Essays in Real Estate and the Real Economy

by Kristopher Kleiner

Department of Economics

Duke University

Date:_______________________________

Approved:

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Pat Bayer, Supervisor

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David Robinson

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Manuel Adelino

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Daniel Xu

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Cosmin Ilut

Dissertation submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy in the Department of Economics
in the Graduate School of Duke University
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ABSTRACT

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Abstract

This dissertation explores the causes and consequences of real estate price fluctuations. Given the collapse of US house prices during 2007-2009 along with the simultaneous rise in national unemployment an thorough understanding of both the housing market and its relation to the labor market has perhaps never been more important. While this dissertation fits in the real estate finance literature, my broader purpose is to use to new micro-level data to empirically test the relevance of financial and macroeconomic theories. Chapter 2 offers evidence that small firms borrow against real estate holdings to pay employment and this collateral channel is responsible for 8-16% of the total decline in employment between 2007-2009. Chapter 3 develops the locally-weighted repeat sales technique, a new econometric estimation to price any real estate property by comparing the house to all properties on the market. We then apply the method to the US Housing Market and find that traditional aggregate house indices such as Case-Shiller have overestimated the bubble by 10%. Chapter 4 uses new data on small firm financials to exhibit that home equity is a significant source of initial financing for large startups: specifically, in our preferred specification we find that a 100% increase in real estate price growth is responsible for an 11% increase in home equity financing among all entrepreneurs and a 21% increase for large start-ups.

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1 Introduction

This dissertation explores the causes and consequences of real estate price fluctuations. Given the collapse of US house prices during 2007-2009 along with the simultaneous credit crisis and the rise in national unemployment I believe that a thorough understanding of both the housing market and its relation to the financial and macroeconomy has perhaps never been more important. While this dissertation fits in the real estate finance literature, my broader purpose is to use to new micro-level data to empirically test the relevance of financial and macroeconomic theories.

My second chapter of my dissertation is titled, "How Real Estate Drives the Economy: An Investigation of Small Firm Collateral Shocks on Employment". The real estate market has been at the center of the debate on the causes and consequences of the rise in unemployment during 2007-2009, yet the mechanism that links these factors remains inconclusive. We propose a simple explanation: since small firms are highly dependent on collateral to access external financing, balance sheet shocks can affect financing availability and impact real outlays. Using UK firm level data we find that the average small business extracts \$0.25 out of every dollar increase in their real estate value and applies \$0.10 for investment and \$0.07 for employment expenditures. Our method exploits cross-sectional differences in exogenous real estate price growth using measures of housing supply elasticity as well as variation in firm real estate holdings. Our channel directly explains 8-16% of the decline in national employment during 2007-2009 and as much as 20-37% for areas worst hit by the housing crisis. The estimates are greatest for both the youngest and smallest firms, and accounting for general equilibrium effects in a macroeconomic framework appears only to magnify our result. Our research highlights the small business collateral channel as a relevant explanation of the recent Great Recession and illustrates business balance sheet shocks as a primary driver of financial frictions to the economy.

The third chapter of my dissertation is titled, "How Case-Shiller got it Wrong: the Effect of Market Conditions on Price Indices" and attempts to extend empirical asset pricing techniques to the study of the housing market. Assets such as real estate, large transportation equipment, and luxury artwork sell infrequently and are not interchangable. As a result traditional price indices, such as the Case-Shiller Index for metropolitan house prices, are the dominant method to measure price fluctuations of these heterogeneous and illiquid assets. First, we highlight that standard price indices are biased towards frequently sold assets and can result in significant financial implications. Secondly, we correct for this mismeasurment by introducing the locally-weighted repeated sales technique, a novel estimation procedure for estimating a distinct price index for any asset and then aggregating assets to define unbiased indices. Our procedure rests on estimating local weights by comparing a given assets to all similar assets sold that period along a number of observable characteristics. Third, we highlight advantage of our technique by examining the US housing market. We find that beginning in 2004 changing credit standards to low income homebuyers resulted in strong price growth and high turnover in low value housing. As a result a Case-Shiller type index substantially overstates the peak of the US housing bubble by 10%.

In the fourth and final chapter, titled "Do Real Estate Prices Impact Entrepreneurial Financing? Evidence from the Home Equity Channel," we examine the use of home equity for small businesses and the effect of real estate price growth on entrepreneurial financing. Using a new micro-level dataset, we find that during the housing boom one-quarter of large US start-ups depended on home equity as a source of initial capital. In response to an exogenous shock to real estate price growth, entrepreneurs increase reliance on home equity financing relative to firms with minimal financing needs. Simultaneously, these firms decline financing through bank loans while less formal financing channels appear unaffected. The results are greatest for firms that receive between $50,000, and $1 million in funding. Specifically, in our preferred specification we find that a 100% increase in real estate price growth is responsible for an 11% increase in home equity financing among all entrepreneurs and a 21% increase for large start-ups. Using a simple back of the envelope calculation we find that 2000-2006 real estate price growth is responsible for at least a 9% increase in the level of initial funding through the home equity channel.

2 How Real Estate Drives the Economy: An Investigation of Small Firm Collateral Shocks on Employment

Introduction

The real estate market has been at the center of the debate on the causes and consequences of the rise in unemployment during 2007-2009. Recent research has argued that the high level of unemployment is the result of a drop in consumer demand driven by housing shocks to household balance sheets[1]. A separate literature highlights the role of toxic real estate assets on bank balance sheets and the resulting decrease in financial lending[2], while still others focus on structural unemployment relating to the decline of construction spending or house lock[3].

To date there has been little attention to the real impacts of the real estate market on the small business balance sheet. Yet, between 1997 and 2009 the Debt-to-GDP ratio of US noncorporate firms (i.e sole proprietorships and limited partnerships) grew faster than both household debt and corporate debt before subsequently declining by 14% during the Financial Crisis[4]. We relate this fact to the simultaneous rise and fall of the commercial real estate market give that: (i) 70% of all commercial and industrial long-term debt and 30-40% of short-term loans in the United States are secured by collateral assets (Berger and Udell 1990) and (ii) real estate is the primary source of collateral for small business borrowing (Federal Reserve Bank of New York 2013).

With this in mind, our paper evaluates an alternative possible explanation of the rise and fall in employment over the last decade: the small business collateral channel. We argue that small financially-constrained firms rely on real estate as a pledgable asset for external financing and that shocks to the value of this real estate can affect firm labor decisions. Using geographic variation in real estate shocks, we find that for a $ 1 decrease in the value of real estate the firm actually owns results in a $ 0.25 decrease in debt and impacts both investment and employment expenditures.

[1]See Mian and Sufi (2011), Mian and Sufi (2012), Mian, Rao and Sufi (2013), Midrigan and Phillippon (2011), Eggertson and Krugman (2012), and Guerreiri and Lorenzoni (2011).

[2]See Chodorow-Reich (2013) and Greenstone and Mas (2013).

[3]See Charles, Hurst, and Notowidigo (2013) and Karahan and Sree (2013).

[4]This is not simply a national phenomenon: between 2002 and 2007 UK private firm liabilities increased from $2,283 billion to $ 3,690 billion, a 62% increase in only five years. During this same period public firms increased from $124 to $156 billion(a 27% increase), and households increased liabilities increased by 65% from $923 to $1,521 billion. A closer look at the data tells us that this increase is largely driven to an increase in loans. Private firms saw an incredible 98% increase in loans (from $664 billion to $1,315.5 billion), while households saw a 71% increase (from $ 847 billion to $1,449 billion).

After aggregating our results and accounting for equilibrium effects in the macroeconomy we find that the small business collateral channel is responsible for 8-16% of the total decline in aggregate employment expenditures. Our work highlights that small firm balance sheet shocks comprise a viable link between financial frictions and the macroeconomy.

We differentiate between two potential explanations of our results. First, collateral restrictions on investment can result in a decline in capital and impact employment due to the complementarities of capital and labor. Alternatively, if small firms fund employment through external financing, then a collateral restriction can directly limit employment spending. We develop both cases in a simple theoretic analysis in order to guide our firm-level empirical analysis.

Our analysis relies on a large and detailed financial dataset of United Kingdom firms. We first distinguish between firms that do and do not own real estate within a set location, and secondly by the level of real estate shock exposure between land-owning firms. Using the former regression design we are able to separate the heterogeneous effect of local demand shocks from collateral shocks, and using the latter we are able to identify the effect of a \$ 1 decrease in the value of real estate that the firm actually owns.

We estimate that firms extract \$ 0.25 of debt for every \$ 1 increase in real estate values[5]. The result is robust to numerous specifications and holds across industries. Instead the estimate appears driven by financial constraints as the effect decreases with firm age.We find the leverage effect is driven by secured financing and that short-term loans are particularly susceptible to collateral shocks. In response to a collateral shock, young firms not only experience a decline in short-term loans, but also an increase in the interest rate.

We note that our estimates may be driven by an unobserved variable causing firm financing decisions to be correlated with: (i) local real estate prices or (ii) the decision to own real estate. To check the first concern we instrument real estate price growth with the local regulatory refusal rate of major real estate projects. Local areas with high regulatory constraints experience large real estate price appreciation in response to increase in the aggregate real estate demand while areas with low regulatory constraints will experience more minor price growth since the demand can be easily supplied. Secondly, initial real estate holdings are an endogenous choice of the firm. While

[5]For comparison Chaney et al (2012) find that the representative US public firm extracts only \$ 0.04, while Mian and Sufi (2011)find that the average US homeowner extracts \$ 0.25-0.30 for every dollar increase in home equity.

we do not have a valid instrument for this concern we include a number of firm characteristics that influence the initial real estate holdings of the firm.

In line with our theoretical model we find that a collateral shock forces firms to cut employment and investment by $0.07 and $0.10, respectively. Focusing our attention on employment we find that the estimate increases to $0.11 when instrumenting for real estate price growth. The effect is strongest during the 2008-2012 years and declines with firm size. Interestingly this effect is entirely driven by changes in the level of employment as opposed to changes in the average wage. We highlight that real estate shocks have no direct employment effects for firms with easy access to alternative external financing by narrowing our analysis to public firms [6].

By appropriately weighting our baseline results and aggregating we are able to tie the decline in total employment to our firm-level estimates. UK employment rose to a high of 95% in 2007 before falling 3% by 2009; during this same time frame real estate prices fell approximately 18%. Using a simple back of the envelope calculation, we find that collateral effects explain about 8% of the total aggregate employment decline in the economy. Applying estimates from the coefficients from the 2007-2012 subsample doubles our result to 16% with effects as large as 37% for areas worst hit by the housing crisis.

Our aggregated effects appear to be largest for the youngest and smallest firms. The collateral channel explains 14-24% of the decline for firms with 10-49 employees, yet only 5-11% of the employment decline for the largest firms (those with at least 250 employees). Similarly, the decline in real estate can explain 15-29% of the total decline in employment for the youngest firms, but a smaller 6-12% of the decline for the oldest firms.

Evaluating only the firm-level effects on aggregate employment, however, misses the second half of the story. First, it is possible that we are actually overestimating the implications of the small business collateral channel since the equilibrium fall in prices may actually raise the output of unconstrained firms and therefore their labor demand. Alternatively, wealth shocks to constrained firms cause a decline in the demand for material goods. This drop in demand will affect all firms and may lead us to underestimate the significance of the collateral channel. Using a simple general equilibrium model we argue that the demand effect cancels out any price effect, leading us to only

[6] In an online appendix we apply our methodology to study the implications on US public firms. We find evidence that investment is partially financed through secured debt, but no evidence that employment is finance through secured debt.

underestimate the true results. Taken together with our empirical findings we find that the small business collateral channel is a relevant explanation of the current state of the economy.

Our results are related to recent work by Gan (2007), Chaney, Sraer, and Thesmar (2012), and Cvijanovic (2013), who use geographic variation in real estate shocks to highlight the effects of financial shocks to firm balance sheets. This paper adds to this literature in a number of important dimensions. While Gan (2007) focuses on investment and Cvijanovic (2013) considers leverage, we instead test the effects of balance sheet shocks on employment, allowing us to directly tie the commercial real estate sector to the real economy. Secondly, to our knowledge we are first to include data on the financial crisis years and slow subsequent economic recovery of 2007-2012, and so quantitatively evaluate the implications of the small business channel on the Great Recession.

More importantly, however, is that we develop a substantially larger dataset that includes small and medium size firms. This is significant on two levels. First, by focusing only on small and medium firms we minimize measurement error that may be biasing the results. The reason is that this line of literature uses firm headquarters to proxy for the location of the firm, a proxy that is most suspect for large firms that own real estate in multiple locations. Secondly, due to our representative data sample we are able to approximate the population-weighted estimates of the employment channel. In comparison, research that includes only public firms is not able to easily move from microeconomic evidence to macroeconomic implications.

There is a small literature that examines the effects of financial shocks on small firm employment such as Benmelech, Bergman, and Seru (2011). Particularly close to our work is Adelino, Antionette, and Severino (2013) who document the role of collateral lending through home ownership to facilitate small business starts and self-employment. However, these papers rely only on regional evidence and do not have data on the financial shock at the firm level [7]. In comparison, this paper uses firm-level evidence and as a result can compare the relative exposure each firm faces to real estate shocks on the balance sheet. We are able to identify the small business collateral shock separate from related local demand shocks as well as equilibrium effects[8].

Several papers discuss the aggregate demand channel as a potential explanation of the 2007-2009

[7]One exception is Chodorow-Reich (2013) who uses firm level data to test the effects of lending supply on small business employment. However, even this paper only includes data on firms that borrow syndicated loans of at least $100,000 in value.

[8]For instance Moretti (2009) finds that new jobs in a local area lead to a multiplier effect where additional jobs are created through increased demand for services

decline in unemployment: Mian and Sufi (2011) estimates the level of home equity-based borrowing between 2002-2006, while Mian and Sufi (2012) and Mian et al (2011) consider the effects of the decrease in equity-based borrowing on employment and consumption, respectively [9]. This channel is difficult to easily quantify for two reasons. First, the aggregate demand channel requires that we can empirically separate collateral and wealth effects from local demand shocks and market-wide financial liberalization, which necessitates detailed information on consumption and home values not available at the household level. Secondly, this channel needs to identify the relationship between consumption and unemployment. In comparison we are able to (i) match real estate ownings with real expenditures at the firm level, and (ii) directly quantify the impact of firm balance sheet shocks on unemployment by narrowing our focus to firm labor expenditures. We find our analysis as complementary to the aggregate demand literature and view the small business collateral channel as a valid alternative explanation for the Great Recession.

A related literature instead discusses the employment effects of toxic real estate assets on financial firm balance sheet. Chodorow-Reich (2013) uses firm-level evidence to test bank lending frictions on employment outcomes, but considers only a small sample of firms and requires all firms access the syndicated loan market. Greenstone and Mas (2013) instead must rely only on local data to pursue their research. This research generally rests on the assumption that firms cannot easily switch to a different lender; while this may be true in the short-term, these papers are not able to explain the slow employment recovery both in the US and abroad.

Other researchers have attempted to explain the simultaneous fall in employment and housing prices through structural issues relating to the reallocation of workers. Charles et al (2013) focus on the employment decline in the construction sector starting in 2007[10]. Alternatively Ferreira, Gyourko, and Tracy (2010), Valetta (2012) and Karahan and Rhee (2013) quantify how low housing values impeded migration to areas with job vacancies[11].

These results introduce a new channel to the large literature on the effect of local real estate prices to household consumption. The large literature on this subject including Case, Quigley, and

[9] In a related paper Bils, Klenlow, and Malin (2012) test the Keynesian model that short-run demand for labor is sensitive to the demand for goods.

[10] See Sahin et al (2013) for a separate article on the effects of structural unemployment.

[11] Business uncertainty is a separate explanation of the rise in unemployment not directly related to real estate and is discussed in Baker et al (2013) and Bloom et al (2013).

Shiller (2003), Ortalo-Magne and Ray (2001), Lustig and van Nieuwerburgh (2004), and Campbell and Cuocco (2007) has generally attributed these shocks to: (i) wealth effects, (ii) collateral effects on constrained homeowners, (iii) unobserved factors such as expected future income shocks, and (iv) financial liberalization that simultaneously affects household consumption and real estate prices. This paper instead presents and quantifies the significance of a fifth channel: income due to collateral effects on constrained firms.

This paper is based on the foundational work of Kiyotaki-Moore (1997) and is especially close in spirit to recent theoretical research on the real effects of firm collateral shocks such as Jermann and Quadrini (2011). Our focus on the indirect effects of the collateral channel- particularly non-financial linkages between firms due to a demand for material goods- is based on the theoretic model of Shourideh and Zetlin-Jones (2012). Finally, our empirical work is related in spirit to Liu, Wang, and Zha (2013a, 2013b) who explore the theoretical relationship between firm real estate shocks and firm employment decisions. Our own work attempts to quantify the microeconomic significance of these channels in an attempt to give empirical validity to the theory that firm financial shocks are responsible for business cycle fluctuations.

The rest of the paper proceeds as follows. Section 2 discusses the econometric methodology and the data sources. Section 3 provides the empirical results. Section 4 quantifies the partial and general equilibrium effects of real estate shocks on firm employment. Section 5 concludes.

Methodology and Data

Accurately estimating the small business collateral channel is not a simple matter. It is not readily apparent how to isolate the effects of collateral shocks or even if real estate prices affect firm employment through the collateral channel. We begin this section by developing a simple static model to develop a clear identification method. According to the theory, collateral shocks affect employment decisions only when the firm is financially-constrained. Next using firm-level data we test first how the average firm increases the level of external debt subject to a positive real estate shock, and secondly how this firm spends the additional borrowing. We control for two endogeneity concerns. First variation in local real estate price may be endogenous to firm financing decisions through local demand or firm investment. Secondly, the decision to purchase real estate is an endogenous choice. We also address numerous sources of potential measurement error and offer evidence that each source is unlikely to significantly affect our results.

Prediction from the Theory

Our theoretical model based on the work of Shourideh and Zetlin-Jones (2012) with two key differences: (i) we focus on firm labor demand as opposed to output, and (ii) we extend the model to incorporate firm labor demand into the collateral constraint. In our baseline framework we assume that firms face a collateral constraint and then derive the firm demand for labor in response to a shock to the collateral constraint. We consider two possible channels for a collateral shock to impact employment: directly when employment cannot be financed through revenue and indirectly due to complements between investment and employment in the production function.

From the model we find that only financially-constrained firms increase employment in response to a real estate shock while unconstrained firms see no effect. We return to the theory when we aggregate the microeconomic result to the macroeconomy, particularly when we attempt to account for general equilibrium effects. We develop the theory in the appendix; here we only introduce the theoretical predictions.

Theoretical Result 1. *When firms partially fund employment through external financing the sensitivity of firm labor to a balance sheet shock is:*

(i) positive for any financially-constrained firm

(ii) positive for any financially-constrained firm conditional on firm capital holdings

(iii) zero for any financially-unconstrained firm

Theoretical Result 2. *When firms partially fund investment through external financing the sensitivity of firm labor to a balance sheet shock is:*

(i) positive for any financially-constrained firm

(ii) zero for any firm financially-constrained firm conditional on firm capital holdings

(iii) zero for any financially-unconstrained firm

While our theoretical model differs significantly from Cvijanovic (2013) and Chaney et al (2012), our theoretical predictions are similar and help guide our identification strategy. We note that this result does not depend on any particular model assumptions and is instead a general result of models with financial frictions. However, this literature has generally focused on the collateral effects to firm debt or investment. Unique to our analysis is our emphasis of the effects of firm employment decisions.

Empirical Methodology

The theoretical model implies a convenient and tractable empirical framework. Following the standard literature we empirically test the impacts of a financial shocks- in our case a real estate shock- to firm employment.

$$Emp\,Cost_{it} = \beta^E Real\,Estate_{it} + \gamma^E Capital_{it} + \phi_t^E \times \theta_l^E + \rho^E Productivity_{it} + \alpha_i^E + \boldsymbol{\lambda}^E \sum X_{i,0} \times P_{lt} + \varepsilon_{it}^E \tag{2.1}$$

$$Capital_{it} = \beta^C Real\,Estate_{it} + \phi_t^C \times \theta_l^C + \rho^C Productivity_{it} + \alpha_i^C + \boldsymbol{\lambda}^C \sum X_{i,0} \times P_{lt} + \varepsilon_{it}^C \tag{2.2}$$

$$Real\,Estate_{it} = P_{lt} \times Real\,Estate\,Holdings_{i,0} \tag{2.3}$$

First Capital is total capital expenditures for firm i in period t while Emp Cost is the annual total cost of employees for firm i in period t. As in our theoretical model we evaluate the effect of an exogenous shock to the net worth of firm i on investment and employment costs. For this exogenous shock we use changes in the market value of real estate holdings. Real Estate measures the value of firm i real estate holdings at time t and so the coefficient β^E measures how a \$1 increase in this variable impacts firm employment decisions. To calculate the market value of real estate we interact the real estate holdings at the start of the sample, Real Estate with P, the price index in location l at time t[12]. Assuming that local real estate prices drive the market value of real estate assets this variable is a valid measurement of the current value of real estate.

Next in our employment regression we condition on capital in the analysis to distinguish between a firm financially-constrained in capital from one constrained in labor. Specifically, according to our theoretical predictions if $\beta^E > 0$ then a sample of firms are financially-constrained in labor. However, a firm may still be financially-constrained in capital even if $\beta^E = 0$.

Our theory dictates that employment is dependent on economy-wide characteristics- specifically the wage rate, the interest rate, and total production. It is critical to control for these factors

[12] This is necessary since real estate holdings in our data are not marked to market but instead valued at historical cost.

in our analysis since the real estate shock affects all firms collectively through equilibrium effects. For instance a negative shock to net worth results to a decrease in the labor demands of financially-constrained firms; however, this affect will also cause an decrease in the equilibrium wage rate and can actually lead to an increase in the labor demand of unconstrained firms. In practice employment is likely influenced by any number of unobservable variables. Therefore we instead include time fixed effects ϕ interacted with location l fixed effects. In this specification we absorb all unobserved variation within a single location in a particular time period.

Additionally our theoretical model implies firm labor decision is dependent on the firm productivity and so included in the regression. Of course productivity is an unobservable characteristic that cannot be easily calculated. Therefore we also allow for unobserved firm heterogeneity by including firm fixed effects α. Finally we cluster all error terms at the level of Year$\times$Region.

Endogeneity Concerns

The primary concern with our methodology is that the value of real estate is not exogenous. First the initial real estate holdings, Real Estate Holdings, is not actually exogenous but instead an endogenous choice of the firm. Secondly, the local real estate prices, P, and firm employment may be jointly determined by an omitted time-varying variable, notably local demand shocks. We discuss both concerns below.

Government Regulation of Real Estate as a Source of Exogenous Variation

Since firm employment and local real estate values may be correlated through an omitted variable we need an exogenous source of variation in local real estate price growth. Recall that we include the time fixed effects interacted with local fixed effects. Therefore there is only a potential endogeneity concern if firms that hold real estate are subject to local demand shocks unique from firms that do not own real estate.

To overcome this issue my first test exploits variation in real estate government regulation as an instrument for real estate price growth. As discussed in Cvijanovic (2013) the intuition for this approach is that the slope of the land supply curve determines how a national real estate demand shock will affect real estate prices in a given area. Local areas with high regulatory constraints experience large real estate price appreciation in response to an increase in the aggregate real estate demand while areas with low regulatory constraints will experience more minor price growth since the demand can be easily supplied.

In a recent paper Mian and Sufi (2011) find that between 1997-2006 inelastic US MSAs experienced house price growth of over 100% while elastic areas saw no increase in house price. To our knowledge we are the first to apply this instrument to data from the United Kingdom. In order to use government regulation as a source of exogenous variation we need to document that this measure offers a single source of variation that explains the real estate price.

To instrument for real estate price growth we follow a similar strategy as Himmelberg, Mayer, and Sinai (2005) and interact the regulatory housing supply measure with the interest rate I and include year fixed effects and local fixed effects.

$$P_{lt} = \beta^P (Refusal_{lt}/I_t) + \phi_t^P + \theta_l^P + \varepsilon_{lt}^P \tag{2.4}$$

The results gives us an instrumented real estate price variable for each local area and each time period.

Firm Characteristic Controls that Determine Initial Real Estate Holdings

By instrumenting for real estate price growth we have controlled for the possibility that firms that hold real estate are differentially affected by local demand shocks. We now turn to the second concern: initial real estate holdings are an endogenous choice of the firm. Therefore we include a number of firm characteristics that influence the initial real estate holdings of the firm. We interact each control by the local price index at time t to allow for shocks to the value of real estate each period.

We include controls that appear to explain the decision to purchase real estate and denote these firm characteristics by $\sum X_{i,0}$ where $X_{i,0}$ denotes a decile indicator variables for firm i in the first initial period[13]. Our firm controls include: (i) total assets, (ii) employment costs, (iii) materials costs, (iv) return on real estate, (v) firm age, (vi) industry codes, and (vii) location controls. To control for the total demand of real estate we include controls on total assets. Next, total employment costs

[13]We are not the first to suggest that firms that own real estate have different characteristics from firms that rent. Krishan and Moyer (1994) find that lessee firms have lower retained earnings relative to total assets, higher growth rates, higher debt ration, and higher bankruptcy than non-lessee firms. Using 3000 public and private firms from the UK Levis and Lasfer (1998) find that leasing firms are more likely to have tax losses, high fixed capital adjustment, high debt-to-equity ratios and to be larger. Lastly, Sharpe and Nguyen (1995) find firms with a high operating lease-to-total lease ratio pay no dividends, have lower earnings to sales, have lower credit ratings, and are generally smaller.

as well as total material costs allow for complementarities in firm production between real estate and employment as well as real estate and materials. Return on real estate is used as a measure of idiosyncratic real estate productivity, and we use firm age as an ex-ante measure of financial-constraint. We also include industry classification to allow for heterogeneous real estate ownership demands among industries and location controls to allow for local differences in ownership.

Data Sources

Real Estate Data

Halifax House Price Index Our primary source of data is from the Halifax House Price Index, which is derived from mortgage data of the country's largest mortgage lender. The data is available at the regional level since 1983 and includes data on a total of twelve different geographic regions. Overall, the UK experienced a boom period between 2002-2007 and a slower bust period 2007-2012. The United Kingdom Price Index increased from 81% during the boom period before falling 18% from its peak.

Northern Ireland had both the largest boom and the largest bust of all UK regions and seems to move more closely with the rest of the Ireland island price indices. In particular, the nominal price index increased a full 175% between 2002 and 2007 before dropping by over 50% from its peak. Outside of Ireland, the Northern region had the second greatest boom period increasing 121% over the first five years in the sample.

Local Planning Authority House Price Index The Local Planning Authority House Price Index is from Hilber and Vermoulen (2013).The data are developed from the Land Registry for 1995-2008. They first account for the composition of sales using a mix-adjustment approach by holding the share of each housing type constant. Then to determine the LPA-specific weights they average the share of sales of each type for each period.

Nationwide House Price Index Our secondary UK Regional Housing data comes from Nationwide, which is derived from Nationwide lending data for properties at the post survey approval stage. The data are available starting in 1980 and breaks down the UK into thirteen geographic regions.

FTSE Commercial Property Index We use the FTSE UK Commercial Property Index Series. The index is derived from the values of the index constituents that are available for purchase in the market; assets used in the calculations currently top ï¿œ60 billion in value. It also includes three additional sector indices covering: Office Property, Industrial Property, and Retail Property.

Real Estate Regulation Data

English Local Planning Authority Regulatory Decisions We develop a measure of housing supply from the direct regulatory decisions for all English Local Planning Authorities (LPAs) on an annual basis between 1979 and 2008 from the Planning Statistics Group at the Department for Communities and Local Government. The data are matched to the LPA using the 2001 LPA boundaries. Regulatory decisions are defined as both refusal rates and planning delays.

In Figure 2.1 we graph the total growth in real LPA house prices between 1995-2007 on the average yearly refusal rate. We find that a one-percentage point increase in the refusal rate predicts a 1.57% increase in real local house prices between 1995-2007[14].

Accounting Data

AMADEUS AMADEUS is a commercial dataset provided by Bureau van Dijk (BvD) and contains detailed information on approximately ten million individual public and private firms across Europe as well as their subsidiaries around the world. The data is generally collected from local information providers, usually the local company registrars, and the data is available at the yearly level. We use a ten year period from 2002-2012 and drop all financial firms, as well as all firms in real estate, insurance, construction, and mining. We also drop any observations with missing variables. We exclude all firms that enter the sample after 2002. We are left with a total of 94,973 total Firm-Year observations.

We next collect data on the firms' real estate holdings; we use Capital (item TFAS) as a proxy for the initial real estate holdings of the firm and then take the ratio over lagged Total Assets (item TOAS). As discussed earlier we then interact this variable with the local price index each

[14]These results closely relate to Hilber and Vermoulen (2013) who find that 2008 real estate prices in the average local planning authority (LPA) would be 35% lower if the regulatory supply constraints were completely relaxed, 10% lower absent of scarcity constraints, and 3% lower in the absence of elevation differentials.

period to capture the relative differences in market values of real estate holdings. We note that an alternative framework would instead define the real estate value of a firm to be gross current total fixed assets; pursuing this avenue would minimize potential measurement error concerns but would form additional endogeneity concerns. In particular in response to real estate price growth it is possible that firms purchase additional real estate. This will then tend to bias our results upwards.

Emp Cost is defined as the Total Cost of Employees (item STAF) over lagged Total Assets (TOAS). In addition we define two additional employment variables: Employees is defined as the Number of Employees (EMPL) over lagged Total Assets (TOAS), while Avg Emp Cost is defined as the Average Cost of Employees (item ACE) in real terms.

We consider a range of debt variables. Our non-current debt variables include Long-Term Debt (item LTDB), and Other Current Debt (item OCLI). Our current debt variables are Short Term Loans (item LOAN),Trade Credit (item CRED), and OtherNon-Current Debt (item OCLI). As before all debt variables are calculated over lagged Total Assets (item TOAS). Our variable Total Debt is then defined as the sum of debt variables.

We have only a noisy measure of the short-term interest rate (item INTE); however, we also have the credit period in days (item CRDE). Therefore we determine the term structure by regressing the short-term interest on the credit period and then defining the Short-Term Interest Rate as the residual of the regression.There are two other financing variables included in the analysis: Equity (item SFHD) and Cash (item CASH) normalized by lagged Total Assets.

We also include additional variables on firm expenditures and finances. Materials Cost is the Cost of Goods Sold (item COST) minus Total Cost of Employees (item STAF) all over Total Assets. Our definition of Investment is the Annual Change in Total Fixed Assets (TFAS) accounting for Depreciation (item DEPR). We define Revenue as the ratio of net income (item OPRE) to lagged total assets and Profit as gross profit before taxes (item PLBT) normalized by lagged Total Assets. Finally, we winsorize all variables at the 5th and 95th percentile[15].

We first summarize the accounting data of UK firms in our sample in Table 1. The median firm in our sample has only 63 employees with the 25th and 75th percentile at 24 and 154 employees, respectively. Our smallest firms have only a single employee, while the largest firm has 471,108 on its

[15] One exception is our measure of the short-term interest rate. We instead winsorize at the 10th and 90th percentile due to the large variation in this variable.

payroll. Therefore our data include the small firms most likely to depend on collateral for external financing.

The mean firm has a 1.89 ratio of revenue to total assets and a profit ratio of 0.05. The firm spends 0.98 on materials, 0.40 on employees, and 0.05 on investment in capital. We find that net total debt is 69% of total assets for the mean firm; this ratio of net debt to total assets is broken into 14% for long-term debt, 4.4% for other non-current debt, 19% for short term loans, 15% for trade credit, and 16% for other current debt.

We consider two alternative sources of financing: Equity, and Cash. The mean firm has an equity to total assets ratio 0f 0.28 and a cash ratio of 0.11. Therefore our representative firms rely heavily on debt likely due to a lack of alternative financing options[16].

Lastly, we consider our real estate variables: the value of firm real estate and the local price index. We find that the value of real estate is 28% of total assets for the mean firm and 21% for the median firm. In addition the price index starts at a value of 1 for all locations in 2002 and has a mean value of 1.46 and a median value of a similar 1.41.

We also summarize the decline of the economy between 2007 and 2009 in Table 14. Real estate prices declined on average 17% while revenue decreased from 1.95 to 1.79 or 8%. The decline in revenue resulted in a 20% drop in investment, a 7% drop in employment spending and an 8% drop in materials spending. Finally debt decreased by 13% during the two year period with a decline in long-term debt, short-term loans, and trade credit of 9%, 13%, and 13%, respectively.

Our empirical methodology requires a measure of productivity. We employ the semi-parametric procedure suggested by Olley and Pakes (1996) to estimate each parameter of the production function. The advantage of this approach over OLS is its ability to control for selection and simultaneity biases as well as deal with the firm serial correlation in productivity. We estimate the materials good share at 0.70, the labor share is estimated to be 0.28 and a capital share of 0.02. The result are fairly constant across time and by industry, although the capital share is slightly higher for manufacturing. These results suggest a large materials cost share and correspond with Jones (2011) who finds that overall intermediate goods share for the U.S. economy is about 43.4%, which is lower for service industries and higher for tradable goods. We discuss the estimation details in the appendix.

[16]Our results validate Robb and Robinson (2010) who find that small firms rely heavily on bank financing compared to alternative external funding sources.

As discussed in Tuzel and Imrohoroglu (2013) even though productivity and profitability are expected to be related, their calculation and interpretation are different. Theoretically profit is the rent to firm owners while productivity is a measure of the efficiency of the firm in converting inputs to outputs. In fact a number of papers- including Gourio (2007) and Novy-Marx (2013)- proxy unobserved productivity with profitability. We present the correlations in Table 17. We find that productivity and profitability are correlated at 0.22.

Worldscope Worldscope includes data on both public and private firms throughout the world. We merge our AMADEUS dataset with Worldscope for an accurate measure of real estate holdings. We use data from 2002-2012. Once we merge the data with AMADEUS we have a total of 5,348 total firm-year observations for 544 firms.

Net Land is defined as gross land (item 18375) over depreciated land (item 18383). Net buildings is defined as gross buildings (item 18376) over depreciated buildings (item 18384). Net machinery is calculated as gross machinery (item 18377) over depreciated machinery (item 18384). Net rental properties is gross rental properties (item 18378) over depreciated rental properties (item 18385). Net transport is gross transportation (item 18380) over depreciated transportation (item 18388). Net capital leases are defined as gross capital lease (item 18381) over depreciated capital leases (item 18389). Net construction in progress is calculated as gross construction in progress (item 18390) over depreciated construction in progress (item 18392), net other PPE is gross other PPE (18379) over depreciated Other PPE (item 18387).

With all this we can then define net real estate as the sum of: net land, net buildings, and net construction. We define total fixed assets as the sum of all net land, net buildings, net construction in progress, net capital lease, net transportation, net machinery, net rental properties, and net other PPE.

Measurement Issues

There are a number of potential measurement error concerns in our analysis. We discuss each issue and offer evidence that our results are not driven by measurement error.

Real Estate Holdings

The first concern is that we proxy for real estate holdings using the Tangible Fixed Assets; therefore we need real estate to be a significant portion of Tangible Fixed Assets. We confirm our proxy using the National Balance Sheet from the UK Office of Statistics in Table 18. The National Balance Sheet data shows the estimated market value of financial and non-financial assets, that is, what these assets would realize if sold at market value. Non-financial assets include both tangible and intangible assets. Tangible Fixed Assets is broken into four components: (i) Dwellings, (ii) Other Buildings and Structures, (iii) Machinery and Equipment, and (iv) Cultivated Assets. We find that in 2012 Real Estate makes up 64.8% of Tangible Fixed Assets, broken into Commercial Real Estate (54.6%) and Residential Real Estate (13.2%). This evidence supports our proxy for real estate holdings.

Of course, the results may be different depending on the type of firm. Given our research focus we also verify that real estate makes up the majority of small firm fixed assets. Unfortunately the United Kingdom has no aggregate data on small firm balance sheet. Instead we use US data from the Federal Reserve Flow of Funds and summarize the results in Table 19. We find that noncorporate firm (i.e. sole proprietorships and limited partnerships) real estate holdings make up 91% of all non-financial assets and 66% of total assets. In comparison, corporate firm real estate holdings make up 59% of non-financial assets and 30% of total assets. Therefore our proxy seems particularly reasonable for smaller firms

A second concern with this evidence, however, is that the data do not clearly differentiate between real estate ownership and financial leasing. According to the United Kingdom Accounting Standards, leases are broken down into operating leases or financial leases. While a financial lease is any lease that transfers substantially all the risks and rewards of the ownership of an asset to the lessee, it is likely that leased real estate cannot be collateralized for a loan or debt contract.

To check that our real estate measure is not driven by leases, we use data from Worldscope to develop a detailed measure of real estate holdings for a subset of our firm-year observations. We find in Table 20 that 72% of all firms in this subsample own some form of real estate. In addition owned real estate makes up 29% of all fixed assets within a firm and 53% of all fixed assets for firms that own real estate. In comparison rental costs and financial leases each make up 0.2% of total fixed assets. When we break down owned real estate holdings we find that 87% of all real estate is made up of buildings while 6% is land and the remaining 7% is construction in progress. The remaining PPE includes Machinery (29% of PPE), Transportation (4% of PPE), and Other PPE (the last 38%)[17].

A third concern with our measure of real estate holdings is that firms may increase their real estate portfolio in response to positive real estate price growth, causing us to overestimate the true results. Therefore we instead interact the 2002 Fixed Total Assets with local real estate markets. However, this strategy has its own concerns. In particular it is possible that firms are drastically buying or selling real estate after 2002, causing significant errors in our measure of real estate holdings. After accounting for depreciation we find that there is only a 3% yearly change in total fixed assets for the median firm.

Firm Location

Next, we assume that the majority of a firm's real estate holdings are located in the same geographic area as the firm headquarters. This will bias our results if the firm owns significant real estate in another location. We note that given the median firm in our sample has only 63 employees this concern seems minor[18].

However we redo our analysis using only small and medium firms (defined in the UK as 250 employees or less) and find that our results only increase in magnitude by this restriction. In addition,we consider three separate definitions of location for our fixed effects specification- UK Local Planning Authority, UK Region, and UK- and find that our results appear similar.

Regional Commercial Real Estate Index

We use the Regional Residential Real Estate Index as a proxy for the Regional Commercial Real Estate Index[19]. This could lead to a biased estimate if the residential and commercial real estate indices are uncorrelated. We compare the quarterly fluctuations between the Halifax Residential Real Estate Index and the FTSE Commercial Real Estate Index from 2006-2012 in Table 21.We find that the indices have a 93% correlation. In addition we find the residential index is correlated with the office index, industrial index, and retail index at levels of 90%, 93%, and 94%. We take this as

[17]It seems reasonable that these results will not be particularly different for private firms. Using UK data on both 3000 public and private firms, Levis and Lasfer (1998) find that 56% of firms in the smallest decile have a lease compared to 55% of firms in the largest decile.

[18]We also acknowledge that Garcia and Norli (2013) find that the median US public firm has offices in only 5 states and in only 4 states for the smallest third by market capitalization. Looking at the 20% least geographically diverse these numbers reduce to 2.6 states, and 2.1 states.

[19]To our knowledge there does not exist a UK Commercial Price Index for individual cities or regions.

evidence that our results are driven by our price index proxy.

Accurate Representation of the Firm Population

We check that our data sample from the Amadeus dataset includes the full range of UK firms and can therefore represent the actual population. This is necessary since we use our results to estimate the total impact of the small business collateral channel to the economy.

We measure the UK firm population from the UK Business: Activity, Size, and Location dataset from the Office of National Statistics. in the 2011 Amadeus dataset to the [20]. We use the Analysis of UK VAT and/or PAYE based Enterprises tables, Table B1.2 Districts, Counties, and Unitary Authorities within Region and Country by Employment Size Band.

We outline the data in Table 22. According to the Office of Statistics the UK has approximately 2.1 million firms, broken into 1.6 million with 0-4 employees (76% of the population), 268,000 with 5-9 employees (13% of the population), 124,000 with 10-19 employees (6% of the population), 66,000 with 20-49 employees (3% of the population), 22,000 with 50-99 employees (1% of the population), 12,000 with 100-249 employees (0.6% of the population), and 8,600 with at least 250 employees (0.4% of the population).

In comparison our cleaned data sample has a total of 9,552 firms as of 2002, separated into 942 firms with 0-4 employees (10% of the sample), 189 firms with 5-9 employees (2% of the sample), 530 firms with 10-19 employees (6% of the dataset), 1769 firms with 20-49 employees (19% of the sample), 2,647 firms with 50-99 employees (28% of the dataset), 2,368 firms with 100-249 employees (25% of the dataset), and 1,973 firms with at least 250 employees (21% of the dataset).Therefore our sample includes firms from the very smallest to the very largest. As a result our estimates should not be biased due to selection into the sample.

When we break the dataset by firm age, we find that the UK has 306,000 firms under two years old, 270,000 firms 2-3 years old, 579,000 4-9 years old, and 926,000 ten or more years old. In our sample we have 952 firms under two years old in 2002 (10%), 831 2-3 years old (9%), 1,909 firms that 4-9 years old (20%), and 5,860 firms that are at least ten years old (61% of the sample).

[20] While our dataset includes years through 2012, we only have access to a small subset of the 2012 Amadeus files.

Evaluating the Decision to Purchase Real Estate

Recall that one concern with our analysis is that firms that own real estate in the initial period are fundamentally different from firms that choose not to own real estate. To alleviate that concern we have included numerous controls that interact observable firm characteristics with the local price index measures.

In Table 23 we offer evidence that our chosen characteristics do indeed explain the level of firm real estate holdings. We believe this is additional evidence that firms that choose to own real estate are not differentially impacted by local demand shocks that may be driving our results.

$$Real\,Estate\,Holdings_{i0} = \alpha_i^R + \boldsymbol{\lambda} \sum X_{i,0} + \varepsilon_t \tag{2.5}$$

We note of course that there are both observable and unobservable characteristics that we do not include in the controls, some of which will also affect the real estate ownership decision. Therefore to verify that initial real estate holdings are not driving our results we allow for numerous robustness checks in our empirical analysis. This is suggestive evidence that even if additional characteristics enter into the ownership decision, they should not significantly bias our baseline results on the impact of real estate shocks to employment and financing decisions.

Results

We next explore the microeconomic implications of the small business collateral channel. We verify two separate statements: (i) debt holdings are affected by real estate shocks, and (ii) this affect on debt has implications on firm expenditure decisions. According to our estimation, the mean firm borrows \$0.25 out of every \$1 increase in the value of real estate to spend on employment (\$0.07) and investment (\$0.10). Overall the results confirm the microeconomic foundation of the small business collateral channel.

Financing Results

How do Small Firms Increase Leverage when Collateral Values Rise?

We first clearly identify that a collateral shock has an effect on firm debt; this is necessary for our analysis on employment to be taken seriously. We run the baseline regression on debt

$$Total\ Debt_{it} = \beta^D Real\ Estate_{it} + \phi_t^D \times \theta_l^D + \rho^D Productivity_{it} + \alpha_i^D + \boldsymbol{\lambda}^D \sum X_{i,0} \times P_{lt} + \varepsilon_{it} \quad (2.6)$$

We find that indeed leverage is positively affected by a real estate shock; specifically firms borrow an additional \$ 0.25 for every \$ 1 increase in real estate. We present our baseline results in Table 3. In our specifications (i)-(ii) we display OLS results using regional price data, while specifications (iii)-(iv) use the LPA price index for England and instrument for real estate price growth.

One concern with our analysis is that our results are driven by unobserved variation within a particular location and year. For instance consider the possibility that real estate shocks are actually affecting the balance sheet of consumers (instead of the firm balance sheet) and this is driving our results through the decline in local demand. We address this issue by directly comparing firms that should be subject to the same consumer demand shock (i.e. we compare the effect of collateral shocks on firms within the same local area) and so absorb any unobserved variation with each year-location pair. Columns (ii) allows for year fixed effects interacted with Local Planning Authority (LPA) fixed effects. We find that our results do not change with the additional fixed effects and that we still have a significant estimate of \$0.24.

We next focus on the instrumented variable results in specification (iii)-(iv). Recall that our measure of local real estate variation is the interaction of the refusal rate and the UK 30-year conventional rate. In Table 16 we include our first stage instrumental variable results and find that a one unit increase in the interaction term results in a 0.35 increase in the local real estate price. In specification (iii) we allow for year fixed effects while in specification (iv) we include year $\times$LPA fixed effects. We find the comparable values of \$0.25 and \$0.21 for (iv) and (v), respectively.

We find that a 1 unit increase in productivity increases debt by \$0.17 for the OLS results and \$0.209 for the IV results. We believe the significance of this variable can be readily explained by the high correlation between profitability and productivity. According to a Neoclassical model of investment with perfect capital markets the coefficient of cashflow should be zero. In contrast, a positive and significant coefficient implies firms are financially constrained and must rely on internal cash flows instead of external financing. If our firms are indeed borrowing against commercial real estate to finance the firm, then we should find that (i) the productivity coefficient is positive and significant and (ii) the real estate coefficient decreases from our first estimate. According to Table 3 this is exactly the case.

How do these results compare to previous studies? Cvijanovic (2013) uses a similar empirical strategy and finds that \$ 1 increase in Real Estate Value increases debt ownings by only \$ 0.06 for US public firms. However, focusing exclusively on financially-constrained firms and owned real estate (as opposed to real estate in a capital lease), Cvijanovic finds that this coefficient increases significantly to \$0.19. Secondly, using US data from the Small Survey of Business Finances Meisenzahl (2013) finds than an additional dollar of total net worth increases external financing by about 30 cents. Lastly, our results also seem closely in line with Mian and Sufi (2010) who find that households extract \$ 0.25-\$ 0.30 from home equity borrowing during 2002-2006.

Are Alternative Explanations Driving our Results?

In Table 4 we divide our data sample into subsets in order to test several alternative theories that may be driving our results.

Alternative Price Index Since our real estate proxy is based exclusively on data from a single mortgage lender (though admittedly the largest lender) we check that are results are not driven by our particular choice for a price index. We estimate our work using the alternative Nationwide Price Index, which is derived from Nationwide lending data for properties at the post survey approval stage. Our results are nearly identical with a \$ 1 increase in real estate values resulting in a \$ 0.23 increased in debt.

Boom and Bust Years A second concern is that our results in the second half of the sample (the years 2007-2012) are entirely driving our results. If this is the case then we may be concerned that our estimation results are due to influences of the depressed macroeconomy on real estate owning firms. We find that firm leverage is positively and significantly affected by real estate during both the boom and bust periods. We estimate a coefficient of \$0.30 during 2002-2007 and a 2007-2012 value of \$0.35. We note that the heterogeneous effect during the boom and bust is not surprising. Theory implies that real estate shocks will only have an effect on financially-constrained firms. Therefore, during periods of high real estate prices, the mean firm is likely less constrained by collateral requirements, and thus our estimate will be smaller. However, as prices start to drop previously unconstrained firms will become financially-constrained and as a result the estimated effect of real estate shocks will become larger. These results closely align with theoretical models that include an occasionally binding borrowing constraint[21].

Small/Medium and Large Firms Next, we check how firm size affects our estimation. It is possible our causality is actually reversed since it is possible that major employers are actually driving the real estate price market. Alternatively, it might be that by using the headquarters as the firm location we are actually including significant measurement error into our estimation. Excluding larger firms is one possible solution to mitigate both issues.

Therefore, we break down the analysis into small and medium firms (defined as less than 250 employees in the UK) and large firms. If reverse causality/firm location is driving our results then the smaller employers should not be affected by real estate shocks. We find that in fact both small/medium and large firms are affected by real estate shocks where the effect is $0.25 and $0.24 out of $1 of real estate value gains form small/medium and large firms, respectively.

Tradable and Nontradable Industries In addition, we may be concerned that shocks to consumer balance sheets, instead of firm balance sheets, are driving our results. This is of course possible if firms that own real estate are comparatively more affected by consumer demand shocks. To address this concern we now compare our results separately for tradable and nontradable industries. Our definitions of tradable and non-tradable industries are based on the classification scheme in Mian and Sufi (2012). If both industries are similarly affected, then our results are not driven by local demand shocks.We estimate that the $1 shock to real estate translates into a $0.25 and a $0.19 change in total net debt for non-tradable and tradable firms, respectively.

High and Low Productivity Our final robustness check is that firms with real estate holdings may simply be more productive or better able to take advantage of financing opportunities. Therefore we split our sample into quartiles by returns on assets (RTAS) and compare firms within the same quartile. We estimate the real estate shock on low RTAS firms at 0.298, compared to a coefficient of 0.249 for high RTAS firms.

Are Credit-Constrained Firms More Likely to Increase Leverage?

[21]See Guerrieri and Iacoviello (2013) for a general equilibrium model with occasionally binding borrowing constraints.

Our analysis is based on the premise that firms use real estate as a pledgable asset to gain access to external finance; this implies that financially-constrained firms will increase debt subject to a positive real estate shock while unconstrained firms will not be affected. To test this premise we separate firms into age cohorts based on firm age in 2002, with the intuition that young firms are ex-ante more financially-constrained than older firms. We graph the results for the third to the tenth decile in Figure 2.2.

Age is of particular interest in our analysis as young firms are disproportionately responsible for the employment growth and declines. We find exactly this same result as both employment growth and employment costs growth are largest for the youngest firms. Therefore for our results to have macroeconomic significance we need young firms to be particularly affected by real estate shocks.

As expected we find that collateral shocks have a comparatively larger effect on the youngest firms, and that this effect declines monotonically with age. In particular we find that the youngest firms extract up to $0.33 while firms at least 50 year of age borrow only $0.17. This result gives additional credibility to our OLS results; if local demand shocks on land-holding firms were driving our estimation then young and old firms with the same exposure to the real estate market should be similarly affected by collateral shocks. Together we use Figure 2.2 as further evidence that it is financial constraints, and not some other unobservable factor, that is driving our estimation results.

Are Real Estate Shocks Really Collateral Shocks?

Our estimates thus far have focused exclusively on total debt. However, if our real estate shock is indeed a collateral shock then we would find the greatest impact on secured debt. Unfortunately, we do not have data on the level of secured debt holdings for each firm. We instead focus our analysis on long-term debt and short-term loans since nearly 70% of all long-term debt and 30-40% of short-term loans are secured (Berger and Udell 1990).

We break down firm debt into five categories: long-term debt, all other non-current debt obligations, short-term loans, trade credit, and all other current debt obligations. As expected, we see that the collateral effect is largest for long-term debt ($ 0.06) and short-term loans ($ 0.06). In comparison we find smaller effects on other types of current debt ($ 0.04), trade credit ($ 0.04), and other non-current debt ($ 0.04). Our research highlights the comparative significance of real estate shocks on more formal credit channels (such as short-term loans and long-term debt) over more informal networks (such as trade credit). As a result we find that real estate price increases appear to allow firms to increase their secured debt holdings relative to non-secured debt holdings. In this way balance sheet shocks alter not only the level of total debt, but also the capital structure.

Are Short-Term Loans Driving the Small Business Collateral Channel?

Our long-term debt estimates are particularly close to previous results. Chaney, Sraer, and Thesmar (2012) find a real estate shock results in a \$0.04 increase in long-term debt, while Cvijanovic (2013) estimate the effect at \$0.06. However, these same papers have found that real estate shocks have no effect on short-term debt even though 30-40% of short term debt is secured. We instead find a large and significant effect. This discrepancy is likely due to our particular focus on small firms instead of US public firms [22].

We confirm this assumption in Table 5 by comparing how constrained firms increase short-term debt subject to a collateral shock. We find that the youngest firms in the sample, those under five years of age in 2002, increase short-term debt by \$0.08, while firms of twenty years or greater increase short-term debt by \$0.03 (a value not significant at the 5% level). Therefore, the effect on short-term loans appears to die out as firms gain access to alternative financing. We offer further evidence of the short-term loan channel by considering the role of the price of short-term debt. As expected we find that a positive real estate shock results in significantly cheaper financing; specifically the decline in the value of real estate between 2007 and 2009 resulted in a 0.1% increase in the short-term interest rate.

We believe these results may be able to explain a number of recent puzzles in the corporate finance literature. For instance Custodio, Ferreira, and Laureano (2012) find that the use of long-term debt by small US corporate firms has decreased in recent decades. According to our results the rise in real estate prices over the past two decades should be met with a comparative rise in the use of short-term loans among small firms.

What Kind of Industries Extract from Commercial Real Estate Equity?

Industries more dependent on external financing- such as those with large and regular investment

[22] The existing theoretical literature such as Vishwanathan and Rampini (2010) can help us understand this discrepancy. They develop a model that collateral mitigates informational imperfections allowing firms to increase their relative level of arm's length debt financing. This implies that in addition to increasing the borrowing constraint, collateral also expands the set of available financing opportunities. Therefore financially-unconstrained firms with large collateral holdings should rely primarily on arm's length financing such as long-term debt, while constrained firms will be more dependent on short-term loans.

needs- should be highly affected by collateral shocks. We break up firms by NAICS two-digit codes, resulting in 12 total industry groups and plot our results in Table 6 [23]. We find positive and statistically significant real estate coefficients for all industries with the smallest estimate at 0.13 for the retail trade industry (NAICS 4400-4500). We find only minor differences between Manufacturing (NAICS 3100-3300)- estimated to be 0.19- and service industries such as Accomodation and Food- estimated to be 0.25. Overall our results do not appear to be driven by any particular industry.

Investment and Spending Results

How do Collateral Shocks Effect Investment Decisions?

While our results on debt are certainly informative, the financing estimates alone do not help us understand the actual implications of the small business collateral channel on the macroeconomy. First of all, the level of debt is only one measure of the external financing supply; firm spending will in addition be affected by additional debt characteristics such as the price of borrowing and the availability of alternative sources of financing. Secondly, it is necessary to actually quantify how firms spend the financing. Firms that pay off more expensive forms of credit are simply using the debt to change the capital structure of the firm, resulting in only minimal effects on the rest of the economy. However, a decrease in investment will result in a drop in aggregate demand, while a decline in labor expenditure will affect aggregate employment. We briefly discuss the results on investment before covering the effects on employment.

We first estimate that a \$1 real estate shock results in a \$0.09 investment in capital. The estimates in Table 7 appear robust to the particular choice of price index. Large and small firms appear to depend similarly on collateral for new investments. This is in contrast to our employment results. We actually find a slightly larger effect of 0.11 for the 2002-2007 years. Tradable good industries see a \$0.10 increase in capital, while nontradable firms see a smaller \$0.07. The coefficient is 0.069 for the low productivity firm subsample and 0.085 for highly productive firms, implying the result is not driven by productivity differences among firms. These results are closely in line with previous estimates: Cvijanovic finds a \$0.06 increase in the investment of highly constrained public firms.

Does a Decline in Firm Expenditures Indirectly Impact Employment?

[23] We exclude industries where our sample includes less than 1000 firm-year observations.

Thus far we have exclusively focused on quantifying how a decline in firm financing opportunities affects employment for that firm. Of course employment could simultaneously drop due to the decline in demand for firm investment and materials. In this case all firms face a decline in employment, even if they do not individually face a financial shock. This mechanism closely relates to the Aggregate Demand Hypothesis, which states that the Great Recession was driven by negative real estate shocks to the household balance sheet. Instead we argue that small business demand for material and tangible investment goods declined due to similar shocks on the firm balance sheet.

Our current empirical framework is not able to easily quantify the general equilibrium effects of the small business collateral channel. Therefore our aggregate results will only quantify the direct implications of collateral shocks on employment. Instead we return to this discussion when we evaluate the equilibrium effects of the small business collateral channel [24].

Employment Results

How do Collateral Shocks Affect Employment Decisions?

We now evaluate the impact of real estate shocks on firm employment decisions. We first present the baseline regression in Table 8. We find that a \$1 real estate shock increases employment by \$0.07 when we include only year fixed effects. Expanding to including year $\times$LPA fixed effects does not alter the baseline result. We next instrument for real estate price growth using the interaction of the LIBOR rate and the LPA average regulatory refusal rate. Our instrumental variables results increase the estimates to \$0.11, and suggest that our OLS estimates may actually be underestimating the true channel.

For robustness we also attempt several robustness checks in Table 9. First, we find that our results are not driven by the choice of price index; using an alternative price index from Nationwide our estimates remains nearly identical at 0.07. Secondly, we find using the Pre-Recession years of 2002 to 2008 decreases only slightly to a \$0.07. However the 2007-2012 subsample coefficient doubles to \$0.13.

[24] An alternative approach to test demand effects on the economy developed by Mian and Sufi (2012) compares the effects of tradable and nontradable employment. They find that 2007-2009 job losses in the non-tradable sector were significantly higher in high leverage US counties, while losses in the tradable sector were distributed evenly. While their framework is able to separate the effects of the decline in demand from the Business Uncertainty Hypothesis or the Structural Unemployment Hypothesis, it is not able to identify if the decline in demand is due to a drop in consumer demand or local business demand.

Distinguishing between firms below and above 250 employees has an impact on our estimation. small/medium firms pay employees \$0.10 more while large firms pay \$0.059 more for each \$1 gain in real estate values. This is in contrast to our debt results where firm size had little effect on our estimates. The result suggests that even though large firms may use real estate as a pledgable asset for external financing, they are better able to access financing when collateral is scarce. To check that consumer demand shocks are not driving the results we test differences between tradable and nontradable goods. Our results remain positive and significant at 0.06 when focusing exclusively on the tradable good sector. Finally, the results cannot be explained by productivity differences between firms that do and do not own real estate.

These results introduce a new channel to the large literature on the effect of local real estate prices to household consumption. We compare our results to two recent research papers on the subject. First, imposing a structural general equilibrium model on national US data Iacoviello and Neri (2010) find that national consumption responds \$0.13 for a dollar change in housing value. Of course In a separate study relying on county and zipcode level data Mian and Sufi (2013) compare the effects of home prices on consumption in low and highly-leverage counties and zip codes to find that households consume an additional \$0.05-0.07 out of \$1 of housing wealth. In addition they find this value is significantly higher in areas with a high housing leverage ratio, which is likely driven by a consumer collateral effect[25].

Are our Results driven by a Change in Employment or Wages?

We next test if this result is driven by a cut in the number of employees or the average real wage. Our results are clear: the effect of a shock to collateral is positive and significant at the 1% level. Wages, however, actually appear to decrease slightly in response to a positive real estate shock. Therefore, focusing on the total employment bill actually results in an underestimate of the true employment effects. The full results are included in Table 10.

Real estate shocks appear to drive employment costs through the extensive margin (number of employees) rather than the intensive margin (wages or hours). Our results highlight significant

[25]Specifically Mian and Sufi find that zip codes with a housing leverage ratio below 30% cut spending on auto sales by \$0.01 for every dollar decline in home value while households with a housing leverage ratio of 90% or higher cut automobile spending by \$0.03.

wage/hours rigidity despite elevated levels of unemployment[26].

Our financially-constrained firms show no evidence of cutting the firm wage relative to unconstrained firms. While we find this fact surprising, it actually reinforces standard models of the wage rate as a price solved for in equilibrium. In this instance real estate shocks should affect the economy-wide wage, but have no effect on the firm-specific wage. We discuss this effect in detail in our general equilibrium results below.

Why are Employees Paid Through External Financing?

As emphasized in Benmelech, Bergman, and Seru (2011) standard theory suggests that labor is paid through the revenues, and as a result financing should not directly affect firm employment decisions. We first offer simple evidence that this does not appear to be the case. Specificaly, we develop an empirical measure of the amount of external financing a firm needs to fund investment and employment. In order for a firm to be able to internally fund employment and investment it is necessary that

$$EmpCost_{it} + Inv_{it} \leqslant InternalFunds_{it} \tag{2.7}$$

$$InternalFunds_{it} = Revenue_{it} - Materials_{it} + Assets_{it} \times Dividends - Interest_{it} \times TotalDebt_{it} \tag{2.8}$$

If Equation 2.7 does not hold then the firm will need to rely on a sourcing of external financing. We are particularly interested in the case where a firm cannot even pay all employment costs with internal funds.

To determine the percentage of employment that is paid through external financing we use the formula

$$\frac{\sum_{it}(EmpCost_{it} - InternalFunds_{it}) \times 1_{[EmpCost_{it} \geqslant InternalFunds_{it}]}}{\sum_{it}(EmpCost_{it})} \tag{2.9}$$

Note that investment expenditures does not enter into the equation as we assume firms use

[26]We refer readers to Daly et al (2011, 2012) and Falick et al (2011) for additional evidence on the subject.

internal funds for investment only after paying all employment costs. We find that 4.2% of all employment is paid through external financing. In line with the theory on financial constraints, small firms pay a full 13.9% of all employment costs with external finances and the effect is monotonically decreasing with firm size. The largest firms, those with at least 250 employees can afford to pay over 97% of all employment costs with internal funds. These results highlight that employment can likely be affected by a large financial shock.

So why are firms unable to pay employees through revenue? Here we consider three standard explanations. The first explanation is that investment is paid through financing and due to complementarities between labor and capital, employment is also adjusted when capital is increased. Secondly, there may be a timing mismatch between the generation of cashflow and the employee payment schedule. Third, fixed costs due to hiring and training new employees or firing costs from compensation packages may not be easily paid through the revenue stream.

We find strong evidence for each explanation. A $1 increase in capital increases labor demand by $0.10. Secondly, cashflow does appear highly correlated with employment expenditures. Our productivity measure-which as discussed before is highly correlated with profitability- is large and significant at 0.17 and 0.16 for OLS and IV, respectively.

Testing the fixed cost hypothesis is more difficult in our current framework. Previous studies have found strong support for a fixed cost of hiring and firing rather than a per capita cost or quadratic costs . For instance, using Compustat data Bloom (2009) finds a high fixed cost of hiring and firing (2.1% of annual revenue), a smaller per capita cost (1.8% of the individual's wage), and no quadratic adjustment costs. With this in mind we offer evidence that (i) firms irregularly alter employment and (ii) hiring is lumpy. First, we find that employment growth exhibits excess kurtosis relative to the normal distribution, and that in any given year in our sample 12-14% of firms keep the total number of employees constant. Additionally, given a firm hires at least one new employee, we find that the firm will actually hire six new employees. Similarly, conditional on firing at least one employee, the median firm will fire six employees. A complete test of fixed costs requires a specified structural model and is the current focus of our ongoing research on the small business collateral channel.

Can the Firm Find Alternative Sources to Finance Employment Costs?

In order for a decline in debt to have any real effect on firm spending our framework requires that alternative sources of financing are more costly than debt or unavailable completely. With this in mind we now offer evidence that the real effects of a real estate shock will be significantly greater for firms with less access to equity financing. We distinguish between publicly-traded firms and private firms in our sample and document that in response to a positive collateral effect public firms increase leverage and investment less than private firms. In Table 11 we find that a \$1 increase in real estate results in a \$0.25 increase in debt for private firms but only a \$0.11 increase for public firms. In contrast we find no significant effect on public firm employment. The result implies that public firms can fully finance employment costs without the debt market, and as a result real estate shocks have no direct effect on firm employment.

One potential explanation for these results is that measurement error is more pronounced with public firms, specifically that our real estate proxy may contain more measurement error for public firms. However, using data from The National Balance Sheet for the UK Office of Statistics we find that real estate makes up 90.5% of all tangible fixed assets for public firms and only 61.5% for private firms. Therefore, if anything, we are actually underestimating the collateral channel for private firms compared to public firms.

Our results can be viewed as a robustness check that the collateral channel is indeed increasing in the level of firm financial constraints and offers empirical support that private firms face a higher risk of financial shocks. We argue this is due to differences of ownership and the availability of financing through equity. Privately-held firms have a concentrated ownership and owners are likely dependent on the dividends of the firm for consumption. If any owner prefers to smooth consumption over time he is not willing to delay the dividend payout that could otherwise fund investment and employment opportunities. As a result the responses of investment and employment to collateral shocks are amplified. In comparison the publicly-held firms are owned by households that can insure themselves against the idiosyncratic risk affecting a particular firm. Therefore, the household is willing to forgo a dividend payout from a firm hit by a large collateral shock. In this way the type of ownership affects dividend decisions and as a result the effect of financial shocks to the firm.

How do Alternative Model Specifications Affect our Results?

There are a number of key assumptions on our model specification, including (i) collateral shocks affect employment levels, (ii) firm investment decisions are chosen simultaneously with employment, (iii) debt contracts are renegotiated yearly, and (iv) productivity is a valid proxy for cashflow. We discuss each specification below.

Employment Growth Regression Our analysis has only considered the effect of a real estate shock to the level of employment costs; however the literature on financial shocks generally focuses on investment, or the annual change in capital, adjusting for depreciation. In line with this literature we therefore use the similar specification

$$\Delta EmpCost_{it} = \beta^E Real\,Estate_{it} + \gamma^E Inv_{i,t} + \phi_t^E \times \theta_l^E + \rho^E Prod_{it} + \alpha_i^Y + \boldsymbol{\lambda}^Y \sum X_{i,0} \times P_{lt} + \varepsilon_{it} \quad (2.10)$$

This specification is particularly reasonable if we believe that changes in employment cost are driven exclusively by demand for new employees through new investments. Then in this case and according to our model we should find that the gamma coefficient remains positive and the real estate shock is not significantly different from zero. We present the results in Table 26 . First, we find that when excluding investment a \$1 in real estate causes a \$0.05 in employment growth. Including investment decreases our result to \$0.03 with a coefficient on investment of 0.19.

Allowing for Time-to-Build Next, we note that capital expenditures are determined prior to employment; therefore employment demand may in fact be driven by lags of capital. In this case we may overestimate the direct effects of real estate shocks on employment costs.

Therefore we include lags of capital according to the specification

$$EmpCost_{it} = \beta^E Real\,Estate_{it} + \sum_{j=0}^{J} \gamma_j^E Capital_{i,t-j} + \phi_t^Y \times \theta_l^Y + \rho^Y Prod_{it} + \alpha_i^Y + \boldsymbol{\lambda}^Y \sum X_{i,0} \times P_{lt} + \varepsilon_{it} \quad (2.11)$$

Our results appear relatively unchanged; present capital has a coefficient of 0.12 while capital for one and two years behind are estimated to be 0.014 and 0.013, respectively.

Subsequent Employment Effects Debt financing contracts may not be immediately renegotiated subject to a positive real estate shock. Instead the renegotiation may be a gradual process. We define our employment as the mean employment cost over the subsequent three years

$$\sum_{j=0}^{J} EmpCost_{i,t+j} = \beta^E Real\,Estate_{it} + \gamma^E Capital_i + \phi_t^Y \times \theta_l^Y + \rho^Y Prod_{it} + \alpha_i^Y + \boldsymbol{\lambda}^Y \sum X_{i,0} \times P_{lt} + \varepsilon_{it} \quad (2.12)$$

We find the employment coefficient to be highly significant at \$0.05 and future capital holdings to be positive and highly significant.

Cashflow Sensitivity of Employment Finally, standard practice in the corporate finance literature includes cashflow sensitivity in the regression analysis. While we have offered evidence that our productivity measure is a related variable we now add cashflow to determine that our results are not driven by an omitted variable. Not surprisingly, cashflow is highly and positively correlated with employment costs. A \$1 increase in cashflow causes firm to increase total employment costs by \$0.15, yet has little effect on our real estate coefficient.

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Evaluating the Macroeconomic Implications

With our estimation in hand we are finally able to estimate the aggregate effects of the small business collateral channel on the the decline in employment in 2007-2009. Doing so requires us to bridge the gap between the microeconomic results and the macroeconomic implications. We do this in three steps: (i) we weight our firm sample by firm age, (ii) sum the weighted sample to estimate aggregate employment effects and (ii) revisit the theoretical model to account for general equilibrium effects that might alter the final result. We estimate that the small business collateral channel is responsible for one third of the decline in investment and 8-16% of the decline in UK employment during 2007-2009 and that accounting for general equilibrium effects only magnify this result.

Partial Equilibrium Employment Effect

Using our firm-level estimates, we are able to calculate the aggregate effect on the population. In order to do so we must first make two assumptions:

1. The total employment effects equal the <u>weighted sum</u> of the direct employment effects measured in each <u>cohort</u>

2. Firms do not <u>enter</u> or <u>exit</u> the population after 2002

The first assumption is simple: we use the weighted sum of each cohort estimation to derive the aggregate effect on the actual population. The second assumption is more involved. Note that due to our methodology we do not include firms not in business in 2002, and so we are not able to estimate the impact of real estate shocks on firms that enter the sample after this date. Therefore we instead assume that the firm population in the aggregate is static. This second assumption likely results in an underestimation of the true aggregate impact due our findings that the effect of collateral shocks on both leverage is greatest for the youngest firms.

Investment Effect due to Collateral Frictions on Capital

We first estimate the investment effects when collateral friction impact capital. We weight the sample to accurately measure by separating each firm into one of seven size cohorts and weight each cohort by its relative population in the UK from Table 22.

We find that firms with less than five employees represent 16.4% of employment, firms with 5-9 employees represent 7% of the population, firms with 10-19 employees represent 7% of the population, firms with 20-49 employees are 8% of the population, firms with 50-99 employees are 5% of the population, and just over half of all employees work for firms with at least 250 employees.

We include the full results in Table 12. We find that the effect of a $1 increase has a similar effect on all firms, ranging from $0.11 for the smallest firms to $0.08 to firms of 100-249 employees, and a weighted estimate of $0.09. According to the results, small firms are no more dependent on collateral to finance investment. We calculate the cumulative expected employment effects of real estate shocks for all firms in cohort $\mathbb{C}$ and then weight the effects using $w_{\mathbb{C}}$

$$E[\Delta\% \, Capital_{2007,2009}] \quad = 100 \times \quad \frac{w_{\mathbb{C}} \sum_{c \in \mathbb{C}} \left[\beta^I_{\mathbb{C}} \times (Real\, Estate_{c,2009} - Real\, Estate_{c,2007}) \right]}{\sum_{c \in \mathbb{C}} Capital_{c,2007} - Capital_{c,2009}} \tag{2.13}$$

The collateral channel can explain one-third of the decline in investment during this period. This major impact is due to the fact that even ex-ante unconstrained firms appear to finance investment through secured debt[27]. This is vital to our findings since large firms (defined as firms with at least 250 employees) compose half of the workforce.

Employment Effect due to Collateral Frictions on Capital

Our analysis has found that the decline in real estate can explain 33% of the decline in investment

[27] Shourideh and Zetlin-Jones (2012) find that even large private firms rely on external financing to pay for 90% of investments.

between 2007 and 2009. This affect should also result in a decrease in demand for labor. Similar to above we calculate the expected employment effects of real estate shocks for all firms in cohort $\mathbb{C}$:

$$E[\Delta\%\,Emp_{2007,2009}] \quad = 100\times \quad \frac{w_{\mathbb{C}} \sum_{c\in\mathbb{C}} \left[\beta^{I}_{\mathbb{C}}\gamma^{E}_{\mathbb{C}} \times (Real\,Estate_{c,2009} - Real\,Estate_{c,2007})\right]}{\sum_{c\in\mathbb{C}} Emp\,Cost_{c,2009} - Emp\,Cost_{c,2007}} \tag{2.14}$$

To estimate the impact we first multiply the decline in the value of real estate for each cohort by β^{I} to quantify the impact on investment and secondly multiply by γ^{E} to estimate the relationship between employment and investment spending. A summary of the analysis is included in Table 12. The average UK firm demand for employment expenditure due to a \$1 increase in capital is \$.11. It is interesting to note that for the smallest firms a rise in capital appears to have no direct effect on employment demand.

In Table 13 we estimate that collateral frictions on investment can explain only 1.2% of the total decline in employment spending between 2007 and 2009. Using coefficients estimated from 2007-2012 raises the aggregate effect only slightly to 1.5%.

This result is small but not surprising for two reasons. First, a \$1 increase in fixed assets increases employment demand by only \$0.11. When we allow for the demand effect in our analysis, our results appear quite small despite the large direct effects on investment. Secondly, it is important to distinguish between capital and investment. Between 2007 and 2009 UK investment dropped by 20%, yet this has only a minor effect on total capital. Overall the employment effects due to collateral frictions on investment are a negligible source of the decline in employment.

Employment Effect due to Collateral Frictions on Employment

In our third and final analysis we test the effect in the case where collateral frictions directly impact employment. We multiply the real estate value decline by β^{E} from our estimates.

$$E[\Delta\%\,Emp_{2007-2009}] = 100 \times \frac{w_{\mathbb{C}} \sum_{c\in\mathbb{C}} \left[\beta^{E}_{\mathbb{C}} \times (Real\,Estate_{c,2009} - Real\,Estate_{c,2007})\right]}{\sum_{c\in\mathbb{C}} Emp\,Cost_{c,2009} - Emp\,Cost_{c,2007}} \tag{2.15}$$

In line with our understanding of financial constraints we find that the employment effect is decreasing in firm size. Firms between 10 and 49 employees have an estimated coefficient of 0.11

while the largest firms see an effect less than half this size. However, the very smallest firms, those under ten employees, see little effect from a real estate shock. We attribute this effect to the fact that the smallest firms are borrowing not against commercial real estate, but instead residential real estate.

The aggregate effect of the collateral channel on labor explains a full 7.1% of the decline in aggregate employment spending between 2007 and 2009. Of course our aggregate effect does depend on both the econometric assumptions and firm sample. First we note that our coefficients are significantly larger in the 2007-2012 subsample. Specifically, we found a $0.13 increase in employment costs as opposed to a $0.07 increase in the full sample. Including this estimate increases our aggregate effect to 14.8%. Next, instrumenting for real estate price growth actually increases our estimate to 11.8%. Alternatively, when we include only firms in the tradable goods sector- minimizing the effect of consumer demand- we estimate an identical 7%. Using these numbers we pose a lower and upper bound of 7.1-14.8% on our aggregate estimate.

The Aggregate Effect of the Small Business Collateral Channel

The combined effect of the small business collateral channel explains a full 8.3% of the decline in employment spending between 2007 and 2009. Using coefficients estimated from 2007-2012 doubles this estimation to 16%. The estimated effect differs significantly by firm size. The collateral channel explains 14-24% of the decline for firms with 10-49 employees, yet only 5-11% of the employment decline for the largest firms.

We also aggregate our results by firm age in Table 12. We find that start-ups (0-1 years of age) compose 15% of all firms and 8.3% of total employment. Young firms (2-3 years of age) are an additional 8% of employment and middle-aged firms (4-9 years of age) compose another 19%. The majority of employment is due to the oldest firms at 65%. Appropriately weighted we find that a direct effect of $0.07 and an indirect effect of $0.09. The decline in real estate can explain 15-29% of the total decline in employment for the youngest firms, but 6-12% of the decline for the oldest firms.

In Table 13 we include the actual employment declines during 2007-2009 for each region in the United Kingdom and well as the aggregate effects of the decline due to the real estate channel. At the low end of the spectrum we find the small business collateral channel explains 6.9-13.7% of the decline in London employment. On the the other extreme Northern Ireland saw both the largest real estate gains and the largest subsequent bust. For comparison we plot the house price index for Northern Ireland with three US cities worst hit by the housing crisis. We find that between 2007 and 2009 Northern Ireland saw a 2.9% decrease in employment spending and according to our estimates 20-37% of this decline is the result of the small business collateral channel.

We compare our estimates to recent related research that links employment to real estate balance sheet shocks.To our knowledge, we are the first to quantify the implications of small firm collateral shocks to employment using firm-level data; however, in contemporaneous work Liu, Wang, and Zha (2013b) using a general equilibrium model and macroeconomic data to estimate that a 10 percent drop in the land price leads to a 0.34 percentage point increase of the unemployment rate (relative to its steady state).Our results find that an 17.4% drop in the real estate price index explains 8-16% of the total decline in employment spending. Considering that employment declined 2.9% in the United Kingdom between 2007 and 2009, a back-of-the envelope calculation implies that a 10% percent drop in prices results in a 0.13-0.27% increase in unemployment.

In a closely related paper Adelino, Schoar, and Severino (2013) use county level data and find that a 1% increase in house price translates to a 0.19% in the total number of small firms (those with 1-4) employees relative to the largest firms. They attribute this rise to homeowners borrowing against home equity to form a business, relying on the fact that larger firms will be unable to finance through home equity alone. They find that the aggregate effect explains a similar 15-25% of the total employment variation.

We also compare the results to the effects of balance sheet shocks to households and the financial sector. Using the relation between non-tradable sector job losses and demand shocks and assuming Cobb-Douglas preferences over tradable and non-tradable goods Mian and Sufi (2012) estimate that the decline in aggregate demand driven by household balance sheet shocks accounts for 65% of the lost jobs in our data.Chodorow-Reich (2013) estimates that balance sheet shocks to the financial sector explains 20-33% of the total decline in unemployment during the 2008 Financial Crisis. Greenstone and Mas (2013) answer the same question using local US data and find up to a 20% decline in unemployment. With these estimates in mind, we believe our own results appear quite reasonable.

General Equilibrium Employment Effects

Recall that our empirical framework first distinguishes between firms that do and do not own real estate, and secondly by the level of real estate shock exposure between land-owning firms. Therefore our aggregate results determine the total change in employment of real estate owning firms relative to firms that do not own real estate. This is potentially a concern since in equilibrium, real estate shocks can affect all firms, not just those with real estate.

As we noted earlier a balance sheet shock to constrained firms results in (i) a direct decline in demand for capital, and (ii) an indirect decline in demand for materials due to production function complementarities. This demand effect, which will affect all firms in equilibrium, may actually contribute to the employment effects, causing us to instead underestimate the actual implications of the small business employment channel.

Alternatively it is possible that we are actually overestimating the implications of the small business collateral channel. The reason is that the equilibrium fall in the wage or real interest rate may actually raise the output of unconstrained firms and therefore their labor demand. However, we are not taking this offsetting effect into account in our empirical framework.

Our current framework is unable to characterize the impact of the demand effect on total employment. Instead we need a way to address both the demand and price effect in a unified framework to determine which effect dominates in equilibrium. Therefore we return to the general equilibrium model of Shourideh and Zetlin-Jones (2012). We assume that firm production is dependent on material goods each period, created from the final good. In this case a negative collateral shocks causes a decline in the demand for the final good due to the complementarities in the production function. Since intermediate good firms each produce a unique output, the demand for all goods produced falls. For a complete description of the model and results we refer readers to our appendix and to the full dynamic model of Shourideh and Zetlin-Jones (2012).

Theoretical Result 3. *The decline in firm demand for materials and investment dominates any price effects from wages. Therefore our empirical results for employment will be magnified when taking into account general equilibrium effects.*

According to our analysis we find that the demand effect does indeed dominate the effect on wages, causing us to only underestimate the true collateral channel. The result holds under a range of reasonable calibrations. We reach this conclusion by determining the equilibrium effects on financially-unconstrained firms. This result leads us to conclude that the partial equilibrium results is a reasonable approximation for the total effects in the economy.

Conclusion

The real estate and credit market has been at the center of the debate on the causes and consequences of the rise in unemployment during 2007-2009, yet the channel linking these financial shocks to the macroeconomy remains unclear. Our research highlights the small business collateral channel as a relevant explanation of the recent Great Recession and illustrates business balance sheet shocks as a primary driver of financial frictions to the economy. For every dollar decrease in the value of real estate firms will lower their debt \$ 0.25. These financial shocks have real implications for the economy since firms are forced to cut investment and employment expenditures by \$0.10 and \$0.07, respectively. After appropriately weighting the sample, we find that balance sheet shocks explain one-third of the decline in investment and 8%-16% of the decline in employment spending between 2007 and 2009. According to a simple model, accounting for general equilibrium effects is unlikely to affect our results.

In our online appendix we extend our empirical analysis to US data. Using aggregate data we first note that during the 2007 recession small US firms reduced their employment twice as much as large firms, consisent with the implications of a credit shock on constrained firms. We then rely primarily on two firm-level accounting data sets: (i) publicly-listed firms from Compustat, and (ii) small start-ups from the Survey of Small Business Owners. According to our analysis a \$1,000,000 increase in the value of real estate translates to 0.8 new employees for each public firm. Secondly, we estimate that real estate price growth between 2002 and 2006 is responsible for an 18% increase in home equity financing for large start-ups.

This paper is a first attempt to quantify the macroeconomic significance of the small business collateral channel. Our results beg the more general question: why do firms pay employees through external financing? One possibility is that firms are unable to directly pay for hiring and firing costs. In a companion paper we develop a full structural estimation to better examine how fixed costs on employment drive our results. In addition, while we focus here on the real effects of employment we note that our empirical framework can be used to study the implications of collateral shocks on additional firm characteristics [28].

We believe this research has important implications for small business financing policy. Small firms are highly dependent on pledgable assets to access external financing, causing an intimate link between collateral shocks and the macroeconomy. Policies that break this close relationship, such as loan guarantee programs, have a strong potential in limiting the aggregate effects of a negative financial shock to firms. Understanding how to best develop these initiatives is a natural next step in our research agenda.

The small business collateral channel is a potential explanation of the depressed employment growth not only in the United Kingdom but around the world. In the US real house prices have only now reached their early 2001 pre-boom levels. At the individual MSA level we find that Atlanta, Cleveland, and Las Vegas are at 25% and Detroit a full 50% below 2001 levels. The small business collateral channel implies that local areas worst hit by the housing bust will continue to experience depressed economies as long as real estate values are also depressed. The purpose of this paper is not to fully explain the causes of the Great Recession, which is likely a combination of several economic factors. Instead we first highlight small firm balance sheet shocks as a mechanism to relate the collapse of the real estate market to the employment. Secondly, and more generally, we lay a foundation to studying the macroeconomic effects of financial friction of small business.

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Theory

We develop a tractable model based on the work of Shourideh and Zetlin-Jones (2012) with two key differences: (i) we focus on firm labor demand as opposed to output, and (ii) we extend the model to incorporate firm labor demand into the collateral constraint. In our baseline framework we assume that firms face a collateral constraint and then derive the firm demand for labor in response to a shock to the collateral constraint. We consider two possible channels for a collateral shock to impact employment: directly when employment cannot be financed through revenue and indirectly due to complements between investment and employment in the production function. From the model we find that only financially-constrained firms increase employment in response to a real

[28] In ongoing work we relate the productivity loss to the simultaneous decline in credit caused by real estate shocks to the firm balance sheet for both US and UK firms (Kleiner 2013a).

estate shock while unconstrained firms see no effect.

We return to the theory when we aggregate the microeconomic result to the macroeconomy, particularly when we attempt to account for general equilibrium effects due to changes in demand. A balance sheet shock to constrained firms results in (i) a direct decline in demand for capital, and (ii) an indirect decline in demand for materials due to production function complementarities. This demand effect, which will affect all firms in equilibrium, may actually contribute to the employment effects, causing us to instead underestimate the actual implications of the small business employment channel. To quantify the demand channel we assume that firm production is dependent on material goods each period, created from the final good. In this case a negative collateral shocks causes a decline in the demand for the final good due to the complementarities in the production function. Since intermediate good firms each produce a unique output, the demand for all goods produced falls.

Alternatively, our results may actually be overstate the small business collateral channel. The reason is that an equilibrium fall in the wage or real interest rate may actually raise the output of unconstrained firms and therefore their labor demand. We allow for the possibility in the model by including a fully-flexible wage rate.

From our analysis we determine that the impact of general equilibrium is largely determined by the elasticity of substitution across firms. If each differentiated good is highly substitutable, then total output depends little on the output of any particular firm. As a result, a financial shock that affects only a subset of firms have little macroeconomic significance.

Calibrating the model we find that the demand effect dominates any wage effect. As a result, the partial equilibrium effects are a reasonable approximation to the total employment effects from the small business collateral channel.

Model 1: Collateral Constraint on Investment

In our economy we include a continuum [0,1] of intermediate good firms along with a single final goods producer. We assume that intermediate good firms face monopolistic competition and sets their price p_i. A final good firm then purchases inputs from intermediate good firms, taking their price as given. Denoting the output of the final good producer as Q and the intermediate good producer i as q_i we define final good output using the standard Dixit-Stiglitz production function

$$Q = \left[\int_0^1 q_i^{\frac{\rho-1}{\rho}} dF(i) \right]^{\frac{\rho}{\rho-1}} \tag{2.16}$$

The final good producer chooses q_i so as to maximize

$$\max_{q_i} \left[\int_0^1 q_i^{\frac{\rho-1}{\rho}} dF(i) \right]^{\frac{\rho}{\rho-1}} - \int_0^1 p_i q_i dF(i) \tag{2.17}$$

We derive the standard demand for each intermediate good as

$$q_i^{-\frac{1}{\rho}} Q^{\frac{1}{\rho}} = p_i \tag{2.18}$$

Each intermediate good firm $i \in [0, 1]$ has a net worth of a_i and productivity z_i and (a_i, z_i) is distributed according to the function $F(a, z)$. While not explicitly modeled, we assume that net worth includes the current value of firm i real estate holdings.

In addition each firm rents capital, k, and hires labor, l, and purchases materials, I, composed of the final good

$$q_i = z_i^{\frac{1}{1-\rho}} (k^\alpha l^{1-\alpha})^\eta I^{1-\eta} \tag{2.19}$$

As is standard in the literature we assume that the firm may rent capital, but only up to a constant of the firm's net worth, $k \leqslant \theta a_i$ where $\theta \geqslant 1$. As mentioned in Shourideh and Zetlin-Jones (2012) this collateral constraint can be rationalized in a more complicated model based on limited enforcement[29].

Definition 1. *A firm is defined as financially constrained in investment if the collateral constraint binds, $k = \theta a_i$.*

The profit function, along with the constraints, for each intermediate good i firm is defined as

[29]This collateral constraint can be easily derived from a dynamic model that includes debt. Consider a firm with debt holdings d_t and capital k_t that must choose investment x_t subject to the financial constraint: $d_t + x_t \leqslant \dfrac{1}{1-\theta}(k_t + x_t)$. By defining net worth as $a_t = k_t - d_t$ we can derive the collateral constraint $k_t + x_t \leqslant \theta a_t$.

$$\pi_i = \max_{k,l,I,p_i} p_i z_i^{\frac{1}{1-\rho}} (kl^{1-\alpha})^{\eta} I^{1-\eta} - wl - rk - I + ra_i \tag{2.20}$$

subject to

$$p_i = Q^{\frac{1}{\rho}} \left[z_i^{\frac{1}{1-\rho}} (k^{\alpha} l^{1-\alpha})^{\eta} I^{1-\eta} \right]^{-\frac{1}{\rho}} \tag{2.21}$$

$$k \leqslant \theta a_i \tag{2.22}$$

By assuming monopolistic competition we impose that the revenue function of each firm exhibits decreasing returns to scale. This means that revenue is directly increasing in z_i and as a result capital is increasing in productivity. With this is mind we can then define a threshold $\underline{a}(z; p_k)$; firms with a net worth above the threshold, $a_i \geqslant \underline{a}(z)$, will be financially-unconstrained in capital while firms with a net worth below this threshold will be financially-constrained. Since our framework is static, any unconstrained firm will choose capital as if no collateral constraints exists.

The optimal capital decision of firm i is

$$k(a, z) = \begin{cases} [\nu(1-\eta)]^{\frac{(1-\eta)\nu}{1-\nu}} \left(\frac{\alpha\eta\nu}{r}\right)^{1+\frac{\alpha\eta\nu}{1-\nu}} \left(\frac{\nu(1-\alpha)\eta}{w}\right)^{\frac{(1-\alpha)\eta\nu}{1-\nu}} Qz & if\ a_i \geqslant \underline{a}(z) \\ \theta a_i & if\ a_i < \underline{a}(z) \end{cases} \tag{2.23}$$

where $\nu = \frac{\rho - 1}{\rho}$. Research on the real impacts of firm collateral constraints has focused primarily on investment effects, while largely disregarding the effects on labor demand. However, here we show that the firm demand for labor is also affected

$$wl = [\nu(1-\eta)]^{\frac{(1-\eta)\nu}{1-(1-\alpha\eta)\nu}} \nu(1-\alpha)\eta^{-\frac{1-(1-\eta)\nu}{1-(1-\alpha\eta)\nu}} w^{\frac{2-(1-\eta)v-(1-\alpha\eta)v}{1-(1-\alpha\eta)\nu}} (Qz)^{\frac{(1-\nu)}{1-(1-\alpha\eta)\nu}} k^{\frac{\alpha\nu\eta}{1-(1-\alpha\eta)\nu}} \tag{2.24}$$

Using Equation 2.24 we therefore find that a negative shock to the value of real estate decreases constrained firm labor demand even though firm hiring is not subject to a collateral restriction. The mechanism is as follows: a tightening of the collateral constraint restricts the firm demand for capital and due to the complementarities of capital and labor in the production function constrained firms also decrease their labor demand. Therefore constrained firms cut labor demand in response to a decrease in the value of their real estate.

Model 2: Collateral Constraint on Labor

We next consider an identical model with one exception. We replace the collateral constraint on capital with a collateral constraint on labor

$$wl \leqslant \lambda a_i \tag{2.25}$$

Definition 2. *A firm is defined as financially-constrained in labor when $wl = \lambda a_i$.*

In this we case we can still solve for the optimal labor decision of the firm

$$wl(a_i, z_i) = \begin{cases} [\nu(1-\eta)]^{\frac{(1-\eta)\nu}{1-\nu}} \left((1-\alpha)\eta\nu\right)^{1+\frac{(1-\alpha)\eta\nu}{1-\nu}} w^{-\frac{(1-\alpha)\eta\nu}{1-\nu}} \left(\frac{\nu\alpha\eta}{r}\right)^{\frac{\alpha\eta\nu}{1-\nu}} Qz & if\ a_i \geqslant \underline{a}(z) \\ \lambda a_i & if\ a_i < \underline{a}(z) \end{cases} \tag{2.26}$$

Relationship to the Empirical Model According to the theoretical model the effect of a real estate collateral shock depends on: (i) the net worth of the firm and the collateral parameter, (ii) the economy-wide output, interest rate, and wage, and (iii) the firm productivity- and implies the following style regression. From the theory we derive the empirical framework

$$\underbrace{Capital_{it}}_{log(k)} = \underbrace{\beta^C Real\,Estate_{it}}_{\kappa_1 log(\lambda a_i)} + \underbrace{\phi_t^C \times \theta_l^C}_{\kappa_2 log(w)+\kappa_3 log(r)+\kappa_4 log(Q)} + \underbrace{\rho^C Productivity_{it} + \alpha_i^C}_{\kappa_5+\kappa_6 log(z_i)} + \boldsymbol{\lambda}^I \sum X_{i,0} \times P_{lt} + \varepsilon_{it}^C \tag{2.27}$$

$$Real\,Estate_{it} = \underbrace{P_{lt}}_{\lambda} \times \underbrace{Real\,Estate\,Holdings_{i,0}}_{a_i} \tag{2.28}$$

Capital is the total capital holdings for firm i in period t. As in our theoretical model we evaluate the effect of an exogenous shock to the net worth of firm i on employment costs. For this exogenous shock we use changes in the market value of real estate holdings. In our theoretical model the collateral shock, λ, is the price of local real estate and the initial net worth of the firm, a_i, are real estate holdings in the first period of our sample. In addition we condition on capital in the analysis so we can distinguish between a firm financially-constrained in capital from one constrained in labor.

Theory dictates that employment is dependent on the economy-wide characteristics of the wage rate, the interest rate, and total production. It is critical to control for these factors in our analysis since the real estate shock affects all firms collectively through equilibrium effects. For instance a negative shock to net worth results to a decrease in the labor demands of financially-constrained firms; however, this affect will also cause an decrease in the equilibrium wage rate and can actually lead to an increase in the labor demand of unconstrained firms. In practice employment is likely influenced by any number of unobservable variables. Therefore we instead include time fixed effects ϕ interacted with location l fixed effects. In this specification we absorb all unobserved variation within a single location in a particular time period.

Additionally our theoretical model implies firm labor decision is dependent on the firm productivity and so included in the regression. Of course productivity is an unobservable characteristic that cannot be easily calculated. Therefore we also allow for unobserved firm heterogeneity by including firm fixed effects α[30].

To directly test the implications on employment we include a similar framework focusing on Emp Cost, the annual employment costs for firm i at time t. The analysis follows the previous set-up with the exception that we include Capital in the empirical regression. By doing so we are able to distinguish between real estate shocks that affect employment indirectly through investment, and shocks that directly affect the firm's ability to pay employment costs

$$\underbrace{Emp\,Cost_{it}}_{log(wl)} = \underbrace{\beta^E Real\,Estate_{it}}_{\chi_1 log(\lambda a_i)} + \underbrace{\gamma^E Capital_{it}}_{\chi_2 log(k)} + \underbrace{\phi_t^E \times \theta_l^E}_{\chi_3 log(w) + \chi_4 log(r) + \chi_5 log(Q)} + \underbrace{\rho^E Productivity_{it} + \alpha_i^E}_{\chi_6 + \chi_7 log(z_i)} + \boldsymbol{\lambda}^E \sum X_{i,0} \times P_{lt} + \varepsilon_{it} \tag{2.29}$$

Household Sector Returing to the model we assume the representative household provides the labor to produce intermediate goods and purchases the final good. We assume consumer have Greenwood, Hercowitz, and Huffman (GHH) preferences and choose labor and consumption

[30] Of course allowing for firm fixed effects is not sufficient if unobservable productivity is actually changing over time. For instance in the case where $log(z_{it}) = log(z_{it-1}) + \epsilon_{it}$ we have $log(z_{it}) = log(z_{io}) + \sum \epsilon_{ij}$. Then we can think of the firm fixed effect α as representing $log(z_{io})$.

$$\underset{C,L}{max} \frac{1}{1-\gamma} \left(C - \psi \frac{L^{\frac{1+\varepsilon}{\varepsilon}}}{\left(\frac{1+\varepsilon}{\varepsilon}\right)} \right)^{1-\gamma} \tag{2.30}$$

subject to

$$C \leqslant wL + \int_0^1 \pi_i dF(i) \tag{2.31}$$

We note that relying on GHH preferences abstracts from possible wealth effects on the labor-leisure tradeoff. However, the assumption is necessary for the tractable analysis below.

Given our focus on regional or city real estate markets, we assume a small, open economy and a competitive labor market. Therefore the wage level w is solved in equilibrium while the interest rate r is given. While we are abstracting from an equilibrium real interest rate, we note that the Federal Funds rate has been pinned near zero since 2009 and so this assumption may not actually be too far off from reality. A number of recent papers have emphasized the effects of the zero lower bound where leveraged households are forced to decrease consumption due to a reduction in borrowing capacity. This research includes Eggertson and Krugman (2012), Guerrieri and Lorenzoni (2012), and Hall (2011).

Market Clearing We assume that firm capital is subject to the collateral constraint $k \leqslant \theta a_i$. The intuition for the case where firm employment is subject to a collateral constraint is similar.

Then the market clearing conditions require that

$$\int_0^1 l_i dF(i) = L \tag{2.32}$$

$$C + \int_i I_i dF(i) = Q \tag{2.33}$$

We can then define the competitive equilibrium of the economy as the set$\{k_i, l_i, I_i, p_i, c, L, Q, w\}$ that satisfies the market clearing conditions, firm production decisions and household sector decisions.

Next we define labor demand as a function of the equilibrium wage, aggregate output, and firm output

$$l = \left(\frac{(1-\alpha)\eta\nu}{w}\right) Q^{1-\nu} q^{\nu} \tag{2.34}$$

Then the optimal aggregate demand is

$$\int lG(da, dz) = \left(\frac{(1-\alpha)\eta\nu}{w}\right) Q^{1-\nu} \int q^{v} G(da, dz) = \left(\frac{(1-\alpha)\eta\nu}{w}\right) Q \tag{2.35}$$

Model Solution As proven in Shourideh and Zetlin-Jones (2012): the wage rate, w, is increasing in θ, the collateral parameter on investment. The theorem follows because a relaxing of the collateral constraint increases aggregate capital demand and so labor demand, causing the wage to rise in equilibrium. This then implies that in all instances aggregate employment is increasing in the wage rate and therefore in θ. The pro-cyclicality of real wage growth has been documented by several authors. Daly, Hobijn, and Wiles (2012) find that a one percent increase in the unemployment rate reduces real wage-growth of individuals by about 1.3 percentage points. This pattern holds across decades and for various subpopulations of the labor market.

From the definition of labor supply and the market clearing condition

$$\int lG(da,\, dz) = \psi^{-\varepsilon} w^{\varepsilon} \tag{2.36}$$

Therefore no matter the specific parameter calibration aggregate employment is increasing in the collateral constraint even when accounting for equilibrium effects. By applying our Theorem we can test if the equilibrium affects will cause us to over or underestimate the small business collateral channel.

To do this we need to characterize the necessary and sufficient conditions for a negative collateral shock to decline employment among even financially-unconstrained firms. In this instance our results will actually underestimate the true impact of a real estate shock on total employment. We determine the output of a financially-unconstrained firm

$$q = \left(\frac{\nu(1-\alpha)\eta}{w}\right)^{\frac{\eta(1-\alpha)}{1-\nu}} (\nu(1-\eta))^{\frac{1-\eta}{1-\nu}} \left(\frac{\alpha\eta\nu}{r}\right)^{\frac{\alpha\eta}{1-\nu}} Q z^{-\nu} \tag{2.37}$$

The optimal labor demand of the unconstrained firm is then solved explicitly

$$l = \left(\frac{(1-\alpha)\eta\nu}{w}\right) Q^{1-\nu} q^{\nu} = (\nu(1-\alpha)\eta)^{\frac{\eta(1-\alpha)}{1-\nu}} (\nu(1-\eta))^{\frac{1-\eta}{1-\nu}} \left(\frac{\alpha\eta\nu}{r}\right)^{\frac{\alpha\eta}{1-\nu}} Q z^{-\nu} \times w^{(1+\varepsilon)(2-\nu)-\frac{\eta(1-\alpha)+1-\nu}{1-\nu}} \tag{2.38}$$

Finally, using the labor market clearing and the fact that household labor supply is simply $\psi^{-\varepsilon} w^{\varepsilon}$we derive

$$Q = \psi^{-\varepsilon}((1-\alpha)\eta\nu)^{-1} w^{1+\varepsilon} \tag{2.39}$$

Using Equation 2.37 and 2.39 we note that that the output of firms depends on the wage rate and aggregate output which is also a function of the wage rate. Therefore the output of a financially-unconstrained firm in increasing in λ when $1 + \varepsilon \geqslant \eta\rho(1-\alpha)$. We find that the labor demand of a financially-unconstrained firm is solely a function of the equilibrium wage rate as well as exogenous productivity which does not depend on the collateral parameter. Therefore to understand the equilibrium effects of a collateral shock on financially-unconstrained firms, we need to determine the sensitivity of employment to the equilibrium wage rate. Extending the analysis of Shourideh and Zetlin-Jones (2012) to consider the labor implications we introduce our key result.

Lemma 1. *b) Employment of financially-unconstrained firms is increasing in the collateral parameter when*

$$\varepsilon > (\rho - 1)\eta(1-\alpha) \tag{2.40}$$

This result follows easily from equation 2.39. We can explain this intuitively. Recall that there are two opposing mechanisms at play in our analysis: a price effect, and a demand effect. The price effect is largely determined by two variables: the labor supply elasticity, ε, and the labor share in the production function, $1-\alpha$. In comparison, the demand effect is determined by ρ, the elasticity of substitution, and η, the share of materials goods in the production function.

We first discuss the price effect. Note that a high labor supply elasticity implies households are very responsive to a fall in the wage rate. Therefore when the real estate price drops, the wage rate declines only minimally in equilibrium, and financially-unconstrained firms face little positive benefit from a collateral shock. Next, when we assume firms have a high share of capital in production relative to labor, then there is minimal benefit to a decline in wages to unconstrained firms.

The intuition for the demand effect is as follows. First, the collateral channel is decreasing in the elasticity of substitution across firms/ goods. Understand that when intermediate goods are not easily substitutable then there are large spillovers from a collateral shock since the demand for all goods will decline. Finally, a high η implies a large labor share relative to material goods, and so a larger benefit to the decline in wages. In addition, when the material good share is small, then the demand effect is also minimized and reinforces the first result. Combined, the share of material goods in production has particularly large implications on the general equilibrium effects.

This result hightlights the significance of the elasticity of substitution in our analysis. Unique to our model is the inclusion of the demand effect on employment: here we find that this demand effect diminishes when firms can easily substitute one intermediate good for another.

We first estimate/calibrate the model parameters as in Table 27 . We estimate the materials good share, $1-\eta$, at 0.70, implying η=0.30. The labor share is estimated to be 0.28, which implies an α of 0.053. The result are fairly constant across time and by industry, although the capital share is slightly higher for manufacturing.

Our other parameters are calibrated from previous estimations and follow the calibrations in the original model of Shourideh and Zetlin-Jones (2012). The intertemporal aggregate elasticity required to match business cycle data is between 2.61 (Ok-Cho and Cooley 1994) and 4 (King and Rebelo 1999) in real business cycle models and 1.92 in menu cost models (Smets and Wouters 1999).We use the mean hours elasticities implied by these three models of 2.84. Finally, Burstein and Hellwig (2008) and Rossi, Chevalier, and Kashyap (2003) use micro-level data and find that the elasticity of substitution across intermediate good producers,$\rho = \frac{1}{1-\nu}$, is 4.

In our baseline specification we indeed find that $\varepsilon - (\rho - 1)\eta(1-\alpha)$=1.99>0. In Table 27 we consider a wide range of alternative parameter values. We find that employment of financially-unconstrained firms is increasing in collateral value over all parameter values. This result similarly holds for the output of unconstrained firms. We conclude that accounting for the effects of general equilibrium only magnifies our results, further validating the small business collateral channel.

*

Olley-Pakes Productivity Methodology

Here we extend the Olley-Pakes Productivity methodology to allow for material cost. Olley-Pakes (1996) developed a simple strategy to estimate productivity in the face of three econometric concerns:

1. Endogeneity of inputs since outputs and inputs are chosen in the same period

2. firms exit the population due to selection

3. unobserved permanent differences across firms causing serial productivity

Our analysis implies the production function:

$$log(q_{it}) = \tfrac{1}{1-\rho} log(z_{it}) + \eta\alpha log(k_{it}) + (1-\eta)(1-\alpha)log(l_{it}) + (1-\eta)log(I_{it}) \tag{2.41}$$

$$\begin{gathered} E[log(q_{it}) \mid l_{it}, k_{it} I_{it}, Survival] = \\ \tfrac{1}{1-\rho} E[log(z_{it}) \mid l_{it}, k_{it}, I_{it}, Survival] + \eta\alpha log(k_{it}) + (1-\eta)(1-\alpha)log(l_{it}) + (1-\eta)log(I_{it}) \end{gathered} \tag{2.42}$$

From Pakes (1994) we know that (nonzero) investment is strictly increasing in productivity given k_{it}, so we have $z_{it} = h_t(x_{it}, k_{it})$ where x_{it} is investment for firm i in period t. Now we can correct for the simultaneity bias using the regression:

$$log(q_{it}) = \beta_l log(l_{it}) + \beta_I log(I_{it}) + \chi(x_{it}, k_{it}) + \varepsilon_{it} \tag{2.43}$$

where $\chi(x_{it}, k_{it})$ is a polynomial function of x and k. The estimates on labor and materials will be lower now since we corrected for the downward bias in capital. We now have an estimate of $\eta = 1 - \beta_I$ and $\beta_l = \eta(1-\alpha)$ or $\alpha = 1 - \beta_l/(1-\beta_I)$.

We can then estimate

$$log(q_{it}) - \beta_l log(l_{it}) - \beta_I log(I_{it}) = \beta_o + \beta_k k_{it} + E[log(z_{it}) \mid z_{it-1}, Survivial] + \zeta_{it} + \varepsilon_{it} \tag{2.44}$$

Since $E[log(z_{it}) \mid z_{it-1}, Survivial]$ is a function of both the unobserved firm productivity (lagged) and the survival probability we use the two standard instruments in the literature: $\chi(x_{it}, k_{it}) - \beta_k k_{it}$ and estimated probability of survival. We estimate the survival probability using a standard probit model as a function of investment and capital.

We include the final estimates of the production function parameters in Table 15.We estimate the materials good share, $1 - \eta$, at 0.70, implying η=0.30. The labor share is estimated to be 0.28, which implies an α of 0.053. The result are fairly constant across time and by industry, although the capital share is slightly higher for manufacturing.

Table 1: Summary Statistics on Firms from the Bureau van Dijks Amadeus Dataset 2002-2012. All variables are taken as a ratio over total assets.

	Mean	Median	P25	P75	Min	Max	N
Revenue	1.89	1.61	0.967	2.42	0.000288	25.9	94973
Profits before Taxes	0.0485	0.0482	0.00355	0.112	-1.1	1.27	94973
Investment	0.0493	0.0221	0.00185	0.0616	-0.0781	0.75	94973
Materials Cost	0.978	0.664	0.219	1.32	-0.919	9.15	94973
Employment Costs	0.408	0.298	0.169	0.494	0.0016	4.83	94973
Total Debt	0.691	0.653	0.456	0.836	0.00178	2.59	94973
Long-Term Debt	0.138	0.0245	0	0.174	0	1.4	94973
Other Non-current Debt	0.0439	0.011	0.000711	0.0407	0	1.02	94973
Short-Term Loans	0.189	0.102	0.025	0.259	0	1.48	94973
Trade Credit	0.152	0.11	0.042	0.219	0	0.666	94973
Other Current Debt	0.161	0.112	0.0606	0.207	0	0.998	94973
Cash	0.11	0.0503	0.00831	0.153	0.0000382	0.991	94973
Equity	0.282	0.354	0.166	0.562	-0.294	0.927	94973
Capital	0.284	0.207	0.0712	0.428	0	0.98	94973
Value of Real Estate	0.459	0.301	0.102	0.639	0	4.68	94973
Price Index	1.5	1.43	1.32	1.68	1	2.75	94973

Table 2: External Financing Summary Statistics. We calculate the percent of employment costs that can not be financed through internal funds.

Size Cohort	% of Emp Cost Paid through External Financing
$<$5 Emp	13.9%
5-9 Emp	9.6%
10-19 Emp	6.5%
20-49 Emp	4.9%
50-99 Emp	3.9%
100-249 Emp	3.5%
$>$ 249 Emp	2.9%
Total Sample	4.2%

Table 3: Baseline Regression of Real Estate Value and Debt Financing Decisions. This table determines if firms use commercial real estate as collateral for access to debt. The dependent variable is Total Debt. The independent variable of interest is the Value of Real Estate, calculated as the ratio of Tangible Fixed Assets to Total Assets in year 2002 multiplied by the current Price Index. Productivity is taken from our earlier estimates. Columns 3 and 4 are estimated using the real estate growth instrument. Columns 1 and 3 include year fixed effects while columns 2 and 4 includes Year×Local Planning Authority fixed effects. Each regression includes X (indicator variables for deciles of total assets, total employment costs, total materials cost, return on assets, firm age, number of employees, LPA, and industry codes) interacted with the price index. All specifications cluster observations at the Year×Region level. T-Statistics are included below the coefficient. We use * to denote significance at the 10% level, ** to denote significance at the 5% level, and *** to denote significance at the 1% level.

	(i)	(ii)	(iii)	(iv)
	OLS	OLS	IV	IV
Value of Real Estate (Regional Index)	0.246***	0.247***		
	(20.99)	(20.91)		
Value of Real Estate (LPA Index)			0.248**	0.213**
			(2.55)	(2.34)
Productivity	0.174***	0.174***	0.209***	0.209***
	(54.61)	(54.62)	(41.04)	(41.09)
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year ×LPA Effects	No	Yes	No	Yes
N	94793	94793	55187	55187
R^2	0.747	0.749	0.794	0.795

Table 4: Robustness Checks on the Relationship between Real Estate Value and Debt Financing Decisions. The dependent variable is Total Debt. The first column uses an alternative residential price index from Nationwide Building Society. The second column includes the Pre-Recession years of 2002-2007. The third column uses the 2007-2012 subsample. The fourth column includes only firms with less than 250 employees, while the fifth column uses data on firms of at least 250 employees. The sixth column includes only industries that produce nontradable goods and the seventh column use only firms in the tradable goods sector. The eighth and ninth columns distinguish between firms with high and low returns on assets. Productivity is taken from our earlier estimates. Columns 4 and 5 are estimated using the real estate growth instrument. All columns includes Year×Local Planning Authority fixed effects. Each regression includes X (indicator variables for deciles of total assets, total employment costs, total materials cost, return on assets, firm age, number of employees, LPA, and industry codes) interacted with the price index. All specifications cluster observations at the Year×Region level. T-Statistics are included below the coefficient. We use * to denote significance at the 10% level, ** to denote significance at the 5% level, and *** to denote significance at the 1% level.

	Alt. Index	2002-2007	2007-2012	Small Firms	Large Firms	Non-Trad	Tradable	Low RTAS	High RTAS
Value of Real Estate	0.232***	0.301***	0.35***	0.255***	0.239***	0.247***	0.193***	0.298***	0.249***
	(20.22)	(18.60)	(15.45)	(21.00)	(12.87)	(20.91)	(10.3)	(14.61)	(9.99)
Productivity	0.175***	0.187***	0.188***	0.173***	0.183***	0.174***	0.213***	0.224***	0.162***
	(55.26)	(40.52)	(47.31)	(48.96)	(30.22)	(54.62)	(30.68)	(27.43)	(31.58)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year×LPA FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	94973	53114	51385	72133	22840	94973	29872	23526	24241
R^2	0.768	0.802	0.848	0.79	0.744	0.768	0.752	0.839	0.858

Table 5: Regression of Real Estate on Short-Term Loans. Ages are defined as of year 2002. All columns includes Year×Local Planning Authority fixed effects. Each regression includes X (indicator variables for deciles of total assets, total employment costs, total materials cost, return on assets, firm age, number of employees, LPA, and industry codes) interacted with the price index. All specifications cluster observations at the Year×Region level. T-Statistics are included below the coefficient. We use * to denote significance at the 10% level, ** to denote significance at the 5% level, and *** to denote significance at the 1% level.

	Short-Term Interest	Short-Term Loans			
		Age<5	5⩽Age < 10	10 ⩽Age < 20	20⩽ Age < 30
Value of Real Estate	-2.05***	0.0844***	0.0527***	0.0593***	0.0314**
	(-14.44)	(6.09)	(4.22)	(5.87)	(2.17)
Productivity	-0.238***	0.0352***	0.0329***	0.0289***	0.0375***
	(-9.17)	(13.03)	(9.55)	(12.04)	(10.58)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year×LPA Fixed Effects	Yes	Yes	Yes	Yes	Yes
N	94973	19162	12062	25791	13875
R^2	0.906	0.703	0.724	0.726	0.716

Table 6: Regression of Real Estate on Debt Financing Decisions by Industry. Industries are defined according to the two-digit NAICS code and industries with less than 1000 firm-year observations are omitted. All columns includes Year×Local Planning Authority fixed effects. Each regression includes X (indicator variables for deciles of total assets, total employment costs, total materials cost, return on assets, firm age, number of employees, LPA, and industry codes) interacted with the price index. All specifications cluster observations at the Year×Region level. T-Statistics are included below the coefficient. We use * to denote significance at the 10% level, ** to denote significance at the 5% level, and *** to denote significance at the 1% level.

	Agriculture	Manufacturing	Retail Trade	Transportation	Information	Bus. Services
NAICS Code	11	31-33	44-45	48-49	51	54
Value of Real Estate	0.224***	0.193***	0.132***	0.256***	0.277***	0.415***
	(3.73)	(10.3)	(3.32)	(7.07)	(5.69)	(8.85)
Productivity	0.16***	0.213***	0.135***	0.163***	0.221***	0.211***
	(8.04)	(30.68)	(15.82)	(16.79)	(14.95)	(26.56)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year×LPA Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
N	1246	29872	4928	5150	3482	6726
R^2	0.868	0.752	0.811	0.755	0.829	0.79

	Management	Admininstrative	Health	Arts & Entertain	Accommodation & Food	Other
NAICS Code	55	56	62	71	72	81
Value of Real Estate	0.26***	0.279***	0.216***	0.427***	0.253***	0.28***
	(5.85)	(6.9)	(4.04)	(9.01)	(9.44)	(4.7)
Productivity	0.205***	0.176***	0.189***	0.125***	0.19***	0.187***
	(14.98)	(21.4)	(9.43)	(8.52)	(14.61)	(9.69)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year×LPA Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
N	4716	7784	2161	2230	4948	3680
R^2	0.747	0.746	0.789	0.868	0.812	0.786

Table 7: Robustness Checks on the Relationship between Real Estate Value and Firm Capital Expenditures. The first column is our baseline estimate. The second column uses an alternative residential price index from Nationwide Building Society. The third column includes the Pre-Recession years of 2002-2007. The fourth column uses the 2007-2012 subsample. The fifth column includes only firms with less than 250 employees, while the sixth column uses data on firms of at least 250 employees. The seventh column includes only industries that produce nontradable goods and the eighth column use only firms in the tradable goods sector. The ninth and tenth columns distinguish between firms with high and low return on assets. Each regression includes X (indicator variables for deciles of total assets, total employment costs, total materials cost, return on assets, firm age, number of employees, LPA, and industry codes) interacted with the price index. All specifications cluster observations at the Year×Region level. T-Statistics are included below the coefficient. We use * to denote significance at the 10% level, ** to denote significance at the 5% level, and *** to denote significance at the 1% level.

	Baseline	2002-2007	2007-2012	Small Firms	Large Firms	Non-Trad	Tradable	Low RTAS	High RTAS
Value of Real Estate	0.0901***	.116***	.101***	.0941***	.0929***	.107***	.0682***	0.0852***	0.0692***
	(30.11)	(22.20)	(11.47)	(28.95)	(18.68)	(11.24)	(18.29)	(16.41)	(11.86)
Productivity	0.0172***	.0189***	.0163***	.0158***	.0218***	.0258***	.0234***	0.0200***	0.0164***
	(33.82)	(24.40)	(17.41)	(29.53)	(19.27)	(15.33)	(23.94)	(14.31)	(23.10)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year×LPA FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	94973	53114	41859	72133	22840	5956	29872	23526	24241
R^2	.532	.611	.653	.537	.568	.587	.482	0.651	0.704

Table 8: Baseline Regression of Real Estate Value on Firm Employment Decisions. The dependent variable is Firm Employment Expenditures. Columns 4 and 5 are estimated using the real estate growth instrument. Columns 1, 2, and 4 include year fixed effects while columns 3 and 5 include Year×Local Planning Authority fixed effects.Each regression includes X (indicator variables for deciles of total assets, total employment costs, total materials cost, return on assets, firm age, number of employees, LPA, and industry codes) interacted with the price index. All specifications cluster observations at the Year×Region level. T-Statistics are included below the coefficient. We use * to denote significance at the 10% level, ** to denote significance at the 5% level, and *** to denote significance at the 1% level.

	(i)	(ii)	(iii)	(iv)	(v)
	OLS	OLS	OLS	IV	IV
Value of Real Estate (Regional Index)	0.119***	.0742***	0.0748***		
	(40.25)	(20.72)	(20.89)		
Value of Real Estate (LPA Index)				0.105**	0.116**
				(2.05)	(2.17)
Capital		0.145***	0.146***	0.203***	0.203***
		(14.83)	(14.74)	(17.95)	(17.95)
Productivity	0.163***	0.149***	0.174***	0.161***	0.161***
	(56.93)	(54.66)	(54.62)	(51.44)	(51.49)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year ×LPA Effects	No	No	Yes	No	Yes
N	94973	94973	94973	55187	55187
R^2	0.914	0.932	0.932	0.794	0.795

Table 9: Robustness Checks on the Relationship between Real Estate Value and Firm Employment Expenditures. The first column uses an alternative residential price index from Nationwide Building Society. The second column includes the Pre-Recession years of 2002-2007. The third column uses the 2007-2012 subsample. The fourth column includes only firms with less than 250 employees, while the fifth column uses data on firms with at least 250 employees. The sixth column includes only industries that produce nontradable goods and the seventh column use only firms in the tradable goods sector. Columns eight and nine distinguish between firms with high and low return on assets. All columns includes Year×Local Planning Authority fixed effects. Each regression includes X (indicator variables for deciles of total assets, total employment costs, total materials cost, return on assets, firm age, number of employees, LPA, and industry codes) interacted with the price index. All specifications cluster observations at the Year×Region level. T-Statistics are included below the coefficient. We use * to denote significance at the 10% level, ** to denote significance at the 5% level, and *** to denote significance at the 1% level.

	Alt. Index	2002-2007	2007-2012	Small Firms	Large Firms	Non-Trad	Tradable	Low RTAS	High RTAS
Value of Real Estate	0.0713***	0.0675***	0.133***	0.102***	0.0592***	0.103***	0.0592***	0.0503***	0.117***
	(20.54)	(15.35)	(11.44)	(22.91)	(11.91)	(6.17)	(12.14)	(10.51)	(10.41)
Capital	0.147***	0.16***	0.126***	0.136***	0.137***	0.128***	0.148***	0.130***	0.162***
	(14.83)	(11.95)	(9.14)	(10.61)	(9.49)	(6.61)	(13.29)	(5.77)	(5.95)
Productivity	0.149***	0.154***	0.138***	0.144***	0.165***	.151***	0.149***	0.189***	0.160***
	(55.51)	(40.5)	(25.2)	(48.2)	(34.46)	(19.24)	(38.96)	(33.11)	(33.22)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year×LPA Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	94973	53114	41859	72133	22840	5956	29872	23526	24241
R^2	0.932	0.951	0.964	0.926	0.959	.966	0.924	0.947	0.956

Table 10: Regression of Real Estate Value and Employees/Wage Decisions. This table determines if the Small Business Collateral Channel works through employment or wages. The dependent variable are Number of Employees and Cost per Employee. The independent variable of interest is the Value of Real Estate, calculated as the ratio of Tangible Fixed Assets to Total Assets in year 2002 multiplied by the current Price Index. Profitability is the ratio of Net Income for the Year/Total Assets. Each regression includes X (indicator variables for deciles of firm age, number of employees, profitability, and two-digit industry codes) interacted with the regional price index. All specifications cluster observations at the Year×Region level. T-Statistics are included below the coefficient. We use * to denote significance at the 10% level, ** to denote significance at the 5% level, and *** to denote significance at the 1% level.

	Number of Employees			Average Employee Cost		
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Value of Real Estate	0.0072***	0.00621***	0.00308***	-2.94***	-2.83***	-6.14***
	(48.79)	(38.19)	(27.59)	(-11.79)	(-10.99)	(-14.36)
Capital		0.00426***	0.00286***		-0.474	-1***
		(18.87)	(15.01)		(-1.60)	(-3.32)
Productivity			0.00148***			0.623***
			(37.4)			(9.57)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year ×LPA Effects	Yes	Yes	Yes	Yes	Yes	Yes
N	94973	94973	94973	94935	94935	94935
R^2	0.949	0.951	0.957	0.911	0.911	0.911

Table 11: Regression of Real Estate Value and Firm Decisions on Public and Private Firms. Each regression includes X (indicator variables for deciles of total assets, total employment costs, total materials cost, return on assets, firm age, number of employees, LPA, and industry codes) interacted with the price index. All specifications cluster observations at the Year×Region level. T-Statistics are included below the coefficient. We use * to denote significance at the 10% level, ** to denote significance at the 5% level, and *** to denote significance at the 1% level.

	Private Firms			Public Firms		
	Debt	Capital	Emp Cost	Debt	Capital	Emp Cost
Value of Real Estate	0.248***	0.0826***	0.0757***	0.146*	0.0754***	0.0217
	(21.27)	(30.31)	(20.58)	(1.95)	(6.72)	(0.47)
Capital			0.145***			0.132***
			(14.31)			(4.68)
Productivity	0.172***	0.017***	0.148***	0.259***	0.0347***	0.157***
	(55.74)	(33.88)	(53.47)	(12.25)	(5.67)	(16.27)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year×Region Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
N	93026	93026	93026	1947	1947	1947
R^2	0.77	0.528	0.933	0.782	0.593	0.942

Table 12: Estimating the Small Business Collateral Channel by Firm Size and Age. This table weights the aggregate effect of the Small Business Collateral Channel on Total Employment. The first column specifies the firm size/age cohort. The second column offers the relative number of firms in each cohort according to the UK Business: Activity, Size, and Location dataset from the Office of National Statistics . The third column is the mean number of employees in each firm by cohort. The fourth column uses this information to weight the total number of employees by cohort. The fifth column estimates β^E the affect of a 1 unit increase in real estate value on employment expenditures. The sixth column estimates γ^E, the increase in employment demand due to a 1 unit increase in capital. The seventh column estimates β^I, the affect of a 1 unit increase in real estate value on firm investment expenditure. The final row includes an estimate of each coefficient appropriately weighted. All regression includes Year×Local Planning Authority fixed effects. Each regression includes X (indicator variables for deciles of total assets, total employment costs, total materials cost, return on assets, firm age, number of employees, LPA, and industry codes) interacted with the price index.We use * to denote significance at the 10% level, ** to denote significance at the 5% level, and *** to denote significance at the 1% level.

Size Cohort	Firm Proportion	# Emp	Weight	β^E	γ^E	β^I
<5 Emp	76%	2.9	16.4%	0.0646	0.0	0.105***
5-9 Emp	13%	7.1	6.9%	0.062*	.181***	0.0784***
10-19 Emp	6%	14.6	6.5%	0.117***	.175***	0.0783***
20-49 Emp	3%	34.2	7.7%	0.116***	.0723***	0.0802***
50-99 Emp	1%	71.1	5.3%	0.0646***	.122***	0.0864***
100-249 Emp	0.6%	156.1	6.9%	0.0591***	0.15***	0.0782***
> 249 Emp	0.4%	1681.0	50.2%	0.0492***	0.122***	0.0851***
Weighted Mean				0.0635	0.107	0.0962

Age Cohort	Firm Proportion	# Emp	Weight	β^E	γ^E	β^I
0-1 Years	15%	36	8.3%	0.133***	0.241***	0.0873***
2-3 Years	13%	39	7.8%	0.133***	0.241***	0.0873***
4-9 Years	28%	45	19.3%	0.0736***	0.142***	0.0943***
10+ Years	45%	67	64.7%	0.0531***	0.119***	0.0908***
Weighted Mean				0.0700	0.143	0.0910

Table 13: Evaluation of the Small Business Collateral Channel. This table estimates the percentage of the total decline in employment expenditures due to the real estate shock on firms. Our estimates use the coefficients from the 2002-2007 period as well as the 2007-2012 subsample. The results are broken down by UK geographic region. The second column is the total decline in employment in each region between 2007 and 2009. The third and sixth column estimate the direct effect of a collateral shock on employment spending. The fourth and seventh column estimate the indirect effect, defined as the employment implications of a real estate shock on firm investment. The fourth and eighth column add the direct and indirect effects.

		From 2002-2007 Estimates			From 2007-2012 Estimates		
	ΔEmployment Rate$_{2007-2009}$	Direct	Indirect	Combined	Direct	Indirect	Combined
United Kingdom	-2.9%	7.1%	1.2%	8.3%	14.8%	1.3%	16.1%
North East	-3.4%	6.9%	1.7%	8.6%	12.2%	1.2%	13.4%
North West	-2.8%	8.2%	1.1%	9.3%	15.1%	1.3%	16.4%
Yorkshire & The Humber	-2.9%	5.4%	2.1%	7.5%	11.9%	1.1%	13%
East Midlands	-1.8%	4.9%	0.8%	5.7%	14.5%	1.5%	16%
West Midlands	-3.8%	6.8%	1.4%	8.2%	14.9%	1.6%	16.5%
East	-2%	9.1%	1.8%	10.9%	13.7%	1.9%	15.6%
London	-1.6%	5.7%	1.1%	6.85	12.6%	1.1%	13.7%
South East	-2%	6.7%	0.7%	7.4%	15.3%	1.2%	16.5%
South West	-2.7%	7.3%	1.4%	8.7%	14.9%	1%	15.9%
Wales	-3.6%	7.2%	1.7%	8.9%	15.1%	1.7%	16.8%
Scotland	-2.3%	6.5%	1.5%	8%	13.8%	1.5%	15.3%
Northern Ireland	-2.9%	17.1%	3.2%	20.3%	32.3%	4.2%	36.5%

Table 14: Evaluation of the Effects of the 2007-2009 Recession on Small Firms. The second and third column denote the mean value for each variable; the fourth column estimates the percentage decline between the 2007 and 2009 values.

Variable	2007	2009	%Δ
Price	1.796	1.483	-17.4%
Value of Real Estate	0.474	0.437	-7.8%
Investment	0.0485	0.0389	-19.8%
Employee Cost	0.415	0.385	-7.23%
Materials Cost	1.42	1.31	-8.40%
Profit	0.0815	0.0582	-28.8%
Revenue	1.948	1.790	-8.11%
Debt	0.706	0.625	-13.0%
Long Term Debt	0.136	0.124	-8.8%
Other Non-Current Debt	0.0457	0.0461	0.87%.
Short Term Loans	0.192	0.168	-12.5%
Trade Credit	0.153	0.133	-13.1%
Other Current Debt	0.179	0.154	-16.2%

Table 15: Regression of Revenue on Input Production Factors using the Olley-Pakes Semi-Parametric Method. We use * to denote significance at the 10% level, ** to denote significance at the 5% level, and *** to denote significance at the 1% level.

	Revenue
Employment Cost	0.284***
	(240.3)
Materials Cost	0.700***
	(677.8)
Capital	0.0162***
	(23.3)
N	94,973

Table 16: Regression of the LPA Real Estate Price Index on our Government Regulatory Restraint Measure. This is the first-stage result for our IV estimation. Our instrument for real estate price growth is $Refusal\,Rate/I_t$ defined as the interaction of the LPA refusal rate of major real estate projects over the 30-year conventional mortgage rate. We use * to denote significance at the 10% level, ** to denote significance at the 5% level, and *** to denote significance at the 1% level.

	LPA Real Estate Price Index
$Refusal\,Rate/I_t$	0.350***
	(5.43)
Year Fixed Effects	Yes
LPA Fixed Effects	Yes
N	55,187
R^2	0.947

Table 17: Correlation between Productivity, Revenue, Profits, and Return on Assets. We define Productivity as the residual of the Production Function Regression. Revenue is defined as Revenue over lagged total assets, Profitability is defined as Profit before Taxes over lagged total assets, and Return on Assets is net income over lagged total assets.

	Productivity	Revenue	Profitability	Return on Assets
Productivity	1			
Revenue	.11	1		
Profitability	.22	.21	1	
Return on Assets	.21	.14	.87	1

Table 19: Real Estate Balance Sheet Summary Statistics from the Federal Reserve Flow of Funds. This table offers a comparison between the real estate owning for US and UK firms during the 2012 fiscal year. Estimates of the Market Value of real estate are shown on the balance sheet; the estimates are from the FFA and are calculated using real estate price indices and net investment from BEA.

	Corporate	Noncorporate	Total
Total Assets (in Billions)	31,618.8	13,849.3	454,68.1
Non-Financial Assets at Market Value	15,857.4	10,050.4	25,907.8
Real Estate at Market Value	9,327.8	9,111.3	18,439.1
Real Estate/Non-Financial Assets	58.8%	90.7%	71.2%
Real Estate/Total Assets	29.5%	65.8%	40.6%

Table 20: Worldscope Summary Statistics on the Subcomponents of Property, Plant and Equipment (PPE). Real Estate is defined as the sum of land ownings, construction in progress, and buildings.

	Mean	Median	St Dev	P25	P75	N
Real Estate as a Fraction of PPE	0.285	0.170	0.314	0.00	0.522	3206
Real Estate Owner (0,1)	0.724	1	0.447	0	1	5348
Real Estate as Fraction of PPE if Owner	0.529	0.499	0.236	0.35	0.708	1729
Other PPE as a Fraction of PPE	0.383	0.164	0.415	0.00	0.908	3206
Capital Leases as a Fraction of PPE	0.002	0.000	0.022	0.00	0.000	3206
Machinery as a Fraction of PPE	0.287	0.160	0.320	0.00	0.525	3206
Transportation as a Fraction of PPE	0.041	0.000	0.142	0.00	0.006	3206

Table 18: Tangible Fixed Assets Balance Sheet Summary Statistics from the Bank of England I. This table collects data on the break-down of non-financial assets for both public and private UK firms for the 2012 fiscal year.

	Total Corp.	Public Corp.	Private Corp.
AN.1 Total Non-Financial Assets	100.0%	100.0%	100.0%
AN.11 Fixed Assets / AN.1 Non-Financial Assets	87.1%	97.3%	86.0%
AN.111 Tangible Fixed Assets / AN.1 Non-Financial Assets	84.4%	93.4%	83.3%
AN.1111 Dwellings/ AN.1 Non-Financial Assets	11.1%	48.1%	7.0%
AN.1112 Other Buildings and Structures / AN.1 Non-Financial Assets	43.5%	36.6%	44.3%
AN.11121 Non-Residential Buildings / AN.1 Non-Financial Assets	19.6%	22.4%	19.3%
AN.11122 Other Structures/ AN.1 Non-Financial Assets	24.0%	14.2%	25.1%
AN.111 Tangible Fixed Assets	100.0%	100.0%	100.0%
AN.1111 Dwellings / AN.111 Tangible Fixed Assets	13.2%	51.5%	8.4%
AN.1112 Other Buildings and Structures / AN.111 Tangible Fixed Assets	51.6%	39.2%	53.2%
AN.11121 Non-Residential Buildings / AN.111 Tangible Fixed Assets	23.2%	24.0%	23.1%
AN.11122 Other Structures / AN.111 Tangible Fixed Assets	28.4%	15.2%	30.1%

Table 21: Correlation Matrix between the UK Commercial and Residential Real Estate Index. The Residential data is the Halifax House Price Index from Lloyds Banking Group and is derived from mortgage data from the nation's largest mortgage provider. The Commercial data is from the FTSE Commercial Property Index Series and are further broken into three subgroups: Retail Index, Office Index, and Industrial Index.

	Residential	Commercial	Retail	Office	Industrial
Residential	1				
Commercial	0.9259	1			
Retail	0.9273	0.9973	1		
Office	0.8977	0.9727	0.9532	1	
Industrial	0.9418	0.9833	0.9874	0.9372	1

Table 22: Data on the Number of Firms in the UK, in the AMADEUS Dataset, and in the Sample Separated by Firm Size and Firm Age.

	Actual		AMADEUS		Data Sample	
Cohort	Number	Percent	Number	Percent	Number	Percent
$<$ 5 Emp	1579840	76	3466	8	942	9.9
5-9 Emp	267950	13	2456	6	189	2.0
10-19 Emp	124440	6	4319	10	530	5.5
20-49 Emp	66445	3	8830	21	1769	18.5
50-99 Emp	21575	1	8937	21	2647	27.7
100-249 Emp	11980	0.6	8272	19	2368	24.8
$>$249 Emp	8630	0.4	6447	15	1973	20.7
Total	2080860	100	42727	100	9552	100
Cohort	Number	Percent	Number	Percent	Number	Percent
$<$ 2 Year	305590	15	1582	4	952	10.0
2-3 Years	270145	13	2630	6	831	8.7
4-9 Years	579300	28	9748	23	1909	19.9
$>$ 10 Years	925825	45	28767	67	5860	61.3
Total	2080860	100	42727	100	9552	100

Table 23: Prediction of initial Real Estate Holdings on observable firm characteristics.

		Real Estate Holdings
Total Assets Fixed Effects	F-Stat	474.89
	p-value	0.0000
Employment Fixed Effects	F-Stat	28.34
	p-value	0.0000
Material Costs Fixed Effects	F-Stat	265.76
	p-value	0.0000
Return on Capital Fixed Effects	F-Stat	7.78
	p-value	0.0008
Firm Age Fixed Effects	F-Stat	77.46
	p-value	0.0000
NAICS Code Fixed Effects	F-Stat	5.75
	p-value	0.0025
Local Planning Authority Fixed Effects	F-Stat	32.79
	p-value	0.0000
N		10,910
R^2		0.424

Table 24: Data on the level of Securitized debt among US Public Firms 1996-2005. This table presents summary statistics on debt composition for a random sample of 305 rated firms from 1996-2005 and is obtained from data originally collected by Rauh and Sufi (2010).

	Mean	St. Dev.	Obs.
Has Secured Debt (0,1)	0.72	0.45	2453
Secured Debt / Total Debt	0.30	0.35	2453
Secured Debt / Total Debt and Equity	0.15	0.23	2453
Has Secured Debt Not Including Mortgage Debt or Equipment Loans (0,1)	0.66	0.47	2453
Secured Debt Not Including Mortgage Debt or Equipment Loans / Total Debt	0.25	0.33	2453
Secured Debt Not Including Mortgage Debt or Equipment Loans / Total Debt and Equity	0.13	0.22	2453

Table 25: Regression of Real Estate on Debt Financing Decisions by Type of Debt. The dependent variables are: (i)Long-Term Debt, (ii) Other Non-Current Debt, (iii) Loan Debt, (iv) Creditor Debt, and (v) Other Current Debt. All columns includes Year×Local Planning Authority fixed effects. Each regression includes X (indicator variables for deciles of total assets, total employment costs, total materials cost, return on assets, firm age, number of employees, LPA, and industry codes) interacted with the price index. All specifications cluster observations at the Year×Region level. T-Statistics are included below the coefficient. We use * to denote significance at the 10% level, ** to denote significance at the 5% level, and *** to denote significance at the 1% level.

	Long-Term Debt	Other Current Debt	Short-Term Loans	Trade Credit	Other Non-current Debt
Value of Real Estate	0.0628***	0.0419***	0.0555***	0.0425***	0.0445***
	(10.21)	(13.39)	(9.54)	(18.46)	(10.82)
Productivity	0.0125***	0.00852***	0.0322***	0.0462***	0.0744***
	(9.22)	(11.95)	(24.8)	(37.6)	(50.17)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year×LPA Fixed Effects	Yes	Yes	Yes	Yes	Yes
N	94973	94973	94973	94973	94973
R^2	0.772	0.644	0.712	0.857	0.779

Table 26: Alternative Empirical Specifications on Real Estate Shocks and Employment. The first and second column defines the dependent variable as the yearly growth in employment costs. The third column includes future capital holdings. The fourth column defines the dependent variable as the mean of employment costs over the following three years. The fifth column includes a measure of cashflow sensitivity. All columns includes Year×Local Planning Authority fixed effects and firm fixed effects. Each regression includes X (indicator variables for deciles of total assets, total employment costs, total materials cost, return on assets, firm age, number of employees, LPA, and industry codes) interacted with the price index. All specifications cluster observations at the Year×Region level. T-Statistics are included below the coefficient. We use * to denote significance at the 10% level, ** to denote significance at the 5% level, and *** to denote significance at the 1% level.

	ΔEmp Cost	ΔEmp Cost	Emp Cost	$\frac{1}{3}\sum_{j=0,1,2}$ Emp $Cost_{it+j}$	Emp Cost
Value of Real Estate	0.0531***	0.0322***	0.0663***	0.0523***	0.0561***
	(14.98)	(12.79)	(13.49)	(13.11)	(22.03)
$Capital_t$			0.121***	0.165***	0.139***
			(10.58)	(12.34)	(14.27)
$Capital_{t-1}$			0.0136**		
			(2.17)		
$Capital_{t-2}$			0.0131*		
			(1.68)		
Investment		0.193***			
		(29.35)			
Productivity	0.0354***	0.0263***	0.151***	0.0591***	-0.169***
	(11.93)	(9.86)	(45.05)	(19.49)	(-16.19)
Cashflow					0.152***
					(60.10)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year×LPA Fixed Effects	Yes	Yes	Yes	Yes	Yes
N	92080	92080	49139	49139	94835
R^2	0.392	0.429	0.947	0.9543	0.935

Table 27: Calibrated Model Parameters. The Baseline Calibration is our preferred calibration and refers to our own estimation or estimates from the literature. The Calibration Range is the range of calibrations where the general equilibrium effects magnify our empirical estimates holding other parameters values constant. BH refers to Burstein and Hellwig, RCK refers to Rosi, Chevalier, and Kashyap, OC refers to Ok-Cho and Cooley, KR refers to King and Rebelo, and SW refers to Smets and Wouters .

Variable	Variable Label	Baseline Calibration	Source	Calibration Range
Share of Capital	α	0.05	Olley-Pakes Estimation	(0,1)
1-Share of Material Goods	η	0.30	Olley-Pakes Estimation	(0,1)
Elasticity of Substitution across Firms	$\rho = \frac{1}{1-\nu}$	4	BH (2008), RCK (2003)	(0,7)
Elasticity of Labor Supply	ε	2.84	OC (1994), KR (1999) SW (1999)	$(1,\infty)$

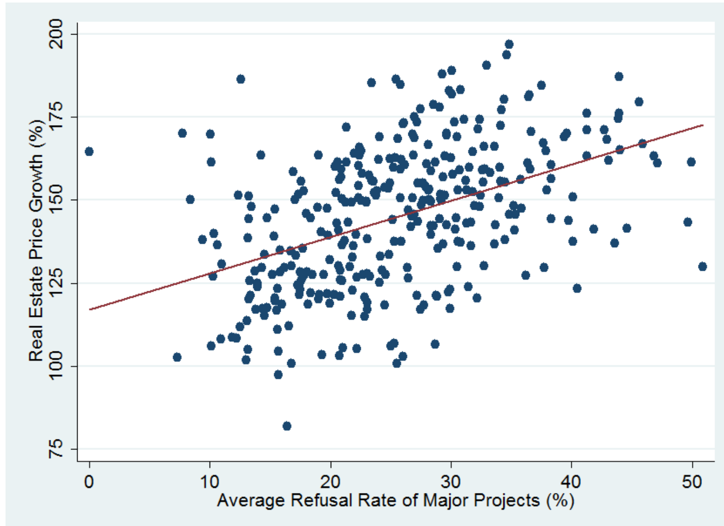

Figure 2.1: Real Estate Price Growth and Government Regulation.

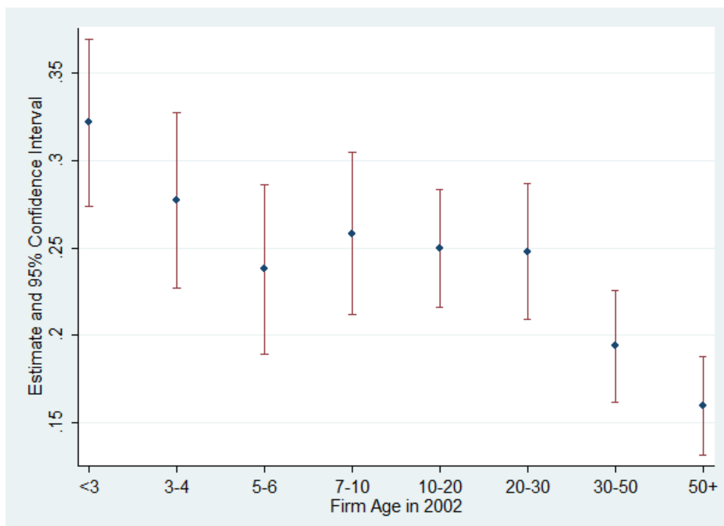

Figure 2.2: Regression of Real Estate Value and Debt Decisions by Firm Age. This table reports the estimate and 95% confidence interval for separate regressions for each firm age group. Groups are based on the age of the firm in 2002. All columns includes Year×Local Planning Authority fixed effects. All specifications cluster observations at the Year×Region level.

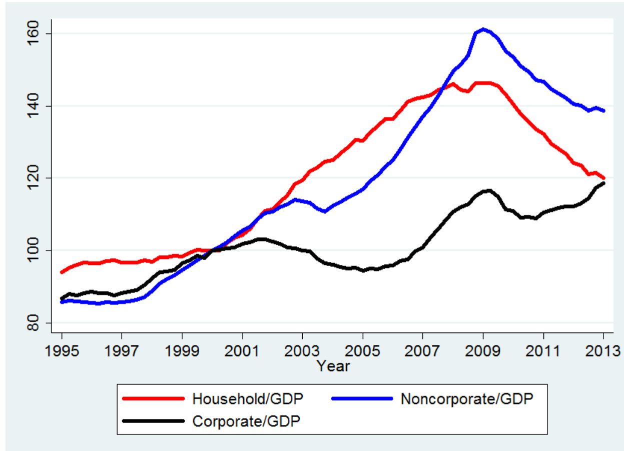

Figure 2.3: US Credit Market Liabilities Index. This figure displays an index of the following variables from 1995-2013: (i) US Household and Nonprofit Organization Credit Market Instrument Liabilities/US GDP, (ii) US Nonfinancial Noncorporate Business Credit Market Instrument Liabilities/ US GDP, and (iii)US Nonfinancial Corporate Business Credit Market/ US GDP. Each variable is indexed to be 100 in the first quarter of 2000. Financial data is collected from the Federal Reserve Board Flow of Funds and GDP data is from the National Income and Product Accounts. As of the first quarter of 2013 Household Liabilities/GDP = 0.77, Corporate Liabilities/GDP = 0.54, and Noncorporate Liabilities were 0.24. In comparison in the first quarter of 2009, these number were Household Liabilities =0.94, and Corporate Liabilities= 0.52, and Nonorporate Liabilities/GDP = 0.28, .

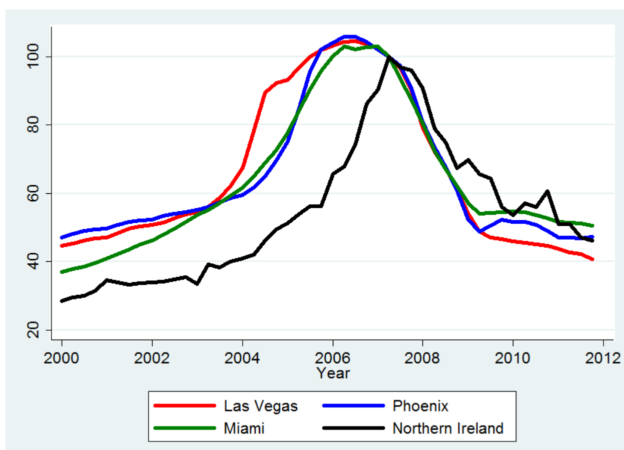

Figure 2.4: Comparison of Northern Ireland Housing Price Index with Three "Boom-Bust" US Cities. Each price index is set at 100 in the first quarter of 2007 during the height of the Northern Ireland housing boom.

3 How Case-Shiller got it Wrong: the Effect of Market Conditions on Price Indices

Introduction

Many assets (i) sell infrequently and (ii) are not interchangeable. For instance, real estate comprises the majority of household wealth and over two-thirds of all firm non-financial assets, yet each property is unique and may not be solved for many years. Similarly, there is only a small market for commercial airplanes and railroad equipment, yet these assets are necessary to value for the producer price index. Even more important is the valuation of risky human capital. Obviously, these assets are particularly important; however, due to this market illiquidity we are not able to accurately value these individual assets. As a result, empirical research on individual illiquid assets has lagged behind more traditional asset pricing topics.

To overcome these issues the standard approach in the literature is to instead aggregate assets to develop a price index, a technique best known in the real estate finance literature. Research in this area has long documented significant cross-sectional heterogeneity among real estate prices across cities, and as a result house price indices are generally have been developed at a local level. These same indices, however, allow for no role in diverse returns within a local area as they require at least one of these conditions to hold: (i) houses with a city exhibit the same price process, or (ii) there is no variation over the business cycle in the composition of houses that are sold.

With this in mind, the purpose of this paper is three-fold. First, we offer evidence of significant change in both the composition and price dispersion among houses with US metropolitan areas between 2002 and 2006. Secondly, to deal with these complications we develop a new technique to price any illiquid asset at all time periods; summing the price indices results in an aggregate price index robust to both heterogeneous returns and changing market composition. Third, we apply our new approach to the US housing market to quantify and correct mismeasurement in traditional US house price indices.

We first document the need for a price index that is robust to changing composition and price dispersion patterns. We break metropolitan houses into subsets based on initial price. We find that during the 2002-2006 US housing boom, low tier housing grew up to twice as fast as high tier housing in certain cities. Similarly, these same houses began to sell significantly more often, affecting the composition of transactions in the market. Using detailed credit data at the household level, we offer simple evidence that both effects are driven by changing credit conditions for low income homebuyers. From the data, it is clear that we need a price index robust to these changing market conditions.

According to this result, price indices may be mismeasured due to changes in the market composition over the business cycle. We believe the simplest solution to this concern is simply keep the composition of assets static: therefore we need a way to value assets even if they are not being sold that particular time period.

Secondly, to achieve this goal we develop a simple but important refinement of the Case-Shiller method that provides heterogeneous estimates of the return series for any given asset, even those that never sell during the sample period. We label our method the locally-weighted repeat sales estimation strategy. The technique works as follows: we first take any given asset and compare the characteristics of our asset to the characteristics of all similar assets sold that time period. This gives us a weight that we can use in a standard least squares estimation.

In addition to providing unbiased metropolitan-level price indices, estimates of the underlying heterogeneous returns themselves open up several potential new lines of inquiry for the literature. These heterogeneous returns series provide a straightforward tool for characterizing aspects of housing price dynamics that the literature has not yet explored, for example: (i) the extent of variation in returns within metropolitan housing markets at various points in the business cycle, (ii) linking local productivity shocks to returns in different segments of the market, (iii) covariation in returns across classes of assets both within and across metropolitan markets, (iv) heterogeneity in returns across different classes of assets over the business cycle, and (v) the extent of positive momentum in housing returns at this more disaggregate level. To highlight the applicability of our estimation we focus on the practical implementation of these latter two topics.

Third, we apply our estimation technique to the housing market. Houses that are more similar- in terms of lot size, age, location, or square footage- are given more weight in the estimation, and the end result is a price index for our specific house. By explicitly aggregating estimated returns for the full census of houses in the metropolitan area to form the metro index, our approach naturally deals with the selection issues that arise in the standard application of repeat sales estimators

We find that beginning in 2004 the Case-Shiller type index substantially overstates the peak of the housing bubble by 10%. On closer inspection we find that the discrepancy is indeed due to the fact that high demand houses in the lowest value quartile generally sell more frequently (and so are over-represented in the repeat sales sample).

There is already a large empirical literature on constructing price indices for illiquid and heterogeneous assets, and much of this work has been directly applied to estimating local real estate values. Original techniques only estimated the median house price in a region. However, economists quickly realized the need to separate between changes in price and changes in quality., and as a result more advanced repeat sales method were developed so that we only compare price changes of the same property (Case and Shiller 1987)[1]. Repeat sales estimation strategies have their own shortcomings. First, because unique houses may have distinct price paths from the overall market, these aggregate price indices are not able to characterize an individual property. Secondly, these methods are biased towards the frequently sold houses[2]. As we illustrate below our locally-weighted repeat sales technique overcomes both limitations.

Secondly, a separate line of research has attempted to test and explain the correlation between house price growth and turnover. There is evidence at both national and regional level that turnover is greatest during periods of high price growth. One explanations for this is that homebuyers pay the down payment through the returns on their previous house (Stein 1995, Ortalo-Magne and Rady 2006). Other papers suggest the result is due to Search and Matching Frictions (Wheaton 1990, Ngai and Tenreyro 2010), while a third literature relies on Behavioral explanations such as the Disposition Effect (Genesove and Mayer 2001). We add to this area by offering documenting that the correlation between turnover and price growth is also strong at the intra-city level.

More generally, this paper brings these two literatures together: we illustrate that due to the correlation between turnover and price growth, local price indices will overestimate price booms. We are the first to examine, correct, and quantify the role of housing market conditions on house price indices.

The remainder of the paper is developed as follows. Section 2 introduces the locally-weighted repeated sales technique. Section 4 introduces our particular real estate datasets used in the analysis and then applies our estimation technique. Section 5 explores the use of the estimation technique to overcome bias in the price index. Section 6 concludes.

[1]Other techniques to separate price and quality include: hedonic models (Rosen 1974, Bajari et al 2012) and latent price models (Epple et al 2013).

[2]Other indices that have attempted to control for this second critique include hedonic repeated measures method by Shiller (1993) and the distance-weighted repeat sales procedure by Goetzmann and Spiegel (1997).

Methodology

In this section, we first illustrate how market conditions may result in mismeasurement in traditional price indices, and secondly develop a new estimation technique robust to this criticism. We specifically, we introduce the locally-weighted repeated sales technique, a method to value of every house in our sample using a unique micro level dataset. We first determine the local weights by comparing the characteristics of our house to the characteristics of all houses sold that quarter. Then using the weights we use least squares to create a price index for our specific house. Aggregating the price indices for all houses in the sample leads to a city-level housing index. We compare the approach to the standard repeat-sales approach in a simple simulation exercise.

Traditional Price Indices

We first discuss the standard econometrics of traditional price indices before introducing the advantages of our new technique. Initially, indices measured the median price growth within a location; however, given researcher quickly realized that the house supply is likely changing over time and as a result simple price indices cannot distinguish price growth from supply changes. To deal with these complications the literature has focused primarily on two strategies to estimate housing price indexes: the hedonic method and the repeat-sales method.

First, the hedonic method attempts to statistically control for differences in the characteristics of housing units. By including house population characteristics it is possible to control for a changing population. Though this is a major advance over the median sales index, hedonic methods are still fundamentally biased as we cannot include all characteristics as hedonic variables. In other words, the lack of house fixed effects implies that unobservable house characteristics may still be driving the price growth.

The standard alternative is the repeated-sales approach, which only uses data on properties that have sold more than once in the sample; this is the method used to construct the current Case-Shiller Price Indices. The advantage of this approach over the hedonic approach is that does not rely on accurately measuring the quality of housing. Instead, house fixed effects are included in the regression; therefore we can account for all observable and unobservable house characteristics as long as the individual house does not receive additions or renovations over time.

Econometrically, the existing literature uses the sample of all repeated sales J_S to estimate price indices (which can be turned into return series) in one of a number of equivalent ways. First, one can set up a regression of log prices on house fixed effects and time dummies:

$$ln(p_{j(s)}) = \xi_j + \omega_s + \varepsilon_{j(s)} \tag{3.1}$$

.

Because house fixed effects,ξ, are included in this regression, only houses that sell multiple times help in identifying the price index and so only repeat sales need be used to estimate equation . It is straightforward to construct a price index and measure returns. Following estimation, a price index π is formed by exponentiating the time effects estimated above: $\pi_t = e^{\omega_t}$; thus $r_{t+k,t} = \frac{\pi_{t+k}-\pi_t}{\pi_t}$.

Now imagine that each repeat sales sold exactly twice at time periods s' and s'' so that the transactions for house j could be denoted as $j(s'')$ and$j(s'')$. Then an alternative way to estimate equation 3.1 would be to first-difference these observations to form:

$$ln(p_{j(s'')}) - ln(p_{j(s')}) = \omega_{s''} - \omega_{s'} + \varepsilon_{s''} - \varepsilon_{s'} \tag{3.2}$$

OLS estimates of the time fixed effects ω_t in equations 3.1 and 3.2 would be identical.

If some houses sell more than twice, one can also take differences between successive repeat sales of house j to form observations, estimating a first-differenced specification equivalent to . Appropriately weighted, this approach can be used to return exactly the same estimates as in equation 3.1. Following estimation, a price index and returns series can be formed in exactly the same way as in the first approach.

The construction of the S\&P Case-Shiller indices is based on a variant of the estimation of equation 3.2. In particular, weighted least squares is used to place more weight on high value observations and less on observations when the time between sales is longer. Value weighting is used because the stated goal of these indices is to provide an estimate of the return on the total value of housing in the metropolitan area[3]. For the purposes of the discussion here, the essential feature of the standard Case-Shiller approach to estimating price indices is that it is based exclusively on the estimated time fixed effects from a regression that includes only properties that sell multiple times during the sample period.

[3]Weighting based on time between sales is done because the return on such properties is noisier. This type of weighting can be incorporated into either of the approaches described above.

Despite its prevalence, the estimated Case-Shiller index will be a proper price index only if one of the following two conditions hold: (i) the subset of houses that sell at each point in time is representative of the housing stock as a whole or (ii) the return process is homogeneous for all of the houses in the metropolitan area. Yet, as we will show both assumptions are clearly rejected in the data. Because returns are heterogeneous and only a selected subset of houses sells at each point in time, a clear selection problem still arises in constructing price indices. Developing a method to overcome this concern is the purpose of the next subsection*.

Locally-Weighted Repeat Sales Technique

We now introduce a new estimation strategy, the locally-weighted repeat sales (LWRS) technique. Our method can improve over the Case-Shiller Housing Price Index since our method is not dependent on which houses are currently sold at any given quarter. By weighting transactions each quarter by housing attributes, we can control for heterogeneity in the market, and so we are able to resolve the selection problem in the Case-Shiller Index.

Due to the natural heterogeneity in the housing market, manifested most completely by the fact that each house inhabits a distinct point in geographic space, the construction of any price index or return series must draw on a wider set of houses. Before describing methods for constructing price indices, it is helpful to define some basic notation. Specifically, let t index time periods, h index the complete set of H houses in the area, j index the sample of J houses that sell multiple times throughout the sample period, $j(s)$ indicate a repeat sale of house j in period s. Let J_S indicate the sample that of transactions involving houses that sell multiple times. We will also use the notation $p_{j(t)}$ for the price of an individual transaction of house j at time t, π_t to indicate the estimated metropolitan price index at time$t$, and $r_{t+k,t}$ to indicate the estimated return for the metropolitan area between times t and $t+k$.

We now describe a procedure for constructing a distinct price index for each house$h$ in the full sample H - including those that never sell in the sample period. Let X_h characterize a set of observable attributes of the house including, for example, precise location, square footage, year built, and lot size. For each house j in the sample of houses that sell multiple times in the study period, we construct a weight based on how similar it is to house h: $w_{hj} = w(X_h, X_j)$. These can be chosen in such a way to place strong weights on properties in close proximity in both geographic and characteristic space (i.e., in real-estate parlance, comparable sales).

To construct the price index for each house, we estimate a locally-weighted version of the repeat-sales regression shown in 3.1 continuing to use all houses that sell multiple times but weighting observations by w_{hj}.

$$ln(p_{j(s)}) = \xi_j + \omega_{hs} + \varepsilon_{j(s)} \tag{3.3}$$

The estimated time dummies ω_{ht} are now a function of the exact weights used and form the basis for the house-specific price index for house h. Notice that the only thing that changes in constructing this price index for different houses in a metropolitan area is the weight on each house j in the repeat sales sample. In practice, these weights will be essentially zero for a large fraction of houses, those distant in either geographic or characteristic space. A price index and returns are formed analogously to the methods above: $\pi_{ht} = e^{\omega_{ht}}$ and $r_{t',t} = \frac{\pi_{ht'} - \pi_{ht}}{\pi_{ht}}$.

In our estimation procedure, every property exists through all time periods in the sample. In actuality, however, many of the houses were built after the first time period; therefore, we are estimating the value of a house before that house was actually built. At first it may appear that a better approach would be to estimate a house price index only after the building year. However, in this scenario, housing attributes are evolving over time and are likely driving the results of housing returns. In comparison, in our approach all attributes stay constant throughout the sample. In this way, we are able to measure returns to housing in Los Angeles, keeping the characteristics of housing in the sample constant.

Taking house h as given, we then construct a weight between the given house and house $j \in \mathcal{J}$, denoted as w_{hj} and defined as

$$w_{hj} = \prod_{c \in C} f_c(x_{cj}, x_{ch})^{\alpha_c}, \quad \sum_{c \in C} \alpha_c = 1 \tag{3.4}$$

where the subscript ch on f denotes the housing characteristic c for house h. We define $X_j = \{x_{cj}\}$ $c \in C$ where x_{cj} denotes the value of characteristic c for house $j \in \mathcal{J}$- such as the square footage of the building. The functions f_{ch} are normal density functions with mean 0 and standard deviation $\tilde{\sigma}_{ch}$; therefore the density is greatest when houses h and j are identical in terms of characteristic c. We use $\tilde{\sigma}_{i,c}$to differentiate from the actual standard deviation of characteristic c between house h and all houses in the sample $j \in \mathcal{J}$, which we instead denote as σ_{hc}.

We note our estimation depends on a two primary parameters: α_c and $\tilde{\sigma}_{ch}$. First, the relative importance of characteristic c in the total weighting is determined as α_c; choosing $\alpha_c = 1$ implies that we value only a single characteristic in our weighting estimation. Secondly, our choice of $\tilde{\sigma}_{ch}$ influences the relative weighting of house j based on characteristic c. For instance, if $\tilde{\sigma}_{hc} \to 0$, then $f_{hc}(\cdot) > 0$ for only the most similar houses and $f_{hc}(\cdot) = 0$ for all other homes. Alternatively as $\tilde{\sigma}_{hc} \to \infty$, the distribution approaches a uniform distribution and all homes are given same $f_{h,c}$ regardless of the similarity between houses. This would be equivalent to our simple repeated-sales approach.

Simulation

To highlight the applicability of our approach against a standard repeat-sales index, we develop a sample dataset and then conduct four separate estimations on the data. In our simulations we assume that (i) a non-random subset of houses sell each time period and (ii) house are not identically subject to the same aggregate shock. The purpose of the simulation is to then both highlight the mismeasurements in a repeat-sales framework and to compare the results to the locally-weighted repeat-sales technique.

In our simulated data, we assume there are two types of houses: (i) high-value and (ii) low-value. All high-type houses share a random component each period, and similarly all low-type houses share a random component each period. In addition, each house has a house-specific component and an error term. Finally, we assume that low-tier housing sales more often than high-tier housing.

In the first estimation, we assume that the econometrician has perfect knowledge of the value of a house every period - i.e. she has information on the appraisal value of every home each month.

This is our baseline simulation and serves as our best-case estimation. In the second, third, and fourth estimations, we instead assume that we only know the value of a house when it is on the market - this is generally the information set econometricians have when developing an aggregate price index.

In the second estimation, we rely on a simple repeat-sales technique. The third estimation applies the LWRS method assuming that the econometrician can perfectly identify a house by type. In the fourth and final simulation we again conduct a LWRS technique, but instead assume that econometricians do not have full information on the type of a given house.

We discuss the specifics of the simulation below. We use $p^i_{j(s)}$ to denote the price of house j at time s and is part of group $i \in \{High, Low\}$where the price process follows

$$p^i_{j(s)} = \zeta_j + \omega^i_s + \varepsilon_{j(s)} \tag{3.5}$$

We use ζ_j to denote a house-specific random component where$\zeta \sim iid\ N(\mu_\zeta, \sigma_\zeta)$. Secondly, $\omega^i_s \sim iid\ N(\mu_\omega \sigma_\omega)$ is a random variable specific to cohort i and period s and is iid across both time and cohorts. Finally$\varepsilon_{j(s)} \sim iid\ N(0, \sigma_\varepsilon)$ is a house and time-specific random variable that is again iid across time and houses. For simplicity we assume that all random variable are standard normal variables.

We assume that high and low-tier housing each comprise half of the housing market; however, low-tier housing sells 75% of the time while low-tier housing sells only 25% of the time. Therefore, low-tier housing will be over-represented in the market and will cause mismeasurement in traditional house price indices.

Recall that the LWRS technique requires the econometrician to have information on the house-type so that we can compare a particular house to similar houses that are on the market. Ideally, the econometrician can identify every house by type; however, it may be possible that there is not perfect information and the econometrician occasionally misidentifies a property. Therefore, in the fourth estimation we assume that the econometrician misidentifies a house ten percent of the time.

We plot the results in Figure3.1. For ease of comprehension, we compare the absolute value of each residual. In the first simulation, where the econometrician has full knowledge of all house prices every period, the mean of the absolute value of the residual is 0.032 with a variance of 0.024. As discussed this is our benchmark to compare all other estimates. In the second estimate, we conduct the traditional repeat-sales; we have a mean of 0.26 and a variance of 0.20. Therefore, the mean is 820% larger than the first estimation, while the variance is 8.3 times larger.

In comparison, the LWRS with perfect information on house type has an average residual of 0.052 (163% larger) and residual variance 153% larger. Finally, the LWRS with imperfect information has a mean of 0.11 (344% greater) and a variance that is 352% larger.

According to our results we find that the LWRS technique is vastly superior to the standard repeat-sale method used by Case-Shiller. This holds true even when we assume that the econometrician can correctly identify all houses. Furthermore, the LWRS estimation with full information has a similar residual to the best case scenario where we can see house prices for every house and every period. Overall the simulation highlights the advantages of the LWRS method over current techniques and suggests that our methods will offer a better evaluation of the housing market when we apply the strategy to the data.

Data

We next introduce and summarize the datasets used in our econometric analysis. Our data comes from merging transaction-level data from Dataquick with loan-level data from the Home Mortgage Disclosure Act dataset. In addition, we rely on the Case-Shiller Tiered Price Indices for aggregate results. According to our summary statistics we find that low tier housing in 2002-2006 experienced the greatest price growth and the greatest turnover. We also argue that this effects appears linked to the credit availability for low tier homebuyers.

Data Sources

Transaction Level Data We rely on a large database of housing transactions from Dataquick, a for profit company that collects information on housing transactions to then sell to banks and lenders. Each transaction includes the transaction price,property identification number, names of the buyer and seller, location of the property, and house characteristics, including square footage and year built. Dataquick creates this database from two sources; the first source is publicly available data that covers every transaction in the US. This data includes all transaction variables, such as buyer and seller name, price, and date. Secondly, housing characteristic variables are from the local tax assessor's office, also a public source. Note that DataQuick has a single assessor file; therefore we cannot take into account major housing improvements. This will affect our calculations of the weighting values through our square footage attribute.

There are two primary advantages of the DataQuick dataset. First, all liens against the property are recorded, so that one can observe second and third mortgages. As a result we can calculate the total mortgage debt for each homeowner. Secondly, the name of both the buyer and seller are recorded on the application. Using this data, we are able to identify the difference between a sale and a foreclosure. A sale is identified if a second transaction on the property occurs in which the buyer in the second transaction is identified as an individual. A foreclosure is identified if the buyer on the second transaction is a bank or mortgage servicer.

We keep observations that are single land parcels, are arms length transactions, and where the buyer and seller are different. We keep observations where the price, square feet, and coordinates are non missing and nonzero. We drop observations where the year built is after 1880 and the transaction year is strictly greater than the year built. We drop duplicates observations with the same price, property id, and transaction date; we also drop any property that sells on the same date at multiple prices. We keep only observations that saw less than a 200% yearly appreciation since the last transaction date. Finally, we drop any house that sells more than six times during the sample, as well as all observations in the bottom 0.5% and top 0.5% of transaction price.

As we noted earlier, Dataquick has only a single assessor file, and as a result does not take into account major housing improvements. To control for major improvements, we drop all observations where the price increased more than 50% annually. Additionally, to attempt to control for suspected improvements, we drop observations where the sum of loans is greater than the transaction price.

We summarize the Los Angeles Data below. After cleaning the data we are left with 549,564 houses sold more than once, and a total of 1,374,260 transactions. On average, our properties sold 2.5 times during our sample with some houses sold up to six times. The mean house was built in 1965 and is 1,574 square feet in size. The mean price is $329,500 with an average yearly price appreciation of 3.6%. All results are first measured on a quarterly basis and multiplied by four to obtain yearly estimates.

To construct a distinct price index for each house, we must run a separate LWRS regression. This is a computationally intensive procedure due both to the large number of observations in the regression (nearly 1.4 million) and well as our reliance on orthogonal decomposition. Therefore, instead of running the LWRS regression for all houses in sample, we randomly draw 5000 houses a calculate a price index for each property.

We summarize the 5000 random properties below: importantly, the subsample looks quite similar to the full sample. As before every house is sold at least twice and not more than six times with an average of 2.5 times during 1988-2010. The average house is built in 1965 and is nearly 1,600 square feet in size. The mean transaction price during the sample is $333,867 with a minimum of $19,772 and maximum of $1,975,000. Finally, yearly appreciation is 3.6%.

While our paper focuses on the Los Angeles market, we redo our analysis for several additional metropolitan areas: (i) San Francisco, (ii) Miami, (iii) Cleveland, (iv) Chicago, and (v) Denver. We choose these geographic regions largely due to data availability, especially during the earlier years of our sample. Importantly for our robustness check, these cities exhibit heterogeneous returns patterns over the time sample. Nominal house prices in San Francisco grew nearly 220% between 1997 and 2006, resulting in one of the largest booms in the country. Values began to fall in 2007, dropping forty percent by 2010. Miami also experienced a housing boom, though substantial growth did not start until 2001. Then prices increased 130% in less than six years before plummeting back to 2003 values. Real estate values have only begun to rebound in 2012. In comparison, Chicago saw a significantly smaller boom, growing eighty percent between 2000 and 2006. However, we do see a large bust as prices fell nearly 35% until recovering in 2012. Cleveland essentially no real estate boom: 2000-2006 real estate prices grew only twenty-five percent, or less than four percent a year. Similar to other cities in the rust belt, there was a housing bust as prices have declined from peak. Finally, as a control we include the Denver metropolitan region. Between 2002 and 2006 Denver real estate prices increased only fifteen percent before declining back to 2002 nominal values in 2009. The city saw essentially no housing boom and only a minimal bust.

Household Credit Data Our Household Credit Data comes the Home Mortgage Disclosure Act Data, a publicly available database of loan applications. We merge this data with the DataQuick dataset using the matching variables: loan amount, lender name, date of transaction, and the geographic location of the property. Using this data we have detailed information on the debt level and income of the homebuyer, as well as the interest rate on the loan.

Aggregate House Price Data Our first data source comes from aggregated data from the Case-Shiller Metropolitan Tiered Indices. These Indices develop a separate price index for the highest, medium, and lowest valued houses in the metropolitan area. These tiers are estimated by separating all transactions each month into one of three bins based on transaction price and then estimating each index separately. For example, in December 2011, the three tiers in Los Angeles are defined as: under $289,982, $298,982-$474,017, and over $4740,17. We offer results for sixteen different metropolitan statistical areas.

Data Summary

With our data sources we can now develop evidence that: (i) housing price growth varies substantially even within metropolitan areas, (ii) the composition of houses changes over the business cycle, and (iii) both effects may be the result of changing credit conditions. In particular we focus on the comparative growth between low and high tier housing within MSAs. We argue that low tier housing sold more often and experienced faster house price growth between 2002-2006 than high tier housing, and then tie this result to credit supply that predominantly affected the less valuable houses in the distribution.

First, the literature has long recognized the level of price dispersion between geographic regions. To deal with this heterogeneity, price indices have been developed for individual US states and metropolitan areas. Consider the price patterns of US cities between 2000 and 2014. Between 2002 and 2006 areas in California, Arizona, Nevada, and Florida experienced annual returns of over twenty percent; these same locations saw similar magnitude drops during 2007-2010. In comparison, other areas, even large metropolitan areas, experienced little 2002-2006 growth and similarly little price loss between 2007-2010.

Perhaps less recognized, however, is the dispersion within metropolitan areas. We illustrate this simple point by plotting the Low and High Tiers from the Case-Shiller Tiered Indices for 2000-2014. Of the sixteen US MSAs, we find the greatest dispersion in Los Angeles, San Francisco, Miami, Washington D.C., and San Diego, respectively. For instance we find that between 2000 and 2006 the top third of Los Angeles market grew 130%; compare this to the bottom third of the market that saw a combined growth of 230% during the same period. The effect is most pronounced during the 2004-2006 years when low tier housing grew over twice the rate of high value housing in all five MSAs.

Secondly, we next offer evidence that during 2004-2006, the houses that sold most often were the same houses that saw the greatest price growth. We plot the relative market share of low and high value housing between 1998 and 2008 for the Los Angeles market. We break housing into quartiles: in 1998 both low and high value housing each composed twenty-five percent of all market share transactions. These values then began to diverge. By 2004-2005 low income housing composed nearly 35% of all transactions, while high income housing made up only fifteen percent. These trends then reversed so that by the end of 2006, low and high value properties composed twenty and twenty-eight percent of all transactions, respectively. It is not surprising that this significant change could affect the composition of home sales and as a result house price indices.

We next to determine that this effect is not simply unique to the Los Angeles market. For instance low tier housing composed only twenty percent of all housing transactions in the San Francisco market before becoming nearly forty of the market at the end of the 2004. These transactions then declined dramatically by 2007 and made up only seventeen percent of all housing turnover. Miami reflects a similar, though weaker, story. Low Tier housing grew from twenty percent of the market to thirty percent, before declining back to fifteen percent in 2007. In comparison, Denver - a metropolitan area that saw little housing boom or bust - shows no clear result. Both low and high tier housing compose roughly one quarter of all housing transactions during the entire 2002-2008 time period.

Our results highlight a strong correlation between house prices and housing turnover. While we are the first to document this result at the intra-city level, previous research has established a similar effect at the inter-city or national level. Stein (1995) finds that a 10% drop in prices is associated with a 1.5 million unit reduction in the number of transactions or about a 38% decline in annual transactions. Other papers have found a similar relationship in the United Kingdom (Ortalo-Magne and Rady 2004). There are a number of potential explanations for this result. For instance, homeowners may depend on returns to the current house to pay the down payment for a new home (Stein 1995, Ortalo-Magne and Rady 2006), search and matching frictions (Wheaton 1990, Ngai and Tenreyro 2010) or behavioral explanations such as the Disposition Effect (Genesove and Mayer 2001). We choose to remain agnostic on the underlying cause of this result, and instead focus on the econometrics consequences of this correlation. In addition, we note that our results do not depend on a positive correlation between turnover and price. Our results generalize to any case in which a subset of assets have a different price process and sell more frequently (for instance a negative correlation would have a similar result).

The underlying question then is what drove the demand for low value housing between 2002 and 2006, and why did this demand suddenly reverse[4]? A key advantage of working with disaggregated portfolios of houses is that it is the possible to link housing price dynamics to underlying changes in the economic and policy environment. While a complete understanding of the relationship between the mortgage and housing markets would require an approach that recognizes their interconnectedness, it is easy to see in the data that the collapse of low tier housing prices is closely linked to the collapse of the availability of credit for buyers of these properties.

We compare low and high tier housing in the Los Angeles MSA along four financial characteristics: (i) Combined Loan-to-Value Ratio, (ii) Debt-to-Income Ration, (iii) Real Income Growth, and (iv) Foreclosure Rate. For homes in the top quartile, the loan-to-value ratio stayed constant between 2002 and 2006. Then we find a decline of about five percentage point between 2006 and 2008. In comparison, for firms in the bottom quartile, the loan-to-value ratio increased from 90% in 2000 to

[4]A large literature has attempted to understand the drivers of house price growth including neighborhood spillover (Bayer et al 2007, Autor et al 2012), productivity growth (Van Nieuwerburgh and Olivier-Weill 2009), or Geographic Elasticity (Saiz 2010). Here, we simply document one possible explanation: financial opportunities.

nearly 94% in 2006; however in the collapse of the credit markets, we find that to LTV ratio declined a eight percent. Therefore, the rise and fall of the Combined Loan-to-Value Ratio is greater for low tier houses. Next, the Debt-to-Income Ratio appears relatively uniform between high and low tier housing. The Ratio for low tier housing (high tier housing) rises from fifteen percent (sixteen percent) in 2003 to twenty-three percent in 2006 before declining to nineteen percent. Similarly, real income growth is comparable across low and high tier housing. Low tier housing had two percent real income growth in 2001, eleven percent in 2006 and negative fifteen percent by 2008. The high tier housing results are similar.

The greatest difference between low and high tier properties is evidenced in foreclosure rates. The Foreclosure rate for high tier housing stays at roughly two percent between 2001 and 2003 before slowly rising to ten percent by 2006. In contrast, the foreclosure rate for low tier housing starts at ten percent in 2001, declines to only one percent in 2006 and then falls to a stunning thirty-five percent in 2008. Of course, these results only suggest a correlation between financial conditions and intra-city house price growth; however, the results warrant future research for a more complete understanding.

Results

We are now ready to apply the locally weighted repeat sales (LWRS) technique to transaction-level data on the US housing market. The first step is to construct the weighting matrix for the subset of properties and then estimate the individual price index. The second step is aggregate the results to develop a price index for any subset of the population. We compare our results to the Case-Shiller results for a number of cities around the US. Additionally, to illustrate the advantage of our method, we apply our estimation to create price indices for houses sorted by (i) location and (ii) past returns.

Technical Results

Before our estimation, we must first detail the implementation of the LWRS technique to the housing market. As discussed before our analysis relies on comparing a given house h to all houses in the sample $j \in \mathcal{J}$ in order to construct the weight ω_{hj}. For simplicity we choose three housing attributes to calculate the weight between house i and $j:$ the age of the building, x_{aj}, square footage, x_{aj}, and the location (or distance), x_{dj} . Distance between houses i and j is calculated using our longitude and latitude data. We can then calculate the weight ω_{hj} as

$$\omega_{hj} = f_{dh}(x_{dj})^{\alpha} \times f_{sh}(x_{sj})^{\beta} \times f_{h,A}(x_{aj})^{1-\alpha-\beta} \tag{3.6}$$

For our estimation we calibrate $\alpha = 0.5$, and $\beta = 0.3$, therefore we weight the distance between houses most heavily, followed by the size of the house, and then by the age of the building. Additionally, recall that f_{ch} are normal density functions with mean x_{ch} and standard deviation $\tilde{\sigma}_{ch}$; we now need to calibrate $\tilde{\sigma}_{ch}$ for the estimation. One obvious possibility is to simply define $\tilde{\sigma}_{ch}$ as the actual standard deviation of characteristic$c$ between house h and all houses in the sample $j \in \mathcal{J}$ (which we denote as: $\sigma_{h,c}$). However, this places too equal a weighting on all houses. Instead we augment the standard deviation as follows: $\tilde{\sigma}_{dh} = 0.1 \times \sigma_{dh}$, $\tilde{\sigma}_{sh} = 0.1 \times \sigma_{sh}$, $\tilde{\sigma}_{ah} = 0.1 \times \sigma_{ah}$.

Equation 3.3 is estimated separately on the repeat sales sample using the weights associated with house h. The resulting parameter estimates provide an estimate of quarterly returns for house h over the sample period and can also be used to construct an estimate of the market value of house h at each point in time. Given the estimates of the return series, we back out the implied house fixed effect for each house that sells at least once and use this with the return series to construct the estimated price of each house at each point in time. We rely only on houses that sell at least once during the sample. For a house that never sells during the sample period, a hedonic approach will be needed to estimate the houses value at a particular point in time.

According to the Case Shiller LA Price Index, properties experienced a yearly mean price appreciation of about 4.9% with a standard deviation of 14.8%. This period, however, saw both substantial price raises and subsequent drops. In particular, yearly appreciation was estimated to be as high as 40.54% in the second quarter of 2004 and dropped as low a -42.4% in the first quarter of 2008. The result is that prices grew over 260% between 1997 and 2006 and 220% in the four years between 2000-2006. Then values declined just as fast, dropping forty percent between 2007 and the end of 2009[5].

We first compare our return distribution to the estimates under the repeat-sales OLS regression. We estimate the mean individual house in our sample saw a mean quarterly return of 0.62% with a standard deviation of 7.4%. In comparison, in our OLS results we estimate the mean return to

[5]To calculate yearly price appreciation, we first calculate quarterly price appreciation and multiply the results by four. By relying on quarterly estimates, we can compare the Case-Shiller results to the results from our estimation technique.

be slightly lower at 0.22% with a standard deviation of 4.7%. The greatest house price gain in our sample occurred in 2004 with a return of 11%. Losses were greatest during the 4th quarter of 2007 and the 1st quarter of 2008 at 11%.The cross-sectional return standard deviation is measured to be 2.7% through our time sample. The standard deviation is greatest in 2008 at a value of 5.0% and a low in 2004 with a value of 1.2%.

Serial correlation in returns has been documented in a number of asset classes, including equities, bonds, currencies, commodities, and real assets (Cutler et al. 1991). However, the effect appears to particularly significant and long-lasting in housing markets where price changes are serially correlated for 8 to 14 quarters (Cho 1996) and (Guren 2013). Various papers have proposed a number of potential explanations for this effect, ranging from investor learning (Annenberg 2013), sentiment-driven house price moments (Burnside et al. 2013), behavioral biases (Barberis et al., 1998, Hong and Stein, 1999), and search frictions (Head et al. 2012).We contribute to this literature by offering new evidence that this same effect holds even at the individual house property level and therefore is not the result of aggregation bias.

We offer two new pieces of evidence of a momentum effect: (i) returns are highly autocorrelated, and (ii) returns are highly predictable at the one year level. First returns are highly correlated with prior returns over the eight previous quarters. The correlation is greatest at the one-year mark: the current quarter returns are correlated at a high 44% with returns from four quarters prior. Positive autocorrelation dies out after the 10th quarter, and we see strong reversal at the end of the fourth year. Specifically,y, autocorrelation is -30% at the end of four years. Our autocorrelation results suggest high momentum at the one-year level. Therefore, we now test the degree that past year returns predict future returns over the next four quarters. In our baseline estimate we find that a 10% increase in returns predicts a 6.7% return. The simple regression results has a relatively high -R^2 of 0.29.

Returning to our predictability estimations, we find that our results are not unique simply for Los Angeles but hold in all four additional metropolitan areas. The effect is strongest in Miami and Chicago (a 10% return predicts over a 9% return the following year). San Francisco experiences a similar effect with Los Angeles at 5%, while Cleveland observes a substantially smaller estimate at 2%. In all cases the effect is highly statistically significant.

Mismeasurement Results

Simply by summing the individual indices we can properly construct returns for any of a number of more aggregate portfolios; aggregating over all the houses in the metropolitan area (including those that do not sell) gives rise to a metropolitan price index that properly accounts for the heterogeneity in the subset of houses that sells at each point in time. Using the locally weighted repeat sales method we can fully estimate reveal the bias in traditional price indices.

Beginning in 2004 the Los Angeles Case-Shiller type index substantially overstates the peak of the housing bubble by roughly 20%. As discussed before, this is due to the fact that same homes that experienced significant price growth also began to sell the most frequently. Not surprisingly then, the estimated metropolitan price indices are remarkably similar between 1988 and 2004 when there is little evidence of any systematic heterogeneity in returns in the metropolitan area.

To further establish our argument we attempt to replicate the Case-Shiller Tiered Index using our LWRS technique. Beginning in July 1989, houses are ranked on the basis of their estimated mean value over the previous year and divided into three tiers. Each tier characterized a third of the aggregate market. Averaging the estimated returns for house each quartile over the next time period provides an estimates of the returns for that portfolio over that period. Moving forward to the next year, portfolios are re-balanced (i.e., houses are divided into three tiers again) on the basis of estimated market value in July 1990 and the procedure is repeated through the first quarter of 2010. We find that the results presented below are nearly identical whether we rebalance portfolios every quarter or every year.

We find that the Case-Shiller Low Tier Index overstates the 2004-2006 bubble by over thirty percent. However, prior to 2004 the LWRS result closely tracks the Case-Shiller estimation. In comparison at the peak of the housing bubble, Case-Shiller measure and the LWRS 2004-2006 price growth differs by less than two percent; we find a similar effect for the Middle Tier of the market. The results appear to suggest that the discrepancy is entirely due to the Low Tier Housing Market - exactly the same homes that saw the greatest turnover. Specifically, certain housing in the low tier subgroup simultaneously experienced high growth and high turnover. In comparison, we find no evidence of this effect in the rest of the market.

For robustness purposes, we complete the analysis for several additional US metropolitan cites. First, Case-Shiller appears to overstate Miami house price growth beginning around 2002 and this result escalates in 2005. Specifically, traditional repeat-sales overestimate the housing boom by roughly twenty percent. Interestingly, Case-Shiller also overstates the price decline: we calculate house prices to be fifteen percent above historical estimates.

In comparison, Case-Shiller does a reasonable job of matching the San Francisco housing boom, but does not accurately reflect the true housing bust. According to Case-Shiller, house prices declined over thirty percent between 2006 and the end of 2008. We instead find no evidence of a San Francisco housing bust. Instead, the LWRS technique estimates that between 2006 and 2008 prices barely moved and if anything slightly increased.

Next, consider the case of Cleveland: the two price indices match precisely between 2000 and 2006; however, Case-Shiller actually underestimates the true decline in prices. The Case-Shiller estimate finds that nominal prices declined only slightly between 2006 and 2008, while the LWRS technique finds that prices actually declined approximately fifty percent in only three years.

Finally, recall that Denver (i) only a minor housing boom and bust and (ii) low tier housing did not experience again turnover growth: as a result, we should expect that the LWRS closely mirrors the Case-Shiller estimation. We find this is exactly the case, and that the distinction between the indices in 2006 is less than one percent.

Overall these result highlight the practicality of the Locally-Weighted Repeat Sales Technique. Despite the simplicity of the estimation, it allows us to control for both changes in housing turnover and intra-city price growth in a way not previously possible. We hope future researcher and practitioners apply our methods to better our understanding of the housing markets.

Application Results

In addition to providing unbiased metropolitan-level price indices, the LWRS technique offers an opportunity to properly construct returns for any of a number of aggregate portfolios. In essence, we now have exactly the kind of data available to empirical asset pricing researchers in equities, bonds, and derivatives. These heterogeneous returns series can then provide a straightforward tool for characterizing aspects of housing price dynamics that the literature has not yet explored for example: (i) the extent of variation in returns within metropolitan housing markets at various points in the business cycle, (ii) heterogeneity in returns across different classes of assets over the business cycle, (iii) linking local productivity shocks to returns in different segments of the market, and (iv) covariation in returns across classes of assets both within and across metropolitan markets.

We now highlight the applicability of the LWRS technique by developing alternative price indices.

First, price indices can also be constructed for particular types of properties (based on observable characteristics) and for particular locations within the metropolitan area; here we focus on the effects of location. Secondly, we can sort houses based on estimated value or returns in previous time periods to develop understand the benefits of momentum and reversal trading strategies.

Sorting on Location To illustrate the application of our analysis, we characterize houses by the relative distance from the city center. There are two early papers that specifically look at differences in house price appreciation rates between low and high end properties. Case and Mayer (1996) look at differential movements in prices within cities of the Boston metro area between 1982 and 1992; they find houses 15.4 miles from Boston grew 5.1% faster than houses 31.5 miles from Boston in a sample from 1982 to 1994. Similarly, Case and Marynchenko (2002) look at differential trends in prices across different zip codes within the Boston, Chicago, and Los Angeles metro areas during the 1983 to 1993 period. More recent papers have attempted to empirically explain the cross-sectional dispersion in housing price between metropolitan areas. For instance Bayer et al. (2007) and Ross-Hansberg et al. (2010) explain cross-section housing within a city with a neighborhood consumption externality, while Guerrieri, Hartley, and Hurst (2011) explain house price movements across neighborhoods within a city to the positive neighborhood externality that individuals like to live next to richer neighbors.

To confirm these studies we consider the effects of population density from the Los Angeles area by sorting each property based on distance from the highest density population neighborhoods. We define neighborhoods using the US Census Bureau's boundaries of 88 cities and 43 census-designated places. We find the Koreatown neighborhood to be the most densely populated neighborhood in the city, with 42,611 people per square mile, followed by Westlake and East Hollywood, with densities of 38,214 and 31,095 population per square mile, respectively. Both Westlake and East Hollywood border Koreatown; therefore, we believe it is reasonable to use the geographic coordinates of Koreatown as the population center of the Los Angeles area.

Intuitively, we should expect that subject to a city-wide demand shock, locations with an inelastic housing supply will experience the largest growth in real estate price. All else equal, high density neighborhoods will have little available land to build new housing and so are comparatively less elastic.

As expected we find that highly dense areas experienced the largest price growth during high demand periods. We consider the 2002-2006 years as a period of a persistent positive national demand shock due to the growth in first time home buyers, high credit supply, and low interest rates. We find that during these years properties closest to Koreatown-specifically the 10% closest among our subsample - saw price growth of nearly 175% between 1996 and 2006, or 17.5% annually. In comparison, houses furthest from Koreatown grew about 12% annually during this same period. The price effects from high density neighborhoods is closely in line with previous estimates.

Sorting on Past Returns Secondly, we offer new evidence that momentum portfolios outperform the market. At each point in time, it is straightforward to bin houses based on their estimated return the previous period. In this way, one can rebalance value-based portfolios at each point in time and construct price (and return) series for these portfolios in a way that is exactly analogous to time-varying portfolios. For our purpose we update portfolios once a year to control for noise in the estimation process, and compare returns over the following year.

We find positive short-run momentum within the LA local metropolitan area. As discussed before, mean returns are estimated to be 4.5% for all properties in our sample, while median returns are similar. Houses at the 90th percentile of returns last year instead experience 9.4% price growth the following year. In comparison houses that had the least growth (bottom decile) see negative returns the following year at the level of 0.4%.

Again, as a robustness check we redo our analysis for the four additional metropolitan areas and again find the qualitative results hold. In San Francisco, a house in the 10th, 50th, and 90th percentile of returns experienced future annual returns of 2%, 6%, and 9% annually. The effects are similar in both Miami and Chicago. Cleveland has experienced significantly lower price returns during our time period (the median is -1%); however, housing in the top 10% of returns actually experienced 7% returns the following year.

Conclusion

Due to its illiquid and unique nature, housing, along with other assets, is difficult to price individually. As a result it has been historically quite difficult to examine the fundamental drivers of housing at the property level. This paper makes two primary contributions to the literature: (i) develop an econometric strategy to value an individual house, and (ii) evaluate the bias underlying standard price indices.

In our empirical analysis we develop the locally-weight repeat-sales index. We take any given house and then weight all nearby houses by numerous physical characteristics. Then we run a repeat-sale index, but weight each house according to similarities with all houses in the market. The result develops an individual price index for any given house. We then apply our estimation to test if standard price indices are mismeasured due to fluctuations in market composition. We find that beginning in 2004 traditional house price indices overestimate the Los Angeles boom by 20%, and that the effect is entirely driven by high turnover and house price growth in the low tier housing market.

The goal of future work is to extend our current analysis to isolate the causes of house return predictability. Theoretic papers such as Barberis, Huang, and Santos (2002), Barberis, Huang, and Thaler (2003), and Grinblatt and Han (2005) suggest that prospect theory and mental accounting help explain the cross-section of stock market returns. A companion paper attempts to better understand the particular role of disposition in real estate price shocks, specifically the tendency of home owners to sale only after a price gain. A positive demand shock results in an increase of houses on the market, causing price depression in the short-term. The cumulative effect is predictability in the market. Empirical research has found that stock prices drift after news announcements. Specifically, not only does good news causes price appreciation, but price continue to drift upwards after receiving good news. The purpose of future work is then to document a similar effect in the housing market.

4 Do Real Estate Prices Impact Entrepreneurial Financing? Evidence from the Home Equity Channel

Introduction

Between 1997 and 2009 the Debt-to-GDP ratio of US noncorporate firms (i.e sole proprietorships and limited partnerships) grew faster than both household debt and corporate debt before subsequently declining by 14% during the Financial Crisis. Both the media and fellow financial researchers have highlighted the possibility that this rise and fall of small business financing is linked to house price growth and could result in macroeconomic consequences:

> *"We show that during the house price boom of 2002-2007, areas with rising house prices (and increased leverage) experienced a significantly bigger increase in small business starts....the collateral channel can account for 10-25% of the increase in pre-crisis employment."* -Adelino, Schoar, and Seveino, 2013
>
> *It is well known that the housing bust has taken a devastating toll on American families, nearly three million of which have lost their homes to foreclosure. Less known is the impact that the housing collapse is having on owners of small businesses, which have often relied upon home-equity borrowing to finance the early stages of growth and development."-Wall* Street Journal, February 1st, 2012

The underlying mechanism implicit in both articles is the role of home equity as a source of initial financing for small firms; to date, however, we have little understanding of the economic significance of home equity financing, or the effects of house price growth on financing opportunities. As a result, any heterogeneous impacts of house prices could be the result of unobservable differences between small and large firms within a region. For instance, if small firms are more at risk of local demand shocks, then price shocks should have a larger relative impact on small firms within a region. Distinguishing between these two stories requires detailed data on entreprenuerial financing decisions.

Therefore, the purpose of this paper is empirically validate the interpretation that house price shocks on entrepreneurs are indeed collateral shocks. Using a new firm-level dataset on US small firms, we offer explicit evidence that (i) home equity is an economically significant source of financing, and (ii) house price shocks impact initial firm financing decisions.

First, during 2006 eleven percent of all start-ups relied on home equity to initially fund the firm. This number increases up to 29% of firms with financing needs between \$100,000 and \$249,999. We find that home equity financing is predicted when (i) the owner has a significant role in the firm or the firm in the principle source of income, (ii) the owner is middle-aged, specifically 35-54 years of

Table 28: Summary Statistics for Los Angeles Housing Market. The top half of the table summarizes the full dataset of all houses in the sample and the respective transactions. The bottom half summarizes a random draw of 5,000 from this full sample; we develop a unique price index for each property in this subsample in our LWRS estimation.

Variable	Mean	Std Deviation	Minimum	Maximum	Observations
Year Built	1965	21	1881	2008	549,564
Square Footage	1574	71	2	33494	549,564
X Coordinate	118.15	.27	117.55	118.90	549,564
Y coordinate	34.01	.26	33.34	34.81	549,564
Number of Transactions	2.5	.77	2	6	1,374,260
Transaction Price	329,491	243,267	19,545	1,992,000	1,374,260
Yearly Appreciation	3.56	0.50	-45	45	824,696
Year Built	1965	21	1885	2008	5,000
Square Footage	1583	719	80	10,070	5,000
X Coordinate	118.15	.27	117.55	118.8685	5,000
Y coordinate	34.015	.26	33.41	34.79496	5000
Number of Transactions	2.50	0.78	2	6	12,537
Transaction Price	333,867	249	19,772	1,975,000	12,537
Yearly Appreciation	3.59	0.51	-41	44	5,000

Table 29: Predictability Results for Individual Properties in US Metropolitan Areas. We document that property-level price returns are highly predictable by regressing returns on lagged returns at the yearly level for five metropolitan areas: Los Angeles, San Francisco, Miami, Cleveland, and Chicago.

	Los Angeles	San Francisco	Miami	Cleveland	Chicago
Lag House Return	.67***	.53***	.93***	.17***	.98***
	(115)	(44)	(60)	(11)	(44)
Constant	.0029***	.014***	-.027***	-.014***	-.011***
	(3.99)	(11.02)	(-11.50)	(-6.97)	(-6.04)
Observations	500	500	500	500	500
R^2	0.29	0.17	0.42	0.025	0.30

* $p<0.1$, ** $p<0.05$, *** $p<0.01$

Table 30: Returns on Housing Momentum Portfolios within US Metropolitan Areas. For each metropolitan area, we sort houses into deciles based on returns over the last year to highlight the advantage of the LWRS technique.

	Variable	Mean	Std. Dev.	Min	Max
Los Angeles	Mean	0.04	0.15	-0.54	0.48
	10th Percentile	-0.01	0.15	-0.44	0.19
	50th Percentile	0.04	0.14	-0.28	0.29
	90th Percentile	0.10	0.14	-0.18	0.38
San Francisco	Mean	0.06	0.11	-0.30	0.37
	10th Percentile	0.02	0.10	-0.27	0.20
	50th Percentile	0.06	0.10	-0.22	0.26
	90th Percentile	0.09	0.10	-0.14	0.29
Miami	Mean	0.06	0.16	-0.39	0.51
	10th Percentile	0.03	0.17	-0.35	0.29
	50th Percentile	0.06	0.16	-0.29	0.31
	90th Percentile	0.10	0.15	-0.23	0.34
Cleveland	Mean	-0.01	0.15	-0.61	0.61
	10th Percentile	-0.09	0.15	-0.52	0.04
	50th Percentile	-0.01	0.13	-0.41	0.08
	90th Percentile	0.07	0.11	-0.24	0.15
Chicago	Mean	0.06	0.07	-0.24	0.38
	10th Percentile	0.01	0.05	-0.09	0.07
	50th Percentile	0.06	0.05	-0.05	0.11
	90th Percentile	0.11	0.05	0.04	0.20

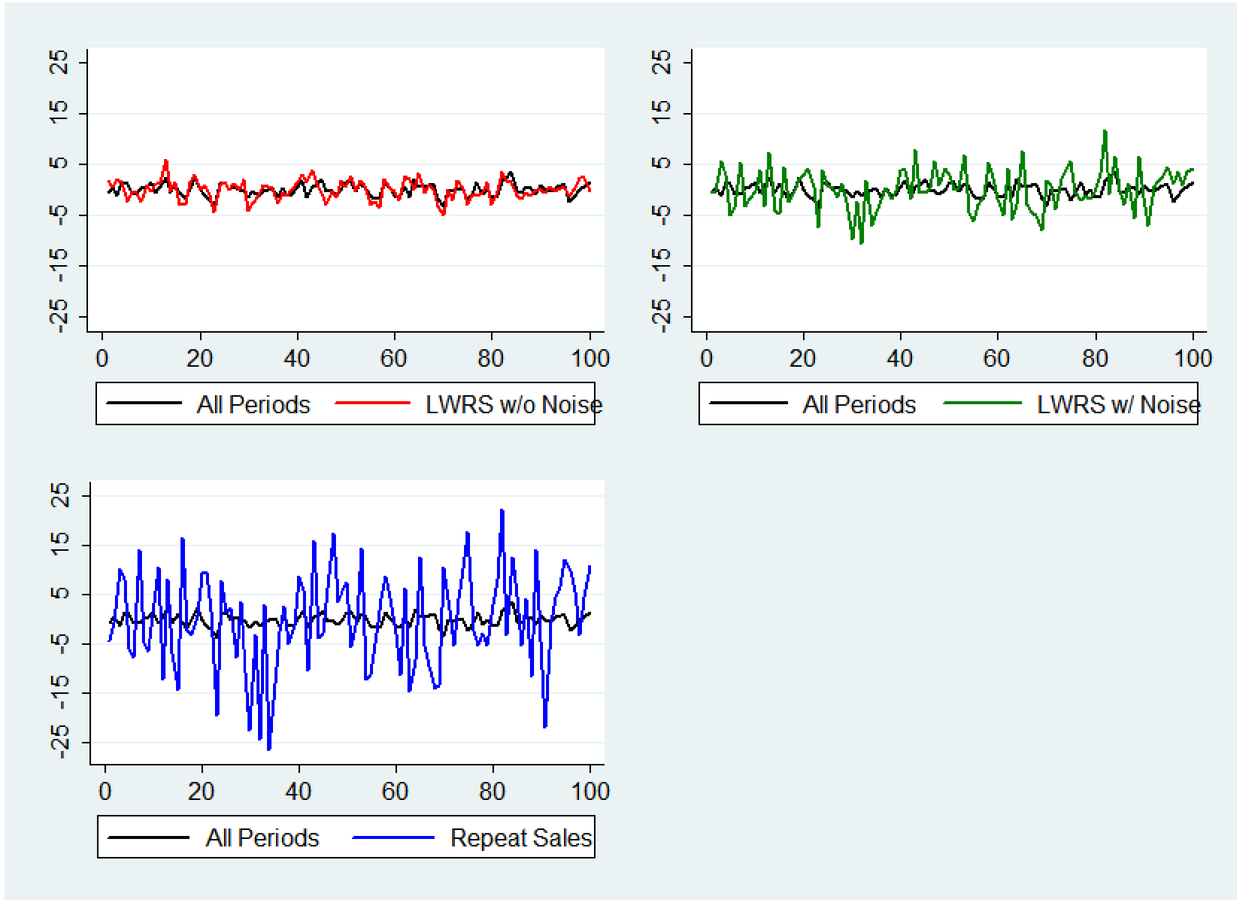

Figure 3.1: Simulation Results for the Repeat-Sales and Locally-Weighted Repeat Sales Methodologies. We develop simulated data where only a subset of houses sell in a given period and houses do not share a single aggregate shock. In each subgraph we graph the residuals of an estimation where the econometrician views the price of every house every time period-i.e. has information on the appraisal value. The top left subgraph also includes residuals from the LWRS method when the econometrician can exactly identify the type of all housing. The top right subgraph includes residuals from the LWRS method when there is noise in the identification of housing type. The bottom right subgraph is a residual for the standard repeat-sales methodology.

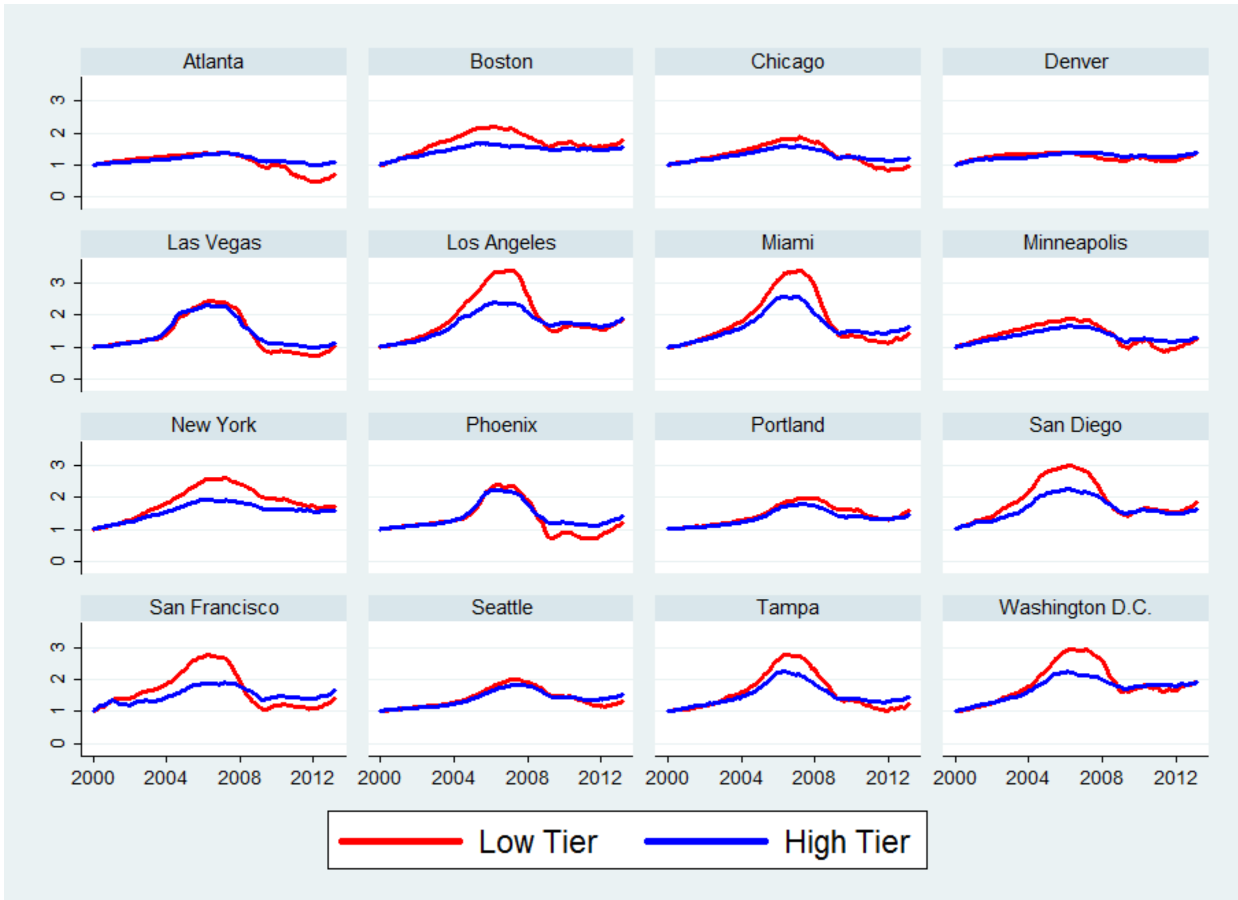

Figure 3.2: City-Level Case-Shiller Price Indices for Low and High-Tier Housing. Case-Shiller separates housing tiers into thirds based on price for sixteen MSAs.

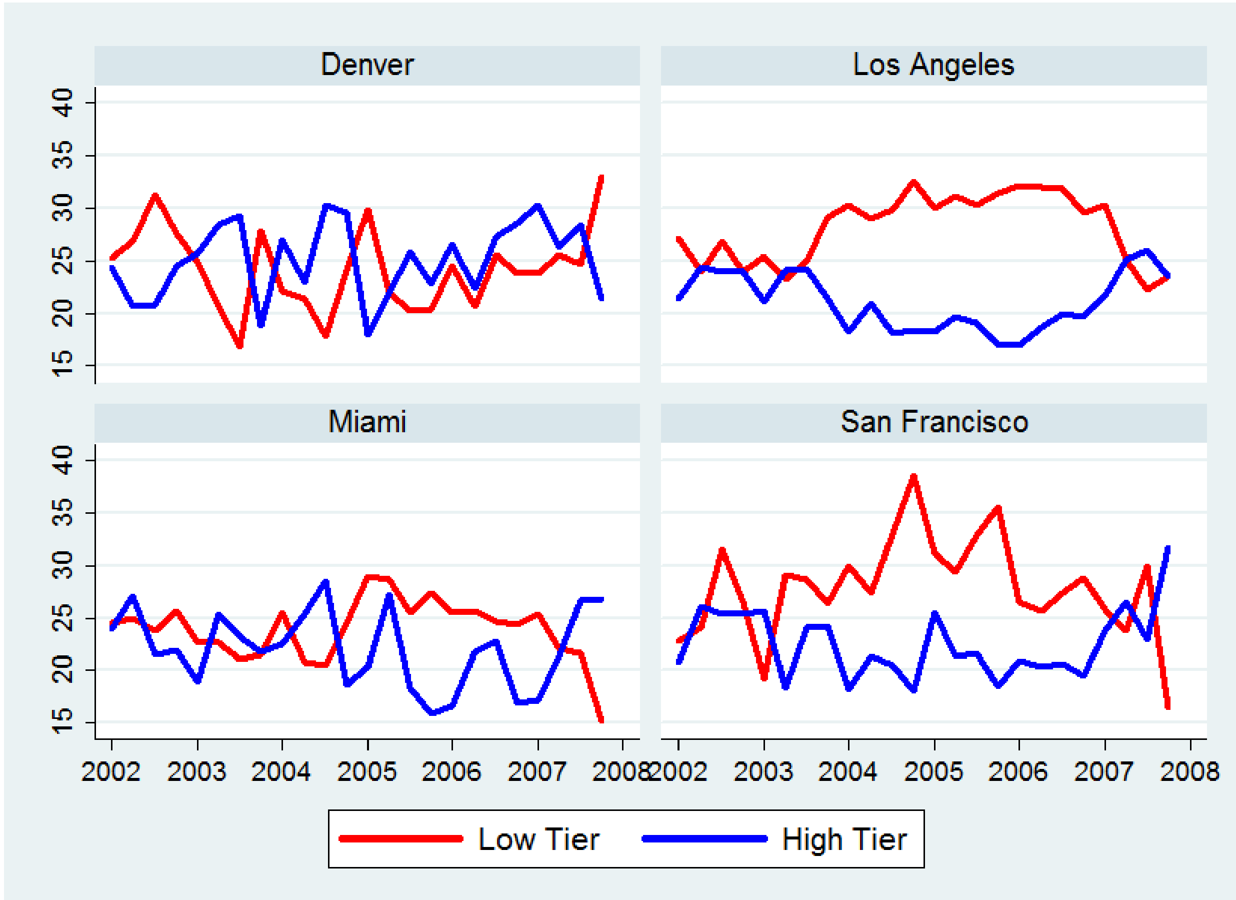

Figure 3.3: High and Low Value Property Transactions as a Percentage of Total Transactions. We split all Los Angeles Properties into quartiles based on price. We then plot the contribution of the top and bottom quantile to the total number of transactions during the 1998-2008 time period.

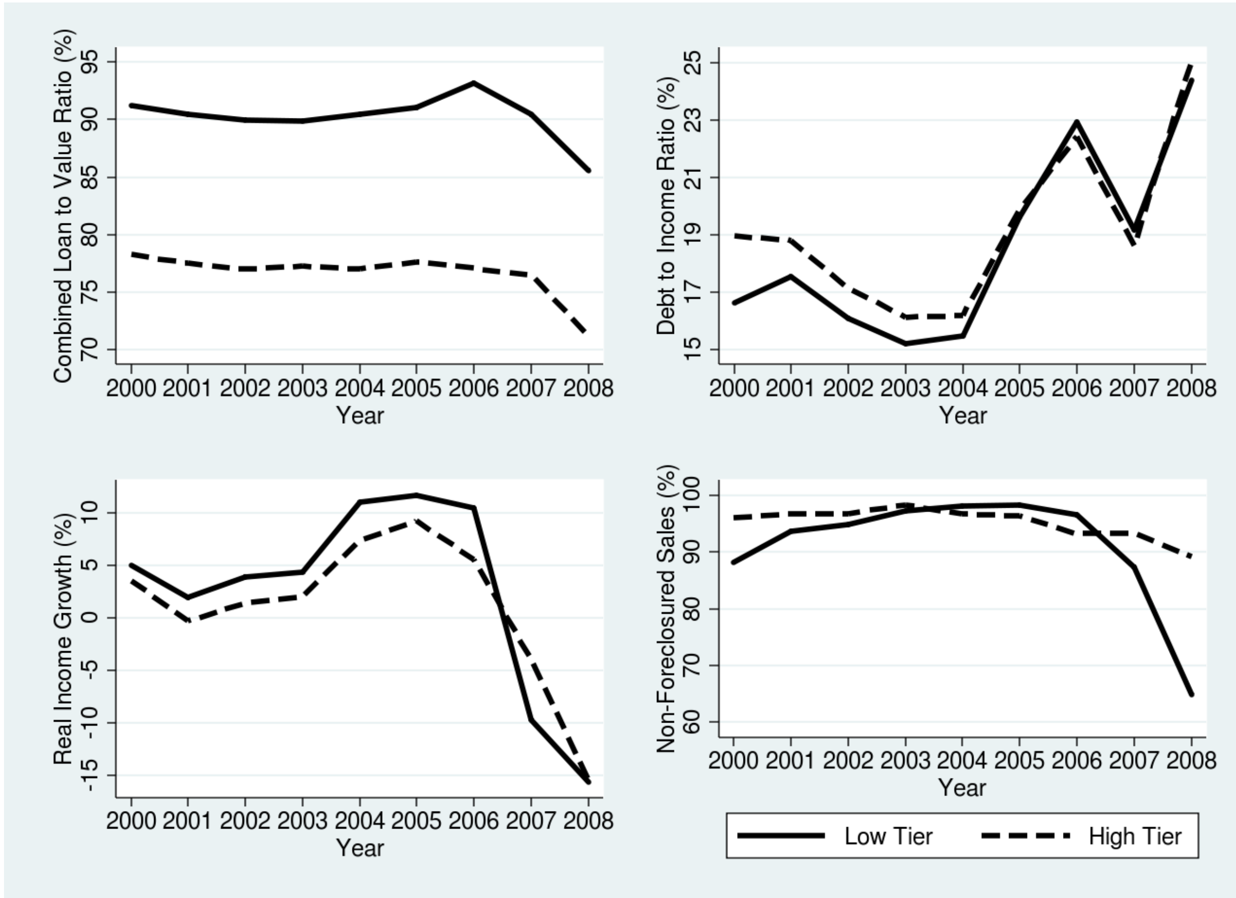

Figure 3.4: Household Financial Condition for Los Angeles Houses by Pricing Tier. We split all Los Angeles Properties into quartiles based on price. We then plot the financial conditions of homebuyers for the top and bottom quartile during the 2000-2008 period. The graph four measures of financial condition: Combined Loan-to-Value Ratio, Income-to-Value Ration, Real Income Growth, and Foreclosed Transactions.

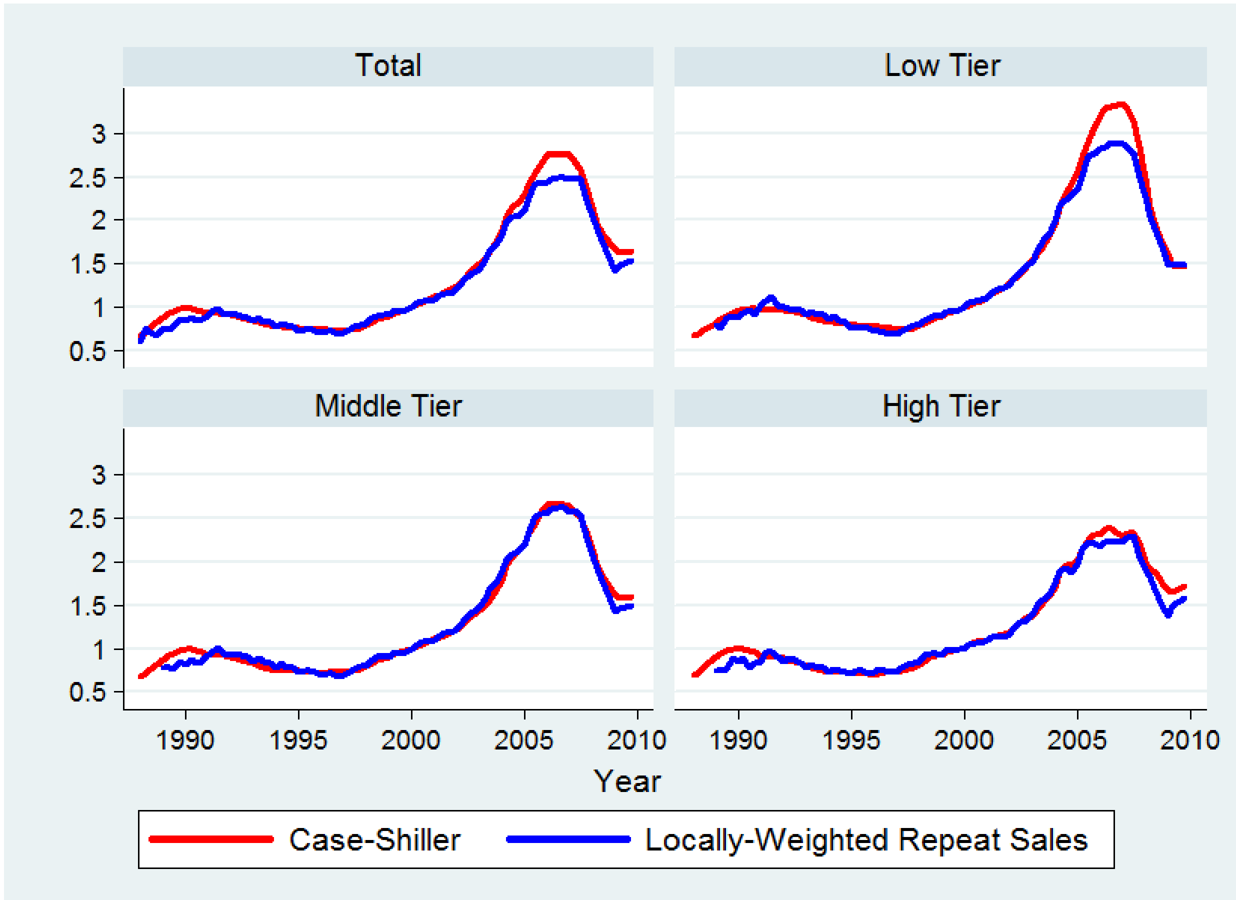

Figure 3.5: LWRS and Case-Shiller Price Indices for Los Angeles Houses by Pricing Tier We sort each house into one of three portfolios based on its initial value. We then compare the results for the LWRS method with the actual Case-Shiller Indices.

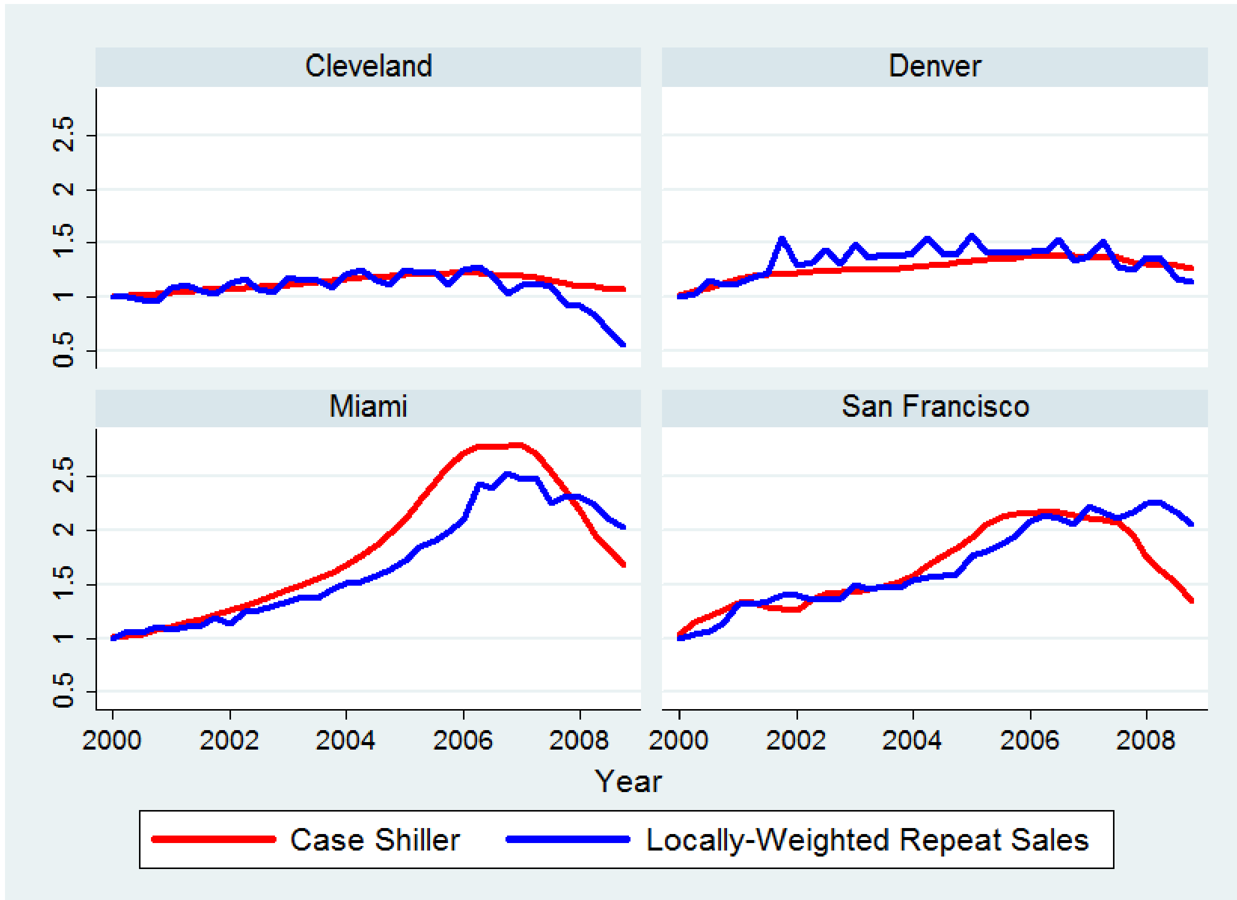

Figure 3.6: LWRS and Case-Shiller Price Indices for Cleveland, Denver, Miami, and San Francisco Housing.

age, or (iii) the firm is in the accomdation and food services sector.

We next highlight the role of house price shocks in small firm financing. To isolate this effect we distinguish between firms that take under \$5,000 in initial financing and firms that at least \$5,000. This allows us to separate local demand shocks-which affect all firms- from collateral shocks that affect only firms with large financing needs.

There are two sources of endogeneity in our analysis. First, firms with large financing needs may be uniquely affected by local demand shocks. Secondly, initial financing needs are an endogenous choice. To overcome the first concern we follow the literature by instrumenting for exogenous house price growth from the housing supply elasticity measure first developed by Saiz (2010). As discussed in Cvijanovic (2013) the intuition for this approach local areas with little undeveloped land experience large real estate price appreciation in response to an increase in the aggregate real estate demand while areas with available undeveloped land will experience more minor price growth since the demand can be easily supplied. Our strategy to alleviate the second issue-financing is an endogenous choice- we allow for both firm and owner characteristics in the empirical specification.

We estimate that a 10% real estate price growth increases home equity financing by 1.1% for the mean firm and the probability that a firm financing exclusively by 0.4%. The results hold when we alternatively develop a psuedo-panel estimation estimation.

The effects of real estate shocks are strongest for large start-ups. A 10% real estate growth increases home equity financing by 2.1% for firms with been \$250,000 and \$1 million in initial financing.

In response to an exogenous shock to real estate price growth, start-ups increase reliance on home equity financing, causing a decline in financing through formal bank loans. Specifically, a 10% increase in real estate prices causes a 1.7% decrease in the probability of bank lending. Other forms of financing appear unaffected, suggesting home equity does not take the place of informal channels such as family loans, savings, or credit cards.

As discussed above we are not the first to identify the role of credit constraints in entrepreneurship. First a number of papers have theoretically documented the role of credit constraints in the entrepreneurship decision, including Evans and Jovanovic (1989) and Cagetti and De Nardi (2006). This theory appears to hold up empirically: one line of the literature has focused on using house price growth as a credit shock on small business. For instance Hurst and Lusardi (2004) document that prices impact the decision to start a business, but only at the top of the wealth distribution.

More recent evidence from Schmalz, Sraer, and Thesmar (2014) suggests instead that house price significantly impact all firms. We contribute to this literature by validating those application of house price growth to understand credit constraints.

Secondly, recent research has found evidence that house price growth on entreprenuers can have implications on macroeconomic employment. For instance, Adelino, Schoar, and Severino (2013) validate that small firm employment in a county is disproportionately affected by house price shocks and they interpret this as evidence of a collateral effect from small firms borrowing against home equity. Missing from this research, however, is evidence of the size and scope of home equity financing among entreprenuers.

More generally, the role of real estate price shocks on the financial sector have been explored in a number of alternative, but related settings. For instance, Mian and Sufi (2011, 2013) argue that strong correlation between house prices and (i) local debt or (ii) local consumption expenditures is evidence of households borrowing against home equity. Meanwhile, a separate literature considers the effect of local commercial real estate shocks on corporate debt (Cvijanovic 2014), corporate investment (Chaney et al. 2012), or small firm employment (Kleiner 2013). Our research sheds lights on these papers by offering direct evidence that the correlation between price shocks and economic outcomes can be attributed to a credit channel.

The outline for this paper is as follows. Section 2 introduces our empirical methodology and summarizes the data. Section 3 discusses the results and Section 4 concludes.

Empirical Methodology and Data

The purpose of our paper is to first determine the role of home equity in small firm financing, and secondly, to evaluate the effect of house price shocks on financing availability. In this section, we determine the empirical specification necessary to achieve the latter goal, and then summarize the data to fulfill the former.

Empirical Methodology

To directly test how real estate price growth affects small firm financing through home equity we run the following linear probability model:

$$\begin{aligned} Home\,Equity_i = \beta \times \Delta\%P^l \times 1[Fin > \$5,000] + \kappa \times \Delta\%P^l \\ +\xi \times \Delta\%Unemp^l + \zeta \times \Delta\%GDP^l + \alpha + controls_{it} + \varepsilon_{it} \end{aligned} \tag{4.1}$$

$$\Delta\%P^l_{2002-2006} = \alpha + \chi \times Elasticity^l + u^l_t \tag{4.2}$$

where $Home\,Equity$ is a binary choice variable: a value of 1 means the business relied on home equity to finance the start-up of the business. Next $\Delta\%P^l_t$ is the state-level residential house price increases between 2002 and 2006.

To identify the effects of a collateral affect separate from a demand shock, we separate between real estate shocks that affect all firms and any additional shock that only affects firms with at least $5,000 in initial financing. Therefore β is our key coefficient of interest and measures the effect of real estate growth on home equity financing.

Since real estate prices are likely correlated with investment opportunities due to the omitted variable of local demand shocks we control for investment opportunities using housing supply elasticity as an instrument for exogenous real estate price growth. To achieve this we develop a new measure of state-wide house supply elasticity as the population-weighted measure of MSA local housing supply elasticity. In addition we include measures of state demand shocks, specifically GDP growth $\Delta\%GDP$ and the unemployment rate $\Delta\%Unemp$.

In addition we include a number of standard controls in our analysis; this allows us control for any differences between small and large financing firms. The controls include both firm characteristics (such as NAICS sector fixed effects and firm size fixed effects) and owner characteristics (such as number of owner, and educational background).

In our first stage results we find that our state-level measure of housing supply elasticity is highly correlated with real estate values between 2002 and 2006. A coefficient of -0.25 implies that a one standard deviation increase in elasticity decreases real estate price growth by 8 percentage points. This reflects that even at the state-level housing supply elasticity was a strong predictor of the run-up of housing price growth documented between 2002 and 2006.

One concern with this analysis is that we are not able to control for unobservable firm characteristics as we only have cross-sectional data. However, due to our large sample we can also develop a psuedo-panel of our data by characterizing a pseudo-firm with a specific state and level of financing needs

$$\begin{aligned} \widehat{Home\,Equity}_{it} &= \beta \times P^l \times 1[Fin > \$5,000] + \kappa \times P_t^l \\ &+\xi \times Unemp_t^l + \zeta \times GDP_t^l + \alpha_i + \delta_t + \psi_l + \widehat{controls}_{it} + \varepsilon_{it} \end{aligned} \tag{4.3}$$

$$P_t^l = \beta^P (Elasticity^l \times I_t) + \phi_t + \theta_l + \alpha_i + \varepsilon_{it} \tag{4.4}$$

In this specification, $\widehat{Home\,Equity}$ is now the probability that pseudo-firm i financed through home equity in year t . In addition α_i is a pseudo-firm fixed effect, δ_t is a year effect, ψ_l is a location fixed effect, and P_t^l is the housing price index for location l. We develop controls for our pseudo-firm, $\widehat{controls}$, which as before control for changes in both firm and owner characteristics.

As before, our analysis relies on an exogenous source of real estate price growth; therefore we also derive a time-varying instrument by interacting the conventional mortgage rate with the state-level housing supply elasticity. The intuition in this specification is that the national mortgage rate is a measure of national house demand. Local demand shocks will most impact house price growth in inelastic regions during periods of high national demand- and therefore low mortgage rates. The specification is similar to Chaney, Sraer, and Thesmar (2012).

Data Summary

Accounting Data

Survey of Small Business Owners Our empirical analysis depends on a new firm-level dataset from the Survey of Business Owners (SBO) Public Use Microdata Sample (PUMS). The SBO PUMS is a cross-sectional dataset on entrepreneurs and surveys a random sample of business from a complete list of all firms operating during 2007 with receipts of $1,000 or more compiled by the IRS. Useful for our purposes the SBO PUMS includes firm data such as external financing sources, location, employment, and revenues, as well as detailed information on business owners. We use the data between 2002 and 2007 for our results.

We first note the magnitude of our sample at 949,169 firms according to Table 31. Employment is the mean number of employees per firm, while all remaining variables are the percentage of firms that rely on the specified external financing option.

In our summary statistics we distinguish cohorts by the level of initial received financing: (i) less than $5,000, (ii) $5,000-9,999, (iii) $10,000-24,999, (iv) $25,000-49,999, (v) $50,000-99,999, (vi) $100,000-249,999, (vii) $250,000-999,999, and (viii) greater than $1 million. In addition note that we have nearly 40,000 firms with financing needs of at least one million dollars on creation. Therefore our sample covers a wide range of start-ups during the 2002-2007 period.

To give some indication we use survey weights to determine the actual proportion in the economy: (i) less than $5,000 make up 51% of firms (ii) $5,000-9,999 compose 12%, (iii) $10,000-24,999 represent 12%, (iv) $25,000-49,999 are 8% of the economy, (v) $50,000-99,999 are 7%, (vi) $100,000-249,999 are 6%, (vii) $250,000-999,999 compose 4% of all firms, and (viii) greater than $1 million represent 1% of initial businesses. Therefore, the larger firms are actually overrepresented in our survey compared to the true population.

The mean firm has 5.1 employees and over half of the firms in our sample are nonemployer firms. Employment in the first cohort (financing under $5,000) is only 3.2 and increases monotonically to 34.5 employees in the largest cohort (financing at least $1 million).

We find strong evidence that larger firms are more likely to rely on more formal sources of financing. For instance 81 percent of all firms in the sample rely on some sort of savings: this value is largest for the smallest cohort (88%) and declines with firm financing needs to 57%. In comparison, 12% of firms take a business loan and this value is largely driven by the largest firms. While only 1% of the smallest firms require a formal business loan, 47% of firms with at least one million dollars in initial funding take a loan.

In line with Robinson and Robb (2012) we find little evidence of family loans even among the smallest firms: 4% of our firms rely on family loans in any way. If anything, family loans actually increse with the size of the firm: only 1% of firms in our smallest cohort recieve family loans, yet among firms with at least $250,000 in initial financing, the level increases to eight percent. Instead of family loans, small firms in our sample tend to depend on savings and credit cards. About one-quarter of firms with $5,000-$100,000 use credit cards in their initial financing.

Following Robinson and Robb (2012) we interpret these magnitudes as an indication of relative important to develop a pecking order. In this case owner equity is the more preferable followed by formal debt channels. For smaller firms the debt channels are through credit cards, while larger firms instead use bank loans and home equity loans. Informal debt channels and outside equity are less preferred, but do become more commong with larger firms.

We also consider the source of later funding as according to our data over half of all firms in our sample require expansion capital at some point after the establishment first opens. The percentages are similar to our results on initial financing with two exceptions. First, entreprenuers are now able to finance firm expansions through profits and sixteen percent choose to follow this strategy. Secondly, credit cards are more common among subsequent financing at a level of 30% compared to 20%.

Real Estate Data

Office of Federal Housing Enterprise Oversight House Price Index The OFHEO House Price Index is available at the state level starting in 1975 and for the majority of Metropolitan Statistical Areas starting in 1987. For our purposes we focus on the state level data between 2002 and 2007. During this time period we find significant cross-sectional heterogeneity in real estate price growth. Specifically, Michigan saw 10% and Indiana and Ohio saw an 11% increase in house price between 2002 and 2006. In comparison Hawaii, Florida, Nevada and California saw a combined growth rate of 93%, 88%, 87%, and 86%, respectively.

Local Housing Supply Elasticity The local housing supply elasticity measure comes from Saiz (2010) and is available for 95 MSAs. It is estimated using processing satellite-generated data on elevation and presence of bodies of water. Given our focus on state-level data, we develop a new measure of state housing supply elasticity: specifically, we weight each MSA as a fraction of the population of the state. From our state-level estimates we find a large range from an elasticity from 0.65 for New Hampshire, 0.69 for New Jersey and New York to 2.83 for Nebraska and Iowa and 3.36 for Kansas.

Regional Data

Bureau of Economic Analysis State GDP Due control for time-varying changes within a state, we also include data on both GDP and unemployment. Our GDP data comes from the Bureau of Economic Analysis. We find that between 2002 and 2006 the median state saw an 11% increase in real GDP with the 10th and 90th percentiles at 5% and 21%.

Bureau of Labor Statistics Unemployment Rate The state-level unemployment rate is the Bureau of Labor statistics. The unemployment rate fell about 1% in the average state with no change at the 90th percentile.

Results

Our empirical specification, taken with the data sources discussed above, provides a simple model to determine that home equity financing is driven by real estate price growth. We now discuss our results and offering significant evidence that the a house price shock on entrepreneurs can indeed be characterized as a collateral shock. Secondly, we determine the effects are greatest for firms that receive greater initial financing. Third, in response to a price shock, entrepreneurs rely less on alternative sources of financing, namely bank loans, family loans, and owner assets.

Who Borrows from Home Equity? We first attempt to determine the size and scope of home equity loans in entreprenuerial financing and find that 11% of all firms fund their small firm with home equity. The value increases to 29% for firms with financing needs of $100,000-249,999 before declining for the very largest firms. Additionally, home equity has increased as a source of financing over the housing cycle. In unreported results we find that 6% of small firms were initially financed through home equity before 1980; the number increases to 7% during 1980-1989, 7% during 1990-1999, and 9% from 2000-2002.We take this as initial evidence that the collateral channel may indeed be an important source of employment during house price booms.

Next, we consider the source of capital after firm establishment: firms are just as likely to rely on home equity later in the lifecycle. Conditional on receiving additional capital, eleven percent of firms use home equity financing. The number raises to twenty-two percent among among firms with $100,000-$250,000 in start-up capital. In our sample we also find that firms that intially raise capital through home equity are likely to return to home equity loans later in the life cycle: the correlation between these two decisions is over 50%.

Lastly, we summarize firm and firm owner characteristics by source of financing. We find home equity financing is most common among (i) firms with involved owners, (ii) owners in middle-age, and (iii) in the service sector.

First, well over half our sample has only a single owner. The firm is more likely to finance through home equity if the firm is her principle source of income (13% vs. 10%) and if the owner is also the manager (14% vs. 10%). In addition, time at the firm is strongly correlated with home equity. If the owner spends less than 20 hours a week at the firm, then there is only a 7% probability she finances through home equity. Instead, 19% of all firms with 60+ owner work weeks finance through home equity.

Secondly, owner age is an important predictor of home equity financing. Only four percent of owners under 25 years of age borrow from their home compared to 13% of owners 35-54. The effect then declines after 55 years of age.

Third, we find that home equity financing is particularly common- 21% to be exact- among firms in the accomdation and food services sector. The effect is followed by retail trade and transportation at a substantially smaller 14%. On the other side of the spectrum, we find that among the mining, professional services, and information sectors only 7% of firms rely on home equity financing.

How do House Prices Impact the Home Equity Channel? We document that local house price returns over the previous year are highly correlated with home equity financing. In our OLS regression, we find that a 100% increase in house prices increases home equity by 11% among all firms. .In addition after including the local demand controls of GDP growth and unemployment growth, the result still holds. Finally, we also estimate that a 100% increase in price results in a 4% increase in the probability a firm finances exclusively home equity.

As we have discussed, real estate price growth and firm financing are likely correlated through time-varying local demand; if GDP and unemployment are not valid proxies of local demand shocks then this effect may be driving the results. Therefore, we redo the analysis by instrumenting for exogenous real estate price growth using housing supply elasticity; again the results hold.

One concern with this analysis is our lack of panel-level data; as a result we cannot accept that unobservable firm fixed effects are driving the results. To overcome the concern we develop a pseudo-firm for each state and financing cohort, and then complete our analysis again in a panel regression structure. The holds are similar to the cross-sectional estimates; increasing house prices by 10% results in an 11% increase in home equity financing and a 6% increases in the chance of financing entirely through home equity.

To put this in perspective we find the effect of 2000-2006 real estate price growth. First understand that our results are only an underestimate of the true channel since we estimate the effect relative to firms with minimal financing needs. Since these firms too borrow against home equity, we are understating the significance of this channel.

W find that real estate price growth between 2000 and 2006 is responsible for an 6.3% increase in home-equity financing. Further, for states in the top 10% of real estate price growth this effect escalates to 14%.

Which Firms are Affected by House Price Shocks? We also check how both firm characteristics affects our home equity financing results by completing our analysis for each financing cohort. We that the home equity channel is greatest for financing needs between $25,000 and $1 million. The effect actually declines slightly with the very largest firms, which is not surprising given that only 10% of these business relied on home equity.

We find that a 10% increase in house prices results in a 2.1% increase in home equity financing for firms that receive between a quarter million and a million in initial funds. We redo our analysis using the panel data and find only larger estimates. Again, to understand the implications, the result suggest that 1999-2006 house price growth increased home equity financing by 12% in the US and up to 27% for particularly inelastic states.

The results are smaller for firms with lower financing needs; this should not be surprising given that most funding comes instead from owners savings and credit cards. Similarly, the largest firms instead rely on either non-secured bank loans or use alternative sources of collateral (for instance commercial properties). Still, we find that all firms sizes are positively and significantly affected by a real estate shock.

Do House Price Shocks Impact Initial Capital Structure? We next test the impact of house price on alternative financing channels. If entrepreneurs swap home equity financing for more expensive forms of financing, then we should find that house price growth is negatively associated with alternative financing, especially more expensive forms of financing. Instead, an insignificant effect indices that home equity offers the small firm the opportunity to expand since other financing sources are still present.

Subject to a positive real estate shock, entrepreneurs rely more heavily on home equity and less on bank loans. Bank loans decline by 1.7% subject to a 10% decline in real estate prices. Other types of loans- government loans, government guaranteed loans, and family loans- also decling during housing booms. In comparison, other forms of financing such as credit cards and savings are only minimally affected by real estate shocks.

The results imply that in response to house price shock, firms trade home equity loans for more expensive forms of formal debt. In comparison, equity and informal credit remain at the previous levels. As a result, we see little effect on the total capital structure of the firm.

One policy implication from this work is the role of governmental loan guarantee programs. Implicitly, these loans should have the greatest impact when the entreprenuer has limited access to collateral, such as when house prices are low. Alternatively, if loan guarantee programs are unaffected by housing shocks, then entreprenuers are either unable or uninterested to access the support exactly when it is most valuable.

Our analysis supports the intuition that real estate price are negatively correlated with loan guarantee financing. Doubling house prices decreases the number of new guaranteed loans by 1.2%. This number differs significantly by the financing needs of the firm: for firms that require $100,000-$250,000 in funding, this same house price shock decreases the loan quantity by three percent.

What are the Aggregate Effects of the Housing Boom on Entreprenuerial Financing? As we have already stated, our results imply that between 2000 and 2006 the number of home equity loans grew 6%. Due to data limitations, it is slightly more difficult to estimate the aggregate the monetary increase of home equity loans for two reasons. First, we only know whether a firm drew on a home equity loan, not the amount. To overcome this issue, we assume that the number of home equity loans is proportional to the total amount of home equity financing; therefore if 10% of firms depend on a home equity loan then we assume that 10% increase of total financing is through this funding channel. We believe this is actually an understatement of the true effect since home equity is a formal financing channel when compared to family loans or credit cards. Secondly, we do not have data on the exact level of financing for each firm. Therefore as a lower bound, we assume that firm financing in each cohort is at the lower bound of the financing cohort; this again is an underestimate since we are substantially underweighting the larger firms that are most dependent on home equity loans.

We find that 2000-2006 real estate price growth resulted in at least a 9% increase in the total amount of home equity financing among entreprenuers. In addition, for areas in the top 10% of house price growth this number reaches over nineteen percent during this same period. The results highlight the significance of the home equity channel among entreprenuers.

Conclusion

This purpose of this paper is twofold: (i) determine the extent of home equity financing among small firms, and (ii) identify when house price shocks can be interpreted as collateral shocks. To achieve the former we summarize the range of home equity financing among both firm and owner characteristics using new US small firm data from the Census Survey of Business Owners. To fulfill the latter goal we evaluate how real estate shocks increase home equity financing in all firms relative to businesses with minimal financing needs.

According to our analysis home equity is a source of financing for about 15% of large start-ups (those that received at least $50,000 in initial funding). Secondly, a house price shock does indeed impact financing: in our preferred specification we find that a 10% increase in real estate price growth is responsible for an 1.1% increase in home equity financing.

We find two primary implications of our research. First, house price growth does indeed impact firm financing decisions and is a reasonable measure of liquidity among entreprenuers. In this way, we validate previous research that has relied on housing shocks to test credit constraints on entreprenuers.

Secondly, the prevalence of home equity financing combined with swings in the housing sector suggest the home equity channel on small firms has the potential for sizable effects on the labor market; given the simultaneous decline in both house prices and small firm financing during the Great Recession, this remains a significant area of future research.

Table 31: Summary Statistics of the Survey of Small Business Owners. Employment is defined as the mean number of employees in each cohort. All other variables represent external financing opportunities and are percentages; a percentage of zero implies no firms rely on the specified financing option while a percentage of 100 implies all firms use the financing option. We distinguish cohorts by financing needs: (i) less than $5,000, (ii) $5,000-9,999, (iii) $10,000-24,999, (iv) $25,000-49,999, (v) $50,000-99,999, (vi) $100,000-249,999, (vii) $250,000-999,999, and (viii) greater than $1 million.

	All Firms	$0	$5,000	$10,000	$25,000	$50,000	$100,000	$250,000	$1M
Employment	3.21	0.90	1.04	1.55	1.99	3.73	5.27	10.34	34.49
Savings	0.81	0.88	0.85	0.80	0.73	0.71	0.70	0.69	0.57
Credit Card	0.20	0.15	0.24	0.24	0.26	0.26	0.23	0.17	0.07
Business Loan	0.12	0.01	0.04	0.09	0.16	0.22	0.29	0.42	0.47
Home Equity	0.11	0.02	0.05	0.12	0.19	0.25	0.29	0.23	0.10
Assets	0.11	0.07	0.09	0.11	0.13	0.16	0.18	0.21	0.19
Family Loan	0.04	0.01	0.02	0.04	0.05	0.06	0.07	0.08	0.08
Govt Loan	0.01	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.03
Govt Guar Bank Loan	0.01	0.0002	0.002	0004	0.009	0.01	0.03	0.06	0.04
Venture Capital	0.007	0.0007	0.002	0.003	0.005	0.007	0.01	0.03	0.09
Grant	0.003	0.002	0.002	0.002	0.002	0.003	0.004	0.005	0.007
Observations	64,302	25,922	7,177	8,206	5,766	5,780	5,788	3,964	1,699

	All Firms	$0	$5,000	$10,000	$25,000	$50,000	$100,000	$250,000	$1M
Employment	3.72	0.96	0.94	1.64	2.03	4.11	5.18	9.80	40.60
Savings	0.67	0.74	0.71	0.67	0.64	0.62	0.62	0.60	0.44
Credit Card	0.30	0.25	0.34	0.35	0.36	0.36	0.33	0.26	0.11
Profits	0.16	0.14	0.16	0.18	0.16	0.15	0.15	0.17	0.21
Business Loan	0.14	0.04	0.05	0.11	0.16	0.21	0.26	0.34	0.42
Home Equity	0.11	0.03	0.06	0.11	0.15	0.19	0.22	0.19	0.09
Assets	0.11	0.07	0.09	0.10	0.12	0.14	0.16	0.17	0.13
Family Loan	0.03	0.01	0.02	0.03	0.05	0.05	0.06	0.06	0.06
Govt Loan	0.01	0.00	0.00	0.01	0.01	0.02	0.01	0.02	0.02
Govt Guar Bank Loan	0.01	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.01
Venture Capital	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.10
Grant	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.01
Observations	40420	13635	4742	5678	4008	4149	4168	2838	1202

Table 32: Summary Statistics of Home Equity Financing. All other variables represent external financing opportunities and are binary outcomes. We break down firms by: (i) number of Owners, (ii) if the firm is the primary income for owner 1, (iii) if owner 1 manages the firm, (iv) weekly hours worked by owner 1, and (v) owner 1 age.

Category		Obs	Mean	Std. Dev.	Category		Obs	Mean	Std. Dev.
Num of Owners	1	37685	0.08	0.28	NAICS Code	Accommodation and Food Services	2785	0.21	0.41
	2	21118	0.15	0.36		Retail Trade	8599	0.14	0.34
	3	2950	0.13	0.34		Transportation	3121	0.14	0.34
	4+	2549	0.13	0.34		Manufacturing	2502	0.13	0.33
						Other	4856	0.12	0.33
Manages Firm	Yes	32820	0.14	0.34		Finance	2904	0.12	0.32
	No	22274	0.08	0.28		Wholesale Trade	2263	0.11	0.31
						Construction	6849	0.11	0.31
Hours	0	1752	0.07	0.26		Real Estate	6005	0.11	0.31
	0-19	14756	0.07	0.26		Health Care	4397	0.11	0.31
	20-29	9212	0.09	0.29		Education	1135	0.09	0.29
	30-39	6948	0.09	0.28		Management	66	0.09	0.29
	40-59	12146	0.14	0.35		Agriculture	387	0.09	0.28
	60+	10352	0.19	0.39		Arts and Entertainment	2271	0.08	0.28
						Administrative	3738	0.08	0.27
Age	Under 25	1510	0.04	0.19		Utilities	100	0.08	0.27
	25-34	10895	0.09	0.29		Information	1700	0.07	0.25
	35-44	16623	0.13	0.34		Professional Services	10237	0.07	0.25
	45-54-	15380	0.13	0.34		Mining	349	0.07	0.25
	55-64	8502	0.10	0.30					
	65+	2204	0.07	0.25					
Principle Income	Yes	28780	0.13	0.33					
	No	26144	0.10	0.30					

Table 33: Effect of a Real Estate Price Shock on the Decision to Finance a Firm Through Home Equity. Home Equity is a binary variable that designates the start-up partially financed the firm through home equity. Only Home Equity is a binary variable that designates the firm was financed exclusively through home equity. Each test is a linear probability regression where the dependent variable is a binary variable that designates the start-up partially financed the firm through the specified option. All specifications include Industry Sector and Firm Size fixed effects and cluster observations at the state level. T-Statistics are included below the coefficient. We use * to denote significance at the 10% level, ** to denote significance at the 5% level, and *** to denote significance at the 1% level.

	OLS		OLS		IV (Elasticity)		IV (Elasticity)	
	Only Home Equity	Home Equity	Only Home	Home	Only Home	Home	Only Home	Home
Elasticity					-.25***	-.25***	-.25***	-.25***
					(-219.77)	(-219.77)	(-219.77)	(-219.77)
Δ% Price Index ×1[Financial>$5,000]	.041***	.11***	.042***	.1***	.042***	.11***	.043***	.11***
	(6.6)	(4.8)	(6.7)	(4.6)	(7)	(4.8)	(7)	(4.6)
Δ% Price Index	.0059***	0.0066	.013***	0.017	.006***	0.0069	.013***	0.018
	(3.4)	(1.3	(4.3)	(1.3)	(3.5)	(1.4)	(4.1)	(1.3)
1[Financial>$5,000]	-.0049*	.081***	-.0048*	.084***	-.0053*	.081***	-.0053*	.085***
	(-1.7)	(3.3)	(-1.7)	(3.4)	(-1.9)	(3.3)	(-1.8)	(3.4)
Δ% GDP			-.044**	-0.058			-.043**	-0.061
			(-2.4)	(-.79)			(-2.3)	(-.77)
Δ% Unemployment			-.0015	0.01			-.003	0.0076
			(-.24)	(0.47)			(-.47)	(0.35)
Observations	64450	64302	63162	63016	62704	62559	61416	61273
R^2	.042	0.13	.042	0.13	.042	0.13	.042	0.13

Table 34: Pseudo-Panel Results of a Real Estate Price Shock on Home Equity. The results are based on a psuedo-panel where the dependent variable is the probability the start-up finances the firm through home equity. State House Prices, State GDP, and State Unemployment are included in the regression. All specifications include year, state, and firm fixed effects and cluster observations at the state level. T-Statistics are included below the coefficient. We use * to denote significance at the 10% level, ** to denote significance at the 5% level, and *** to denote significance at the 1% level.

	Through Home Equity	Only Home Equity	Through Home Equity		Only Home Equity	
	All Firms	All Firms	Below $50,000	Above $50,000	Below	Above
Price Index ×1[Financial>$5,000]	.11**	.06**	.077*	.25***	.063**	.045**
	(2.4)	(2.4)	(1.7)	(6)	(2.4)	(2.4)
Price Index	-.071	.026	-.12	.068	.021	0.027
	(-.74)	(.5)	(-1.1)	(.63)	(.36)	(0.56)
State GDP	2.5e-07**	8.0e-08	2.8e-07**	8.7e-08	8.6e-08	3.00E-08
	(2.5)	(1.5)	(2.5)	(.72)	(1.4)	(0.55)
State Unemployment	-.0031	-.0041*	-.0015	-.0066	-.0037	-0.0035
	(-.76)	(-1.8)	(-.34)	(-1.3)	(-1.5)	(-1.5)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1140	1140	950	380	950	380
R^2	0.78	0.48	0.77	0.91	0.49	0.56

Table 35: Effect of a Real Estate Price Shock on the Decision to Finance the Firm Through Home Equity by Financing Needs. Each test is a linear probability regression where the dependent variable is a binary variable that designates the start-up partially financed the firm through the specified option. All specifications include Industry Sector and Firm Size fixed effects and cluster observations at the state level. T-Statistics are included below the coefficient. We use * to denote significance at the 10% level, ** to denote significance at the 5% level, and *** to denote significance at the 1% level.

	$5000	$10,000	$25,000	$50,000	$100,000	$250,000	$1M
Δ% Price Index ×1[Financial>$5,000]	.032**	.061**	.14***	.16***	.17***	.21***	.12*
	(2.1)	(2.7)	(3)	(3.5)	(2.9)	(5.9)	(2)
Δ% Price Index	.007	.0062	.0086	.007	.015*	.00085	.0047
	(1.1)	(.79)	(.95)	(.79)	(1.8)	(.12)	(.86)
1[Financial>$5,000]	.025***	.075***	.11***	.18***	.2***	.14***	.049
	(3)	(5)	(4.2)	(5.9)	(6.2)	(6.3)	(1.6)
Δ% GDP	-.019	-.0095	-.019	-.016	-.067	.015	-.01
	(-.56)	(-.25)	(-.49)	(-.35)	(-1.4)	(.47)	(-.4)
Δ% Unemployment	.014*	-.0013	.019*	-.0093	-.0031	.0047	.00068
	(1.8)	(-.097)	(1.7)	(-.57)	(-.21)	(.51)	(.087)
Observations	31545	32507	30163	30197	30184	28476	26311
R^2	.019	.058	.11	.17	.18	.14	.024

Table 36: Effect of a Real Estate Price Shock on all Financing Decisions. Each test is a linear probability regression where the dependent variable is a binary variable that designates the start-up partially financed the firm through the specified option. All specifications include Industry Sector and Firm Size fixed effects and cluster observations at the state level. T-Statistics are included below the coefficient. We use * to denote significance at the 10% level, ** to denote significance at the 5% level, and *** to denote significance at the 1% level.

	Home Equity	Bank Loan	Owner Assets	Grant	Venture
Δ% Price Index ×1[Financial>$5,000]	.11***	-.17***	.022**	-.0018	.0044
	(4.6)	(-11)	(2.2)	(-1.1)	(1.5)
Δ% Price Index	.018	-.016	-.046***	.00086	-000037
	(1.3)	(-1.4)	(-4)	(.65)	(-.031)
1[Financial>$5,000]	.085***	.52***	.11***	.003**	.058***
	(3.4)	(17)	(6.6)	(2.1)	(6.7)
Δ% GDP	-.061	.05	.068	.00069	-.001
	(-.77)	(.66)	(1.6)	(.12)	(-.14)
Δ% Unemployment	.0076	.0091	-.026	.0034	-.0048
	(.35)	(.4)	(-1.6)	(1.5)	(-1.6)
Observations	61273	61273	61273	61273	61273
R^2	.13	.2	.027	.0037	.033

	Gov Guar Loan	Gov. Loan	Credit	Loan from Family	Savings
Δ% Price Index ×1[Financial>$5,000]	-.012***	-.0068**	0.0019	-.013***	.0011
	(-4.9)	(-2.5)	(.14)	(-2.8)	(0.084)
Δ% Price Index	-.0033*	.00073	.024	-.0092*	.045**
	(-1.9)	(.5)	(1.3)	(-1.7)	(2.7)
1[Financial>$5,000]	.05***	.027***	-.0066	.083***	-.34***
	(6.4)	(5.2)	(-.39)	(9.2)	(-14)
Δ% GDP	.022**	-.0083	-.0027	.059*	-.15**
	(2.2)	(-.98)	(-.03)	(1.7)	(-2.2)
Δ% Unemployment	.00031	.000078	.000062	-.005	-0.0016
	(.-69)	(.022)	(.0026)	(-.7)	(-.059)
Observations	61273	61273	61273	61273	61273
R^2	.031	.014	.037	.029	0.067

Table 37: Effect of a Real Estate Price Shock on the Decision to Finance the Firm Through Loan Guarantee Programs by Financing Needs. Each test is a linear probability regression where the dependent variable is a binary variable that designates the start-up partially financed the firm through the specified option. All specifications include Industry Sector and Firm Size fixed effects and cluster observations at the state level. T-Statistics are included below the coefficient. We use * to denote significance at the 10% level, ** to denote significance at the 5% level, and *** to denote significance at the 1% level.

	\$5000	\$10,000	\$25,000	\$50,000	\$100,000	\$250,000	\$1M
Δ% Price Index ×1[Financial>\$5,000]	-.00014	-.0051	-.017***	-.019***	-.03***	-.021	-.0094
	(-.13)	(-1.3)	(-3.5)	(-2.9)	(-2.9)	(-1)	(-.42)
Δ% Price Index	-.00096*	-.0045	-.0013	-.0018	-.0011	-.004	-.0011
	(-1.9)	(-.83)	(-1.1)	(-2.2)	(-.99)	(-2.1)	(-1.4)
1[Financial>\$5,000]	.00066	.0067**	.02***	.02***	.041***	.065***	.046***
	(1.3)	(2.5)	(4.6)	(4.6	(6.4)	(4.8)	(2.8)
Δ% GDP	.003*	-.00085	.0053	.0092***	.0044	.027**	.0046
	(1.8)	(-.024)	(.85)	(2.2)	(.66)	(2.4)	(1.3)
Δ% Unemployment	.0012**	(-.0098)	-.00085	.0025	-.00064	.0015	.0019
	(2.2)	(-.56)	(-.3)	(1.4)	(-.23)	(.43)	(1.5)
Observations	31545	32507	30163	30197	30184	28476	26311
R^2	.0019	.0056	.011	.013	.032	.056	.035

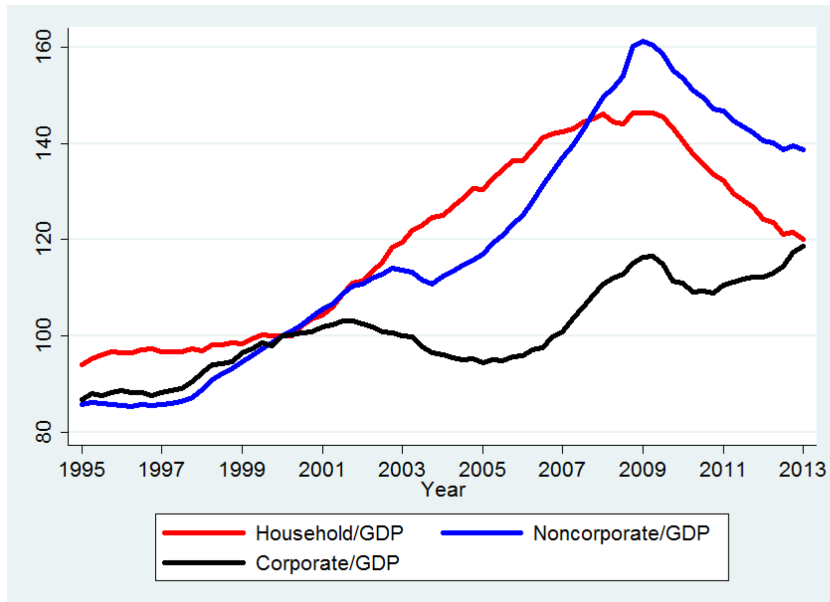

Figure 4.1: US Credit Market Liabilities Index. This figure displays an index of the following variables from 1995-2013: (i) US Household and Nonprofit Organization Credit Market Instrument Liabilities/US GDP, (ii) US Nonfinancial Noncorporate Business Credit Market Instrument Liabilities/ US GDP, and (iii)US Nonfinancial Corporate Business Credit Market/ US GDP. Each variable is indexed to be 100 in the first quarter of 2000. Financial data is collected from the Federal Reserve Board Flow of Funds and GDP data is from the National Income and Product Accounts. As of the first quarter of 2013 Household Liabilities/GDP = 0.77, Corporate Liabilities/GDP = 0.54, and Noncorporate Liabilities were 0.24. In comparison in the first quarter of 2009, these number were Household Liabilities =0.94, and Corporate Liabilities= 0.52, and Nonorporate Liabilities/GDP = 0.28, .

5 Conclusion

This dissertation explores the causes and consequences of real estate price fluctuations. Given the collapse of US house prices during 2007-2009 along with the simultaneous rise in national unemployment we believe that a thorough understanding of both the housing market and its relation to the macroeconomy has perhaps never been more important. While this dissertation fits in the real estate finance literature, my broader purpose is to use to new micro-level data to empirically test the relevance of financial and macroeconomic theories.

My second chapter of my dissertation is titled, "How Real Estate Drives the Economy: An Investigation of Small Firm Collateral Shocks on Employment". The real estate market has been at the center of the debate on the causes and consequences of the rise in unemployment during 2007-2009, yet the mechanism that links these factors remains inconclusive. We propose a simple explanation: since small firms are highly dependent on collateral to access external financing, balance sheet shocks can affect financing availability and impact real outlays. Using UK firm level data we find that the average small business extracts \$0.25 out of every dollar increase in their real estate value and applies \$0.10 for investment and \$0.07 for employment expenditures. Our method exploits cross-sectional differences in exogenous real estate price growth using measures of housing supply elasticity as well as variation in firm real estate holdings. Our channel directly explains 8-16% of the decline in national employment during 2007-2009 and as much as 20-37% for areas worst hit by the housing crisis. The estimates are greatest for both the youngest and smallest firms, and accounting for general equilibrium effects in a macroeconomic framework appears only to magnify our result. Our research highlights the small business collateral channel as a relevant explanation of the recent Great Recession and illustrates business balance sheet shocks as a primary driver of financial frictions to the economy.

The third chapter of my dissertation is titled, "The Effect of Illiquid and Heterogeneous Assets on Price Index Bias: Evidence from the US Housing Market" and attempts to extend empirical asset pricing techniques to the study of the housing market. Assets such as real estate, large transportation equipment, and luxury artwork sell infrequently and are not interchangable. As a result traditional price indices, such as the Case-Shiller Index for metropolitan house prices, are the dominant method to measure price fluctuations of these heterogeneous and illiquid assets. First, we highlight that standard price indices are biased towards frequently sold assets and can result in significant financial implications. Secondly, we correct for this mismeasurment by introducing the locally-weighted repeated sales technique, a novel estimation procedure for estimating a distinct price index for any asset and then aggregating assets to define unbiased indices. Our procedure rests on estimating local weights by comparing a given assets to all similar assets sold that period along a number of observable characteristics. Third, we highlight advantage of our technique by examining the US housing market. We find that beginning in 2004 changing credit standards to low income homebuyers resulted in strong price growth and high turnover in low value housing. As a result a Case-Shiller type index substantially overstates the peak of the US housing bubble by 10%.

In the fourth and final chapter, titled "Do Real Estate Prices Impact Entrepreneurial Financing? Evidence from the Home Equity Channel," we examine the use of home equity for small businesses and the effect of real estate price growth on entrepreneurial financing. Using a new micro-level dataset, we find that during the housing boom one-quarter of large US start-ups depended on home equity as a source of initial capital. In response to an exogenous shock to real estate price growth, entrepreneurs increase reliance on home equity financing relative to firms with minimal financing needs. Simultaneously, these firms decline financing through bank loans while less formal financing channels appear unaffected. The results are greatest for firms that receive between $50,000, and $1 million in funding. Specifically, in our preferred specification we find that a 100% increase in real estate price growth is responsible for an 11% increase in home equity financing among all entrepreneurs and a 21% increase for large start-ups. Using a simple back of the envelop calculation we find that 2000-2006 real estate price growth is responsible for at least a 9% increase in the level of initial funding through the home equity channel.

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Biography

Kristopher Kleiner was born on June 1st, 1987 in Westland, Michigan. He attended the North Carolina School of Science and Mathematics. He then went on to recieve his Bachelors Degree from North Carolina State University in 2008, his Masters Degree from North Carolina State University in 2009, and his Ph.D. in Economics from Duke University in 2014. He will be starting as an Assistant Professor of Finance at Indiana University in the Summer of 2014.