The Spillover Effects of the Housing Market on Local Employment

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Abstract

I investigate the impact of the housing dynamics on local employment. This can occur through at least two channels – the price channel and the quantity channel. I use changes in house prices to capture the first channel, and changes in housing supply to account for the second. To evaluate the two effects, I build an econometric model using a panel of commuting zone level employment, housing price and building permit data from 1991 to 2015. I incorporate lagged housing variables in the model to allow that both housing effects could take time to play out fully, and the lagged dependent variable to account for partial adjustment in the labor market. To identify the causal effects, I use the housing supply elasticity and the national mortgage interest rate as instruments for the endogenous housing variables. I find evidence that 1) both price and quantity effects have significant impacts on employment changes; 2) the quantity effect is more persistent, widespread and economically significant than the price effect. Moreover, I exploit home refinancing data to show that the price effect primarily works through the collateral borrowing channel rather than the direct wealth channel. Finally, my case study indicates that the price and quantity effects account for 45 % of the employment growth drop from 2007 to 2008. And the price effect is twice the quantity effect during this period.

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1. Introduction

As Leamer (2007) says, “Housing IS the Business Cycle”. Indeed, out of the ten recessions since World War II, eight have been preceded by a collapse in the housing sector (Leamer, 2007). Therefore, studying the spillover effect of the housing market is crucial to uncover labor market fluctuations.

The debate after the Great Recession has proposed several mechanisms on how housing can affect employment. I group them in two main channels. First is the price channel; in other words, the rise in housing prices has a positive effect on local employment. A series of studies has shown that households increase collateral borrowing and consumption in response to their house value appreciation (Campbell and Cocco, 2004; Case et al., 2001; Mian et al., 2013; Mian and Sufi, 2014a). With respect to the labor market, the increase in consumption lifted local labor demand, thus generating new jobs and raising employment. This feature fundamentally contributed to the co-movement of the housing market and the real economy in the first decade of the 21st century.

Fluctuations in housing prices are also associated with local business dynamics. Chaney et al. (2012) shows that corporate investment rises significantly when firms gain from real estate property appreciation, which leads to business expansion and local job creation. On the other hand, Adelino et al., (2015) and Harding and Rosenthal (2017) also find that increases in housing prices are also associated with a higher self-employment rate, where unemployed individuals use their houses as collateral for start-up loans to open new businesses.

The second channel is the quantity channel; that is, increases in housing supply (with housing price fixed) also lead to more employment. The most direct impact of supply increases is in the construction sector. Charles et al. (2016) show that more housing demand significantly increases both the employment rate and the share of construction employment locally. Meanwhile, new house construction also raises local demand for associated real estate services, mortgage brokerage, home related durables and house renovations (Benmelech et al. 2017).

However, although these mechanisms have been established in the literature, their relative importance hasn’t been closely examined. Leamer (2007) compares the volatility of house prices and building starts, and concludes that “it’s a volume cycle, not a price cycle” since house price changes are much smaller than housing starts. Besides, house prices are sticky downwards as homeowners are reluctant to sell their depreciated property in a bust. So he argues that the drop in house prices cannot be as destructive as the drop in housing starts in recessions. Quigley and Case (2008) also agree with this point. They add one evidence that the impact of house prices on consumption is asymmetric, and the decline in house prices won't affect consumption as much as the rise. However, these aggregate analyses have never assessed the impact of price and quantity changes in the same framework. Charles et al. (2016) provide a model that is closest to this problem; but they mix the price and quantity changes in one variable, which represents local changes in housing demand. Less volatility and asymmetry don't necessarily lead to a smaller price effect. If a one-unit change in house prices is associated with a larger change in the labor market than housing starts, the comparison of the price and quantity effects in the business cycle, particularly in economic recessions, is ambiguous.

This paper joins the discussion of assessing the housing effects on local employment. My main objective is to separately identify the price effect and the quantity effect, and to compare their economic significance. My analysis is based on a panel econometric framework. To do so, I construct a panel of 678 commuting zones from 1991 to 2015 which includes annual local employment, house price growth and new building permits. The sample period covers the 2000-2006 housing boom, the 2007-2009 housing bust, and other periods with stable housing markets. The panel feature of my data allows me to exploit the sample large variation in the housing dynamics, both across and within commuting zones.

The housing effect could last for more than a year. For the price effect, it takes time for real estate owners, including homeowners and businesses, to realize their property appreciation, and to take further steps to take advantage of the appreciation, such as applying for home equity loans, engaging in self-employment, increasing corporate investment, and expanding human resources. For the quantity effect, the construction work usually takes 9-12 months to complete, and other processes such as inspection, transaction and new home investment also need months to complete. To account for the dynamics of the two housing effects, I include the lagged changes in the housing variables in my model. With the lagged variables, I can allow that the housing effects could take more than a year to fully play out. Besides, I also add the lagged dependent variable, which accounts for the partial adjustment characteristic in the labor market.

Recent studies tend to focus on particular periods when house prices rise or decline substantially, like 2002-2006 in Mian and Sufi (2014a), 2007-2009 in Mian and Sufi

(2014b), 2000-2006 in Charles et al. (2016), and 2002-2007 in Adelino et al. (2015). They regress the changes in consumption, employment or corporate investment on changes in house prices, house net worth or housing demand over the entire period. These models have several drawbacks. First, they only assess the housing effects in extreme boom or bust periods, which may exaggerate their estimates and can hardly be applied to normal periods. Second, their estimate cannot reveal the dynamics of the housing effects; that is, how fast the labor market responds to housing market changes. Does a price shock immediately affect employment, or three years later? In addition, their sample variation is restricted since they can only exploit cross-sectional variation, but not within-area dynamics.

Changes in the housing price and supply are not exogenous, which will confound the causal estimates. Several immediate reasons emerge. First is the simultaneity problem. Since the observed labor market outcomes are the intersection of simultaneous labor demand and supply equations, labor supply shifters will also affect the outcome variable along with changes in the housing market. Second is the reverse causality argument. That is, changes in labor market conditions will in turn affect the housing market. Lastly, changes in housing variables might also proxy local labor demand shifts, making it difficult to identify the housing effects.

My identification strategy first relies on the Fixed Effect estimator, which captures within-commuting zone changes to identify the housing effect. A key assumption for the Fixed Effect estimator to be causal is that the commuting zone dummies absorbs all the across commuting zone differences which affects both the housing market and the labor market. However, the commuting zone dummies could only take account of time-invariant heterogeneity, and Fixed Effects could still suffer from omitted variable bias if there remain other time-varying factors which confound the estimate. To further deal with this problem, I include the baseline demographic controls in the model, and interact them with time dummies, since otherwise they will fall out of the panel model. This is intended to better account for time-varying commuting zone differences and make them comparable. Furthermore, applying the fixed effects estimator to the dynamic panel data model will cause biased estimates. Therefore, I apply the General Method of Moments (GMM) estimator of Arellano and Bond (1991) with the lagged dependent variable in the model.

Beyond the Fixed Effect estimator, the GMM estimator and demographic controls, I use an Instrumental Variable (IV) framework to derive the exogenous variation in the housing variables to deal with endogeneity issues. The instruments are housing supply elasticities

(Saiz, 2010) and the national mortgage interest rate. The first instrument factors in the exogenous heterogeneity of local housing supply conditions, and the second is a national demand shifter which is independent of local development. Similar identification strategies have been used by Chaney et al. (2012), Mian and Sufi (2012) and Adelino et al. (2015). To ensure the housing spillover effects are not generated by confounding changes in local labor demand and income shocks, I explicitly control for the Bartik instrument (Basso and Peri, 2015) and the per capita personal income of the commuting zone.

Based on the estimates, I compare the economic significance both in the entire sample and in the Great Recession. This practice directly tests Leamer (2007)'s claim: It's a volume cycle not a price cycle. The entire sample economic significance is measure by the standardized coefficient. And I apply the estimated results to calculate the share of employment decline in the Great Recession that could be explained by the drop in the house price and by the drop in new housing starts.

I exploit the refinancing data to uncover the mechanism of the price effect, which operates at least through the direct wealth channel and the collateral borrowing channel. I add the growth rate of refinancing in the model, which mutes the collateral borrowing channel when house wealth appreciates. The price estimate with the refinancing control measures the direct wealth effect after explicitly controlling for the credit expansion due to home value appreciation. Such practice helps distinguish the two channels from the price effect and observe which channel is more important. If a strong wealth effect on the labor market exists, then the price estimate should stay significant when I mute the collateral borrowing channel. Likewise, if the collateral borrowing channel is nonsignificant, then adding the refinancing growth won't make much change to the estimates.

In addition to estimating the housing effects on total commuting zone employment, I also study their influence on three separate industrial sectors: the non-tradable sector, the tradable sector and the construction sector. The purpose of this endeavor is to trace down the influence of both housing effects on different sectors of the labor market. As the price effect and quantity effect work in different ways, their impact on these three sectors should vary. Supposedly, the price effect will mainly affect the non-tradable sector as Mian and Sufi (2014b) suggests, if the increase in consumption is largely spent on local services. The quantity effect affects first the construction sector at the building period, and then the non-tradable sector throughout home pre- and post- transaction periods. The impacts on the tradable sector, which mainly produce manufactured goods, is not straightforward. Mian and Sufi (2014b) shows that house price shouldn't affect tradable employment, because it relies little on local demand. But one could also expect a positive impact from the collateral borrowing perspective.

My paper is directly related to the study by Charles et al. (2016). In that paper, they exploit the cross-sectional variation across metropolitan statistical areas (MSAs) to estimate the effect of housing booms and busts on labor market outcomes in the middle run, the housing boom from 2000 to 2006 and the housing bust from 2006 to 2012. They create a housing demand variable, which is the sum of the changes in house prices and the changes in new housing supply. Their claim is that the housing demand variable incorporates both the demand side and the supply side shifts in the housing market; and they show that this variable has a significant effect on employment changes. My study improves on this study in three ways. First, I identify the two channels through which the changes in the housing market affect labor market outcomes. That is, I separate the housing demand variable in their study, and evaluate each effect of price change and supply quantity. Second, I build a panel data model which allows me to exploit the within-commuting zone variation of the housing market, so that I can capture the short-term and long-term effects. Third, their study uses the structural break technique which only applies to the special housing boom and bust periods, my identification strategies allow me to analyze the relationship more generally using a panel data over a longer period.

The rest of the paper is organized as follows. Section 2 reviews the relevant literature. Section 3 discusses the theory underlying the housing effects, followed by section 4 on the empirical model. I present the data in Section 5 and show the results in Section 6. Using the estimates in Section 6, I conduct a case study of the Great Recession in Section 7. Finally, section 8 concludes.

2. Literature Review

This section reviews the related literature of my thesis. The Great Recession triggered by the housing collapse starting in 2006 evoked a large volume of studies on the cause and consequences of the housing cycle, especially the housing bust. Here, I first present two papers which overview the housing cycle and its link with economic recessions. Then I move on to studies focusing on specific channels through which the housing fluctuations could spill over to other parts of the economy.

Leamer (2007) underscores the importance of the housing decline in driving and predicting economic downturns. This paper depicts fundamental characteristics of the housing cycle, and how they relate to the business cycle. The topic, Housing IS the Business Cycle, is strong enough to make this point. He provides two key arguments. First, new residential investment is the best indicator of economic recessions compared to other components of GDP. Out of ten economic recessions since the World War II, eight of them were proceeded with new residential investment drops. And these drops contributed to 25% of the weakness in GDP one year before the recessions, more than any other components. He also uses the episodic approach to show the ordering of collapse in these components in economic downturns. Residential investment comes first, then consumer durables, nondurables, service, and the last comes business equipment and software.

Second, the housing cycle is a volume cycle, not a price cycle. Home prices are sticky downward. Therefore, when housing demand softens, the number of new housing starts and sales adjusts rather than the price. He shows that the volatility of home prices is much lower than of housing starts throughout the nation. In fact, the price adjustment sluggishness causes this feature of the housing cycle and makes the volume a sensitive indicator of the economy. However, the fact that housing price being more stable than new housing supply doesn't necessarily mean its impact is smaller.

Quigley and Case (2008) presents an aggregate analysis on the income effect and the wealth effect of the housing bust. They focus on the impact of both effects on the aggregate economic output; and estimate how much they accounted for the drop in GNP in the Great Recession, based on the experiences from last three recessions. The wealth effect comes from higher household consumption following home value appreciation, either by directly withdrawing equity from real estate assets, or by saving less on other forms. However, they also predict a relative small wealth effect on the economy. First, the housing price is sticky downward. Second, the consumption response to housing price is asymmetric: although home value appreciation leads to consumption increase, its depreciation has no significant effect. The income effect is more influential. It causes not only job loss in developers, builders and the construction industry, but also fewer home sales and weaker demand for home-related durables. Considering all losses from fewer housing starts, the decline in building volume is reduced GDP growth rate in the first half of 2007 by 3%.

Campbell and Cocco (2007) is a novel study on the link between house prices and household consumption. They distinguish two channels: one is the pure wealth effect that an increase in household's perceived wealth raises consumption, the other one is the collateral borrowing effect that increased house worth relaxes household borrowing constraints. They use a pooled cross-sectional household level data in U.K., and provide evidence for both channels. For the wealth effect, they find that it's largest for old homeowners, and smallest and insignificant for young homeowners. Besides, the collateral borrowing effect works particularly well for households who are more likely to be borrowing constrained. And the consumption growth is associated with both regional and national house price growth.

Mian and Sufi (2011) explores the home equity-based borrowing channel in the housing boom and bust. Using a special panel of 74,000 U.S. nation-wide homeowners from a national consumer credit bureau agency, they regress the change household leverage growth on regional house price growth from 2000 to 2006, with the housing supply elasticity instrumenting the price growth. They report that households increase 25 cents of borrowing out of every dollar gain in house worth on average. Then, they separate the whole sample according to credit scores and household age. Large heterogeneity emerges: households with lower credit scores and lower ages borrow much more aggressively against the house price gains. This channel is significant in the leverage crisis in the housing bust, because they find that 39% of defaults between 2006 and 2008 were caused by the aggressive borrowers during the housing boom.

Adelino et al. (2015) and Harding and Rosenthal (2017) both investigate the role of housing wealth increment on self-employment. The first study highlights the collateral borrowing channel of the housing cycle. The theory is that collateral borrowing, especially mortgage lending, is crucial to employment in small businesses. To test this, they regress the changes in employment on housing price growth by county between 2002 and 2007, using the Saiz elasticity as an instrument for the endogenous housing price growth. They find that the price effect is asymmetric by the size of the establishment: only the small firms employment increases with positive price changes. And their result is immune to alternative increased local demand hypothesis and specific employment increase in the construction and the non-tradable sectors.

The second study uses the 1985-2013 American Housing Survey household panel to assess whether housing capital gains encourage self-employment. The advantage of the household panel is that it allows a direct measure of house value appreciation net of maintenance expenditure, while other studies use regional house price growth as an indirect proxy. Their fixed effect estimates show that a 20% real increase in home value over a two-year period increases the self-employment probability by 1.5 percentage points. The incentive comes from low cost mortgage debt available to homeowners, compared to a small business loan which is more expensive. They also show that the effect is only significant when house value is increasing; in other words, a drop in house value won't lead to self-employment exits in bad times.

Mian and Sufi (2014b) examines the housing net worth channel to explain the 2007-2009 drop in employment. The mechanism is similar to the general literature: the decrease in household net worth suppresses consumer demand through the deterioration of the balance sheet and tighter borrowing constraints. They classify industries into tradable and non-tradable sectors, and argue that the household net worth channel should only affect non-tradable sector employment, whose demand depends on local consumption, but not the tradable sector employment, which is mainly determined by nation-wide demand. They model the cross-section changes in county non-tradable employment from 2007 to 2009 as a function of county housing net worth shocks. The regression results reveal remarkable job loss from the housing net worth decline; and it's not explained by supply-side specific shocks, construction decline exposure, credit constraint and policy uncertainty. They also discover little labor market adjustment to the housing net worth shock with insignificant changes in wage and migration.

Chaney et al. (2012) discusses the collateral borrowing channel from the firms' perspective. They look at aggregate corporate investment in the housing boom. Their identification uses local house price variations and compares corporations with real estate properties with those without; and it instruments the house price changes with the Saiz elasticity. Drawing on the firm panel and MSA house price data from 1993 to 2017, they find that corporations increases investment by 6 cents out of every dollar gain in their real estate collaterals.

Charles et al. (2016) examines the impact of the housing boom on non-college male employment. They claim that the positive employment effect of the housing boom from 2000 to 2006 masked the downward pressure from the nation-wide manufacturing decline, and the collapse of the housing market in 2007 un-masked this trend and led to the unemployment rise. In order to test this hypothesis, they create a change in housing demand variable, which is the sum of the change in housing price and the change in annual building permits, and an exogenous change in manufacturing employment measure like the Bartik instrument. The results corroborate their hypothesis: a one standard deviation increase in housing demand would increase the employment rate of prime-aged non-college men by 1.3 percentage points from 2000 to 2006, and a one standard deviation decrease in the manufacturing employment share would decrease the employment rate by 0.9 percentage point in the same period. However, by having the housing demand variable as a mix of price and quantity changes, they don't decompose the income and wealth effects, but rather consider the housing effect as a whole.

Benmelech et al. (2017) studies the stimulative effect of home purchases on household consumption and investment, which is part of the income effect in (Quigley and Case, 2008)'s framework. They build a panel of household home-related spending and home purchases using the Consumer Expenditure Survey and BuildFax property level building permits from 2001 to 2013. With an event study method controlling for household fixed effects, they find that home purchasers significantly raise their spending in home-related durables, improvement and maintenance within the first year of new ownership. This also applies for both sellers and buyers before the transaction. And the aggregate analysis shows that the decline in home-related consumption and investment caused by the home sales downturn is remarkable during the Great Recession. In recognition of the potential omitted variable bias of their model, they also estimate the home purchase effect on home-unrelated expenditures and find no significant increase.

Laeven and Popov (2016) discusses the impact of the housing boom and bust on employment outcomes through the shift of skill formation of the young population. On the one hand, the housing boom from 2000 to 2006 created a large quantity of low-skill jobs in construction, mortgage brokerage and real estate sales. On the other hand, rising home values came as a burden for them as renters and potential home buyers. As a result, the real education investment increases for them; and it's more attractive to make quick money from the low-skilled jobs than pursue higher level education. When the bust arrived, these low-skill jobs were tremendously reduced, and the unemployment rate is much higher for the cohort who forfeited higher education in the boom.

To sum up, although the literature agrees that quantity changes in the housing market have a greater impact on the economy that price changes, most papers have investigated the price effect on local consumption and employment, and very few have studied the quantity effect in detail, as shown above. Beyond that, the claim that housing starts declines are more salient contributor to recessions than price drops is also subject to examination. The claim is based on one observation of the housing market: the house price is sticky downwards. However, there is no study that compares the price effect and quantity effect in the same framework. One could argue that although house prices are as volatile as housing starts overall, in recessions however, a 1 percent decrease in the house price could be far more destructive than a drop in the housing starts. Separating the two effects makes some sense because they affect the economy in distinctive ways. But we need more empirical evidence than the volatility to come to Leamer (2007)'s conclusion that "it's a volume cycle, not a price cycle".

3. Theory

This section discusses the theoretical bases of the topic. I group the ways that the housing market affects the local labor market into the price effect and the quantity effect. That is, the changes in house price and in new building starts have separate influences on local labor demand. Then I argue that these two effects take more than one year to fully play out, justifying the inclusion of lagged variables in the regression.

To the best of my knowledge, the price effect could shift out local labor demand, thus boost local employment, in two ways. First is a direct wealth effect. When a household buys a house, it's equivalent to saying that the household decides to hold a long position on their home asset, in the hope that the house value will rise. When the house value appreciates, although the homeowners cannot get cash from their real estate immediately, they perceive an accumulation in household wealth, which leads to an increase in consumption. Campbell and Cocco (2004) examine this phenomenon from a financial perspective. The increase in consumption mainly happens in the service sector, such as retail stores, restaurant services, shopping malls etc. As local service consumption increases, the local service firms will hire more employees to meet the increasing service demand, which leads to an increase in the local labor demand.

Second is a collateral borrowing effect. Simply put, a more valued house enables its owner to borrow more from the banks against its increased equity. Recent innovations have made it simpler to extract cash from home equity. For a homeowner, this could happen through several forms of loans, such as home equity loan, home equity line of credit, cash-out refinance and reverse mortgage. In a rising housing market, these loans are more likely to be approved because the house collaterals which are used to secure the loan are expected to appreciate in the short term. In terms of the labor market, these loans could have separate effects depending on their use. If households use the money to buy new cars, invest in home improvement and enjoy better medical services, then it is equivalent to a direct wealth effect. The difference is that the collateral borrowing effect may be larger, as households could leverage more, that is, borrow much more money and spend from various sources of loans than the direct wealth effect. Other than consumption, households could also use the loan as a start-up capital to open new businesses, in other words, to engage in self-employment. The interest rates of home-equity based loans are usually lower than other business loans, which is an incentive for homeowners to borrow on their house if they want to open new businesses. Self-employment creates new jobs locally: an unemployed homeowner will become employed through this approach. The new businesses will also hire new workers to cater to its needs. Therefore, collateral borrowing has a direct impact on local job creation.

The story doesn't stop at the homeowners and new businesses: it applies to the existing businesses, as well. Corporations can also cash out funds from their appreciated real estate properties in order to increase investment. This can lead to corporate expansions and hiring new workers.

The quantity effect, which comes from the change in local housing starts, works differently from the price effect. It first happens in the construction sector. More building starts boost residential investment and create more construction works locally, which will raise local employment in the real estate developing and construction industry. Beyond the construction sector, the quantity effect also spillovers to other industries. Transaction of a new home is associate with many other services. Completed buildings come with new house sales, and home sales are related with real estate service, building appraisal, mortgage needs. When the number of housing starts goes up, the local employment in these related service industries also follows with an increase. Besides, the quantity effect even persists after the transaction. New homeowners will spend money on furniture, home appliances, decoration and improvement. These spending all lead to high local labor demand in related industries. To sum up, the quantity change in the housing market will have persistent effects on the labor market in the construction stage, pre-transaction stage and post-transaction stage.

Based on how the price and quantity effects work, it's reasonable to believe that both of the two effects will need several years to fully take effect. For the quantity effect, as I have just discussed, the effect will persist through three stages from the start of the construction to some time after the house transaction. As each stage takes time, the whole quantity effect won't be realized within one year. First, the construction work for one unit usually takes more than a year to complete. For example, if a building permit is granted in August 2006, then the firm might need to hire a construction team to work towards Match 2008 to complete the building. Then, the job generated from the building permit in 2006 will at least persist from 2006 to 2008. After the construction is done, it still needs several months to list it in the market, advertise, and finally make the sale. Investment and improvement of the new house also takes months.

The price effect might not last as long as the quantity effect; but still, we may suspect it operates with a lag. Homeowners cannot realize the change in the house price immediately. Usually, people get an estimate of their house market value through home sales in the neighborhood, such as from Zillow.com, or seeking advice from realtors. In other words, there is no real-time house price available, unlike stock prices. Thus, there is a lag between when the house price rise happens and when the homeowner decides to take advantage of it. Also, subsequent decisions, such as applying for a loan, buying a car, and opening a business, don't happen overnight. And the labor market also lags in responding to the increased demand.

4. Empirical Model

To assess the impact of the housing market on the labor market, I specify a growth rate model by regressing the changes in labor market statistics on changes in the two housing variables, namely, the housing price and building permits. First, I difference employment and house prices because they are non-stationary. Moreover, my house price index data is not comparable across regions, so I put its changes, which is comparable, in the model. The level of building permits is the flow of local housing supply, in which sense it's already a variable denoting the change. However, the number of building permits is only associated with the level of employment, but the change in building permits is associated with the change in employment, which is the dependent variable in my model. Hence, the number of building permits is also differenced.

Another important feature of the model is that I include the lagged dependent variable and two lags of the changes in the housing variables. Including the lagged dependent variables is to consider the partial adjustment mechanism in the labor market. It will also allow me to produce the long-run propensity of the housing market dynamics. The lags in housing variables allow for lagged response of the local labor market to housing market dynamics.

The finite distributed lag panel model is thus

$$\Delta E_{k,t} = \beta_0 + \rho \Delta E_{k,t-1} + \sum_{i=0}^{2} \beta_{P,i} \Delta H_{k,t-i}^{P} + \sum_{i=0}^{2} \beta_{S,i} \Delta H_{k,t-i}^{S} + \beta_t X_k + \tau_t + \mu_k + \epsilon_{k,t} \quad (1)$$

where $E_{k,t}$, $H_{k,t}^{P}$ and $H_{k,t}^{s}$ are employment, housing price and the number of building permits in commuting zone k in year t; Δ denotes the annual log change in one variable, for example $\Delta E_{k,t} = \log(E_{k,t}) - \log(E_{k,t-1})$. X_k is a vector of baseline demographic controls. τ_t is the time dummy, μ_k is the commuting zone fixed effect and $\epsilon_{k,t}$ is the zero-mean idiosyncratic error term.$\beta_{P,i}$ and $\beta_{S,i}$ are the two parameter vectors of the housing effects: the contemporaneous effects with their two lags, where the lags are included to capture the housing effects dynamics; ρ is the parameter of the lagged dependent variable; β_t is a vector of time-varying parameters of the baseline demographic controls.

The key of the model is the inclusion of commuting zone fixed effect μ_k. The fixed effect accounts for the unobserved heterogeneity across commuting zones which affects employment trends. It allows for the identification of $\beta_{P,i}$ and $\beta_{S,i}$ to come from changes in growth in the housing variables within a commuting zone. For the estimates of $\beta_{P,i}$ and $\beta_{S,i}$ to be causal, the crucial identification assumption is that the fixed effect captures all the time-invariant and unobserved commuting zone characteristics that are correlated with the housing market.

Admittedly, the fixed effects may not control for time-varying factors still left in the error term that are correlated with the housing market dynamics, which can bias the estimate. To better control for the cross-commuting zone differences, I include a vector of baseline demographic variables in the model, including the share of women employees, the share of black employees, the share of immigrant employees, the share of employees with a college degree, the share of population over 55 years old, and the homeownership rate. These control variables are measured as of time prior to the sample period, thus avoiding the “bad control” problem discussed by (Angrist and Pischke, 2008). And their function is to take the inherent differences of the commuting zones into account in order to make these geographic units comparable. Following Zabel (2014), I allow the coefficient vector on the time-invariant controls to vary by year.

However, the fixed effect approach jointly with the baseline demographic controls will not guarantee a causal estimate. Underlying the fixed effect method is that there may be latent confounding factors that are changing over time, so that part of them are still left in the error term. It's likely that unobservables in the error term which codetermine the changes in housing variables and in the local employment will cause endogeneity of the model. Several immediate reasons for endogeneity emerge. First, latent labor supply changes will confound the model, since the labor outcome is determined as the solution of simultaneous labor demand and supply equations. Second, the simple inverse causality logic will bias the estimate. That is, to argue that the increase in employment share will in turn boost housing prices and supply. Lastly, changes in housing variables might proxy for local labor demand shifts. Think of Boston, if the biochemistry industry hires lots of new employees after a positive technology shock, the increase in labor demand in Boston will push up the housing price when housing supply is fixed. Then, the positive relationship is driven by the technology shock, rather the housing spillover.

To better tackle the endogeneity problem, I use an Instrumental Variable (IV) framework. The idea is that the changes in housing variables are the outcomes of shifts of local housing supply and demand, which could be related with unobserved labor market changes. Therefore, by using the instrument I want to identify the exogenous part that is orthogonal to labor market dynamics. The instruments I use are the national mortgage interest rate, which captures exogenous housing demand shifts, and housing supply elasticity (Saiz, 2010), which extracts exogenous housing supply shifts. I interact the mortgage interest rate with the Saiz elasticity to let the impact of the interest rate vary by commuting zone, and interact the Saiz elasticity with the year dummies to make the cross sectional measure identified in the panel model. A similar identification approach is used by Chaney et al. (2012), and Mian and Sufi (2012), and Adelino et al. (2015). Since the Saiz instrument is time-invariant, I interact it with the year dummies. Now, the identification comes from both cross-sectional and within commuting zone changes.

Finally, estimating the panel model with the lagged dependent variable using the fixed effect estimator causes biased estimates. Therefore, I apply the General Method of Moments estimator (GMM) introduced by Arellano and Bond (1991) with the lagged dependent variable inclusion, and incorporate the IV method inside the GMM estimator.

5. Data

The empirical analysis is conducted at the commuting zone level. A commuting zone is comprised of several neighborhood counties which share a common labor market. Compared with the definition of Metropolitan Statistical Areas (MSA) which is often used in studying housing and labor market dynamics, commuting zones better approximate regional economy units, and include rural areas excluded in MSA compositions. Accordingly, the data collection strategy is that I first gather data at the county level, and then assemble commuting zone level statistics as the population weighted average of county level statistics. I use the commuting zone definition of Autor at al. (2013) provided at David Dorn's Data Page[1].

Table 1 summarizes the data sources of all variables used in the paper.

5.1 Labor Market Statistics

I obtain employment data from the County Business Patterns (CBP)[2]. CBP records county level employment by industry, which suits the purposes of my study. First, the industry disaggregated data allow me to study the housing effects on different sectors. I follow the construction, non-tradable and tradable sectors division criterion proposed by Mian and Sufi (2011) and build employment for each of the three sectors. Second, I compute the Bartik instrument, an exogenous measure of local labor demand shocks, with the CBP industrial level employment data and the BLS national industrial-level employment data following the method discussed by Zabel (2012). The construction of all the three kinds of variables above requires a transition from SIC codes to NAICS codes, as employment is organized by 4-digit SIC codes before 1997. To do so, I use 4-digit SIC and 6-digit NAICS concordance provided by the Bureau of Labor Statistics[3]. Moreover, I get personal income per capita data from the Bureau of Economic Analysis[4].

5.2 Housing Variables

There are two housing market variables included in the study: the housing price and building permits. I use the County Annual House Price Indexes produced by the Federal Housing Finance Agency[5]. The Indexes record the cumulative annual changes in housing

[1] http://www.ddorn.net/data.htm
2 https://www.census.gov/programs-surveys/cbp.html
3 https://www.bls.gov/ces/sic4tonaics.htm
4 https://www.bea.gov/iTable/index_regional.cfm
5 https://www.fhfa.gov/

price compared with the base year for each county, which allows me to keep track of the average house value appreciation by commuting zone over the sample period. For the building permits, I rely on the annual building permit units by county from the Building Permits Survey, U.S. Census Bureau[6].

5.3 Others

There are two important instruments used in the study: one is the housing supply elasticity, and the other one is the national mortgage interest rate. The housing supply elasticity is constructed by Saiz (2010) based on geographical and regulatory constraints for urban development. Hence, this measure is strongly correlated with housing price and supply changes, but exogenous to labor market dynamics. However, Saiz (2010) only estimate the housing supply elasticity for metropolitan areas, which causes a sharp decrease in the sample size of study if this instrument is to be used. The other instrument is the national mortgage interest rate, which I treat as an exogenous housing demand shifter. For this data, I use the 30-year national mortgage interest rate from the Federal Reserve Economic Database (FRED)[7], and I deflate the interest rate by national consumer price index inflation.

Finally, in order to account for the commuting zone heterogeneity in the regression, I also construct several baseline demographic control variables from the 1990 Decennial Census, including the share of college-degree employees, the share of female employees, the share of black employees, the share of immigrant employees, and the homeownership rate. These variables are exogenous in the model, since they are ahead of the sample period of study. And they are intended to capture the inherent differences of the labor markets that are not accounted by the fixed effect dummies.

Table 2 lists the summary statistics of all the variables in the study. Some variables are rescaled to make their statistics comparable with each other. The labor statistics variables are separated into two groups: Commuting Zone level statistics and population subgroups statistics. The Commuting Zone level statistics contain 741 Commuting Zones from 1991 to 2015, while subgroup statistics are only available from 2005 to 2015 for the same Commuting Zones. With missing records, the housing price index data only covers 684 commuting zones over the period, while permit units data covers 739 commuting zones.

6 https://www.census.gov/construction/bps/
7 https://fred.stlouisfed.org/

Because Saiz elasticity only covers metropolitan areas, this transforms to 251 commuting zones with an available elasticity measure[8].

The summary statistics reveal large variations in the sample data; indeed, my identification strategy exploits these large variations. The mean commuting zone employment is 148,000, and its standard deviation is about three times larger than the mean. The similar relationship of the standard deviation and mean applies to population and labor force. For the housing variables, the average annual growth rate of house price is 0.03, with a standard deviation of 0.05. The mean building permits growth rate is quite small, while its standard deviation is as 10 times as the growth rate of house price.

5.4 Graphical Evidences

Before showing the regression results, I present some graphical results to show the relationship between the two housing variables and employment. The graphs include national time series and cross-sectional plots in selected years.

Figure 1 and Figure 2 plot the national trend of the two housing variables and total employment from 1990 to 2017. The national data comes from the Federal Reserve Economic Database[9]. These two figures provide the time series evidence of the housing spillover effect. On first sight, the most salient feature of the two figures is that the two housing variables and total national employment go hand in hand. The 1990-1991 Recession and 2007-2009 Recession both came with declines in house price and quantity[10]. The correlation coefficient could give us a first impression of the closeness of the housing and employment series. The correlation between employment and home price index over the period is 0.90, and between employment and the number of building permits is 0.07. Although both are positive, the comparison indicates that the house price is much more closely related with employment that new housing starts.

Figure 3 plots the annual percent change of the home price index and building permits. It's very clear to compare the relative volatility of the two series in Figure 3, which is an important stylized fact in the housing market. The volatility of building permits is much larger than the home price index. At the national level, the standard deviation of the percent

[8] When calculating housing price elasticity for commuting zones, I assume that the counties inside one county based statistical area (CBSA, geographical unit used by Saiz (2010)) shares the same elasticity. Then I map the counties to Commuting Zones and compute the population weighted average.

[9] https://fred.stlouisfed.org/

[10] The exception here is the 2001 Recession with no significant response in the housing market. This is because the 2001 Recession was triggered by the bubble burst in the dot-com businesses.

changes in building permits is 17.5, more than three times than the standard deviation of the percent change in home price index at 5.7. I have shown that the commuting zone level data gives me even larger difference, around 10 times, in the quantity and price standard deviations. The house price is sticky downward. When demand in the local housing market softens, the volume of house sales and new housing starts adjusts as the house price changes sluggishly. This could also be illustrated by observing the two housing changes before and during the Great Recession in Figure 3. As we can see, before the great recession, new housing starts had started to decline in April 2006, while the home price continued to increase until March 2007, one year later than the negative adjustment in quantity. In addition, at the trough during the Great Recession, the annual building permits decline was 51.8 percent, but the maximum annual house price was only 12.7 percent. Even during the Great Recession, the house price doesn't respond as much as quantity.

Moving beyond the national time series evidence of the housing effects, I draw four cross-sectional scatter plots of commuting zone changes in employment against changes in house price and quantity in Figure 4 and 5. The four plots in each figure are in 1992, 2000, 2008 and 2015. Compared to the time series figures, these plots exploit the cross-sectional variation in the housing dynamics and their outcomes. As we can see, all the eight plots in Figure 4 and 5 support positive relationships between the changes in the housing variables and changes in employment. The four slope estimates in Figure 4 are 0.62, 0.15, 0.11 and 0.35; and the slope estimates in Figure 5 are 0.05, 0.02, 0.02 and 0.2. All these estimates are significantly positive at the 1% significance level. Once again, the price estimates are larger than the quantity estimates, suggesting that a one percentage point increase in the house price growth is associated with more changes in employment growth than the same increase in quantity growth.

In conclusion, I show in these figures that the house price and quantity are both positively correlated with employment. I also find that a unit change in price growth is correlated with a larger effect than quantity growth, but the price volatility is smaller than the quantity volatility. The comparisons leave me a puzzle to solve in the following section: which of the two housing variables is more economically significant to employment?

These figures only serve as a graphical impression of the housing spillover effects. And these results no doubt suffer from omitted variable bias. The national trends in the housing variables and employment could be driven by another national time series, such as manufacturing decline. And the commuting zones could be different in other ways, so the simple linear regression estimates are not reliable. I will address these problems below in my regressions and pursue the causal estimates.

6. Results

6.1 Commuting Zone Employment Estimates

I present the Commuting Zone employment estimates in Table 3. Column (1) lists the baseline specification of the Fixed Effect (FE) estimator, where I only include the year dummies and fixed effect dummies in the regression. The coefficient estimates on the housing variables are all significant at the 5% significance level from the contemporaneous change to the second lag. It reports that, on average, a 1 percentage point change in house price growth is associated with a 0.097 percentage point change in employment growth in the same year, and 0.107 percentage point change in total after two years, all else equal. Analogously, a 1 percentage point change in the building permits growth leads to a 0.009 percentage point change in employment growth in the same year, and a 0.03 percentage point change in total after two years. The short run Impact Multipliers after two years for both housing variables are larger than the contemporaneous estimates, indicating that it time for their effects to fully play out.

Column (2) shows the result after including the baseline demographic control variables; as a result, house price estimates change a lot. The contemporaneous estimate jumps from 0.097 to 0.170, and the first and second lag estimates are no longer significant. The results for the building permit estimates aren't significantly affected: although all the three estimates decrease by around 0.002, they still stay statistically significant at the 1% significance level. These changes mean that the house price growth is more closely correlated the inherent differences. Now, we can also see that the quantity effect is more persistent than the price effect.

Then, I add the Bartik Instrument in the regression and report the result in Column (3). The Bartik Instrument is an exogenous measure of local labor demand shock. It is constructed using the local industrial structure and national industrial employment changes. One could suspect that the quantity and price changes in the housing market are driven by shifts in labor demand, which contributes to employment changes. Therefore, I include the Bartik Instrument to control explicitly for local labor demand changes. If the suspicion holds true, I would expect to see no significant effect, or at least small effects, of the housing variables after including the Bartik Instrument. The results reported in Column (3) rule out this concern, as the estimates are still basically unchanged with Column (2). Similarly, I control for the natural logarithm of per capita income in Column (4). This is to test whether changes in income, rather than changes in home worth, drive the wealth effect and create jobs. The estimates still stay very similar to Column (2).

Using the results in Column (4), a 1 percentage point increase in house price growth contributes to 0.163 percentage point increase in employment growth in the same year, and 0.142 percentage point increase in total within two years, on average and ceteris paribus. Only the contemporaneous coefficient is significant at the 5% level of significance. The estimates translate to a standardized coefficient of 0.179 contemporaneously, and 0.156 within two years. The influence from building permits growth lasts longer than house price growth, with its estimates staying significant at the 5% significance level from the year of the change to two years later. On average, a 1 percentage point increase in building permits growth is associated with a 0.008 percentage point increase in employment growth in the same year, and a 0.024 percentage point increase in total within two years. Accordingly, the standardized coefficient is 0.077 in the same year, and 0.232 within two years. Although the impact multiplier of building permits growth is much smaller than house price growth, the high volatility, thus a higher standard deviation, of building permits growth gives it a larger standardized coefficient in the short run. Over the entire sample period, the quantity effect is more economically significant than the price effect.

Column (5) reports results with the lagged dependent variable being added in the regression with the GMM-FE estimator, which considers partial adjustment in the labor market. Under this specification, the contemporaneous price estimate stays basically. The contemporaneous quantity estimate and its first lag increase, while the second lag is no longer significant. The coefficient of lagged dependent variable is 0.161 and significant at the 5% significance level, which means the long-run price and quantity effects will be slightly larger than the short run effects.

6.2 Robustness Check

The fixed effect estimator with the controls won't guarantee causality. The regression may still suffer from omitted variable bias, reverse causality and simultaneity problems. Column (8) and (9) present the FE-IV and GMM-FE-IV estimator results. The numbers of observations for the two columns is smaller as the Saiz elasticity is only available in metropolitan areas. Therefore, to make these results comparable with the FE and GMM-FE estimates, Column (6) and Column (7) apply the FE and GMM-FE estimators again on the same sample as that of Column (8) and (9). Restricting the sample doesn't change the estimates much.

Before I introduce the IV estimates, Table 4 lists the first stage estimates for changes in house price and building permits. For the impact of mortgage interest rate to vary by commuting zone, I interact the series with the Saiz elasticity. I also interact the Saiz elasticity with the year dummies for them to be identified in the FE estimator. I perform a F-test on the joint significance of the instruments. Both first stage regressions pass the weak instrument test at the 1% significance level. The coefficient estimate of the interaction of mortgage interest rate is positive for changes in house price. When the interest rate drops, it's costless for home buyers to finance their home purchases, which puts upward pressure on housing demand. Then, a supply elastic region, where new houses can be built more easily, will see smaller price increase than a supply inelastic region. The estimates for the interaction terms (not shown in the table) are mostly negative for changes in house price. For house price estimates, if a positive housing demand shock happens in a commuting zone with elastic housing supply, that is, the elasticity is large, then the local market will respond with a larger increase in building starts and smaller increase in house prices. For building permits estimates and following the same logic, the coefficients should be negative for the interactions between the interest rate and Saiz elasticity, and between Saiz elasticity and year dummies. But my results are positive for all the interactions. The reason is that I am using the changes of building permits instead of its level here as the dependent variable. If I do regress the number of building permits on the same regressors, these coefficients are indeed positive. It may be that areas where supply is elastic have more stable amount of new buildings each year, so the quantity growth responds less to demand shocks.

In Column (8), the price effect decreases from 0.177 of the GMM-FE estimator to 0.071. The quantity effect now is only significant at the current period with a larger coefficient estimate. The p-values for both the price and quantity coefficients increase, since the FE-IV estimator leads to larger standard errors. The GMM-FE-IV estimator is more efficient than the FE-IV estimator, since identification uses both external information, the instruments, and internal information, the lags of the lagged dependent variables. The results in Column (9) is very similar to Column (7).

6.3 Decomposing the Wealth Channel and the Collateral Borrowing Channel

The price effect takes place at least through the direct wealth channel and the collateral borrowing channel. To distinguish these two channels, I control for the growth rate of total commuting zone home refinancing to mute the collateral borrowing channel. Keeping the growth rate of refinancing fixed, the price growth estimate will become the total price effect net of the collateral borrowing effect, which is close to the direct wealth effect.

The commuting zone home refinancing figures come from the 1991-2016 Flat Files of the Home Mortgage Disclosure Act (HMDA) released by the Federal Financial Institutions Examination Council's (FFIEC) [11]. It provides public mortgage loan data by each record with detailed information on loan amount, loan purpose, action taken and applicant demographic information among others. I only keep the approved refinancing loan records in the Flat Files and aggregate the total loan amount by commuting zone. One limitation of the HMDA data is that it doesn't cover the universe of mortgage records. Only institutions which meets the criterion in its size, the extent of its business in an MSA, and whether it is in the business of residential mortgage lending are required to report. In spite of the limitation, the aggregate refinancing based on "large" institutions records is a good proxy of the collateral borrowing amount in a commuting zone.

I add the growth rate of refinancing as a control in equation (1) and list the FE-IV and GMM-FE-IV estimator results in Table 5. For comparison, I include the results without the refinancing control in Column (1) and (3), and results with the refinancing control in Column (2) and (4). The price estimates under both estimators significantly decrease by around half with the inclusion of refinancing growth, and they are no longer significant at 5%. The rise in the house price growth rate does not significantly contribute to local employment growth, holding the refinancing growth and other regressors constant, which amounts to no significant wealth effect. Meanwhile, the estimates for the quantity increase moderately with the inclusion. These results imply that the price effect works primarily through the credit expansion after home value appreciation; and there is no evidence that the direct wealth effect significantly increases local employment.

The direct wealth effect from an increase in house price is limited to local employment. It could be explained from several aspects. First, across different sources of household assets, the effect of capital gains in housing is substantially lower than corporate equity gains due

[11] https://www.ffiec.gov/hmda/

to varying perception of asset liquidity (Juster et al., 2006). Second, to different homeowners, the rise in house prices could be seen as a mixed signal. While elder homeowners may enjoy the equity appreciation and expand their consumption, younger homeowners are likely to view this as a higher cost for their house upgrade in the future (Compell and Cocco, 2007). The last but not the least, the local population is comprised of both homeowners and renters. Higher house prices mean higher rent for renters, which will depress their consumption budget outside the housing cost. In a word, the direct wealth effect is both limited in its size, and heterogeneous among homeowners, even negative for renters; thus, its aggregate impact on local employment is not significant.

6.4 Sectoral Employment Estimates

After presenting the total employment impact, I separately estimate the housing impact on sectoral employment, which are the construction sector, the non-tradable sector and the tradable sector. The purpose is to find the industrial paths of the housing effects. The estimates by the FE-IV and GMM-FE-IV estimators are shown in Table 6.

In general, I find that the price changes only affect the construction sector and the non-tradable sector, while the quantity changes affect all the three sectors. This shows that the quantity effect is wider than the price effect in terms of affected sectors. Similar with total employment, the point estimates for the price effect is larger than the corresponding quantity effect estimates except for the tradable sector. But as the standard deviation of the price growth rate is only one tenth of the quantity growth rate, the quantity effect is still more economically significant in all three sectors. The lagged effects are only significant for the construction industry with the GMM-FE-IV estimator– all other sectoral effects are only significant in the current period. Finally, the lagged dependent variable estimates in the GMM-FE-IV estimator are all between -0.2 and 0.2, implying that the long-run effects are not much different from the short-run effects.

The price effect is insignificant for the tradable sector, which is consistent with Mian and Sufi (2012). However, my estimates show that the quantity effect is significantly positive in the tradable sector with the GMM-FE-IV estimator[12], even larger than the effect in the non-tradable sector. It could be possibly explained from two perspectives. First, although most manufactured goods produced by the tradable sector are affected by national demand rather than regional demand, the rise in new housing starts increases local sales in

[12] The FE-IV estimate of the quantity effect on tradable employment is also large, although not statistically significant at the 10% level of significance.

construction materials and machinery. Second, more housing starts may go hand in hand with manufacturing business expansion. More industry house supply, which is part of the quantity changes, could supply more spaces for the non-tradable sector, increase its output and thus create more employment.

6.5 The Reverse Effect

The housing market and local labor market move simultaneously. The changes in house price and quantity influence local employment changes; and reversely, local employment changes also affect house price and quantity. Keeping all else equal, more employment locally increases housing demand, which pushes up both house price and building starts. The responses of the house price and quantity following the demand shock partly depend on the housing supply elasticity. Suppose commuting zone A and B encounter the same amount of positive housing demand shock, if the housing market in commuting zone A is more elastic than B, then commuting zone A is more capable of providing new housing to satisfy the demand shock than B. It follows that commuting zone A will experience more building and less increase in house price starts than B. As a result, the labor market will also react differently as the housing market is heterogeneous. Glaeser et al. (2006) shows that high construction regulation brings not only higher house prices and wages but also lower population growth. Saks (2008) and Zabel (2012) further develop this idea. These two papers both find that supply constraint areas experience higher house price growth, wage, lower employment growth, population growth and in-migration in response to employment shocks.

Table 7 formally estimates the impact of employment changes on two housing changes. I regress log changes in house price and building permits on the log changes in local employment, and include year dummies, fixed effect dummies and demographic controls in Column (1) and (3). Column (2) and (4) adds the interaction between employment changes with housing supply elasticity to factor in the housing market heterogeneity. The signs of the estimates are as expected: the changes in employment have positive effects on both changes in house prices and in building permits. In addition, the interaction estimate is negative in Column (2) and positive in Column (4), which means that the house price grows less and building permits grow more in a more elastic commuting zone in response to a positive employment shock.

7. Case study: Job loss in 2007-2008

This section presents an aggregate analysis on the impact of the price and quantity effects during the Great Recession. The primary focus of this analysis is to test whether the housing starts decline has a greater effect on aggregate employment than the house price decline, although we already know that the quantity decline is much larger. I restrict my attention to the period between December 2007 to December 2008. Although the Great Recession was officially over in June 2009, my estimate is based on annual data and therefore cannot capture exactly the effect during the half-year end of the recession. The housing market did start to rebound around the end of 2008, especially in terms of new building starts; thus, the housing effect would turn positive after 2008, which would decrease the job loss estimate during the housing bust. Therefore, I study only the first year of the Great Recession that was accompanied by a severe housing collapse.

The data for this aggregate analysis are from the Federal Reserve Economic Data[13]. I use the monthly S&P/Case-Shiller U.S. National Home Price Index for house price measurement, and the monthly New Private Housing Units Authorized by Building Permits for the number of housing starts. The employment figure is the All Employees: Total Nonfarm Payrolls series. Since I am carrying out the analysis for December 2007 to December 2008, I only keep these statistics in December in any year.

Let $\Delta H_t^{P,g}$ and $\Delta H_t^{S,g}$ be the changes in the annual growth rate of house price and building permits from year $t-1$ to t.

$$\Delta H_t^{k,g} = \Delta H_t^k - \Delta H_{t-1}^k = (\log(H_{t-1}^k) - \log(H_{t-1}^k)) - (\log(H_{t-1}^k) - \log(H_{t-2}^k)), k\epsilon\{P,S\} \quad (2)$$

Then, the estimated effects of these changes on the changes in the annual growth rate of employment, denoted as $\Delta\hat{E}_{2008}^{P,g}$ and $\Delta\hat{E}_{2008}^{S,g}$ are expressed as:

$$\Delta\hat{E}_{2008}^{k,g} = \hat{\beta}_{k,0}\Delta H_{2008}^{k,g} + \hat{\beta}_{k,1}\Delta H_{2007}^{k,g} + \hat{\beta}_{k,2}\Delta H_{2006}^{k,g}, k\epsilon\{P,S\}, \quad (3)$$

where $\hat{\beta}_0^k$ is the estimated contemporaneous impact of price or quantity changes; $\hat{\beta}_1^k$ and $\hat{\beta}_2^k$ are the first and second lag estimates. Therefore, the shares of the price and quantity effects in the total decline in employment growth are:

[13] https://fred.stlouisfed.org/

$$\Delta\hat{S}^{k,g}_{2008} = \Delta\hat{E}^{k,g}_{2008}/\Delta E^{g}_{2008},\ k\epsilon\{P,S\}, \tag{4}$$

where $\Delta E^{k,g}_{2008}$ is the actual drop in employment growth during the period: $\Delta E^{g}_{t} = \Delta E_t - \Delta E_{t-1}$.

Table 8 shows the result. The analysis uses the coefficient estimates of the GMM-FE-IV estimator of the local employment estimates (Column (9) in Table 3), which is the most complete specification in this paper[14]. I compute the change in the growth rate for the housing variables in Column (2) and national employment in Column (4) during December 2007 to December 2008. For the changes in building permits, I also include its first lag, since the coefficient on the first lag is still positively significant. Column (3) is the figure in Column (2) multiplied by the corresponding coefficient estimate. For example, a 7.2% decline in the house price growth rate contributes to a decrease of 0.072×0.159=0.0114 in the employment growth rate. Column (5) records the share of the price effect and the quantity effect in the total decrease in the employment growth rate in the period. For the quantity effect, it's the sum of the contemporaneous effect and the first lagged effect, divided by the total decrease in the employment growth rate.

The result in Table 8 shows a different picture from the relative economic significance over the longer period. The price effect contributes to 33.5% of the decline in employment growth during the period, while the quantity effect only contributes 12.4%, around one third of the price effect contribution. Although the standardized coefficient figures in Section 6 indicate that the quantity effect is more economically significant than the price effect, here in the case of the Great Recession, the inequality turns to a different direction.

8. Conclusion

I build a dynamic econometric model using panel data in terms of growth rates to investigate the spillover effect of the housing market on the labor market. In particular, I include both the changes in housing price and in building permits to separate the price channel and the quantity channel. The analysis uses a panel data of over 600 commuting zones from 1991 to 2015, which contains large housing market variation both within and across commuting zones. Using different specifications, I find that increases in both

[14] Only the contemporaneous price and quantity and first-lag quantity estimates are significant. Therefore, I only include 2007-2008 price change, 2006-2007 and 2007-2008 quantity changes in Table 8.

housing price growth and building permits growth have significantly positive effects on commuting zone employment growth.

The impact of a 1 percentage point increase in the house price growth rate is much larger than the building permits growth rate. However, since the standard deviation of the house price growth is only one tenth of the building permit growth, the standardized coefficient of the price effect is only about half of the quantity effect. Over the entire sample period, I conclude that the quantity effect is more economically significant than the price effect.

Another feature of the housing effects is the dynamics. The full impact of price and quantity changes may take more than one year to play out. To allow for the lagged housing effects, I add the lagged variables to the model. The results in most specifications show that the quantity effect lasts more than one year. The estimate of the first lag is also very close to the contemporaneous estimate, and significant at traditional significance levels. I don't find such lagged feature for the price effect.

I exploit the refinancing data to uncover the mechanism of the price effect, which operates through the wealth channel and the collateral borrowing channel. If a strong wealth effect on the labor market exists, then the price estimate should stay significant when I mute the collateral borrowing channel. Likewise, if the collateral borrowing channel is nonsignificant, then adding the refinancing growth won't make much change to the estimates. As a result, when refinancing growth is added in the model, the price estimate is no longer significant. The result indicates that the collateral borrowing channel is the major price effect mechanism, while the impact from the wealth channel on local employment is not significant.

I also estimate the housing effects on construction, non-tradable and tradable sectoral employment. I find that the house quantity growth affects all the three sectors, whereas the house price growth only affects the construction and non-tradable sector. The sectoral estimates show that the quantity effect is more widespread than the price effect.

Finally, I apply the estimation results to the Great Recession from Dec 2007 to Dec 2008 to assess the housing effects on total national employment. This analysis joins the discussion of Leamer (2007) and Quigley and Case (2008) on comparing the relative importance of housing starts and the price decline to collapse in the real economy. My results are different than their conclusion. Although the house price is sticky downward and doesn't drop as much as new building permits, it explains a larger proportion of the decline in employment growth. This is because a 1 percentage point decrease in house price growth is much more destructive than a 1 percentage point decrease in building permits growth. The house price and quantity effects together account for 45% of the drop in employment growth over the period. Therefore, while new building starts was a good predictor for the Great Recession, the house price was a more influential trigger.

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Appendix

Table 1. Data Sources

Data	Years	Source
Employment by industry	1990-2015	County Business Patterns
Personal Income Per Capita	1990-2015	Bureau of Economic Analysis
Housing Price Index	1990-2015	Federal Housing Finance Agency
Building Permits	1990-2015	Building Permits Survey
Baseline Controls	1990	1990 Decennial Census, IPUMS
Consumer Price Index	1990-2015	Bureau of Labor Statistics
National Mortgage Interest Rate	1990-2015	Federal Reserve Economic Data
Housing Supply Elasticity	/	Saiz (2010)

Table 2. Summary Statistics

VARIABLES	N	Mean	Std	Max	Min
Labor Market Statistics					
Employment (× 100,000)	18,523	1.48	4.35	68.37	0.00
Personal Income Per Capita (× 10,000)	18,443	2.52	0.61	10.48	0.95
Housing Variables					
House Price Growth Rate	16,218	0.03	0.05	0.57	-0.34
Building Permits Growth Rate	16,921	-0.00	0.51	4.57	-4.38
Exogenous Variables					
Saiz Housing Supply Elasticity	6,275	2.94	1.72	11.25	0.72
30-year Mortgage Interest Rate	18,525	6.35	1.57	9.25	3.66
Bartik Insturment	18,523	0.04	0.09	0.62	-0.33
Baseline Demographic Controls (1990)					
Share of College-degree Employees	17,075	0.21	0.06	0.53	0.09
Share of Female Employees	17,075	0.45	0.02	0.50	0.37
Share of Black Employees	17,075	0.06	0.09	0.56	0.00
Share of Immigrant Employees	17,075	0.04	0.05	0.67	0.00
Homeowner Rate	17,075	0.66	0.08	0.82	0.29
Share of Age over 55 in the Population	17,075	0.21	0.04	0.08	0.32

Table 3. Commuting Zone Employment Estimates

Log Changes in	Employment								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Estimator	FE	FE	FE	FE	GMM-FE	FE	GMM-FE	FE-IV	GMM-FE-IV
Lagged Dependent Variable					0.161**		0.155***		0.166***
					(0.072)		(0.058)		(0.057)
Log Changes in House Price									
Contemporaneous	0.097***	0.170***	0.169***	0.163***	0.161***	0.164***	0.177***	0.071**	0.159***
	(0.018)	(0.023)	(0.022)	(0.024)	(0.053)	(0.034)	(0.054)	(0.034)	(0.050)
First Lag	0.038***	0.015	0.015	0.013	-0.009	0.005	-0.031		-0.031
	(0.014)	(0.022)	(0.023)	(0.022)	(0.060)	(0.033)	(0.063)		(0.059)
Second Lag	-0.028**	-0.021	-0.022	-0.034	0.024	-0.031	0.025		0.015
	(0.012)	(0.020)	(0.020)	(0.022)	(0.047)	(0.029)	(0.051)		(0.047)
Log Changes in Building Permits									
Contemporaneous	0.009***	0.008***	0.008***	0.008***	0.014***	0.010***	0.012**	0.033*	0.013***
	(0.002)	(0.001)	(0.001)	(0.002)	(0.005)	(0.002)	(0.005)	(0.017)	(0.005)
First Lag	0.014***	0.011***	0.011***	0.011***	0.010**	0.013***	0.009*		0.009*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.005)	(0.003)	(0.005)		(0.005)
Second Lag	0.007***	0.005***	0.005***	0.005***	0.004	0.005***	0.002		0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)	(0.002)	(0.004)		(0.004)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effect Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic Controls		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bartik Instrument			Yes	Yes	Yes	Yes	Yes	Yes	Yes
Per Capita Income				Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,085	13,107	13,107	13,107	13,107	5,289	5,289	5,771	5,289
Number of czone	678	632	632	632	632	241	241	241	241

Note: Robust standard errors in parentheses, clustered in commuting zones. The columns in the table applies Fixed Effect (FE, Column (1)-(4) and (6)), Generalized Method of Moments with Fixed Effects (GMM-FE, Column (5) and (7)), Fixed Effect with Instrumental Variables (FE-IV, Column (8)) and Generalized Method of Moments with Fixed Effects and Instrumental Variables (GMM-FE-IV, Column (9)) to estimate equation (1). All regressions are weighted by commuting zone population to correct for heteroskedasticity. Column (2) adds to Column (1) the demographic controls interacted with year dummies. Column (3) controls for the Bartik Instrument which is constructed following Zabel (2012). Column (4) further controls the per capita income. Column (6)-(7) restrict the sample to commuting zones with available housing supply elasticity figures in order to compare with Column (8)-(9). The FE-IV estimates are using the optimal lag structure; that is, adding more lags will give insignificant estimates. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 4. First Stage Estimates

	(1)	(2)
Log Changes in	House Price	Building Permits
Mortgage interest rate× Saiz elasticity	0.009***	0.047**
	(0.002)	(0.022)
Saiz elasticity×Year dummies	Yes	Yes
Weak Instrument Test (p-value)	0.00	0.00
Year Dummies	Yes	Yes
Fixed Effect Dummies	Yes	Yes
Observations	6,007	5,787
R-squared	0.639	0.503
Number of czone	241	242

Note: Robust standard errors in parentheses, clustered in commuting zones. The table lists the first stage estimates of the IV estimators. All regressions are weighted by commuting zone population to correct for heteroskedasticity. The weak instrument test is performed by testing the joint significance of the instrument estimates using an F test; p-value is provided in the table. *** p<0.01, ** p<0.05, * p<0.1.

Table 5. Decomposing the Wealth Channel and the Collateral Borrowing Channel

Log changes in	Employment			
	(1)	(2)	(3)	(4)
	FE-IV	FE-IV	GMM-FE-IV	GMM-FE-IV
Lagged Dependent Variable			0.166***	0.271*
			(0.057)	(0.156)
Log Changes in House Price				
Contemporaneous	0.071**	0.044	0.159***	0.097
	(0.034)	(0.037)	(0.050)	(0.079)
First Lag			-0.031	0.032
			(0.059)	(0.107)
Second Lag			0.015	-0.013
			-0.031	0.032
Log Changes in Building Permits				
Contemporaneous	0.033*	0.040**	0.013***	0.021**
	(0.017)	(0.018)	(0.005)	(0.010)
First Lag			0.009*	0.022
			(0.005)	(0.014)
Second Lag			0.002	-0.008
			(0.004)	(0.012)
Log Changes in Total Refinancing		0.006**		0.003
		(0.003)		(0.004)
Year Dummies	Yes	Yes	Yes	Yes
Fixed Effect Dummies	Yes	Yes	Yes	Yes
Demographic Controls	Yes	Yes	Yes	Yes
Bartik Instrument	Yes	Yes	Yes	Yes
Per Capita Income	Yes	Yes	Yes	Yes
Observations	5,771	5,171	5,289	4,739
Number of czone	241	216	241	216

Note: Robust standard errors in parentheses, clustered in commuting zones. Only FE-IV and GMM-FE-IV estimators are applied in this table. All regressions are weighted by commuting zone population to correct for heteroskedasticity. Column (2) and (4) add the log changes in total commuting zone refinancing volume to Column (1) and (3). The FE-IV estimates are using the optimal lag structure; that is, adding more lags will give insignificant estimates. *** p<0.01, ** p<0.05, * p<0.1.

Table 6. Sectoral Employment Estimates

Log changes in	Construction Employment		Non-tradable Employment		Tradable Employment	
	(1)	(2)	(3)	(4)	(5)	(6)
	FE-IV	GMM-IV	FE-IV	GMM-IV	FE-IV	GMM-IV
Lagged Dependent Variable		0.141***		0.025		-0.165
		(0.053)		(0.046)		(0.101)
Log Changes in House Price						
Contemporaneous	0.406***	0.324***	0.076*	0.201***	-0.045	-0.083
	(0.076)	(0.069)	(0.044)	(0.065)	(0.089)	(0.162)
First Lag		0.083		-0.042		0.106
		(0.087)		(0.082)		(0.244)
Second Lag		-0.104		0.067		-0.065
		(0.070)		(0.069)		(0.156)
Log Changes in Building Permits						
Contemporaneous	0.126***	0.043***	0.048**	0.015**	0.050	0.054**
	(0.045)	(0.015)	(0.022)	(0.007)	(0.042)	(0.025)
First Lag		0.051***		-0.000		-0.012
		(0.016)		(0.009)		(0.028)
Second Lag		0.031*		0.001		0.031
		(0.017)		(0.008)		(0.029)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effect Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Demographic Controls	Yes	Yes	Yes	Yes	Yes	Yes
Bartik Instrument	Yes	Yes	Yes	Yes	Yes	Yes
Per Capita Income	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,289	5,289	5,289	5,289	5,289	5,289
Number of czone	241	241	241	241	241	241

Note: Robust standard errors in parentheses, clustered in commuting zones. The table estimate equation (1) while substituting the dependent variable using log changes in sectoral employment. All regressions are weighted by commuting zone population to correct for heteroskedasticity. The FE-IV estimates are using the optimal lag structure; that is, adding more lags will give insignificant estimates. *** p<0.01, ** p<0.05, * p<0.1.

Table 7. The Impact of Employment Change on Housing Changes

	(1)	(2)	(3)	(4)
Log changes in	House Price		Building Permits	
Log changes in employment	0.420***	0.597***	0.969***	0.958**
	(0.057)	(0.161)	(0.173)	(0.383)
Log changes in employment ×		-0.069*		0.062
Housing supply elasticity		(0.040)		(0.114)
Year Dummies	Yes	Yes	Yes	Yes
Fixed Effect Dummies	Yes	Yes	Yes	Yes
Demographic Controls	Yes	Yes	Yes	Yes
Observations	14,613	5,771	15,621	5,787
R-squared	0.727	0.756	0.402	0.540
Number of czone	638	241	678	242

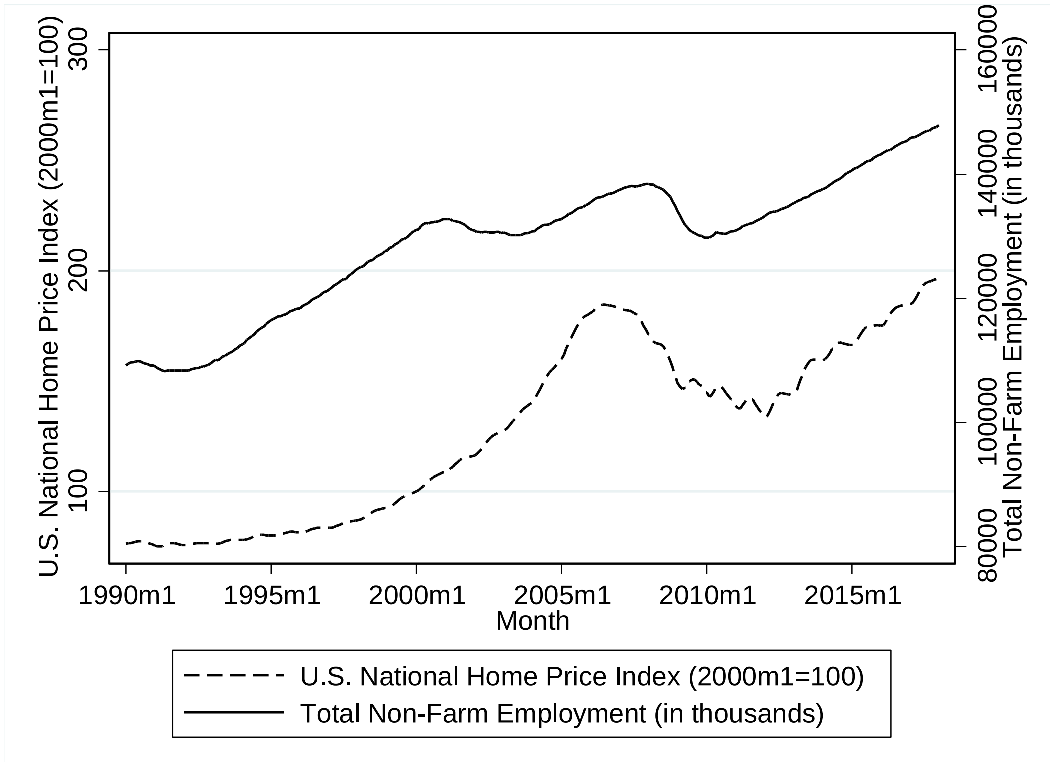
Note: Robust standard errors in parentheses, clustered in commuting zones. All regressions are weighted by commuting zone population to correct for heteroskedasticity. *** p<0.01, ** p<0.05, * p<0.1.

Table 8. Aggregate Analysis in December 2007- December 2008

Variable	Percent Changes in the Growth Rate	Impact on the Percent Change in National Employment Growth Rate	Percent Change in the National Employment Growth Rate	Contribution on the Change in the National Employment Growth Rate
(1)	(2)	(3)	(4)	(5)
House Price Growth	-7.2	-1.14		33.5%
Building Permits Growth	-25.7	-0.33	-3.4	12.4%
Building Permits Growth (First Lag)	-9.1	-0.08		

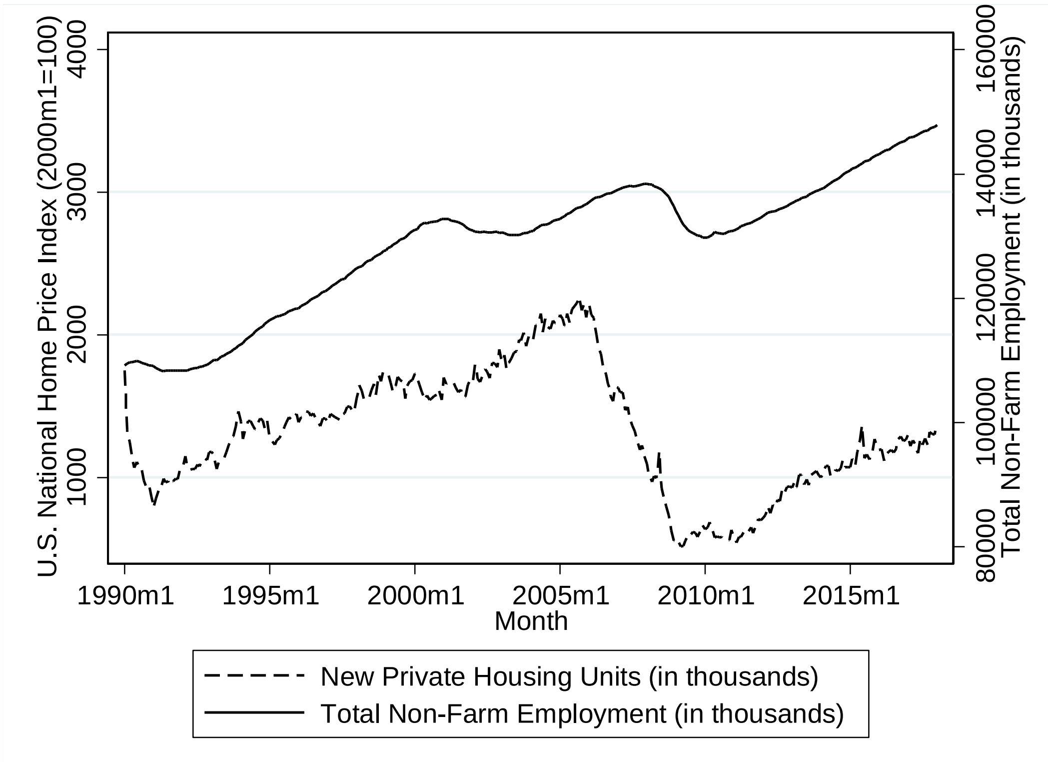
Note: This table applies the regression results of Column (9) in Table 3 to conduct an aggregate analysis on the Great Recession. I focus on the period between December 2007 and December 2008. Column (2) lists the percent changes in the growth rate of national house price and building permits; Column (4) is the percent change in the national employment growth rate. The national figures are from the Federal Reserve Economic Database (FRED). The changes in growth rate are expressed as $\Delta X_{2008}^{growth} = (log(X_{2008}) - log(X_{2007})) - (log(X_{2007}) - log(X_{2006}))$, where $X \in \{H^P, H^S, E\}$. Column (3) shows the product of Column (2) and the corresponding coefficient of Column (9) in Table (3). I only include the contemporaneous house price growth change, and the building permits growth change to its first lag since only their estimates are significant in Column (9) in Table 3. Column (5) is Column (3) divided by (4), where I add the current quantity effect and its lag to calculate the contribution of the total quantity effect.

Figure 1. National Home Price Index and Total Employment: Time Series Evidence (1990-2017)



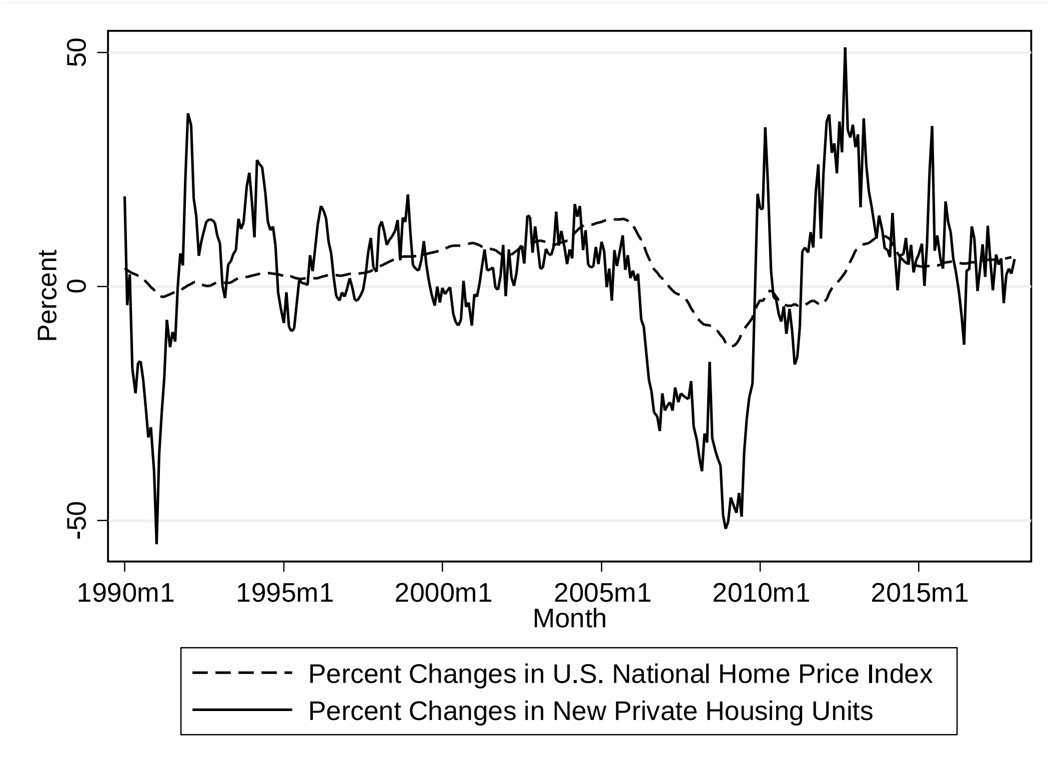
Notes: The series for the figure are from the Federal Reserve Economic Database (FRED).

Figure 2. National Building Permits and Total Employment: Time Series Evidence (1990-2017)



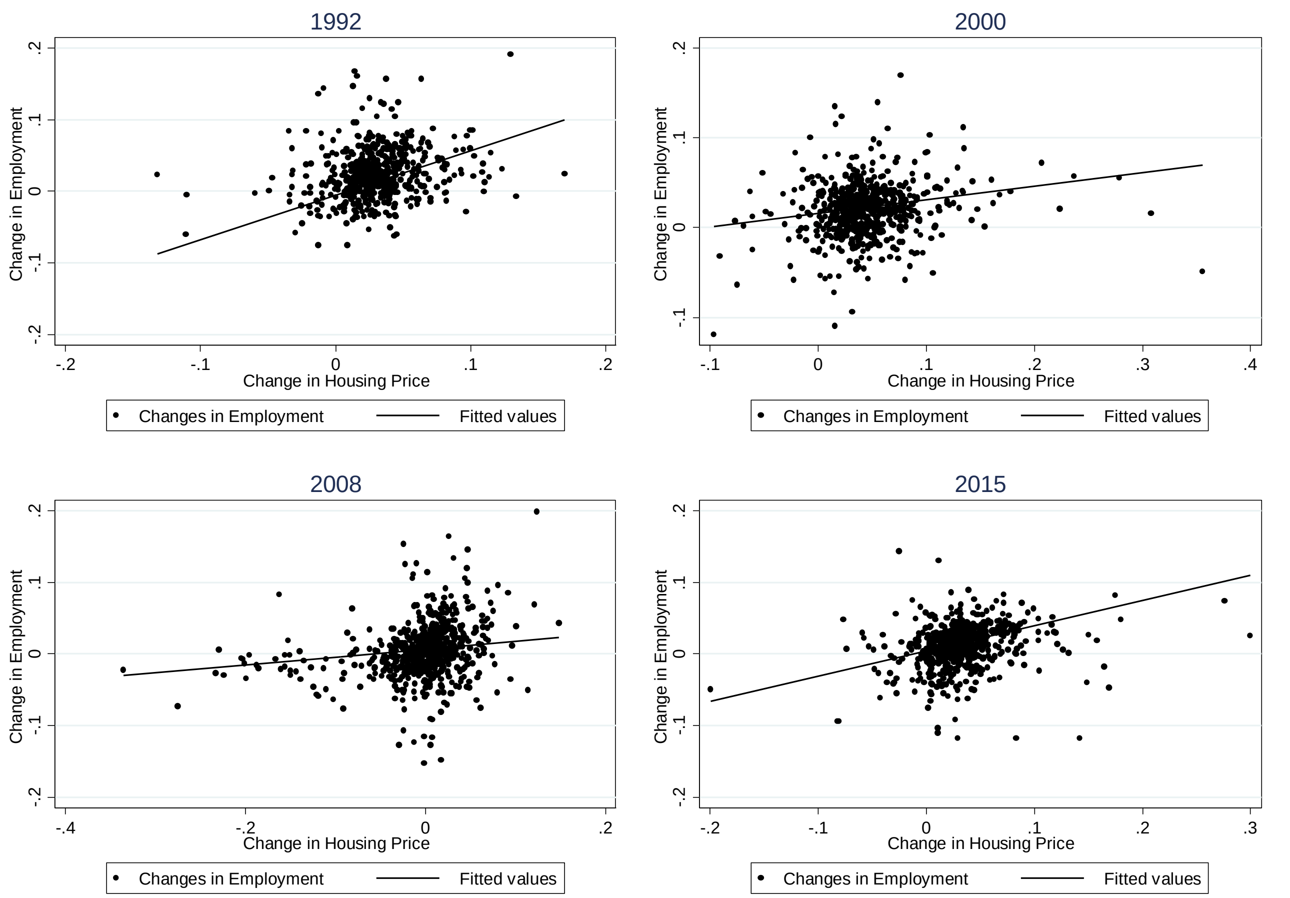
Notes: The series for the figure are from the Federal Reserve Economic Database (FRED).

Figure 3. Annual Changes of National Home Price Index and Building Permits (1990-2017)



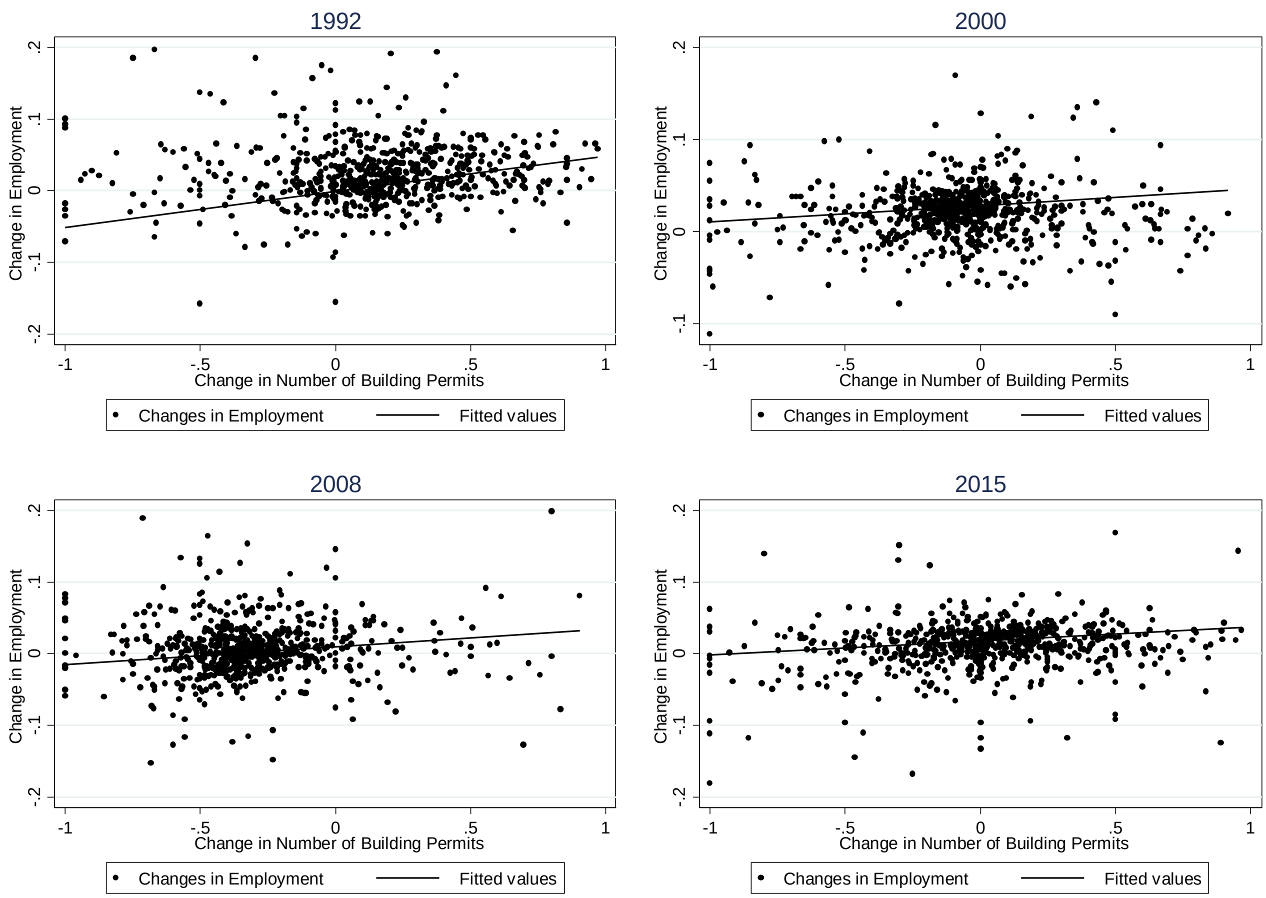
Notes: The series for the figure are from the Federal Reserve Economic Database (FRED).

Figure 4. Commuting Zone Home Price Index and Employment Changes: Cross Sectional Evidence



Notes: The house price data is from the Federal Housing Finance Agency; the employment data is from the County Business Pattern.

Figure 5. Commuting Zone Building Permits and Employment Changes: Cross Sectional Evidence



Notes: The building permit data is from the Building Permit Survey, U.S. Census Bureau; the employment data is from the County Business Pattern.