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Capital Expenditures, Asset Dispositions, and the Real Estate Cycle

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Keywords
real estate equity investment, real estate capital markets, JEL R3, JEL R33

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Comments

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Abstract

Recent empirical research provides evidence on the asset disposition choices of individual and institutional real estate investors that is consistent with the 'disposition effect'. We propose a value-add investment strategy as an alternative rational explanation for the observed patterns in disposition choices. The main value-add mechanism in real estate investment is capital expenditures. However, capital expenditure investment is a real option whose exercise depends on its moneyness, which is a function of the economic environment. Therefore, we study the links between economic conditions, building-level capital expenditures, and subsequent transactions throughout the real estate cycle. We present empirical evidence consistent with our proposed rational explanation for the alleged disposition effect in real estate asset disposition decisions.

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1 Introduction

Loss aversion, also termed the disposition effect, is a behavioral bias that may affect investors. Shefrin and Statman (1985) introduce the concept to describe the observation that investors appear to be reluctant to realize losses. The concept draws upon prospect theory (Kahneman and Tversky, 1979), mental accounting (Shefrin and Thaler, 2004; Thaler, 2004, 2008), aversion to regret (Kahneman and Tversky, 1982; Thaler, 1980), and the ability to exercise self-control (Shefrin and Thaler, 2004). For instance, Odean (1998) and Ivković, Poterba, and Weisbenner (2005) provide evidence of the disposition effect among individual investors using data from stock and mutual fund transactions. [1]

While the observation of the disposition effect originates in passive financial security investments such as stocks and mutual funds, investors in real assets such as real estate may also continue to hold poorly performing assets while selling strongly performing assets. These patterns are observed among individual and institutional investors (Bokhari and Geltner, 2011; Genesove and Mayer, 2001) and REITs (Crane and Hartzell, 2010).

However, claims of a disposition effect in real estate often ignore the active management aspect of real estate investment that may alter disposition decisions. In contrast to many of the passively held financial securities where the disposition effect was first observed, real estate demands active management of daily operational activities that include general maintenance as well as decisions regarding subsequent investment in the property. As a result, an alternative rational explanation may exist to explain the observed disposition effect whereby investors pursue a value-add strategy and keep a property until they have made sufficient improvements to that property to realize a profit on the sale. Such a property may well perform poorly in the interim and thus could result in outcomes that are observationally similar to the ones that led prior behavioral work to conclude existence of a disposition effect. Importantly, prior work has made efforts to rule out alternative explanations but has stopped short of addressing the possibility of a rational value-add strategy behind the observed disposition patterns.

[1] Ben-David and Hirshleifer (2012) concisely summarize the literature. DellaVigna (2009) provides a general survey of the evidence on reference dependence.

In this study, we use information about value-add strategies and subsequent disposition decisions through the property cycle to address this gap in the literature. An important mechanism by which investors implement value-add strategies is through value-enhancing improvements via capital expenditures. Empirical evidence supports the link between capital expenditures and value. Using property-level data, Ghosh and Petrova (2015) for instance find that capital expenditures increase property value. Separately, Bond, Shilling, and Wurtzebach (2014) point out that capital expenditures are not mandatory. In fact, investors have a real option to make improvements now, or delay them. Peng and Thibodeau (2011) and Ghosh and Petrova (2015) provide evidence in favor of this real options view on capital expenditures.

Consistent with this view, we model the capital expenditure decision as a real option to restore a property that has suffered physical depreciation and economic obsolescence to its new, undepreciated state. We argue that investors make capital expenditure decisions to maximize the expected payoff from this option.

In addition, we recognize the fact that investors also have an option to dispose of the property. Like the capital expenditure decision, the disposition decision is closely related to the economic environment. To illustrate these relationships, we introduce the concepts of highest and best use versus second best use into the modeling framework. Combining the concepts regarding the optimal time to invest in capital expenditures with the classic highest and best use assumption, we develop a set of testable hypotheses about the likelihood of sale following capital expenditure decisions. By also incorporating past capital appreciation returns into the empirical analysis, we are then in a position to compare our predictions with the evidence for the disposition effect (Bokhari and Geltner, 2011; Crane and Hartzell, 2010; Genesove and Mayer, 2001).

Consistent with our hypotheses, we present empirical evidence that an increase in expected market rents increases the payoff and likelihood of capital expenditures. This occurs because the cash flow underlying the option to invest in capital expenditures is the income from the property in its existing depreciated condition. Our findings thus add to the evidence for capital expenditures as a real option, as in Bond, Shilling, and

Wurtzebach (2014); Ghosh and Petrova (2015); Peng and Thibodeau (2011).

We also find that higher capital expenditures are associated with higher subsequent real capital appreciation returns. Our result is consistent with Ghosh and Petrova (2015) who find that CAPEX are positively related to excess NPI returns. We extend this prior work by considering the effect of CAPEX on capital appreciation specifically, rather than total NPI returns. Our work thus helps distinguish between the findings in Ghosh and Petrova (2015) and those in Bond, Shilling, and Wurtzebach (2014) who report that CAPEX are associated with higher income but are not capitalized into market values.

Finally, we find an inverse relationship between capital expenditures on building expansion and improvement and dispositions. This finding is consistent with a value-add strategy where the owner carries out multi-period investment projects that help reposition the property to its undepreciated state, enabling the owner to capture full market lease rates.

In all of our models, we are unable to replicate the disposition effect, measured as a positive coefficient on the cumulative capital appreciation return of the property (Crane and Hartzell, 2010), after controlling for capital expenditures. In conclusion therefore, we present evidence for a rational value-add investment strategy as an alternative explanation for the disposition effect that has been documented in residential and commercial real estate investment. Our finding implies that the evidence for this behavioral bias is not robust to controlling for this observationally similar but rational alternative. Our findings suggest that future research into this question should account for the value-add and potentially other alternative explanations for the disposition effect.

2 Related literature

Behavioral finance and economics attempts to explain seemingly irrational actions of individuals. For example, financial researchers have explored behavioral factors in corporate decision-making; see Baker and Wurgler (2011) for a survey of the literature. One stream of this literature assumes that managers are subject to behavioral biases that stem from bounded rationality (Gabaix, 2014) or overconfidence (Ben-David and Graham, 2013). Malmendier and Tate (2015) survey the literature on overconfidence. These managerial biases are further enabled by limited governance (Adams, Almeida, and Ferreira, 2005; Bertrand and Schoar, 2003; Gompers, Ishii, and Metrick, 2003). Managerial irrationality then has significant consequences for the investment policy (Malmendier and Tate, 2005) and the financial policy (Baker and Xuan, 2016) of the firm.

An alternative view is that managers respond rationally to mis-pricing of securities due to behavioral biases among investors, giving rise to market timing and catering considerations. Studies in this vein analyze the effects of security mis-pricing on investment policy (see, e.g., Polk and Sapienza (2009) or Baker, Stein, and Wurgler (2003)); financial policy (see, e.g., Graham and Harvey (2001) for survey evidence and Baker and Wurgler (2002) or Baker, Greenwood, and Wurgler (2003) for empirical evidence on timing of equity and debt issuance choices, respectively); payout choices (Baker and Wurgler, 2004); and a range of other corporate policies.

Research in real estate has confirmed the effects of managerial biases, especially overconfidence, on the investment (Eichholtz and Yönder, 2015) and financing (Yung, Li, and Sun, 2015) choices of real estate firms (REITs). Similarly, market timing and catering considerations stemming from behavioral biases among investors have been shown to affect REIT financing choices (Boudry, Kallberg, and Liu, 2010; Harrison, Panasian, and Seiler, 2011; Mori, Ooi, and Wong, 2014; Ooi, Ong, and Li, 2010) and dividend policy (Boudry, 2011; Case, Hardin, and Wu, 2012; Chou, Hardin, Hill, and Kelly, 2013). [2]

As for the disposition effect, Genesove and Mayer (2001) are the first to document loss aversion in real property. Using data on the Boston housing market, they find that homeowners subject to losses on the sale of their home set higher asking prices, attain higher selling prices, and are significantly less likely to sell than other owners. They conclude that, consistent with the disposition effect, homeowners are reluctant to realize losses.

[2] Seiler (2014) points out that there are broader applications of behavioral concepts in real estate, such as the familiarity bias of homeowners towards their existing property or the endowment effect, which is linked to mental accounting and may explain why homeowners require a larger compensation to give up their home than simply the value of a similar asset. Furthermore, Guiso, Sapienza, and Zingales (2013) examine behavioral factors in determinants of attitudes towards strategic mortgage default.

Bokhari and Geltner (2011) extend this evidence to commercial real estate investors, who may be more sophisticated and thus less sensitive to loss aversion. Using a data set of US commercial real estate transactions, they confirm that investors facing a loss set higher asking prices, achieve higher transaction prices and experience a longer time-on-market, implying a lower hazard rate of sale. Finally, Crane and Hartzell (2010) explore the evidence for the disposition effect in corporate-level REIT investments. They find that REIT managers also tend to sell strongly performing properties while continuing to hold poorly performing investments.

While prior work rules out some alternative explanations for the observed patterns, particularly in relation to the hazard rate of sale – such as optimal tax timing, mean reverting property returns, and asymmetric information (Crane and Hartzell, 2010) – the literature stops short of considering the possibility of a typical value-add investment strategy that requires holding the property through a phase of poor performance until capital expenditures improve its value enough to produce a gain on sale. This alternative explanation for the observed disposition patterns is the focus of our study.

3 Hypothesis development

3.1 Model setup

We adopt the real option analysis presented in Dixit and Pindyck (1994), Pindyck (1988), and Bertola (1998) for incremental investment problems to the case of commercial real estate to highlight the optionality associated with capital expenditure investment decisions. Abstracting from discussion of fixed and variable costs, we assume that a property generates the following simple profit flow

$$\pi = HM(K) \tag{1}$$

where $M(K)$ is a concave function of capital (K) invested in the property, and H is a random shift variable reflecting uncertainty over future rents. We assume that H can be described by the geometric Brownian motion such that

$$dH_t = \alpha_H H_t dt + \sigma_H H_t dz_H \tag{2}$$

where α_H and σ_H are the expected growth rate and volatility associated with the market rents, respectively, and $E\left[dz_H^2\right] = dt$. For analytical convenience, we assume that the function $M(K)$ takes a specialized Cobb-Douglas form

$$M(K) = K^{\theta},\ 0 < \theta < 1. \tag{3}$$

Finally, we note that κ represents unit cost of capital.

3.2 Depreciation and capital expenditures

If we assume that physical depreciation and economic obsolescence occurs exponentially through time following a Poisson process, then over a small time increment of dt, the invested capital in the property will depreciate with probability $\lambda K dt$. Furthermore, assuming no investments in capital expenditures, then the property will depreciate at the rate $dK = -\lambda K dt$ and the rental flow at time t is $H_t M(Ke^{-\lambda t})$. Thus, the expected value of the property at the date of purchase is

$$V(K,H) = \hat{E}\int_0^{\infty} H_t M(Ke^{-\lambda t})e^{-\rho t}dt \tag{4}$$

where ρ is the discount rate. Using Ito's lemma, we can show that (4) is the solution to the following differential equation

$$\frac{1}{2}\sigma^2 H^2 \frac{\partial^2 V}{\partial H^2} + \alpha H \frac{\partial^2 V}{\partial H} - \lambda K \frac{\partial V}{\partial K} - \rho V + HM(K) = 0. \tag{5}$$

Next, we note that if the owner makes capital expenditures of dK_g, then the change in capital invested in the property is given as

$$dK = dK_g - \lambda K dt \tag{6}$$

and we denote the option to make these investments as $F(K,H)$.

Using the usual assumptions associated with the contingent claims approach to real option models regarding the creation of a replicating portfolio with an asset spanning H, we get

$$\frac{1}{2}\sigma^2 H^2 \frac{\partial^2 F}{\partial H^2} + (r-\delta)H\frac{\partial F}{\partial H} - \lambda K \frac{\partial F}{\partial K} - rF = 0 \tag{7}$$

where r is the risk-free rate, $\delta = \mu - \alpha_H$, and the risk-adjusted discount rate μ is used in place of ρ. Differentiating (7) with respect to capital K results in the following equation for the value of the marginal capital expenditure investment option $(f(K,H))$:

$$\begin{aligned}\frac{1}{2}\sigma^2 H^2 \frac{\partial^2 f(K,H)}{\partial H^2} + (r-\delta)H\frac{\partial f(K,H)}{\partial H}\\ -\lambda K \frac{\partial f(K,H)}{\partial K} - (r+\lambda)f(K,H) = 0\end{aligned} \tag{8}$$

Since $M(K) = K^\theta$ by assumption in equation (3), we can assume that the capital expenditure option depends on the composite variable $h = HK^{\theta-1}$. Thus, substituting $\frac{\partial f(K,H)}{\partial H} = K^{\theta-1}g'(h)$ where $f(K,H) = g(h)$ yields

$$\frac{1}{2}\sigma^2 h^2 \frac{\partial^2 g(h)}{\partial h^2} + [r - (\delta + \lambda(\theta-1))]h\frac{\partial g(h)}{\partial h} - (r+\lambda)g(h) = 0. \tag{9}$$

Equation (9) that has the solution

$$g(h) = Bh^{\beta_1} \tag{10}$$

where β_1 is the positive root of the quadratic that corresponds to equation (9).[3] Following the exposition in Dixit and Pindyck (1994), the optimal rent (H^*) that triggers investments in capital expenditures is

[3] $\beta_1 = \frac{1}{2} - (r - (\delta + \lambda(\theta-1))/\sigma^2 + \sqrt{[(r - (\delta + \lambda(\theta-1)))/\sigma^2 - \frac{1}{2}]^2 + 2r/\sigma^2}$

$$H^* = \frac{\beta_1}{\beta_1 - 1}\frac{(\delta + \lambda\theta)\kappa}{\theta K^{\theta-1}} \tag{11}$$

From equation (11), we can see that an increase in the growth rate associated with market rents (α) reduces the critical value necessary to trigger capital expenditures and thus decreases the delay between capital expenditure investments. Next, an increase in the volatility surrounding market rents (σ) increases the trigger value and thus results in a longer time between capital expenditure investments. These relationships are illustrated numerically in Figure 1.

[Figure 1 about here.]

3.3 The disposition decision

In order to analyze the decision to sell the investment, we note that the property's current owner, as the marginal investor, deploys the building at its highest and best use, which is assumed to follow the rent process described in equation (2). The concept of highest and best use (HBU) is a standard convention in the real estate literature that implies that property owners maximize value otherwise there would be incentives to trade. To capture this incentive, we assume that the building could be redeployed by a new owner at a second best use (SBU) who would then realize a rental flow that corresponds to a random shift variable (S) reflecting uncertainty over future rents. As with the highest and best use case described above, we assume that the second best random shift variable is described by the following geometric Brownian motion:

$$dS_t = \alpha_S S_t dt + \sigma_S S_t dz_S \tag{12}$$

where α_S and σ_S are the expected growth rate and volatility associated with the SBU rents, respectively, and $E\left[dz_S^2\right] = dt$. Thus, as with the case of the highest and best use and recognizing that a property deployed at its SBU also depreciates at the rate $-\lambda K dt$, the value of the property when utilized at its the second best rental flow is given as

$$V(K,S) = E\int_0^{\infty} S_t M(Ke^{-\lambda t})e^{-\rho t}dt. \tag{13}$$

We now focus on the evolution of H and S through time that creates opportunities to trade. We note that the current owner's opportunity to sell the property is equivalent to a perpetual put option. In this context, we denote the value of the option to sell as $W(K,H,S)$ since it is a function of two stochastic variables. The payoff at any time t to selling the property is $V(K,S,t) - V(K,H,t)$. Thus, the owner maximizes the present value of the payoff:

$$W(K,H,S) = \max\ \hat{E}[(V(K,S,T) - V(K,H,T)), 0]e^{-\mu T} \tag{14}$$

where T is the unknown future date that the property is sold, and μ is the discount rate. Using Ito's Lemma and denoting the correlation between H and S as ρ_{HS} with $E\left[dz_H dz_S\right] = \rho_{HS}dt$, the value of this disposition option is the solution to the following partial differential equation:

$$\begin{aligned} dW = &\frac{1}{2}\left[\sigma_H^2 H^2 \frac{\partial^2 W}{\partial H^2} + \sigma_S^2 S^2 \frac{\partial^2 W}{\partial S^2} + 2\rho_{HS}\sigma_H\sigma_S HS\frac{\partial^2 W}{\partial H \partial S}\right] \\ &+\frac{\partial W}{\partial H}dH + \frac{\partial W}{\partial S}dS. \end{aligned} \tag{15}$$

Obviously, equation (15) is a complicated partial differential equation that can be solved numerically. The complication arise by recognizing the path dependency inherent in the capital expenditure option. That is, the HBU value of the property at any point t that determines whether it is optimal to sell to the second best user is conditional on knowing whether the owner invested in capital expenditures during the period prior to t.

Following classical option pricing insights, we note that: (i) A higher growth rate in current market HBU rents (α_H), holding all else constant, decreases the critical threshold for capital expenditures and thus increasing the property value. This results in decreasing the payoff and probability of selling the investment; (ii) Conversely, a higher growth rate in the second best rental use (S), holding all else constant, would increase the probability of selling. Thus, the probability of selling is a function of the relative difference in the rental growth rates. In other words, the probability of selling is an increasing function of the ratio of the SBU rent growth rate to the HBU rent growth rate ($\frac{\alpha_S}{\alpha_H}$). Similarly, the probability of selling increases as the ratio of SBU rent volatility (σ_S) to HBU rent volatility (σ_H) increases. Note that an increase in σ_H lowers the probability of capital expenditure investments and therefore increases the probability of disposition.

We also note that differences in expectations regarding economic and physical depreciation can also alter the probability of exercising the option to sell. For example, if buildings deployed at their highest and best use require higher levels of maintenance or experience greater utilization, then the probability of sale will increase.

Finally, the option to invest in capital expenditures impacts the decision to sell in two ways. First, past cumulative investments in capital expenditures increase the HBU valuation and thus reduces the payoff from selling to the SBU investor and hence reduces the probability of sale. Second, the option to make future capital expenditures to offset the effects of depreciation increases the property value to the HBU owner, again lowering the potential payoff from disposition and reducing the probability of sale. However, increases in HBU depreciation increase the trigger threshold for capital expenditures and thus lowers the property value. Figure 2 illustrates the relationship and suggests that on balance, the probability of sale declines in capital expenditures.

[Figure 2 about here.]

4 Empirical approach

Empirically, we observe neither market rents, in the sense of the notional rent that would be achieved by a brand-new building, nor obsolescence. Rather, we observe realized income that is the net result of market rents, cumulative depreciation, and the extent to which depreciation was mitigated by capital expenditures. Furthermore, we do not observe uncertainty around market rental growth and depreciation separately from one another either. Instead, we observe shocks to expected property-level income growth. As a result, we have the following empirically testable hypotheses:

Hypothesis 1 follows by noting that observed property income is a function of expected income and actual obsolescence. An increase in expected income reduces the critical value of rent necessary to trigger capital expenditures and decreases the delay between capital expenditures. In other words, higher expected income growth increases the payoff and likelihood of capital expenditures.

Hypothesis 1: *An increase in expected income growth from the property increases subsequent capital expenditures.*

Based on the real options framework, keeping everything else constant, uncertainty increases the value of keeping the option alive and not exercising in the current period. Therefore, an increase in the volatility of income growth increases the threshold value of rent necessary to carry out capital expenditures and thus produces a longer time delay between capital expenditure investments, reducing their likelihood.

Hypothesis 2: *Higher income growth volatility reduces subsequent capital expenditures.*

To formally test hypotheses 1 and 2, we estimate the following OLS model of the real quarterly capital expenditures per square foot for property i at time t ($CAPEX_{i,t}$) as a function of income growth expectations and volatility in the previous period $t-1$:

$$CAPEX_{i,t} = \gamma_0 + \gamma_1 GE_{i,t-1} + \gamma_2 VOL_{i,t-1} + \gamma_3 \mathbf{X}_{i,t-1} + u_{it} \tag{16}$$

where γ denotes the coefficients to be estimated, $GE_{i,t-1}$ is the expected rate of property income growth at time $t-1$, $VOL_{i,t-1}$ is the volatility of growth expectations over the preceding four quarters up to and including $t-1$, scaled by the average growth expectation over that period, $\mathbf{X}_{t-1}$ is a matrix of control variables measured at time $t-1$, and u_{it} is the residual. For CAPEX, we distinguish between capital expenditures on expansion and improvement as well as tenant incentives and lease commissions. The control variables include the one-period real income return, the loan-to-value ratio, the time since acquisition, property size (sq ft), the log of the initial real market value, as well as indicators for property type, geographic region (division), and quarter. Consistent with Hypotheses 1 and 2, we expect a positive value for γ_1 and a negative value for γ_2.

The model also predicts that CAPEX will increase the value of the property. This is not a direct prediction, but is implied by the model. As per hypothesis 1, higher rental growth is associated with an increased likelihood of CAPEX, and results in higher property values. At the same time, property values increase with CAPEX because CAPEX restore the property to an undepreciated state and enable the owner to capture the full market rent, reinforcing the positive effect on values and supporting capital appreciation.

Hypothesis 3: *An increase in CAPEX increases capital appreciation returns.*

In order to test hypothesis 3, we estimate the following OLS model of real quarterly capital appreciation returns for property i in quarter t ($APP_{i,t}$) as a function of real cumulative CAPEX up to an including $t-1$:

$$APP_{i,t} = \gamma_0 + \gamma_1 CAPEX_{i,t-1} + \gamma_2 \mathbf{X}_{i,t-1} + u_{it} \quad (17)$$

where notation and control variables are as in Equation (16) above. Consistent with hypothesis 3, we expect a positive value on coefficient γ_1. Here, we focus on real cumulative capital expenditures, again split into expansion and improvement versus tenant incentives and lease commissions, in order to account for the fact that more extensive capital expenditure projects take several quarters to complete. Cumulative real CAPEX are scaled by the initial real market value of the property.

Finally, the model predicts a lower likelihood of sale following higher CAPEX. Again, this is not directly observed but it is implicit in the model. Higher CAPEX implies a higher HBU property value and thus the probability that the SBU value will be greater than the HBU value is reduced, all else being equal. Therefore, the probability of a sale declines following higher CAPEX.

Hypothesis 4: *Higher capital expenditures reduce the subsequent likelihood of sale.*

To test hypothesis 4, we follow the empirical strategy proposed in Kiefer (1988).[4] Specifically, we employ a hazard model of the holding period where the probability of selling property i at time t, given that it was not yet sold, is modeled as:

$$h(i,t) = h_0(i,t)\exp(\gamma_1 CAPEX_{i,t-1} + \gamma_2 CAPP_{i,t-1} + \gamma_3 \mathbf{X}_{i,t-1}) \tag{18}$$

where $h_0(i,t)$ denotes the baseline hazard rate, CAPEX measures cumulative CAPEX up to and including $t-1$, CAPP is the cumulative real appreciation return, which serves as proxy for the disposition effect, and $\mathbf{X}_{t-1}$ contains the covariates from Equation (16). We estimate the coefficients via Cox's partial likelihood method. Following standard practice, properties that are not sold during the sample period are included in the estimation but are considered right censored. Consistent with hypothesis 4, we expect a negative sign on the coefficient γ_1. The disposition effect would predict a positive value for γ_2.

5 Data

Our data consists of a sample of US direct real estate investments. We collect the required data on property and financial characteristics as well as the necessary appraisal- and transaction-based data from $NCREIF$. We begin our analysis in 2000, the first year for which *NCREIF* covers a significant number of properties and offers the full breadth of capital expenditure data required for our analysis. We end the study period in 2015, the last full year for which data is available at the time of writing.

Within this period, we start with entire $NCREIF$ universe 2000-2015 and then focus on properties that form part of $NCREIF's\ NPI$, have no missing values in the required variables, and no entries of zero square feet for size. We further require properties to have at least one year of data in order to calculate our volatility measure. We also filter out data errors such as properties with an entry of zero for the year of construction, where the building age is less than zero, where the real initial acquisition cost was smaller than

[4] This type of model was subsequently also employed in Genesove and Mayer (2001), Crane and Hartzell (2010) and Bokhari and Geltner (2011).

US$1, and where the values for CAPEX are negative.[5]

NCREIF reports a range of different types of capital expenditures. We focus on capital improvements and property expansions as well as tenant incentives and lease commissions. It is important to note that we do not consider routine repairs and maintenance.[6] Capital expenditures associated with tenant incentives and lease commissions are often part of the negotiation over leasing and thus reflect market leasing conditions, not an effort to restore the property to an undepreciated state. Our hypothesis development on the other hand is more closely associated with value-enhancing improvement and expansion projects that alter the physical structure of the property to restore its quality. Therefore, we primarily focus on capital improvements and expansion capital expenditures, but use the data on tenant incentives and lease commissions as contrasting evidence. Figure 3 shows the evolution of the quarterly average values of the two main groups of capital expenditures.

[Figure 3 about here.]

Recall that in the regressions for capital expenditures as a function of growth expectations and volatility, we measure the two main CAPEX components (expansion and improvement as well as tenant incentives and lease commissions) in real terms (CPI-adjusted) and on a per square foot basis. In the regressions for the capital appreciation return and the sales decision, we measure real CAPEX on a cumulative basis, scaled by the initial real market value of the property.

It is worth noting that there is no mechanical relationship between capital appreciation returns and capital expenditures. Capital appreciation returns are calculated as the quarterly change in the market value of the property. The market value of the property is based on appraisals, not historic cost plus any capitalized expenses. Therefore, if CAPEX are carried out, the value of CAPEX does not necessarily translate on a one-to-one basis into an exactly equivalent increase in the market value of the property.

[5] Those represent accounting anomalies where excess reserves for CAPEX projects were booked and then reversed when the actual cost of the projects was revealed.

[6] Another possibility is that CAPEX are used to reposition the building to a different use. This strategy is beyond the scope of our analysis.

We measure growth expectations as follows: We add a time series of yields on 10-year US government bonds and the risk premium on a benchmark for BBB-rated corporate bonds as proxy for the typical property risk premium. From this, we subtract the current trailing four-quarter capitalization rate for each property (net operating income divided by property value) to obtain an implied real growth expectation for every property/quarter. Next, we calculate the standard deviation of those growth expectations over four quarters, scaled by the average growth expectation over those four quarters. We use this standard deviation as our measure for the volatility of growth expectations.

Following the literature, we include the following time-varying control variables in our estimation: the cumulative real capital appreciation return through $t-1$ as a proxy for the disposition effect, the one-period real income return, the loan-to-value ratio, and the years since acquisition. We include the following time-invariant control variables: property size (sq. ft.), the log of the initial real market value when the property entered the sample, as well as indicators for property type, geographic region and quarter or year of acquisition. All continuous variables are winsorized at 1st and 99th percentile to mitigate undue influence of outliers. Figure 4 shows the quarterly number of properties in the sample in Panel (a) and the quarterly number of sales in Panel (b).

[Figure 4 about here.]

Table 1 provides variable definitions and shows the descriptive statistics for the 207,399 property-quarter observations in the sample. The unconditional hazard rate of sale in any given quarter is 3%. Total real cumulative capital expenditures on expansion and improvement as well as tenant incentives and lease commissions both average 5% of the real initial market value of the property.[7]

In terms of the property characteristics and financial indicators, we note that the

[7] Also note that our data set contains observations where capital expenditures is zero. This is a useful feature of the data set because it rules out sample selection bias. Selection bias occurs when a sample is restricted to observations where a variable of interest, such as capital expenditures, takes a certain value or exceeds a certain threshold, which would be a concern for our study if we only recorded a capital expenditures observation when capital expenditures is non-zero (and positive). However, our capital expenditures variables frequently take the value of zero, meaning that the decision not to invest in capital expenditures is included in the *NCREIF* data, mitigating this potential selection bias.

average cumulative real capital appreciation was 0%, largely due to the impact of the global financial crisis of 2007, and the average real income return was 2%. The average size of the properties in our sample is approximately 190,000 sq. ft. with an average log market value of 16.94 (US$22.75 million). The average loan-to-value (LTV) ratio is 29%.

[Table 1 about here.]

Table 2 shows the pairwise Pearson correlation coefficients between the variables. We note that the indicator variable for sale quarter is positively correlated with tenant incentive and lease commission capital expenditures but not significantly correlated with improvement and expansion capital expenditures. We also note that the cumulative appreciation return is inversely correlated with the sale quarter indicator. We explore these unconditional results further in our main regression analysis. Beyond that, we find no excessive correlations between the main variables of interest, alleviating concerns around multicollinearity.

[Table 2 about here.]

6 Results

6.1 Capital expenditures as a function of growth expectations and volatility

Table 3 presents the estimated coefficients for the OLS regression of equation (16), namely capital expenditures as a function of growth expectations and volatility. Capital expenditures are measured as real quarterly CAPEX per sq. ft. of the property. The Table reports results for the two groups of capital expenditures (improvement and expansion, and tenant incentives and lease commissions, respectively) and across recession versus non-recession sub-periods as defined by NBER recession dates. To restate our hypotheses, we expect increases in expected income growth to be positively related to subsequent capital expenditures (hypothesis 1) and increases the the volatility of income growth to be inversely related to subsequent capital expenditures (hypothesis 2). Our results support the first hypothesis for both groups of capital expenditures, and are consistent across recession and non-recession periods.

[Table 3 about here.]

In column (1) of Table 3, we report results for CAPEX associated with property improvements and expansion over the entire study period. First, we note a positive and statistically significant coefficient for growth expectations. The estimated coefficient implies that a one standard deviation increase in income growth from the mean corresponds to a 0.02 percent increase in subsequent capital expenditures. While this effect appears modest in economic terms, it is worth noting that it is measured on real (inflation-adjusted) CAPEX per sq. ft., and that expansion and improvement projects typically take several quarters to complete.

Consistent with model predictions, this positive relation between increases in growth expectations and subsequent capital expenditures is based on the relative strength of two competing factors, rent and obsolescence, in determining the return on a capital expenditure investment. For example, if expected market rents increase, then the payoff to restoring the property to an undepreciated state is higher because the market rent that may be captured after a completed investment is higher.

If physical depreciation and economic obsolescence increase, then the payoff to capital expenditures is also higher. Thus, both factors act to increase the likelihood of capital expenditures. However, higher rental growth is likely to occur jointly with lower rates of physical depreciation and economic obsolescence. As a result, the observed increase in the income growth expectation may stem from higher rental growth or lower depreciation and obsolescence. At any given point in time, these two factors could counteract each other in the overall effect on subsequent capital expenditures. Yet, our results suggest that the market rent effect outweighs the depreciation and obsolescence effects, possibly because the latter effects materialize through the availability of competing undepreciated supply, which arguably takes time to enter the market given the lengthy construction process.

Column (2) of Table 3 shows a positive and statistically significant relation between growth expectations and CAPEX related to tenant incentives and lease commissions as measured over the entire study period. The estimated coefficient implies that a one standard deviation increase in rental growth is associated with a 0.03 percent increase in real tenant incentives and lease commissions. We expect this positive relation between growth expectations and subsequent tenant incentives and lease commissions as property owners have positive incentives to invest in tenant incentives or lease commissions during lease negotiations and these measures often result in higher base rents, which is all the more advantageous for the owner in a period when market rents are rising.

Turning to hypothesis 2, we find that volatility of income growth expectations is statistically insignificant in determining subsequent CAPEX, across the two CAPEX types and across recession versus non-recession periods. If volatility of income growth increases, then real option theory suggests that the value of keeping the capital expenditure option alive also increases. This effect should reduce subsequent capital expenditures. However, the capital expenditure option is not the only option the property owner has available to them. Rather, consistent with a realistic set of investor choices, there is also the disposition decision, which is, among other factors, a function of the property's value. Next, we will consider the relationship between CAPEX and the value of the property, by examining the effect of different types of CAPEX on capital appreciation returns. We will then return to explaining our findings regarding hypothesis 2.

6.2 Capital expenditures and capital value

Table 4 presents the estimated coefficients for the OLS regression of equation (17), that is, capital appreciation returns as a function of capital expenditures. Capital appreciation returns are measured on a quarterly basis and in real (inflation-adjusted) terms. Capital expenditures are measured as real cumulative CAPEX incurred up to and including the period prior to measuring the capital appreciation return on the property, in recognition of the fact that capital expenditure projects often span several quarters. The Table again reports results for the two groups of capital expenditures (improvement and expansion, and tenant incentives and lease commissions, respectively) and across recession versus non-recession sub-periods as defined by NBER recession dates. To restate our hypotheses, we expect increases in capital expenditures to be positively related to subsequent capital appreciation returns (hypothesis 3). Our results support this hypothesis for both groups of capital expenditures, but we find insignificant results for the recessionary sub-periods.

[Table 4 about here.]

In column (1) of Table 4, we report results for capital appreciation returns over the entire study period. First, we note a positive and statistically significant coefficient for expansion and improvement CAPEX. The estimated coefficient implies that a one standard deviation increase in income growth from the mean corresponds to a 0.04 percent increase in subsequent capital appreciation returns. Column (2) of Table 4 shows a positive and significant coefficient for tenant incentives and lease commissions. The estimate implies that a one standard deviation increase in tenant incentives and lease commissions is associated with a 0.05 percent increase in subsequent capital appreciation returns. While these effects appear modest in economic terms, it is worth noting that they are measured on real (inflation-adjusted) quarterly capital appreciation returns.

Our finding here also helps explain the evidence in relation to hypothesis 2. If uncertainty around income growth increases, then uncertainty around the value of the asset increases, and as a result, the discount rate is likely to increase. A higher discount rate implies a higher probability of sale, everything else being equal. However, an outright asset sale results in a lost chance of recovery. An alternative way of recovering lost ground between the required rate of return and the actual rate of return is to invest in capital expenditures to increase the property's value. Our findings regarding hypothesis 3 show that there indeed appears to be a positive relationship between capital expenditures and the capital appreciation return on the property. The cost of losing the capital expenditure option is then viewed as the price of keeping the asset and thus retaining the optionality of benefiting from a recovery. Our results are consistent with the value-add strategy balancing out the effect of losing the capital expenditure option. Our finding is intuitive when we consider that the positive payoff from an eventual disposition in a stronger economic environment is compounded by the improvements that were made to the asset during the period of uncertainty.

Our findings in this section and the previous section relate to the literature on the optionality of capital expenditures. Consistent with real options theory, Bond, Shilling, and Wurtzebach (2014) find that CAPEX increase with market lease rates. Our work is consistent with their findings. Further, Peng and Thibodeau (2011) and Ghosh and Petrova (2015) find that capital expenditures decrease in the level of economic uncertainty, which increases the value of the option to delay improvements. Our work extends these prior studies in two ways. First, we study income prospects and volatility in those prospects specific to individual buildings rather than general economic uncertainty. Second, we consider a full set of investor choices that includes the capital expenditure option and the disposition decision. As a result, we derive a different set of predictions, underscoring the value of recognizing a fuller set of investor choices. Further, these previous studies find mixed evidence for whether, and if so, to what extent, capital expenditures are capitalized into property values. Our results are more consistent with Ghosh and Petrova (2015), who find that CAPEX are to some extent incorporated into values.

6.3 Consequences for disposition decisions

Table 5 presents the coefficients from the estimation of equation (18) testing our hypothesis concerning disposition decisions as a function of capital expenditures. According to hypothesis 3, we expect an inverse relationship between capital expenditures and subsequent dispositions. The coefficients reported in Table 5 are consistent with this hypothesis as far as expansion and improvement CAPEX in the full study period (Column (1)) and the non-recession sub-periods (Column (2)) are concerned.

[Table 5 about here.]

In economic terms, the coefficients reported in Column (1) of Table 5 imply that a one standard deviation increase in expansion and improvement CAPEX is associated with a decline in the log hazard rate of 0.11 percent during the full study period and 0.10 percent during the non-recession sub-periods. We find no significant results during recessionary sub-periods or for tenant incentive and lease commission expenditures. Our findings suggest that the relation between capital expenditures and subsequent dispositions is conditional on the economic environment. If we observe capital expenditures during a period of economic expansion, then the odds of the HBU value being lower than the alternative SBU value are lower, making a sale less likely. Our estimates support this rationale.

We interpret our findings as evidence of the varying marginal value of capital expenditures in terms of improving the gain on a potential sale of the asset. During a period of increasing property values, the marginal gain on sale that can be achieved from making substantial improvements or carrying out expansions that change the nature of the asset may be low, leading to an inverse relationship between capital expenditures and the likelihood of sale.

To explicitly test the disposition effect, we include the cumulative real appreciation return in equation (18). According to the disposition effect hypothesis, the probability of property sale should be positively related to the cumulative real appreciation return. However, the marginal effect reported in Table 5 indicates an inverse relation between cumulative appreciation and the hazard rate of disposition after controlling for the effects of capital expenditures and income growth expectations. The marginal effect suggests that a one standard deviation increase in cumulative real appreciation results in a 0.42 percent decline in the log hazard rate of subsequent sale. This finding is contrary to the evidence typically presented in support of the disposition effect. For instance, Crane and Hartzell (2010) report that a higher cumulative appreciation return is associated with a higher hazard rate of sale, consistent with the behavioral notion that investors hold losing investments in an attempt to avoid realizing financial losses. We find the opposite effect in our data. Our finding is also contrary to prior work on the disposition effect in real estate as presented in Genesove and Mayer (2001), Bokhari and Geltner (2011), and Crane and Hartzell (2010).

There may be several reasons for this inconsistency. First, in contrast to Genesove and Mayer (2001), we focus on commercial, not residential properties. The sophisticated institutional investors that constitute the sample of investors in typical $NCREIF$ properties may be less sensitive to the loss aversion bias. Second, our findings also contrast with Bokhari and Geltner (2011) who focus on commercial properties held by institutional investors. However, our study differs from their work in the data set employed

(*NCREIF* in this study versus *Real Capital Analytics* in their analysis), the sample period (our work extends beyond 2009, the date when the sample in Bokhari and Geltner (2011) ends), and we explicitly control for the possibility of a value-add strategy where investors continue to hold a poorly performing property until they have made sufficient improvements via capital expenditures to realize a gain on sale. The consideration for a value-add investment strategy is also a distinguishing feature between our work and Crane and Hartzell (2010) who study the evidence for the disposition effect in REITs.

7 Conclusion

We present evidence for an alternative rational explanation to the alleged disposition effect in real estate investment holdings: a value-add investment strategy that continues to hold a poorly performing property not in an irrational attempt to avoid realizing a loss, but because the investment strategy requires holding the asset until substantial improvements via capital expenditures facilitate a gain on sale. Corollaries are evidence to support the real options prediction that higher expected income growth increases subsequent capital expenditures, and that both expansion and improvement as well as tenant incentive and lease commission expenditures are capitalized into property values.

Our work expends the existing literature on real estate CAPEX by separately considering expansion and improvement projects as well as tenant incentives and lease commissions, by incorporating the option to sell and by conditioning the relationships described on the prevailing economic environment.

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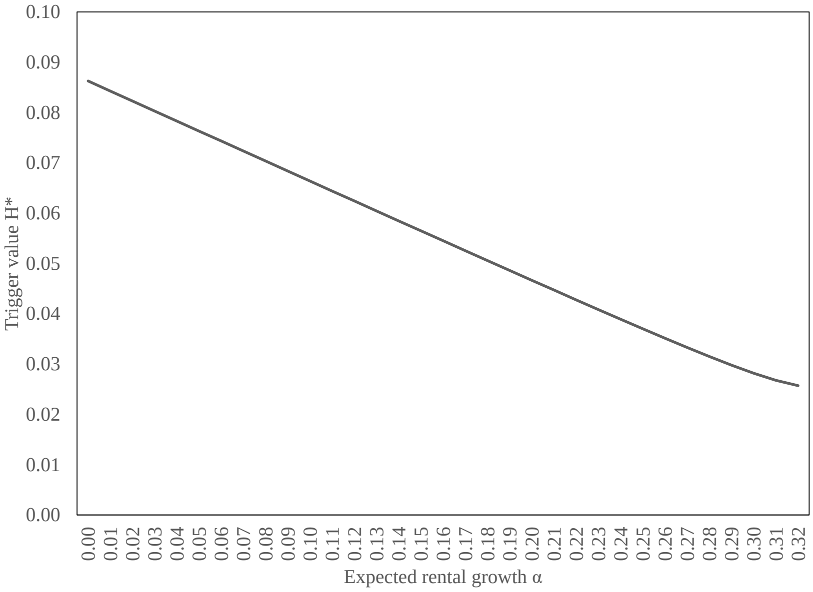
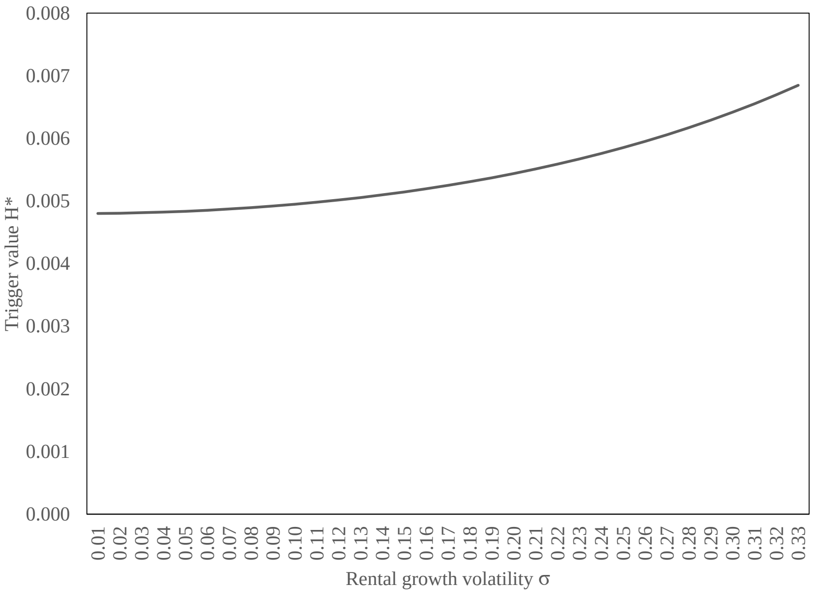
8 Figures and Tables

Evolution of threshold values H* as a function of rental growth and volatility



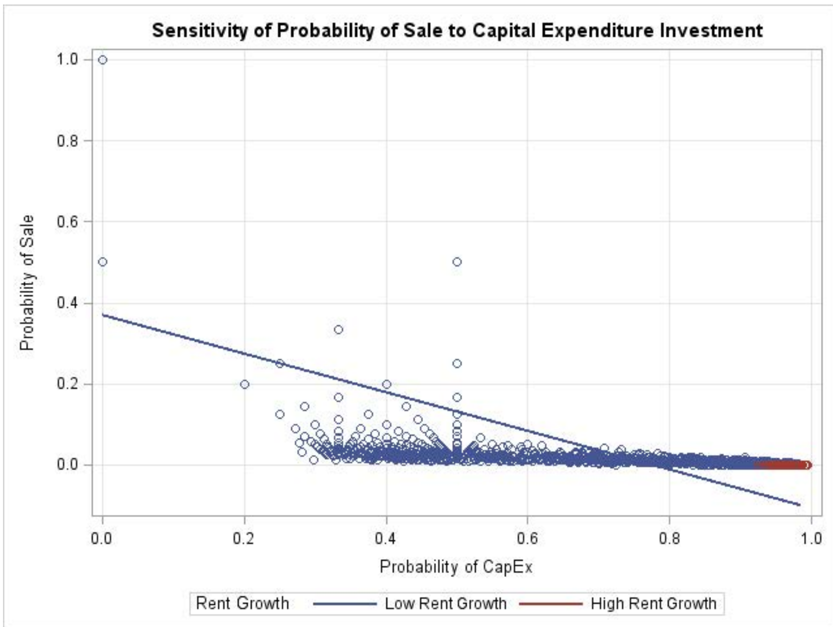
(a) H* as a function of expected rental growth α



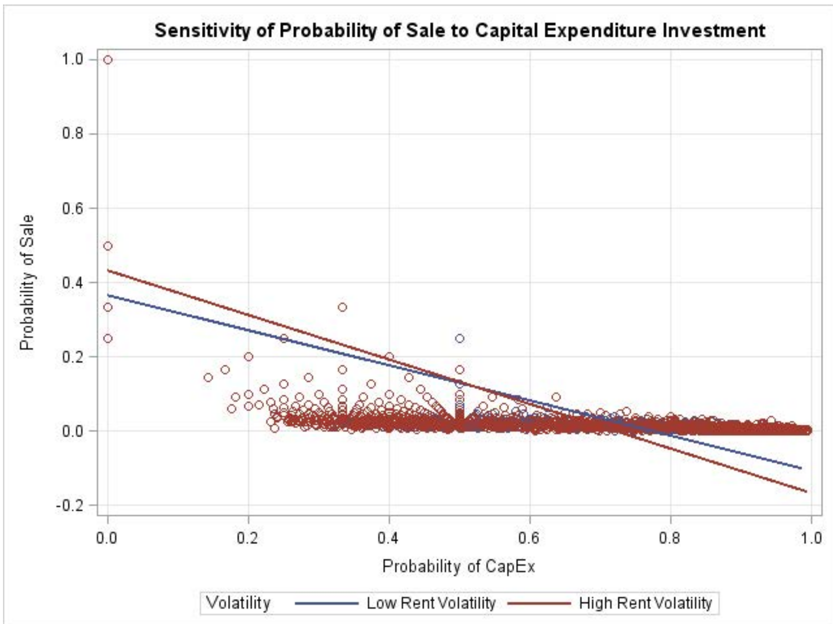
(b) H* as a function of rental growth volatility σ

Fig. 1. The figure shows the evolution of the threshold levels of rent H* that trigger investment in capital expenditures as a function of expected rental growth α (Panel (a)) and volatility of rental growth σ (Panel (b)).

Evolution of the probability of sale as a function of capital expenditures



(a) Probability of sale as a function of CAPEX for different α



(b) Probability of sale as a function of CAPEX for different σ

Fig. 2. The figure shows the probability of sale as a function of CAPEX with different levels of rental growth α (Panel (a)) and volatility of rental growth σ (Panel (b)).

Descriptive statistics

Variable	Mean	SD	P5	P25	Median	P75	P95	Min	Max
Sale Quarter	0.03	0.16	0.00	0.00	0.00	0.00	0.00	0.00	1.00
Log Sq Ft	12.17	0.90	10.64	11.62	12.22	12.75	13.62	9.50	14.24
Log Log Real Initial Market Value	11.49	1.12	9.47	10.80	11.55	12.22	13.28	8.50	14.18
Log Market Value	16.94	1.14	14.95	16.22	16.96	17.66	18.83	14.05	19.81
Real Income Return	0.02	0.01	0.00	0.01	0.02	0.02	0.03	-0.01	0.04
LTV Ratio	0.29	0.31	0.00	0.00	0.27	0.54	0.84	0.00	1.11
Growth Expectation	0.00	0.03	-0.05	-0.02	-0.01	0.01	0.04	-0.09	0.09
Growth Volatility	0.04	-0.18	0.04	0.25	1.12	0.07	0.25	-1.12	1.12
Cumulative Real Appreciation Return	0.00	0.32	-0.54	-0.16	0.02	0.18	0.51	-3.35	1.99
Expansion and Improvement	0.05	0.11	0.00	0.00	0.01	0.04	0.21	0.00	0.80
Tenant Incentives and Lease Commissions	0.05	0.09	0.00	0.00	0.02	0.06	0.21	0.00	0.52
Years Since Acquisition	5.10	3.52	1.25	2.25	4.25	7.00	12.25	1.00	17.00

Table 1: The table presents the descriptive statistics on 207,399 property-quarter observations in our initial sample (82,558 for growth volatility). Sale Quarter is an indicator that takes the value of 1 if the property was reported sold in a given quarter, 0 otherwise. Log Sq Ft is the natural logarithm of the size of the property. Log Real Initial Market Value is the natural logarithm of the real market value of the property as of the end of the first quarter in which a market value estimate is reported. For comparison, Log of Market Value is the natural logarithm of the nominal market value over time. Real Income Return is the quarterly real income return on the property. LTV ratio is the ratio of the outstanding loan balance at the end of the quarter relative to the current estimated market value of the property. Growth expectation is the current implied real growth rate, obtained as the current property capitalization rate minus the risk-free rate (10-year treasury yield) minus the risk premium (BBB corporate bond yield). Growth Volatility is the standard deviation of this growth expectations over four quarters, scaled by the average growth expectation over this period. Cumulative Real Appreciation Return is based on the quarterly change in the market value of the properties, where the market value is obtained through appraisals or, where possible, actual transaction values. Expansion and Improvement as well as Tenant Incentives and Lease Commissions are measured cumulatively and in real terms based on quarterly reported figures, and scaled by the initial market value of the property. Years since Acquisition measures the time since the property was acquired by the current owner. Real values are deflated by the CPI, obtained from the Bureau of Labor Statistics, and are shown in 2010 US$.

Pairwise Pearson correlation table

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Sale Quarter	1										
(2) Expansion and Improvement	-0.0016	1									
(3) Tenant Incentives and Lease Commissions	0.0195*	0.3039*	1								
(4) Log Sq Ft	-0.0066	0.1008*	0.0307*	1							
(5) Log Real Initial Market Value	-0.0234*	-0.0727*	-0.1403*	0.6602*	1						
(6) Cumulative Appreciation Return	-0.0227*	0.0262*	0.0112*	0.1692*	0.0857*	1					
(7) Income Return	-0.0150*	-0.0420*	0.0228*	0.0955*	0.0614*	0.1163*	1				
(8) LTV Ratio	-0.0244*	0.0068	-0.0828*	-0.0354*	-0.0248*	-0.1987*	0.0181*	1			
(9) Years Since Acquisition	0.0179*	0.1501*	0.2579*	0.0964*	0.0307*	0.2143*	-0.0272*	-0.2603*	1		
(10) Growth Volatility	-0.0049	0.0024	-0.0096*	0.0197*	0.0286*	0.0323*	-0.0145*	-0.0079*	0.0017	1	
(11) Growth Expectation	0.0160*	0.0355*	-0.0044	-0.0923*	-0.0910*	-0.0150*	-0.7469*	-0.0576*	-0.0257*	0.0178*	1

Table 2: The table presents the pairwise Pearson correlation coefficients on the variables in our study from the observations in Table 1. Variables are defined as in Table 1. The asterisks indicate significance at the 5% level.

OLS models for capital expenditures as a function of growth expectations and volatility
– Coefficient estimates are shown –

	Full period		Non-Recession		Recession	
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Imp/Exp	TI/LC	Imp/Exp	TI/LC	Imp/Exp	TI/LC
Growth Expectation	0.008***	0.011***	0.005***	0.009***	0.020***	0.017***
	(6.23)	(7.50)	(4.00)	(5.78)	(6.36)	(5.62)
Growth Volatility	-0.000	0.000	-0.000	0.000	-0.000	-0.000
	(-1.34)	(0.64)	(-0.51)	(1.47)	(-1.47)	(-0.82)
Log Sq Ft	-0.001***	-0.001***	-0.000***	-0.000***	-0.001***	-0.002***
	(-7.68)	(-8.83)	(-4.78)	(-4.22)	(-7.34)	(-9.46)
Log Real Initial Market Value	0.001***	0.001***	0.000***	0.000***	0.001***	0.001***
	(9.81)	(12.11)	(7.32)	(9.06)	(8.00)	(10.14)
Income Return	-0.017***	-0.019***	-0.019***	-0.019***	-0.011	-0.023**
	(-5.02)	(-4.59)	(-5.28)	(-4.17)	(-1.33)	(-2.64)
LTV Ratio	0.000	-0.000	0.000	-0.000	0.000	0.000
	(1.07)	(-0.44)	(0.37)	(-1.18)	(1.80)	(1.04)
Years Since Acquisition	0.000	0.000	0.000	-0.000	0.000	0.000
	(1.07)	(0.73)	(0.75)	(-0.02)	(1.25)	(1.73)
Constant	0.001	-0.001*	-0.000	-0.002***	0.003**	0.004***
	(1.48)	(-2.17)	(-0.85)	(-4.05)	(3.22)	(4.45)
Observations	74,273	74,273	54,458	54,458	19,815	19,815
R-squared	0.052	0.139	0.049	0.155	0.075	0.134
Property type effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarter effects	Yes	Yes	Yes	Yes	Yes	Yes
Division effects	Yes	Yes	Yes	Yes	Yes	Yes
No of property clusters	8,035	8,035	7,769	7,769	4,385	4,385

Table 3

The table presents the coefficient estimates from the OLS regression $CAPEX_{it} = \gamma_0 + \gamma_1 GE_{i,t-1} + \gamma_2 VOL_{i,t-1} + \gamma_3 \mathbf{X}_{i,t-1} + u_{it}$, where $CAPEX_{it}$ is the firm-quarter observations of capital expenditures per square foot, $GE_{i,t-1}$ is the expected rate of property income growth at time $t-1$, $VOL_{i,t-1}$ is the volatility of growth expectations over the preceding four quarters scaled by the average growth expectation over this period, $\mathbf{X}_{t-1}$ is a matrix of control variables measured at time $t-1$, and u_{it} is the residual. CAPEX is shown separately for expansion/improvement (Exp/Imp) as well as tenant incentives/lease commissions (TI/LC). All regressions are estimated for the full study period, as well as recession/non-recession sub-periods based on NBER recession dates. $\mathbf{X}_{t-1}$ includes the following control variables: the one-period real income return, the loan-to-value ratio, the time since acquisition, property size (sq ft), the log of the initial real market value when the property entered the sample, as well as indicators for property type, geographic region, and quarter. All continuous variables are winsorized at 1st and 99th percentile to mitigate undue influence of outliers. The variables are defined as in Table 1. All right-hand side variables are lagged by one quarter. T-statistics, shown in parentheses, are based on standard errors clustered by property. Significance is indicated as follows: *** p<0.001, ** p<0.01, * p<0.05.

OLS models for real capital appreciation returns as a function of capital expenditures
– Coefficient estimates are shown –

VARIABLES	(1) Full period	(2) Non-Recession	(3) Recession
Expansion and Improvement	0.004**	0.004**	0.004
	(3.07)	(2.84)	(1.15)
Tenant Incentives and Lease Commissions	0.005**	0.007**	-0.002
	(2.71)	(3.11)	(-0.37)
Log Sq Ft	0.001***	0.001***	0.002***
	(6.19)	(4.95)	(3.42)
Log Real Initial Market Value	0.000	0.000	-0.003***
	(-0.96)	(1.38)	(-5.63)
Income Return	0.243***	0.196***	0.626***
	(10.83)	(8.14)	(9.83)
LTV Ratio	0.002***	0.000	0.012***
	(4.36)	(0.85)	(9.62)
Years Since Acquisition	-0.000*	-0.000*	0.000
	(-2.30)	(-2.44)	(-0.31)
Constant	-0.026***	-0.028***	-0.012*
	(-10.25)	(-10.20)	(-2.21)
Observations	247,492	210,415	37,077
R-squared	0.149	0.076	0.219
Property type effects	Yes	Yes	Yes
Quarter effects	Yes	Yes	Yes
Division effects	Yes	Yes	Yes
No of property clusters	13,793	13,594	6,520

Table 4
The table presents the real capital appreciation return $APP_{i,t} = \gamma_0 + \gamma_1 CAPEX_{i,t-1} + \gamma_2 \mathbf{X}_{i,t-1} + u_{it}$ where $CAPEX_{i,t-1}$ measures cumulative real capital expenditures up to and including $t-1$, and $\mathbf{X}_{t-1}$ contains the covariates from Equation (16). CAPEX is shown separately for expansion/improvement (Exp/Imp) as well as tenant incentives/lease commissions (TI/LC). The regressions are estimated for the full study period, as well as recession/non-recession sub-periods based on NBER recession dates. $\mathbf{X}_{t-1}$ includes the following control variables: the one-period real income return, the loan-to-value ratio, the time since acquisition, property size (sq ft), the log of the initial real market value when the property entered the sample, as well as indicators for property type, geographic region, and quarter. All continuous variables are winsorized at 1st and 99th percentile to mitigate undue influence of outliers. The variables are defined as in Table 1. All right-hand side variables are lagged by one quarter. T-statistics, shown in parentheses, are based on standard errors clustered by property. Significance is indicated as follows: *** $p<0.001$, ** $p<0.01$, * $p<0.05$.

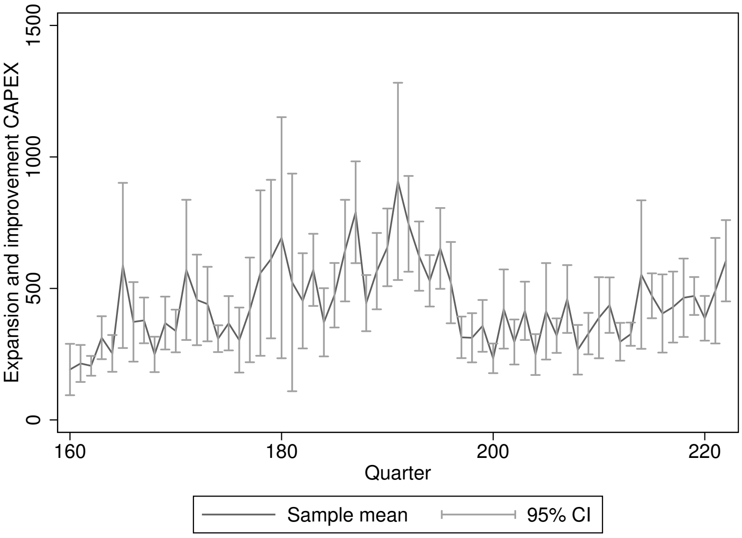
Cox partial likelihood models for the likelihood of sale as a function of capital expenditures
– Coefficient estimates are shown –

VARIABLES	(1) Full period	(2) Non-Recession	(3) Recession
Expansion and Improvement	-0.010***	-0.009**	-0.033
	(-3.41)	(-3.13)	(-1.54)
Tenant Incentives and Lease Commissions	0.006	0.006	-0.004
	(1.47)	(1.63)	(-0.20)
Cumulative Appreciation Return	-0.013***	-0.012***	-0.037***
	(-12.37)	(-10.51)	(-8.60)
Income Return	-0.04	-0.046	0.084
	(-0.89)	(-1.01)	(0.40)
LTV Ratio	-0.006***	-0.004***	-0.041***
	(-5.16)	(-3.83)	(-5.99)
Years Since Acquisition	-0.005***	-0.005***	-0.003
	(-11.77)	(-11.08)	(-1.50)
Log Sq Ft	0.117***	0.119***	0.094
	(4.60)	(4.53)	(1.00)
Log Real Initial Market Value	-0.232***	-0.229***	-0.292***
	(-10.47)	(-9.94)	(-3.68)
Observations	247,492	209,612	37,880
Property type effects	Yes	Yes	Yes
Division effects	Yes	Yes	Yes
Acquisition Year effects	Yes	Yes	Yes
No of property clusters	13,793	13,590	6,598

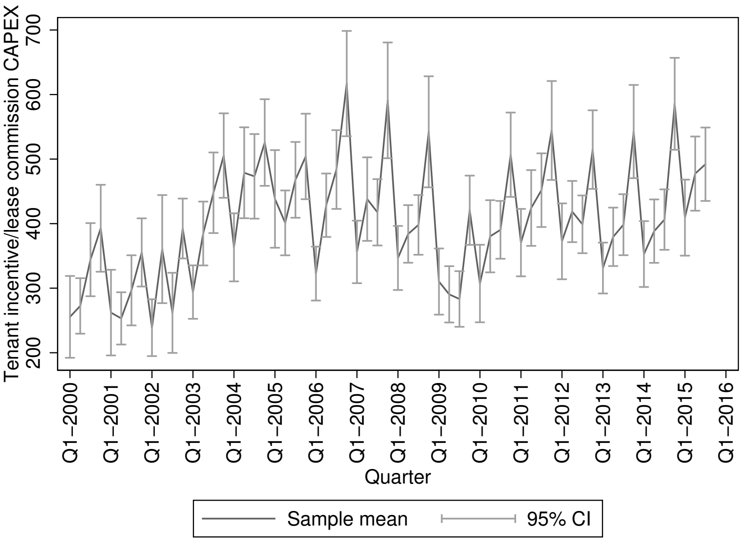
Table 5

The table presents the Cox hazard rate of sale $h(i,t) = h_0(i,t)\exp(\gamma_1 CAPEX_{i,t-1} + \gamma_2 CAPP_{i,t-1} + \gamma_3 \mathbf{X}_{i,t-1})$ where $h_0(i,t)$ denotes the baseline hazard rate, $\mathbf{X}_{t-1}$ contains the covariates from Equation (16). CAPEX is shown separately for expansion/improvement (Exp/Imp) as well as tenant incentives/lease commissions (TI/LC). The regressions are estimated for the full study period, as well as recession/non-recession sub-periods based on NBER recession dates. $\mathbf{X}_{t-1}$ includes the following control variables: the one-period real income return, the loan-to-value ratio, the time since acquisition, property size (sq ft), the log of the initial real market value when the property entered the sample, as well as indicators for property type, geographic region, and acquisition year. All continuous variables are winsorized at 1st and 99th percentile to mitigate undue influence of outliers. The variables are defined as in Table 1. All right-hand side variables are lagged by one quarter. We estimate the coefficients via Cox's partial likelihood method. Following standard practice, properties that are not sold during the sample period are included in the estimation but are considered right censored. Variables are defined as in Table 1. All right-hand side variables are lagged by one quarter. Z-statistics, shown in parentheses, are based on standard errors clustered by property. Significance is indicated as follows: *** p<0.001, ** p<0.01, * p<0.05.

Evolution of CAPEX components



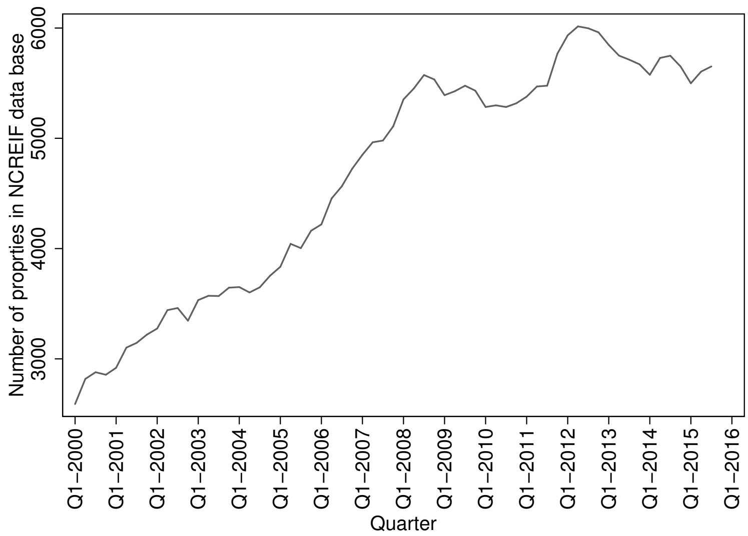
(a) Expansion and improvement CAPEX



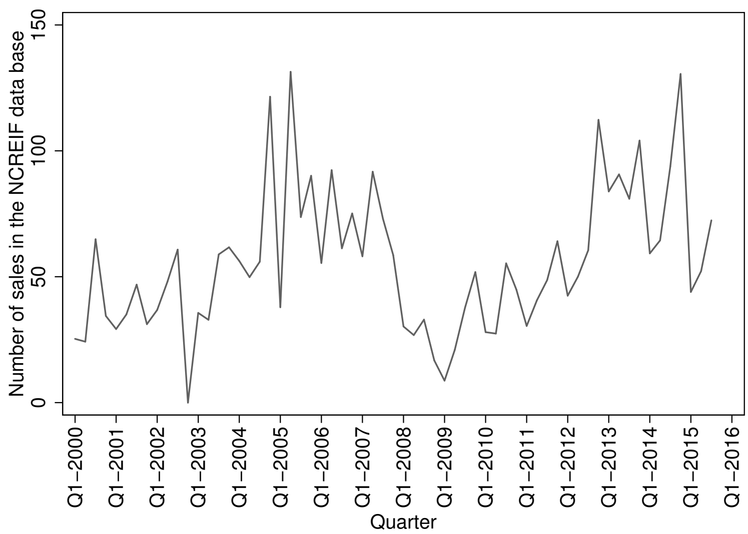
(b) Tenant incentives and lease commissions

Fig. 3. The figure shows the evolution of expansion and improvement CAPEX (Panel (a)) and tenant incentive and lease commission CAPEX (Panel (b)) over the period 2000 to 2014.

Evolution of sample properties and sales



(a) Number of properties



(b) Number of sales

Fig. 4. The figure shows the evolution of the quarterly number of properties in our final sample (Panel (a)) and the number of property sales (Panel (b)) over the period 2000 to 2014.