# The Effects of Local Risk on Homeownership[*]

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*Abstract*

Housing is a local good and local risk could affect housing decisions. We develops a household intertemporal choice model to illustrate how local income risks affect household tenure choice and housing price through financial investment effect and consumption hedging effect. We decompose income dynamics into three components: idiosyncratic growth (local alpha), systematic risk (local beta) and idiosyncratic risk (local sigma). Using the Current Population Survey 1999-2014, we find that households have stronger incentives to purchase housing asset in a region with higher systematic risk and lower idiosyncratic risk, due to consumption hedging effect and financial investment effect respectively. Effects are stronger in the areas with low housing supply elasticity. Price-to-rent ratios also increases with local alpha and local beta, and decreases with local sigma.

*Keywords*: Local Risk; Financial Investment Effect; Consumption Hedging Effect; Housing Market; Tenure Choice

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# 1 Introduction

Purchasing a home is one of the most important decisions for a household. On one hand, housing is considered as an investment good and accounts for a significant fraction of household wealth.[1] On the other hand, it is also considered as a consumption good and accounts for the largest consumer expenditure in total consumption.[2] Different consumers chooses housing with different characteristics and locations. Given the dual role of housing asset, local risks could affect tenure choice through two distinct channels. The first is financial investment effect (Flavin and Yamashita, 2002; Cocco, 2004). An asset with higher expected return and lower risk is more desirable for purchase. The second channel is consumption hedging effect. Homeownership gives household the ability to use an early purchase to hedge against future uncertain housing cost (Sinai and Souleles, 2005; Ortalo-Magne and Rady, 2006; Han, 2010).

Local risk could affect housing tenure choice in the opposite directions through these two effects and empirical literature finds mixed results. Studies have shown that higher risk weakens investment motive and discourages homeownership (Henderson and Ioannides, 1983; Fu, 1991; 1995). Other studies find that households are more likely to hedge housing consumption risk by purchasing a house in a highly fluctuating local market (Sinai and Souleles, 2005; Ortalo-Magne and Rady, 2006; Han, 2010).

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[1] It accounts about one quarter of the aggregate household wealth (Bertaut and Starr-McCluer, 2002) and two thirds for median household wealth (Tracy and Schneider, 2001) in U.S.

[2] In 2014 personal housing consumption expenditures were about 1.8 trillion dollars, and accounts for 15.3% of household budgets in US based on NIPA table.

Unlike most other consumption goods, housing is immobile thus mainly consumed by local residents. As a result, housing tenure decision and housing dynamics is closely tied to local economy, including local economic growth and local risk which varies across areas due to different economic conditions and demographic factors.

We construct measures of local risk to capture the fluctuations in local economy. We mainly use income dynamics to capture local risk and decompose it into three components: local alpha, the idiosyncratic component of income growth, local beta, which measures the systematic risk of one region relative to the aggregate shock, and local sigma, the idiosyncratic income volatility in an area.

Using a simple household intertermporal choice model, we illustrate that a household is more likely to own a home in an area with higher local alpha, since it implies the local market has higher growth in the future, and more likely to own in an area with higher systematic risk (local beta) due to consumption hedging effect, as such risk is undiversifiable but can be hedged by purchasing a house early. On the contrary, a household is less likely to own in an area with higher idiosyncratic risk (local sigma) due to financial investment effect, when household compares risk in housing asset with other assets in the market.

To test our hypothesis, we regress the income growth of each county on national income growth in a 30-year rolling window to obtain the intercept, coefficient and residual standard errors and name them as local alpha, local beta, and local sigma, respectively. We first confirm that the idiosyncratic growth of local income (local alpha) is highly related to regional housing price growth; and housing price is more procyclical in a region with higher local beta and more fluctuant in a region with higher local sigma. We then incorporated our estimated local risk measures with the Current Population Survey (CPS) and find that local risk measures are significantly correlated with household tenure choices. After controlling for various household characteristics, we find that households living in a county with higher local alpha and higher local beta are more likely to own a home, while households living in a lower local sigma county has a lower probability of owning a home. Housing price to rent ratio also positively correlated with local alpha and beta, while negatively correlated with local sigma. Local risk factors explain about 20% of the variation in housing price to rent ratio.

Our results are robust under different model specifications (Probit or OLS), and are robust using either county-level analysis or MSA level analysis. We also find similar results when we use alternative data, the American Community Survey (ACS). In additional, we find that the relation between local risk factors and tenure choice is stronger in a housing market with tighter land supply constraint where housing price is more sensitive to demand shock.

Our paper is related to a growing stream of the literature that examines the consumption motive and investment motive on housing tenure choice. Henderson and Ioannides (1983) and Fu (1991) illustrate that tenure choice depends on both investment and consumption motives, and household purchases self-occupied home only when housing investment motive exceeds housing consumption motive. Thus, the gap between investment motive and consumption motive can be used to predict the homeownership of household in empirics (Ioannides and Rosenthal, 1994). On the investment side, investment on housing asset is a joint decision with other risky assets held by a household (Brueckner, 1997; Flavnin and Nakagawa, 2008). In particular, the usage of the mortgage on housing purchasing intensifies housing asset risk in the portfolio of household (Chetty, Sándor, and Szeidl, 2017). On the consumption side, owning a home provides self-insure against the uncertainty of future housing cost (Ortalo-Magne and Rady, 2006; Han, 2010; Sinai and Souleles, 2005). Davidoff (2005) finds that households whose income covary relatively strongly with housing prices should own relatively little housing, as the comovement of income weakens consumption hedging effect. Our study decomposes the local income dynamics and shows that the financial investment effect and consumption hedging effect of homeownership respond to different components of local risk.

Our research is also related to a growing literature that aims to understand cross-market housing price dynamics. Earlier studies discuss the housing price in combination with urban wage and amenity in a spatial equilibrium framework (e.g. Rosen, 1974; Roback, 1982; Albouy, 2016). Recent literature incorporates housing supply and demand factor to explore the housing price in local market. For example, Sinai and Souleles (2005) find that in markets where rent volatility is greater, the price to rent ratio is larger. Han (2013) shows the risk-return relationship of the housing can be explained by three local market factors: hedging incentives, supply constraints, and urban market growth. Tuzel and Zhang (2017) argue that the industry composition in one region dominates the local risk, and further impacts the price of local factors, such as real estate and labor, and asset pricing. Our analysis proposes that the local income dynamics could drive housing sales price and rental price in opposite direction and thus changes local price to rent ratio.

This paper proceeds as follows. In the next section, we present a simple model to characterize how local income dynamics affect housing tenure choice. Section 3 describes the decomposition of local income dynamics and the data source of our empirics. Section 4 presents our empirical findings on the connection between local risk components, local housing market, and homeownership. Section 5 shows robustness tests of our main results. Section 6 concludes.

## 2 Model

This section presents a simple model to illustrate the effect of income growth, systematic risk, and idiosyncratic risk on housing tenure choice. The model help understand why local housing is a good hedge against national income risk and why measures of local risk explain housing price growth.

To simplify the discussion, we assume a representative household living in one city without any decision of moving to another city. Household utility is generated from consumption of numeraire goods, $C_t$, and a consumption of housing space, $H_t$. The utility function at time $t$ is $u_t(C_t, H_t)$. Household receives an uncertain income $I_t$ at time $t$, and decides its consumption of $C_t$ and $H_t$, together with assets holding $S_t$, and homeownership $\theta_t$(=1 if owns a home). The intertemporal budget constraint between time $t$ and $t-1$ would be:

$$C_t + Q_t H_t(1-\theta_t) + P_t H_t \theta_t + S_t = I_t + P_t \theta_{t-1} H_{t-1}(1-\mu) + S_{t-1}(1+R_t), \tag{1}$$

where $R_t$ is the return of non-home assets at time $t$; $Q_t$ is the rents of rented housing at time $t$; and $\mu$ is the depreciation rate of housing asset.

Housing supply is constrained by land availability. An elasticity of housing, $\xi$, captures heterogeneity across cities[3],

$$P_t = H_t^{\xi}. \tag{2}$$

We assume no arbitrage in the housing rental market which implies the following

$$Q_t = P_t(R_t + \mu). \tag{3}$$

The value function of the household's intertemporal problem is

$$V_t(I_t, H_{t-1}, \theta_{t-1}, S_{t-1}) = \max_{C_t, H_t, \theta_t, S_t} \{u_t(C_t, H_t) + \delta E[V_{t+1}(I_{t+1}, H_t, \theta_t, S_t)]\}, \tag{4}$$

where $\delta$ is the discount factor. We assume the household solve its problem at $A^*(t) = \{C_t, H_t, \theta_t, S_t\}$, and then observe how the value function changes in response to the homeownership as following:[4]

$$\frac{\partial V_t}{\partial \theta_t} = P_t H_t(R_t + \mu - 1)\frac{\partial u_t}{\partial C_t} + \delta E\left[P_{t+1} H_t (1-\mu)\frac{\partial u_{t+1}}{\partial C_{t+1}}\right]. \tag{5}$$

Consider the Euler equation as following:

$$\delta E\left[(1+R_{t+1})\frac{\partial u_{t+1}}{\partial C_{t+1}}\Big/\frac{\partial u_t}{\partial C_t}\right] = 1.$$

Thus, we have

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[3] The supply function echoes the empirical findings such as Green, Malpezzi and Mayor (2005), Saiz (2010).

[4] To calculate derivatives, we aggregate up $\theta_t$ to represent homeownership rate in a region with value between 0 and 1.

$$\frac{\partial V_t}{\partial \theta_t} = P_t H_t (1-\mu-R_t)\frac{\partial u_t}{\partial C_t}\left\{E\left[\frac{P_{t+1}(1-\mu)}{P_t(1-\mu-R_t)(1+R_{t+1})}\right]-1\right\}. \tag{6}$$

The sign of $\frac{\partial V_t}{\partial \theta_t}$ is depended upon the component, $E\left[\frac{P_{t+1}(1-\mu)}{P_t(1-\mu-R_t)(1+R_{t+1})}\right]-1$, since $P_t H_t(1-\mu-R_t)\frac{\partial u_t}{\partial C_t} > 0$. If $\mu$ is very small , equation (6) can be written as

$$\frac{\partial V_t}{\partial \theta_t} = \Lambda_t E[\Delta p_{t+1} - \Delta R_{t+1}]. \tag{7}$$

where $\Lambda_t = P_t H_t (1-\mu-R_t)\frac{\partial u_t}{\partial C_t}$, and $x_{t+1} = \ln X_{t+1}$. $\Delta p_{t+1}$ indicates the future housing price growth, while $\Delta R_{t+1}$ is the change of asset returns. Note that the fluctuation of asset return resulted from the aggregate shock to the whole economy. Thus, the sign of $\frac{\partial V_t}{\partial \theta_t}$ is decided by how the fluctuation of housing price in one city is sensitive to the aggregate shock. If the expected housing price growth larger than the increment of aggregate asset returns, households would be more likely to purchase their home.

If we substitute equation (2) into equation (7) and consider a housing demand function $h_{t+1} = h(i_{t+1})$, equation (7) will be

$$\frac{\partial V_t}{\partial \theta_t} = \Lambda_t E[\xi h_{t+1}(i_{t+1}) - \xi h_t(i_t) - \Delta R_{t+1}]. \tag{8}$$

This equation shows that the homeownership in one city is related to its income volatility relative to the aggregate shock. Moreover, housing supply elasticity also plays a role by amplifying income volatility.

Furthermore, we decompose the income trend of the representative household as:

$$\Delta i_{t+1} = \alpha + \beta \Delta R_{t+1} + \varepsilon_{t+1}, \tag{9}$$

where $\alpha$ is constant indicating the idiosyncratic growth of income; and $\Delta R_{t+1}$ is the change of asset returns reflecting the aggregate shock in our model; and $\varepsilon_{t+1}$ is a random variable representing the idiosyncratic uncertainty. $\varepsilon_{t+1}$ follows a normal distribution with variance $\sigma^2$.

Plug in equation (9) into equation (8) we have:

$$\frac{\partial V_t}{\partial \theta_t} = \Lambda_t \left\{ \xi h'(i_t)\alpha + [\xi h'(i_t)\beta - 1]E(\Delta R) + \frac{\xi h''(i_{t+1})}{2}\sigma^2 \right\}. \tag{10}$$

This equation illustrates that the homeownership is driven by three components in our analysis. First, higher $\alpha$ suggests higher growth of income in this city. It implies a strong housing demand in the future thus investing on housing is profitable. Second, because $h'' < 0$, equation (10) shows larger $\sigma$ suggests a lower homeownership rate. Idiosyncratic risk discourages the homeownership in one city since housing assets in this city are risky. This is financial investment effect in our model.

Third, $[\xi h'(i_t)\beta - 1]E(\Delta R)$ can be interpreted as hedging against aggregate shock through homeownership. $E(\Delta R)$ is the expected change of asset return. It is related to the expected mean and variance of aggregate shock. On average the aggregate economy is expected to be growing, it is reasonable to assume $E(\Delta R) > 0$. A larger $\beta$ implies this city is more procyclical with the whole economy. Households are more likely to hedge the aggregate shock through homeownership. This is the consumption hedging effect in our model. In addition, housing elasticity $\xi$ amplifies the effects of $\alpha$, $\beta$ and $\sigma$ on homeownership. If housing market is constrained by land supply, housing price and homeownership will be more responsive to local risk.

# 3 Data and Measurement

In this section, we estimate the income dynamics model to construct local risk measures, and describe how we use various data sources to construct each analysis variable.

## 3.1 Construction of Local Risk Measures

The primary data source for local risk measure construction is personal total income data from the Bureau of Economic Analysis (BEA) by the U.S. Department of Commerce from 1969 to 2014. We use income both at the county level and at the national level. We deflate income into 2014 dollars using the CPI from the Bureau of Labor Statistics (BLS) and then calculate the annual growth rate for each county and the whole nation.

Borrowing the merits of Fama and Macbeth (1973), we regress regional income growth on national level income growth to obtain the measures of idiosyncratic risk and systematic risk for each county as equation (9) shown. The empirical model is as follows,

$$r_{i,t} = \alpha_i + \beta_i R_{i,t} + \varepsilon_{i,t}, \tag{11}$$

$$\varepsilon_{i,t} \sim N(0, \sigma_i),$$

where $r_{i,t}$ is the income growth of region $i$ at year $t$ ; $R_{i,t}$ is the national income growth at year $t$; $\alpha_i$ is the local alpha of region $i$ measuring the idiosyncratic component of growth; $\beta_i$ is the local beta of region $i$ measuring the systematic risk; and $\varepsilon_{i,t}$ is the residual. The standard deviation of $\varepsilon_{i,t}$ is local sigma $\sigma_i$ measuring the idiosyncratic risk of region $i$ .

To obtain the time-varying estimates of equation (11), a 30-year rolling window is applied to our sample. We get estimates of local alpha $\alpha_i$, local beta $\beta_i$, and local sigma $\sigma_i$ in the above equation at year $t$ by using the income growth between $t-29$ and $t$. Therefore, for each county we have estimates of alpha, beta, and sigma for year 1999 to 2014. Overall, our research includes 49,483 county-year observations. It covers over 2,500 counties in U.S. from 1999 to 2014.

We construct local risk measures at the county level for several reasons. First, county is the smallest geographic region where data are available in many household level survey datasets. Second, the boundary of U.S. county is relatively stable over time, compared with alternative measures such as MSA.[5] In the U.S., county is an administrative or political subdivision of a state. It does not frequently change, while the definition of MSA is adjusted with urban sprawl. Third, it is common that individuals live and work in the same county, thus income dynamics in a county captures housing market dynamics of the same county (e.g. Mian and Sufi, 2014). Nonetheless, we calculate the local risk measures at the MSA level as a robustness test.

[Insert Figure 1 about Here]

We visualize the estimates of local alpha, local beta and local sigma across counties in 2014 in Figure 1. The northeast coast is a relatively more developed region, thus has higher local alphas. This is consistent with our hypothesis that alpha captures active growth in the region. Local beta captures how a county responds to national income growth. East and west coast have higher betas

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[5] MSA is also often defined as a geographical region of local market (e.g. Autor, Dorn and Hanson, 2016; Tuzel and Zhang, 2017). A MSA usually contains several counties. Our empirical analysis shows that neighboring counties have very similar local risk factors, thus our results are also consistent at MSA level. Furthermore, MSA level analysis only focus on urban area.

where economy is strongly correlated with national economic cycle. Local sigma has different geographical distribution from local alpha and local beta. The central U.S. has higher idiosyncratic risk than the east coast and the west coast.

[Insert Table 1 about Here]

To highlight the significant variation of local risks across counties, Table 1 lists five counties with the lowest and highest local alpha, local beta, and local sigma in 2014. Some counties achieve 8% annual income growth while other counties experience negative idiosyncratic growth. Panel B suggests that 1% personal income growth nationwide is associated with more than 1% negative income growth for the five lowest local beta counties. However, in Loving, Texas, 1% increase in national personal income growth is associated with 3.8% increase in county average personal income growth. Counties in the east coast show very low idiosyncratic risk in Panel C. For example, Delaware, PA, which is pretty well developed with high population density, has the lowest local sigma in 2014. As local sigma captures the unexplained portion of the income growth rate, we expect it to be uncorrelated with economic development in a region. Overall, counties with the lowest local alpha and local beta are usually areas that are less developed, which is not always the case for the lowest local sigma.

[Insert Table 2 about Here]

Local risk factors exhibit substantial variation across years. We present the summary statistics of local alpha, local beta and local sigma by year from 1999 to 2014 in Table 2.[6] The standard deviations of each local risk factor decrease. It implies an increasing convergence or declining inequality across regions over time.

## 3.2 Household Information

To examine the relationship between local risk and homeownership, we use the March Current Population Survey (CPS) from 1999 to 2014.[7] The CPS is a national representative survey of about 60,000 U.S. households, and the survey is conducted monthly by the U.S. Census Bureau. Our research uses the data surveyed in March. Sample households are selected by a multistage stratified statistical sampling scheme in 408 counties.

The CPS data include rich information on household characteristics. Our critical dependent variable is household tenure status. *Homeownership* is a dummy variable indicating whether a household owns a home. We also use information on education, age, number of children, race, and ethnicity as control variables in the regressions. *Education* is a dummy to show whether the head of household has a college degree or above. *Kids* is a dummy to show whether the household has children younger than 16 years old. *Income* is the total household annual income. *Size* is the number of household members. *Age* is the head's age of household. We also control for the race of head of household: white, Asian, black or others.

We merge our estimates of local alpha, local beta, and local sigma by county and year with

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[6] By definition the mean of local alpha over all the years is zero and average of local beta is 1.

[7] Our data are obtained from IPUMS CPS project, https://cps.ipums.org/cps/.

the CPS data to examine the effects of local risk on household homeownership status. The summary statistics of household characteristics are shown in the Appendix Table A1.

We also use an alternative data source, the American Community Survey (ACS), as a robustness check.[8] The geographical information in the ACS is only available after 2005. It provides a sample covering 473 counties from 2005 to 2014.

### 3.3 Construction of Housing Market Measures

We use several data sources to capture housing market dynamics. First, we use housing price index at the county level from the Federal Housing Finance Agency (FHFA), starting from 1975.[9] We construct housing price growth and volatility measure based on this data source.

Second, housing price to rent ratio is calculated based on median home rent and median home value from Zillow 2010-2014.[10] The Zillow's median rent series (Zillow Rent Index, ZRI) tracks the monthly median rent in certain geographic regions. It estimates rents based on proprietary statistical and machine learning models. Within each county, the Zillow model observes recent rental listings and learns the relative contribution of various home attributes in predicting prevailing rents. The Zillow's median home value series (Zillow Home Value Index, ZHVI) is based on estimated sales prices on every home, not just the home that has been actually sold in that period, which deals with the changing composition of properties sold in one period versus

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[8] Our data is obtained from IPUMS project, https://usa.ipums.org/.

[9] Note that the FHFA housing price data only include 375 counties in 1975 initially, increases to 2,690 in 2004, and gradually expand to all counties.

[10] The data are obtained from https://www.zillow.com/research/data/ and only available since 2010.

another. We construct the price to rent ratio by dividing the Zillow's median home value by median rental value. The summary statistics are shown in the Appendix Table A1. The mean of price to rent ratio is around 10.

Third, following existing literature (e.g. Han, 2013; Mian, Rao and Sufi, 2013), we construct two measures to examine the effect of local risk on homeownership conditional on the tightness of land supply constraint. The first measure is the fraction of undevelopable land by Saiz (2010). He processes satellite-generated data on terrain elevation and the presence of water bodies to precisely estimate the amount of undevelopable land in U.S. metropolitan areas. The fraction of the undevelopable land for each MSA is purely based on geographical conditions and measures the supply constraint in the housing market. The second measure is the Wharton Regulation Index (WRI) developed by Gyourko, Saiz, and Summers (2007). This index captures the intensity of local land growth control policies in a number of dimensions. Lower values in WRI, which are standardized across all municipalities in the original sample, are considered as signifying the adoption of more laissez-faire policies toward real estate development. Metropolitan areas with higher housing values usually have zoning regulations or project approval practices that constrain new residential real estate development. Both the undevelopable land fraction and WRI are provided at the MSA level. We proxy county-level land supply elasticity using MSA level elasticity.

## 4 Empirical Analysis

In this section, we first present the correlation between local risk factors and the local housing market. Then we examine how local risk factors affect household tenure status. Last, we examine the effect of local risk factors on housing price to rent ratio.

## 4.1 Predictability of Local Risk

Housing demand is generated from residents in the local area since housing is immobile. As we shown in our model, total local income decides the demand of housing, and is significantly related to the housing price dynamics. Before we examine the effect of local income risks on household tenure status, we first show that local risk measures in our research are good predictors of future housing price dynamics.

First, we examine the predictability of local alpha (idiosyncratic growth of local income) on the future housing price growth. To this end, the model specification is as follows,

$$r_{t,t+n}^{i} = \delta + \gamma_1 \alpha_{i,t} + \tau_t + \mu_i + \epsilon_{i,t}, \tag{12}$$

where $r_{t,t+n}^{i}$ is the housing price growth in county $i$ from year $t$ to $t+n$, $\alpha_{i,t}$ are local alpha in county $i$ at year $t$, $\tau_t$ is a set of year dummies; $\mu_i$ is a set of county dummies; $\delta$ is constant term; and $\varepsilon_{i,t}$ is the residual. We regress the local alpha in one county at year $t$ on its one, two and three years ahead housing price growth, respectively, where $n \in \{1,2,3\}$. The results are presented in Table 3.

[Insert Table 3 about Here]

Column 1, 3 and 5 in Table 3 shows the predictability of local alpha on housing price growth during one, two and three years, respectively and only control year fixed effects. The coefficient on local alpha in each column is significantly positive. It implies that the idiosyncratic growth rate is significantly correlated with housing price growth. R-square suggests that local alpha with year fixed effects alone explain almost 40 percent of the total variation in housing price. Column 2, 4 and 6 in Table 3 add the county-level fixed effects. The coefficients on local alpha are still significantly positive. In addition, the magnitude of the estimated coefficients is close to those in Column 1, 3 and 5, suggesting that the predictability of local alpha even after controlling the regional variations.

Second, we examine the correlation between local beta (systematic risk) and housing price growth. The empirical model is as follows,

$$r^i_{t,t+n} = \delta + \gamma_1 \beta_{i,t} + \gamma_2 \beta_{i,t} \times shock_{t,t+n} + \tau_t + \mu_i + \epsilon_{i,t}, \tag{13}$$

where $\beta_{i,t}$ are local beta at county $i$ in year $t$, and $shock_{t,t+n}$ is the aggregate shock proxied by real GDP growth from year $t$ to $t+n$. The interacted term shows that the housing price growth could be forecasted by local beta conditional on the aggregate economic growth. A significant and positive $\gamma_2$ implies that housing price in a county with higher systematic risk is more responsive to aggregate economic changes.

[Insert Table 4 about Here]

Table 4 presents the empirical results. Similarly, we test the one, two and three years ahead housing price growth, respectively. Column 1, 3 and 5 show the results without county fixed effects, and Column 2, 4 and 6 add county fixed effects into the regressions. Overall, all coefficients on the interacted terms are positive, and they are significant at 1% level when the dependent variable is housing price growth during one and two years. Predictability is weaker if the dependent variable is housing price growth three years ahead, although the *p-value* in Column 4 is still close to 5%, and *p-value* in Column 5 is around 10%.

Third, we examine the predictability of local sigma (idiosyncratic risk) on the housing price volatility. We use the following model:

$$VOL_{i,t+n} = \delta + \gamma_1 \sigma_{i,t} + \tau_t + \mu_i + \epsilon_{i,t}, \tag{14}$$

where $VOL_{i,t+n}$ is the housing price volatility in county $i$ at year $t+n$. We measure it by the standard deviation of annual housing price growth rate from year $t+n-14$ to $t+n$. $\sigma_{i,t}$ is the estimated local sigma in county $i$ at year $t$.

[Insert Table 5 about Here]

Similarly, we regress the local sigma on the one, two and three years ahead housing price volatility respectively. We also consider the specifications both with and without county fixed effects. The results of regressions are shown in Table 5. Overall, all the coefficients on local sigma are positive and significant at 1% level. It implies that the local idiosyncratic risk is highly correlated to the housing price volatility.

In summary, our empirical findings show that local income growth and local income risk are highly correlated with housing price and housing price volatility. It is reasonable to assume that households make housing tenure decisions based on local income risk.

## 4.2 Homeownership

Our model illustrates that a household decides to purchase a home in a location with higher expected growth, higher systematic risk due to hedging effect, and lower idiosyncratic risk due to financial investment effect. We first plot the raw correlation between county-level homeownership rate in 2014 from CPS and local alpha, local beta, and local sigma in Figure 2. Panel A shows the relation between local alpha and homeownership rate. Counties with higher local alpha have slightly higher homeownership rate. Panel B shows that the local beta has a strong positive correlation with homeownership rate. The correlation between local sigma and homeownership rate is plotted in Panel C. Households prefer not to purchase a home in counties with higher idiosyncratic risk. Overall, we find that local alpha has a very small positive relationship with homeownership, while local beta, the systematic risk, is strongly related with whether owning a home. On the contrary, idiosyncratic risk, measured by local sigma, is negatively related with homeownership.

[Insert Figure 2 about Here]

We further control year fixed effect, county fixed effect and household characteristics using linear regression model as follows:

$$T_{i,j,t} = \delta + \gamma_1 \alpha_{i,t} + \gamma_2 \beta_{i,t} + \gamma_3 \sigma_{i,t} + \beta X_{j,t} + \tau_t + \mu_i + \epsilon_{i,j,t}, \tag{15}$$

where $T_{i,j,t}$ is the tenure status of household $j$ in county $i$ at year $t$; $\alpha_{i,t}$, $\beta_{i,t}$ and $\sigma_{i,t}$ are local alpha, local beta and local sigma in county $i$ at year $t$, respectively; $X_{j,t}$ is a vector of household characteristics, including education, children, race and ethnicity, income, household size, and head's age; $\tau_t$ is a set of year dummies; $\mu_i$ is a set of county dummies; $\delta$ is constant term; and $\varepsilon_{i,j,t}$ is the i.i.d. residual. We are primarily interested in estimates of $\gamma_1$, $\gamma_2$ and $\gamma_3$. They indicate the effects of different local risk components on tenure status of household after controlling other factors.

[Insert Table 6 about Here]

Our baseline results are shown in Table 6. We first run regression include only local alpha in column 1, only local beta in column 2, and only local sigma in column 3. Household tenure status is significantly related to all three different local risk components at 1% level. Households tend to purchase their residence in the county with higher expected growth, higher systematic risk and lower idiosyncratic risk. We further include all three local risk factors in the same regression. The results are shown in Column 4 after controlling year fixed effects. The sign on each coefficient is still consistent with that in Column 1 to 3. The regression still suggests that systematic risk is positively associated with homeownership, while idiosyncratic risk is negatively associated with homeownership. It is consistent with our hypothesis that when systematic risk is higher in a local area, residents prefer to purchase home to hedge against future housing market uncertainty, the consumption hedging effect. When idiosyncratic risk is higher, residents tend to purchase low-risk assets rather than purchasing home, the financial investment effect. To control time and regional variations, Column 5 adds county and year fixed effects. The explanatory power largely increases but the sign of coefficients on local risk factors are still consistent with those in Column 4.

Column 6 further controls household characteristics including education, children, race and ethnicity, income, household size, and head's age. Households with college degree or above are more likely to purchase homes. Households with children are less likely to own the current residence. White households have a higher probability to live in purchased homes than blacks, Asian and other race households. Homeownership increases with total household income and household size. We also find elder households are more likely to own homes. These findings are consistent with previous literature on tenure choice. The explanation power increases by 20% after controlling for household characteristics, while the coefficients on local risk factors are still similar to those in column 5. This implies that the local factors are not highly correlated to household characteristics in our model. Overall, our baseline regression illustrates that households have a higher probability to purchase a house in a region with higher local alpha, higher local beta and lower local sigma.

As our model shown, the effects of local income dynamics on local housing market depend upon the housing supply elasticity. Thus, we interact the land supply measure with local risk components to discover the heterogeneous effects across counties with different land supply constraints. The empirical results are presented in Table 7. Colum 1 and 2 use the fraction of undevelopable land as the measures on land supply constraint. Column 1 control the land supply measure instead of county fixed effects, and Column 2 control the county fixed effects. We are mainly interested in the interacted terms. They are significant in both columns, and they imply that households who live in the land supply constrained counties are more likely to be affected by local risk.

[Insert Table 7 about Here]

An alternative measure of supply constraint is the Wharton Regulation Index (WRI). It is a policy based measure. Higher WRI value indicates a region with more administrative procedures to regulate land development, thus housing supply is more inelastic. Column 3 and 4 in Table 7 show the results based on the WRI measure. Column 3 controls the WRI instead of county fixed effects and indicates that the coefficients on the interacted terms are all significant. Constrained land supply enhances the effects of local risk on homeownership. Column 4 adds the county fixed effects and the coefficient on the interacted term between local idiosyncratic growth component and WRI is significant and positive. But the interacted terms between local beta and WRI and between local sigma and WRI are insignificant. It is potentially resulted from the endogeneity between land policy and other natural factors[11]. Overall, our empirical analysis shows that the effects of local risk on tenure choice are stronger when housing supply is less elastic.

## 4.3 Price to Rent Ratio

After establishing that local risk components have different impacts on household tenure decision, we proceed to explore the impact of local risk on the local housing market dynamics. Specifically,

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[11] Saiz (2010) demonstrate that higher housing prices, demographic growth, and natural constraints beget more restrictive land-use regulations.

we study whether the local risk is related to housing price to rent ratio, which captures both housing transaction and rental market. To this end, we estimate the following model,

$$PR_{i,t} = \delta + \gamma_1 \alpha_{i,t} + \gamma_2 \beta_{i,t} + \gamma_3 \sigma_{i,t} + \beta Z_{i,t} + \tau_t + \epsilon_{i,j,t}, \quad (16)$$

where $PR_{i,t}$ is the housing price to rent ratio for county $i$ at year $t$; and $Z_{i,t}$ is a vector of variables to control the heterogeneity of counties including county income level and income growth.

[Insert Table 8 about Here]

Zillow data provide the price to rent ratio for over 1,000 counties each year from 2010 to 2014. We run the regression of equation (16) and report the results in Table 8. Panel A shows the results pooling all the years. Column 1 to Column 3 only includes one type of local risk. Local alpha and beta are significantly positively related to price to rent ratio; and the coefficient on local sigma is significantly negative. Among them, local beta has higher explanatory power with the adjusted R square of 8.6%, compared to about 1% for local alpha and sigma. Column 5 further controls for total income and income growth and the model explanatory power increases to over 20%.

We also estimate equation (16) year by year and present the results in Panel B of Table 8. All coefficients on the local risk factors are significant and the magnitudes of hem are also very close. It implies that the correlation between local risk components and price to rent ratio is stable and does not change much over time.

In a partial equilibrium framework, strong demand of owning homes pushes up the sales price, and because rental demand decreases accordingly given a fixed amount of households in the same area, rental price drops.

# 5 Robustness Checks

We conduct a series of robustness checks. First, we examine the robustness of results using Probit model versus linear regression. Second, an alternative sample from ACS data is used as a comparison. Third, local risk measures are constructed at the MSA level. We show that these alternative specifications do not change our main findings.

## 5.1 Alternative Model Specification

Our main regression of equation (15) is a linear regression model. The dependent variable is a dummy to indicate that whether household owns the current residence. One concern of the linear model is that some observations in the tail of the residual's distribution could bias the estimates. A discrete choice model usually uses a Probit or Logit function to transform the residual's distribution and shrink it between 0 and 1. In this part, we use a Probit model to estimate equation (15) as a robustness check.

[Insert Table 9 about Here]

Table 9 shows the results of Probit model. Column 1 applies the same specification in Column 5 of Table 6 and Column 2 adds household characteristics as Column 6 of Table 6. Estimates from Probit model is consistent with linear regression results, that a household is more likely to own a house in a region with higher local alpha, higher local beta, and lower local sigma. Column

3 and 4 further check the model's specifications in Column 1 and 3 of Table 7 where the interacted terms between local risk and land supply measures are added. Again, the results are consistent with our findings in linear model.

### 5.2 Alternative Sample

Our main analysis use CPS survey which covers about 60,000 households every year; and after match with local risk information, our sample includes about 468,000 household-year observations over 16 years. In this section, we use the American Community Survey (ACS) to conduct robustness check. The ACS provides a larger sample of households in the U.S. and each year about one million households' information is collected. Due to the availability of geographical information, we use the ACS sample from 2005 to 2014 with over 6.7 million observations to run the same regression as in Table 6.

[Insert Table 10 about Here]

The results are presented in Table 10. All coefficients are significant at 1% level. Our findings using the ACS sample is consistent with the CPS sample. The coefficients on local risk factors indicate that households are more likely to own a house in a region with higher potential growth and systematic risk. Households prefer not to purchase a house in a region with higher idiosyncratic risk. Furthermore, the coefficients on the characteristics of households in our regression have the same sign as the results in Table 6.

### 5.3 Alternative Geographical Region

The main analysis construct local risk measures at the county level. Our implicit assumption is that a county naturally forms the local housing market, and the housing demand is mainly driven by income dynamics of that county. Some existing studies examine the local housing market at the MSA level which usually contains several neighbored counties (see, for example, Davidoff, 2006; Han, 2010; Tuzel and Zhang, 2017). In this section, we calculate our local risk factors at the MSA level.

We first aggregate county-level income into MSA-level income based on the definition file of MSA in 2012. Then we calculate local risk components in 369 MSAs from 1999 to 2014. After matching the local risk factors at the MSA level to the CPS data, we examine the relationship between local risk and homeownership. The results are in Table 11.

[Insert Table 11 about Here]

Column 1 shows the regression results without household level controls; and Column 2 adds the characteristics of households into regressions. The results indicate that all local risk components are significantly related to the homeownership of households. The results are consistent with our findings at the county level. Furthermore, the magnitudes of coefficients on local risk factors are close to the estimates at the county level.

## 6 Conclusion

This paper discusses the importance of local income dynamics in shaping household tenure decisions and housing price dynamics. We decompose the local income dynamics at the county level into three components: idiosyncratic expected growth, systematic risk, and idiosyncratic risk. We develop an intertemporal choice model and illustrate how these three components affect housing tenure choice. We find that households are more likely to own home in a location with higher expected growth (local alpha), higher systematic risk (local beta) and lower idiosyncratic risk (local sigma). Housing price to rent ratios are also positively associated with local alpha and local beta, and negatively associated with local sigma.

Our study argues that household tenure choice is a dual decision on which location to live geographically and how to optimally allocate asset over time. Local income dynamics affect local housing market. Household chooses the location with lower idiosyncratic risk. Meanwhile, households adjust their consumption intertemporally. Thus, they could purchase a house early to hedge systematic risk.

Our analyses shed light on the importance of local economic conditions on housing decisions and housing market dynamics. In the scope of this paper, the local income dynamics is exogenously decided by the local economic and demographic conditions, such as the industry structure, population composition, natural endowment, and single households cannot change the income dynamic of a location. They shape the local income dynamics together and then impact the housing decision of one household.

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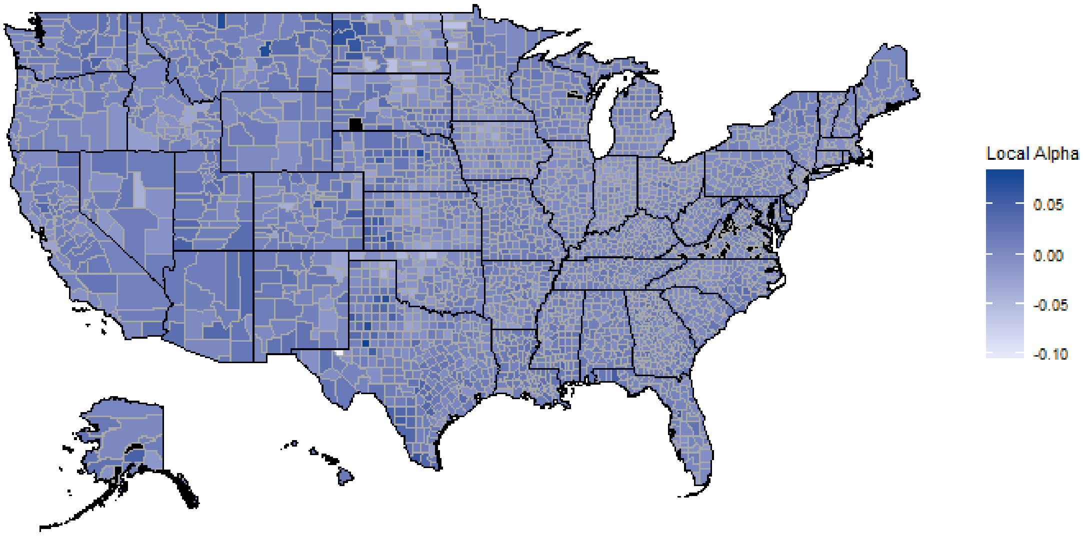
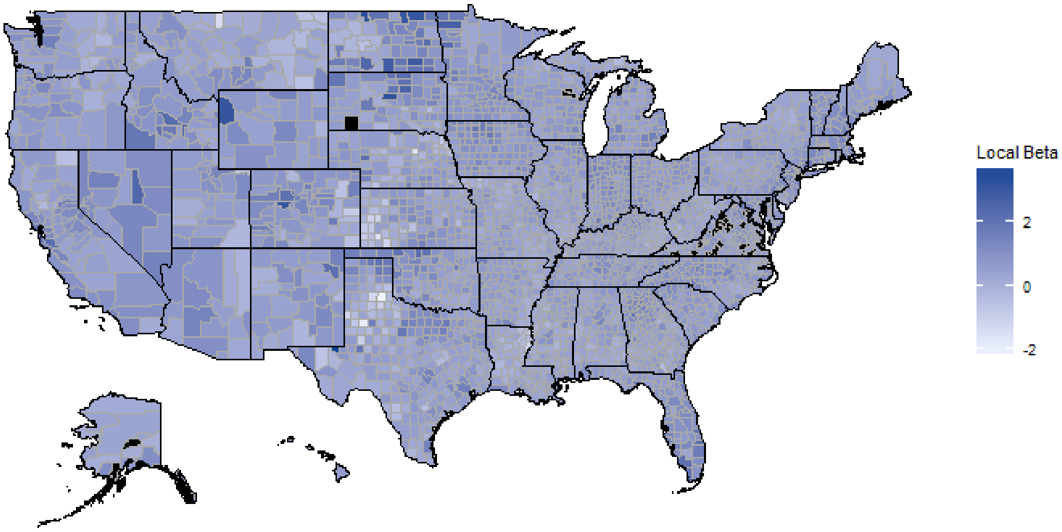
**Figure 1. Geographic Distribution of Local Alpha, Local Beta and Local Sigma**

This figure displays the value of local alpha, local beta and local sigma in 2014 by county. The local alpha, local beta and local sigma are calculated based on a 30-year rolling window regression of local income growth on national income growth. The personal income data by county come from the Bureau of Economic Analysis (BEA).

(a) Local Alpha



(b) Local Beta



(c) Local Sigma

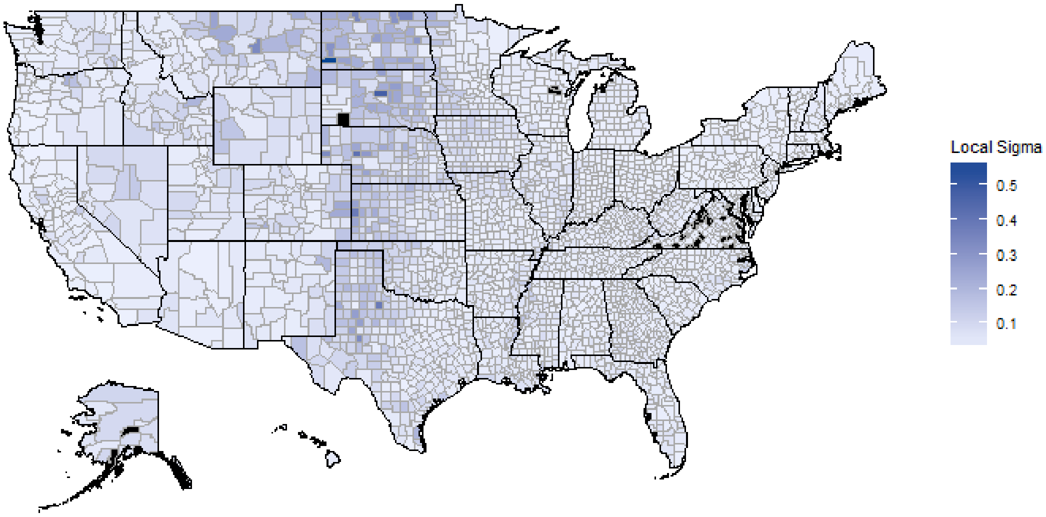
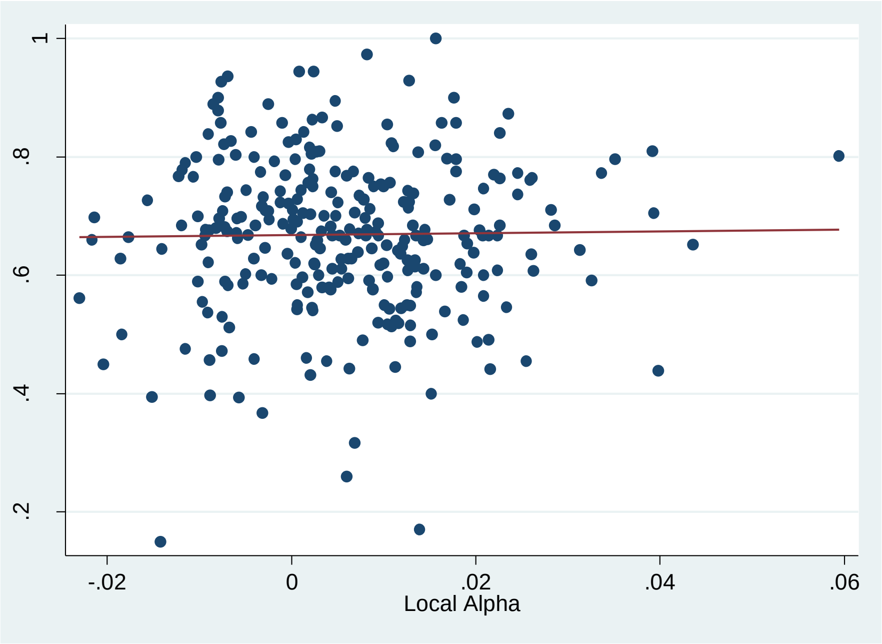


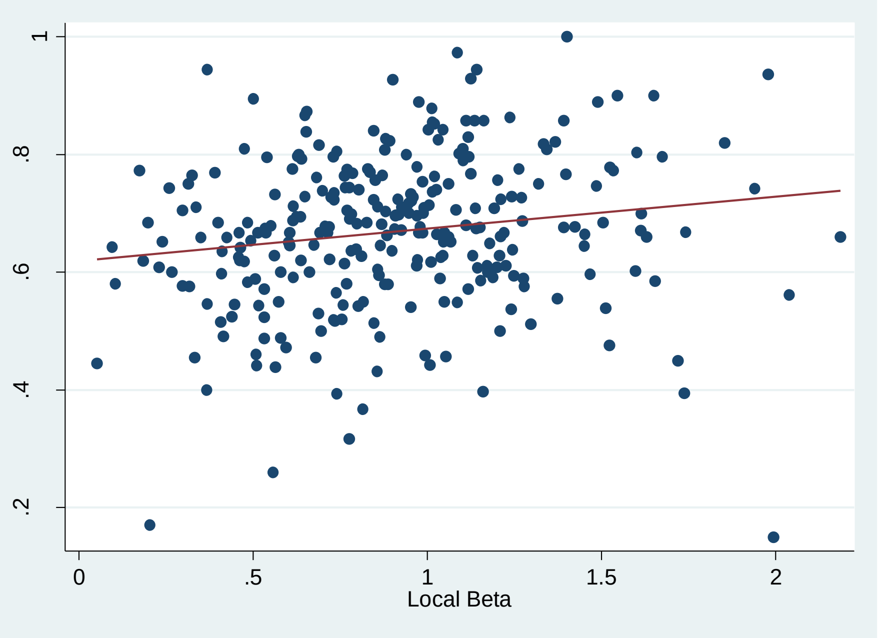
**Figure 2. Local Alpha, Local Beta, Local Sigma and Homeownership Rate by Counties**

This figure presents the relation between local alpha, local beta, local sigma and homeownership rate by county respectively. The horizontal axis in each panel is local alpha, local beta and local sigma in 2014 respectively; and the vertical axis is the homeownership rate at the county level in 2014. The thin line is the linear prediction plot.

(a) Local Alpha v.s. Homeownership Rate



(b) Local Beta v.s. Homeownership Rate



(c)Local Sigma v.s. Homeownership Rate

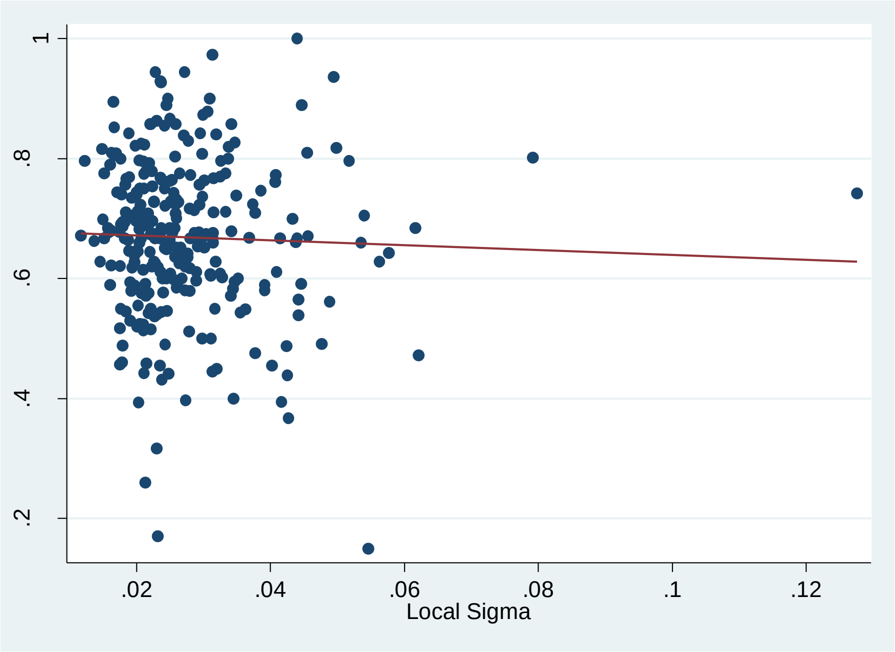


**Table 1. Counties with Highest and Lowest Alpha, Beta and Sigma**

This table presents counties with the lowest local alpha, local beta and local sigma (left column), and the counties with the highest local alpha, local beta and local sigma (right column) as of 2014. The county level personal income growth is regressed on the national personal income growth. The intercept is defined as local alpha; the coefficient on national personal income growth is local beta; and the standard deviation of residuals is local sigma. The personal income data come from Bureau of Economic Analysis (BEA).

Panel A

| Lowest Local Alpha Counties | | Highest Local Alpha Counties | |
|---|---|---|---|
| County Name | Local Alpha | County Name | Local Alpha |
| Loving, TX | -0.11 | Liberty, MT | 0.08 |
| Towner, ND | -0.06 | Petroleum, MT | 0.08 |
| Marshall, MN | -0.06 | Haskell, KS | 0.08 |
| Emmons, ND | -0.06 | Wheeler, NE | 0.08 |
| Norman, MN | -0.05 | Martin, TX | 0.08 |

Panel B

| Lowest Local Beta Counties | | Highest Local Beta Counties | |
|---|---|---|---|
| County Name | Local Beta | County Name | Local Beta |
| Hall, TX | -2.17 | Pitkin, CO | 3.18 |
| Lynn, TX | -1.93 | Teton, WY | 3.18 |
| Wheeler, NE | -1.71 | Sully, SD | 3.31 |
| Haskell, KS | -1.67 | Renville, ND | 3.38 |
| Liberty, MT | -1.45 | Loving, TX | 3.82 |

Panel C

| Lowest Local Sigma Counties | | Highest Local Sigma Counties | |
|---|---|---|---|
| County Name | Local Sigma | County Name | Local Sigma |
| Campbell, KY | 0.01 | Greeley, KS | 0.39 |
| Delaware, PA | 0.01 | King, TX | 0.39 |
| Bucks, PA | 0.01 | Arthur, NE | 0.42 |
| Luzerne, PA | 0.01 | Sully, SD | 0.48 |
| Hennepin, MN | 0.01 | Slope, ND | 0.58 |

**Table 2. Summary Statistics of Local Risk Factors**

This table presents the summary statistics of local alpha, local beta and local sigma. The mean, standard deviation and median are reported by year. Calculation of local alpha, local beta and local sigma is described in table 1.

| Year | Local Alpha | | | Local Beta | | | Local Sigma | | |
|---|---|---|---|---|---|---|---|---|---|
| | mean | s.d. | median | mean | s.d. | median | mean | s.d. | median |
| 1999 | -0.007 | 0.040 | -0.002 | 1.215 | 1.069 | 1.084 | 0.070 | 0.069 | 0.047 |
| 2000 | -0.006 | 0.039 | -0.001 | 1.159 | 1.020 | 1.030 | 0.069 | 0.069 | 0.047 |
| 2001 | -0.006 | 0.038 | -0.001 | 1.151 | 1.003 | 1.027 | 0.069 | 0.068 | 0.046 |
| 2002 | -0.005 | 0.036 | 0.000 | 1.100 | 0.951 | 0.979 | 0.068 | 0.068 | 0.045 |
| 2003 | 0.001 | 0.029 | 0.002 | 0.877 | 0.746 | 0.869 | 0.065 | 0.065 | 0.043 |
| 2004 | 0.003 | 0.028 | 0.003 | 0.826 | 0.737 | 0.840 | 0.063 | 0.063 | 0.043 |
| 2005 | 0.001 | 0.026 | 0.002 | 0.871 | 0.665 | 0.862 | 0.062 | 0.061 | 0.042 |
| 2006 | 0.001 | 0.026 | 0.002 | 0.844 | 0.675 | 0.838 | 0.061 | 0.060 | 0.041 |
| 2007 | 0.002 | 0.025 | 0.002 | 0.826 | 0.681 | 0.836 | 0.060 | 0.059 | 0.041 |
| 2008 | 0.005 | 0.024 | 0.005 | 0.728 | 0.660 | 0.765 | 0.060 | 0.058 | 0.041 |
| 2009 | 0.005 | 0.017 | 0.005 | 0.737 | 0.486 | 0.723 | 0.059 | 0.056 | 0.040 |
| 2010 | 0.006 | 0.016 | 0.006 | 0.721 | 0.482 | 0.718 | 0.057 | 0.053 | 0.039 |
| 2011 | 0.005 | 0.016 | 0.005 | 0.751 | 0.484 | 0.733 | 0.056 | 0.047 | 0.039 |
| 2012 | 0.005 | 0.016 | 0.006 | 0.735 | 0.495 | 0.710 | 0.055 | 0.047 | 0.039 |
| 2013 | 0.006 | 0.015 | 0.006 | 0.718 | 0.484 | 0.695 | 0.055 | 0.047 | 0.038 |
| 2014 | 0.007 | 0.014 | 0.007 | 0.656 | 0.482 | 0.631 | 0.054 | 0.047 | 0.037 |

**Table 3. Predictability of Local Alpha**

This table shows the regression results of local alpha on the one, two and three years ahead housing price growth, respectively. Standard Errors are in parentheses. The housing price growth is calculated based on FHFA county level housing price index. Calculation of local alpha is described in table 1. All coefficients are significant at 1% level.

| Dependent Variable | Housing Price Growth | | | | | |
|---|---|---|---|---|---|---|
| Time Period | 1 Year | | 2 Years | | 3 Years | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Local Alpha | 0.147 | 0.251 | 0.301 | 0.353 | 0.448 | 0.430 |
| | (0.010) | (0.020) | (0.016) | (0.031) | (0.023) | (0.046) |
| County Fixed Effects | No | Yes | No | Yes | No | Yes |
| Year Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 41,423 | 41,423 | 41,356 | 41,356 | 38,691 | 38,691 |
| R-squared | 0.367 | 0.410 | 0.453 | 0.513 | 0.475 | 0.551 |

**Table 4. Predictability of Local Beta**

This table shows the regression results of local beta on the one, two and three years ahead housing price growth, respectively. The housing price growth is calculated based on FHFA county level housing price index. Calculation of local beta is described in table 1. *Shock* is the one, two and three years ahead aggregate real GDP growth, respectively. Standard Errors are in parentheses. All coefficients are significant at 1% level except the number in bold.

| Dependent Variable | Housing Price Growth | | | | | |
|---|---|---|---|---|---|---|
| Time Period | 1 Year | | 2 Years | | 3 Years | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Local Beta | -0.007 | -0.013 | -0.014 | -0.023 | -0.021 | -0.034 |
| | (0.001) | (0.001) | (0.001) | (0.002) | (0.002) | (0.003) |
| Local Beta×Shock | 0.123 | 0.118 | 0.075 | 0.066 | **0.052** | **0.040** |
| | (0.023) | (0.023) | (0.024) | (0.024) | **(0.026)** | **(0.025)** |
| County Fixed Effects | No | Yes | No | Yes | No | Yes |
| Year Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 38,803 | 38,803 | 36,135 | 36,135 | 33,472 | 33,472 |
| R-squared | 0.383 | 0.429 | 0.474 | 0.538 | 0.499 | 0.578 |

**Table 5. Predictability of Local Sigma**

This table shows the regression results of local beta on the one, two and three years ahead volatility of housing price growth, respectively. The volatility of housing price growth is calculated based on FHFA county level housing price index. Calculation of local beta is described in table 1. Standard Errors are in parentheses. All coefficients are significant at 1% level.

| Dependent Variable | Housing Price Growth Volatility | | | | | |
|---|---|---|---|---|---|---|
| Time Period | 1 Year | | 2 Year | | 3 Year | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Local Sigma | 0.098 | 0.094 | 0.091 | 0.099 | 0.085 | 0.112 |
| | (0.007) | (0.015) | (0.007) | (0.015) | (0.007) | (0.015) |
| County Fixed Effects | No | Yes | No | Yes | No | Yes |
| Year Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 26,388 | 26,388 | 25,506 | 25,506 | 24,489 | 24,489 |
| R-squared | 0.076 | 0.756 | 0.077 | 0.775 | 0.077 | 0.797 |

**Table 6. Local Risk and Homeownership, from CPS 1999-2014**

This table reports the results of OLS regression of local risk and homeownership. The dependent variable is whether a household owns the current residence. Calculation of local alpha, local beta and local sigma is described in table 1. *Education* is a dummy indicating whether the head of household has a college degree or above. *Kids* is a dummy to show whether the household has children younger than 16 years old. *Black, Asian* and *Other Ethic* are dummies on race and ethnicity of the head of household. *Log(Income)* is the log of total household annual income. *Log(Household Size)* is the log of number of household members. *Log(Age)* is the log of head's age of household. The data come from the Current Population Survey 1999 to 2014. Standard Errors are in parentheses. All coefficients are significant at 1% level.

| Dependent Variable | Homeownership | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Local Alpha | 1.669 | | | 3.451 | 1.618 | 1.368 |
| | (0.040) | | | (0.053) | (0.210) | (0.183) |
| Local Beta | | 0.006 | | 0.086 | 0.052 | 0.046 |
| | | (0.002) | | (0.002) | (0.010) | (0.009) |
| Local Sigma | | | -1.066 | -3.040 | -0.915 | -0.859 |
| | | | (0.066) | (0.073) | (0.244) | (0.213) |
| Education | | | | | | 0.086 |
| | | | | | | (0.001) |
| Kids | | | | | | -0.022 |
| | | | | | | (0.002) |
| Black | | | | | | -0.115 |
| | | | | | | (0.002) |
| Asian | | | | | | -0.007 |
| | | | | | | (0.003) |
| Other Race | | | | | | -0.064 |
| | | | | | | (0.003) |
| Log(Income) | | | | | | 0.118 |
| | | | | | | (0.001) |
| Log(Household Size) | | | | | | 0.120 |
| | | | | | | (0.002) |
| Log(Age) | | | | | | 0.451 |
| | | | | | | (0.002) |
| County Fixed Effect | No | No | No | No | Yes | Yes |
| Year Fixed Effect | No | No | No | No | Yes | Yes |
| Observations | 468,716 | 468,716 | 468,716 | 468,716 | 468,716 | 468,716 |
| Adjusted R-Square | 0.004 | 0.000 | 0.001 | 0.009 | 0.080 | 0.297 |

**Table 7. The Differential Effect of Local Risk Components on Homeownership across Land Supply**

This table reports the results of OLS regression of local risk and homeownership, across land supply elasticities. The dependent variable is whether a household owns the current residence. Calculation of local alpha, local beta and local sigma is described in table 1. The interacted terms between local risk factors and land supply measure are added in the regression. Column (1) and (2) use the log of percentage of undevelopable land; and column (3) and (4) use the Wharton Regulation Index. Household control includes whether the head of the household has a college degree or above, whether the household has children younger than 16 years old, log of age of household head, log of household size, whether black, whether Asian, and whether other race and ethnicity, with omitted category of whites. Standard Errors are in parentheses. ***, **, and * denote significance at the 1%, 5% and 10% level.

| Dependent Variable | Homeownership | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Local Alpha | -4.629*** | -3.373*** | 3.068*** | 0.957*** |
| | (0.211) | (0.906) | (0.072) | (0.320) |
| Local Alpha×Land Supply | 2.625*** | 1.502*** | 3.254*** | 1.234** |
| | (0.067) | (0.273) | (0.108) | (0.487) |
| Local Beta | -0.088*** | -0.120*** | 0.090*** | 0.047*** |
| | (0.009) | (0.046) | (0.003) | (0.015) |
| Local Beta×Land Supply | 0.056*** | 0.056*** | 0.028*** | 0.033 |
| | (0.003) | (0.014) | (0.004) | (0.024) |
| Local Sigma | -1.185*** | -2.422** | -2.572*** | -1.082*** |
| | (0.364) | (1.165) | (0.109) | (0.353) |
| Local Sigma×Land Supply | -0.636*** | 0.383 | -4.458*** | 0.417 |
| | (0.110) | (0.353) | (0.156) | (0.514) |
| Land Supply | -0.114*** | | 0.022*** | |
| | (0.003) | | (0.006) | |
| Household Control | Yes | Yes | Yes | Yes |
| County Fixed Effects | No | Yes | No | Yes |
| Year Fixed Effects | Yes | Yes | Yes | Yes |
| Observations | 294,312 | 294,312 | 294,312 | 294,312 |
| R-squared | 0.267 | 0.308 | 0.262 | 0.308 |

### Table 8. Local Risk and Price to Rent Ratio

This table reports the results of regressions of local risk and price to rent ratio. The price to rent ratio data is from Zillow and defined as the total value of house over annual rent payment at certain county. Calculation of local alpha, local beta and local sigma is described in table 1. *Income Growth* is the annual personal income growth in the county; and *Total Income* is the total personal income of county. Regression sample period is 2010-2014. Standard Errors are in parentheses. All coefficients are significant at 1% level except the number in bold.

| Dependent Variable | Price to Rent Ratio | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Panel A: County Level Regression | | | | | |
| Local Alpha | 19.624 | | | 68.229 | 69.544 |
| | (2.732) | | | (2.860) | (2.823) |
| Local Beta | | 2.026 | | 3.247 | 2.860 |
| | | (0.092) | | (0.100) | (0.101) |
| Local Sigma | | | -17.868 | -29.840 | -25.761 |
| | | | (2.201) | (2.035) | (2.048) |
| Income Growth | | | | | **3.192** |
| | | | | | **(1.335)** |
| Total Income | | | | | 0.022 |
| | | | | | (0.001) |
| Year Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| R-squared | 0.013 | 0.086 | 0.016 | 0.190 | 0.229 |
| Observations | 5,347 | 5,347 | 5,347 | 5,347 | 5,347 |
| Panel B: Subsample Regression by Year | | | | | |
| | 2010 | 2011 | 2012 | 2013 | 2014 |
| Local Alpha | 72.490 | 63.665 | 63.991 | 73.306 | 64.341 |
| | (6.024) | (5.750) | (6.123) | (7.195) | (6.968) |
| Local Beta | 2.720 | 2.424 | 2.424 | 3.034 | 3.006 |
| | (0.225) | (0.216) | (0.225) | (0.243) | (0.233) |
| Local Sigma | -25.562 | -24.517 | -24.133 | -24.983 | -23.776 |
| | (4.419) | (4.775) | (4.330) | (5.022) | (4.621) |
| Control | Yes | Yes | Yes | Yes | Yes |
| R-squared | 0.245 | 0.194 | 0.248 | 0.221 | 0.270 |
| Observations | 1,031 | 1,071 | 1,079 | 1,080 | 1,086 |

**Table 9. Probit Model of Local Risk and Homeownership**

This table reports the results of Probit regression of homeownership. The dependent variable is a dummy to indicate whether the household own the current residence. Calculation of local alpha, local beta and local sigma is described in table 1. Land supply is measured by the log of percentage of undevelopable land in column (3), and is measured by Wharton Regulation Index in column (4). Household control includes whether the head of the household has a college degree or above, whether the household has children younger than 16 years old, log of age of household head, log of household size, whether black, whether Asian, and whether other race and ethnicity, with omitted category of whites. Standard Errors are in parentheses. All coefficients are significant at 1% level.

| Dependent Variable | Homeownership | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Local Alpha | 4.879 | 5.102 | -14.988 | 10.378 |
| | (0.606) | (0.670) | (0.761) | (0.254) |
| Local Beta | 0.159 | 0.175 | -0.249 | 0.306 |
| | (0.029) | (0.032) | (0.032) | (0.011) |
| Local Sigma | -2.269 | -2.779 | -5.950 | -8.220 |
| | (0.693) | (0.763) | (1.295) | (0.378) |
| Local Alpha×Land Supply | | | 8.584 | 10.799 |
| | | | (0.241) | (0.388) |
| Local Beta×Land Supply | | | 0.173 | 0.069 |
| | | | (0.010) | (0.015) |
| Local Sigma×Land Supply | | | -1.433 | -14.415 |
| | | | (0.389) | (0.544) |
| Land Supply | | | -0.387 | 0.089 |
| | | | (0.012) | (0.020) |
| Household Control | No | Yes | Yes | Yes |
| County Fixed Effects | Yes | Yes | No | No |
| Year Fixed Effects | Yes | Yes | Yes | Yes |
| Observations | 468,693 | 468,693 | 294,312 | 294,312 |
| Pseudo-R2 | 0.0620 | 0.257 | 0.228 | 0.222 |

### Table 10. Local Risk and Homeownership, ACS 2005-2014

This table reports the results of OLS regression of local risk and homeownership. The dependent variable is a dummy to indicate whether the household own the current residence. Calculation of local alpha, local beta and local sigma is described in table 1. *Education* is a dummy to show whether the head of household has a college degree or above. *Kids* is a dummy to show whether the household has kids younger than 16 years old. *Black, Asian* and *Other Ethic* are a group of dummies to identify the ethnic of head of household. *Log(Income)* is the log of total household annual income. *Log(Size)* is the log of number of household members. *Log(Age)* is the log of head's age of household. The data come from American Community Survey 2005 to 2014. Standard Errors are in parentheses. All coefficients are significant at 1% level.

| Dependent Variable | Homeownership | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Local Alpha | 1.377 | | | 2.715 | 1.145 | 1.079 |
| | (0.012) | | | (0.015) | (0.083) | (0.072) |
| Local Beta | | 0.01 | | 0.076 | 0.033 | 0.032 |
| | | (0.000) | | (0.001) | (0.004) | (0.003) |
| Local Sigma | | | -0.323 | -1.935 | -0.383 | -0.206 |
| | | | (0.017) | (0.019) | (0.080) | (0.069) |
| Education | | | | | | 0.053 |
| | | | | | | (0.000) |
| Kids | | | | | | -0.007 |
| | | | | | | (0.000) |
| Black | | | | | | -0.136 |
| | | | | | | (0.001) |
| Asian | | | | | | -0.029 |
| | | | | | | (0.001) |
| Other Race | | | | | | -0.079 |
| | | | | | | (0.001) |
| Log(Income) | | | | | | 0.13 |
| | | | | | | (0.000) |
| Log(Size) | | | | | | 0.103 |
| | | | | | | (0.000) |
| Log(Age) | | | | | | 0.435 |
| | | | | | | (0.000) |
| County Fixed Effect | No | No | No | No | Yes | Yes |
| Year Fixed Effect | No | No | No | No | Yes | Yes |
| Observations | 6,704,292 | 6,704,292 | 6,704,292 | 6,704,292 | 6,704,292 | 6,611,543 |
| Adjusted R-Square | 0.002 | 0.000 | 0.000 | 0.005 | 0.056 | 0.289 |

**Table 11. Local Risk and Homeownership, MSA Level Analysis**

This table reports the results of OLS regression of local risk and homeownership at the MSA level. The dependent variable is a dummy to indicate whether the household own the current residence. Calculation of local alpha, local beta and local sigma is described in table 1 but calculated based on MSA level. The sample is from US CPS; 1999-2014 Household control includes whether the head of the household has a college degree or above, whether the household has children younger than 16 years old, log of age of household head, log of household size, whether black, whether Asian, and whether other race and ethnicity, with omitted category of whites. Standard Errors are in parentheses. All coefficients are significant at 1% level.

| Dependent Variable | Homeownership | |
|---|---|---|
| | (1) | (2) |
| Local Alpha | 1.082*** | 1.048*** |
| | (0.321) | (0.281) |
| Local Beta | 0.028** | 0.030** |
| | (0.013) | (0.012) |
| Local Sigma | -0.941*** | -0.866*** |
| | (0.283) | (0.248) |
| Household Control | No | Yes |
| County Fixed Effects | Yes | Yes |
| Year Fixed Effects | Yes | Yes |
| Observations | 431,563 | 431,563 |
| R-squared | 0.079 | 0.296 |

## Appendix Table A1. Summary Statistics of Main Variables

The table presents the summary statistics of variables in the empirical analysis. Calculation of local alpha, local beta and local sigma is described in table 1. The sample period of local risk is from 1999 to 2014. The data of households' characteristics is from the CPS from 1999 to 2014. *Homeownership* is a dummy to indicate whether the household own the house. *Education* is a dummy to show whether the head of household has a college degree or above. *Kids* is a dummy to show whether the household has children younger than 16 years old. *Black, Asian* and *Other Ethic* are a group of dummies to identify the ethnic of head of household. *Log(Income)* is the log of total household annual income. *Log(Size)* is the log of number of household members. *Log(Age)* is the log of head's age of household. The data of housing price is from Zillow from 2010 to 2014. *Price to Rent Ratio* is defined as the total value of house over annual rent payment. Income growth and total income is calculated based on personal income by counties from BEA. The data of housing price is from Zillow from 2010 to 2014. *Price to Rent Ratio* is defined as the total value of house over annual rent payment. Income growth and total income is calculated based on personal income by counties from the BEA.

| Variable | Obs. | Mean | Std. Dev. | 25th | Median | 75th |
|---|---|---|---|---|---|---|
| *Local Risk* | | | | | | |
| Local Alpha | 49483 | 0.00 | 0.03 | -0.01 | 0.00 | 0.01 |
| Local Beta | 49483 | 0.87 | 0.75 | 0.49 | 0.82 | 1.17 |
| Local Sigma | 49483 | 0.06 | 0.06 | 0.03 | 0.04 | 0.07 |
| | | | | | | |
| *Households Characteristics* | | | | | | |
| Homeownership | 468716 | 0.64 | 0.48 | 0 | 1 | 1 |
| Education | 468716 | 0.59 | 0.49 | 0 | 1 | 1 |
| Kid | 468716 | 0.38 | 0.49 | 0 | 0 | 1 |
| Black | 468716 | 0.15 | 0.36 | 0 | 0 | 0 |
| Asian | 468716 | 0.05 | 0.23 | 0 | 0 | 0 |
| Other Race | 468716 | 0.04 | 0.20 | 0 | 0 | 0 |
| Income | 468716 | 66409 | 73243 | 24000 | 47005 | 85000 |
| Age | 468716 | 48 | 16 | 35 | 46 | 59 |
| | | | | | | |
| *Housing Price* | | | | | | |
| Price to Rent Ratio | 5347 | 10.23 | 2.72 | 8.41 | 9.87 | 11.64 |
| Income Growth | 5347 | 0.02 | 0.03 | 0.00 | 0.02 | 0.03 |
| Total Income | 5347 | 10.50 | 25.37 | 1.37 | 3.35 | 8.87 |