Collateral Shocks and Corporate Employment*

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Abstract

We analyze how firm-level shocks to collateral values influence employment outcomes among U.S. corporations. Using comprehensive employment data from the U.S. Census Bureau, we estimate that employment expenditures increase by $0.10 per $1 increase in firms' real estate collateral values. These effects are stronger among financially constrained firms, and additional hiring is funded through debt issuance, consistent with a collateral channel. This relation holds among firms in tradable goods sectors, alleviating concerns about local demand shocks. Thus, through a collateral lending channel, fluctuations in the U.S. commercial real estate market are an important driver of corporate labor demand.

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Precisely how do firm-level credit constraints come about, how do they interact with economic conditions, and can they have real effects? In an environment with incomplete or unenforceable contracts, firms have limited debt capacity and collateral must be pledged to secure loans (Hart and Moore, 1994).[1] Such collateral-based financing constraints can provide a link between real estate values and factor input use by firms that translate into employment and business cycle fluctuations (Liu et al., 2013). In the wake of a U.S. real estate bust and slow recovery, there has been renewed interest in quantifying the importance of shocks to collateral values for corporate balance sheets, as well as firms' investment and employment decisions. In this paper, we analyze the link between real estate collateral values and corporate employment based on administrative data from the U.S. Census Bureau.

Several distinct economic mechanisms predict that credit constraints can affect firms' costs of financing human capital. For example, if collateral value appreciation allows for external funding of investment, this could also increase employment if they are complementary inputs in the production function. Absent capital-labor complementarities (or capital altogether) in the production process, employment might still depend on external finance and thus directly on changes in collateral values. In particular, employment costs may include an upfront, fixed component associated with hiring or training, and firm-specific investments by workers (Oi, 1962). Furthermore, the unique costs associated with downsizing the labor force—firing costs or sticky wages—can be mitigated when firms better access to finance.[2] Finally, if the cash-flow cycle is mismatched with the timing of operating costs, then the firm may need to pay employees from working capital (Jermann and Quadrini, 2012). Based on such reasoning, we estimate the sensitivity of corporate labor demand to the market value

[1]Berger and Udell (1990) show that 70 percent of all commercial and industrial long-term debt and 30 and 40 percent of short-term loans in the United States are secured, most often by real estate assets.

[2]These costs can increase operating leverage and, potentially, the costs of financial distress (Serfling, 2016). Moreover, deadweight losses in bankruptcy might be transmitted to workers' long-term earnings, necessitating higher upfront compensation (Berk et al., 2010; Graham et al., 2016). In addition, credit constrained firms may find it more costly to hoard labor, since labor hoarding draws on firms' liquidity (Giroud and Mueller, 2017).

of firms' real estate assets.

Hitherto, the role of collateral value on employment has been studied using aggregated (precisely, county-level) data (Adelino et al., 2015). We improve on such prior analysis in two important ways. First, we measure collateral values and employment outcomes at the firm level, allowing for a tighter identification through the use of time-varying firm controls as well as firm fixed effects. Second, our main source of variation is not based on aggregated house prices, as in prior analysis, but on individual values of firms real estate holdings, based on the empirical strategy in Chaney et al. (2012), which uses historical book values of firms real estate holdings inflated with house price indices to obtain market value estimates of firms real estate holding. This gives us confidence that the effects we are documenting come from actual shocks to firms' collateral value and not, for example, from shocks to local consumer demand (which are also correlated with aggregated house prices; see Mian and Sufi, 2014).

We conduct our analysis using establishment-level data from the U.S. Census Bureau, which, crucially, includes complete and reliable information on corporate employment in terms of both the number of employees and expenditures (i.e., payroll).[3] We merge the Census data with balance sheets from Compustat covering publicly traded firms from 1993 until 2006. We thus link administrative data on employment and firms' locations with real estate holdings. We use an instrumental variables (IV) strategy to identify exogenous variation in local real estate prices and thus real estate–owning firms' collateral values. Following Chaney et al. (2012), we instrument for local real estate prices with the interaction of the land supply elasticity at the metropolitan statistical area (MSA) level with nationwide mortgage interest rates. Our approach allows us to control for potential unobserved local economic shocks that may jointly affect real estate prices and the growth opportunities of real estate–owning firms.

[3]The Census employment data are more informative than sources used in prior literature, notably, Compustat, survey data, and hand-collected information on layoff announcements. Our data are complete in terms of coverage, contain information on payroll, and are disaggregated to the establishment level.

We provide micro-evidence that firms increase employment when the market value of their real estate collateral appreciates. On average, firms increase employment expenditures by about $0.10 per $1 increase in the value of their collateral, or about a 15.6 percent increase of the standard deviation of employment. This sizable response results from changes in the number of employees, as opposed to adjustments in the average wage. Consistent with higher collateral values facilitating lending, we show this additional hiring is funded through debt issues and the effects are stronger for firms likely to be financially constrained. Importantly, our findings hold when we focus our attention on industries least likely to be influenced by local demand shocks, namely, firms in tradable industries.

We exploit the unique attributes of the establishment-level data to refine our empirical approach and conduct a more in-depth analysis of these employment effects. We incorporate establishment-level information on the geographical dispersion of operations within firms coupled with previously unexplored data on manufacturing plant ownership. Using these data we, first, more accurately measure collateral value shocks and show our benchmark results are not an artifact of our identification assumption that real estate assets are located in the same MSA as headquarters. Second, since the plant-level real estate ownership data covers private firms, we modify our framework to compare the employment response of private and public firms. Consistent with private firms being more financially constrained, we find that they exhibit a sharper employment response to collateral shocks.

Taken together, our findings show how boom-bust cycles in the U.S. commercial real estate market are an important driver of domestic fluctuations in corporate labor demand. Our evidence therefore lends empirical support to theoretical models showing how credit constraints interact with collateral values to provide a channel to spread and amplify economic shocks (e.g., Liu et al., 2013). It also buttresses prior empirical work, notably, Adelino et al. (2015), who provide evidence for a collateral channel using more aggregated collateral shocks and employment data.

These results relate to at least two strands of the literature. First, research on the real effects of financing frictions. Until recently, this literature has focused on investment; however, an emerging literature examines how financial frictions interact with corporate labor demand. Recent papers focus on the importance of supply-side shocks, including banks' balance sheets. Benmelech et al. (2015) identify the effects on labor at both the firm and U.S. county levels using three quasi-experiments emphasizing constraints on the supply side. Duygan-Bump et al. (2015) document relatively large employment cuts during the recent U.S. financial crisis for small firms from industries with higher financing needs. Similarly, Chodorow-Reich (2014) shows there were significant firm-level employment effects for corporations reliant on credit lines from impaired banks during the crisis (see also, Berton et al., Forthcoming; Popov and Rocholl, Forthcoming).[4] Giroud and Mueller (2017) find that the employment losses in the Great Recession arising from consumer demand shocks—due to household deleveraging, as in Mian et al. (Forthcoming)—were amplified by weak firm balance sheets (high leverage). We shed light on a precise firm balance sheet channel—from collateral values to firm balance sheets (debt capacity) and corporate employment decisions—and document the importance of such collateral constraints using comprehensive firm-level employment measures derived from administrative U.S. Census data.

Second, we contribute to a literature on the real effects of collateral-based lending constraints, specifically real estate collateral. From a theoretical perspective, Kiyotaki and Moore (1997) model the relation between firm collateral shocks and investment. Jermann and Quadrini (2012) show collateral constraints can matter for aggregate investment, and Liu et al. (2013) stress the importance of real estate collateral and land price dynamics for

[4]Several other recent empirical papers examine how debt financing constraints affect employment decisions. Using hand-collected data from the Great Depression, Benmelech et al. (2017) show that limited access to local bank financing accounted for up to one-third of the aggregate decline in employment among large firms during the 1928–1933 period. Falato and Liang (2016) and Agrawal and Matsa (2013) connect reduced financing availability after technical and payment defaults in credit agreements, respectively, to employment cutbacks. Focusing instead on access to public equity capital markets, Borisov et al. (2017) find stronger employment growth among U.S. IPO firms relative to similar firms that remain private.

this relation. On the empirical front, we complement recent work linking exogenous variation in real estate collateral values to U.S. corporate investment; notably, Chaney et al. (2012). Our contribution is to provide evidence of a link between the commercial real estate sector and employment over a relatively normal business cycle. The closest paper is this regard is Adelino et al. (2015), which documents the importance of firms' collateral constraints for business entry and exit rates among U.S. entrepreneurial firms based on aggregated county-level data.[5] We push this line of inquiry forward, by expanding the scope of the analysis and making substantial methodological improvements that allow for precise measurement. In doing so, we show that collateral-based financing constraints matter not only for the smallest entrepreneurs in the economy, but also larger privately held and publicly traded firms that use the increased availability of pledgeable assets to externally fund additional employment.

1 Data and Empirical Methodology

1.1 Data sources

We use firm-level data from Compustat. We start with the sample of firms active in 1993.[6] We then apply the following filters. We drop firms missing total assets. We keep firms headquartered in the United States and exclude those operating in the following industries: finance, insurance, real estate (SIC 60-67), construction (SIC 15-17), and mining (SIC 10-14). Finally, we keep firms with the required data for at least three consecutive years.

The establishment-level data come from the U.S. Census Bureau. The primary data source is the Longitudinal Business Database (LBD), an annual register of all U.S. private-sector places of employment ("establishments") with at least one paid employee. The LBD

[5] Schmalz et al. (2017) show housing wealth matters for start-up entry and success among French entrepreneurs. Corradin and Popov (2015) find similar evidence in the U.S. context based on survey evidence.

[6] This is the last year that the accumulated depreciation of buildings is reported in Compustat. As described in Section 1.2, this item is required to measure the value of real estate assets.

contains longitudinal establishment identifiers as well as data on employment and payroll, industry codes, corporate ownership (used to assign establishments to firms), and, importantly for our purposes, location. Consistent with the standard U.S. statistical agency definition, annual employment is equal to the total number of employees on payroll as of March 12th each year. We retain establishment-years with nonmissing and nonzero employment and payroll data, and with at least two consecutive years of data. We merge Compustat firms to establishments in the LBD via the Compustat-SSEL bridge maintained by the U.S. Census Bureau where possible. When this is not possible (e.g., the bridge ends in 2005), we match via the employer identification number (EIN) along with employer name and address.

Data on manufacturing plants are obtained from the Census of Manufacturers (CMF) and the Annual Survey of Manufacturers (ASM). The CMF covers all U.S. manufacturing establishments ("plants") with at least one paid employee and is conducted every five years in Census years (years ending with either 2 or 7). The ASM covers a subset of CMF plants in non-Census years. This includes plants with greater than 250 employees and a randomly selected subset of smaller plants. The longitudinal establishment identifiers in the LBD are used to merge the CMF and ASM at the plant-level. The CMF and ASM provide similar data to the LBD, but, importantly, the 1992 CMF also provides plant-level data on rental payments and the book value of buildings for the subset of manufacturing plants. We use these data to construct measures of real estate ownership for both public and private firms, for the limited subsample of manufacturing firms.

We obtain data on real estate prices at the MSA level from the Office of Federal Housing Enterprise Oversight (OFHEO). The OFHEO provides price indices of single-family homes in the United States at the MSA level after 1977.[7] We use these real estate price indices to

[7]We use OFHEO residential real estate prices to proxy for commercial real estate prices. The residential prices have the advantage of being available for a greater number of MSAs and for a long time-series, but are less ideal as they do not explicitly consider commercial real estate prices. In practice, the MSA residential and commercial price indices have a correlation equal to +0.42 for our event window (Chaney et al., 2012).

update the value of firms' real estate assets beyond 1993, using information on the location of headquarters from Compustat and establishments from the LBD (see Section 1.2). We match the MSA-level price data to headquarters locations in Compustat using a mapping from Federal Information Processing Standards (FIPS) codes to MSA identifiers provided by the OFHEO.

1.2 Variable construction and summary statistics

Our main dependent variable is the annual dollar change in employment expenditures normalized by lagged plants, property, and equipment (PPE). Employment expenditures are measured using payroll data from the LBD, aggregated to the firm level. We focus on this measure, as it gives a straightforward interpretation of a dollar value increase in employment resulting from a $1 increase in the collateral value of a firm.

We use four alternative measures of the employment decision based on data from the LBD. First, we use the annual change in the number of employees scaled by lagged PPE. Second, we use the annual change in the number of employees divided by one half of the sum of current and lagged employment. This latter measure is the symmetric employment growth rate, which can accommodate both entry and exit as well as being less sensitive to outliers (Davis et al., 1998). Third, we use the average wage growth, defined as the annual change in payroll divided by the number of employees. These different employment measures uncover how firms adjust employment, that is, more employees or wages per employee. Finally, we examine the firm-level growth in the number of establishments to capture adjustments in operations along the extensive margin, i.e., through establishment openings and closures.

We proxy for collateral value using the market value of real estate assets of each firm. Our measurement and construction of the market value of real estate assets follows Chaney et al. (2012). We proceed in two steps. We first measure each firm's value of real estate assets as of 1993 using data from Compustat. Then, we use time-series and geographical variation in real estate prices to isolate changes in these real estate asset values.

To estimate the market value of real estate assets of each firm, we first define real estate assets, *RE Assets*, as buildings (Compustat item FATB), land and improvement (FATC), and construction in progress (FATP). It is important to recognize that Compustat reports real estate asset values at historical cost. Thus, depending on the year when the assets were purchased and the real estate price variation from the year of acquisition to the reporting year, the market value of real estate will likely differ from the recorded book value.

To estimate the market value of real estate for our time horizon (1993–2006), we first estimate its value in 1993. We do so because this is the last year that the accumulated depreciation of buildings (DPACB) is reported in Compustat.[8] To estimate the value in 1993, we estimate the average age since purchase. The ratio of accumulated depreciation of buildings (DPACB) to the historic cost of buildings (FATB) is used to compute the fraction of the initial value of the buildings claimed at depreciation. Then, assuming an average depreciable life of buildings of 40 years, the average age of buildings for a given firm i is calculated as: $Age_{i,1993} = 40 \times \frac{DPACB_{i,1993}}{FATB_{i,1993}}$. The market value of real estate assets in 1993 for firm i located in MSA m is then estimated as:

$$RE\ Value_{i(m),1993} = RE\ Assets_{i(m),1993} \times \frac{RE\ Price\ Index_{m,1993}}{RE\ Price\ Index_{m,1993-Age_{i,1993}}}$$

where $RE\ Price\ Index_{m,t}$ is MSA-level residential real estate prices after 1977 and Consumer Price Index inflation beforehand.

Once we have the market value in 1993, we then calculate the market value of real estate for firm i in year t by multiplying the 1993 value with the MSA-level growth in the residential

[8] Only buildings are depreciated under the U.S. GAAP.

price index from 1993 to t:[9]

$$RE\ Value_{i(m),t} = RE\ Value_{i(m),1993} \times \frac{RE\ Price\ Index_{m,t}}{RE\ Price\ Index_{m,1993}}.$$

Unfortunately, Compustat does not provide information on the location of firms' real estate assets; all we know is their combined value at the firm level. However, Compustat does provide information on the location of firms' headquarters. We therefore proxy for the location of real estate using the headquarters MSA.[10] For this to be a valid approximation, we rely on the following two assumptions. First, headquarters and owned real estate assets are located in the same MSA. Second, firms' headquarters are a large fraction of the value of real estate assets.

To assess these assumptions, we use three approaches. First, we use establishment-level data from the LBD on the locations of firms' operations to form alternative measures of exposure to firm-level real estate shocks. Second, we use data hand-collected from SEC 10-K filings identifying firms that report owning their headquarters.[11] Third, for the subset of manufacturing firms, the CMF provides plant-level data on the book value of buildings and other structures. We use this data to measure the market value of real estate assets at the plant-level and aggregate up to the firm-level. In each case, our results are similar, indicating that our method for calculating the value of real estate assets provides a good-quality approximation.

We use standard firm-level variables commonly used in the financial constraints literature to supplement our main analysis. These variables are described here and precisely defined in Appendix A. To account for observable differences among firms in our regressions, we

[9]When measuring real estate assets, we ignore the sales and purchases of real estate post-1993. This mitigates potential endogeneity concerns, since real estate acquisitions may reflect better firm-level investment opportunities. The trade-off with this approach is that, by ignoring acquisitions, we may introduce measurement error into the quantity of real estate assets that are exposed to variation in real estate prices.

[10]Zip codes are matched to MSA identifiers using a correspondence provided by the U.S. Census Bureau.

[11]These data are kindly made available online by Chaney et al. (2012).

consider the following firm-level characteristics: return on assets, total assets, Tobin's q, cash flow, age, two-digit SIC industry, and MSA of headquarters location fixed effects. We also include several measures of debt issuance and repayment constructed using Compustat data: long-term debt issues, long-term debt repayment, and annual changes in current debt and long-term debt (net), all scaled by PPE. These variables are used as dependent variables to corroborate our central hypothesis that collateral value appreciation leads to hiring funded by additional debt issues. All ratios are winsorized at the 1 percent level to ensure that results are robust to outliers.

With these data requirements in place, particularly the Compustat-SSEL link, we are able to construct a final sample containing 13,000 firm-year observations. Summary statistics are presented in Table I.[12] Importantly, as of 1993, 64.1 percent of firms reported real estate ownership in Compustat data. For the average firm, the market value of real estate assets represents 85 percent of (lagged) PPE, which represents a significant portion of the tangible assets held on the balance sheet of these corporations. Other firm- and establishment-level variables appear broadly consistent with the empirical corporate finance literature (e.g., Giroud and Mueller, 2015). This indicates that the match to the Census data does not lead to any sample selection issues, which is unsurprising given the data is administrative and should cover the universe of Compustat firms.

Finally, following Chaney et al. (2012), we instrument for local real estate price growth using the interaction of local land supply elasticity and long-term interest rates. Local land supply elasticities are collected from Saiz (2010). These elasticities attempt to measure the availability of developable land in each MSA based on satellite-generated data. They vary from 0 to 4 with an elasticity of 4 corresponding to an MSA with land supply that is relatively easy to expand. We measure long-term interest rates using the interest rate on

[12]In accordance with the Census Bureau's disclosure requirements, the numbers of observations in tables are rounded off, and we do not report any quantile values.

30-year, fixed-rate conventional residential mortgage loans from the Federal Reserve.

1.3 Identification and empirical model

Changes in the market value of real estate holdings may affect the amount of assets a firm has available to pledge in collateralized borrowing. To examine the implications for corporate employment, we begin with a version of a standard reduced-form investment equation with employment given by:

$$Employment_{it} = \alpha_i + \alpha_m \times \alpha_t + \beta \; RE \; Value_{it} + \theta' \mathbf{X}_{imt} + \epsilon_{it}, \tag{1}$$

where i indexes firms, m indexes headquarters' locations (i.e., MSAs), t indexes years, *Employment*$_{it}$ is the annual change in the dollar value of employment expenditures scaled by lagged PPE, and *RE Value* is the market value of real estate assets scaled by lagged PPE. We incorporate firm fixed effects (α_i) and MSA-year fixed effects ($\alpha_m \times \alpha_t$), where the latter controls for local shocks in growth opportunities. A vector of control variables, **X**, includes the ratio of cash flow to PPE, the one-year lagged Tobin's q, and other initial firm characteristics interacted with the MSA-year fixed effects. Inclusion of MSA-year fixed effects controls for the effects of local economic shocks on corporate employment outcomes, regardless of whether firms own real estate or not. The error terms, ϵ_{it}, are clustered at the MSA-year level, which is conservative given the main independent variable, *RE Value*, is measured at the firm level (Bertrand et al., 2004).

The main coefficient of interest, β, measures how a firm's employment responds to an extra dollar of real estate holdings. If some firms face financial constraints, the coefficient β will be strictly positive. The null hypothesis is that collateral values are irrelevant for employment behavior (because financial constraints are not binding or additional real estate collateral cannot be pledged), which corresponds to β equal to zero.

Identification of β comes from within-MSA-year variation in the response of corporate hiring to real estate valuations between firms with different real estate exposures at the same point in time. The key concern is that real estate values could proxy for an omitted variable such as the state of the local economy. For example, a positive demand shock could lead to increased production and hence demand for all factors of production including labor, as well as greater demand for housing. Alternatively, higher real estate prices could increase demand for goods and prompt growth in corporate hiring, because households feel wealthier or withdraw home equity (Mian and Sufi, 2014). Either way, if firms with greater real estate holdings are more sensitive to local market conditions, then this could lead to a spurious positive estimate of β.

Following Chaney et al. (2012), we use an instrumental variables (IV) approach to identify exogenous variation in the value of firms' real estate holdings. We first instrument for real estate market prices using the interaction of land supply elasticities with shifts in the nationwide mortgage interest rate. The intuition for this approach is as follows: for a given increase in real estate demand—proxied by a decrease in mortgage interest rates—the extent to which local real estate prices rise is determined by the slope of the local land supply curve. If the local land supply curve is flat (elastic), then greater demand will result in additional land development as opposed to higher land prices. On the other hand, if land supply is inelastic, then greater demand will result in higher prices.[13] In MSAs with more inelastic local land supply elasticities, we therefore expect falls in mortgage interest rates to result in greater real estate price appreciation. To illustrate this logic, Figure 1 plots the real estate price index from 2000 until 2006 separately for MSAs with high and low land supply elasticities along with a nationwide mortgage interest rate. Evidently, low-elasticity MSAs experience a more pronounced boom in the real estate market than high elasticity MSAs.

[13]This intuition is consistent with empirical evidence from the house price booms of the 1980s (Glaeser et al., 2008), as well as the most recent episode (Mian and Sufi, 2011).

Accordingly, the first stage of our IV approach predicts real estate prices by:

$$RE\ Price\ Index_{mt} = \alpha_m + \alpha_t + \psi\ Elasticity_m \times Mortgage\ Rate_t + \nu_{mt}, \tag{2}$$

where m indexes MSAs, t indexes years, α_m are MSA fixed effects, and α_t are year fixed effects. $Elasticity_m$ is the MSA-level local land supply elasticity, and $Mortgage\ Rate_t$ is the nationwide rate at which banks finance 30-year, fixed-rate conventional residential mortgage loans. The error terms, ν_{it}, are clustered at the MSA level.[14] The second stage of the IV regression modifies Equation (1), with employment now given by:

$$Employment_{it} = \alpha_i + \alpha_m \times \alpha_t + \beta\ \widehat{RE\ Value}_{it} + \theta' \mathbf{X}_{imt} + \epsilon_{it}, \tag{3}$$

where the market value of real estate holdings as of 1993 is now inflated by the instrumented MSA-level price index from 1993 to year t, giving $\widehat{RE\ Value}_{it}$. We will refer to this as our baseline specification throughout the remainder of the paper.

There is one remaining endogeneity concern when estimating of Equation (3): that real estate owning firms might exhibit different responses to changes in local real estate prices that are unrelated to local demand (such as a credit supply channel). We approach this issue by controlling for the interaction of observable firm characteristics that determine real estate ownership with MSA-year fixed effects. If real estate owners' fundamentals are more sensitive to fluctuations in real estate prices that are unrelated to local demand, then controlling for this interaction may allow us to identify the collateral lending channel. Heterogeneity in the ownership decision should partly be controlled for through the inclusion of firm fixed effects, but controlling for the observable determinants of real estate holdings may help improve identification. We focus on the real estate ownership decision as of 1993 and the

[14]Appendix IA.I presents the results of this first-stage estimation, which indicate that ψ is large and statistically significant, and the instrument is not weak (i.e., the F statistics are all greater than 10).

following determinants: five quintiles of *Return on Assets, Total Assets, Age,* and industry and MSA fixed effects.[15] These firm-level characteristics, measured as of 1993 and interacted with MSA-year fixed effects in our baseline specification, are thus included in the vector of controls, **X**. However, we recognize that some unobservable, potentially time-varying characteristic of real estate owning firms could make them more sensitive to changes in local real estate prices (unrelated to local demand). The absence of such unobservables is our final identifying assumption.

2 Results

2.1 Collateral Shocks and Corporate Employment

Table II provides the results of estimating the relation between employment and collateral based on Equations (1) and (3). Column [1] shows the results from the estimation of Equation (1) using ordinary least squares (OLS) and without any time-varying firm controls. The coefficient on *RE Value* is equal to 0.107 and significant at the 1 percent confidence level. The direction of this estimate is consistent with our expectation that firms with greater real estate holdings increase their employment more when real estate prices rise. In terms of economic magnitudes, the estimate implies that increasing the market value of real estate holdings by one standard deviation (that is, roughly a 1.121 increase) leads to a 0.119 increase in employment, which constitutes about 16.3 percent of its standard deviation (0.733). In dollar terms, an extra dollar of real estate collateral increases employment expenditures by about \$0.107.

[15] We find that firms in our sample that have higher return on assets, larger firms, and older firms are more likely to purchase real estate. Appendix IA.II demonstrates the importance of these firm characteristics in two ways. First, we estimate a cross-sectional regression of the firm-level market value of real estate and an ownership indicator—a variable equal to one if the firm reports real estate assets in Compustat—on firm characteristics as of 1993. Second, we simply show the differences in summary statistics between owners and renters.

Column [2] shows the results of the OLS estimation once we add controls for investment opportunities: cash flow and Tobin's q. We find both *Cash Flow* and q have a positive impact on employment, in line with expectations, although only the latter is statistically significant. Column [3] further saturates this specification with MSA-year fixed effects. Note that the coefficient on *RE Price Index* is no longer identified once we include these fixed effects. This is our preferred specification, as β is now identified from firms operating in the same MSA and industry in the same year that are exposed to the same real estate price shock, but have different real estate holdings. In both columns, we see the resulting coefficient is unchanged in terms of magnitude and significance.

Column [4] now conducts the IV estimation of Equation (3), with real estate prices instrumented using the interaction of the local land supply elasticity and nationwide mortgage rate. Section 1.3 provides details of the IV strategy and first-stage results, so here we focus on the second-stage equation. The column shows that the IV estimation yields a similar coefficient of 0.098, which is also significant at the 1 percent level. Thus, the IV and OLS estimates are similar in terms of both magnitude and significance.

2.1.1 Robustness checks

As described earlier, our approach isolates exogenous variation in real estate collateral values, which addresses the concern that real estate assets may proxy for growth opportunities. However, our measurement of the market value of real estate assets relies on several assumptions that may introduce measurement error into the regression analysis. Columns [1] to [4] of Table III address this issue directly.

We first investigate our assumption that the location of all real estate assets is the same MSA as headquarters. This assumption may be problematic if the majority of real estate holdings are located elsewhere. In this case, the estimates reported in Table II might be subject to measurement error and biased either downwards or upwards. If the measurement error is independent of the true market value of real estate, then the estimate of β may be biased toward zero (attenuation bias). On the other hand, if the measurement error is positively correlated with the true value of real estate—say, if firms with the largest real estate holdings have lower fractions of their holdings in the headquarters MSA—then β may be biased upward.

We gauge the importance of our location assumption using establishment-level data on the location of firms' operations from the LBD. The LBD provides establishment-level employment data that can be used to construct weights that indicate how exposed each firm is to each MSA-level real estate market.[16] We consider two such weighting schemes. First, for each firm, we weight according to the fraction of the firm's total employment located in each MSA ("Employment-Weighted"). Second, we assign a 100 percent weight to the MSA with the greatest fraction of the firm's employment ("Employment-Maximum"). These weights are then interacted with appropriate MSA-level real estate price indices and aggregated to the firm-year level to give a quasi–real estate price index. This firm-year-level price index can then be used to inflate the market value of real estate assets as of 1993, as described in Section 1.2, and provide a more refined measure of collateral value.

Columns [1] and [2] show the results of the IV estimation of Equation (3) using these two alternative weighting schemes. In both cases, the coefficient on *RE Value* is positive and statistically significant at the 1 percent confidence level. The point estimates—0.094 and 0.082 for employment-weighted and employment-maximum, respectively—are consistent with Table II, although slightly smaller in magnitude. This suggests the location assumption may introduce measurement error in our baseline regression, leading to (slightly) inflated estimates of the impact of collateral on employment. One explanation mentioned earlier is that firms with the largest real estate ownership may also have more dispersed holdings.

[16]This is only relevant for "multi-unit" firms with more than one establishment. Such firms compose more than 84 percent of the observations in our sample. Appendix IA.III provides detailed summary statistics for both single- and multi-unit firms.

Column [3] turns to plant-level real estate ownership data reported in the 1992 CMF for the subset of manufacturing firms. While the data is restrictive in terms of industry coverage, it allows us to sidestep assumptions about the location of owned real estate assets. Thus, the choice of which MSA-level price index to use to inflate book values is unambiguous. We measure the market value of real estate assets at the plant level by inflating the book value of building assets by the MSA price index corresponding to the location of the plant. We assume that the real estate was purchased—and the book value recorded—in the first year that the plant appears in the LBD. We arrive at a firm-level series for real estate collateral value by aggregating this market value across plants and scaling by PPE. As shown in the column, this approach yields a point estimate that is in line with the baseline estimate.

To further investigate the location assumption, we use data on which firms own their headquarters, hand-collected from SEC 10-K filings. In particular, we restrict the sample to firms where we know with certainty whether the firm did or did not own its headquarters in 1997, the first year when filings were available in electronic format. This reduces the sample size to approximately 9,000 firm-year observations. We calculate the market value of real estate assets following the usual procedure and estimate Equation (3) on this subsample. Column [4] shows the coefficient of interest is now 0.110 and remains significant at the 1 percent confidence level, which conforms well with the baseline IV estimates.

Next, we take a much simpler approach and replace *RE Value* with *RE Owner*—an indicator variable equal to one if the firm reports any real estate holdings in 1993—as the main independent variable in Equation (3). This indicator variable is interacted with the MSA-level real estate price index corresponding to each firm's headquarters location. If collateral values matter for employment, then we would expect that the coefficient on *RE Owner* × *RE Price Index* should be positive. This approach complements the baseline regression analysis by using a simpler method to calculate real estate exposure. It also allows us to investigate whether previous estimates are driven by a small number of large real estate holders. Column [5] shows a positive coefficient on the interaction, which is consistent with our expectation.

One remaining concern is our estimates may be affected by reverse causality in real estate holding decisions: hiring by large firms might affect local real estate prices by increasing local demand for housing. In a final robustness test, we address this issue by repeating our baseline IV estimation on a subsample of small firms located in large MSAs. We define small firms as those belonging to the bottom three quartiles of the size distribution, and large MSAs are restricted to the top 20 (ranked on population). The estimated coefficient reported in column [6] is 0.166 and is statistically significant at the 1 percent confidence level, thus alleviating the reverse causality concern. In fact, the point estimate for the small firms is larger than the baseline estimate, a fact we will revisit when we discuss the role of ex ante financial constraints.

2.1.2 Alternative measures of employment

In Table IV we consider several alternative measures of employment. The results both serve as robustness checks and shed light on the channel through which firms expand employment (i.e., more employees or wages per employee).

We explore additional measures that are each calculated using employment data from the LBD. Column [1] uses the annual change in the number of employees scaled by lagged PPE as the dependent variable. Column [2] uses the annual change in number of employees divided by one-half of the sum of current and lagged employment, that is, the symmetric employment growth rate. In each of these two columns, the coefficient on *RE Value* is positive and statistically significant at the 1 percent level, consistent with the increase in collateral value leading to hiring of new employees. Column [3] uses the average wage growth (payroll divided by the number of employees) and shows that the coefficient of interest is essentially zero and insignificant. Thus, we find the change in real estate collateral value results in incremental hiring, but not higher wages for existing or new employees. Finally, column [4] examines the firm-level establishment growth rate and shows that this incremental hiring arrives in conjunction with new establishment openings.[17]

2.1.3 Comparing tradable and nontradable industries

We next perform sample splits at the industry level to further address the possibility that local demand shocks give rise to a spurious correlation between real estate prices, real estate holdings, and corporate employment. While a local demand shock associated with real estate price appreciation should affect all firms similarly, the collateral lending channel is only relevant for firms with real estate holdings. However, it is still possible that real estate holding firms respond more to local demand shocks. To examine this possibility, we separate out industries most likely to benefit from local demand shocks ("nontradable" industries, such as construction and restaurants) from all others ("tradable" industries, such as heavy manufacturing). Naturally, firms from tradable industries are less likely to make employment decisions in response to local demand shocks.

We partition industries on the basis of tradability and rerun our main specification separately on each subsample. The results of this analysis are reported in Table V. We first split industries based on the average distance of shipments following Adelino et al. (2015), who use shipment distance data from the 2007 Census Commodity Flow Survey for their classification. In particular, we classify three-digit NAICS industry-state pairs as tradable if the median reported shipment distance is above 600 miles. Columns [1] and [2] show the results of the IV estimation. For both columns, we see that the coefficient of interest is posi-

[17]These employment measures also indicate that our results are not an artifact of scaling variables by PPE. For completeness, in Appendix IA.IV, we also replace employment with investment—defined as capital expenditures divided by lagged PPE—as the dependent variable in our baseline firm-level specification with MSA-year fixed effects. In line with Chaney et al. (2012), we find an investment response of about six cents per dollar increase in real estate collateral.

tive and significant at least at the 5 percent level.[18] Most importantly, the coefficient for the "Tradable" subsample is positive (0.104) and highly significant, indicating that the collateral effect is still strong once we exclude firms most likely to be sensitive to local demand shocks.

We next repeat our tests simply classifying manufacturing firms as belonging to tradable industries and all other firms as nontradable.[19] The same pattern emerges: employment expenditures of firms from tradable industries, here manufacturers, show a strong dependence on real estate collateral values. This indicates that the relationship we uncover in our baseline sample is not driven by the inclusion of non-manufacturers. Thus, the interpretation that our real estate collateral effect is proxying for a greater sensitivity to local demand shocks among real estate holding firms does not appear validated by the data.

2.2 Evidence on the collateral lending channel

Theoretical work highlights how increasing available collateral can expand debt capacity, particularly among credit constrained firms (e.g., Almeida and Campello, 2007). This helps to alleviate potential inefficiencies resulting from imperfect capital markets—such as incomplete contracting or information problems—and allows constrained firms to efficiently expand employment. Here, we present evidence consistent with this collateral channel by, first, analyzing whether the effect of real estate collateral values on corporate employment varies with financial constraints. Then, to further corroborate the theory, we show how firms' debt financing responds to changes in collateral values.

[18] F-tests of equality indicate that the differences in *RE Value* point estimates across the tradable and nontradable firms are insignificant at conventional levels for both measures of industry tradability.

[19] We define nontradable as all non-manufacturing industries, which contrasts with Mian and Sufi (2014) who classify only restaurant and retail industries as nontradable.

2.2.1 Impact of financial constraints

We sort firms into either "Constrained" or "Unconstrained" groups using four (lagged) measures of financial constraints.[20] We first consider firm size. For each year in the sample, we label firms as financially constrained if they are in the bottom four deciles of the asset size distribution and unconstrained if they are in the top four deciles. All other firm-years are excluded from the analysis. Second, we use payout policy to classify firms. In particular, for each year, we calculate the payout ratio of each firm: total payouts (dividends plus stock repurchases) divided by operating income. Each year, firms in the lowest four deciles of the distribution of payouts are labeled as financially constrained, firms in the highest four deciles of the distribution are considered unconstrained, and all other firms are discarded. Third, we use long-term bond rating from Compustat (assigned by Standard & Poor's). Among those firms with outstanding long-term debt, we label unrated (rated) firms as financially constrained (unconstrained). Finally, we examine privately held and publicly traded firms. As argued by Saunders and Steffen (2011), private firms face higher borrowing costs due to information asymmetry and limited access to equity markets, among other reasons. If greater collateral values allow for increased use of secured debt—thus, ameliorating information problems (Rampini and Viswanathan, 2010)—then private firms may be more likely to respond through additional hiring.

While employment data for private firms is readily available in the LBD, we must restrict the sample to manufacturing firms to collect plant-level information on the book value of real estate assets from the 1992 CMF. As described in Section 1.2, we use this data to construct real estate collateral value shocks at the plant level, which we aggregate to the firm level. Since we are unable to incorporate firm control variables from Compustat for private firms, we construct alternative measures based on the CMF and ASM data and substitute these

[20] The use of lagged values alleviates concerns that the classification might be contaminated by contemporaneous real estate price appreciation.

into Equation (3). In particular, we substitute the time-varying firm controls and initial firm characteristics (*Return on Assets*, etc.) with counterparts based on the Census data.[21] To ensure comparability, we follow the same approach when constructing these variables for both private and public manufacturing firms.

Table VI reports the results of estimating Equation (3) on the constrained and unconstrained subgroups. The point estimates indicate that there are substantial differences in the responsiveness of firm-level employment to variation in real estate collateral values between the groups. In particular, the size of the coefficient of interest, β, is estimated to be at least 50% as large for the constrained group in all three cases. Moreover, these differences are significant at least at the 10 percent level for each measure of financial constraints, using an F-test of equality of the *RE Value* point estimates across the constrained and unconstrained firms. Thus, we find evidence that increases in collateral values are particularly effective at facilitating hiring among the set of financially constrained firms.

2.2.2 Debt financing response

We now provide direct evidence that firms' debt financing decisions respond to fluctuations in real estate asset values. This allows us to corroborate previously mentioned theories of production under collateral constraints that predict firms convert capital gains on real estate collateral into greater employment. These theories predict that firms will raise additional debt, and this debt may be secured on the appreciated real estate assets.

Table VII shows the results of reestimating our baseline regression model (column [4] of Table II) with measures of debt issuance as the dependent variable. Columns [1] to [4] present the estimates for four measures of debt issuance constructed using the Compustat data. To obtain estimates that are comparable with our employment expenditures results, we divide each of these measures by lagged PPE.

[21] For MSA fixed effects, we assign each firm to the MSA accounting for its greatest employment share.

Columns [1] and [2] use measures of flows of long-term debt: long-term debt issuance and long-term debt repayment, respectively. We find that firms with larger real estate exposures make greater debt issuances and repayments: a $1 increase in the market value of real estate assets leads to a $0.069 increase in debt issues and a $0.052 increase in debt repayments. Column [3] estimates of the overall effect on net long-term debt issuance—calculated as the yearly difference in the stock of long-term debt—and finds a positive relation between real estate collateral appreciation and debt utilization. Column [4] instead focuses on current (i.e., short-term) debt and similar, albeit weaker in magnitude, effects emerge. Thus, we uncover a positive relation between real estate collateral values and long-term debt issuance and repayment, as well as the overall level of debt utilization.

2.2.3 Alternative mechanism: CEO miscalibration

In this final section, we examine an alternative explanation: the expansion in employment at firms with greater collateral values may reflect CEO overconfidence. If CEOs perceive the increase in the value of the firm's assets as reflecting their own skill or miscalibration about the future prospects for the firm, then they may choose to increase employment (Ben-David et al., 2013). Prior literature suggests that when firms expand operations due to managerial miscalibration they tend to overinvest relative to the first-best, which has negative effects on firm performance. Moreover, these negative performance effects tend to be pronounced when overconfident managers are not disciplined by corporate governance mechanisms (Malmendier and Tate, 2005, 2008). We follow this prior literature to investigate this alternative by examining firm-level performance.

The results are shown in Table VIII. We use two measures of firm-level performance: return-on-assets (ROA) and the ratio of net operating cash flows to (lagged) assets. As is standard in the corporate governance literature (e.g., Giroud and Mueller, 2011), we capture the quality of corporate governance with the G- and E-Index.[22] In the case of ROA, we find very weak evidence of a positive relation between performance and changes in real estate collateral values, on average. This positive effect appears to be driven by firms with strong governance, as measured by the G-Index. These results are very weak, however, and mostly statistically insignificant. Once we consider the E-Index and net operating cash flows to assets, the results are mixed and always statistically insignificant. Overall, these findings as inconsistent with the CEO miscalibration alternative, which predicts a negative relation between collateral changes and firm performance (due to an inefficient expansion). We must caveat this conclusion by noting these governance indices are endogenous and it is therefore tricky to interpret the point estimates in the table. That being said, our evidence in Table VI (employment response only among financially constrained firms) and Table VII (debt financing response to collateral changes) gives us confidence that we are identifying a collateral lending channel.

3 Conclusion

Using comprehensive employment data from the U.S. Census Bureau, we measure the sensitivity of corporate employment to changes in debt capacity induced by fluctuations in real estate prices over the period from 1993 until 2006. We provide evidence that firms significantly increase employment when the value of real estate collateral appreciates. On average, a publicly traded U.S. corporation increases employment expenditures by about \$0.10 per \$1 increase in the value of its collateral, or about 15.6 percent of the standard deviation of employment per standard deviation increase in collateral values. The micro-evidence we present highlights the empirical importance of the collateral lending channel as a key determinant of corporate employment decisions. Our evidence is consistent with

[22] Only about 25% of firm-years have governance data and therefore it is not feasible to estimate the model with MSA $\times$ year fixed effects.

models of credit constraints and their interaction with real estate collateral values providing a channel to amplify economic shocks (Kiyotaki and Moore, 1997; Liu et al., 2013).

Throughout the paper we have been silent on the welfare implications of these employment expansions. The rise in real estate prices and associated increase in debt capacity allows credit constrained firms to expand their scale of operation. What remains unclear is whether this expansion is efficient overall in terms of aggregate productivity. On the one hand, if credit constrained firms were previously underinvesting in positive NPV projects, then higher efficiency should naturally follow. On the other hand, during real estate booms capital may reallocated to firms or industries with greater real estate collateral at the expense of other lending opportunities (Chakraborty et al., Forthcoming). If industries with greater real estate ownership are less productive (e.g., Gopinath et al., Forthcoming), then efficiency losses may occur in the aggregate. Understanding the connections between housing price booms, factor misallocation, and aggregate efficiency remains an exciting area for future research.

References

Adelino, M., A. Schoar, and Severino, F. (2015) House prices, collateral, and self-employment, *Journal of Financial Economics* 117:288–306.

Agrawal, A., and Matsa, D. (2013) Labor unemployment risk and corporate financing decisions, *Journal of Financial Economics* 108:449–470.

Almeida, H., and Campello, M. (2007) Financial constraints, asset tangibility, and corporate investment, *Review of Financial Studies* 20:1429–1460.

Almeida, H., Kim, H. B., and Kim, C. S. (2015) Internal capital markets in business groups: Evidence from the asian financial crisis, *Journal of Finance* 70:2539–2586.

Ben-David, I., Graham, J., and Harvey, C. (2013) Managerial miscalibration, *Quarterly Journal of Economics* 128:1547–1584.

Benmelech, E., N. K. Bergman, and Seru, A. (2015) Financing labor, Working Paper, Northwestern University.

Benmelech, E., D. Papanikolaou, and Frydman, C. (2017) Financial frictions and employment during the great depression, Working Paper, Northwestern University.

Berger, A. N., and Udell, G. F. (1990) Collateral, loan quality and bank risk, *Journal of Monetary Economics* 25:21–42.

Berk, J. B., Stanton, R., and Zechner, J. (2010) Human capital, bankruptcy, and capital structure, *Journal of Finance* 65:891–926.

Berton, F., S. Mocetti, A. Presbitero, and Richiardi, M. (Forthcoming) Banks, firms, jobs, *Review of Financial Studies*.

Bertrand, M., E. Duflo, and Mullainathan, S. (2004) How much should we trust differences-in-differences estimates? *Quarterly Journal of Economics* 119:249–275.

Borisov, A., A. Ellul, and Sevilir, M. (2017) Access to public capital markets and employment growth, Working Paper, Indiana University.

Chakraborty, I., I. Goldstein, and MacKinlay, A. (Forthcoming) Housing price booms and crowding-out effects in bank lending, *Review of Financial Studies*.

Chaney, T., D. Sraer, and Thesmar, D. (2012) The collateral channel: How real estate shocks affect corporate investment, *American Economic Review* 102:2381–2409.

Chodorow-Reich, G. (2014) The employment effects of credit market disruptions: Firm-level evidence from the 2008–9 financial crisis, *Quarterly Journal of Economics* 129:1–59.

Corradin, S., and A. Popov (2015) House prices, home equity, and entrepreneurship, *Review of Financial Studies* 28:2399–2428.

Cvijanović, D. (2014) Real estate prices and firm capital structure, *Review of Financial Studies* 27:2690–2735.

Davis, S. J., J. C. Haltiwanger, and Schuh, S. (1998) *Job creation and destruction*, Cambridge, MA:MIT Press.

Duygan-Bump, B., A. Levkov, and Montoriol-Garriga, J. (2015) Financing constraints and unemployment: Evidence from the great recession, *Journal of Monetary Economics* 75:89–105.

Falato, A., and Liang, N. (2016) Do creditor rights increase employment risk? Evidence from loan covenants, *Journal of Finance* 71:2545–2590.

Giroud, X. (2013) Proximity and investment: Evidence from plant-level data, *Quarterly Journal of Economics* 128:861–915.

Giroud, X., and Mueller, H. M. (2011) Corporate governance, product market competition, and equity prices, *Journal of Finance* 66:563–600.

——— (2015) Capital and labor reallocation within firms, *Journal of Finance* 70:1767–1804.

——— (2017) Firm leverage, consumer demand, and employment losses during the great recession, *Quarterly Journal of Economics* 132:271–316.

Gopinath, G., S. Kalemi-Ozcan, L. Karabarbounis, and Villegas-Sanchez, C. (Forthcoming) Capital allocation and productivity in South Europe, *Quarterly Journal of Economics*.

Graham, J., H. Kim, S. Li, and Qiu, J. (2016) Employee costs of corporate bankruptcy, Working Paper, Duke University.

Glaeser, E. L., J. Gyourko, and Saiz, A. (2008) Housing supply and housing bubbles, *Journal of Urban Economics* 64:198–217.

Hart, O., and Moore, J. (1994) A theory of debt based on the inalienability of human capital, *Quarterly Journal of Economics* 109:841–879.

Jermann, U., and Quadrini, V. (2012) Macroeconomic effects of financial shocks, *American Economic Review* 102:238–271.

Kiyotaki, N., and Moore, J. (1997) Credit cycles, *Journal of Political Economy* 105:211–248.

Landier, A., V. B. Nair, and Wulf, J. (2009) Trade-offs in staying close: Corporate decision making and geographic dispersion, *Review of Financial Studies* 22:1119–1148.

Liu, Z., P. Wang, and Zha, T. (2013) Land-price dynamics and macroeconomic fluctuations, *Econometrica* 81:1147–1184.

Malmendier, U., and Tate, G. (2005) CEO overconfidence and corporate investment, *Journal of Finance* 60:2661–2700.

——— (2008) Who makes acquisitions? CEO overconfidence and the market's reaction, *Journal of Financial Economics* 89:20–43.

Maksimovic, V., and Phillips, G. (2002) Do conglomerate firms allocate resources inefficiently across industries? Theory and evidence, *Journal of Finance* 57:721–767.

Matvos, G., and Seru, A. (2014) Resource allocation within firms and financial market dislocation: Evidence from diversified conglomerates. *Review of Financial Studies* 27:1143–1189.

Mian, A., and Sufi, A. (2011) House prices, home equity–based borrowing, and the U.S. household leverage crisis, *American Economic Review* 101:2132–2156.

——— (2014) What explains the 2007–2009 drop in employment? *Econometrica* 82:2197–2223.

Mian, A., A. Sufi, and Vernier, E. (Forthcoming) Household debt and business cycles worldwide, *Quarterly Journal of Economics*.

Oi, W. Y. (1962) Labor as a quasi-fixed factor, *Journal of Political Economy* 70:538–555.

Popov, A., and Rocholl, J. (Forthcoming) Do credit shocks affect labor demand? Evidence for employment and wages during the financial crisis, *Journal of Financial Intermediation*.

Rampini, A., and Viswanathan, S. (2010) Collateral, risk management, and the distribution of debt capacity, *Journal of Finance* 65:2293–2322.

Saiz, A. (2010) The geographic determinants of housing supply. *Quarterly Journal of Economics* 125:1253–96.

Saunders, T., and Steffen, S. (2011) The costs of being private: Evidence from the loan market, *Review of Financial Studies* 24:4091–4122.

Serfling, M. (2016) Firing costs and capital structure decisions, *Journal of Finance* 71:2239–2286.

Schmalz, M. C., D. A. Sraer, and Thesmar, D. (2017) Housing collateral and entrepreneurship, *Journal of Finance* 72:99–132.

Strebulaev, I., and Yang, B. (2013) The mystery of zero-leverage firms, *Journal of Financial Economics* 109:1–23.

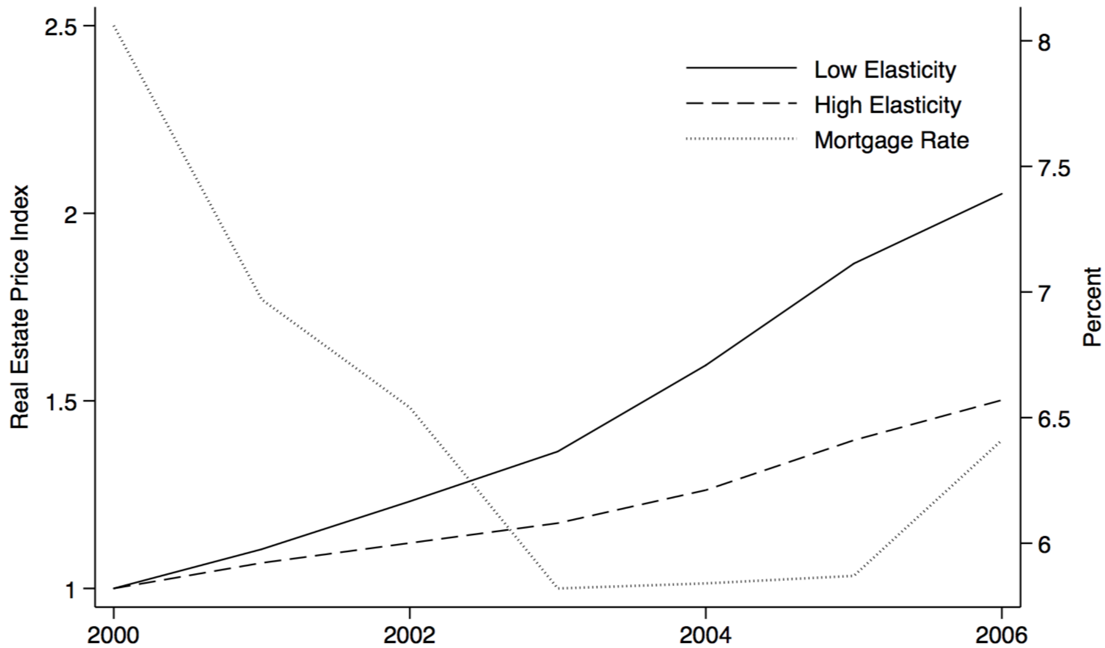

Figure 1: Relative evolution of U.S. real estate prices. This figure plots the time-series average of annual MSA-level real estate prices (residential, single-family home) and the 30-year, fixed rate conventional residential mortgage interest rate. The price index is normalized to one in 2000. The period shown here is from 2000 until 2006, which is shorter than the period used in the regressions. The series is plotted separately for MSAs with high (top quartile) and low (bottom quartile) elasticity of land supply.

Table I
Summary statistics

This table provides sample summary statistics at the firm-year level. All variables are defined in Appendix A.

	Rounded N	Mean	Std.
	[1]	[2]	[3]
Employment Expenditures	13,000	0.193	0.733
Number of Employees	13,000	2.594	15.795
Number of Employees (Alt.)	13,000	0.011	0.323
Average Wage	13,000	0.002	0.008
Establishment Growth	13,000	0.046	0.221
RE Value	13,000	0.852	1.121
RE Value (Employment-Weighted)	13,000	0.890	1.215
RE Value (Employment-Maximum)	13,000	0.881	1.207
RE Value (HQ Owner)	9,000	0.781	1.134
RE Owner	13,000	0.641	0.480
Return on Assets	13,000	0.007	0.236
Cash Flow	13,000	-0.265	2.668
q	13,000	2.087	1.554
Total Assets	13,000	1,511.688	5,910.535
Age	13,000	20.108	14.067

Table II
Collateral shocks and firm-level employment

This table presents estimates of the firm-level impact of real estate collateral value on corporate employment. The unit of observation in each regression is a firm-year pair. The dependent variable is the annual change in employment expenditures divided by the lagged value of plants, property, and equipment (PPE). The main independent variable is the market value of real estate assets scaled by lagged PPE, which is calculated assuming assets are located in the same MSA as firms' headquarters (see Section 1.2). Columns [1] to [3] show the results of the OLS estimation. Column [4] instruments for the market value of real estate using the triple-interaction of the local land supply elasticity, the nationwide mortgage interest rate, and the market value of real estate holdings in 1993. Each regression controls for firm fixed effects, as well as initial firm characteristics (five quintiles of *Return on Assets, Total Assets, Age*, and two-digit SIC industry dummies) interacted with either MSA-level real estate prices or MSA-year fixed effects. All variables are defined in Appendix A. Standard errors (in parentheses) are clustered at the MSA-year level. ***, **, and * denote 1, 5, and 10 percent statistical significance, respectively.

Dependent variable: *Employment Expenditures*	[1]	[2]	[3]	[4]
RE Value	0.107***	0.102***	0.102***	0.098***
	(0.022)	(0.021)	(0.021)	(0.021)
Cash Flow		0.011	0.011	0.011
		(0.009)	(0.009)	(0.009)
q		0.047***	0.047***	0.047***
		(0.012)	(0.012)	(0.012)
Firm fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	N	N
RE price index	Y	Y	N	N
RE price index × init. controls	Y	Y	N	N
MSA × year fixed effects	N	N	Y	Y
MSA × year fixed effects × init. controls	N	N	Y	Y
Rounded N	13,000	13,000	13,000	13,000
R^2	0.55	0.56	0.56	0.56

Table III
Robustness checks for firm-level analysis

This table presents robustness checks of the baseline estimates of the firm-level impact of real estate collateral value on corporate employment. The unit of observation in each regression is a firm-year pair. The dependent variable is the annual change in employment expenditures divided by the lagged value of plants, property, and equipment (PPE). The main independent variable is the market value of real estate assets scaled by lagged PPE. Column [1] instead assumes that real estate assets are geographically distributed in proportion to establishment-level employment. Column [2] assumes that real estate assets are located in the MSA with the greatest firm-level employment. Column [3] uses plant-level ownership data for manufacturing firms. Column [4] uses the market value of real estate assets for firms that own their headquarters. Column [5] replaces the market value of real estate assets with an indicator variable equal to one if the firm had positive real estate holdings in 1993. Column [6] restricts the sample to firms in the bottom three quartiles in the distribution of total assets and in the largest 20 MSAs by population. All columns use IV estimation, where the market value of real estate is instrumented for using the triple-interaction of the local land supply elasticity, the nationwide mortgage interest rate, and the market value of real estate holdings in 1993. Each regression controls for firm and MSA-year fixed effects, as well as initial firm characteristics (five quintiles of *Return on Assets, Total Assets, Age,* and two-digit SIC industry dummies) interacted with MSA-year fixed effects. All variables are defined in Appendix A. Standard errors (in parentheses) are clustered at the MSA-year level. ***, **, and * denote 1, 5, and 10 percent statistical significance, respectively.

Dependent variable: *Employment Expenditures*						
Robustness check:	E-weighted RE prices	E-maximum RE prices	Plant-level ownership	HQ RE value	RE owner indicator	Large MSA, small firm
	[1]	[2]	[3]	[4]	[5]	[6]
RE Value	0.094***	0.082***	0.115***	0.110***		0.166***
	(0.019)	(0.017)	(0.032)	(0.031)		(0.035)
RE Owner $\times$ *RE Price Index*					1.005***	
					(0.243)	
Firm controls	Y	Y	Y	Y	Y	Y
Firm fixed effects	Y	Y	Y	Y	Y	Y
MSA $\times$ year fixed effects	Y	Y	Y	Y	Y	Y
MSA $\times$ year fixed effects $\times$ init. controls	Y	Y	Y	Y	Y	Y
Rounded N	13,000	13,000	7,000	9,000	13,000	5,000
R^2	0.56	0.56	0.70	0.58	0.56	0.54

Table IV
Alternative measurement of firm-level employment

This table presents estimates of the firm-level impact of real estate collateral value on alternative measures of corporate employment. The unit of observation in each regression is a firm-year pair. The dependent variable changes across specifications. Column [1] uses the annual change in number of employees divided by the lagged value of plants, property, and equipment (PPE). Column [2] uses twice the annual change in number of employees divided by the sum of current and lagged employment (i.e., the symmetric growth rate). Column [3] uses the change in the average wage (payroll divided by number of employees). Column [4] uses uses the establishment growth rate. The main independent variable is the market value of real estate assets scaled by lagged PPE, which is calculated assuming assets are located in the same MSA as firms' headquarters (see Section 1.2). All columns use IV estimation, where the market value of real estate is instrumented for using the triple-interaction of the local land supply elasticity, the nationwide mortgage interest rate, and the market value of real estate holdings in 1993. Each regression controls for firm and MSA-year fixed effects, as well as initial firm characteristics (five quintiles of *Return on Assets, Total Assets, Age,* and two-digit SIC industry dummies) interacted with MSA-year fixed effects. All variables are defined in Appendix A. Standard errors (in parentheses) are clustered at the MSA-year level. ***, **, and * denote 1, 5, and 10 percent statistical significance, respectively.

Dependent variable:	*Number of Employees*	*Number of Employees (Alt.)*	*Average Wage*	*Establishment Growth*
	[1]	[2]	[3]	[4]
RE Value	1.520***	0.053***	0.110	0.013*
	(0.511)	(0.013)	(0.289)	(0.007)
Firm controls	Y	Y	Y	Y
Firm fixed effects	Y	Y	Y	Y
MSA × year fixed effects	Y	Y	Y	Y
MSA × year fixed effects × init. controls	Y	Y	Y	Y
Rounded N	13,000	13,000	13,000	13,000
R^2	0.53	0.50	0.44	0.57

Table V
Employment effects by tradable and nontradable industries

This table presents estimates of the firm-level impact of real estate collateral value on corporate employment across two definitions of tradable and nontradable industries. The unit of observation in each regression is a firm-year pair. The dependent variable is the annual change in employment expenditures divided by the lagged value of plants, property, and equipment (PPE). The main independent variable is the market value of real estate assets scaled by lagged PPE, which is calculated assuming assets are located in the same MSA as firms' headquarters (see Section 1.2). Columns [1] and [2] classify three-digit NAICS industry-state pairs as tradable based on the median of the shipment distance distribution (above 600 miles). Columns [3] and [4] define manufacturing firms as tradable and other firms nontradable. All columns use IV estimation, where the market value of real estate is instrumented for using the triple-interaction of the local land supply elasticity, the nationwide mortgage interest rate, and the market value of real estate holdings in 1993. Each regression includes firm controls (*Cash Flow* and q), firm and MSA-year fixed effects, as well as initial firm characteristics (five quintiles of *Return on Assets, Total Assets, Age,* and two-digit SIC industry dummies) interacted with MSA-year fixed effects. All variables are defined in Appendix A. Standard errors (in parentheses) are clustered at the MSA-year level. ***, **, and * denote 1, 5, and 10 percent statistical significance, respectively.

Dependent variable: *Employment Expenditures*				
	Shipping distance		Manufacturing industry	
	Tradable	Nontradable	Tradable	Nontradable
	[1]	[2]	[3]	[4]
RE Value	0.104**	0.122***	0.094***	0.207**
	(0.041)	(0.035)	(0.023)	(0.090)
Firm controls	Y	Y	Y	Y
Firm fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
MSA × year fixed effects	Y	Y	Y	Y
MSA × year fixed effects × init. controls	Y	Y	Y	Y
Rounded N	5,000	2,000	8,000	5,000
R^2	0.60	0.82	0.58	0.75

Table VI
Impact of financial constraints

This table presents estimates of the firm-level impact of real estate collateral value on corporate employment across ex ante financially constrained and unconstrained firms. The unit of observation in each regression is a firm-year pair. The dependent variable is the annual change in employment expenditures divided by the lagged value of plants, property, and equipment (PPE). The main independent variable is the market value of real estate assets scaled by lagged PPE, which is calculated assuming assets are located in the same MSA as firms' headquarters (see Section 1.2). Columns [1] and [2] classify firms in the bottom four deciles of the size distribution (lagged total assets) as constrained and firms in the top four deciles as unconstrained. Columns [3] and [4] classify firms in the bottom four deciles of the payout ratio distribution (dividends plus repurchases over operating income) as constrained and firms in the top four deciles as unconstrained. Columns [5] and [6] classify firms with long-term debt outstanding and no bond rating as constrained and firms with a bond rating unconstrained. Columns [7] and [8] classify privately held firms as constrained and publicly traded firms as unconstrained. All columns use IV estimation, where the market value of real estate is instrumented for using the triple-interaction of the local land supply elasticity, the nationwide mortgage interest rate, and the market value of real estate holdings in 1993. Each regression includes firm controls (*Cash Flow* and q), firm and MSA-year fixed effects, as well as initial firm characteristics (five quintiles of *Return on Assets, Total Assets, Age,* and two-digit SIC industry dummies) interacted with MSA-year fixed effects. In columns [7] and [8], firm controls include the firm-level value of shipments and number of plants. For private firms, *Return on Assets* is computed as the total value of shipments minus labor and materials costs scaled by total depreciable assets; *Total Assets* is the sum of depreciable assets across plants; *Age* is the age of the oldest plant belonging to the firm. All variables are defined in Appendix A. Standard errors (in parentheses) are clustered at the MSA-year level. ***, **, and * denote 1, 5, and 10 percent statistical significance, respectively.

Dependent variable: *Employment Expenditures*								
Financial constraint:	Firm size		Payout policy		Bond rating		Publicly traded	
	C	U	C	U	C	U	C	U
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
RE Value	0.152**	0.022	0.156***	0.049	0.122***	0.004	0.154***	0.096***
	(0.071)	(0.022)	(0.058)	(0.034)	(0.040)	(0.026)	(0.016)	(0.037)
Firm controls	Y	Y	Y	Y	Y	Y	Y	Y
Firm fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
MSA × year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
MSA × year fixed effects × init. controls	Y	Y	Y	Y	Y	Y	Y	Y
Rounded N	5,000	5,000	7,000	4,000	8,000	3,000	133,000	4,000
R^2	0.60	0.72	0.60	0.77	0.65	0.63	0.36	0.53

Table VII
Collateral shocks and debt financing

This table presents estimates of the firm-level impact of real estate collateral value on corporate debt. The dependent variables in columns [1] to [5] are various measures of debt flows. Column [1] measures *Debt Issues* as long-term debt issuance divided by lagged PPE. Column [2] defines *Debt Repayment* as long-term debt repayment divided by lagged PPE. Column [3] defines *Changes in LT Debt* as the yearly difference in the stock of long-term debt divided by lagged PPE. Column [4] defines *Changes in Current Debt* as the net change in current debt divided by lagged PPE. The main independent variable is the market value of real estate assets scaled by lagged PPE, which is calculated assuming assets are located in the same MSA as firms' headquarters (see Section 1.2). All columns use IV estimation, where the market value of real estate is instrumented for using the interaction of the local land supply elasticity, the nationwide mortgage interest rate, and the market value of real estate holdings in 1993. Each regression includes firm controls (*Cash Flow* and q), firm and MSA-year fixed effects, as well as initial firm characteristics (five quintiles of *Return on Assets, Total Assets, Age,* and two-digit SIC industry dummies) interacted with MSA-year fixed effects. All variables are defined in Appendix A. Standard errors (in parentheses) are clustered at the MSA-year level. ***, **, * denote 1, 5, and 10 percent statistical significance.

Dependent variable:	*Debt Issues*	*Debt Repayment*	*Changes in LT Debt*	*Changes in Current Debt*
	[1]	[2]	[3]	[4]
RE Value	0.069**	0.052***	0.057**	0.011**
	(0.034)	(0.020)	(0.023)	(0.005)
Firm controls	Y	Y	Y	Y
Firm fixed effects	Y	Y	Y	Y
MSA × year fixed effects	Y	Y	Y	Y
MSA × year fixed effects × init. controls	Y	Y	Y	Y
Rounded N	12,000	13,000	13,000	13,000
R^2	0.64	0.67	0.49	0.43

Table VIII
Performance effects associated with collateral value changes

This table presents estimates of the firm-level impact of real estate collateral value on corporate performance across two definitions of corporate governance. The unit of observation in each regression is a firm-year pair. The dependent variable is firm performance calculated as return on assets and net operating cash flow to assets in columns [1] to [5] and [6] to [10], respectively. The main independent variable is the market value of real estate assets scaled by lagged PPE, which is calculated assuming assets are located in the same MSA as firms' headquarters (see Section 1.2). We classify firms as having strong (weak) governance based on lagged G-Index of 9 and below (10 and above). Under the E-Index, firms have strong (weak) governance when the index is equal to 2 or less (equal to 3 or more). All columns use IV estimation, where the market value of real estate is instrumented for using the triple-interaction of the local land supply elasticity, the nationwide mortgage interest rate, and the market value of real estate holdings in 1993. Each regression includes firm controls (*Cash Flow* and q), firm and MSA-year fixed effects, as well as initial firm characteristics (five quintiles of *Return on Assets, Total Assets, Age,* and two-digit SIC industry dummies) interacted with MSA-level real estate prices. All variables are defined in Appendix A. Standard errors (in parentheses) are clustered at the MSA-year level. ***, **, and * denote 1, 5, and 10 percent statistical significance, respectively.

Dependent variable:	*Return on Assets*					*Net Operating Cash Flow/Assets*$_{t-1}$				
		G-Index		E-Index			G-Index		E-Index	
Governance:		Strong	Weak	Strong	Weak		Strong	Weak	Strong	Weak
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
RE Value	0.005*	0.008	–0.004	0.002	–0.001	–0.001	–0.006	–0.000	–0.006	0.003
	(0.003)	(0.005)	(0.004)	(0.005)	(0.004)	(0.003)	(0.005)	(0.009)	(0.005)	(0.006)
Firm controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Firm fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
RE price index	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
RE price index × init. controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	3,333	1,721	1,612	1,698	1,635	3,333	1,721	1,612	1,698	1,635
R^2	0.81	0.84	0.85	0.83	0.85	0.66	0.71	0.67	0.71	0.66

Appendix A: Variable definitions

This appendix presents the definitions for the variables used throughout the paper.

Variable	Definition	Source
Panel A: Firm-level variables		
Employment Expenditures	Change in payroll summed across establishments over lagged PPE	LBD, Compustat
Number of Employees	Change in employees summed across establishments over lagged PPE	LBD, Compustat
Number of Employees (Alt.)	Two times the change in employees summed across establishments over sum of current and lagged employment (i.e., symmetric growth rate)	LBD
Average Wage	Total payroll divided by total number of employees	LBD
Establishment Growth	Change in number of establishments over lagged establishments	LBD
RE Value	Market value of real estate assets assuming located in same MSA as HQ scaled by lagged PPE	OFHEO, Compustat
RE Value (Employment-Weighted)	Market value of real estate assets assuming located in proportion to establishment-level employment scaled by lagged PPE	OFHEO, Compustat, LBD
RE Value (Employment-Maximum)	Market value of real estate assets assuming located in MSA with greatest firm-level employment scaled by lagged PPE	OFHEO, Compustat, LBD
RE Owner	Equal to one if the book value of real estate holdings is greater than zero	Compustat
HQ RE Value	Market value of real estate for HQ owners scaled by lagged PPE	Chaney et al. (2012)
Return on Assets	Income minus depreciation divided by total assets	Compustat
Net Operating Cash Flow/Assets	Net cash flow from operations divided by lagged assets	Compustat
Cash Flow	Ratio of cash flow (EBITDA) to lagged PPE	Compustat
q	Ratio of market to book value of assets	Compustat
Total Assets	Book value of assets	Compustat
Age	Number of years since IPO	Compustat