JRAP 43(2): 178-185. 

The Journal of
Regional
Analysis
& Policy

# A Simple Test of σ-Convergence in U.S. Housing Prices across BEA Regions

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**Abstract.** This study probes the convergence of housing prices at the regional and the state levels. Regional classification follows the Bureau of Economic Analysis (BEA) designation of eight regions using quarterly data from 1975:1 to 2012:3. The statistical approach employed is σ-convergence, where regional and state variances are computed for testing the hypotheses. The results indicate that housing prices in nine states converge to the overall U.S. housing prices while the remaining forty-one states fail to do so. At the regional level, housing prices in the Great Lakes, Plains, Southeast, Rocky Mountains, and Southwest regions diverge from overall U.S. housing prices, while housing prices in New England, Mideast, and Far West tend to converge.

## 1. Introduction

Convergence, according to Angulo et al. (2001), is the tendency toward equalization, for instance, among countries, regions, or states. Tools devised to measure convergence rely on measures known as absolute β-convergence, which is based on regression analysis, and σ-convergence, which is based on dispersion analysis. Other competing hypotheses of convergence, as pointed out by Galor (1996), are conditional β-convergence and club convergence. In the former case, entities with identical structural characteristics converge to one another over time, irrespective of their initial conditions. In the latter case, entities converge to one another provided that their initial conditions are the same. In a broader sense, as Doyle (1997) and O'Leary (1997) state, convergence implies a process by which economic variables display narrow dispersion (σ-convergence). Hotelling (1933) argues that the tendency towards convergence is consistent with the diminution of variance, unlike what Friedman (1992) calls the convergence through regression fallacy.

The focus of this study is to investigate σ-convergence to determine whether housing prices across the states and economic regions (as defined by the Bureau of Economic Analysis, BEA) converge based on the conjecture that the rise or collapse of the housing market may affect U.S. states and economic regions differently. Indeed, in the aftermath of the housing market collapse, as noted by Santos (2012), the number of homes with outstanding mortgage balances reached 55 million, amounting to some $9.5 trillion. Housing prices declined in the range of 20 percent to 40 percent due to the recent recession (i.e., the so-called Great Recession), causing some 10 million borrowers to default on their home loans. Additionally, about 22 percent of homeowners owe more on their homes than the homes are worth (underwater). And, although interest rates are low by historical standards, due to expansionary monetary policies, the housing market has been relatively slow to recover. Focusing on the period immediately leading up to the housing market collapse, Cohen et al. (2012) find that housing prices rose substantially on the east and west coasts, due in large measure to the appreciation in land values rather than the physical housing structure, much more so than the interior region of the U.S.

For instance, in Los Angeles, San Diego, and Miami, housing prices tripled. In the bust, the decline in Las Vegas, Phoenix, and Miami was 50 percent or more.

While there have been a number of studies investigating the convergence of U.S. regional housing prices, as the following literature review will show, we undertake a straightforward analysis of variance approach that examines the variance of housing prices at the state level within regions defined by the Bureau of Economic Analysis (BEA) in testing for σ-convergence across BEA regions. In other words, we explore whether states partitioned in accordance with the BEA classifications converge or diverge from the national trends.

Section 2 discusses the literature with respect to U.S. studies on regional housing price convergence. Section 3 describes the data and methodology, with results presented in Section 4. Concluding remarks are given in Section 5.

## 2. Literature review

The transmission of shocks in housing prices across regions with prices converging over time is known as the "ripple" effect (Meen, 1999). As noted by Drake (1995), Meen (1999), Gupta and Miller (2012a,b), Apergis and Payne (2012), Payne (2012), and Barros et al. (2012; 2013), the transmission of shocks across housing markets can be attributed to migration patterns, equity conversion, spatial arbitrage, and spatial patterns in the determinants of house prices. The migration of households from higher priced regions to lower priced regions to take advantage of housing price differentials as well as the process of equity conversion may inflate the prices at the margin in the relocation regions. Alternatively, instead of physically relocating to a new region, households may engage in spatial arbitrage whereby financial capital moves from higher priced regions to purchase houses in lower priced regions in anticipation of higher future prices in the lower priced regions. Finally, if the underlying determinants of house prices across regions are correlated, then regional house prices may very well reflect the same correlated movement.

The literature on regional housing price convergence reflecting the "ripple" effect has been varied in terms of the econometric methodology employed. While a great deal of literature on regional housing price convergence exists across countries, we focus our attention to the studies pertaining to the U.S. Pollahowski and Ray (1997) were among the first to explore the presence of price diffusion between contiguous regions for the nine U.S. census regions and metropolitan areas. Pollahowski and Ray were unable to identify diffusion between contiguous regions, finding no difference in price diffusion patterns between neighboring and non-neighboring regions. Zohrabyan et al. (2008) were among the first to employ time series cointegration techniques to show that regions that are prominent with respect to financial and economic factors lead the overall U.S. housing market. Clark and Coggin (2009) yielded mixed results on the convergence of regional housing prices in the U.S. within a structural time series framework for the nine census regions. In an examination of housing prices for the western U.S. states using a spatial-temporal analysis, Kuethe and Pede (2011) showed convergence across these states.

Holmes et al. (2011) employ a non-parametric methodology to U.S. state housing prices to demonstrate convergence. Apergis and Payne (2012) apply clustering and club convergence procedures to U.S. state housing prices to reveal three convergence clubs among the 50 states. Using cointegration and Granger-causality testing, Gupta and Miller (2012a) provide results indicating that housing prices in Los Angeles cause housing prices directly in Las Vegas and indirectly in the case of Phoenix. In addition, housing prices in Las Vegas cause housing prices in Phoenix, along with the housing prices in Los Angeles being largely exogenous and housing prices in Phoenix failing to have a causal impact on housing prices in either Los Angeles or Las Vegas. Utilizing the same cointegration and Granger-causality testing framework, Gupta and Miller (2012b) examine housing prices in eight Southern California MSAs to find a long-run cointegrated relationship among the eight MSAs. The results of Granger-causality tests indicate that housing prices in the Santa Anna MSA cause housing prices in six of the seven MSAs. The Oxnard MSA is influenced the most from other MSAs (six of the seven MSAs), and the housing prices in the Santa Barbara MSA causes housing prices in only two other MSAs.

Payne (2012) investigates the long-run relationship among housing prices across the nine U.S. census regions using the autoregressive distributed lag approach to find long-run convergence, noting the variation in the degree of convergence in both the short-run and long-run. Barros et al. (2012) use fractional integration and cointegration procedures and do not find cointegration between state housing prices and aggregate U.S. housing prices, thus showing the absence of convergence. In a related study, Barros et al. (2013) examine the ratio of state housing prices to the U.S. aggregate housing price using a fractional unit root testing approach. Their results show that U.S. state housing prices exhibit long memory behavior of varying degrees with support for convergence mixed across states.

## 3. Data and methodology

The data is obtained from the St. Louis Federal Reserve database, FRED II, for the house price index from the Federal Housing Finance Agency. For each state in the United States, quarterly data is provided from 1975:1 to 2012:3. Government agencies such as the Bureau of the Census, the Bureau of Economic Analysis (BEA), and the Federal Reserve Board provide different definitions of regional boundaries. According to Perlman (1982), two regional groupings of the United States that furnish convenient access to data are the Bureau of the Census, with nine clusters of states, and the Bureau of Economic Analysis, with eight clusters. The latter are better suited for economic analysis because the clustering is made according to economic homogeneity, hence the BEA designated regions are used in the analysis.

According to Rey and Dev (2006) and Delagard and Vastrup (2001), σ-convergence is measured by an index of dispersion such as the variance. Convergence is present if the variance has the tendency to decline. The variance $S^2$ as used in this study is

$$S^2 = \frac{1}{n-1}\Sigma(Y_i - \bar{y})^2. \tag{1}$$

In equation (1), $y_i$ is housing index for state i for a particular quarter, $\bar{y}$ is state $i$ mean for a period of years, n is the number of years for each of the $N=50$ states (District of Columbia is excluded). The procedure followed in this study, because of the large number of years, is to compute averages of housing indices for the years under consideration. This scheme provides 50 state observations. These 50 observations, in turn, were collected into eight regional sets depicting averages of the eight regions. The averaging of averages, as was done here, is a reasonable and unbiased approach, as indicated by Shackleford (2003). For this purpose, suppose the 50 state observations are placed into eight distinct regional sets as defined by the BEA and the sets are labeled 1,2,…,8. Each set, representing a region, is composed of a number of constituent states, as shown in Table 1.

To observe the nature of variability across regions in Table 1 and to investigate whether the means for regions differ significantly, one-way analysis of variance is performed. The null hypothesis is

$$H_0: \mu_1 = \mu_2 = \ldots = \mu_8 = \mu \tag{2}$$

where $\mu_i$ are the expected regional means tested by the F-ratio. A significant value of F indicates that the observed values contain variability that cannot be explained by chance alone, and $H_0$ must be rejected. The test, however, does not tell us which of the means are different. If $H_0$ is rejected, then a subsequent comparison procedure, called multiple comparisons, is usually undertaken. This procedure, as explained by Olson (1987), compares all the combinations of the sample means, two at a time. While there are several multiple comparison procedures, the one used here is the Tukey simultaneous comparison, which ranks the observed means in ascending order and separates them into homogeneous sets.

Let $N$ be the number of states and $G$ the number of regions. That is $N=50$ and $G=8$. Let $A_g$ denote the set of state indices in the $g$th set for a given region, that is, $i \in A_g$ . The variance $S^2$ can be decomposed into a between regional sum of squares and a within regional sum of squares as

$$S^2 = \sum_{g=1}^{G} \frac{N_g}{N} \Sigma\,(\bar{Z}_g - \bar{Z})^2$$

(between regions)

$$+ \sum_{g=1}^{G} \frac{N_g}{N} \sum_{i \in A_g} \frac{1}{N_g} (Z_1 - \bar{Z}_g)^2$$

(within regions) (3)

where $N_g$ = the number of states in $A_g$ and $\bar{Z}_g = \sum_{i \in A_g} \frac{Z_i}{N_g}$.

The convergence hypothesis is

$$H_o: \sigma_i^2 = \sigma^2, i = 1,2, \ldots 8 \tag{4}$$

(versus the alternative of $H_a: \sigma_i^2 \neq \sigma^2$)

for which a test statistic of the form

$$F^* = \frac{S_i^2}{S^2} \tag{5}$$

may be envisioned as a proper test for convergence between the eight regions and the U.S., as indicated by Mood et al. (1974).

$F^*$ of equation (5) is compared for statistical significance with F(α,m-1,w-1) when $F^*>1$ and 1/F(α,w-1,m-1) when $F^*<1$. Note that the degrees of freedom differ between the total $S^2$ of equation (3) and its partitions into between and within regions. For the total, with $N=50$ observations, the degrees of freedom are $N$-1=49. For the between portion, with the number of regions $G=8$, the degrees of freedom are $G$-1=7. For the within portion, the degrees of freedom are $N$-$G$=42.

A similar hypothesis test is conducted for the convergence of states' variance to an overall U.S. variance. The hypothesis takes the form

$$H_0: \sigma_i^2 = \sigma^2, i = 1,2, \ldots 50 \quad (6)$$

(versus the alternative of $H_a: \sigma_i^2 \neq \sigma^2$)

with a test statistic

$$F^* = \frac{S_i^2}{S^2} \quad (7)$$

where $S_i^2$ and $S^2$ are the respective state and overall U.S. variances.

Each of the variances is computed from the 151 observations. For large samples, the critical values of $F^*$ of equation (7) at the 5 percent significance level are F=1.26 when $F^*>1.00$ and F=0.79 when $F^*<1.00$. For the 1 percent significance level, the corresponding F values are F=1.39 and F=0.72.

## 4. Results

Summary statistics for the housing index are provided by state for each of the eight BEA regional classifications as shown in Table 1. In Table 2, similar information is provided, this time for the eight BEA regions. It is apparent that the New England region (R1) has the highest mean at 270.5, with Massachusetts recording the highest value of the index at 351.8 and Vermont with the lowest at 236.1. The Mideast and Far West regions follow with means 257.9 and 211.6, respectively. The region with the lowest mean is the Southwest at 159.4, with Oklahoma at 132.2 registering the minimum and with Arizona at 181.9 registering the maximum.

Table 3 provides the result of the ANOVA for testing the equality of the means as shown in Table 2. With an F-value of 12.73, the null hypothesis for the equality of means is rejected with a p-value of 0.000. This result is not surprising, as one would expect housing prices across regions will differ. What is of interest in Table 3 is the partition of total sum of squares by equation (3), which reveals that the "Between" portion accounts for 68 percent as compared to 32 percent for the "Within" portion, an indication that within the states in a region, the differences in housing prices seems to be rather small.

The multiple comparison procedure by the Tukey simultaneous comparison procedure lines up the regions in ascending order to be regions R1 (New England) and R2 (Mideast), which differ significantly from the other six regions. The R8 (Far West) region differs significantly at 5 percent level from R6 (Southwest), R4 (Plains), and R5 (Southeast). R8 also differs at the 10 percent level from R7 (Rocky Mountain) and R3 (Great Lakes).

Table 4 shows the results for the testing of σ-convergence as provided in equations (4) and (5). The hypothesis is designed to ascertain which regions converge to the national trends. The regions that diverge at the 1 percent level are the Great Lakes, the Plains, the Southeast and the Rocky Mountain. The Southwest region diverges at the 5 percent level. The other three regions (New England, Mideast, and Far West) show convergence.

Table 5 reports the results of testing the hypothesis of equality of states' variances to that of the U.S. The states' variances were obtained as the squared standard deviation from Table 2. The U.S. variance is $S^2 = 8848.1$. It seems that only nine states converge to the U.S. at the 5 percent significance level: Arizona, Colorado, Illinois, Minnesota, Montana, Nevada, Pennsylvania, Utah, and Wisconsin. At the 5 percent significant level, twenty-five states diverged from below (Alabama, Alaska, Arkansas, Georgia, Idaho, Indiana, Iowa, Kansas, Kentucky, Louisiana, Michigan, Mississippi, Missouri, Nebraska, New Mexico, North Carolina, North Dakota, Ohio, Oklahoma, South Carolina, South Dakota, Tennessee, Texas, West Virginia, and Wyoming) and the remaining sixteen states diverged from above (California, Connecticut, Delaware, Florida, Hawaii, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Oregon, Rhode Island, Vermont, Virginia, and Washington). The results in Tables 4 and 5 confirm the broad results of Barros et al. (2013), in that many states in the BEA regions failed to support the convergence hypothesis, as well as those of Clark and Coggin (2009), in the case of census regions. Though the studies by Holmes et al. (2011) and Payne (2012) provide relatively strong support for convergence, the differing results may be attributed to differences in regional classification and methodological approaches.

**Table 1.** Housing Index Descriptive Statistics by State in BEA Regions.

| Region/State | Mean | Std | Min | Max | Region/State | Mean | Std | Min | Max |
|---|---|---|---|---|---|---|---|---|---|
| **R1: New England** | | | | | **R5: Southeast** | | | | |
| Connecticut | 249.99 | 122.97 | 61.86 | 473.9 | Alabama | 182.11 | 71.56 | 70.65 | 309.73 |
| Massachusetts | 351.78 | 208.14 | 65.87 | 724.28 | Arkansas | 159.42 | 57.57 | 60.72 | 257.51 |
| Maine | 262.73 | 138.78 | 50.87 | 512.48 | Florida | 199.32 | 106.43 | 66.75 | 480.26 |
| New Hampshire | 245 | 128.78 | 42.33 | 482.58 | Georgia | 190.38 | 78.16 | 71.89 | 329.32 |
| Rhode Island | 277.58 | 161.66 | 61.42 | 601.84 | Kentucky | 179.1 | 74.24 | 64.73 | 295.4 |
| Vermont | 236.05 | 124.01 | 56.41 | 458.05 | Louisiana | 144.25 | 57.24 | 52.46 | 248.35 |
| **R2: Mideast** | | | | | Mississippi | 157.12 | 56.48 | 70.6 | 259.09 |
| Delaware | 248.73 | 129.31 | 75.36 | 502.08 | North Carolina | 193.76 | 83,24 | 66 | 339.15 |
| Maryland | 237.26 | 135.01 | 62.07 | 531.02 | South Carolina | 194.89 | 83.4 | 69.96 | 344.58 |
| New Jersey | 270.27 | 155.44 | 59.93 | 575.85 | Tennessee | 179.56 | 73.55 | 66.04 | 305.77 |
| New York | 317.41 | 179.43 | 73.6 | 643.56 | Virginia | 223.27 | 120.91 | 66.24 | 466.77 |
| Pennsylvania | 215.98 | 193.1 | 69.32 | 399.51 | West Virginia | 138.42 | 49.11 | 51.09 | 224.92 |
| **R3: Great Lakes** | | | | | **R6: Southwest** | | | | |
| Illinois | 203.12 | 94.29 | 62.67 | 374.08 | Arizona | 181.93 | 93.11 | 55.72 | 425.48 |
| Indiana | 166.02 | 62.25 | 61.03 | 257.55 | New Mexico | 179.03 | 77.84 | 55.55 | 332.71 |
| Michigan | 182.73 | 82.06 | 59.61 | 320.58 | Oklahoma | 132.16 | 42.89 | 51.78 | 207.24 |
| Ohio | 171.21 | 65.85 | 63.99 | 267.47 | Texas | 145.74 | 48.03 | 55.39 | 230.14 |
| Wisconsin | 184.38 | 86.1 | 61.62 | 328.5 | **R7: Rocky Mtn.** | | | | |
| **R4: Plains** | | | | | Colorado | 202.21 | 102.83 | 53.9 | 364.83 |
| Iowa | 154.47 | 61.07 | 57.29 | 251.1 | Idaho | 172.14 | 78.97 | 60.25 | 341.54 |
| Kansas | 151.24 | 55.4 | 61.22 | 240.8 | Montana | 187.56 | 99.47 | 54.97 | 380.07 |
| Minnesota | 192.11 | 96.76 | 55.26 | 372.07 | Utah | 188.94 | 94.04 | 55.61 | 383.27 |
| Missouri | 177.92 | 72.28 | 65.26 | 299.71 | Wyoming | 146.37 | 71.25 | 48.91 | 288.71 |
| North Dakota | 150.86 | 59.57 | 60.15 | 285.36 | **R8: Far West** | | | | |
| Nebraska | 164.21 | 62.8 | 61.94 | 258.09 | Alaska | 166.34 | 67.63 | 62.7 | 288.46 |
| South Dakota | 169.07 | 74.26 | 61.39 | 296.82 | California | 251.87 | 158.19 | 41.65 | 640.09 |
| | | | | | Hawaii | 243.11 | 145.38 | 49.85 | 536.72 |
| | | | | | Nevada | 176.49 | 86.45 | 52.65 | 407.73 |
| | | | | | Oregon | 205.62 | 121.37 | 51.07 | 458.8 |
| | | | | | Washington | 226.29 | 132.71 | 46.17 | 502.19 |

Note: Calculations from quarterly data from 1975:1 to 2012:3. Base period 1980.1=100.

**Table 2.** Housing Index Descriptive Statistics for BEA Regions.

| Region | Name | n | Mean | Std. | Min | Max |
|---|---|---|---|---|---|---|
| **R1** | New England | 6 | 270.52 | 42.37 | 236.05 (VT) | 351.78 (MA) |
| **R2** | Mideast | 5 | 257.93 | 38.61 | 215.98 (PA) | 317.41 (NY) |
| **R3** | Great Lakes | 5 | 181.49 | 14.34 | 182.73 (IN) | 203.12 (IL) |
| **R4** | Plains | 7 | 165.7 | 15.36 | 150.86 (ND) | 192.11 (MN) |
| **R5** | Southeast | 12 | 178.47 | 24.67 | 138.42 (WV) | 199.32 (FL) |
| **R6** | Southwest | 4 | 159.72 | 24.64 | 132.16 (OK) | 181.93 (AZ) |
| **R7** | Rocky Mountain | 5 | 179.44 | 21.34 | 146.37 (WY) | 202.21 (WY) |
| **R8** | Far West | 6 | 211.62 | 35.06 | 166.34 (AK) | 251.87 (CA) |

Note: Calculations from Table 1
Source: Federal Housing Finance Agency from St. Louis Federal Reserve data base, FRED II.

**Table 3.** ANOVA Results.

| Source | SS | % | Df | MS | F | p-value |
|---|---|---|---|---|---|---|
| Between | 71,442.35 | 68 | 7 | 10,206.05 | 12.73 | 0 |
| Within | 33,660.65 | 32 | 42 | 801.44 | | |
| Total | 105,103.00 | 100 | 49 | | | |

Note: Calculations from Table 1
Source: Federal Housing Finance Agency from St. Louis Federal Reserve data base, FRED II.

**Table 4.** Hypothesis Testing for Regional σ-Convergence.

| Region | Name | F-test | Critical Point | |
|---|---|---|---|---|
| | | | 5% | 1% |
| **R1** | New England | 0.84 | 0.41 | 0.29 |
| **R2** | Mideast | 0.69 | 0.39 | 0.26 |
| **R3** | Great Lakes | 0.10* | 0.39 | 0.26 |
| **R4** | Plains | 0.11* | 0.43 | 0.31 |
| **R5** | Southeast | 0.28* | 0.5 | 0.38 |
| **R6** | Southwest | 0.28* | 0.35 | 0.23 |
| **R7** | Rocky Mountain | 0.21* | 0.39 | 0.26 |
| **R8** | Far West | 0.57 | 0.42 | 0.29 |

Note: Calculations by equation (4)
Source: Source: Federal Housing Finance Agency from St. Louis Federal Reserve data base, FRED II.

**Table 5.** Hypothesis Testing for State σ-Convergence.

| State | F-Test | State | F-test |
|---|---|---|---|
| Alabama | 0.579 | Montana | 1.118 |
| Alaska | 0.517 | Nebraska | 0.446 |
| Arizona | 0.98 | Nevada | 0.844 |
| Arkansas | 0.375 | New Hampshire | 1.874 |
| California | 2.828 | New Jersey | 2.73 |
| Colorado | 1.195 | New Mexico | 0.684 |
| Connecticut | 1.709 | New York | 3.639 |
| Delaware | 1.89 | North Carolina | 0.783 |
| Florida | 1.28 | North Dakota | 0.401 |
| Georgia | 0.69 | Ohio | 0.49 |
| Hawaii | 2.389 | Oklahoma | 0.208 |
| Idaho | 0.705 | Oregon | 1.665 |
| Illinois | 1.005 | Pennsylvania | 1.201 |
| Indiana | 0.438 | Rhode Island | 2.954 |
| Iowa | 0.422 | South Carolina | 0.786 |
| Kansas | 0.347 | South Dakota | 0.623 |
| Kentucky | 0.623 | Tennessee | 0.611 |
| Louisiana | 0.37 | Texas | 0.261 |
| Maine | 2.177 | Utah | 0.999 |
| Maryland | 2.06 | Vermont | 1.738 |
| Massachusetts | 4.896 | Virginia | 1.652 |
| Michigan | 0.761 | Washington | 1.99 |
| Minnesota | 1.058 | West Virginia | 0.273 |
| Mississippi | 0.361 | Wisconsin | 0.838 |
| Missouri | 0.59 | Wyoming | 0.574 |

Note: Calculations by equation (5). F-values>1.26 or <0.79 indicate significance at the 5 percent level. For 1 percent, the corresponding values are >1.39 or <0.72.
Source: Federal Housing Finance Agency from St. Louis Federal Reserve data base, FRED II.

## 5. Concluding remarks

This study examines whether σ-convergence exists with respect to housing prices across the 50 U.S. states and the eight BEA regions, especially in light of the recent housing market collapse and re-emergence of the housing market in recent years. We undertake a straightforward analysis of variance approach in evaluating the variance of housing prices at the state level within regions defined by the Bureau of Economic Analysis (BEA). The results reveal a great deal of variation across states and regions. First, we find little difference in housing prices for states within a region. Second, with respect to convergence across regions, the results show that the housing prices in the Great Lakes, the Plains, Southeast, Rocky Mountain, and Southwest regions diverge from overall U.S. housing prices while the housing prices in the New England, Mideast, and Far West tend to converge to overall U.S. housing prices. Third, in regards to convergence of housing prices for individual states to the overall U.S. housing price, nine states exhibit convergence, with the remaining forty-one states failing to do so.

The absence of σ-convergence across some states and regions suggests that the mobility of resources (labor and financial capital) to effectively arbitrage differential housing prices may be limited. Furthermore, the absence of convergence for a majority of the states and regions implies that regional housing markets may be driven by local demand and supply factors. Another observation is that the response of regional housing prices to business cycle fluctuations may be asymmetric and exhibit nonlinear behavior over the housing cycle (Miles, 2008; Kim and Bhattacharya, 2009). In addition, the non-standardization of housing, transaction costs, and uncertainty, not to mention construction lags, may account for the inefficiency of the housing market to respond effectively to price signals in the marketplace (Grenadier, 1995; Gu, 2002).

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