takes place, the acquirer is more like an independent variable deriving the whole merger process and most information known to about the possible M&A deal is mainly driven by the acquirer; however, there will always be speculation about possible targets. Although not explicitly stated Hunter and Jagtiani (2003) illustrated that in a merger, the acquirer influences the fees to be paid towards the merger and movement of shares prices before and after the merger. Therefore, acquirer is more like the market of the specific merger transaction. As the empirical study analyse when the optionality emerges, the volatility is based of returns as calculated based on the share price of the acquirer until one day prior the merger announcement. Baker and Savasoglu (2003), Fuller *et al.* 2002, Hamich (2004), Mitchell *et al.* 2004, Officer (2003) and Shleifer and Vishny (2003) state that a days ranging form twenty (20) to fifty three (53) prior merger announcement give a good insight of events unfoldings and likely state of the merged entity. Prior studies on volatility of stock markets such as one by Alexander and Lazar (2009) illustrated that volatility is stochastic in the long run and deterministic in the short, although deterministic volatility is stochastic in relation to stock price at same time. As the empirical study is on tradable assets, then the stochastic volatility model used to estimated volatility should be scale-invariant and one such model Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model. Alexander (2008) stated that a process is scale-invariant only if the ratio of the option price to its underlying price is same; however, scale-invariance theory is beyond the scope of this empirical study. When you estimate GARCH parameters sample size should be at least five hundred (500) in order to have "good" parameters, however, in some mergers sample sizes would be less than 500.

Insert Appendix one here

Appendix one on normality tests illustrate that data is skewed and is not normally distributed as illustrated by the Jarque-Berra values. Therefore, the stochastic volatility should be modelled by stochastic volatility model that takes into account asymmetry of data and skewness. In principle, normality tests support using a GARCH (1; 1) model in this case. Alexander (2008) and Hull (2006) stated that some advantages of GARCH (1; 1) include the leverage effect captured by the model and suitability for asymmetric data. The daily weekly returns of acquiring REIT since it has been listed will be used to estimate *parameters* of *GARCH (1; 1)* model of each merger. Alexander (2008) stated that that *conditional variance* equation of asymmetric GARCH model is $\sigma_t^2 = \omega + \alpha(\varepsilon_{t-1} - \lambda)^2 + \beta\sigma_{t-1}^2$ where $\omega > 0, \alpha, \beta, \lambda \geq 0$. Alexander (2008) further stated that ω (omega) is the constant coefficient of the variance equation, α (alpha) determines *reaction* of the volatility to market events, β (beta) determines the *persistence* in volatility, $\alpha + \beta$ determines the rate of *convergence* of the conditional volatility to the long term average level and λ (lambda) determines the *leverage* effect in GARCH (1;1) and ε (error term) is the divergence between the same calculated and forecasted dependent variable. Alexander (2008) illustrated that $\alpha + \beta \leq 1$ otherwise the variance formula will explode. The long-term volatility $(\bar{\sigma})$ is the annualised is given by the following formula; $\bar{\sigma} = \sqrt{\frac{\omega}{1 - \alpha - \beta}}$ implying that all GARCH parameters determine the long term volatility.

7 Empirical Results

7.1 GARCH (1; 1) Results

Insert Appendix two here

Appendix two illustrates that most estimated GARCH (1;1) model parameters (omega, alpha, leverage and beta) are statistically significant, which makes the parameters reliable in this empirical study; however, there some which are statistically insignificant for reasons stated earlier relating to data. Moreover, the sum of alpha (α) and beta (β) is at most one; otherwise the GARCH (1; 1) model would explode. Stochastic volatilities (σ_t) versus their long-term average volatilities $(\bar{\sigma})$ confirm that during the M&A activity, all different deals‘ stochastic volatilities are higher their long-term avarega volaities. The phenomenn were stochastic volatilities converger to ther long-term avaregae volatilities from above is synonymous with volatile financial markets. In principle, the GARCH (1;1) illustrate that between mid-1990s to late-2000s, the US stock market was bullish.

Insert Appendix three here

The model selection criteria (Akaike info criterion, Schwartz criterion and Hannan-Quinn criterion) as illustrated by appendix three, indicate the selected model, GARCH (1; 1) is a good model given the number of data points used to simulate the model's parameters. Asemota and Shittu (2009) illustrated that with a minimum sample of 50 data points irrespective the level of the process used to simulated statistical model, Akaike info criterion, Schwartz criterion and Hannan-Quinn criterion confirm that simulated GARCH model parameters are "good fits". In this empirical study the Durbin-Watson statics around 2, indicating that there is no autocorrelation in the data used. Durbin-Watson static states that values less than 2 indicates a positive serial correlation while Durbin-Watson static bigger than 2 indicate negative serial correlation. In principle, GARCH (1; 1) parameters and supporting variables illustrated that numbers for the model are 'good' ones.

7.2 Option Pricing Results

Insert appendix four here

The option values illustrate a pattern where option values of NAVs and funds used for acquisitions are the highest, flowed by option values of NAVs, then followed option values of share prices and funds used for acquisitions and option values of share prices only are the lowest. Mid-1990s to sometime 2000s, US economy was relatively booming which and in booming markets, asset values and prices tend to increase on average. On factor that drives assets' values in booming markets is demand of those goods and services by consumers. As stated earlier on, on the background to the empirical study, we gave a conceptual view on similarity of share prices and NAVs. Therefore, taking our conceptual view and Alexander's (2008) convergence theory of share prices and NAVs, we can assume that NAVs converge to their long term average in the long-run just like share prices. Furthermore, Capozza nd Israelsen (2007) stated that REITs' NAVs mean revert; however, NAVs take longer to mean-revert when REITs' capital structure includes debt and in this empirical study anlysed REITs' capital structure includes debt. Given that REITs' assets are relatively high in reality; therefore, the long term average NAVs of REITs during that booming period should be relative high. Intuitively, the NAV's structure is more likely to be convex in shape. Convex shaped derivatives products such as variance swaps are very lucrative than linear ones as illustrated by Alexander (2008). On the other hand, prices are mainly driven by financial market sentiments about specific stocks; therefore, share prices' long term average should be relative smaller as share prices move up and down on going basis. The two last statements, in principle give an insight why call values from share prices are lower than call values from NAVs. The fund factor, difference when funds are taken into account an when funds are not taken into account of the same item; illustrate that injection of funds increase the call option value of the M&A deal. If funds used in acquisition are taken as an underlying of the deal; therefore, it makes sense when the underlying increase, the call option value should increase. The call option value of merger between Ambassador Apartments, Inc (AIV) and with Apartment Investment and Management Company is zero because their their normal cumulative probabilities of this M&A deal are out-of-money. Therefore, that merger should not have taken the place at that time, may be things could have been better after that initial transaction date. Another interesting illustration is that some call options calculated using share prices are negative, implying short call options. Normally, when there is short call option is because the investor wants to finance his or her position. In principle, more money was needed to finance those M&A deals. SNL Financials does not have information stating whether on some deals, investors had to get extra money to conclude the M&A deals. After, making follows-ups with those REITs which we got short call options, only two (Simon Property Group, Inc and United Dominion Realty Trust, Inc) responded. Both REITs stated that they never took on extra funds to finance M&A deals. Therefore, short call options, especially for those REITs that responded are misleading as no extra funds were needed for the transactions. However, the "mis-leading" long call values give rise to arbitrage opportunities to stock market professionals such as traders depending on their investment positions at that point in time.

Insert figure 1 here

Most valuable call options were in hotel, apartment and reatil sectors and as illustrated by figure 1, those secotrs were better performing sectors during the analysed merger period of REITs. In principle, it makes sense to acquire a performing asset aand increase an existing organic structure of a REIT.

8 Conclusion

In this empirical study, we illustrate that when one REIT takes over another, there is extra value that emerges from the M&A deal due to emerging exchange option. Furthermore, when calculated exchange options in REITs industry is better to use NAVs than share prices as share prices leading to misleading conclusion. Although NAV methodology is not as robust as other methods like earnings based calculations, NAV preserves homogeneity amoung different REITs and markets. Most valuations of real estate assets are done once annually, meaning that the lagging effect of true values is not captured as much as by share prices than by NAVs, which base their calculations on evaluated assets of REITs. Furthermore, the funds used in acquisition actual add extra value to overall merged entity, although we didn't quantifying extra value added. In simple terms, REITs can increase their value by getting extra funds and making acquisitions without making any operational changes. Despite that there were extra values during M&A deals during mid-1990s to sometime 2000s, it should be born in mind that deals were concluded during booming times and they might be different in bearish markets. In bullish markets, M&As in REITS industry is not a bad thing after all and maybe M&As should be encouraged.

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Appendix
Appendix One: Normality Test Results

Acquirer	Ticker	Skewness	Kurtosis	Jarque-Berra	Prob
American Campus Communities, Inc.	ACC	-0.137	10.554	2583.26	0.000
Apartment Investment and Management Company	AIV	0.310	5.221	191.94	0.000
Bay Apartment Communities, Inc.	AVB	0.449	4.959	194.67	0.000
Brandywine Realty Trust	BDN	1.844	23.804	78583.21	0.000
Camden Property Trust	CPT	-0.033	5.823	937.62	0.000
Colonial Properties Trust	CLP	-0.198	7.823	2725.56	0.000
Developers Diversified Realty Corporation	DDR_1	0.080	6.368	926.05	0.000
Developers Diversified Realty Corporation	DDR_2	-0.140	5.801	1140.40	0.000
Duke Realty Investments, Inc.	DRE	-0.539	20.710	33657.75	0.000
Equity Office Properties Trust	ELS_1	0.293	7.726	1833.87	0.000
Equity Office Properties Trust	ELS_2	0.304	7.998	2348.59	0.000
Equity One, Inc.	EQY_1	0.342	7.509	970.00	0.000
Equity One, Inc.	EQY_2	0.268	7.358	616.04	0.000
Equity Residential Properties Trust	EQR_1	0.748	9.343	1806.70	0.000
Equity Residential Properties Trust	EQR_2	0.825	9.750	3516.70	0.000
Equity Residential Properties Trust	EQR_3	0.850	9.731	2980.01	0.000
Equity Residential Properties Trust	EQR_4	0.766	9.289	1693.53	0.000
General Growth Properties, Inc.	GGP	0.837	10.150	5034.51	0.000
Health Care Property Investors, Inc.	HR_1	-0.268	7.088	1046.99	0.000
Health Care Property Investors, Inc.	HR_2	-0.412	6.848	2048.52	0.000
Highwoods Properties, Inc.	HIW	0.930	8.608	660.40	0.000
Kimco Realty Corporation	KIM_1	0.222	6.241	1299.13	0.000
Kimco Realty Corporation	KIM_2	0.035	6.340	1732.02	0.000
Lexington Corporate Properties Trust	LXP	0.228	12.671	12565.31	0.000
Liberty Property Trust	LRY	-0.104	5.312	740.14	0.000
Mid-America Apartment Communities, Inc.	MAA	1.884	11.166	835.65	0.000
Pennsylvania Real Estate Investment Trust	PEI	-0.057	5.957	1321.95	0.000
Post Properties, Inc.	PPS	-0.219	6.821	541.20	0.000
ProLogis	PLD_1	2.003	40.977	169830.20	0.000
ProLogis	PLD_2	3.464	56.849	143576.80	0.000
Public Storage, Inc.	PSA	-0.194	11.766	14095.06	0.000
Simon Property Group, Inc.	SPG_1	0.096	9.857	5230.25	0.000
Simon Property Group Inc.	SPG_2	0.183	4.583	63.36	0.000
Simon Property Group Inc.	SPG_3	-0.278	4.076	7.58	0.000
SL Green Realty Corp.	SLG	0.039	9.168	4882.46	0.000
United Dominion Realty Trust, Inc.	UDR	2.650	25.216	6759.66	0.000
Vornado Realty Trust	VNO	7.228	119.537	1672582	0.000

Source: SNL Financials
Note: Results were simulated using Eviews

Appendix Two: GARCH (1; 1) Results

Ticker	$\overline{\sigma}$	σ_t	ω	$P(\omega)$	α	$P(\alpha)$	ε	$P(\varepsilon)$	λ	$P(\lambda)$	β	$P(\beta)$	$\alpha+\beta$
ACC	0.00913	0.78297	0.0000049	0.0009	0.05932	0.0002	0.00070	0.5757	0.08111	0.0025	0.88242	0.000	0.9417
AIV	0.00255	0.00057	0.0000059	0.0001	0.03538	0.0004	0.00121	0.0904	0.03798	0.8156	0.05847	0.000	0.0938
AVB	0.00989	0.70572	0.0000076	0.0005	0.09234	0.0000	0.00075	0.4654	0.05009	0.0768	0.82975	0.000	0.9221
BDN	0.00973	0.90538	0.0000014	0.0000	0.05257	0.0000	0.00028	0.3045	0.04043	0.0000	0.93265	0.000	0.9852
CPT	0.00867	0.69893	0.0000067	0.0000	0.07034	0.0000	0.00006	0.8720	0.08651	0.0000	0.84096	0.000	0.9113
CLP	0.01001	0.27496	0.0000310	0.0000	0.11632	0.0000	0.00013	0.7995	0.10005	0.0002	0.57418	0.000	0.6905
DDR_1	0.00870	0.86603	0.0000023	0.0000	0.04815	0.0000	0.00006	0.8899	0.04104	0.0001	0.92133	0.000	0.9695
DDR_2	0.01105	0.75187	0.0000075	0.0000	0.08624	0.0000	0.00041	0.3105	0.04038	0.0010	0.85269	0.000	0.9389
DRE	0.01240	0.92067	0.0000011	0.0013	0.05869	0.0000	0.00067	0.0633	0.01753	0.0636	0.93409	0.000	0.9928
ELS_1	0.01458	0.83923	0.0000070	0.0000	0.06925	0.0000	0.00036	0.2405	0.00737	0.4305	0.89766	0.000	0.9669
ELS_2	0.01313	0.82151	0.0000066	0.0000	0.07424	0.0000	0.00021	0.7281	0.02011	0.0354	0.88772	0.000	0.9620
EQY_1	0.01581	0.48664	0.0000375	0.0000	0.17719	0.0000	0.00029	0.7441	0.06062	0.0839	0.67273	0.000	0.8499
EQY_2	0.02148	0.56675	0.0000379	0.0000	0.24555	0.0000	0.00054	0.6418	0.03606	0.4315	0.67231	0.000	0.9179
EQR_1	0.00880	0.89318	0.0000024	0.0000	0.01818	0.0183	0.00086	0.2854	0.02918	0.0094	0.95096	0.000	0.9691
EQR_2	0.00949	0.85990	0.0000033	0.0000	0.03857	0.0000	0.00019	0.7480	0.02919	0.0018	0.92538	0.000	0.9640
EQR_3	0.00965	0.86701	0.0000031	0.0000	0.04022	0.0000	0.00019	0.7605	0.02732	0.0075	0.92691	0.000	0.9671
EQR_4	0.00907	0.89331	0.0000025	0.0001	0.01974	0.0132	0.00076	0.3692	0.02792	0.0158	0.94997	0.000	0.9697
GGP	0.01009	0.56879	0.0000147	0.0000	0.07953	0.0000	0.00030	0.2120	0.08962	0.0000	0.77608	0.000	0.8556
HR_1	0.01216	0.59021	0.0000199	0.0000	0.07770	0.0000	0.00037	0.6870	0.05569	0.0458	0.78772	0.000	0.8654
HR_2	0.01392	0.25381	0.0000591	0.0000	0.16983	0.0000	0.00054	0.4359	0.02335	0.3548	0.52516	0.000	0.6950
HIW	0.00600	0.77712	0.0000026	0.0370	0.02332	0.0880	0.00085	0.3318	0.13671	0.0000	0.90373	0.000	0.9270
KIM_1	0.00973	0.59008	0.0000116	0.0000	0.11111	0.0000	0.00038	0.4207	0.03171	0.0551	0.76631	0.000	0.8774
KIM_2	0.00981	0.66207	0.0000094	0.0000	0.08940	0.0000	0.00022	0.5994	0.03708	0.0068	0.81295	0.000	0.9024
LXP	0.01333	0.74202	0.0000134	0.0000	0.05655	0.0000	0.00014	0.8120	0.03950	0.0042	0.86799	0.000	0.9245
LRY	0.01006	0.71966	0.0000088	0.0000	0.04990	0.0000	0.00042	0.4572	0.04204	0.0016	0.86315	0.000	0.9130
MAA	0.01060	0.63217	0.0000174	0.0005	0.04113	0.0000	0.00034	0.7032	0.14386	0.0728	0.88626	0.000	0.8451
PEI	0.01123	0.67902	0.0000127	0.0143	0.05976	0.0000	0.00141	0.0143	0.04292	0.0001	0.83951	0.000	0.8993
PPS	0.00888	0.22494	0.0000269	0.0000	0.14474	0.0000	0.00018	0.8196	0.11251	0.0129	0.51404	0.000	0.6588
PLD_1	0.01124	0.56866	0.0000198	0.0000	0.04407	0.0000	0.00003	0.9554	0.08404	0.0000	0.79921	0.000	0.8433
PLD_2	0.01229	0.50686	0.0000276	0.0000	0.05953	0.0000	0.00013	0.8727	0.08697	0.0060	0.75788	0.000	0.8174
PSA	0.01307	0.59888	0.0000216	0.0000	0.08956	0.0000	0.00086	0.1163	0.06903	0.0000	0.78407	0.000	0.8736
SPG_1	0.01267	0.17717	0.0000583	0.0000	0.19992	0.0000	0.00120	0.0632	0.00161	0.9564	0.43682	0.000	0.6367
SPG_2	0.02037	0.89657	0.0000041	0.0203	0.07584	0.0010	0.03993	0.7849	0.03993	0.1694	0.91437	0.000	0.9902
SPG_3	0.02602	0.99398	0.0000028	0.4832	0.12557	0.1354	0.00289	0.1672	0.10043	0.3094	0.91563	0.000	1.0412
SLG	0.01243	0.15598	0.0000614	0.0000	0.17295	0.0000	0.00103	0.1097	0.02378	0.3856	0.42942	0.000	0.6024
UDR	0.01319	0.31630	0.0000503	0.0002	0.10487	0.0140	0.00060	0.6785	0.31078	0.0144	0.60589	0.000	0.7108
VNO	0.01594	0.39101	0.0000429	0.0000	0.27263	0.0000	0.00000	0.9991	0.13702	0.0000	0.55853	0.000	0.8312

Source: SNL Financials
Note: Results were simulated using Eviews

Appendix Three: Model Selection Criteria

Acquirer	Ticker	Durbin-Watson stat	Akaike info criterion	Schwartz criterion	Hannan-Quinn criterion
American Campus Communities, Inc.	ACC	2.032262	-5.295742	-5.268151	-5.285297
Apartment Investment and Management Company	AIV	1.939354	-6.105223	-6.072217	-6.092591
Bay Apartment Communities, Inc.	AVB	1.959522	-6.145061	-6.115755	-6.133926
Brandywine Realty Trust	BDN	2.343004	-4.469670	-4.460654	-4.466483
Camden Property Trust	CPT	1.940183	-6.262029	-6.249388	-6.257468
Colonial Properties Trust	CLP	2.237751	-6.180139	-6.167390	-6.175536
Developers Diversified Realty Corporation	DDR_1	2.044890	-5.951547	-5.934428	-5.945254
Developers Diversified Realty Corporation	DDR_2	1.977533	-5.951743	-5.941064	-5.947929
Duke Realty Investments, Inc.	DRE	2.423130	-5.185708	-5.172029	-5.180748
Equity Office Properties Trust	ELS_1	1.967536	-5.663663	-5.649312	-5.658385
Equity Office Properties Trust	ELS_2	1.975464	-5.752548	-5.737151	-5.746925
Equity One, Inc.	EQY_1	2.307180	-5.458166	-5.431248	-5.447991
Equity One, Inc.	EQY_2	2.303924	-5.352244	-5.315927	-5.338265
Equity Residential Properties Trust	EQR_1	1.904152	-5.828684	-5.799721	-5.817687
Equity Residential Properties Trust	EQR_2	1.811971	-5.997607	-5.978844	-5.990671
Equity Residential Properties Trust	EQR_3	1.805338	-5.936599	-5.915160	-5.928608
Equity Residential Properties Trust	EQR_4	1.910184	-5.797219	-5.767051	-5.785736
General Growth Properties, Inc.	GGP	1.901523	-6.102447	-6.089697	-6.097792
Health Care Property Investors, Inc.	HR_1	2.131470	-5.801344	-5.779835	-5.793325
Health Care Property Investors, Inc.	HR_2	2.041468	-5.742387	-5.730929	-5.738278
Highwoods Properties, Inc.	HIW	2.153194	-6.120363	-6.065939	-6.098920
Kimco Realty Corporation	KIM_1	1.955930	-6.406911	-6.394600	-6.402476
Kimco Realty Corporation	KIM_2	1.916873	-6.318542	-6.308519	-6.314976
Lexington Corporate Properties Trust	LXP	2.357210	-5.540669	-5.529315	-5.536599
Liberty Property Trust	LRY	2.006370	-6.133545	-6.122443	-6.129571
Mid-America Apartment Communities, Inc.	MAA	1.856961	-5.791174	-5.720339	-5.762659
Pennsylvania Real Estate Investment Trust	PEI	2.053791	-5.966254	-5.955994	-5.962599
Post Properties, Inc.	PPS	1.976156	-6.526595	-6.493945	-6.514108
ProLogis	PLD_1	1.979486	-5.862648	-5.849906	-5.858048
ProLogis	PLD_2	1.941065	-5.719726	-5.693735	-5.709923
Public Storage, Inc.	PSA	2.122719	-5.673083	-5.664360	-5.670006
Simon Property Group, Inc.	SPG_1	1.981270	-5.981896	-5.968652	-5.977104
Simon Property Group Inc.	SPG_2	2.071211	-6.173700	-6.128324	-6.156004
Simon Property Group Inc.	SPG_3	2.145803	-5.991437	-5.854971	-5.936001
SL Green Realty Corp.	SLG	1.951291	-5.976134	-5.964382	-5.971912
United Dominion Realty Trust, Inc.	UDR	1.774121	-5.263977	-5.191826	-5.235137
Vornado Realty Trust	VNO	1.718642	-6.006929	-5.994611	-6.002492

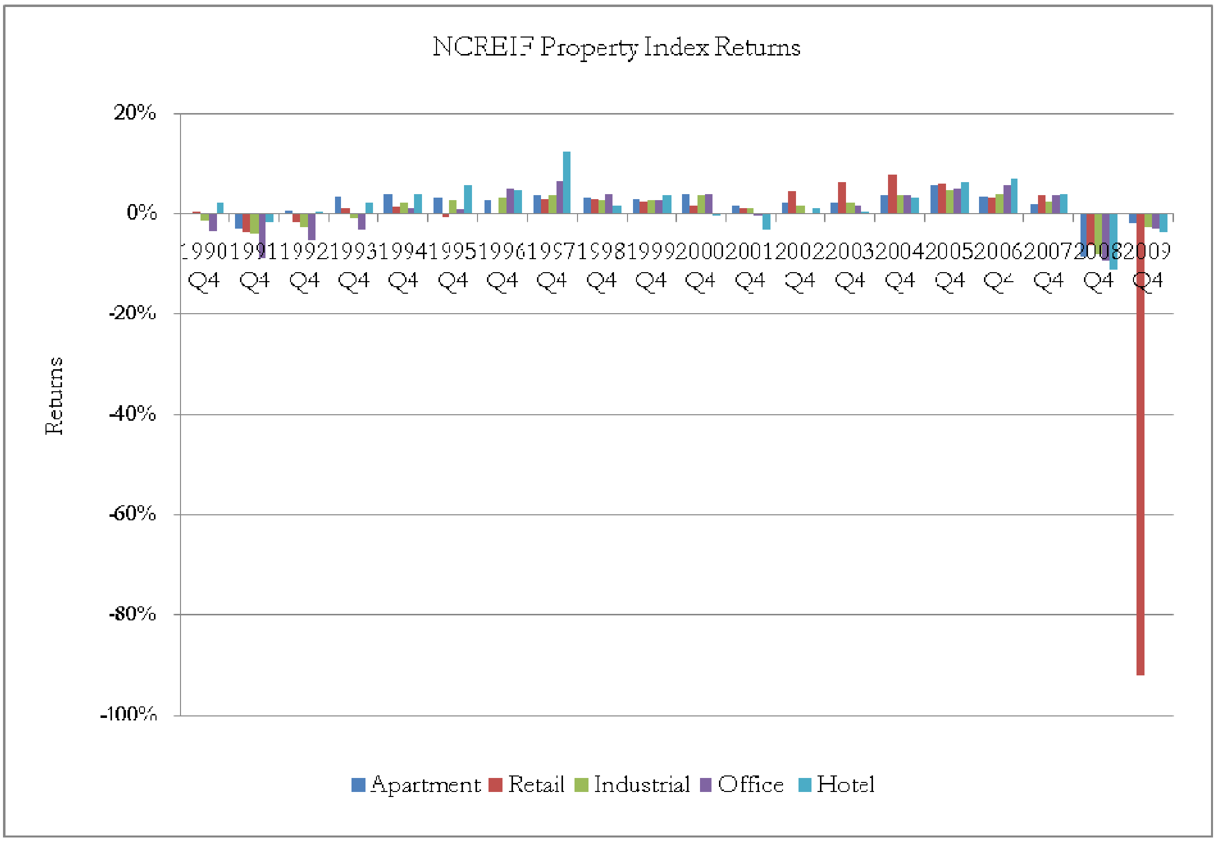
Source: SNL Financials
Note: Results were simulated using Eviews

Appendix Four: Call Option Values

Acquirer's Ticker	Target	Acquirer's line of business	Target's line of business	Call (Share Prices)	Call (Share Prices & Funds)	Fund Factor	Call (NAVs)	Call (NAVs & Funds)	Fund Factor
ACC	GMH Communities Trust	Student Housing	Student Housing	21.95	23.35	0.064	21.88	22.78	0.041
AIV	Ambassador Apartments, Inc.	Multi-family	Multi-family	0.00	0.00	1.000	0.00	0.00	0.101
AVB	Avalon Properties, Inc.	Multi-family	Multi-family	4.95	9.94	1.010	267.40	274.14	0.025
BDN	Prentiss Properties Trust	Office	Office	-0.16	-0.67	3.103	45.01	46.52	0.034
CPT	Summit Properties Inc.	Multi-family	Multi-family	9.75	3.67	0.624	28.33	29.15	0.029
CLP	Cornerstone Realty Income Trust Inc.	Diversified	Multi-family	29.89	30.98	0.037	5.25	5.40	0.029
DDR_1	American Industrial Properties REIT	Shopping Center	Industrial	-2.88	-2.54	0.119	55.59	55.94	0.006
DDR_2	Inland Retail Real Estate Trust, Inc.	Shopping Center	Shopping Center	42.68	48.65	0.140	257.11	263.07	0.023
DRE	Weeks Corporation	Office	Industrial	-1.46	-1.52	0.039	11.05	11.21	0.015
ELS_1	Cornerstone Properties, Inc.	Office	Office	7.83	8.42	0.076	17.79	17.92	0.007
ELS_2	Spieker Properties, Inc.	Office	Office	-6.12	-3.39	0.446	15.55	15.72	0.011
EQY_1	IRT Property Company	Shopping Center	Shopping Center	1.44	3.11	1.159	90.83	92.75	0.021
EQY_2	United Investors Realty Trust	Shopping Center	Shopping Center	5.06	6.11	0.207	27.94	28.36	0.015
EQR_1	Evans Withycombe Residential, Inc.	Multi-family	Multi-family	2.55	2.42	0.054	16.23	16.31	0.005
EQR_2	Grove Property Trust	Multi-family	Multi-family	3.77	3.25	0.138	20.32	20.33	0.001
EQR_3	Lexford Residential Trust	Multi-family	Multi-family	0.71	0.17	0.761	19.11	19.14	0.001
EQR_4	Wellsford Residential Property Trust	Multi-family	Multi-family	-2.18	-3.14	0.442	4.55	4.60	0.012
GGP	JP Realty, Inc.	Regional Mall	Regional Mall	10.94	11.25	0.028	0.81	0.83	0.020
HR_1	American Health Properties, Inc.	Health Care	Health Care	-1.87	-2.42	0.298	37.94	38.51	0.015
HR_2	CNL Retirement Properties, Inc.	Health Care	Health Care	10.56	11.61	0.100	21.16	21.98	0.039
HIW	Crocker Realty Trust, Inc.	Office	Office	16.86	17.17	0.018	8.76	8.90	0.016
KIM_1	Mid-Atlantic Realty Trust	Shopping Center	Shopping Center	-0.18	-0.05	0.744	76.56	76.83	0.004
KIM_2	Pan Pacific Retail Properties, Inc.	Shopping Center	Shopping Center	-8.62	10.27	0.192	47.94	48.64	0.015
LXP	Newkirk Realty Trust, Inc.	Diversified	Diversified	2.57	3.04	0.184	14.25	14.58	0.023
LRY	Republic Property Trust	Industrial	Office	29.67	31.33	0.056	42.80	43.00	0.005
MAA	America First REIT, Inc.	Multi-family	Multi-family	6.83	7.17	0.049	3.28	3.32	0.012
PEI	Crown American Realty Trust	Regional Mall	Regional Mall	15.40	16.16	0.049	9.68	10.36	0.070
PPS	Columbus Realty Trust	Multi-family	Multi-family	11.26	11.48	0.019	5.69	5.80	0.019
PLD_1	Catellus Development Corporation	Industrial	Industrial	8.64	10.64	0.232	50.73	51.55	0.016
PLD_2	Meridian Industrial Trust, Inc.	Industrial	Industrial	-0.49	-0.61	0.238	40.27	40.52	0.006
PSA	Shurgard Storage Centers, Inc.	Self-Storage	Self-Storage	9.69	21.88	1.259	2004.97	2026.23	0.011
SPG_1	Chelsea Property Group, Inc.	Regional Mall	Outlet Center	-1.01	-0.10	0.897	0.30	0.34	0.139
SPG_2	DeBartolo Realty Corporation	Regional Mall	Regional Mall	7.57	8.49	0.122	7.20	7.28	0.011
SPG_3	MSA Realty Corporation	Regional Mall	Shopping Center	18.80	16.98	0.097	0.54	0.54	0.002
SLG	Reckson Associates Realty Corporation	Office	Office	41.33	40.60	0.018	5.09	7.48	0.470
UDR	American Apartment Communities II, Inc.	Multi-family	Multi-family	-1.55	-1.38	0.106	8.43	8.82	0.046
VNO	Arbor Property Trust	Diversified	Regional Mall	23.67	24.41	0.031	11.43	11.47	0.003

Source: SNL Financials

Figures



Source: National Council of Real Estate Investment Fiduciaries (NCREIF)
Figure 1