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The Collateral Channel: How Real Estate Shocks Affect Corporate Investment†

By Thomas Chaney, David Sraer, and David Thesmar*

What is the impact of real estate prices on corporate investment? In the presence of financing frictions, firms use pledgeable assets as collateral to finance new projects. Through this collateral channel, shocks to the value of real estate can have a large impact on aggregate investment. To compute the sensitivity of investment to collateral value, we use local variations in real estate prices as shocks to the collateral value of firms that own real estate. Over the 1993–2007 period, the representative US corporation invests $0.06 out of each $1 of collateral. (*JEL* D22, G31, R30)

In the presence of contract incompleteness, Barro (1976), Stiglitz and Weiss (1981), and Hart and Moore (1994) point out that collateral pledging enhances a firm's financial capacity. Providing outside investors with the option to liquidate pledged assets ex post acts as a strong disciplining device on borrowers. This, in turn, eases financing ex ante. Asset liquidation values thus play a key role in the determination of a firm's debt capacity. This simple observation has important macroeconomic consequences: as noted by Bernanke and Gertler (1989) and Kiyotaki and Moore (1997), business downturns will deteriorate assets values, thus reducing debt capacity and depressing investment, which will amplify the downturn. This "collateral channel" is often the main suspect for the severity of the Great Depression (Bernanke 1983) or for the extraordinary expansion of the Japanese economy at the end of the 1980s (Cutts 1990). In the current context of abruptly declining real estate prices in the United States, an assessment of the relevance of this "collateral channel" is called for. This paper attempts to empirically uncover the *microeconomic* foundation for this mechanism.

We show that over the 1993–2007 period, a $1 increase in collateral value leads the representative US public corporation to raise its investment by $0.06. This

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sensitivity can be quantitatively important in the aggregate. This is because real estate represents a sizable fraction of the tangible assets that firms hold on their balance sheet. As we show in this paper, in 1993, among public firms in the United States, 59 percent reported at least some real estate ownership. Among these land-holding firms, the market value of real estate accounted for 19 percent of the firm's total market value. To get at this $0.06 sensitivity, we use variations in local real estate prices, either at the state or the city level, as shocks to the collateral value of land-holding firms. We measure how a firm's investment responds to each additional dollar of real estate that the firm *actually* owns, and not how investment responds to real estate shocks overall. This empirical strategy uses two sources of identification. The first comes from the comparison, within a local area, of the sensitivity of investment to real estate prices across firms with and without real estate. The second comes from the comparison of investment by land-holding firms across areas with different variations in real estate prices. The methodology is similar to Case, Shiller, and Quigley (2001) in their study of home wealth effects on household consumption.

Two sources of endogeneity might affect our estimation: (i) real estate prices may be correlated with the investment opportunities of land-holding firms, and (ii) the decision to own or lease real estate may be correlated with the firm's investment opportunities. As in Himmelberg, Mayer, and Sinai (2005) or Mian and Sufi (2011), we address the first source of endogeneity by instrumenting local real estate prices using the interaction of long-term interest rate with local housing supply elasticity. We do not have a proper set of instruments to deal with the second source of endogeneity. We make two attempts at gauging the severity of the bias it may cause. We first control for the observable determinants in the ownership decision, which leaves the estimation unchanged. Second, we estimate the sensitivity of investment to real estate prices for firms that acquire real estate *before* and *after* they do so. Before acquiring real estate, future purchasers are statistically indistinguishable from firms that never own real estate. The sensitivity of their investment to real estate prices becomes large, positive, and significant only after they acquire real estate.

Our article is related to the recent, emerging literature on collateral and investment. Gan (2007), in an important contribution, showed, using a difference-in-differences like approach, that land-holding Japanese firms were more affected by the burst of the real estate bubble in the beginning of the 1990s than firms with no real estate. We view our contribution as complementary. First, one might worry that, because the Japanese economy is bank oriented, the role of collateral is much larger than in a more market-based economy like the United States. Second, her paper exploits extreme market conditions, and, in particular, a period where banks in Japan were distressed. This might affect the degree of financing frictions that firms face and, hence, lead to an upward bias of the effect. While we provide specific evidence on the recent real estate bubble, we also use a large US sample over a long period, covering mostly "normal" market conditions. Third, the fact that the burst of the Japanese real estate bubble in the late 1980s was so large means that there is very little variation in real estate price movements between different locations within Japan, as reported by Gan using prefecture-level prices. In our data, the large dispersion in price movements between US states and cities allows us to control for local market conditions more precisely, and to rely on weaker identifying assumptions. The identification assumption in Gan (2007) is that land-holding firms were not differentially affected by the burst of the bubble when compared to non–land-holding firms. This is a strong assumption considering that land-holding firms are larger firms that might have been more exposed, for instance, to exchange rates swings contemporaneous to the bubble. Our identifying assumption requires only that land-holding and non–land-holding firms have the same reaction to variations in *local* real estate prices, a much weaker assumption.[1] Another important contribution is Peek and Rosengren (2000), who look at the supply side of credit. Based also on the Japanese real estate bubble, they show that banks owning depreciated real estate assets cut their credit supply, leading to a decrease in their clients' investment.[2]

Finally, our article is also closely related to recent works that try to highlight the role of collateral in financial contracts. Benmelech, Garmaise, and Moskowitz (2005) document that more liquid (or more "redeployable") pledgeable assets are financed with loans of longer maturities and durations. Benmelech and Bergman (2008) documents how US airline companies are able to take advantage of lower collateral value to renegotiate ex post their lease obligation downward. Finally, Benmelech and Bergman (2009) construct industry-specific measures of redeployability and show that more redeployable collateral leads to lower credit spreads, higher credit ratings, and higher loan-to-value ratios. While we do not go into such details in the examination of financial contracts, our article contributes to this literature by empirically emphasizing the importance of collateral for financing and investment decisions.[3]

The remainder of the article is organized as follows. Section I presents the construction of the data and summary statistics. Section II describes our main empirical results on investment and capital structure decisions. Section III concludes.

I. Data

We use accounting data on US listed firms, merged with real estate prices at the state and Metropolitan Statistical Area (MSA) level.

A. *Accounting Data*

We start from the sample of active COMPUSTAT firms in 1993 with nonmissing total assets (COMPUSTAT item No. 6). This provides us with a sample of 9,211 firms and a total of 83,683 firm-year observations over the period 1993–2007. We keep firms whose headquarters are located in the United States and exclude from the sample firms operating in the finance, insurance, real estate, construction, and mining industries, as well as firms involved in a major takeover operation. We require

[1] Another contribution looking at collateral shocks triggered by the Japanese crisis can be found in Goyal and Yamada (2004).

[2] Gan (2007) also uses the Japanese crisis as a shock to banks' health and identifies the importance of bank health on their clients' investment.

[3] For other contributions emphasizing the role of collateral in boosting pledgeable income, see, among others, Eisfeldt and Rampini (2009) and Rampini and Viswanathan (2010).

firms to have available data every consecutive year they appear in the sample. We keep only firms that appear at least three consecutive years in the sample. This leaves us with a sample of 5,584 firms and 50,858 firm-year observations.

Real Estate Assets.—We collect data on the value of real estate assets of each firm. After measuring the initial market value of real estate assets of each firm, we will identify variations in their value coming from variations in real estate prices across space and over time.

First, we measure the market value of real estate assets. Following Nelson, Potter, and Wilde (2000), three major categories of property, plant, and equipment are included in the definition of real estate assets: Buildings, Land and Improvement, and Construction in Progress. Unfortunately, these assets are not marked-to-market, but valued at historical cost. To recover their market value, we calculate the average age of those assets and use historical prices to compute their current market value. The procedure is as follows. The ratio of the accumulated depreciation of buildings (COMPUSTAT item No. 253) to the historic cost of buildings (COMPUSTAT item No. 263)[4] measures the proportion of the original value of a building claimed as depreciation. Based on a depreciable life of 40 years,[5] we compute the average age of buildings for each firm. We infer the market value of a firm's real estate assets for each year in the sample period (1993–2007) by inflating their historical cost with state-level residential real estate inflation after 1975, and CPI inflation before 1975.[6,7]

The accumulated depreciation on buildings is no longer available in COMPUSTAT after 1993.[8] This is why, when measuring the value of real estate, we restrict our sample to firms active in 1993. There are 2,792 firms in 1993 in our sample for which we are able to construct a measure of the market value of real estate assets and 27,543 corresponding firm-year observations. Table 1 reveals two striking facts. In 1993, 59 percent of all US public firms reported some real estate ownership. Moreover, for the median firm in the entire sample, the market value of real estate represents 28.4 percent of the book value of Property, Plants and Equipment (and 4 percent of the firm's total market value). For the median *land-holding* firm in COMPUSTAT, the market value of real estate represents 95 percent of the book value of Property, Plant and Equipment and 19.3 percent of the firm's total market value. Real estate is thus a sizable fraction of the tangible assets that corporations hold on their balance sheet.

Second, to measure accurately how the value of real estate assets evolves, we need to know the location of these assets. COMPUSTAT does not provide us with the geographic location of each specific piece of real estate owned by a firm. However,

[4] Unlike buildings, land and improvements are not depreciated.

[5] As in Nelson, Potter, and Wilde (2000), this assumption can be tested by estimating annual depreciation amounts (as the change in total depreciation). Building cost, when divided by annual depreciation, provides an estimate of depreciable life. Although inconsistent, the average life estimated by this approach ranges from 38 to 45 years. This confirms our assumption of a 40-year-life.

[6] Real estate assets at cost are defined as Land and Improvements (COMPUSTAT item No. 260), Buildings (COMPUSTAT item No. 263), and Construction in Progress (COMPUSTAT item No. 266).

[7] For firms with missing book value of real estate assets in 1993, we assign a book value of 0 in 1993 if they have a 0 book value of real estate assets in 1994.

[8] In 1994, ten of the 15 schedules required for Electronic Data Gathering, Analysis, and Retrieval system (EDGAR) filings were eliminated. In particular, the accumulated depreciation on Buildings is no longer reported.

TABLE 1—SUMMARY STATISTICS

	Mean	Median	SD	25th percentile	75th percentile	Obs.
Firm-level data						
Investment	0.35	0.21	0.40	0.11	0.41	27,201
Δ(PPE) − (RE)	0.06	0.00	0.34	−0.08	0.13	23,593
3 years mean CAPEX	0.42	0.24	0.47	0.13	0.48	21,186
Industry-adj. CAPEX	0.01	−0.09	0.39	−0.21	0.07	27,173
Cash	0.01	0.26	1.76	−0.11	0.59	27,407
Market/Book	2.18	1.53	1.76	1.11	2.48	25,210
Debt Issues	0.48	0.01	1.02	0.00	0.38	26,336
Debt Repayment	0.35	0.08	0.65	0.00	0.33	26,825
Net Debt Issues	0.08	0.00	0.50	−0.08	0.06	25,760
Changes in current debt	0.01	0.00	0.15	0.00	0.00	27,543
RE Value (State - residential)	0.86	0.28	1.36	0.00	1.12	27,543
RE Value (MSA - residential)	0.83	0.24	1.34	0.00	1.10	26,107
RE Value (MSA - office)	0.77	0.09	1.27	0.00	1.01	20,353
State Residential Price Index	0.59	0.55	0.20	0.43	0.72	27,543
MSA Residential Price Index	0.59	0.56	0.20	0.41	0.72	26,138
MSA Office Price Index	0.68	0.69	0.21	0.52	0.80	20,589
Local Housing Supply Elasticity	1.17	0.90	0.67	0.65	1.31	22,916
Initial firm level data (1993)						
RE OWNER	0.59	1.00	0.49	0.00	1.00	2,792
Log (asset)	4.08	3.97	2.19	2.61	5.49	2,791
ROA	0.00	0.07	0.25	−0.03	0.12	2,782
Age	12.22	8.00	10.57	3.00	19.00	2,792
10K information on headquarter ownership (1997)						
HQ OWNER	0.24	0	0.429	0	0	3,727

Notes: Investment is defined as capital expenditure (item No. 128) normalized by the lagged book value of properties, plant and equipment (PPE: item No. 8). "Δ(PPE) − Δ(RE)" is the yearly growth in PPE minus the yearly growth in real estate assets, normalized by lagged PPE (item No. 8). "3 years mean CAPEX" is the average capex over the next three years normalized by lagged PPE. "Industry-adj. CAPEX" is the firm CAPEX minus the average CAPEX in the industry normalized by lagged PPE. Cash is defined as income before extraordinary items + depreciation and amortization (item No. 14 + item No. 18) normalized by lagged PPE (item No. 8). Market/Book is defined as the market value of assets (item No. 6 + (item No. 60 × item No. 24) − item No. 60 − item No. 74) normalized by their book value (item No. 6). Debt Issues is defined as item No. 111 normalized by lagged PPE (item No. 8). Debt Repayment is defined as item No. 114 normalized by lagged PPE (item No. 8). Net Debt Issues is defined as Debt Issuance minus Debt Repayment. Changes in current debt is defined as item No. 301 normalized by lagged PPE (item No. 8). RE Value is the ratio of the market value of real estate assets normalized by lagged PPE (see Section I for details on the construction of this variable). *RE OWNER* is a dummy variable equal to 1 if the firm reports any real estate holding in 1993. ROA is defined as operating income before depreciation minus depreciation and amortization normalized by total assets ((item No. 13 − item No. 14)/item No. 6). Age is the number of years since IPO. MSA/State Level Residential Prices Growth Rate (resp. Index) is the growth rate (resp. level normalized to 1 in 2006) of the MSA/State OFHEO real estate price index. Office Prices Growth Rate (resp. Index) is the growth rate (resp. level normalized to 1 in 2006) of MSA level office price index. Local Housing Supply Elasticity comes from Saiz (2010). HQ OWNER is a dummy variable equal to 1 if the firm reports headquarter ownership in its 1997 10K files.

the data reports headquarter location (variables STATE and COUNTY). We use the headquarter location as a proxy for the location of real estate. There are two assumptions underlying this choice. First, headquarters and production facilities tend to be clustered in the same state and MSA. Second, headquarters represent an important fraction of corporation real estate assets. To support these assumptions, we manually collected information on the location of a firm's real estate using its 10K files. We discuss these data in detail in Section IC.

Other Accounting Data.—Aside from data on real estate, we use other accounting variables and construct ratios as is typically done in the corporate finance literature.

We compute investment rate as the ratio of capital expenditures (COMPUSTAT item No. 128) to past year's Property Plant and Equipment (lagged item No. 8).[9] We compute the Market-to-Book ratio as follows: we take the total market value of equity as the number of common stocks (item No. 25) times end-of-year close price of common shares (item No. 24). To this, we add the book value of debt and quasi equity, computed as book value of assets (item No. 6) minus common equity (item No. 60) minus deferred taxes (item No. 74). We then normalize the resulting firm's "market" value using book value of assets (item No. 6). We also use the ratio of cash flows (item No. 18 plus item No. 14) to past year's PPE (lagged item No. 8).

We use COMPUSTAT to measure debt issuance. We measure long term debt issues as long term debt issuance (item No. 111) normalized by lagged PPE (lagged item No. 8). We also compute long term debt repayment (item No. 114) divided by lagged PPE. Finally, only the net change in current debt (item No. 301) is available in COMPUSTAT, and we also normalize it by lagged PPE. Net change in long term debt is defined as long term issuance minus long term repayments normalized by PPE. Because data on issuances and repayments are sometimes missing, we also compute net change in long term debt as the yearly difference in long term debt normalized by lagged PPE.

In most of the regression analysis, we use initial characteristics of firms to control for the potential heterogeneity among our 2,792 firms. These controls, measured in 1993, are Return on Assets (operating income before depreciation (COMPUSTAT item No. 13) minus depreciation (COMPUSTAT item No. 14) divided by Assets (COMPUSTAT item No. 6)), Assets, Age measured as number of years since IPO, two-digit SIC codes and state of headquarters' location.

Finally, to ensure that our results are statistically robust, all variables defined as ratios are windsorized using as thresholds the median plus/minus five times the interquartile range.[10] Table 1 provides summary statistics on most accounting variables used in the article. We simply remark that the debt-related variables (Debt Repayment, Debt Issues, Net Debt Issues and Changes in Current Debt) have high means (0.48 for debt issues, for instance) but fairly low medians (e.g., 0.01 for debt issues). This is because (i) these variables are normalized by lagged PPE, which is notably smaller than total assets, and (ii) these variables are left censored so that they are naturally right skewed and as a consequence, even after windsorizing, there is still an important mass on the right tail of these distributions.

Ex Ante Measure of Credit Constraint.—The standard empirical approach in the investment literature uses ex ante measures of financial constraint to sort between "Constrained" and "Unconstrained" firms. Estimations are performed separately for each set of firms. We follow Almeida, Campello, and Weisbach (2004) in this approach and define three measures of credit constraint using the following schemes:

[9] This normalization by PPE is standard in the investment literature (see, e.g., Kaplan and Zingales 1997 or Almeida, Campello, and Weisbach 2004). It provides typically a median investment ratio of 0.21. An alternative specification is to normalize all variables by lagged asset value (item No. 6), as in Rauh (2006) for instance, which delivers notably lower ratios.

[10] The debt-related variables (Debt Repayment, Debt Issues, Net Debt Issues and Changes in Current Debt) have to be windsorized using the fifth /ninety-fifth percentiles as thresholds as the interquartile range for these variables is close to 0. Our results are unchanged if we use this 5 percent windsorizing methods for all variables.

- Payout ratio: In every year over the 1993–2007 period, we rank firms based on their payout ratio and assign to the financially constrained (unconstrained) group those firms in the bottom (top) three deciles of the annual payout distribution. We compute the payout ratio as the ratio of total distributions (dividends (COMPUSTAT item No. 21) plus stock repurchases (COMPUSTAT item No. 115)) to operating income (COMPUSTAT item No. 20).
- Firm Size: In every year over the 1993–2007 period, we rank firms based on their total assets and assign to the financially constrained (unconstrained) group those firms in the bottom (top) three deciles of the annual asset size distribution.
- Bond Rating: In every year over the 1993–2007 period, we retrieve data on bond ratings assigned by Standard and Poor's (COMPUSTAT item No. 280) and categorize those firms with long term debt outstanding but without a bond rating as financially constrained. Financially unconstrained firms are those whose bonds are rated.

B. *Real Estate Data*

Real Estate Prices.—We use data on residential and commercial real estate prices, both at the state and at the MSA level.

Residential real estate prices come from the Office of Federal Housing Enterprise Oversight.[11,12] The OFHEO provides a Home Price Index (HPI), which is a broad measure of the movement of single-family home prices in the United States.[13] Because of the breadth of the sample, it provides more information than is available in other house price indices. In particular, the HPI is available at the state level since 1975. It is also available for most Metropolitan Statistical Areas, with a starting date between 1977 and 1987 depending on the MSA considered. We match the state level HPI with our accounting data using the state identifier from COMPUSTAT. To match the MSA level HPI, we aggregate Federal Information Processing Standards codes from COMPUSTAT into MSA identifiers using a correspondence table available from the OFHEO website.

Commercial real estate prices come from Global Real Analytics. This dataset provides a price index for Offices and Industrial Commercial Real Estate. This index is only available for a subset of 64 MSAs in the United States with a starting date between 1985 and 2003.

Table 1 provides details on these indices (that have been normalized to 1 in 2006). The correlation between the residential and commercial indices at the state level is 0.57, and 0.42 at the MSA level. The correlation between the two residential indices is 0.86.

[11] http:\\www.ofheo.gov/index.asp.

[12] The OFHEO is an independent entity within the Department of Housing and Urban Development, whose primary mission is "ensuring the capital adequacy and financial safety and soundness of two government-sponsored enterprises (GSEs)–the Federal National Mortgage Association (Fannie Mae) and the Federal Home Loan Mortgage Corporation (Freddie Mac)."

[13] The HPI is computed using a hedonic regression, and each release of the HPI offers a different value of the index for a given state year. This article uses the 2007 release, but results are virtually similar if using the 2008 release.

Measuring Land Supply.—Controlling for the potential endogeneity of local real estate prices in an investment regression is an important step in our analysis. Following Himmelberg, Mayer, and Weisbach (2005), we instrument local real estate prices using the interaction of long-term interest rates and local housing supply elasticity. Local housing supply elasticities are provided by Saiz (2010) and are available for 95 MSAs. These elasticities capture the amount of developable land in each metro area and are estimated by processing satellite-generated data on elevation and presence of water bodies. As a measure of long-term interest rates, we use the "contract rate on 30-year, fixed rate conventional home mortgage commitments" from the Federal Reserve website, between 1993 and 2007.

C. *Measurement Issues*

The empirical methodology we use in this paper relies on several approximations that introduce measurement errors in the regression analysis. In this section, we present evidence in support of these approximations.

The first approximation we make relates to the location of firms' real estate assets. We assume that firms own most of their real estate assets in the state (or MSA) where their headquarters are located. We do so because there is no systematic source of information on corporations' "true" location(s). To check the validity of this approximation, we collected manually information on the ownership status of a firm's headquarter from the 10K forms filed with the Securities and Exchange Commission for the year 1997.[14] These documents were retrieved from the SEC's EDGAR website (http:\\www.sec.gov/edgar.shtml). Information on a firm's headquarters ownership was available for 4,065 firms in 1997.[15] Of those firms, 3,393 firms also have nonmissing information on the value of their real estate assets in COMPUSTAT.

Table 2 presents some simple summary statistics for those 3,393 firms. Of the 1,578 firms that report owning no real estate assets in COMPUSTAT in 1997, only 33 firms (2 percent) report owning their headquarters in their 10K forms. The extent of measurement errors from using balance sheet data to assess firms' real estate holdings seems limited.

On the other hand, of the 1,815 firms that report owning some real estate assets in COMPUSTAT, only 806 (44 percent) actually report owning their headquarters in their 10K forms.[16] This suggests that our assumption that all of the real estate assets of a firm are located in its headquarters' state (or MSA) is conservative. If not all of a firm's real estate assets are located in its headquarters state or MSA, we will tend to *overestimate* the fraction of the value of its real estate that comoves with the prices

[14] 1997 is the earliest date for which 10K forms are available. We also collected the same information for the year 2000, which we use in our study of the real estate bubble of the early 2000s in Section IIG.

[15] Four thousand, one hundred twenty-one firms reported in their 10K files a single headquarters. In addition, 171 firms reported two distinct headquarters, and 19 reported three or more headquarters. These cases of multiple headquarters seem to typically correspond to small firms that have both their headquarters in either a small city, or in the suburb of a large city and, in addition, have an address in a large city that they use primarily as a mailing address (in some of those 183 cases, we could explicitly identify the address for the second headquarters as a PO box). We dropped those few observations with multiple headquarters.

[16] Note that a firm may not own its headquarters but may still own other real estate assets in its headquarters state or MSA.

TABLE 2—10K HEADQUARTER OWNERSHIP AND COMPUSTAT REAL ESTATE OWNERSHIP

	No HQ ownership in 10K	HQ ownership in 10K
No RE in COMPUSTAT	1,545	33
>0 RE in COMPUSTAT	1,009	806

Notes: This table presents the cross-tabulation of headquarter ownership in the 1997 10K file and real estate ownership in COMPUSTAT for COMPUSTAT firms in 1997. ">0 RE in COMPUSTAT" means that the firm reports some real estate ownership in COMPUSTAT in 1997, and "No RE in COMPUSTAT" means that the firm reports no real estate assets in 1997 in COMPUSTAT. "No HQ ownership in 10K" means that the firm reports that it leases its headquarter(s) in its 1997 10K file. "HQ ownership in 10K" means that the firm reports that it owns its headquarter(s) in its 1997 10K file.

in its headquarters state or MSA, and we will therefore *underestimate* the impact of a firm's collateral on its investment. To gauge the importance of this assumption, we also run regressions using as explanatory variable a dummy for whether a firm owns its headquarters (based on 10K files information) instead of using the actual value of a firm's real estate assets. We find that the economic significance of our coefficient of interest is similar to that found when using the information on the entire value of real estate assets from COMPUSTAT.

Second, using the OFHEO residential real estate prices as a proxy for commercial real estate prices could be a source of noise in our regression. As noted earlier, the correlation between the two indices ranges from 0.42 (at the MSA level) to 0.57 (at the state level). Moreover, the commercial index is available only at the MSA level, and for a subset of cities. Therefore, there is a trade-off: this index corresponds more accurately to the true nature of firms' real estate assets, but it relies on the stronger assumption that these assets are mostly located in the city where headquarters are located. We present evidence using both series of prices (residential and commercial) and show that our results do not depend on the price index used.

II. Real Estate Prices and Firm Behavior

In this section we analyze the impact of real estate shocks on corporate investment. Our goal is to provide an estimate of the financial multiplier (i.e., by how much an increase in assets' value increases investment) at the firm level.

A. *Empirical Strategy*

We run different specifications of a standard investment equation. Specifically, for firm i, at date t, with headquarters in location l (state or MSA), investment is given by

$$(1) \qquad INV_{it}^{l} = \alpha_i + \delta_t + \beta \cdot RE\ Value_{it} + \gamma P_t^l + controls_{it} + \epsilon_{it},$$

where INV is the ratio of investment to lagged PPE, $RE\ Value_{it}$ is the ratio of the market value of real estate assets in year t to lagged PPE, and P_t^l controls for the level of prices in location l (state or MSA) in year t.

The interpretation of this reduced form equation is based on a simple model of investment under collateral constraint.[17] In the presence of financing constraints, at least a fraction of firms will use their pledgeable assets as collateral to finance their investment. A constrained firm will borrow a fraction the collateral value of all its pledgeable assets. Conditional on not defaulting on its debt at the end of a period, a firm will repay its debt and then use its collateral again to finance investment in the subsequent period. This model justifies our choice of regressing the annual investment of a firm on the current market value of its entire stock of real estate assets. The coefficient $\hat{\beta}$ is a composite measure of the fraction of firms in the sample that face financing constraints, the severity of these financing constraints, and the fraction of the value of real estate assets that can be used as collateral. If some firms face financing constraints, the coefficient $\hat{\beta}$ will be positive. In a reduced form, this coefficient $\hat{\beta}$ measures, for the average firm in the sample, the fraction of its collateral that can be used to finance investment.

Following the guidance of the theory, and as is typically done in the reduced-form investment literature, we control for the ratio of cash flows to PPE and the one year lagged market to book value of assets. The theory predicts that while the reduced form coefficient $\hat{\beta}$ should be larger in the absence of a control for the market value of the firm, it should still be positive provided there is a sufficient fraction of constrained firms in the sample.[18] We also include a firm fixed effect α_i, as well as year fixed effects δ_t, designed to capture aggregate specific investment shocks, i.e., fluctuations in the global economy. Finally, the variable P_t^l controls for the overall impact of the real estate cycle on investment, irrespective of whether a firm owns real estate or not. Shocks ϵ_{it} are clustered at the State/MSA $\times$ year level. This correlation structure is conservative given that the explanatory variable of interest $\mathit{RE\ Value}_{it}$ is defined at the firm level (see Bertrand, Duflo, and Mullainathan 2004).

As noted in Section IA, the market value of the entire real estate portfolio of a firm can be estimated only before 1993, which is the last year for which accumulated depreciations on buildings are available. $\mathit{RE\ Value}_{i1993}$ is thus defined as the initial market value of a firm's real estate assets, and subsequent variations in $\mathit{RE\ Value}_{it}$ capture fluctuations in the market values of these specific assets.[19]

Let us also highlight that the coefficient β measures how a firm's investment responds to each additional \$1 of real estate *the firm actually owns*, and not how investment responds to real estate shocks overall. This specification allows us to abstract from state-specific shocks that would affect firms both with and without real estate assets.

[17] In the working paper version Chaney, Sraer, and Thesmar (2009), we develop a simple model of investment under collateral constraint to justify this specification.

[18] Formally, if the estimated coefficient $\hat{\beta}$ is positive after controlling for the market value of a firm, we can reject the assumption that firms do not face any financing constraint, while if the estimated coefficient $\hat{\beta}$ is negative, we cannot reject this assumption.

[19] Using only the initial value of real estate in 1993 offers an additional advantage: if a firm discovers a profitable investment opportunity, and if it leases some of its real estate, we may expect that its landlord will try to extract as much rent as possible from this future investment; to escape from this hold-up problem, we may expect this firm to become owner of its real estate exactly when it is about to invest; in such a scenario, we would then see a spurious correlation between the current value of the real estate a firm owns and its investment. We circumvent this problem by using variations in the value of real estate that come only from market prices, and not from the contemporaneous strategy of the firm.

Endogeneity Issues.—There are two potential sources of endogeneity in the estimation of equation 1: (i) real estate prices could be correlated with investment opportunities and (ii) the ownership decision could be related with investment opportunities.

There are two immediate reasons why real estate prices could be correlated with investment opportunities. The first one is a simple reverse causality argument: large firms might have a nonnegligible impact through the demand for local labor and locally produced intermediates on the local activity, so that an increase in investment for such large land-holding firms could trigger a real estate price appreciation. This would lead us to overestimate β. Second, it could be that our measure of real estate prices proxies for local demand shocks, and that land-holding firms are more sensitive to local demand.

To address this source of endogeneity, we instrument MSA-level real estate prices. As already mentioned in Section IB, and following Himmelberg, Mayer, and Sinai (2005) and Mian and Sufi (2011), we do so by interacting local housing elasticities with aggregate shifts in the interest rate. When interest rates decrease, the demand for real estate increases. If the local supply of land is very elastic, the increased demand will translate mostly into more construction (more quantity) rather than higher land prices. If the supply of land is very inelastic on the other hand, the increased demand will translate mostly into higher prices rather than more construction. We expect that in MSAs where land supply is more constrained, a drop in interest rate should have a larger impact on real estate prices (our first-stage regression). We thus estimate, for MSA l, at date t, the following equation predicting real estate prices P_t^l:

$$P_t^l = \alpha^l + \delta_t + \gamma \cdot Elasticity^l \times IR_t + u_t^l, \tag{2}$$

where *Elasticity* measures constraints on land supply at the MSA level, *IR* is the nationwide real interest rate at which banks refinance their home loans, α^l is an MSA fixed effect, and δ_t captures macroeconomic fluctuations in real estate prices, from which we want to abstract. The results of this first-stage regression are presented in Table 3.

To further address this concern, we verify in Section IIC that our results are robust to restricting our sample of firms to small firms in large cities. In those cases, we do not expect any individual firm to have a sizable impact on local real estate prices through a general equilibrium feedback.

The second source of endogeneity in the estimation of equation 1 comes from the ownership decision: if firms that are more likely to own real estate are also more sensitive to local demand shocks, we would overestimate β. As a first step in addressing this issue, we control for initial characteristics of firm i, X_i, interacted with real estate prices P_t^m. If those controls identify characteristics that make firm i more likely to own real estate, and if those characteristics also make firm i more sensitive to fluctuations in real estate prices, controlling for the interaction between those controls and the contemporaneous real estate prices allows us to separately identify the collateral channel we are interested in.

The X_i are controls that we believe might play an important role in the ownership decision and include five quintiles of Age, Assets, and Return on Assets as well as two-digit industry dummies and State dummies. We show in Table 4 that these

Table 3—First-Stage Regression: The Impact of Local Housing Supply Elasticity on Housing Prices

	MSA Residential Prices		MSA Office Prices	
	(1)	(2)	(3)	(4)
Local housing supply elasticity mortgage rate	0.028***		0.036***	
	(6.3)		(5)	
First quartile of elasticity mortgage rate		−0.064***		−0.066***
		(−8.9)		(−5.1)
Second quartile of elasticity mortgage rate		−0.046***		−0.033**
		(−6)		(−2)
Third quartile of elasticity mortgage rate		−0.014**		−0.0097
		(−2.2)		(−0.41)
Year dummies	Yes	Yes	Yes	Yes
MSA fixed effect	Yes	Yes	Yes	Yes
Observations	1,358	1,358	804	804
Adjusted R^2	0.94	0.94	0.84	0.84

Notes: This table investigates how local housing supply elasticity, as defined by Saiz (2009), affects real estate prices. The dependent variable is the real estate price index, defined at the MSA level—columns 1 and 2—and the MSA office price index—columns 3 and 4. Columns 1 and 3 use directly the local housing supply elasticity, while columns 2 and 4 use quartiles of the elasticity. All regressions control for year as well as MSA fixed effects and cluster observations at the MSA level. *T*-stats in parentheses.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

characteristics are good predictors of the decision to buy real estate assets and, to a lesser extent, on the amount of real estate purchased. Table 4 is a simple cross-sectional OLS regression of *RE OWNER*, a dummy equal to 1 when the firm owns real estate, and *RE Value*, the market value of the firm's real estate assets, on the initial characteristics mentioned above. Older, larger, and more profitable firms, i.e., mature firms, are more likely to be owners in our dataset.[20]

Controlling for the observed determinants of real estate ownership, we estimate the following reduced form investment equation:

$$INV_{it}^{l} = \alpha_i + \delta_t + \beta \cdot RE\ Value_{it} + \gamma P_t^l + \sum_{\mathrm{k}} \kappa_k \cdot X_k^i \times P_t^l + controls_{it} + \epsilon_{it}. \tag{3}$$

However, some determinants of the land-holding decisions might not be observable, which makes our approach in equation (3) insufficient. Unfortunately, it is difficult to find firm-level instruments that predict real estate ownership. Yet, we can still attempt to empirically measure how different land-holding firms are compared to non–land-holding firms. To do so, we look in Section IIF at the sensitivity of investment to real estate prices for firms that are about to purchase a property, but

[20] Note that, from an intuitive perspective, these firms seem to be more likely to be insulated from local demand shocks. This suggests that the hypothesis according to which land-holding firms are *inherently* more likely to be affected by local demand shocks is not the most likely a priori.

TABLE 4—DETERMINANTS OF REAL ESTATE OWNERSHIP

	RE OWNER (1)	RE Value (state) (2)
2nd quintile of asset	0.16***	0.12*
	(7.5)	(1.8)
3rd quintile of asset	0.32***	0.17**
	(14)	(2.5)
4th quintile of asset	0.49***	0.33***
	(20)	(4.4)
5th quintile of asset	0.51***	0.11
	(18)	(1.3)
2nd quintile of ROA	0.13***	0.4***
	(5.6)	(5.8)
3rd quintile of ROA	0.14***	0.25***
	(6)	(3.5)
4th quintile of ROA	0.14***	0.21***
	(5.8)	(3)
5th quintile of ROA	0.12***	0.23***
	(5.3)	(3.3)
2nd quintile of age	0.045**	0.017
	(2)	(0.25)
3rd quintile of age	0.12***	0.13**
	(6)	(2.2)
4th quintile of age	0.24***	0.5***
	(11)	(7.7)
5th quintile of age	0.26***	0.92***
	(11)	(13)
Industry fixed effect	Yes	Yes
State fixed effect	Yes	Yes
Observations	2,782	2,782
Adjusted R^2	0.54	0.24

Notes: This table shows the determinant of Real Estate Ownership in 1993. The dependent variable is *RE OWNER* (column 1), a dummy indicating whether the firm reports any real estate asset on its balance sheet in 1993 and RE Value (column 2), the market value of real estate assets in 1993. Control variables include five quintiles of Asset, Age, ROA, as well as Industry and State fixed effects. *T*-stats in parentheses.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

before the purchase. If the unobserved characteristics that codetermine investment and ownership are time invariant, then it should be the case that firms that are about to purchase real estate assets are already more sensitive to the real estate cycle. Section IIF shows that this is not the case and describes the implementation of this test in greater detail. We insist, however, that while suggestive, this approach is by no means definitive, as the unobserved heterogeneity could well vary with time.

B. *Main Results*

Table 5 reports estimates of various specifications of equations (1) and (3). Column 1 starts with the simplest estimation of equation (1) without any additional controls. Land-holding firms increase their investment more than

Table 5—Real Estate Prices and Investment Behavior

	Capital expenditure							
	(OLS)	(OLS)	(OLS)	(OLS)	(OLS)	(IV)	(OLS)	(IV)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RE Value (State Res. Prices)	0.074***	0.065***	0.052***					
	(15)	(13)	(11)					
RE Value (MSA Res. Prices)				0.053***				
				(11)				
RE Value (MSA O. Prices)					0.06***	0.062***		
					(8.9)	(5.5)		
RE OWNER × MSA O. Prices							0.21***	0.44***
							(3.3)	(2.75)
State Res. Prices	−0.11*	−0.91**	−0.46					
	(−1.8)	(−2)	(−1.2)					
MSA Res. Prices				−0.58				
				(−1.3)				
MSA O. Prices					0.25	0.22	0.062	0.2
					(0.27)	(0.09)	(0.065)	(0.075)
Cash			0.027***	0.027***	0.026***	0.026***	0.026***	0.026***
			(8.4)	(8.9)	(7.5)	(3.8)	(7.5)	(4.4)
Market/Book			0.068***	0.068***	0.071***	0.07***	0.072***	0.071***
			(20)	(20)	(19)	(10.1)	(19)	(11.3)
Init. Controls × State Res. Prices	No	Yes	Yes	No	No	No	No	No
Init. Controls × MSA Res. Prices	No	No	No	Yes	No	No	No	No
Init. Controls × MSA Off. Prices	No	No	No	No	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	27,201	27,026	24,167	22,894	17,805	17,586	18,031	17,731
Adjusted R^2	0.28	0.29	0.33	0.33	0.33	0.33	0.33	0.33

Notes: This table reports the empirical link between the value of real estate assets and investment. The dependent variable is capital expenditure (item No. 128 normalized by lagged item No. 8). Columns 1, 2, and 3 use the state-level residential price index. Column 4 uses MSA-level residential prices, while columns 5, 6, and 7 use MSA-level office prices. Except for column 1, all regressions control for firm-level initial characteristics (five quintiles of age, asset, and ROA, as well as two-digit industry and state of location) interacted with Real Estate Prices. All regressions, except columns 1 and 2, control for Cash and previous year Market/Book. Columns 6 and 8 present IV estimates where MSA office prices are instrumented using the interaction of real mortgage rate interacted with the local elasticity of land supply taken from Saiz (2010) (see column 3 in Table 3 for the first-stage regressions). All specifications use year and firm fixed effects and cluster observations at the state-year or MSA-year level. In the IV specifications in columns 6 and 8, standard errors are bootstrapped within MSA-year clusters. *T*-stats are in parentheses.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

non–land-holding firms when real estate prices increase. The baseline coefficient is 0.074, so that each additional $1 of real estate collateral increases investment by $0.074. The coefficient is significant at the 1 percent confidence level. The effect is economically large: a one–standard deviation increase in *RE Value* increases investment by 26 percent of investment's standard deviation.[21]

In column 2, we add the initial controls interacted with real estate prices that account for the observed heterogeneity in ownership decisions and its potential impact on the sensitivity of investment to real estate prices. The coefficient is now

[21] Increasing *RE Value* by one standard deviation (1.36) increases *INV* by $0.074 \times 1.36 = 0.10$, which represents 26 percent of investment's standard deviation (0.4).

0.065, still significant at the 1 percent confidence level, somewhat smaller but not statistically different from 0.074 found in column 1.

Column 3 adds state variables traditionally used in estimating investment equations, i.e., Cash and Market to Book. The reduced form sensitivity remains positive but is now smaller, equal to 0.052.[22,23] In other words, a one–standard deviation increase in collateral value explains an 18 percent standard deviation increase in investment once the effect of the Market to Book and the other controls are accounted for. Note that, as is traditional in the investment literature, both Cash and Market to Book have a significant, positive impact on investment.

Column 4 replicates the estimation performed in column 3 using the MSA-level residential price index instead of the state-level index. Using MSA level prices has both advantages and drawbacks. It offers a more precise source of variation in real estate prices. It also makes our identifying assumption that investment opportunities are uncorrelated with variations in local prices milder. However, there are potentially larger measurement errors, as we now rely on the assumption that all the real estate assets that a firm owns are located in the headquarters' city. The results in column 4 show that the coefficient remains stable, at 0.053.

Column 5 uses commercial real estate prices instead of residential prices. The lower number of MSAs with available commercial real estate prices reduces slightly the number of observations (22,894 observations compared to 24,167 in the specification using MSA residential prices). However, the sensitivity remains strongly positive and significant at the 1 percent level and is slightly higher than that computed using residential prices: a \$1 increase in the value of commercial real estate assets leads to an average increase of \$0.06 in investment.

Column 6 implements the IV strategy where real estate prices are instrumented using the interaction of interest rates and local constraints on land supply (see Section IIA). Let us first briefly comment on the first-stage regressions, which are direct estimations of equation 2. These estimations are presented in Table 3. The first two columns predict MSA residential prices, while the two last columns predict MSA office prices. In columns 1 and 3, we directly use the measure of local housing supply elasticity provided in Saiz (2010). In columns 2 and 4, we group MSAs by quartile of local housing supply elasticity.

Low values of local housing supply elasticity correspond to MSAs with very constrained land supply. We expect the positive effect of declining interest rates on prices to be stronger in MSAs with less elastic supply. As expected, the γ coefficient in equation 2 is positive and significant at the 1 percent confidence level. For instance, using the results in column 4, a 100–basis points interest rate decline increases the office price index by 6.6 percentage points more in "constrained" cities (top quartile of the elasticity distribution) than in "unconstrained" cities (bottom quartile). These effects

[22] In particular, in unreported regressions, we see that most of the drop in the sensitivity comes from adding the control for the Market-to-Book ratio and not from adding Cash.

[23] As we explain in our working paper (Chaney, Sraer, and Thesmar 2009), the drop in β once the Market-to-Book ratio is controlled for can easily be interpreted in the light of a simple model of investment with collateral constraints. Intuitively, to leave the Market-to-Book ratio unchanged after a positive shock to the value of the firm's real estate assets, there needs to be a negative shock to unobserved productivity. This negative shock to productivity generates a negative shock to investment. As a consequence, the response of investment to the initial shock in real estate prices will be smaller than it would have been had the Market-to-Book ratio not been controlled for.

are economically large, and significant. All *F*-tests for nullity of the instrument are above 10, which leads us to conclude that these instruments are not weak.

Moving to the second-stage equation, we simply use predicted prices $\widehat{P_t^l}$ from the estimation of equation 2 as an explanatory variable in equation 3.[24] Column 6 in Table 5 reports the result of the estimation when the instrument used in the first stage is the local housing supply elasticity (i.e., column 3 of Table 3). The coefficient estimated from this IV regression is very close to the one obtained from the OLS regression, equals to 0.062 and remains significant at the 1 percent level.

Column 7 tests whether the relation between collateral value and investment found in columns 1–5 depends on the shape of the empirical distribution of collateral values. To do so, we interact the *RE OWNER* dummy (equal to 1 when a firm initially owns some real estate assets) with the real estate price index. The estimated coefficient is positive and strongly significant, indicating that our results are not driven by firms with large real estate holdings. Of course, the interpretation of the coefficient on this dummy specification (*RE OWNER*) is not directly comparable to the one with the continuous variable (*RE Value*). While the 0.06 coefficient in column 5 means that a \$1 increase in the value of a firm's real estate assets translates into a \$0.06 increase in investment, the 0.21 coefficient in column 7 means that on average, for a unit increase in the local price index, a firm that owns at least some real estate increases its investment rate by 21 percentage points more than a firm that does not own real estate. The economic magnitude implied by this dummy specification is very similar to the specification that uses the value of real estate, as in column 5. A one–standard deviation increase in the interaction between the dummy *RE OWNER* and land prices (respectively, *RE Value*) increases investment by 21 percent (respectively, 19 percent) of investments standard deviation.[25]

Column 8 implements the IV strategy on the dummy specification of column 7. In that specification, the sensitivity of investment to real estate prices for owners versus non-owners increases almost twofold, from 0.21 to 0.44. The associated standard error also increases significantly, but the estimated coefficient remains significant at the 1 percent confidence level.

C. *Robustness Checks*

Table 6 provides various robustness checks of the baseline estimation of equation (3) in column 5 of Table 5.

[24] Because we construct our set of predicted prices on a different sample than the sample over which we run our investment regression, we need to adjust our standard errors to account for this predicted regressor. In all our IV specification, we thus report bootstrapped t-stats. The bootstrap has been done as follows: we first draw a random sample with replacement within the sample of MSA-years; we run the first-stage regression on this sample; we then draw another random sample with replacement within the sample of firm-years; to correct for the correlation structure of this sample (MSA-year), this random draw is made at the MSA-year level, and not at the firm-year level (i.e., we randomly draw with replacement a MSA-year and then select all the firms within this MSA-year); we finally run our second-stage regression on this sample. We repeat this procedure 500 times, and the standard error we report corresponds to the empirical distribution of the coefficients estimated.

[25] The coefficient β for the dummy specification in column 7 is 0.21, and one standard deviation of the right-hand side variable *RE Owner* $\times$ MSA office prices is 0.39, so that $0.21 \times 0.39 \approx 0.082$ represents 20.5 percent of investment's standard deviation. (0.40). The coefficient β for the comparable continuous specification in column 5 is 0.06, and one standard deviation of the RHS variable *RE Value* is 1.27, so that $0.06 \times 1.27 \approx 0.076$ represents 19 percent of investment's standard deviation (0.40).

Table 6—Real Estate Prices and Investment Behavior: Robustness Checks

	Before 1999 (1)	After 2000 (2)	Large MSAs small firms (3)	Δ(PPE) − Δ(RE) (4)	3-years mean capex (5)	Ind. − adj. capex (6)	Unrestricted sample (7)	10K info (8)
RE Value	0.08***	0.078***	0.058***	0.03***	0.088***	0.061***		
(MSA O. Prices)	(6.1)	(5.6)	(5.7)	(4.1)	(12)	(9.2)		
RE OWNER × MSA O. Prices							0.23***	0.17***
							(2.9)	(3.2)
MSA O. Prices	−1.1	0.81	0.12	−0.56	−0.72	0.33	0.99	2.9
	(−0.98)	(1)	(0.21)	(−0.58)	(−0.36)	(0.37)	(0.66)	(1.6)
Cash	0.029***	0.02***	0.022***	0.022***	0.042***	0.025***	0.016***	0.017***
	(5.5)	(3.6)	(4.7)	(6.8)	(12)	(7.3)	(5.5)	(5.1)
Market/Book	0.079***	0.058***	0.061***	0.061***	0.069***	0.068***	0.087***	0.069***
	(15)	(8.5)	(12)	(18)	(17)	(18)	(25)	(21)
Init. controls × MSA O. Prices	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11,440	6,365	9,282	15,691	14,384	17,782	19,886	17,558
Adjusted R^2	0.37	0.32	0.28	0.19	0.49	0.27	0.33	0.28

Notes: This table tests the robustness of the link between the value of real estate assets and investment. The baseline regression is column 5 of Table 5. Columns 1 and 2 report regression results for two subperiods: 1993–1999 (column 1) and 2000–2007 (column 2). Column 3 restricts the sample to firms in the bottom three quartiles of size and in the top 20 MSAs. Column 4 uses as a dependent variable variations in PPE minus variations in real estate assets normalized by lagged PPE. Column 5 uses as dependent variable the average capital expenditure over the next three years normalized by lagged PPE. Column 6 uses capital expenditure minus the yearly average capital expenditure in the industry normalized by lagged PPE as a dependent variable. Column 7 uses the dummy variable specification of column 7 in Table 5, but does not restrict the sample to firms present in 1993. Column 8 also uses the dummy variable specification of column 8 in Table 5 but uses headquarter ownership information as reported in the firm's 10K file. All regressions use MSA-level office prices, year and firm fixed effect, control for Cash, previous year Market/Book ratio, and initial controls interacted with MSA-level office prices. Standard errors are clustered at the MSA-year level. *T*-stats are in parentheses.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Columns 1 and 2 reproduce the estimation on two different subsample periods: before 1999 in column 1, and after 2000 in column 2. A potential issue with pooled regressions as the ones presented in Table 5 is that they might conceal a fair amount of heterogeneity in the elasticity over time. For instance, the sensitivity of investment may be different in a growing environment than in a recession. We cannot report yearly estimates, but we reproduce the estimation of equation (3) on two different subperiods, 1993–2000 and 2000–2007. The estimated coefficients are significant in both subperiods. The estimated coefficient β is only marginally higher before 1999 than after 2000 (0.08 versus 0.078), and not statistically different. Neither the significance nor the magnitude of the coefficient of interest seems to come from some particular years in our sample.

Column 3 estimates equation 3 on a subsample of small firms in large MSAs. This specification addresses the concern of reverse causality, whereby a large firm's investment may increase local real estate prices. We consider only firms in the lower three quartiles of size, and in the largest 20 MSAs. The estimated coefficient remains significant at the 1 percent confidence level and is only marginally smaller than, but not statistically different from, the coefficient estimated on the entire sample (0.058 compared to 0.06).

Column 4 uses as a dependent variable variations in PPE net of variations in real estate assets. One possible concern may be that investment includes investment in real estate assets. If a firm were to systematically acquire real estate assets when real estate prices increase, and all the more so if that firm already owns more real estate, one would mechanically find a positive and significant β coefficient.[26] Removing any acquisition or sales of real estate from investment addresses this concern. The estimated coefficient remains large and significant at the 1 percent level.[27]

Column 5 uses as a dependent variable the average investment over the subsequent three years, and not the investment over a single year. One may expect that in the presence of collateral constraints, the renegotiation of debt contract with lenders following an appreciation of a firm's real estate may be gradual. As expected, the coefficient increases from \$0.06 to \$0.088, implying that each additional \$1 of collateral leads to an average increase in yearly investment of 8.8 cents over the next three following years. This coefficient is directly comparable to Gan (2007), who also uses the average investment over the subsequent three years as a dependent variable. She finds an 0.8 percentage point decrease in investment for a 10 percent drop in real estate value while the corresponding figure in our setting is 0.88.[28]

Column 6 uses as dependent variable the investment of firm i adjusted for the overall investment of firms in i's two-digit SIC code. Such a specification addresses the concern that investment may be concentrated in specific sectors where firms tend to own their real estate, and that those sectors may have been concentrated in areas that experienced large real estate price inflation. The coefficient of interest remains unchanged at \$0.061 of investment per \$1 of collateral and remains significant at the 1 percent level.

Column 7 uses the entire sample of firms, without restricting our attention to firms that were present in our sample in 1993. This specification addresses the possible concern that selection and survivorship bias may lead to biased estimates. Of course, as explained in Section IA, the information on the accumulated depreciation on buildings that we use to construct the market value of real estate assets is not available beyond 1993. For firms that enter our dataset after 1993, we know only the book value of their real estate assets but cannot infer their market value. We therefore estimate the dummy specification of equation 3. The results of this regression in column 7 of Table 6 are to be compared to the similar regression in column 7 of Table 5. The coefficient of interest is unchanged (0.23 compared to 0.21) and remains statistically significant at the 1 percent level in this unrestricted sample.

Column 8 uses the information on whether a firm actually owns its headquarters directly from the 10K files for the year 1997.[29] The collection of this data is described in Section IC. Unfortunately, the 10K files do not provide us with information on the value of a firm's real estate, but only on whether a firm owns its headquarters or not.

[26] In unreported regressions, we verify directly that firms do not seem to follow such a strategy for their acquisition of real estate.

[27] Note that yearly variations in PPE are not directly comparable to investment, as they do not account for the depreciation of physical capital. We use as a dependent variable the difference between changes in PPE and changes in real estate assets, which are comparable to each other. This further addresses the concern that the value of different types of assets may be reevaluated differently.

[28] Gan (2007) measures the response of the average investment over the period 1994–1998 to the collapse in land prices in 1989.

[29] 10K files become available only in 1997.

We therefore estimate the same dummy specification of equation (3) as in column 7 of Table 5 or column 7 of Table 6. The coefficient of interest drops somewhat from 0.23 to 0.17, but it remains significant at the 1 percent level.

Finally, we also estimated all the regressions presented in Table 6 implementing the IV strategy where real estate prices are instrumented on the interaction of interest rates and local constraints on land supply (see Section IIA). The results are essentially unchanged.[30]

D. *Heterogeneous Responses: Ex Ante Credit Constraints*

As pointed out in a different context by Kaplan and Zingales (1997), it is unclear a priori that the sensitivity of investment to collateral value should be increasing with the extent of credit constraints. This remains ultimately an empirical question, which we answer using three different ex ante measures of credit constraints based on: (i) dividend payments (ii) firm size and (iii) credit rating. Those measures are defined in Section IA. We estimate equation (3) separately for "constrained" and "unconstrained" firms.

As reported in Table 7, there is a strong cross-sectional heterogeneity in the response of investment to balance sheet shocks. The sensitivity of investment to collateral value is on average twice as large in the group of "constrained" firms relative to the group of "unconstrained" firms. For instance, the coefficient β for firms in the bottom 3 deciles of the size distribution is 0.091 compared to 0.042 for the firms in the top 3 deciles. The difference between these two coefficients is significant at the 1 percent level for all three measures of credit constraints.

Here again, the results are similar when instrumenting real estate prices using the interaction of interest rates and local constraints on land supply.[31]

E. *Collateral and Debt*

In this section, we try to explore the channel through which firms are able to convert capital gains on real estate assets into further investment. In unreported regressions, we investigate whether firms, when confronted with an increase in the value of their real estate assets, are more likely to sell them and cash out the capital gains. We do not find it to be the case. This implies that outside financing has to increase to explain the observed increase in investment. Standard theories of investment with collateral constraints (as, e.g., in Hart and Moore 1994) would predict that collateral value leads to more or larger issues of new debt, secured on the appreciated value of land holdings.

Table 8 reports results of the effect of an increase in land value on debt issues, using COMPUSTAT data. To simplify interpretation, we remove the Cash and Market/Book controls from equation (3) and replace investment on the right-hand side with debt issues and debt repayments:

$$DebtIssues_{it}^{l} = \alpha_i + \delta_t^l + \beta \cdot RE\,Value_{it} + \epsilon_{it}^{l}. \tag{4}$$

[30] The results from the IV estimations are available from the authors upon request.
[31] The results from the IV estimations are available from the authors upon request.

Table 7—Real Estate Prices and Investment Behavior: "Constrained" versus "Unconstrained" Firms

	Capital expenditure					
	Payout policy		Firm size		Bond ratings	
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
RE Value	0.084***	0.043***	0.091***	0.042***	0.073***	0.03***
(MSA Office Prices)	(7.2)	(4.1)	(6.1)	(4.4)	(7.2)	(3.6)
	(7)	(4.3)	(5.9)	(4.6)	(7.2)	(3.7)
MSA Office Prices	−0.22	0.18	−6.2	−0.51	−0.14	−1.9
	(−0.084)	(0.16)	(−0.71)	(−0.51)	(−0.087)	(−1)
Cash	0.02***	0.055***	0.014***	0.08***	0.026***	0.055***
	(4.5)	(6.1)	(2.7)	(5.7)	(5)	(3.2)
Market/Book	0.069***	0.06***	0.057***	0.055***	0.075***	0.064***
	(13)	(8.3)	(11)	(7.4)	(13)	(5.8)
Initial controls × MSA Office Prices	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Test "Const. = Unconst."	3.16***		3.01***		3.14***	
Observations	8,879	6,090	5,846	4,535	10,409	3,208
Adjusted R^2	0.29	0.48	0.18	0.66	0.32	0.6

Notes: This table differentiates the results of column 5 in Table 5 according to ex ante measures of credit constraints. The dependent variable is capital expenditure (item No. 128 normalized by lagged item No. 8). RE Value (MSA Office Prices) is the market value of real estate assets normalized by lagged PPE. All regressions control for firm-level initial characteristics (five quintiles of Age, Asset, and ROA as well as initial two-digit industry and state of location) interacted with Real Estate Prices, as well as for Cash and previous year Market/Book. Constraint category assignments use ex ante criteria based on firm dividend payout (columns 1 and 2), size (columns 3 and 4), and bond ratings (columns 5 and 6). Test "Const. = Unconst." is a *t*-test of equality of the RE Value coefficients between the constrained and the unconstrained firms. All specifications use year and firm fixed effect and cluster observations at the MSA-year level. *T*-stats in parentheses.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

To obtain estimates comparable to investment results, our debt issues variables are normalized by lagged tangible fixed assets (PPE). Thus, the results obtained when estimating equation (4) should be compared with the coefficient β derived in column 2 of Table 5, i.e., 0.067.

The results are presented in Table 8. Columns 1 and 2 look at the inflows and outflows of debt. We find that land-holding firms make larger debt issuances and repayments when the value of their real estate increases. A \$1 increase in collateral value increases debt issues by \$0.095 and debt repayments by \$0.05. The difference between the two, i.e., net debt issues as presented in column 3, increases by \$0.032, in a range similar to the observed increase in investment. The fact that *both* repayment *and* issues increase when collateral value increases suggests that firms take advantage of the appreciated value of their collateral to renegotiate former debt contracts, reimbursing former loans and issuing new, cheaper ones. If this were the case, the marginal interest rates of companies with increasing collateral value should decrease. Unfortunately, COMPUSTAT reports only a noisy measure of average interest rates, preventing us from testing this natural interpretation of the results. Doing so would require the use of an alternative source of data. A potential worry with results in columns 1 to 3 is that flows data (i.e., issuances and repayments) are of a lower quality than stock data (i.e., the level of long-term debt). Column 4 confirms the robustness of these results by

TABLE 8—REAL ESTATE PRICES AND DEBT ISSUES

	Debt issues (1)	Debt repayment (2)	Net debt issues (3)	Changes in long-term debt (4)	Changes in current debt (5)
RE Value (MSA Office Prices)	0.095***	0.05***	0.032***	0.044***	0.0034
	(5.5)	(5)	(3.5)	(5.6)	(1.2)
MSA Office Prices	3.1	2.5	0.12	0.048	0.56*
	(0.94)	(0.83)	(0.23)	(0.069)	(2)
Initial controls × MSA Office Prices	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	19,375	19,691	18,952	20,138	20,210
Adjusted R^2	0.3	0.36	0.096	–0.0069	0.012

Notes: This table reports the relationship between collateral value and capital structure. The dependent variable is Debt Issues (column 1), Debt Repayment (column 2), Net Debt Issues (column 3), Changes in Long-Term Debt (column 4), and Changes in Current Debt (column 5). RE Value (MSA Office Prices) is the market value of real estate assets computed using MSA-level office prices normalized by lagged PPE. All regressions control for firm-level initial characteristics (five quintiles of Age, Asset, and ROA as well as initial two-digit industry and state of location) interacted with Real Estate Prices. All specifications use year and firm fixed effect and cluster observations at the MSA-year level. *T*-stats are in parentheses.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

looking at yearly variations in the stock of long-term debt. The reported coefficient (0.044) is similar to that in column 3.

On the short-term liability side, lines of credits might be easier to obtain when secured on valuable collateral. However, we observe only a small, positive and slightly significant net increase in short term debts, with a coefficient of \$0.0034 per \$1. Borrowers are more likely to use longer-term liabilities to finance their additional investment.

The results are similar when instrumenting real estate prices using the interaction of interest rates and local constraints on land supply.[32]

F. *Are Real Estate Purchasers Different from Nonpurchasers?*

The decision by firms to own real estate assets on their balance sheet is not random. This can introduce a bias in the various regressions we have presented so far. For instance, if firms with more cyclical strategies were to own their real estate properties—for a reason we do not model here—the estimated β would be upward biased.

In this section, we show that our results are robust to assuming a time-invariant unobserved heterogeneity across firms that would affect both the real estate ownership and the sensitivity of investment to real estate prices. Our test consists in estimating the sensitivity of investment to real estate prices for firms that purchase a property both before and after this acquisition. We find that, *before* the acquisition, future owners are

[32] The results from the IV estimations are available from the authors upon request.

statistically indistinguishable from firms that never own real estate. Yet, these firms behave like other real-estate holding firms *after* they acquire their properties.

To implement this idea we do not rely on the market value of the real estate assets, but only on whether firms own real estate or not. This allows us to work with a larger sample, as we do not require information on buildings depreciations. These results are to be compared to the dummy specification presented in column 7 of Table 5.

We start with a sample of all COMPUSTAT firms that are not in the Finance, Insurance, Real Estate, Construction, or Mining Industries, that are not involved in major takeovers, and that have at least three consecutive years of appearance in the data. The sample period is 1984 to 2007, 1984 being the year when information on real estate assets starts being available in COMPUSTAT. We define a firm as a purchaser if it has initially no positive real estate assets on its balance sheet and strictly positive real estate assets after some date. When a firm moves more than once between 0 and positive real estate assets, we retain only the first acquisition in our sample). We require that the firm has at least two years of available data before and after the purchase of the real estate asset to be included in the sample. We end up with a sample of 367 purchasers and 4,136 purchaser-year observations, with purchasing date ranging from 1986 to 2005. The number of purchaser-year observations *before* the purchase is 2,144. The group of nonpurchasers is defined as those firms that report no real estate assets from 1984 to 2007 in COMPUSTAT. This leaves us with a sample of 2,751 firms and 16,011 firm-year observations for nonpurchaser.

We first estimate equation (1) separately for nonpurchasers and for purchasers *before* the purchase of land. The results are presented in Table 9, columns 1 and 2. If anything, purchasers have, prior to acquiring real estate, a lower sensitivity of investment to real estate prices than nonpurchasers. More importantly, neither sensitivities nor the difference between these two sensitivities are statistically different from 0. Future owners are statistically indistinguishable from non-owners before they acquire land. The data reject the existence of a time-invariant unobserved heterogeneity that would simultaneously affect real estate ownership and investment sensitivity to the local real estate cycle. However, we emphasize again that this does not imply that the decision to own land is exogenous: firms could decide to buy real estate anticipating that their investment opportunities will be more correlated with the local real estate cycle, creating a bias in the estimation.

The sample of purchasers also allows us to confirm the findings in Section IIB by investigating the *within* dimension of the data. In order to do so, we also estimate equation (1) for purchasers *after* they acquire real estate assets. The results are presented in column 3 of Table 9. The sensitivity of investment to real estate prices is 0.38 for purchasers once they become land holders, and it is significant at the 5 percent level. Relative to column 2, we see that purchasing real estate is associated with a 0.64 increase in the sensitivity of investment to real estate prices. This difference is significant at the 2 percent level. This difference between owners and non-owners is larger but not statistically different from the comparable coefficient (0.21) in column 7 of Table 5.[33]

[33] As the estimation corresponds to a specification with a *RE OWNER* dummy variable, the natural benchmark is that of column 7 in Table 5.

TABLE 9—REAL ESTATE PRICES AND INVESTMENT: THE CASE OF PURCHASERS

	Capital expenditure			Changes in long-term debt		
	Non-purchaser (1)	Purchaser before the purchase (2)	Purchaser after the purchase (3)	Non-purchaser (4)	Purchaser before the purchase (5)	Purchaser after the purchase (6)
MSA Office Prices	0.015	−0.26	0.38**	0.04	−0.29	0.64***
	(0.23)	(−1.3)	(2)	(0.7)	(−1.4)	(2.7)
Cash	0.018***	0.033***	0.032**	−0.005**	0.0012	0.0012
	(6.6)	(3.4)	(2.3)	(−2.1)	(0.16)	(0.081)
Market/Book	0.074***	0.072***	0.071***	0.016***	0.012	0.041***
	(23)	(7.2)	(6.2)	(6.1)	(1.5)	(4)
Test "Purch. = Non Purch."	1.36			1.58		
Test "Purch. before = Purch. after"		2.40**			3.11**	
Observations	15,794	1,651	1,794	15,956	1,659	1,797
Adjusted R^2	0.36	0.47	0.44	0.16	0.24	0.21

Notes: This table compares the investment behavior of non–land-holding Corporations, and of real estate purchasers before and after their acquisition of land. Capital Expenditure, normalized by lagged PPE, is the dependent variable in columns 1 to 3; Changes in Long-Term Debt, normalized by lagged PPE, is the dependent variable in columns 4 to 6. Columns 1 and 3 look at the sensitivity of investment and debt issues to MSA Office Prices for firms that never own real estate assets in our sample. Columns 2 and 4 look at the same sensitivities for firms that will acquire real estate but before they acquire it. Columns 3 and 6 estimate the same sensitivities for real estate purchasers, but after they have purchased their real estate assets. Test "Purch. = Non Purch." presents the p-value from a t-test of equality of the MSA Office Prices coefficients between the non-purchasers and the purchasers before the purchase. Test "Purch. before = Purch. after" presents the p-value from a t-test of equality of the MSA Office Prices coefficients between the purchasers before and after the purchase. All specifications control for Cash and previous year Market to Book, use year and firm fixed effects and cluster observations at the state-year level. T-stats in parentheses.
***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Columns 4, 5, and 6 of Table 9 run the same regressions as in columns 1, 2, and 3 using variations in long-term debt as a dependent variable. The sensitivity of debt issues to local real estate prices for land-holding firms is not significantly different from that of future owners *before* they purchase their real estate assets (columns 4 and 5). Debt issues become significantly more sensitive to local real estate prices *after* firms acquire land (column 6). Overall, the analysis in this section confirms that our main results on investment and debt issuance do not seem to be caused by a time-invariant unobserved heterogeneity that would simultaneously affect real estate ownership and investment or debt sensitivity to the local real estate.

G. *A Closer Look at the Real Estate Bubble*

In this section, we investigate the impact of the recent surge of real estate prices between 2002 and 2006 on corporate investment. This allows us to (i) further test the robustness of our results, (ii) reduce the extent of measurement errors, and (iii) provide a simple illustration of the methodology used in this paper. This section follows closely the methodology outlined in Mian and Sufi (2011) and is similar in spirit to that in Gan (2007).

We divide the sample between MSAs with high and low local housing supply elasticity (fourth versus first quartile), and between firms owning versus renting real estate. In order to reduce the extent of measurement errors (see Section IC), we collected manually information on headquarter ownership in 2000, using

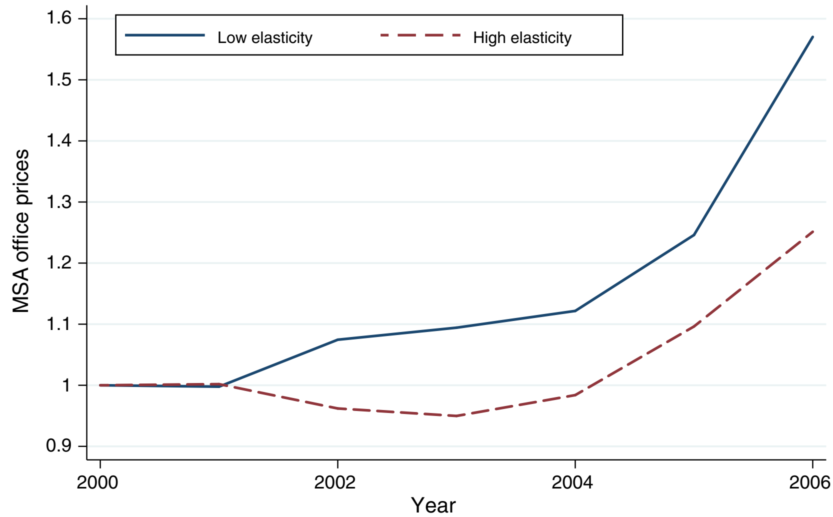

Figure 1. Relative Evolution of Office Prices (High versus Low Elasticity MSA, 2000–2006)

Note: This figure shows the average office price index (normalized to 1 in 2000) for MSAs in the bottom quartile of land supply elasticity ("Low Elasticity MSA") in a solid line and MSAs in the top quartile of land supply elasticity ("High Elasticity MSA") in a dashed line.

the information reported by firms in the 10K forms filed with the Securities and Exchange Commission.[34] We thus take seriously the claim made in Section IC that headquarters represent a significant fraction of the nonspecific real estate assets held by corporations and restrict the identification on headquarter ownership only. We then simply compare the evolution of investment of headquarters' owners versus renters in cities with high versus low elasticities.

Figure 1 shows the evolution of office prices from 2000 to 2006 for MSAs with high and low local housing supply elasticity. It confirms that, while the boom in real estate prices was more dramatic for the residential market, it also affected commercial prices. Low elasticity MSAs experienced a much larger increase in office prices than high elasticity MSAs: from 2000 to 2006, office prices increased by 59 percent for low elasticity MSAs, while they increased only by 24 percent for high elasticity MSAs. Figure 2 implements our methodology looking at the cumulative sum of capital expenditures relative to initial asset over the period. In low elasticity MSAs, the ratio of accumulated CAPEX over the 2000–2006 period relative to initial PPE (solid line) ended up 40 percentage points higher than that of firms renting their headquarters. By contrast, in high elasticity MSAs, there is no sizable difference in the evolution of capital expenditures of firms owning their headquarters relative to firms renting them (dashed line). If anything, owners saw a smaller increase in capital expenditure than renters. Figure 3 leads to similar conclusions on long-term debt: firms owning their headquarters in low elasticity MSAs took advantage of the real

[34] Information on headquarter ownership is inferred from Item 2 of the 10K file, which lists the properties owned or leased by the firm.

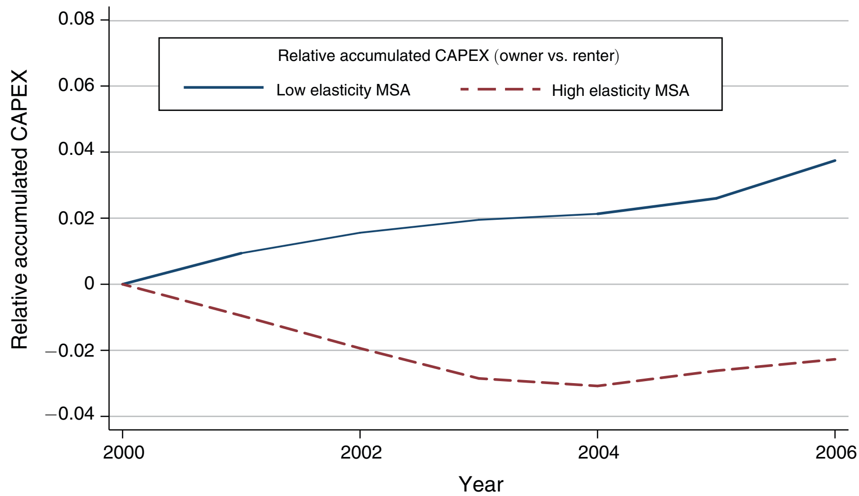

Figure 2. Relative Evolution of Accumulated CAPEX (Owners versus Renters, 2000–2006)

Notes: This figure shows, for each year between 2000 and 2006, the difference between the average accumulated CAPEX of headquarter owners minus the average accumulated CAPEX of headquarter renters, for MSAs in the bottom quartile of land supply elasticity ("Low Elasticity MSA") in solid and MSAs in the top quartile of land supply elasticity ("High Elasticity MSA") in dashed lines. Accumulated CAPEX is defined as 0 in 2000, and then as the sum of all CAPEX made by the firm between 2000 and the current year, normalized by assets in 2000.

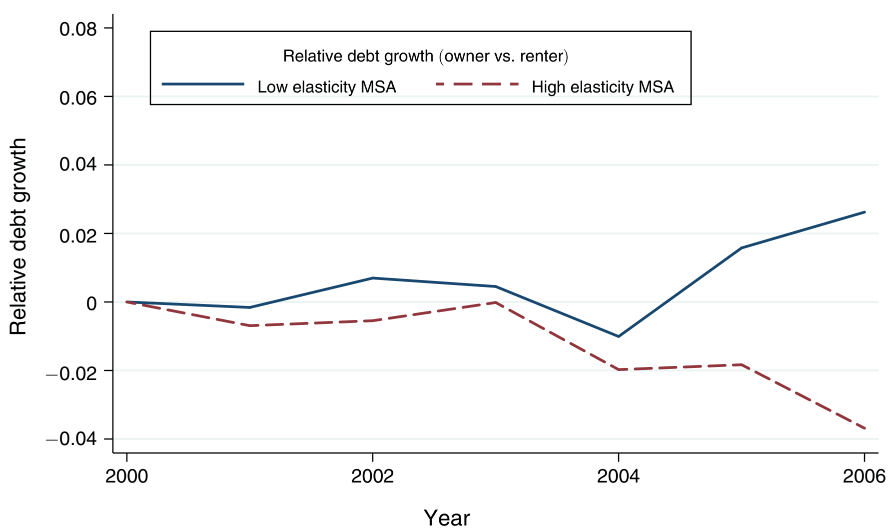

Figure 3. Relative Evolution of Aggregate Debt (Owners versus Renters, 2000–2006)

Notes: This figure shows, for each year between 2000 and 2006, the difference between the total debt growth of headquarter owners minus total debt growth of headquarter renters, for MSAs in the bottom quartile of land supply elasticity ("Low Elasticity MSA") in solid and MSAs in the top quartile of land supply elasticity ("High Elasticity MSA") in dashed lines. Debt growth is defined as 0 in 2000, and then as long term growth between 2000 and the current year, normalized by assets in 2000.

Table 10—Headquarter Ownership and the Impact of the Real Estate Bubble

	Accumulated capex				Changes in total debt			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Headquarter owner × Δ(office prices) 2000–2006	0.18**				0.075*			
	(2.3)				(1.8)			
Headquarter owner × elasticity		−0.092**	−0.1***			−0.043**	−0.044**	
		(−2.6)	(−2.8)			(−2.5)	(−2.6)	
Headquarter owner × second quartile of elasticity				−0.0025				0.0017
				(−0.038)				(0.057)
Headquarter owner × third quartile of elasticity				−0.021				−0.0045
				(−0.32)				(−0.11)
Headquarter owner × fourth quartile of elasticity				−0.12*				−0.063**
				(−1.8)				(−2.1)
Elasticity		0.08***	0.086***			0.006	0.0069	
		(2.8)	(3.1)			(0.7)	(0.82)	
Δ(office prices) 2000–2006	−0.024				0.032			
	(−0.45)				(1.4)			
Second quartile of elasticity				0.0082				−0.012
				(0.39)				(−0.69)
Third quartile of elasticity				0.042				−0.0091
				(1.3)				(−0.83)
Fourth quartile of elasticity				0.12***				0.0091
				(2.6)				(0.8)
Log (assets2000)			−0.02***	−0.02***			−0.0035	−0.0032
			(−3.4)	(−3.4)			(−1.2)	(−1.2)
Observations	1,696	1,794	1,794	1,794	1,772	1,870	1,870	1,870
Adjusted R^2	0.002	0.0091	0.019	0.017	0.0049	0.0023	0.0035	0.004

Notes: This table explores the impact of the real estate bubble from 2000 to 2006, depending on headquarter ownership as reported in the 10k files. Columns 1 to 4 use accumulated capital expenditures normalized by initial assets as a dependent variable. Columns 5 to 8 use changes in total debt normalized by initial assets as a dependent variable. Elasticity refers to local housing supply elasticity provided in Saiz (2010). Observations are clustered at the MSA Level. *T*-stats are in parenthesis.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

estate price boom to increase their stock of debt relative to firms in similar MSAs but renting headquarters (solid line) and relative to MSAs where the bubble did not have a large impact on office prices (dashed line).

Table 10 confirms this graphical evidence using firm-level regressions. We adopt a long-run difference-in-differences strategy and estimate the following equation:

$$(5)\qquad \frac{CAPEX_{im}^{00\text{–}06}}{Assets_{im}^{00}} = \alpha_m + \beta\,\frac{\Delta(Office\ Price)_m^{00\text{–}06}}{Office\ Price_m^{00}} \times Headquarters_i + \gamma\,\frac{\Delta(Office\ Price)_m^{00\text{–}06}}{Office\ Price_m^{00}} + \epsilon_{im},$$

where $\frac{CAPEX_{im}^{00\text{–}06}}{Assets_{im}^{00}}$ is firm i accumulated capital expenditure from 2000 to 2006, normalized by assets in 2000, $\frac{\Delta(Office\ Price)_m^{00\text{–}06}}{Office\ Price_m^{00\text{–}06}}$ is MSA m office price growth from 2000 to 2006, and $Headquarters_i$ is a dummy equal to 1 if firm i owns its headquarters in 2000, as reported in its 10K file.

The results from this dummy specification using the information from the 10K files are to be compared to column 8 of Table 6.

Column 1 in Table 10 directly estimates equation (5). The results from this dummy specification using the information from the 10K files are to be compared to column 8 of Table 6. Over the period 2000–2006, and in response to a 10 percent real estate price increase, a firm that owns its headquarters will increase its investment rate by 1.8 percentage points compared to a firm that rents its headquarters. The magnitude of this effect is similar to the result over the entire sample period 1993–2007 (2.1 percentage point investment rate increase for a 10 percent price appreciation), and somewhat larger than found by Gan (2007) for the burst of the Japanese real estate bubble (0.8 percentage points).

Column 2 replaces the local office price growth by the local housing supply elasticity: this corresponds to the reduced form of an instrumental variable regression where local prices are instrumented by local housing elasticity. As expected, since the higher the local housing elasticity, the lower the increase in local land prices, we find a negative sign on the interaction between housing elasticity and the owner dummy: in MSAs with a high housing elasticity, price increases have been moderate, and there is not much difference in the investment of owners compared to renters; in MSAs with a low housing elasticity, price increases have been dramatic, and owners increase their investment more than renters.

Column 3 augments the previous regression in column 2 by controlling for initial firm size. This is natural, as there is a fair amount of heterogeneity between firms that own versus rent their headquarters.

Column 4 uses quartiles of local housing supply elasticity instead of the elasticity itself.

Finally, columns 5–8 replicate the regressions in columns 1–4, replacing the accumulated investment by the accumulated long term debt $\left(\frac{\Delta Debt_{im}^{00-06}}{Assets_{im}^{00}}\right)$ as the dependent variable.

Overall, the results in Table 10 confirm the analysis of Figures 2 and 3. Firms owning their headquarters experienced a significantly larger growth in assets and long-term debt relative to renters, especially in MSAs where office prices increased a lot, i.e., in MSAs with lower housing supply elasticity. This effect is monotonic in the local housing supply elasticity.

III. Conclusion

When the value of a firm's real estate appreciates by \$1, its investment increases by approximately \$0.06. This investment is financed through additional debt issues. The impact of real estate shocks on investment is stronger when estimated on a group of firms which are more likely to be credit constrained. As we showed in this article, real estate represents a significant fraction of the assets held on the balance sheet of corporations. As a consequence, one could expect the impact of real estate shocks on aggregate investment to be nontrivial. However, this is not necessarily the case in a world where responses to balance sheet shocks are heterogeneous. In particular, small firms respond more than large firms, which attenuates the aggregate impact of credit constraints. Understanding how one can go from the micro estimates we offer in this paper to the macro impact of real estate shocks on investment, and therefore on GDP, remains unclear. We hope to tackle this question in future research.

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