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Corporate Real Estate Ownership and Productivity Uncertainty

Daxuan Zhao,* and Tien Foo Sing**

This article empirically tests the relationship between corporate real estate (CRE) holdings and productivity risks of firms. Using a large sample of public listed U.S. firms for the period from 1984 to 2011, we show that CRE ownership is significantly and negatively correlated with productivity risks of firms. Firms with high-productivity risk own less CRE assets. When testing dynamic changes to CRE holdings, we estimate a significant and positive elasticity of CRE investments of 5.2% in response to cash flow shocks. If the adjustment cost is high, high-risk firms are expected to hold less CRE assets, so that they could reduce potential losses associated with CRE holdings when negative productive shocks occur.

Introduction

Corporate real estate (CRE) that includes both land and physical structures is the single largest fixed capital investment for many firms. US public listed nonreal estate firms owned on average about 10% CRE in their total assets for the periods from 1984 to 2011.[1] The average CRE ratio was 25% in the early 1980s, and some manufacturing firms owned as high as 40% CRE during the periods (Zeckhauser and Sliverman, 1983). In France, CRE made up about 44% of the property, plant and equipment investment (PPE) by book value (Chaney, Sraer and Thesmar, 2012); whereas, in Japan, land owned by average Japanese firms accounted for 67.7% of the replacement costs (Gan 2007a,b).

While most of the firms use CRE for production purposes, some firms invest in CRE for its long term price appreciation potentials. The literature is divided on the question of whether firms should use their limited resource to

*School of Business, Renmin University of China, Beijing 100872, China; Institute of High Performance Computing, Agency for Science, Technology and Research, Singapore 138632; Institute of Real Estate Studies, National University of Singapore, Singapore 119077; or zhaodaxuan@gmail.com
**Department of Real Estate, National University of Singapore, Singapore 117566 or rststf@nus.edu.sg .

[1]Based on the calculations by the Authors; see Table 1.

increase productive outputs rather than investing in CRE.[2] Many studies have shown that CRE ownership has negative impact on the performance of nonreal estate firms (Linnerman 1998, Deng and Gyourko 1999, Brounen and Eichholtz, 2005). Firms with intensive real estate holdings, either through direct ownership or capital leases, are exposed to greater systematic and real estate market risks (Tuzel 2010, Ling, Naranjo and Ryngaert, 2012). The results were derived based on the premise that CRE ownership is an exogenous variable that explains variations in firms' stock market performance controlling for heterogeneity among firms.

There are two strands of literature that explain the motives of CRE ownerships by firms. The first one is related to the collateral channel effect of CRE, which predicts a positive relationship between CRE values and firms' investments (Gan 2007a,b, Chaney, Sraer and Thesmar 2012). Firms use CRE assets as collaterals to increase debt capacity when CRE values increase. Therefore, the collateral benefits motivate firms to own instead of lease CRE. The second story is related to corporate governance of firms. Insider managers governed by weak boards use excessive CRE acquisitions to support their "empire building" motives (Veale 1989, Coles, Daniel and Naveen 2006). Why do some firms hold CRE in their balance sheets? On the assumption that CRE ownership is endogenously determined in a firm's production function, this study offers a CRE ownership story that is different from the earlier collateral channel and "empire building" stories. It hypothesizes a negative relationship between CRE ownership and productivity uncertainty of firms.

Built on the premise that CRE is not exogenously determined, we propose a simplified two-period model to evaluate options of leasing versus owning CRE assets by a value maximizing firm in response to uncertain productivity shocks. Holding CRE is costly; firms incur sunk costs for holding excess CRE assets. Our model conjectures that firms facing high-productivity risk invest less in CRE ownership because of high holding costs, *ceteris paribus*.

We empirically test the hypothesis that CRE ownership is negatively correlated with productivity uncertainty using a large sample of U.S. public listed firms for the period 1984–2011. Our results show that CRE ownership is significantly and negatively correlated with firms' productivity risks. Firms with high-productivity uncertainty own less CRE compared to firms with low-productivity uncertainty. This article also finds that firms dynamically adjust

[2]The financial leasing literature advocates that firms should lease instead of own CRE, so that they could channel their capital to more productive uses (Miller and Upton 1976, Lewellen, Long and McConnell 1976, Wolfson 1985). Brounen and Eichholtz (2005) found a declining trend in CRE ownerships for international firms, because of increasing popularity of leasing option.

CRE holdings in response to changes in productivity risks. The elasticity of CRE holding to cash flow risks is estimated at 5.2%. The results are consistent with the adjustment cost literature, which argues that high-risk firms have less economic incentives to own CRE, so that they could minimize losses when selling CRE during the period of negative productivity shocks.

The remainder of the article is organized as follows: Section 2 reviews the past studies on CRE ownerships. Section 3 derives a simple two-period theoretical model on CRE strategies of owning versus leasing CRE space. Section 4 discusses data sources and descriptive statistics. Section 5 presents empirical results on the relationships between CRE ownership and productivity uncertainty. Various robustness tests are conducted, and results are also explained in this section. Section 6 concludes the article.

Literature Review

CRE is the single largest fixed capital investment of many public listed firms. It is not substitutable by other capital goods, such as equipment and plants. Firms have an option to either own or lease CRE. CRE held by public listed nonreal estate firms is significantly under-valued by the markets dampening stock prices of firms holding large CRE assets (Deng and Gyourko 1999, Liow 2004, Brouner and Eichholtz 2005, Brounen, Colliander and Eichholtz 2005, Ling, Naranjo and Ryngaert 2012). However, some firms still hold substantial CRE because of economic, operational and strategic considerations (Liow and Nappi-Choulet 2008).

Most of the existing literature has been ambiguous in explaining the channel through which CRE ownership affects the firms' stock price performance. As CRE is highly illiquid and irreversible, Tuzel (2010) argues that firms owning CRE incur high adjustment costs when they are forced to sell their CRE assets in depressing markets. The high irreversibility discounts of CRE drive up risk premiums of firms with high real estate holdings. She predicted that systematic risk premiums of high-CRE holding firms were 3% to 6% higher than the premiums of comparable low-CRE holding firms. However, Brounen and Eichholtz (2005) found the opposite results when they study the impact of owning CRE using a sample of international firms.

Despite the high irreversibility discounts, CRE holdings are still relatively high in some countries. Chaney, Sraer and Thesmar (2012) showed that CRE constitutes about 85% and 44% of the lagged average PPE of firms in the United States and France, respectively. These firms use CRE as a collateral channel to increase external financing capacity (Benmelech, Garmaise and Moskowitz 2005, Gan 2007ab, Chaney, Sraer and Thesmar 2012). The

collateral effects of CRE were estimated at about 6% in the United States, 11% in France (Chaney, Sraer and Thesmar 2012) and 8% in Japan (Gan 2007a) on average. However, Wu, Gyourko and Deng (2013) found that insignificant collateral effects for state-owned enterprises (SOEs), a unique institutional feature in the China's capital market. The SOEs with privileged access to capital market do not rely on the property collateral channel to obtain financing for new investments.

Leasing has become an increasingly popular alternative for firms to procure CRE space for their production needs (Brounen and Eichholtz, 2005). Some firms use the leasing strategy to preserve liquidity because leasing is viewed as a "*100% financing*" contract that has no direct impact on operational cash flows (Schallheim 1994, Brealey, Myers and Allen 2005). The "liquidity perseverance" hypothesis is, however, disputed by some researchers, who argue that leasing contracts and debt financing are not perfectly substitutable. Ang and Peterson (1984) find no significant empirical evidence that firms leasing fixed assets has relatively lower debt than firms owning fixed assets. However, Eisfeldt and Rampini (2009) show that leasing increases debt capacity of constrained firms.

Lease financing could also reduce bankruptcy costs (Krishnan and Moyer 1994) and credit risks of firms (Grenadier 1996, Ambrose and Yildirim 2008, Agarwal *et. al*. 2011). Other economic benefits associated with leasing include accrued tax advantages, lower maintenance and repair costs (Miller and Upton 1976, Lewellen, Long and McConnell 1976, Wolfson 1985).

Theoretical Framework on CRE Strategies of Firms

We present a simple theoretical model to illustrate the underlying logic of firms' CRE ownership versus leasing decisions taking into consideration uncertainty in the production function. In our model, owning and leasing are the two different ways of procuring CRE assets in production.

We propose a two-period model denoted by $t = 0$ and $t = 1$. At $t = 0$, a representative firm invests in CRE valued at h using an internal fund of e. We assume that the firm distributes surpluses, if any, back to investors as dividends, which is equal to

$$d_0 = e - h. \tag{1}$$

Firm uses CRE assets for its production at $t = 1$. The output of firm is dependent on a state s, denoted as $y(s)$ and the risk in production is idiosyncratic. The CRE space required in the production is an increasing function, $c(s)$. If the CRE investment h cannot meet the requirement of production at time

$t = 1$, the firm can lease the short-fall in CRE, $[\ c(s) - h]$, at a leasing rate p^l. However, the firm cannot lease out its CRE that is in excess of the production capacity, $[c(s) - h > 0]$. The excess CRE is considered a sunk cost for owning more CRE, and the firm sells its excess CRE at a depreciation rate at the end of $t = 1$.[3] The dividend at time $t = 1$ is

$$d_1(s) = y(s) - \max[0, c(s) - h] \times p^l. \tag{2}$$

The value function of the firm at $t = 0$ is

$$d_0 + \frac{1}{1+r}\left[\sum_{s\in S} \pi(s) d_1(s) + h(1-\delta)\right], \tag{3}$$

where d_0 and $d_1(s)$ are dividends at time $t = 0$ and $t = 1$, respectively; r is the interest rate; and $\pi(s)$ is the probability function of state. Substitute Equations (2) and (3) into the value function, we have

$$e + \frac{1}{1+r}\sum_{s\in S} \pi(s) y(s) - \frac{1}{1+r}\left\{h(r+\delta) + \sum_{s\in S} \pi(s) p^l \times \max[0, c(s) - h]\right\}. \tag{4}$$

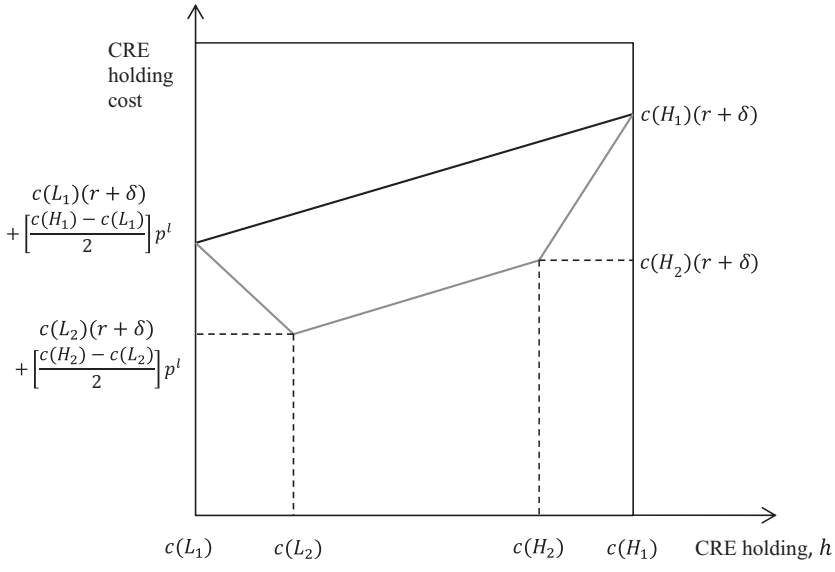
In Equation (4), e represents the initial endowment; $\frac{1}{1+r}\sum_{s\in S} \pi(s) y(s)$ represents the total output of the firm and the last part represents the total payment for CRE. For a value maximizing firm, the rationale strategy is to minimize the total cost by selecting a right mix of owning and leasing contracts for CRE assets.

We assume that s has two states, high (H) and low (L), that is, $s = \{H, L\}$, with an equal probability of occurrence. To illustrate firms' CRE decisions under different productivity uncertainty scenarios, we compare two firms with the states of production uncertainty represented by s_1 and s_2, respectively, where $L_2 > L_1$ and $H_2 < H_1$. Given that firms have the same expectations in the two states, a firm that expects an uncertainty state of s_1 is more risky than a firm that expects s_2. To simplify the model, we define $c(s)$ as a linear function of s, $[c(S_1) + c(S_2) = c(S_1 + S_2)]$. In Figure 1, the horizontal axis represents the CRE investment h at time 0, and the vertical axis represents the total payment, which is the last term of Equation (4). The black line represents the payment by a firm with uncertainty $s_1 = \{L_1,\ H_1\}$, and the gray line represents the payment by a firm with uncertainty $s_2 = \{L_2,\ H_2\}$.

First, the CRE holding cost of a low-risk firm (gray line) is lower than that of a high-risk firm (black line). For each given h, the CRE holding cost of

[3]The US Bureau of Economic Analysis (BEA) reports a relatively lower depreciation rate of between 1.5% and 3% for nonresidential real estate compared to the depreciation rates of 10–30% for equipment.

Figure 1 ■ Holding costs and investments in corporate real estate.



Notes: The horizontal axis is the CRE investment$h$ at date 0; and the vertical axis is the total payment for CRE. The black line represents the CRE strategies of firms in a risky state of productivity uncertainty,$s_1 = \{L_1,\ H_1\}$; and the gray line represents CRE strategies of firms in a riskless state of productivity uncertainty$s_2 = \{L_2,\ H_2\}$.

a high-risk firm is $h(r+\delta) + \frac{1}{2}p^l[c(H_1) - h]$ which is higher than the CRE holding cost of a low-risk firm, $h(r+\delta) + \frac{1}{2}p^l[c(H_2) - h]$. It implies that the low-risk firm will hold more CRE asset than the high-risk firm with same budget constraints, *ceteris paribus*. Second, high-risk firm in a state s_1 invests at the left boundary $c(L_1)$ with the lowest payment; and the firm in a state s_2 can invest more CRE at $c(L_2)$. A firm with high-productivity uncertainty purchases less CRE for its production because the CRE adjustment cost is high. In our model, the sunk cost of excess CRE investment is high because a firm cannot adjust its CRE ownership quickly in response to productivity shocks. A high-risk firm chooses to lease CRE instead of buying to reduce the adjustment cost.

Data

Our samples of nonreal estate firms listed on major stock exchanges in the United States are collected from the Compustat database. For a sample period from 1984 to 2011, we construct an unbalanced panel of 91,948 firm-year

observations. The numbers of firms vary from a minimum of 1,633 firms in 1984 to a maximum of 5,076 firms in 1998. Based on the financial and CRE data from the Compustat, we derive a list of variables for our empirical tests, which is shown in Table 1. Detailed derivations of the key variables are discussed in the following sections.

Production Uncertainty

Firm's productivity, or more specifically, the output per unit of capital, "CASH_A," is defined as cash flows from operations of a firm divided by its total assets in book value (#AT).[4] The cash flows from operations are computed as the sum of income before extraordinary items (#IB) and depreciation and amortization (#DP). We choose the cash flow variables over the total sale and EBITDA in computing the productivity measure, because net (internal) cash flows are directly related to firms' financing decision and output of production. The 2% observations in the tailed distribution of "CASH_A" are winsorized to minimize measurement errors.

Based on "CASH_A," we define two volatility measures for the output per unit capital of firms. First, we compute the standard deviation of "CASH_A" as a measure of the productivity uncertainty, which is denoted as "RISK1." We include only sample firms that have at least five-year data on cash flows and total assets when computing the "RISK1" variable. The second proxy of productivity uncertainty denoted as "RISK2" is adjusted for potential shocks in business cycles, which is defined as the time-variant differences between the firm-level productivity and the average industry-level productivity:

$$RISK2 = \sqrt{\frac{1}{T-1}\sum_{t=1}^{T}\left(C_{i,t} - \frac{1}{T}\sum_{i=1}^{T} C_{i,t}\right)^2}, \tag{5}$$

where

$$C_{i,t} = CASH\_A_{i,t} - \frac{1}{N_I}\sum_{i=1}^{N_I} CASH\_A_{i,t}, \tag{6}$$

where t indicates the year of observation, $T \geq 5$ sets a time window of more than five years for the estimates, and N_I indicates the number of firms in the same industry I in year t. The industry portfolio as denoted by the subscript I is defined by the first two digits of a firm's SIC code.

[4]The variable starting with # indicates the name in Compustat. The same shall apply hereinafter.

Table 1 ■ Definitions of variables.

Variables	Definition	Source
Corporate Real Estate Ownership (CRE)	Corporate real estate ownership is derived from the components of the property, plant, and equipment (PPE), which is defined as the sum of building costs (#FATB), land and improvements (#FATP) and costs of construction in progress (#FATC)	CompuStat
Ratio of Corporate Real Estate Ownership to Total Asset (CRE_A)	Corporate real estate ownership (CRE) is normalized by the total assets (#AT) for each firm	CompuStat
Relative Ratio of Corporate Real Estate Ownership to Total Asset (CRE_RA)	The relative ratio of corporate real estate ownership to total asset is defined as $CRE\_RA_{i,t} = CRE\_A_{i,t} - \frac{1}{N_I}\sum_{i}^{N_I} CRE\_A_{i,t}$, where $CRE\_A_{i,t}$ is the ratio of corporate real estate ownership to total asset for firm i in year t; and N_I is the number of firms in the same industry I in year t.	CompuStat
Ratio of Corporate Real Estate Ownership to Total PPE (CRE_P)	Corporate real estate ownership (CRE) is normalized by the amount of PPE at costs (#PPEGT) for each firm	CompuStat
Productivity (CASH_A)	Productivity is defined as the ratio of total cash flow to total assets: $CASH\_A = \frac{IB+DP}{AT}$, where IB is income before extraordinary items; and DP is depreciation and amortization	CompuStat
Productivity Risk Measure (RISK1)	The first productivity risk measure is defined as: $RISK1 = \sqrt{\frac{1}{T-1}\sum_{t=1}^{T}(CASH\_A_{i,t} - \frac{1}{T}\sum_{i=1}^{T} CASH\_A_{i,t})^2}$, where t indicate the year of observation and $T \geq 5$.	CompuStat
Productivity Risk Measure (RISK2)	The second productivity risk measure adjusted for fluctuation from business cycle: $RISK2 = \sqrt{\frac{1}{T-1}\sum_{t=1}^{T}(C_{i,t} - \frac{1}{T}\sum_{i=1}^{T} C_{i,t})^2}$, where $C_{i,t} = CASH\_A_{i,t} - \frac{1}{N_I}\sum_{i=1}^{N_I} CASH\_A_{i,t}$; t indicates the year of observation and $T \geq 5$; N_I is the number of firms in the same industry at year t	CompuStat

Table 1 ■ continued.

Variables	Definition	Source
Leverage	Leverage ratio is defined as the long-term debt (#DLTT) divided by total assets (#AT)	CompuStat
Size	Firm size (SIZE) is defined as the log of total book value of assets (#AT)	CompuStat
Ratio of PPE excluding CRE to Total Asset (PPE_A)	PPE at costs (#PPEGT) without CRE is normalized by total assets (#AT)	CompuStat
Tobin's Q	Tobin's Q is computed as: $Tobin\prime Q = \frac{CSHO \times PRCC\_F}{AT - CET - TXDB}$, where *CSHO* is the number of shares of common stock; *PRCC_F* is the end-of-year closing price of common shares; *AT* is the book value of assets; *CET* is the common equity and *TXDB* is deferred taxes	CompuStat
Ratio of Capital Leasing to Total Asset (CL_A)	Capital leasing (#FATL) is normalized by the total assets (#AT) for each firm	Compustat
Relative Ratio of Capital Leasing to Total Asset (CL_RA)	Relative ratio of corporate real estate leasing to total asset is defined as: $CL\_RA_{i,t} = CL\_A_{i,t} - \frac{1}{N_I}\sum_{i}^{N_I} CL\_A_{i,t}$, where $CL\_A_{i,t}$ is the ratio of corporate real estate leasing to total asset for firm i at year t and N_I is the number of firms in the same industry at year t	Compustat
National Property Return	The National-level property return is computed based on index published by National Council of Real Estate Investment Fiduciaries (NCREIF) from 1984 to 2011	NCREIF
Housing Price Index (HPI)	The state-level housing price changes is computed from the Federal Housing Financial Agency (FHFA) index, where the housing price index is matched to the headquarter locations of firms at the state level. The log of the index is used to smooth out the trend	FHFA
Commercial Property Index (NPI)	The NCREIF property index at the MSA-level is used to control for the movements in U.S. commercial property markets. The MSA location of each firm is identified based on the city identifiers of firms' headquarters. The log of the index is used to smooth out the trend	NCREIF

Notes: The table summarizes a list of empirical variable used in the empirical analyses. Firms' financial variables are mainly obtained from Compustat.

Corporate Real Estate (CRE) Ownership

The Compustat's data on PPE are broken into "buildings," "capitalized leases," "machinery and equipment," "natural resources," "land and improvements" and "construction in progress." We adopt the definition of Chaney, Sraer and Thesmar (2012), which derives CRE by adding the three PPE components that are "building costs" (#FATB), "land and improvements" (#FATP) and "costs of construction in progress" (#FATC). We divide the CRE values by two denominators: total asset value (#AT) and total PPE value (#PPEGT), to derive the two CRE ratios denoted as "CRE_A" and "CRE_P," respectively. As the Compustat only reports the PPE in "historical cost" since 1984, our PPE data cover the period from 1984 to 2011. We use the year-on-year changes in "historical PPE costs" to represent net investments in CRE.

Because CRE holdings vary across different industries, we analyze within-industry variations in CRE holdings using a relative CRE variable, "CRE_RA," which is computed as the difference between the CRE ratio of firm i in year t and the average CRE ratio of N firms in industry I in year t:

$$CRE\_RA_{i,t} = CRE\_A_{i,t} - \frac{1}{N_I}\sum_{i}^{N_I} CRE\_A_{i,t}, \tag{7}$$

where the industry I is identified by the first two digits of SIC code of firms.

Other Control Variables

In the empirical models, we control for firm characteristics using a number of finance variables collected from the Compustat. First, we use "leverage" and "Tobin's Q" to account for variations in financial performance of firms. The leverage ratio is defined as the long-term debt (#DLTT) divided by the total asset value. The Tobin's Q is defined as the ratio of the market value of equity to the book value of firm, where the market value of equity is computed by multiplying the number of shares of common stock (#CSHO) by the end-of-year closing price of common shares (#PRCC_F); and the book value of firm is computed as the book value of assets (#AT) minus common equity (#CEQ) and deferred taxes (#TXDB).

Second, we use the ratio of total PPE (#PPEGT) excluding CRE to total assets to control for variations in non-CRE fixed capital goods, such as equipment and plants of firms. The firm size defined as the natural logarithm of total book assets (#AT) is also added in the regressions. Capitalized lease is deemed as an alternative option to the owning option in the model. CRE leasing is represented by the ratio of capitalized leases to book value of total assets

denoted as "CL_A."[5] The relative CRE leasing ratio, "CL_RA," is calculated as the ratio of the CRE leasing of a firm *i* to average CRE leasing of other comparable firms in the industry *I*.

Third, the SIC code is included in our studies to control for industry-related heterogeneity. Our regressions control the industry fixed effects represented by 72 industry groups based on the first two digits of SIC code.

For the last group of control variables, we include separately either the state-level housing price index (HPI) of the Federal Housing Financial Agency (FHFA)[6] or the Metropolitan Statistical Area (MSA)-level property price index (NPI) of the National Council of Real Estate Investment Fiduciaries (NCREIF),[7] and merge the indices by the firms' headquarter locations to adjust for spatial–temporal variations in property prices.[8] The log price returns capture both the time-variant and spatial-dependent property price movements.

Empirical Results

This section presents the empirical strategy and results on the relationship between CRE ownership and productivity uncertainty using data of the public listed nonreal estate firms in the United States for the sample periods from 1984 to 2011. We first show the descriptive statistics of CRE holdings and the relative CRE holdings sorted by different productivity risks of firms. We regress the CRE holdings on firms' productivity risks controlling for firm heterogeneity and time-dependent market variations. Robustness tests are conducted using different risk measures and different firm types.

[5]Capitalized leases for real estate are significantly larger than capitalized leases for other equipment for the average U.S. firms (Eisfeldt and Rampini 2009, Tuzel 2010).

[6]The HPI house price index published by the FHFA tracks the residential real estate price movements at the state level since 1975 (Source: http://www.fhfa.gov/).

[7]The NCREIF real estate price index first published in 1978 is a composite measure of total return of private commercial real estate at the Metropolitan Statistical Area (MSA) level. (Source: http://www.ncreif.org/). We acknowledge the suggestion of one of the referees for the use of NCREIF indices in this article.

[8]As the HPI indices are available at the state-level, we match the HPI indices directly to the locations of the firms' headquarters using the sate identifier (#STATE). For NCREIF MSA-level (NPI) indices, we convert the city (#CITY) identifiers of the headquarter locations of sample firms into the MSA identifiers and match them to the corresponding NPI indices. For the NPI indices, about 7,000 observations are dropped in the matching process due to missing data.

Table 2 ■ Descriptive statistics on corporate real estate ownership.

	1980s	1990s	Post 2000	Total
Full Sample				
Mean	0.150	0.109	0.076	0.096
Median	0.118	0.030	0.002	0.014
SD	0.172	0.162	0.143	0.155
Obs.	9,875	34,585	47,488	91,948
SIC = 2				
Mean	0.168	0.127	0.092	0.113
Median	0.165	0.104	0.024	0.067
SD	0.135	0.142	0.133	0.139
Obs.	1,659	5,828	8,571	16,058
SIC = 3				
Mean	0.149	0.104	0.077	0.096
Median	0.143	0.076	0.025	0.057
SD	0.140	0.121	0.108	0.120
Obs.	3,472	11,322	14,555	29,349
SIC = 5				
Mean	0.179	0.152	0.133	0.147
Median	0.133	0.070	0.043	0.062
SD	0.183	0.197	0.200	0.197
Obs.	1,558	4,888	5,150	11,596

Notes: The table summarizes the descriptive statistics of corporate real estate (CRE) ownership, which is represented by the ratio of corporate real estate to total asset (CRE_A), for the full sample periods and three subsample periods (1980s, 1990s and Post 2000). The industry-sorted CRE_A ratio is also presented in the table. "SIC=#" indicates the industry type of firms, where "#" indicates the first digit of the SIC code. The statistics of firms in light manufacture industry (SIC = 2), heavy manufacture industry (SIC = 3) and wholesale and retail (SIC = 5) are shown in the table.

CRE Ownerships

Table 2 shows the average CRE to total asset ratios of the sample firms, "CRE_A," for three different subperiods: 1980s, 1990s and post-2000s. The statistics show significant declines in CRE holdings of the sample firms in the sample periods from 1984 to 2011. The average CRE holdings to total asset ratio was estimated at 15% in the 1980s; but the ratios decreased to 10.9% and 7.6% in the 1990s and the post-2000s, respectively. The declining CRE trend implies that firms use less real estate space with advanced production technologies.

By sorting the average CRE based on the first digit of the SIC industry codes, we affirm Tuzel's (2010) observation that CRE holdings of firms are heterogeneous across different industries. Firms in the wholesale and retail

industry (SIC5)[9] have the highest proportion of CRE holdings estimated at 14.7% on average during the sample periods. The average CRE ratio of heavy manufacturing firms (SIC3) of 9.6% is lower than 11.3% CRE holdings of light manufacturing firms (SIC2). The results imply that given capital constraints, heavy manufacturing firms own less CRE compared to light manufacturing firms, so that they could channel more investments into capital intensive plats and machineries.

Table 3 reports descriptive statistics of the mean relative CRE of the sample firms that are sorted into five quantiles by "RISK1" in Panel A and "RISK2" in Panel B, respectively. The full samples consist of 91,948 firm-year observations. The results in Panel A show that the mean relative CRE, "CRE_RA," is negatively correlated with the productivity uncertainty of the sample firms, "RISK1." Firms in the first quartile of the "RISK1" panel have the lowest productivity risks, but they own 3% more CRE than the industry average. In contrary, the high-productivity risk firms in the fifth quantile by the RISK1 hold on average 4% less CRE than the industry average. The difference in the relative CRE ratios between the high-risk firms and the low-risk firms is estimated at about 7%.

For the "RISK1" sorted firms in Panel A, we further split the sample firms into the top 30 percentile ("high-leverage" group) and the bottom 30 percentile ("low-leverage" group) by the relative leverage ratio[10] of the sample firms, and recompute the relative CRE ratios for these two sub-groups. The results show that the negative relationships of relative CRE ratio and productivity risk still hold. The negative effect of "RISK1" on CRE holding is stronger in the low-leverage group of firms. The interquantile difference in the relative CRE ratio between the first quantile firms and the fifth quantile firms is larger at 7.9% for the low-leverage group compared to 4.3% for the high-leverage group. The between-group comparison shows that the high-leverage group owns more real estate than the low-leverage group across all risk quantiles.

Panel B of Table 3 shows the comparable statistics of the relative CRE ratio of the sample firms sorted by "RISK2." The different risk-based treatment does not change the results, which show that the negative relationships between the relative CRE holding and the productivity risk are still significant.

[9]"SIC5" indicates that the first digit of the SIC code is "5." The same coding shall apply hereinafter.

[10]The relative leverage ratio is computed as the difference between the firm's leverage ratio and the average leverage ratio of firms in the same industry, based on the first two digits of the firm's SIC code.

Table 3 ■ Descriptive statistics of corporate real estate ownership by productivity uncertainty.

Risk Level	Low	2	3	4	High	Obs.
Panel A (relative CRE holding sorted by RISK1 measure)						
Full sample						
Mean	0.030	0.022	0.005	−0.020	−0.040	91,948
Median	−0.006	−0.006	−0.018	−0.047	−0.056	
SD	0.144	0.134	0.133	0.126	0.111	
Low leverage						
Mean	0.019	0.006	−0.017	−0.044	−0.060	29,693
Median	−0.010	−0.017	−0.037	−0.061	−0.067	
SD	0.140	0.138	0.137	0.119	0.101	
High leverage						
Mean	0.032	0.031	0.031	−0.016	−0.011	28,630
Median	−0.007	−0.001	−0.008	−0.031	−0.051	
SD	0.152	0.147	0.148	0.107	0.157	
Panel B (relative CRE holding sorted by RISK2 measure)						
Full sample						
Mean	0.021	0.020	0.007	−0.012	−0.037	91,948
Median	−0.007	−0.011	−0.016	−0.038	−0.055	
SD	0.149	0.131	0.128	0.131	0.113	
Panel C (Relative CRE leasing sorted by RISK2 measure)						
Full sample						
Mean	−0.015	−0.009	0.000	0.010	0.014	91,948
Median	−0.018	−0.019	−0.016	−0.014	−0.016	
SD	0.069	0.078	0.082	0.102	0.131	

Notes: Panel A shows the descriptive statistics of relative corporate real estate ownership, "CRE _RA," for sample firms sorted by productivity risk measure "RISK1" into five different risk quantiles. In Panel A, the sample firms are also sorted into low- and high-leverage groups based on the bottom and top 30% firms by the relative leverage ratio, respectively. Panel B uses an alternative productivity risk measure, "RISK2" to sort the sample firms. Panel C shows the descriptive statistics of relative corporate real estate leasing, "CL_RA" for sample firms sorted by "RISK2."

In Panel C of Table 3, we replace the CRE ownership ratio with the relative CRE leasing ratio, "CL_RA," where the relative CRE leasing ratio is defined as the difference between the CRE leasing ratio of firms and the industry-average CRE leasing ratio. We sort the sample firms by the productivity uncertainty measure, "RISK2," and summarize the statistics in Panel C. In contrary to the CRE ownership ratio results, we find that firms with low-productivity risks have lower CRE leasing ratios relative to firms with high-productivity risk. The results seem to imply that the decision to either own or lease CRE is dependent on productivity uncertainty of firms. High-risk firms

use more CRE through the leasing option, while low-risk firms own more CRE assets.

CRE Ownership and Productivity Uncertainty

The earlier descriptive statistics show that firms' choice of CRE holdings is heterogeneous across industry. Firms with different productivity risks and leverage constraints adopt different CRE strategies. We test the CRE choice model of firms using the following regression setup:

$$CRE\_A_{i,t} = \alpha + \beta RISK_{i,t} + \delta X_{i,t-1} + \lambda_i + \tau_t + \varepsilon_{i,t}, \tag{8}$$

where the dependent variable $CRE\_A_{i,t}$ is the CRE holding to total asset ratio of firm i in year t; $RISK_{i,t}$ is the measure of productivity uncertainty for firm i in year t; and X is a vector of firm-specific factors that includes leverage ratio, firm size, PPE excluding CRE ratio, firm's productivity and CRE leasing ratio. We control for property price movements using the national-level NCREIF property return, the MSA-level NCREIF property price and the state-level FHFA housing price indices. The terms λ_i and τ_t capture both the industry-fixed effects and the year-fixed effects in the models. The industry effects are represented by the first two digits of the SIC code of the sample firms. The terms α, β and δ are the estimated regression coefficients, and $\varepsilon_{i,t}$ is the residual term of the regression. We use one-year lagged variables for leverage, firm size, PPE excluding CRE ratio and productivity to mitigate potential endogeneity problems in the models.[11]

In our empirical design, we hypothesize that CRE holdings of firms vary significantly and negatively with productivity uncertainty of the firms. Firms with high-productivity uncertainty hold less CRE relative to firms with low-productivity risks. Table 4 shows the results of Equation (8) with White's heteroscedastic-consistent standard errors. Column (1) shows that the coefficient on "RISK1," as the proxy for productivity uncertainty, is significantly negative implying that firms with high-productivity risk own less CRE. The coefficient on the national-level NCREIF property return is significant and positive, which suggests that firms invest more CRE during the rising property markets. The positive coefficients on the leverage ratio and firm size indicate that big and high-leveraged firms own more CRE assets. More productive firms (firms generating higher cash flows per unit capital) also own more

[11]We compute the productivity risk using time series observation, but our cross-sectional regressions capture variations in CRE holdings on productivity risk across individual firm samples. The time-dependent endogeneity between risk and CRE assets as pointed out by Ambrose, Moussa and Jiro (2014) is less critical in our models.

Table 4 ■ Effects of productivity uncertainty on corporate real estate ownership.

	CRE Holding (CRE_A)					
Dependent Variable	(1)	(2)	(3)	(4)	(5)	(6)
RISK1	−0.018***					
	(0.001)					
RISK2		−0.017***	−0.017***	−0.013***	−0.199***	−0.023***
		(0.001)	(0.001)	(0.003)	(0.033)	(0.001)
Leverage(-1)	0.005	0.005	0.013***	0.013***	0.002	0.014***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.010)	(0.003)
Size(-1)	0.007***	0.008***	0.007***	0.006***	−0.005***	0.009***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)
PPE excluding CRE(-1) (PPE_A)	0.018***	0.018***	0.016***	0.030***	0.037***	0.018***
	(0.005)	(0.005)	(0.004)	(0.003)	(0.007)	(0.006)
Productivity(-1) (CASH_A)	0.004***	0.005***	0.006***	0.007***	−0.014	0.004***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.016)	(0.001)
CRE Leasing(CL_A)	−0.238***	−−0.238***	−0.232***	−−0.278***	−0.610***	−0.258***
	(0.011)	(0.011)	(0.012)	(0.019)	(0.030)	(0.014)
National Property Return	0.069***	0.070***			−0.012	0.073***

Table 4 ■ continued.

	CRE Holding (CRE_A)					
Dependent Variable	(1)	(2)	(3)	(4)	(5)	(6)
	(0.006)	(0.006)			(0.014)	(0.006)
log Housing Price Index			−0.038***			
			(0.002)			
log Commercial Property Index				−0.011***		
				(0.001)		
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	91,948	91,948	84,502	17,588	7,162	68,644
R^2	0.309	0.308	0.317	0.348	0.458	0.253

Notes: The dependent variable is the corporate real estate ownership measured by "CRE_A." The models are estimated using the OLS regression controlling for firm heterogeneity. The property market movements are also represented by national level NCREIF price return, MSA-level NCREIF price and FHFA state-level price in separate models. The industry fixed effects based on the first two digits of SIC code and year fixed effects are controlled in the model. White's Standard Errors are given in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

CRE. The coefficient on PPE excluding CRE ratio, "PPE_A," is also significant and positive. Given that CRE and the non-CRE PPE are complementary capital goods, the growth theory of Romer (1994) and Levine (2005) predict that high-productive firms reap positive return to scale effects by increasing both CRE and other non-CRE factor inputs in the production function. Leasing or owning is a discrete choice option for firms to meet CRE needs in the production. The significant but negative coefficient on CRE leasing indicates that firms use CRE leases to substitute for direct ownership of CRE assets.

In Column (2), we repeat the regression by substituting "RISK1" with "RISK2," where the latter is adjusted for cyclical economic impact on firms' outputs. The results show that the coefficient on RISK2 is still significant and negative. We could not reject the hypothesis that CRE holdings of firms are significantly and negatively correlated with productivity risks of firms. In Columns (3) and (4), we use different property price indicators to control for temporal movements in real estate prices. The negative relationships between CRE holdings and productivity risks, "RISK2" are significant at less than 1% level in both models. We show that the coefficients on the two housing price variables—the state-level HPI and the MSA-level NCREIF NPI—are significant and the signs are negative. The results indicate that firms in the states or the MSAs that experience high property price increases invest less in CRE assets. CRE holdings of firms in the states or MSAs with rising property prices are lower than firms in the states and the MSAs with weakening property prices.

The survival bias test is conducted in Column (5), where firms are filtered out if either (1) a firm was not listed on or before 1984, or (2) a firm exited from the market before 2011. The survival criteria ensure continuity in the observations for the full 28-year period from 1984 to 2011. The filtering process is necessary to avoid oversampling of "older" firms; and 7,162 firm-year observations are retained after the filtering process. The results show that the coefficient on "RISK2" estimated based on the smaller sample is still significant and negative. The "RISK2" effect of -0.199 is stronger relative to the estimate of -0.017 in the full sample model. The hypothesis that CRE holdings are negatively correlated with firms' productivity risks is not rejected. The results withstand the survival bias tests.

In Column (6), we exclude firms in the "agriculture," "mining," "banking, finance, real estate and service" industries, which are identified by "0," "6" and "7" in the first digit of SIC code, respectively. Firms in the agriculture and mining industries use large tracts of land as the factor input in production; whereas finance and service firms use mostly operating leases for CRE that are not reflected in the firms' balance sheets. Real estate firms are also excluded

Table 5 ■ Alternative measures of corporate real estate ownership.

	CRE_RA		CRE_P	
Dependent Variable	(1)	(2)	(3)	(4)
RISK1	−0.024***		−0.052***	
	(0.001)		(0.003)	
RISK2		−0.023***		−0.048***
		(0.001)		(0.003)
Leverage(−1)	0.013***	0.013***	0.025***	0.025***
	(0.003)	(0.003)	(0.006)	(0.006)
Size(−1)	0.009***	0.009***	0.018***	0.018***
	(0.000)	(0.000)	(0.000)	(0.000)
PPE excluding CRE(−1) (PPE_A)	0.017***	0.017***	−0.047***	−0.046***
	(0.005)	(0.005)	(0.015)	(0.015)
Productivity(−1) (CASH_A)	0.003***	0.004***	0.003	0.004**
	(0.001)	(0.001)	(0.002)	(0.002)
CRE Leasing(CL_A)	−0.258***	−0.258***	−0.376***	−0.377***
	(0.014)	(0.014)	(0.024)	(0.024)
National Property Return	0.020***	0.020***	0.110***	0.111***
	(0.006)	(0.006)	(0.010)	(0.010)
Year Fixed Effects	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes
Observations	68,644	68,644	67,694	67,694
R^2	0.088	0.087	0.234	0.233

Notes: The dependent variables are the relative corporate real estate ratio, "CRE_RA" in Columns (1) and (2); and the ratio of corporate real estate to PPE, "CRE_P" in Column (3) and (4). The models are estimated using the OLS regression controlling for firm heterogeneity. The industry fixed effects based on the first two digits of SIC code and year fixed effects are controlled in the model. White's Standard Errors are given in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

from the samples in the robustness test because these firms hold real estate for both corporate and business purposes. The results in Column (6) show that the coefficient on "RISK2" is statistically and economically significant. The test reaffirms the hypothesis that CRE holdings are negatively correlated with productivity uncertainty of firms. The coefficients on other variables are consistent with those estimated in the earlier models.

Alternative Measures of CRE Ownership

We conduct additional tests using different measures of CRE holding to avoid possible measurement biases. We use the relative CRE holding ratio, "CRE_RA" (Columns 1 and 2, Table 5) to adjust for industry-specific heterogeneity. For firms with only a small fraction of fixed asset in the balance

sheets, the total asset by book value could overrepresent the true production capacity of these firms and bias the results downward. We use the CRE holding to PPE ratio, "CRE_P" (Columns 3 and 4, Table 5), as an alternative proxy in the models to reduce firm-specific biases. The results in Columns (1) and (2) of Table 5 show that the relative CRE holding ratio, "CRE_RA," is significantly and negatively related to productivity uncertainty. In Columns (3) and (4) of Table 5, the results show that the CRE to PPE ratio, "CRE_P," is also significantly and negatively correlated with the two productivity uncertainty measures. The coefficients on "RISK1" and "RISK2" in the "CRE_P" models are larger in magnitude compared to those estimated in the "CRE_RA" in Columns (1) and (2). We could not rule out the hypothesis that productivity risks have significantly negative impact on firms' CRE holdings. Firms with high-productivity risk own less CRE relative to firms with low risks in the production outputs.

The coefficients on other control variables in Table 5, except for the lagged non-CRE PPE ratio variable, are significant and consistent with those found in Table 4. "PPE_A" has a negative and significant coefficient in the "CRE_P" models (Columns 3 and 4). The negative results indicate possible substitution effects between CRE and PPE for firms with a high fraction of PPE in their balance sheets.

Heterogeneity in CRE Ownership by Industry

We further test if the negative relationships between CRE holdings and productivity risks vary across different industries. We regress the CRE holding ratio, "CRE_A," on the two productivity risks indicators, "RISK1" and "RISK2" for firms in the ten industry sectors identified by the first digit of SIC code. The results in Table 6[12] show that the coefficients on the two productivity risk variables, "RISK1" and "RISK2," are highly significant and negative in all the industry sectors, except for "transportation and communication" (SIC4) and "finance and services" (SIC6) industries. Transportation and communication firms invest heavily on non-CRE PPE, such as automobiles and equipment in operations; and as a result, productivity risk has insignificant impact on CRE holdings of these firms. Firms in the highly regulated finance industry own a relatively small fraction of CRE in their balance sheets. Real estate firms, including REITs (SIC"6"), hold real estate as a part of the core business, and real estate investment assets are not captured in PPE.

[12]We report only the coefficients on RISK1 and RISK2. Other coefficients are not included in the Table 6 due to space constraints, but the results are generally consistent.

Table 6 ■ Relationships between corporate real estate ownership and productivity uncertainty by industry.

Dependent Variable	CRE Holding (CRE_A)									
SIC	0	1	2	3	4	5	6	7	8	9
Panel A										
RISK1	−0.153***	−0.039***	−0.025***	−0.032***	0.002	−0.021***	0.006	−0.010***	−0.037***	−0.010***
	(0.028)	(0.005)	(0.002)	(0.002)	(0.005)	(0.005)	(0.006)	(0.003)	(0.007)	(0.004)
Observation	382	1,650	16,058	29,349	5,140	11,596	7,176	14,478	4,555	1,564
R^2	0.644	0.103	0.226	0.172	0.159	0.381	0.233	0.499	0.270	0.091
Panel B										
RISK2	−0.207***	−0.046***	−0.024***	−0.030***	0.006	−0.019***	0.010	−0.008***	−0.034***	−0.010**
	(0.034)	(0.006)	(0.002)	(0.002)	(0.006)	(0.005)	(0.007)	(0.003)	(0.007)	(0.004)
Observations	382	1,650	16,058	29,349	5,140	11,596	7,176	14,478	4,555	1,564
R^2	0.653	0.105	0.225	0.171	0.159	0.381	0.234	0.499	0.270	0.091

Notes: The dependent variable is "CRE_A" and the explanatory variables are the same as that in Table4 , Columns (1) and (2). The table shows only the coefficients and standard deviations for the two risk variables: "RISK1" and "RISK2." The results on other variables are not presented due to space constraints. We run the models by different SIC industries represented by the first digit of the SIC code, which include SIC0 = agriculture; SIC1 = mining; SIC2 = light manufacture; SIC3 = heavy manufacture; SIC4 = transportation and communication; SIC5 = wholesale and retail; SIC6 = finance service; SIC7 = service; SIC8 = health and outsourcing service; SIC9 = international affairs. White's Standard Errors are given in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table 7 ■ Corporate real estate ownership and leverage.

	CRE Holding (CRE_A)			
	Unconstrained firms (low-leverage firms)		Constrained firms (high-leverage firms)	
Dependent Variable	(1)	(2)	(3)	(4)
RISK1	−0.013***		−0.039***	
	(0.001)		(0.005)	
RISK2		−0.012***		−0.038***
		(0.001)		(0.005)
Leverage(−1)	0.013**	0.013**	0.001	0.001
	(0.006)	(0.006)	(0.001)	(0.001)
Size(−1)	0.013***	0.013***	−0.001	−0.001
	(0.000)	(0.000)	(0.001)	(0.001)
PPE excluding CRE(−1) (PPE_A)	0.040***	0.040***	0.002	0.002
	(0.004)	(0.004)	(0.004)	(0.004)
Productivity(−1) (CASH_A)	0.002**	0.003***	0.009***	0.010***
	(0.001)	(0.001)	(0.003)	(0.003)
CRE Leasing(CL_A)	−0.257***	−0.258***	−0.238***	−0.238***
	(0.016)	(0.016)	(0.026)	(0.026)
National Property Return	0.067***	0.067***	0.043***	0.043***
	(0.012)	(0.012)	(0.013)	(0.013)
Year Fixed Effects	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes
Observations	23,049	23,049	19,854	19,854
R^2	0.276	0.276	0.236	0.235

Note: The dependent variable is "CRE_A." Based on the leverage ratio of firms, we split the sample firms into a low-leverage group based on the bottom 30% of the sample firms, and a high-leverage group based on the top 30% percentile of the sample firms. The regression results of the low-leverage group are shown in Column (1) and (2); whereas the regression results of the high-leverage group are shown in Column (3)and (4). The models are estimated using the OLS regression controlling for firm heterogeneity. The industry fixed effects based on the first two digits of SIC code, and year fixed effects are controlled in the model. White's Standard Errors are given in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

Land is a major component of the fixed assets of agriculture and mining firms (SIC0), which own as high as 24.6% of CRE in the total assets compared to the industry average of 9.6%. The impact of high-CRE holdings of the SIC0 firms is reflected in the regression results (Table 6), which report the largest coefficients on "RISK1" and "RISK2" among the "CRE_A" models. However, other services firms (SIC7) have the smallest coefficients of −0.010 and −0.008 for "RISK1" and "RISK2" variables, respectively. The small elasticity of CRE holdings for firms in the service sector suggests that these firms tend to lease rather than own CRE for their operating needs.

CRE Ownership and Leverage

We run the CRE holdings regressions using two sub-samples of firms in the top 30 percentile ("constrained") and the bottom 30 percentile ("unconstrained") by the relative leverage ratio. The results in Table 7 show that the two risk variables, "RISK1" and "RISK2," are significantly and negatively correlated with CRE holdings in both the "constrained" (top 30% by leverage) and the "unconstrained" (bottom 30% by leverage) groups of firms. However, the absolute value of the coefficient for the unconstrained firms is smaller than that for the constrained firms. The results imply that the high-leverage firms tend to be more sensitive in their CRE decisions to productivity shocks compared to the low-leverage firms (the unconstrained group). The results are consistent with the prediction of our theoretical model that high-leverage firms with higher cost of debt will be more careful in using their internal cash flows to avoid the cost of holding excess CRE.

We observed that the coefficients on other control variables are consistent with the previous regressions, but the coefficients on firm's size and PPE excluding CRE ratio are insignificant for the high-leverage group. Unconstrained firms adjust their CRE asset in response to the scale of production. Given that CRE asset and non-CRE asset are complementary, firms facing financing constraints are more likely to trade off CRE investments for non-CRE PPE investments.

Dynamic Adjustments to CRE Holdings

We next test dynamic adjustments of firms' CRE holdings in response to cash flow changes. We use year-on-year changes in CRE holdings in the logarithm term, $\Delta\ln(CRE_{i,t})$, to proxy the CRE adjustment rate, and regress it against year-on-year changes in the productivity, $\Delta CASH\_A_{i,t}$, controlling for firm-specific, industry-specific and time-specific variations:

$$\Delta \ln\left(CRE_{i,t}\right) = \alpha + \gamma \Delta CASH\_A_{i,t} + \delta X_{i,t-1} + \lambda_i + \varepsilon_{i,t}, \tag{9}$$

where X is a vector of control variables that include leverage ratio, Tobin's Q, firm's size, non-CRE PPE ratio, productivity and CRE holding. They are given in time $t-1$ to avoid potential endogeneity. We also include the NCREIF property price return to reflect temporal changes in the market conditions. The firm fixed effects, λ_i, are also controlled in the model. The coefficient γ is the elasticity of CRE holdings with respect to productivity shocks. We also use the change in log-cash flow, $\Delta\ln(CASH_{i,t})$, as the alternative proxy for the productivity shocks in the log-difference CRE model. In this regression, we only consider firms that "*survive*" the full 28-year sample period from 1984 to 2011.

Table 8 ■ Dynamic changes in corporate real estate ownership.

	$\Delta \ln CRE$	
Dependent Variable	(1)	(2)
$\Delta CASH\_A$	0.274***	
	(0.101)	
$\Delta \ln CASH$		0.052***
		(0.010)
Leverage(−1)	−0.145**	−0.139**
	(0.058)	(0.058)
Tobin's Q(−1)	0.004***	0.003**
	(0.001)	(0.001)
Size(−1)	−0.060***	−0.053***
	(0.006)	(0.007)
PPE excluding CRE(−1)(PPE_A)	0.002	−0.028
	(0.044)	(0.049)
Productivity(−1)(CASH_A)	0.713***	0.985***
	(0.115)	(0.144)
CRE Holding(−1) (CRE_A)	−0.949***	−0.903***
	(0.117)	(0.124)
National Property Return	0.002	0.001
	(0.001)	(0.001)
Firm Fixed Effects	Yes	Yes
Observations	7,708	6,912
R^2	0.097	0.114

Notes: The dependent variable is the change of corporate real estate ownership, $\Delta \ln CRE$. We use the change in cash flow and log-change in cash flow to represent productivity shocks as in Columns (1) and (2), respectively. The models are estimated using the OLS regression controlling for firm heterogeneity. The industry fixed effects based on the first two digits of SIC code, and year fixed effects are controlled in the model. White's Standard Errors are given in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

The regression results are summarized in Table 8. The change in CRE holdings is significantly and positively correlated with the changes in productivity of firms as measured by $\Delta CASH\_A_{i,t}$. In Column (2) where the log-change in cash flows is used as a proxy for the productivity shocks, the elasticity coefficient predicts that firms increase CRE holdings at a rate of 5.2% for every 1% increase in cash flows, *ceteris paribus*. The results show that firms' CRE decision is not a static process. Firms increase CRE holdings when the productivity increases, and reduce CRE holdings when the productivity decreases. Consistent with the adjustment cost hypothesis of Tuzel (2010), firms with high-productivity risk own less CRE assets to avoid losses when they are forced to cut CRE holdings during low-productivity periods.

The other control variables in the two models have consistent signs. Firms with a high ratio of long-term debt in the previous year own less CRE. Smaller firms are more likely to purchase more CRE. Firms with a large share of CRE assets in the previous year are more likely to reduce CRE investments in the current year. More productive firms are also expected to hold more CRE assets. The negative coefficient on the property return indicates that firms do optimally time their CRE purchases.

Conclusion

There are two main strands of literature examining CRE holdings of firms. The adjustment costs literature argues that CRE holdings increase systematic risks of firms. However, the collateral channel literature predicts that appreciation in CRE values induces firms to invest more in non-CRE investments. These two strands of literature assume that CRE investment decisions are exogenous; and motivations underlying firms' CRE ownership are neglected. The point of departure in this study hinges on the premise that firms' CRE ownership is endogenously determined taking into account variations in productivity risks of firms. It empirically tests the hypothesis that CRE holdings are negatively correlated with productivity risks of firms.

Using a large sample of public listed U.S. firms for the period from 1984 to 2011, we show that CRE holdings are significantly and negatively correlated with productivity risks of firms. High-productive risk firms are more averse to owning CRE compared low-productive risk firms. Firms with high-productivity risks hold a relatively smaller share of CRE in the total assets controlling for the firm-specific, industry-specific and time-dependent heterogeneities. Our study contributes to the neo-classical literature by linking firms' CRE holdings to the productivity risks of firms. Adding to the literature arguing leasing as a pure financial decision (Miller and Upton 1976), our CRE holdings experiment shows that firms with high-productivity risk hold less CRE assets in their balance sheets.

Our results also support the adjustment costs literature showing that a positive and significant elasticity of CRE investments to cash flow shocks of about 5.2%, *ceteris paribus*. Consistent with Tuzel's (2010) model, if the adjustment cost is high, high-risk firms are more likely to lease rather than directly own CRE assets, so that they could reduce potential losses associated with CRE holdings when negative productive shocks occur.

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