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# Real Estate Risk, Corporate Investment and Financing Choice

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**Abstract** This paper empirically examines how real estate risk impacts corporate investment and financing decisions. Using a panel of United States firms from 1985 to 2013, we document that real estate risk is negatively associated with firms' long-term investments and long-term external financing in equity and debt. The results are robust to different risk measurements and in particular salient during the financial crisis period when the endogeneity between risk and investment is less of a concern. The effect on firm leverage, however, depends on risk measures. Overall, in contrast to previously documented positive effects of the real estate value, real estate risk exposure exhibits mostly the opposite effects on investment,

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financing and capital structure. This difference is consistent with option value determinants. Findings in this paper shed new lights on the impact of real estate holding on corporate decisions, offer a new explanation for the underperformance of hedge funds' real estate strategies, and confirm the theoretical predictions in Deng et al. (2015).

**Keywords** Real estate risk · Corporate investment · External financing

**Jel Codes** G12 · G30 · G32

## Introduction

Real estate assets are unique compared to other capital goods. Their unique features are associated with several interesting patterns in corporate finance. First, the collateral effect of real estate assets suggests that an increase in real estate value exerts a positive impact on corporate financing and hence investment through its collateral function (Berger and Udell 1990; Chaney et al. 2012). The collateral channel, however, also makes firms vulnerable to real estate market fluctuations such as bubbles and busts (Gan 2007a). Second, the high irreversibility and low depreciation rate of real estate assets (Glaeser and Gyourko 2005) deteriorate the firm's capacity to withstand productivity shocks (Tuzel 2010). Moreover, while real estate assets provide an ideal diversification and inflation hedge (Ambrose et al. 2013), investors demand an additional return premium on firms concentrating in real estate ownership (Funke et al. 2010; Ling et al. 2012). This feature leads to underperformance in hedge funds that focus on real estate strategies (Ambrose et al. 2013).

Despite these complexities in financial decisions and performance associated with real estate, no study has examined the real effect of the risk embedded in corporate real estate holdings. This paper fills this void by examining how real estate risk affects corporate real estate investments and financing decisions using real estate holdings of U.S. firms from 1985 to 2013.

Our hypotheses are developed based on Deng et al. (2015)'s theoretical model on how the adjustment cost and risk of corporate assets-in-place affect corporate investment and financing decisions. The model is set up in an option framework, where the investment decision is determined by the option value of the economic shocks, i.e., expected returns and volatilities. By solving for the optimal solution, the model predicts that high asset risk leads to a low level of investment and that the correlated risk between different types of assets is also negatively associated with investment. The model also predicts that assets with high collateral values lower debt cost and drive up firms' leverage and investment. The risk of assets-in-place, however, drives up financing costs, in turn reduces investment and external financing in both debt and equity.

Although all investments have irreversible feature and Deng et al. (2015)'s model applies to general assets, focusing on the real estate holding and its risk provides three advantages in empirical examination. First, as real estate assets have a strong irreversible feature compared to other assets, the cross sectional differences in real estate holding can proxy for the cross sectional differences of adjustment costs.[1] Second, differentiating real estate risk from equity market risk allows us to measure the correlated risk between different types of assets in addition to risk of each market. Third, corporate investment is arguably less endogenous to real estate market risk than equity market risk, which alleviates endogeneity issue in the empirical tests.

We use two market-return-based measurements for real estate risk. The first is the real-estate-industry specific risk, which uses residuals from a time-series estimation of real estate investment trusts' (REITs') returns on equity market returns. The second is the individual firms' exposure to real estate risk; that is, an estimated beta on REITs' returns from a two-factor model which empirically includes the equity market return and the real estate return.

We find that both measures of real estate risk are negatively associated with corporate investment and external financing. However, the effect on leverage is mixed. On the one hand, asset risk raises financing cost for both debt and equity financing channels. On the other hand, the collateral effect of real estate increases debt financing but also makes firms more vulnerable to credit market conditions. Consistent with the previous literature on the collateral channel (Chaney et al. 2012; Gan 2007b), we find that the value of real estate is positively associated with debt financing and investment. Overall, the empirical evidence is consistent with Deng et al. (2015)'s theoretical predictions.

However, investment opportunities and real estate market condition could be endogenous. While the real estate market condition affects firm investments, the converse may also be true. Corporate investments, especially those by large firms with substantial real estate assets, could influence real estate prices through labor demand, etc. To address this issue, we focus on the subprime crisis period, where the exogenous economic shock and extreme financial condition eliminated any possible influence a firm may have on the real estate market via investments. In other words, the real estate market condition during the subprime crisis is exogenous to firm investment. We run the regression within the subprime crisis period and find the empirical evidence to be robust.

We can also utilize the crisis period for a difference-in-difference test in the full sample by interacting the crisis indicator with firms' real estate exposure to further differentiate the effect of real estate risk from the crisis effect. We find that the sensitivity of investment to real estate risk exposure is actually stronger during the crisis period, while the negative relation remain robust during the normal period.

The following economic mechanisms could establish the negative relation between real estate risk and corporate investments. On the one hand, stakeholders of assets-in-

[1] High adjustment cost associated with real estate assets is documented both in business media press and academic research papers. For example, WSJ (3/26/01) expressed analysts' concerns about Hilton and Starwood in particular because "owning hotels is more risky than managing or franchising them because of the cost of carrying and maintaining property". In term of magnitude, Tuzel (2010) set the adjustment cost parameter for real estate investment to 2.4 but other investment 0.8, after calibrations to match the volatilities of structures and equipment investment growth.

place with high risk demand high expected returns, which increases the threshold for the investment decision. On the other hand, the high risk of assets-in-place suggests high uncertainty in the collateral value[2] and liquidation value, which affect the firm's financing capacity and hence investment. Shleifer and Vishny (1992) hypothesize that asset quality is an important determinant of both liquidation value and debt capacity, and the asset liquidation value influences a firm's financing choices. By modeling liquidation value with the tenant and location quality of the property, Liu et al. (2012) show that firms that hold assets with higher tenancy quality and are located within a more diverse mix of industries issue more debt.

The feedback effect between credit market condition and asset risk can further strengthen the negative relation between assets risk and investment. For example, the fluctuation of asset prices may transmit to the real economy by affecting a firm's valuation and hence credit-worthiness, which affect the firm's investment and output (Bernanke and Gertler 1989; Bernanke and Gertler 1990; Kiyotaki and Moore 1997). When bank loans are the major source of external financing (Mayer 1990), the feedback effect from the banking industry facing demand fluctuation may lead to a further cut in the firm's investment. For example, during the collapse of the Japanese asset market, the decline in real estate prices led to an increased volume of nonperforming loans for Japanese banks, which responded by shrinking risk-weighted assets, particularly for the overseas clients (McCauley and Yeaple 1994; Peek and Rosengren 1997).

Our paper makes a number of contributions to the literature. First, to the best of our knowledge, among empirical studies relating real estate with corporate investment, this paper is one of the first to examine the impact of real estate risk, while prior literature mostly focuses on real estate value. The only exception is Gan (2007b), which sheds some lights on the risk effect by documenting that firms holding real estate assets reduced investment more than other firms during Japan's 1990s real estate bubble bust period—an economic downturn scenario.[3] Our results however are from normal economic conditions that do not rely on the systematic change of financing channel and credit market condition, as Deng et al. (2015)'s model is based on solving firms' real option maximization problems in a general setting.

The empirical evidence also provide insight on why firms holding more real estate are less capable of adjusting for productivity shocks (Tuzel 2010). Investments are negatively associated with the adjustment cost of the assets and real estate assets have high adjustment cost. Therefore, firms may underinvest when the economy is booming and overinvest when it is in recession. Moreover, to reflect this real estate asset related relative inefficiency, stock returns are therefore highly correlated with real estate market performance (Ling et al. 2012).

[2] The literature has demonstrated that, the value of real estate assets is positively associated with corporate investments through collateral functions in the lending channel. Gan 2007a uses the Japanese land market collapse in 1990s as a natural experiment, to show that through the lending channel, Japanese firms that hold lands suffer from the credit crunch more severely, especially when the firms have no alternative external financing channel. Gan (2007b) further shows the real effect of the collateral value loss. Manufacturing firms reduce their investment significantly as firms with larger losses in collateral value obtain a smaller loan amount.

[3] The analysis on Japan however is restricted to the time-series dimension of the valuation changes. There is no characterization of the microeconomic mechanism through which firm-level collateral value changes due to the asset risk. The financing frictions during the collapse of Japanese land market may also bias the effect upward.

The rest of this paper proceeds as follows. Second section develops hypotheses and methodology. Third section describes the data. Fourth section presents the empirical results and robustness tests. Fifth section concludes the paper.

## Hypothesis and Methodology

### Review of the Model

A strand of literature has applied the real option framework to analyze corporate investment decisions (Brennan and Schwartz 1985; Dixit and Pindyck 1994; McDonald and Siegel 1985, 1986; Berk et al. 1999). In this framework, a firm's value originates from the value of assets-in-place and the value of growth options, in which the firm's investment decision is to exercise the real option to maximize firm value. For example, Carlson et al. (2006) develop two models that link the expected return and endogenous corporate investment decision determined by firm's asset in place. They suggest that the book-to-market effect is driven by gearing and the size effect is relevant to the proportional growth.

Our hypotheses however are directly derived from Deng et al. (2015)'s theoretical model that focuses on the endogeneity of assets risk, corporate investment and financing decisions. The option-framework model has four key assumptions similar to those in Berk et al. (1999) and Carlson et al. (2004). First, the firm operates within a continuous but infinite time horizon. Second, the firm have a perfect interest alignment between the management and the shareholders. Third, the firm is a monopolist on the product market and hence the market clearance price is determined by its output and a downward sloping iso-elastic demand. Finally, the output strictly increases with firm capital and the new irreversible investment, where the rate of depreciation and the adjustment cost of investment depend on the composition of the assets (Cooper 2006).

In the model, the value of the real option depends on the level and risk of demand shock, the production capacity of the current assets and new investment, operational cost, and adjustment cost.

$$V_t \equiv \max_{Q,I} E\left\{\int_0^\infty e^{-rs} C_{t+s} ds \middle| F_t\right\} \equiv \max_{Q,I} E\left\{\int_t^\infty e^{-r(s-t)} (Y_t - (F_t + \lambda_t)) ds \middle| F_t\right\} \quad (1)$$

where r is the discount rate; Q is the production capacity; I is investment; $C_{t+s}$ is the cash flow of the firm at time $t+s$; $F_t$ is the fixed operating cost in each period; $\lambda_t$ is the adjustment cost; $Y_t$ is total sales in each period and equal to $P_t Q_t$, $X_t Q_t^{1-1/\alpha}$; $X_t$ evolves according to the process $dX_t = \mu X_t dt + \sigma X_t dB_t$; $\alpha$ is the elasticity of demand, $0 < \frac{1}{\alpha} < 1$.

The manager optimizes firm value by deciding when to exercise the real option and how much to investment. The determinants are the demand shock and firm characteristics captured by the above parameters.

The solution of the baseline model shows that the optimal investment threshold increases with the adjustment cost of assets λ and the risk of the external demand shock σ, but decreases with the elasticity od demand $\varphi$.

$$x_t^* = \left(1 + \frac{1}{\varphi - 1}\right)(F + \lambda)\frac{\delta}{Q_t^{1-\frac{1}{\alpha}}}, \text{where } \varphi = \sqrt{\left(\frac{1}{2} - \frac{\mu}{\sigma^2}\right)^2 + \frac{2r}{\sigma^2}} + \frac{1}{2} - \frac{\mu}{\sigma^2}; \quad (2)$$

where δ is the rate of depreciation.

By further extending the model to consider the risk hedging purpose of assets (Chang and Chang 2003) and financing cost, Deng et al. (2015) shows that optimal investment level increases with not only the risk of demand shock, but also the risk of existing assets, the correlated risk between the demand shock and existing assets, and financing costs.

## Hypotheses

As real estate has higher adjustment costs than other assets, firms holding more portion of real estate assets have higher average adjustment costs in its assets. How does the adjustment cost affects investment? Take land development as an example. Developing land implies that the firm foregoes current profits. These foregone profits are an opportunity cost and must be offset by a more valuable option to motivate alternative asset investment. Therefore, the firm with more real estate holdings optimally invests at a lower demand level.

*H1: Investment is low when the proportion of real estate assets is high.*

The risk related to real estate assets could be the firm's exposure to real estate market and the correlated risk between the real estate market and equity market. A large holding of illiquid real estate assets undermines a firm's ability to adjust to productivity shocks and its exposure to real estate market risk also increases the required expected return in investment decision. In a real option framework, both these two mechanisms increase the investment threshold. We hypothesize that:

*H2: Investment is low when the real estate risk is high.*
*H3: Investment is low when the correlation between assets-in-place is high.*

Although the collateral channel suggests that the value of assets-in-place, in particular real estate assets, enables better access to debt financing, the risk of real estate assets, irrespective of whether it comes from market fluctuations or the firm's exposure to the markets, increases the uncertainty of future cash flows, and hence hurts the firm's credit-worthiness. Real asset risk also reduces collateral value of real estate assets and increases debt financing costs. So are equity financing costs, as investors demand high expected return to compensation for large exposure to market fluctuation. Therefore, the risk of assets raises the firm's financing costs in both equity and debt and reduces the firm's external financing capacity (Deng et al. 2015).

*H4: The real estate risk reduces external financing in both equity and debt.*

When both debt and equity financing decreases, what happens to leverage? Since real estate market shocks are often correlated with real economy shocks, the bank industry is likely to face a credit crunch during the real estate markets' downturn period. Because of this feedback effect, debt financing may decrease more than equity financing. The overall leverage, therefore, is likely to be negatively associated with the real estate risk in the time-series pattern.

*H5A: The market-wide risk of real estate assets reduces the firm's leverage.*

In cross-section, however, while the real estate risk raises financing cost in both equity and debt, real estate assets with collateral values can reduce the cost of debt. Therefore, firm leverage is likely to be positively associated with the proportion of collateral assets over total assets in the firm.

*H5B: Firms with larger exposure to real estate market risk have higher leverage.*

## Methodology

When empirically verifying these hypotheses, we construct two measurements of real estate risk to capture its fluctuation in both time series and cross section. In time series, we use year-specific unexpected fluctuation to capture the time-series variation in real estate market risk. To do so, we first orthogonalize the excess returns of REIT returns to the excess market returns:

$$R_{re,t}-R_f = \alpha_0 + \alpha_1\left(R_{mk,t}-R_f\right) + \varepsilon_t \tag{3}$$

where $R_{re}$ is the return on the REITs index and $R_{mk}$ is the return on the CRSP value-weighted portfolio. Both index returns are measured in excess of the risk-free rate $R_f$ on U.S. 1-month Treasuries. The regression is conducted with monthly data over the full sample period, 1985 to 2003. The estimated residuals are real estate market specific returns orthogonal to the stock market returns. For each year, we calculate the standard deviation of the monthly residuals within the year and define it as *REM Volatility* $(\hat{\varepsilon}_t)$,a time-series measure of real estate asset risk.

To capture the cross-sectional variation of real estate risk among the firms, we estimate the firm's exposure to the real estate market risk factor using a multi-factor asset pricing framework (Jorion 1990; Ling et al. 2012). We estimate the following two-factor model using monthly returns:

$$R_{it}-R_f = \alpha_0 + \beta_i^{mk}\left(R_{mk,t}-R_f\right) + \beta_i^{re}\left(R_{re,t}-R_f\right) + \varepsilon_{it}, \tag{4}$$

where $R_{it}$ is the return on firm stocks, $R_f$ is the return on 3-month Treasuries, $R_{re}$ is the return on REITs index and $R_{mk}$ is the return on the CRSP value-weighted portfolio. The coefficient $\beta_i^{mk}$ is the market beta. The coefficient $\beta_i^{re}$ (the real estate beta) is the firm *i*'s exposure to the real estate risk. We prefer the two-factor model here over the Fama–French equation, because the beta measured from the latter are likely to suffer from a correlated-error problem, as large firms are more likely than small firms to hold real estate assets. Nevertheless, we conduct robustness tests with the Fama-French equation too.

To test the hypotheses on the investment, we regress the investment on the real estate risk measures and firm characteristics in the panel:

$$Investment_{it} = a_i + b{*}RE\ exposure_{it} + c{*}controls_{it-1} + w_{it} \tag{5}$$

where *Investment* is CAPEX/PPE, $a_i$ is firm fixed effect, and RE exposure takes the real estate risk measures described above. We also include the value of real estate holdings (*RE Value*) as a consistency check in line with the prior literature on real estate value effect.

As real estate assets have higher adjustment costs compared to other corporate assets, it is reasonable to assume that the proportion of real estate assets over total assets is highly correlated with firms' assets' adjustment cost. We hence use the ratio of real estate value over total asset value, *RE Weight,* to proxy for the cross-sectional variation in the asset adjustment cost.

To address the concern on the endogenous relation between investment and real estate market condition, we utilize the subprime crisis period. During the crisis, all firms are affected by the exogenous economic shock and the extreme financial condition eliminated any possible influence a firm may have on investment. In other words, real estate market condition is entirely exogenous in this period. Hence, the association discovered between investment and real estate risk by estimating Eq. (5) for the crisis period from July 2007 to June 2009 is not likely driven by the causality from investment to market risk.

The crisis natural experiment also provides a unique setting to differentiate the effect of real estate risk versus crisis effect. We include risk measures, crisis dummy and their interactions in the regression and compare how the coefficient changes. We also conduct in the full sample a difference-in-difference identification with individual firms' risk exposure $\beta_i^{re}$.

$$\begin{aligned} Investment_{it} = {} & a_i + b{*}RE\ exposure_{it} + c{*}controls_{it-1} \\ & + d^{*}Crisis + e^{*}Crisis{*}RE\ exposure_{it} + w_{it} \end{aligned} \tag{6}$$

where *Crisis* is a dummy variable that equals 1 if the observations are from July 2007 to June 2009, otherwise zero. Other specifications are the same as in Eq. (5).

To analyze how the change of firms' underlying real estate risk affects both equity and debt financing. We estimate the following financing equations:

$$Financing_{it} = a_i + b^{*}RE\ exposure_{it} + c{*}controls_{it-1} + w_{it} \tag{7}$$

where financing takes the variables of equity and debt financing, respectively. RE exposure takes the real estate risk measures described above. $a_i$ is the firm fixed effect. We also include *RE Value* and *RE Weight* in the regressions.

Finally, to analyze the effect of real estate risk on firm leverage, we run the following regression:

$$Leverage_{it} = a_i + b^*RE\ exposure_{it} + c^*controls_{it-1} + w_{it} \quad (8)$$

where $Leverage_{it}$ is measured as the short-term and the long-term liabilities over the total assets for each firm in each year. We choose the book leverage instead of the market leverage to reduce the endogeneity issue related to real estate market conditions – the market value leverage increases when market equity value decreases. *RE exposure* takes the real estate risk measures described above. $a_i$ is the firm fixed effect.

## Data

The sample is a panel of U.S. listed firms from 1985 to 2013 with 7332 US listed firms and 71,158 firm-year observations. Among them, 2386 firms report real estate holding, counting 14,281 firm*year observations. Financial firms and REITs are excluded from the sample. We use the full sample for analyses that do not rely on real estate holdings, while analyses that require the real estate holding data are restricted to the subsample of firms with real estate holding. Appendix Table 9 shows the similarity in the industry distributions of these two samples.

The accounting data are retrieved from the COMPUSTAT and the stock return data from the CRSP. We measure the real estate holding using the book value of buildings, land and improvements, and construction (Chaney et al. 2012; Nelson et al. 2000). In COMPUSTAT, "Building" reports the replacement cost of the buildings, "Land and improvement" reports both acquisition costs and related expenses on the land, and "Construction in process" includes uncompleted real estate development projects valued at their historical cost.

We deploy the FTSE NAREIT Composite real estate investment trust (REITs) index to measure real estate asset returns.[4] On the one hand, REITs are excluded from the market portfolio in the most empirical tests of asset pricing models, isolating the real estate risk from market risk (Funke et al. 2010). On the other hand, REITs returns are frequently disclosed, reducing information asymmetry. Therefore, REITs returns capture real estate market performance in a timely way and relatively independently from other investment/financial assets.

We construct the year-specific unexpected fluctuation to capture the time-series variation in real estate market risk by estimating Eq. (1) as described in section "Hypothesis and Methodology". In Fig. 1-A, we plot the stock market excess returns and the orthogonalized real estate specific returns; in Fig. 1-B, we plot the stock market volatility (the standard deviation of monthly excess returns within each year) and *REM Volatility*. Both figures show a salient shift around the peak of the tech-bubble. The

[4] The FTSE NAREIT Composite REITs index is a market capitalization-weighted index of all tax-qualified publicly-traded REITs, including equity REITs (EREITs), hybrid REITs (HREITs), and mortgage REITs (MREITs). Observations of the index returns are available at the National Association of Real Estate Investment Trusts (NAREIT), www.nareit.com.

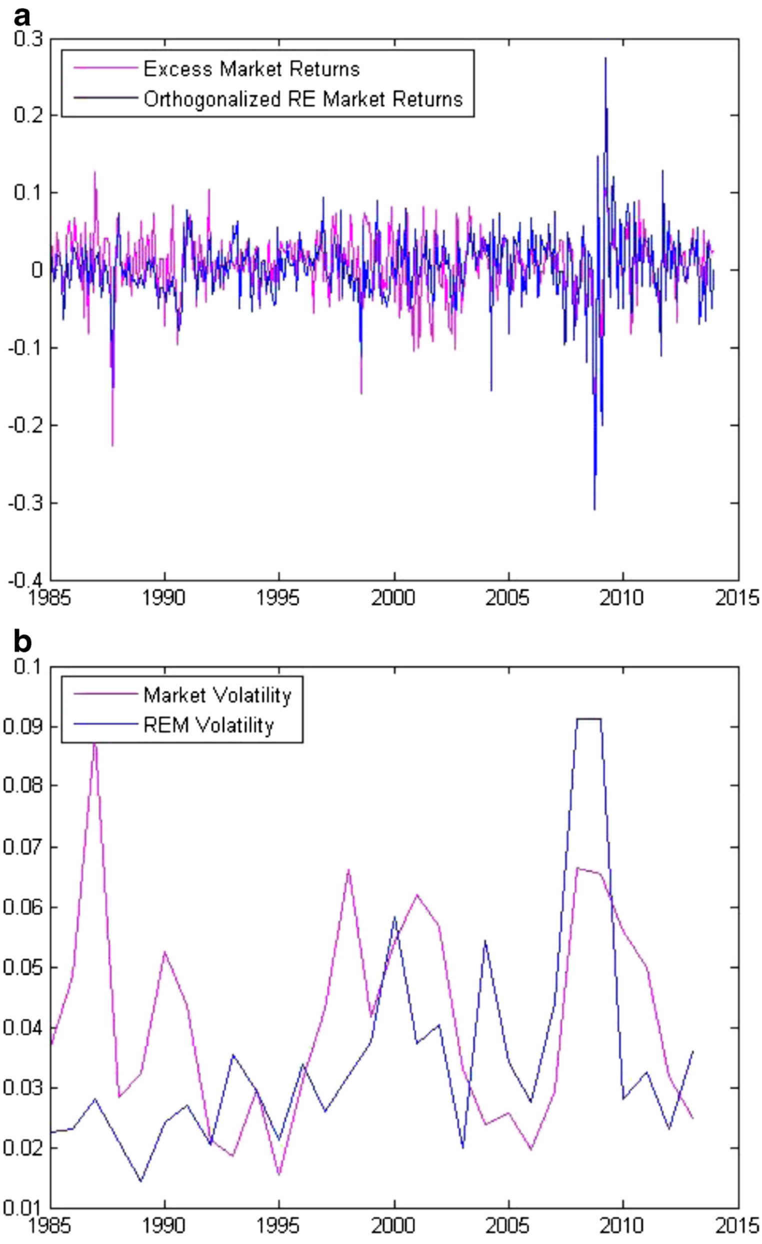


**Fig. 1** Stock market returns and real estate specific returns from 1985 to 2013. Figure 1-A plots excess stock market returns and orthogonalized real estate specific returns over the 1985 to 2013 period. Real estate market risk is estimated using in the following model. $R_{re,t}-R_f=\alpha_0+\alpha_1(R_{mk,t}-R_f)+\varepsilon_t$ where $R_{re}$ is the return on the composite REITs index, $R_f$ is the U.S risk-free rate on U.S. 3-month Treasuries, and $R_{mk}$ is the return on the CRSP value-weighted portfolio. Figure 1-B plots *Market Volatility* and *REM Volatility* from 1985 to 2013. *REM Volatility* is the standard deviation of monthly residuals within the year. The residuals are estimated by orthogonalizing the excess returns of the FTSE NAREIT Composite REIT to the excess returns of the CRSP value-weighted portfolio. *Market Volatility* is the standard deviation of the monthly excess return on the CRSP value-weighted portfolio within the year

market returns are higher than the real estate specific returns before 2000 than afterwards. The real estate market volatility before 2000 is relatively smaller than it is afterwards. The real estate risk especially amplifies after 2005 as the subprime crisis emerges.

We construct the cross-sectional variation of real estate risk among the firms by estimating Eq. (4) as described in the methodology as well as using Fama-French equation for robustness test. For each firm and each year, we run Eq. (4) with monthly returns from the past 60 months. Firms with less than 24 months of observations in the past 60 months are excluded. We use estimated $\beta_i^{re}$ to measure individual firms' exposure to real estate risk, named *REM Beta*. Regressions with a rolling window produce a panel of individual firms' real estate market exposure. To measure the correlated risk between the real estate assets and other corporate assets, we calculate the correlation on a yearly basis between the REITs index returns and CRSP value-weighted index returns using monthly observations, named *REM Co-movement*.

We measure corporate investment (*Investment*) using capital expenditure over the total PPE (property, plant and equipment lagged by one year). We measure equity and debt financing in terms of access, amount and change in balance. *Equity Dummy* equals 1 if the firm issues equity in the year, otherwise 0; *Equity Issue* is the amount of equity issued in the year scaled by the total assets[5]; *Debt Issue* is the amount of debt issued in the year, scaled by the total assets; *Debt Change* is the net change of the debt balance in the year over the total assets.

We also include a set of control variables. Following the existing literature, we use *Log(Asset)* (total assets (in logarithm of millions of dollars)) and *Log(Sale)* (the natural logarithm of the firm's sale amount), *Leverage* (the short-term and the long-term liabilities over the total assets), *MB* (the firms' market value divided by its book value of the assets) to measure the growth opportunity, *Log(Cash)* (cash and short-term investment) to measure firms' liquidity, *Profit* (net operating income scaled by the total assets) and *Tangibility* (PPE over the total assets). All variables are winsorized at the 1% level on both sides of the distribution in the empirical analysis. Table 8 lists all the variables used in this paper's empirical analysis.

Table 1 describes the key variables used in the empirical analyses. Panel A summarizes firm characteristics, investment, financing, and economic conditions observable for the full sample. Panel B summarized the same set of variables as in Panel A but for the subset of firms with real estate holding. Panel C summarizes real estate related variables, among which only the RE value and RE weight (%) require observations of real estate holding data.

Comparing the summary statistics in Panel A and Panel B shows these two patterns. First, firm size measured in assets and sales is similar in the two samples. Second, consistent with the hypotheses that we will test, firms that report real estate holding have lower investment, debt issuance, equity issuance, cash holdings and market valuation, but higher leverage, tangibility and profitability. Overall, the subsample of firms that report real estate holding are reasonably representative of the full sample, which suggest that all results in the paper are potentially applicable to all firms.

[5] We infer equity issuance by observing the change of the shares (scaled by multiple stock price and divided by book value of total assets at the end of the year). As firms may repurchase or issue shares for option compensation, we require the change of equity to be larger than 1% to be quantified as equity issuance equal 1, otherwise 0.

**Table 1** Descriptive statistics

| Variables | Observations | Mean | Std. dev. | P50 | P1 | P99 |
|---|---|---|---|---|---|---|
| Panel A: Full sample | | | | | | |
| Investment (%) | 70,077 | 25.98 | 20.86 | 19.5 | 3.67 | 83.04 |
| Debt Issue (%) | 61,319 | 8.25 | 13.55 | 2.26 | -4.81 | 47.80 |
| Debt Change (%) | 37,474 | 0.66 | 6.06 | 0 | -11.59 | 15.35 |
| Equity Dummy | 71,158 | 0.37 | 0.48 | 0 | 0 | 1 |
| Equity Issue (%) | 26,001 | 18.71 | 22.65 | 6.61 | 1.03 | 65.98 |
| MB (%) | 70,903 | 144.5 | 91.73 | 112.1 | 51.38 | 403.8 |
| Log(Cash) | 71,158 | 2.39 | 2.22 | 2.39 | -1.53 | 6.34 |
| Log(Asset) | 71,136 | 5.59 | 2.05 | 5.52 | 2.14 | 9.37 |
| Log(Sale) | 70,550 | 5.56 | 2.05 | 5.6 | 1.81 | 9.19 |
| Leverage (%) | 70,903 | 22.79 | 18.55 | 21.18 | 0 | 61.35 |
| Profit (%) | 70,944 | 9.42 | 12.03 | 11.45 | -23.7 | 26.97 |
| Tangibility (%) | 71,028 | 30.34 | 23.16 | 23.93 | 2.76 | 79.75 |
| Crisis | 29 | 0.10 | 0.31 | 0 | 0 | 1 |
| Panel B: Subsample of firms that report real estate holdings | | | | | | |
| Investment (%) | 14,058 | 20.87 | 16.97 | 16.03 | 3.67 | 83.04 |
| Debt Issue (%) | 11,523 | 6.68 | 10.83 | 3.13 | -4.81 | 47.80 |
| Debt Change (%) | 9078 | 0.67 | 6.19 | 0 | -11.59 | 15.35 |
| Equity Dummy | 14,281 | 0.28 | 0.45 | 0 | 0 | 1 |
| Equity Issue (%) | 4070 | 18.16 | 22.23 | 6.09 | 1.02 | 65.98 |
| MB (%) | 14,268 | 123.5 | 72.5 | 101.4 | 51.38 | 403.8 |
| Log(Cash) | 14,281 | 1.60 | 2.05 | 1.34 | -1.53 | 6.34 |
| Log(Asset) | 14,281 | 5.50 | 2.09 | 5.34 | 2.14 | 9.37 |
| Log(Sale) | 14,218 | 5.52 | 1.98 | 5.49 | 1.81 | 9.19 |
| Leverage (%) | 14,268 | 27.33 | 16.79 | 28.21 | 0 | 61.35 |
| Profit (%) | 14,259 | 11.7 | 9.49 | 12.41 | -23.7 | 26.97 |
| Tangibility (%) | 14,281 | 43.21 | 21.08 | 38.59 | 2.76 | 79.75 |
| Crisis | 29 | 0.10 | 0.31 | 0 | 0 | 1 |
| Panel C: Real estate measures | | | | | | |
| REM Volatility (%) | 29 | 3.49 | 1.84 | 2.93 | 1.43 | 9.13 |
| REM Beta | 71,158 | 0.23 | 0.63 | 0.19 | -0.95 | 1.52 |
| REM Co-movement (%) | 29 | 58.65 | 25.21 | 62.68 | -21.83 | 94.2 |
| RE Value | 12,531 | 3.32 | 2.05 | 3.23 | -0.36 | 6.96 |
| RE Weight (%) | 14,280 | 11.35 | 10.47 | 9.82 | 0 | 38.24 |

Our sample includes 7332 US listed firms from 1985 to 2013 with 71,158 firm*year observations. Among them, 2386 firms report real estate holding, counting 14,281 firm*year observations. This table describes the key variables used in the empirical analysis. All the variables are winsorized at 1% distribution on both ends. Panel A summarizes firm characteristics, investment, financing, and economic conditions observable for the full sample. Panel B summarized the same set of variables as in Panel A but for the subset of firms with real estate holding. Panel C summarizes real estate related variables, among which only the RE value and RE weight (%) require observations of real estate holding data

To verify that firms' exposure to real estate risk is not a mimicking factor of the market exposure, we form 10 × 10 portfolios based on the firm size and the real estate βs estimated with data in the prior five years in any year during the period from 1985 to 2010. We then estimate the portfolio's real estate beta and market beta. Table 2 reports portfolio returns, post-ranking real estate βs and market βs, respectively, in panels A, B, and C. Panel A shows that the spread of returns across the 10 real estate β deciles is smaller than the spread across the 10 size deciles, and the spreads of average returns across the real estate β deciles decrease with firm size. Panels B and C show that the post-ranking real estate βs closely reproduce the ordering of the pre-ranking real estate βs, but the post-ranking market βs do not reproduce the order of the pre-ranking real estate βs. The latter is consistent with findings in the asset pricing literature and remains a puzzle. These patterns confirm that the real estate factor is not a mimicking factor for the market factor.

## Empirical Results

This section reports the empirical evidence on investment, financing and capital structure. The results overall support the hypotheses on how real estate risk affects firms' investment and financing decisions. Findings related to the value of real estate holdings are also consistent with the empirical evidence document in previous studies.

### Real Estate Risk and Corporate Investment

Table 3 reports the empirical relations between real estate risk and corporate investment. Column (1) reports the results with the simplest estimation with only control variables, and they explain about 11% of corporate investment. Column (2) shows that the weight of real estate assets in total assets (*RE Weight*), as a cross-sectional proxy for adjustment cost, is significantly and negatively associated with investment. For each 1% increase in the real estate assets weights, the investment is decreased by 0.11%.

Columns (3) and (4) show that both real estate industry specific risk (*REM Volatility*) and the firm-specific exposure to the real estate market (*REM Beta*) are significantly and negatively associated with investment. When the real estate market risk increases by 1%, the investment decreases by 0.52%. For each 1% increase in the firm-specific exposure to the real estate market (*REM Beta*), the investment decreases by 0.71%. In column (7), the firm-specific exposure (*REM Beta*) interacts with the real estate industry risk (*REM Volatility*)—that is, the actual risk that firms are exposed to (*REM Volatility* * *REM Beta*)—and the interaction term has a significantly negative relation with investment. For each 1% of increase of real estate risk, the firm investment decreases by 0.26%.

In verifying consistency with the existing literature on the effect of real estate value, column (5) includes firm's real estate value (*REM Value*) in the specification. We find that for each one unit of increase in the log value of real estate measured in millions of dollars, investment increases by 42%—a magnitude similar to that found in previous studies and significant at the 1% level (Chaney et al. 2012).

The regression specification in column (6) includes the correlation between the real estate market risk and equity market risk (*REM Co-movement*). The results show that

**Table 2** Returns and factor exposures for 10 × 10 portfolios formed on firm size and real estate market exposure

| | All | Low-β | β-2 | β-3 | β-4 | β-5 | β-6 | β-7 | β-8 | β-9 | High-β |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Panel A: Average monthly returns | | | | | | | | | | | |
| All | 1.17% | 1.03% | 0.93% | 1.04% | 1.13% | 1.22% | 1.26% | 1.23% | 1.24% | 1.27% | 1.35% |
| Small-ME | 1.82% | 1.94% | 1.35% | 1.82% | 1.73% | 1.79% | 1.83% | 1.93% | 1.77% | 2.01% | 2.08% |
| ME-2 | 1.42% | 1.59% | 1.04% | 0.96% | 1.21% | 1.44% | 1.59% | 1.47% | 1.53% | 1.46% | 1.91% |
| ME-3 | 1.18% | 1.19% | 0.93% | 1.09% | 0.99% | 1.16% | 1.21% | 1.41% | 1.19% | 1.16% | 1.49% |
| ME-4 | 1.13% | 0.90% | 0.81% | 1.02% | 1.29% | 1.23% | 1.30% | 1.04% | 1.31% | 1.18% | 1.23% |
| ME-5 | 1.02% | 0.73% | 0.80% | 0.76% | 0.89% | 1.07% | 1.33% | 1.09% | 1.13% | 1.23% | 1.15% |
| ME-6 | 1.02% | 0.70% | 0.76% | 0.88% | 0.91% | 1.17% | 1.09% | 1.19% | 1.15% | 1.34% | 0.99% |
| ME-7 | 1.06% | 0.80% | 0.88% | 0.93% | 1.10% | 1.13% | 1.02% | 1.19% | 1.21% | 1.17% | 1.22% |
| ME-8 | 1.04% | 0.89% | 0.93% | 0.94% | 1.13% | 1.08% | 1.16% | 1.11% | 1.06% | 1.15% | 0.99% |
| ME-9 | 1.03% | 0.73% | 0.94% | 1.02% | 1.06% | 1.10% | 1.05% | 0.96% | 1.07% | 1.07% | 1.30% |
| Large-ME | 0.97% | 0.85% | 0.85% | 0.99% | 0.96% | 1.06% | 0.98% | 0.95% | 0.97% | 0.94% | 1.09% |
| Panel B: Post-ranking real estate βs | | | | | | | | | | | |
| All | 0.23 | 0.37 | 0.30 | 0.30 | 0.29 | 0.29 | 0.26 | 0.21 | 0.21 | 0.14 | -0.02 |
| Small-ME | 0.14 | 0.20 | 0.13 | 0.17 | 0.12 | 0.27 | 0.12 | 0.05 | 0.23 | 0.13 | -0.04 |
| ME-2 | 0.14 | 0.22 | 0.15 | 0.20 | 0.18 | 0.20 | 0.15 | 0.12 | 0.11 | 0.09 | 0.02 |
| ME-3 | 0.20 | 0.20 | 0.25 | 0.27 | 0.29 | 0.25 | 0.30 | 0.22 | 0.22 | 0.05 | -0.04 |
| ME-4 | 0.28 | 0.32 | 0.33 | 0.36 | 0.41 | 0.31 | 0.31 | 0.26 | 0.28 | 0.17 | 0.02 |
| ME-5 | 0.30 | 0.35 | 0.38 | 0.42 | 0.38 | 0.33 | 0.32 | 0.31 | 0.23 | 0.15 | 0.09 |
| ME-6 | 0.32 | 0.44 | 0.42 | 0.37 | 0.37 | 0.39 | 0.40 | 0.27 | 0.32 | 0.23 | 0.04 |
| ME-7 | 0.31 | 0.50 | 0.41 | 0.37 | 0.35 | 0.35 | 0.36 | 0.34 | 0.27 | 0.21 | -0.06 |
| ME-8 | 0.30 | 0.58 | 0.38 | 0.33 | 0.32 | 0.32 | 0.35 | 0.24 | 0.25 | 0.22 | -0.03 |
| ME-9 | 0.23 | 0.51 | 0.31 | 0.32 | 0.27 | 0.29 | 0.17 | 0.18 | 0.16 | 0.12 | -0.05 |
| Large-ME | 0.12 | 0.37 | 0.19 | 0.19 | 0.19 | 0.17 | 0.11 | 0.09 | 0.05 | -0.01 | -0.19 |
| Panel C: Post-ranking market βs | | | | | | | | | | | |
| All | 0.83 | 0.36 | 0.39 | 0.48 | 0.61 | 0.69 | 0.82 | 0.96 | 1.07 | 1.26 | 1.65 |
| Small-ME | 0.74 | 0.40 | 0.49 | 0.48 | 0.59 | 0.59 | 0.81 | 0.91 | 0.81 | 1.04 | 1.33 |
| ME-2 | 0.79 | 0.46 | 0.39 | 0.41 | 0.54 | 0.61 | 0.78 | 0.92 | 1.06 | 1.19 | 1.58 |
| ME-3 | 0.79 | 0.48 | 0.36 | 0.41 | 0.56 | 0.67 | 0.75 | 0.91 | 0.99 | 1.24 | 1.56 |
| ME-4 | 0.81 | 0.40 | 0.33 | 0.44 | 0.52 | 0.66 | 0.78 | 0.98 | 1.05 | 1.30 | 1.59 |
| ME-5 | 0.81 | 0.38 | 0.30 | 0.32 | 0.55 | 0.68 | 0.81 | 0.96 | 1.09 | 1.34 | 1.65 |
| ME-6 | 0.82 | 0.33 | 0.34 | 0.45 | 0.58 | 0.66 | 0.78 | 1.00 | 1.12 | 1.34 | 1.63 |
| ME-7 | 0.84 | 0.31 | 0.35 | 0.51 | 0.62 | 0.71 | 0.87 | 0.94 | 1.07 | 1.27 | 1.79 |
| ME-8 | 0.86 | 0.31 | 0.39 | 0.51 | 0.67 | 0.77 | 0.81 | 0.94 | 1.13 | 1.27 | 1.79 |
| ME-9 | 0.90 | 0.30 | 0.47 | 0.62 | 0.73 | 0.77 | 0.88 | 0.99 | 1.15 | 1.31 | 1.81 |
| Large-ME | 0.93 | 0.27 | 0.51 | 0.66 | 0.74 | 0.80 | 0.95 | 1.03 | 1.19 | 1.34 | 1.82 |

Firm-level real estate risk exposure and equity market exposure are estimated using the following model with five-year rolling windows: $R_{it}-R_f=\alpha_0+\beta_i^{mk}\left(R_{mk,t}-R_f\right)+\beta_i^{re}\left(R_{re,t}-R_f\right)+\varepsilon_{it}$ where $R_{re}$ is the excess Composite REIT index return, $R_f$ is the risk-free rate on 3-month U.S. Treasuries and $R_{mk}$ is the return on the CRSP value-weighted portfolio. The coefficient $\beta_i^{mk}$ is the market beta. The coefficient $\beta_i^{re}$ (the real estate beta) is the firm *i*'s exposure to the real estate risk factor, after controlling for the stock market movement.

The full sample is used in this analysis. We sort firms based on size and estimated real estate beta (pre-ranking) and form 10 × 10 portfolios. We then estimate the portfolio market beta and the real estate beta for the next year. This table presents the portfolio's returns, the post-ranking market beta and the real estate risk beta. Firms with less than 24 months observations in their 60 months portfolio formation periods are excluded

**Table 3** Real estate risk and corporate investment

| *Y = Investment* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Column 1 | Column 2 | Column 3 | Column 4 | Column 5 | Column 6 | Column 7 | Column 8 | Column 9 |
| *RE Weight* | | -0.11*** | | | | | | | |
| | | -0.07 | | | | | | | |
| | | (−7.64) | | | | | | | |
| *REM Volatility* | | | -0.52*** | | -0.58*** | -0.47*** | -0.50*** | | |
| | | | -0.05 | | -0.04 | -0.04 | -0.04 | | |
| | | | (−11.80) | | (−5.89) | (−10.61) | (−10.89) | | |
| *REM Beta* | | | | -0.71*** | | | 0.07 | -0.87*** | -0.81*** |
| | | | | -0.02 | | | 0.002 | -0.03 | -0.02 |
| | | | | (−5.25) | | | (0.24) | (−3.41) | (−6.00) |
| *RE Value* | | | | | 0.42*** | | | 0.44*** | |
| | | | | | 0.06 | | | 0.06 | |
| | | | | | (3.07) | | | (3.25) | |
| *REM Co-movement* | | | | | | -0.02*** | | | -0.03*** |
| | | | | | | -0.03 | | | -0.03 |
| | | | | | | (−6.44) | | | (−8.69) |
| *REM Volatility * REM Beta* | | | | | | | -0.26*** | | |
| | | | | | | | -0.03 | | |
| | | | | | | | (−3.11) | | |
| *MB* | 0.05*** | 0.06*** | 0.05*** | 0.05*** | 0.06*** | 0.05*** | 0.05*** | 0.06*** | 0.05*** |
| | (48.64) | (22.15) | (48.60) | (48.18) | (18.67) | (48.35) | (48.10) | (18.71) | (47.80) |
| *Log(Cash)* | 0.97*** | 0.30*** | 1.04*** | 0.97*** | 0.07 | 1.04*** | 1.04*** | 0.07 | 0.97*** |

**Table 3** (continued)

*Y = Investment*

| | Column 1 | Column 2 | Column 3 | Column 4 | Column 5 | Column 6 | Column 7 | Column 8 | Column 9 |
|---|---|---|---|---|---|---|---|---|---|
| | (18.02) | (3.43) | (19.18) | (17.98) | (0.90) | (19.17) | (19.16) | (0.86) | (18.12) |
| *Log(Asset)* | -2.10*** | -5.11*** | -2.09*** | -2.15*** | -4.52*** | -2.07*** | -2.14*** | -4.73*** | -2.13*** |
| | (−15.30) | (−21.23) | (−15.25) | (−15.59) | (−21.68) | (−15.10) | (−15.55) | (−23.07) | (−15.44) |
| *Log(Sale)* | 0.24* | 3.93*** | 0.23* | 0.27* | 3.47*** | 0.22 | 0.27* | 3.57*** | 0.25* |
| | (1.71) | (14.52) | (1.66) | (1.93) | (12.44) | (1.56) | (1.95) | (12.85) | (1.82) |
| *Leverage* | -0.12*** | -0.08*** | -0.13*** | -0.12*** | -0.07*** | -0.13*** | -0.12*** | -0.07*** | -0.12*** |
| | (−26.19) | (−8.28) | (−26.70) | (−25.56) | (−7.09) | (−26.78) | (−26.00) | (−6.71) | (−25.67) |
| *Profit* | 0.10*** | 0.13*** | 0.10*** | 0.10*** | 0.11*** | 0.10*** | 0.10*** | 0.11*** | 0.10*** |
| | (11.52) | (5.64) | (10.97) | (11.66) | (4.61) | (10.99) | (11.10) | (4.60) | (11.65) |
| *Crisis* | 0.57** | 0.36 | 1.56*** | 0.48* | 1.70*** | 2.11*** | 1.42*** | 0.22 | 1.34*** |
| | (2.29) | (0.63) | (5.78) | (1.92) | (3.30) | (7.49) | (5.23) | (0.51) | (4.96) |
| *Constant* | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *No. of obs.* | 69,314 | 14,009 | 69,314 | 69,314 | 12,390 | 69,314 | 69,314 | 12,390 | 69,314 |
| *Adjusted* $R^2$ | 0.11 | 0.17 | 0.11 | 0.11 | 0.16 | 0.11 | 0.11 | 0.16 | 0.11 |

This table presents the relation between the real estate risk and corporate investment from 1985 to 2013. Column 1, Column 3, Column 4, Column 6, Column 7 and Column 9 report the results using the full sample. Column 2, Column 5 and Column 8 report the results using the subsample with firms that report real estate holding. The dependent variable is *Investment*, measured as capital expenditure (CAPEX) in the observation year over property, plant, and equipment (PPE) in the previous year. The variables of interest are *RE Weight*, *REM Volatility*, *REM Beta*, *REM Co-movement* and *RE Value*, as defined in Table 8. The independent variables are *MB*, *Log(Cash)*, *Log(Asset)*, *Log(Sale)*, *Profit*, *Leverage* and *Crisis*. Variables are in percentage measure if they are ratios. *, ** and *** represent the 10%, 5% and 1% significance levels, respectively. Coefficients and standardized coefficients (elasticity) for the variables of interest are presented in sequence, and T-statistics are included in parentheses the co-movement between these two markets is also negatively associated with firms' investments. For each 1% increase in the correlation of the two markets' returns, investment decreases by 0.02%.

Overall, the results in Table 3 support the hypotheses that corporate investment is negatively associated with the adjustment cost and the risk of assets-in-place (H1, H2, H3).[6]

Table 4 presents the results for sub-period sample from year 2007 to year 2009 during the subprime crisis. We find that the coefficients on the real estate risk measures remain negative and the magnitudes of all the measures are greater compared with estimations based on the full sample. When the real estate market risk (*REM Volatility*) increases by 1%, the investment decreases by 1.44% in the crisis period compared with a magnitude of 0.52% in the full sample. For each 1% increase in *REM Beta*, investment decreases by 2.04% compared with 0.71% in the full sample. Moreover, when we include the assets risk in the analysis, the coefficient on real estate value remains positive during the crisis period, which differs from the results in Gan (2007a), in which the analysis does not control for real estate risk.

To investigate the cause of this difference, we include an interaction term between *REM Volatility* and *REM Beta* in the regression. As column (6) shows, the coefficient of the interaction term is insignificant; however, the magnitude of *REM Beta* becomes greater. The results suggest that firms with larger exposures to real estate are more sensitive in shrinking their investment when real estate industry risk is high.

These findings suggest that the negative impact of real estate value on investment documented in Gan (2007a) during the crisis period is driven by the time-specific real estate risk rather than the value of the real estate. That is, because the negative shocks to the real estate industry are large during the bubble bust, firms with larger real estate holdings reduce investment by more, while the direct effect of real estate value is always positive.

We also apply the difference-in-difference approach in the full sample, with an indicator for the crisis period and its interaction with the real estate risk and the real estate value, to identify risk effect versus crisis effect. As columns (7) and (8) show, the difference-in-difference estimate of crisis impacts is indeed larger for firms with larger real estate risk exposure. The significant and negative signs on the interaction term of real estate risk measures and the indicator for the crisis period (*Crisis*) further demonstrate that the effect of real estate risk on the investment is particularly large during the bubble bust, while the crisis by itself does not have such an effect.

[6] This paper report regression results where the specification does not include industry fixed effect, although our key results are robust to industry fixed effects and the table are available upon request. This report decision is made to keep our paper focused by avoiding distraction by an interesting finding on a control variable that is not central to this paper's focus but important for the broad literature: Contrary to the existing literature that real estate value has a positive relation with investment, when we include the risk of the real estate and industry in the analyses, the coefficients on this control variable become negative. This finding cast new light or possibly doubts on the existing studies. That is, the existing evidence on the effect of real estate value might be likely due to the failure of control real estate risk and industry at the same time. Given its impact, we think, if to report, it is better to be companied by a rigorous further investigation, which practically needs another differently focused and carefully executed paper. Since it is not the focus of our paper and has no impact on our results, we decide to report results without losing this paper's own focus.

**Table 4** Real estate risk and corporate investment during the subprime crisis period

| *Y = Investment* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Column 1 | Column 2 | Column 3 | Column 4 | Column 5 | Column 6 | Column 7 | Column 8 |
| *REM Volatility* | -1.39*** | | -1.44*** | -0.30** | | -1.44*** | -0.23*** | |
| | -0.18 | | -0.19 | -0.16 | | -0.19 | -0.02 | |
| | (−16.90) | | (−17.27) | (−2.56) | | (−17.21) | (−4.39) | |
| *REM Beta* | | -0.93 | -2.04*** | | 1.74 | -2.75** | | -0.66*** |
| | | -0.02 | -0.05 | | 0.06 | -0.06 | | -0.02 |
| | | (−1.56) | (−3.45) | | (0.71) | (−2.16) | | (−4.86) |
| *RE Value* | | | | 3.03*** | 3.13*** | | | |
| | | | | 1.01 | 1.04 | | | |
| | | | | (5.45) | (5.34) | | | |
| *REM Volatility * REM Beta* | | | | | | 0.14 | | |
| | | | | | | 0.02 | | |
| | | | | | | (0.68) | | |
| *REM Volatility * Crisis* | | | | | | | -1.07*** | |
| | | | | | | | -0.10 | |
| | | | | | | | (−11.11) | |
| *REM Beta * Crisis* | | | | | | | | -1.34** |
| | | | | | | | | 0.01 |
| | | | | | | | | (−2.57) |
| *Crisis* | | | | | | | 6.70*** | 0.56** |
| | | | | | | | 0.10 | 0.01 |
| | | | | | | | (11.91) | (2.19) |
| *MB* | 0.03*** | 0.04*** | 0.03*** | -0.04 | -0.03 | 0.03*** | 0.05*** | 0.05*** |

**Table 4** (continued)

| *Y = Investment* | Column 1 | Column 2 | Column 3 | Column 4 | Column 5 | Column 6 | Column 7 | Column 8 |
|---|---|---|---|---|---|---|---|---|
| | (9.58) | (11.34) | (9.47) | (−1.57) | (−1.18) | (9.46) | (48.15) | (48.19) |
| *Log(Cash)* | 1.18*** | 0.93*** | 1.18*** | -0.07 | -0.07 | 1.18*** | 1.02*** | 0.97*** |
| | (6.45) | (5.03) | (6.47) | (−0.30) | (−0.31) | (6.46) | (18.82) | (18.00) |
| *Log(Asset)* | -0.79* | -0.77* | -0.86* | -3.13** | -3.62*** | -0.86* | -2.10*** | -2.15*** |
| | (−1.73) | (−1.67) | (−1.89) | (−2.45) | (−2.85) | (−1.88) | (−15.32) | (−15.61) |
| *Log(Sale)* | -1.04** | -0.89** | -0.98** | -0.64 | -0.35 | -0.98** | 0.22 | 0.27** |
| | (−2.39) | (−2.01) | (−2.25) | (−0.71) | (−0.39) | (−2.27) | (1.62) | (1.97) |
| *Leverage* | -0.14*** | -0.14*** | -0.14*** | -0.02 | -0.01 | -0.14*** | -0.13*** | -0.12*** |
| | (−9.68) | (−9.39) | (−9.49) | (−0.49) | (−0.29) | (−9.50) | (−26.50) | (−25.54) |
| *Profit* | 0.08*** | 0.08*** | 0.08*** | 0.05 | 0.02 | 0.08*** | 0.10*** | 0.10*** |
| | (3.13) | (3.02) | (2.92) | (0.23) | (0.10) | (2.94) | (11.24) | (11.58) |
| *Constant* | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *No. of obs.* | 7167 | 7167 | 7167 | 198 | 198 | 7167 | 69,314 | 69,314 |
| *Adjusted $R^2$* | 0.11 | 0.08 | 0.11 | 0.19 | 0.17 | 0.11 | 0.11 | 0.11 |

This table presents the relation between real estate risk and corporate investment during the financial crisis period from column 1 to column 6 from July 2007 to June 2009. Column 1, Column 2, Column 3 and Column 6 report the results using the full sample. Column 4 and Column 5 report the results using the subsample with firms that report real estate holding. Column 7 and column 8 are the difference-in-difference analysis using the full sample from 1985 to 2013, where *Crisis* is a dummy variable that equals 1 if the observations are from July 2007 to June 2009, otherwise zero. The dependent variable is *Investment*, the corporate investment ratio, measured as capital expenditure (CAPEX) in the observation year over property, plant, and equipment (PPE) in the previous year. The variables of interest are *REM Volatility*, *REM Beta*, *REM Co-movement* and *RE Value*, as defined in Table 8. The independent variables are *MB*, *Log(Cash)*, *Log(Asset)*, *Log(Sale)*, *Profit*, *Leverage* and *Crisis*. For analyses that use only market level or market value computed real estate risk, the results cover the full sample. For the analyses that use real estate holding variables, the results therefore only include firms that report real estate holdings. *, ** and *** represent the 10%, 5% and 1% significance levels, respectively. Coefficients and standardized coefficients (elasticity) of the variables of interest are presented in sequence, and T-statistics are included in parentheses

Overall, the results using crisis as a quasi-experiment confirm that the negative relation between the investment and the real estate risk is robust to the potential issue of endogenous investment opportunity. It confirms that corporate investment is negatively associated with the real estate risk and the correlation risk among corporate assets (H1, H2, and H3).

**Real Estate Risk and Corporate Financing Choices**

*Debt Financing*

Table 5 presents the results on how real estate risk affects debt issuance. The dependent variable in the first three columns is *Debt Issue*, observed for each firm in each year. The dependent variable in the last three columns is *Debt Change*, also observed for each firm in each year. Consistent with prior literature on collateral effect, we find that the value of real estate assets (*RE Value*) is positively and significantly associated with the new debt issuance (*Debt Issue*) and the change in debt balance (*Debt Change*). Consistent with our hypothesis (H4), both real estate risk measures are negatively and significantly associated with the debt issuance (*Debt Issue*) and the change in debt balance (*Debt Change*). The economic magnitudes of these effects are large. Specifically, for each one standard deviation increase in the real estate industry specific risk (*REM Volatility*), *Debt Issue* decreases by 3% of its standard deviation, which represents a 0.37% decrease in the debt issuance for each 1% increase in *REM Volatility*. For each one standard deviation increase in firms' exposure to the real estate market (*REM Beta*), there is a 14% standard deviation decrease in the log(debt issuance), which represents a 2.48% decrease in the debt issuance for each 1% increase in *REM Beta*.

*Equity Financing*

In Table 6, we report how the risk of assets-in-place affects equity financing. The dependent variable in the first three columns is *Equity Dummy*, which takes the value 1 when the firm issues new equity in the year, otherwise 0. The dependent variable in the last three columns is *Equity Issue,* measured as the amount of equity issued in the year over total assets. We find that both the real estate market risk (*REM Volatility*) and the firm's exposure to the real estate market (*REM Beta*) are significantly and negatively associated with the likelihood of the firm issuing new equity (*Equity Dummy*). The regression specification also includes the correlation between the real estate market risk and equity market risk (*REM Co-movement*). The results show that the co-movement between the equity market and the real estate market is also negatively associated with the likelihood of firms issuing new equity. For each 1% increase in the correlation of the two markets' returns, the likelihood of firms issuing new equity decreases by 0.001%.

In the last three columns, we report how the amount of equity issuance is affected by the real estate risk. We find that both real estate risk measures are significantly and negatively associated with the amount raised through equity (*Equity Issue*). Each one standard deviation increase in the real estate market risk (*REM Volatility*) is related with a 6% standard deviation decrease in *Equity Issue*, which represents a 0.75% decrease in equity financing for each 1% increase in the real estate market risk (*REM Volatility*). Each one standard deviation in the firm-specific exposure to real estate market (*REM*

**Table 5** Real estate risk and debt issuance

| | Debt issue | | | Debt change | | |
|---|---|---|---|---|---|---|
| | Column 1 | Column 2 | Column 3 | Column 4 | Column 5 | Column 6 |
| *REM Volatility* | -0.37*** | -0.36*** | -0.54*** | -0.08 | -0.08 | -0.13** |
| | -0.03 | -0.03 | -0.05 | -0.01 | -0.01 | -0.02 |
| | (−4.24) | (−4.50) | (−6.60) | (−1.51) | (−1.48) | (−2.25) |
| *RE Weight* | 0.02** | | | 0.005 | | |
| | 0.02 | | | 0.01 | | |
| | (2.15) | | | (0.68) | | |
| *REM Beta* | | -0.31 | -2.48*** | | -0.30** | -0.94** |
| | | -0.02 | -0.14 | | -0.03 | -0.09 |
| | | (−1.55) | (−3.62) | | (−2.16) | (−2.24) |
| *RE Value* | | 0.73*** | 0.73*** | | 0.18*** | 0.18*** |
| | | 0.14 | 0.14 | | 0.06 | 0.06 |
| | | (8.39) | (8.34) | | (3.07) | (3.03) |
| *REM Volatility * REM Beta* | | | 0.90*** | | | 0.26* |
| | | | 0.12 | | | 0.06 |
| | | | (3.34) | | | (1.65) |
| *Log(Cash)* | 0.05 | -0.01 | -0.01 | -0.07 | -0.10** | -0.10** |
| | (0.78) | (−0.10) | (−0.22) | (−1.57) | (−2.22) | (−2.28) |
| *Log(Asset)* | -0.38*** | -1.05*** | -1.05*** | 0.19*** | 0.03 | 0.03 |
| | (−5.23) | (−9.73) | (−9.72) | (3.86) | (0.42) | (0.43) |
| *Profit* | -0.01 | -0.02 | -0.02 | -0.00 | 0.00 | 0.00 |
| | (−1.06) | (−1.01) | (−1.03) | (−0.37) | (0.14) | (0.15) |
| *Leverage* | 0.26*** | 0.26*** | 0.26*** | 0.06*** | 0.06*** | 0.06*** |
| | (33.07) | (30.28) | (30.32) | (11.09) | (11.19) | (11.19) |
| *Crisis* | -0.65 | -0.97** | -0.83* | 0.28 | 0.28 | 0.31 |
| | (−1.14) | (−2.12) | (−1.83) | (0.74) | (0.75) | (0.82) |
| *Constant* | Yes | Yes | Yes | Yes | Yes | Yes |
| *No. of obs.* | 11,514 | 10,223 | 10,223 | 9071 | 8084 | 8084 |
| *Adjusted* $R^2$ | 0.15 | 0.15 | 0.15 | 0.03 | 0.03 | 0.03 |

This table presents the relation between real estate risk and debt issuance. The table reports the results using the subsample with firms that report real estate holding from 1985 to 2013. The dependent variable is *Debt Issue*, measured as the amount of debt issued in the year over total assets or *Debt Change,* measured as the net change of debt balance in the year over total assets. The variables of interest are *RE Weight*, *REM Volatility*, *REM Beta* and *RE Value*, as defined in Table 8.The independent variables are *Log(Cash)*, *Log(Asset)*, *Profit*, *Leverage* and *Crisis.* For analyses that use only market level or market value computed real estate risk, the results cover the full sample. For the analyses that use real estate holding variables, the results therefore only include firms that report real estate holdings. *, ** and *** represent the 10%, 5% and 1% significance levels, respectively. Coefficients and standardized coefficients (elasticity) for the variables of interest are presented in sequence, and T-statistics are included in parentheses

*Beta*) is associated with a 3% standard deviation decrease in the log(equity issuance), which represents a 0.89% decrease in equity financing for each 1% increase in *REM Beta*. Contrasting with results on the likelihood of firms issuing new equity, the

**Table 6** Effect of real estate factor on the likelihood of equity issuance

| | Equity dummy | | | Equity issue | | |
|---|---|---|---|---|---|---|
| | Column 1 | Column 2 | Column 3 | Column 4 | Column 5 | Column 6 |
| *REM Volatility* | -0.03*** | | -0.03*** | -0.75*** | | -0.76*** |
| | 0.95 | | 0.95 | -0.06 | | -0.06 |
| | (−6.20) | | (−5.82) | (−9.87) | | (−9.85) |
| *REM Beta* | | -0.07*** | -0.02 | | -0.89*** | -1.04** |
| | | 0.96 | 0.99 | | -0.03 | -0.03 |
| | | (−5.90) | (−0.83) | | (−4.12) | (−2.11) |
| *REM Volatility * REM Beta* | | | -0.02* | | | 0.03 |
| | | | 0.97 | | | 0.01 |
| | | | (−1.94) | | | (0.23) |
| *REM Co-movement* | -0.001* | -0.001*** | -0.001** | -0.07*** | -0.09*** | -0.08*** |
| | 0.99 | 0.97 | 0.98 | -0.04 | -0.09 | -0.08 |
| | (−1.67) | (−3.19) | (−2.21) | (−10.56) | (−13.27) | (−10.92) |
| *Log(Cash)* | 0.09*** | 0.08*** | 0.08*** | 1.03*** | 0.91*** | 1.01*** |
| | (14.59) | (13.85) | (14.45) | (10.06) | (8.94) | (9.93) |
| *Log(Asset)* | -0.16*** | -0.16*** | -0.16*** | -0.98*** | -0.99*** | -1.00*** |
| | (−23.08) | (−23.27) | (−23.18) | (−8.34) | (−8.41) | (−8.51) |
| *Profit* | -0.01*** | -0.01*** | -0.01*** | -0.14*** | -0.13*** | -0.14*** |
| | (−14.48) | (−13.88) | (−14.22) | (−11.55) | (−10.60) | (−11.24) |
| *Leverage* | -0.01*** | -0.00*** | -0.00*** | -0.16*** | -0.15*** | -0.16*** |
| | (−11.11) | (−10.29) | (−10.51) | (−19.37) | (−18.56) | (−18.88) |
| *Crisis* | -0.35*** | -0.40*** | -0.36*** | -3.24*** | -4.09*** | -3.22*** |
| | (−12.29) | (−14.43) | (−12.45) | (−7.12) | (−9.17) | (−7.08) |
| *Constant* | Yes | Yes | Yes | Yes | Yes | Yes |
| *No. of obs.* | 70,715 | 70,715 | 70,715 | 25,844 | 25,844 | 25,844 |
| *Adjusted* $R^2$ | N/A | N/A | N/A | 0.05 | 0.05 | 0.05 |
| *Pseudo* $R^2$ | 0.02 | 0.02 | 0.02 | N/A | N/A | N/A |

This table presents the relation between real estate risk and equity issuance. The table reports the results using the full sample from 1985 to 2013. The dependent variable is *Equity Dummy*, which equals 1 if the firm issues equity in the year, otherwise 0, or *Equity Issue,* measured as the amount of equity issued in the year over total assets. The variables of interest are *RE Weight*, *REM Volatility*, *REM Beta* and *REM Co-movement*, as defined in Table 9. The independent variables are *Log(Cash)*, *Log(Asset)*, *Profit*, *Leverage* and *Crisis.* For analyses that use only market level or market value computed real estate risk, the results cover the full sample. For the analyses that use real estate holding variables, the results therefore only include firms that report real estate holdings. *, ** and *** represent the 10%, 5% and 1% significance levels, respectively. Coefficients and standardized coefficients (elasticity) of the variables of interest are presented in sequence, and T-statistics are included in parentheses

correlation between real estate market risk and equity market risk (*REM Co-movement*) is negatively associated with the amount raised through equity (*Equity Issue*). For each 1% increase in the correlation of the two markets' returns, the amount raised through equity (*Equity Issue*) decreases by about 0.08%.

Overall, the results in Table 6 support our hypothesis that the risk of real estate assets raises financing costs, which reduces equity financing (H4).

*Capital Structure*

Finally, we examine the real estate holding's effect on capital structure. Table 7 shows that the real estate industry specific risk is negatively associated with the leverage

**Table 7** Real estate factor and capital structure

| Leverage | | | | |
|---|---|---|---|---|
| | Column 1 | Column 2 | Column 3 | Column 4 |
| *REM Volatility* | -0.33*** | | | -0.34*** |
| | -0.03 | | | -0.02 |
| | (−8.90) | | | (−2.99) |
| *REM Beta* | | 2.27*** | | 1.87*** |
| | | 0.08 | | 0.07 |
| | | (21.74) | | (7.43) |
| *RE Value* | | | -0.12 | -0.13 |
| | | | -0.01 | -0.02 |
| | | | (−0.92) | (−1.03) |
| *MB* | -0.02*** | -0.02*** | -0.03*** | -0.03*** |
| | (−23.84) | (−21.89) | (−12.45) | (−12.07) |
| *Log(Cash)* | -3.36*** | -3.36*** | -1.65*** | -1.65*** |
| | (−69.61) | (−70.31) | (−18.31) | (−18.36) |
| *Log(Asset)* | 4.76*** | 4.79*** | 2.23*** | 2.37*** |
| | (91.51) | (92.45) | (14.42) | (15.25) |
| *Profit* | -0.21*** | -0.22*** | -0.44*** | -0.44*** |
| | (−34.72) | (−35.16) | (−20.49) | (−20.11) |
| *Tangibility* | 0.16*** | 0.16*** | 0.19*** | 0.19*** |
| | (50.18) | (50.86) | (25.43) | (25.41) |
| *Crisis* | -1.09*** | -1.41*** | -1.39*** | -0.59 |
| | (−5.00) | (−6.78) | (−2.67) | (−1.01) |
| *Constant* | Yes | Yes | Yes | Yes |
| *No. of obs.* | 70,646 | 70,646 | 12,515 | 12,515 |
| *Adjusted* $R^2$ | 0.23 | 0.24 | 0.21 | 0.22 |

This table presents the relation between real estate risk and capital structure. Column 1 and Column 2 report the results using the full sample from 1985 to 2013. Column 3 and Column 4 report the results using the subsample with firms that report real estate holding from 1985 to 2013.The dependent variable is *Leverage*, measured as short-term and long-term liabilities over total assets. The variables of interest are *REM Volatility*, *REM Beta* and *RE Value*, as defined in Table 8. The independent variables are *MB*, *Log(Cash)*, *Log(Asset)*, *Profit*, *Tangibility* and *Crisis*. For analyses that use only market level or market value computed real estate risk, the results cover the full sample. For the analyses that use real estate holding variables, the results therefore only include firms that report real estate holdings. Coefficients and standardized coefficients (elasticity) for the variables of interest are presented in sequence, and T-statistics are included in parentheses.*, ** and *** represent the 10%, 5% and 1% significance levels, respectively

(H5A). However, in cross-section, firm-specific exposure to the real estate market is positively associated with firm leverage (H5B), which is consistent with the crowding effect of debt through the collateral channel. In columns (3) and (4), we include the value of the real estate assets in the specification; the coefficients on the real estate risk measures remains significant, and the signs are consistent with those in the first two columns.

The robustness tests discussed in the "Data" section and "Empirical results" section give similar results to those reported here. They are available upon request.

## Conclusion

Real estate composes a significant part of firm's portfolio. This research empirically explores the relation between real estate risk and corporate investment of these firms. Using U.S. firms' real estate holdings from 1985 to 2013, we find that real estate risk is negatively associated with firms' long-term investments and long-term external financing in equity and debt. This is in contrast to previously documented positive effects of the real estate value, indicating that effect of real estate risk on corporate decisions is indeed differ from the value measures and requires new theory to gain a better understanding. This difference is however intuitive from the real option framework as it is consistent with how the first and second moments of the underlying determine the option value.

This study contributes to the understanding of the real effect of real estate asset risks. While real estate constitutes a significant part of firms' portfolios, very little is known about the effects of real estate risk on firms' corporate decisions. Our empirical results also provides insights on previously documented positive effects of the real estate value – we find this positive effect is sustained through the crisis period rather than turns into negative after we control for the real estate risk's negative effect on investment and financing in cross section. This finding calls for a careful revisits of some empirical results and interpretations in the extant literature.

## Appendix

**Table 8** Variable definitions

| Variable name | Definition | Data sources |
|---|---|---|
| Panel A: Variables of interests | | |
| *Investment* | Capital expenditure over scaled by property, plant, and equipment (PPE) | Compustat |
| *Debt Issue* | The amount of debt issued in the year over total assets | Compustat |
| *Debt Change* | Net change of debt balance in the year over total assets | Compustat |
| *Equity Dummy* | Equals 1, if the firm issue equity in the year, otherwise 0 | Compustat |
| *Equity Issue* | The amount of equity issued in the year over total assets | Compustat |
| *Leverage* | Short-term and long-term liabilities over total assets | Compustat |

**Table 8** (continued)

| Variable name | Definition | Data sources |
|---|---|---|
| Panel B: Real estate risk measures | | |
| *REM Volatility* | We orthogonalize the excess returns of FTSE NAREIT Composite REIT to the excess returns of CRSP value-weighted portfolio; both are unannualized and measured in excess of the risk-free rate $R_f$ on U.S. 1-month Treasuries. We then calculate the standard deviation of the monthly residuals as a time-series measure of real estate asset risk. | NAREIT, CRSP |
| *REM Beta* | The risk loading on the real estate market return from a two-factor model in which Composite REIT returns and market returns proxy for the two factors' premium. | NAREIT, CRSP |
| *REM Co-movement* | The correlation of the monthly returns on the FTSE NAREIT Composite Real Estate index and CRSP value-weighted index for each year. | NAREIT, CRSP |
| Panel C: Control variables | | |
| *RE Value* | The book value of buildings, land, improvements, and construction (in logarithm of million dollars). | Compustat |
| *RE Weight* | The book value of buildings, land, improvements, and construction over total assets | Compustat |
| *MB* | Market capitalization and total liability over total assets | Compustat |
| *Log(Cash)* | Cash and short-term investment (in logarithm of million dollars) | Compustat |
| *Log(Asset)* | Total assets (in logarithm of million dollars) | |
| *Log(Sale)* | Total sales (in logarithm of million dollars) | Compustat |
| *Profit* | Operating income over total assets | Compustat |
| *Tangibility* | Property, plant, and equipment (PPE) over total assets | Compustat |
| *Crisis* | Equals 1, if the observation year is between 2007 and 2009, otherwise 0. | Compustat |

**Table 9** The industry distribution of the sample firms

| | Full sample firms | | Firms with RE holdings | |
|---|---|---|---|---|
| | Number of firms | Portion of total | Number of firms | Portion of total |
| Consumer Nondurables | 456 | 6% | 190 | 8% |
| Consumer Durables | 196 | 3% | 72 | 3% |
| Manufacturing | 996 | 14% | 495 | 21% |
| Energy | 407 | 6% | 30 | 1% |
| Chemicals and Allied Products | 191 | 3% | 87 | 4% |
| Business Equipment | 1610 | 22% | 441 | 18% |
| Telephone and Television Transmission | 245 | 3% | 41 | 2% |
| Utilities | 228 | 3% | 190 | 8% |
| Shops-Wholesale, Retail, and Services | 950 | 13% | 327 | 14% |

**Table 9** (continued)

| | Full sample firms | | Firms with RE holdings | |
|---|---|---|---|---|
| | Number of firms | Portion of total | Number of firms | Portion of total |
| Healthcare, Medical Equipment, and Drugs | 915 | 12% | 194 | 8% |
| Others | 1138 | 16% | 319 | 13% |
| Total | 7332 | 100% | 2386 | 100% |

This table compares the industry distributions of the full sample firms and the subsample of firms that report real estate holding. The classification of the industry are based on four-digit SIC codes. 1. Consumer Non-Durables: 0100–0999,2000–2399,2700–2749, 2770–2799,3100–3199,3940–3989; 2. Consumer Durables: 2500–2519, 2590–2599,3630–3659, 3710–3711, 3714–3714, 3716–3716, 3750–3751, 3792–3792, 3900–3939, 3990–3999; 3. Manufacturing: 2520–2589, 2600–2699, 2750–2769, 3000–3099, 3200–3569, 3580–3629, 3700–3709, 3712–3713,3715–3715,3717–3749,3752–3791,3793–3799,3830–3839, 3860–3899; 4. Energy: 1200–1399, 2900–2999; 5. Chemicals and Applied Products: 2800–2829, 2840–2899; 6. Business Equipment: 3570–3579, 3660–3692,3694–3699, 3810–3829, 7370–7379; 7. Telephone and Television Transmission: 4800–4899; 8. Utilities: 4900–4949; 9. Shops, Wholesale, Retail, and Services: 5000–5999, 7200–7299, 7600–7699; 10. Healthcare: 2830–2839, 3693–3693, 3840–3859, 8000–8099; 11. Others (excluding Finance: 6000–6999)

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