Stability of Housing Prices in Major US Cities: A Time Series Analysis of S&P/Case-Shiller Housing Price Indices

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Abstract

In this paper we explore the long term movement in the housing prices in select American cities. Using the monthly S&P/Case-Shiller Home Price Indices, we look at the stability of housing prices in 14 selected large American cities. We undertake the ADF (GLS) unit root test for the index in each city and find the optimal lag requirement for achieving stationarity using three criteria (Schwartz 1978; Ng and Perron 1995; Ng and Perron 2001). Optimal lag periods necessary to achieve stationarity differ widely across the cities. We also identify three distinct cycles of convergence-divergence in the housing prices across the US. Housing prices broadly converged between January, 1987 and January, 2000. At this point a rapid divergence in the prices set in and this trend continued until the middle of 2006. After about June of 2006, housing prices (probably) started correcting themselves resulting into a rapid convergence again. This trend continues according to the very latest data available.

JEL Classifications: R0, C2

"*Evidence on participation, diversification, and mortgage refinancing suggests that many households invest effectively, but a minority make significant mistakes.*"

(Campbell 2006)

Introduction

The American housing market has gone through some big changes in recent years. While residential home prices rose rapidly from 2000 until about 2006, some signs of slowdown became apparent by 2006-07. By the end of 2007, American housing market was clearly in a recession. Inventories started rising, and buyers started disappearing from the market. The downturn accelerated further during the fist half of 2008. National foreclosure and housing related bankruptcy rates are worryingly high and policy-makers are justifiably concerned.

Housing represents significant store of value for the American households. According to the S&P/Case-Shiller Home Price Indices' fact sheet, "*The value of residential real estate held by households and nonprofit organizations totaled US$ 22.5 trillion in 2007. This is comparable to the market capitalization of US$ 19.9 trillion in domestic equities and the US$ 29.7 trillion outstanding in bonds.*"[1]

Given the tremendous value of the residential real estate, a downturn in the housing market will probably have a significant impact on many other sectors in the economy. Buying a house is a major decision for any household. For a majority of the households, house-ownership constitutes a major portion of the total wealth. House ownership may significantly affect the consumption behavior of the households ((Case, Quigley et al. 2001).)

Distress in the American housing market is all too apparent at this point. Mortgage Bankers Association predicts that one out of every two hundred houses would be foreclosed. Every quarter in America, 250,000 new families enter into foreclosure. Mortgage Bankers Association also estimates that one child in every classroom in America would loose his/her home because the parents are unable to meet their financial obligation.[2]

If recent economic indications are of any value in America, housing sector slump is having a major impact on the economy. Mortgage backed securities and risks inherent therein are cited to be major reasons behind the financial distress for companies like Lehman Brothers, Washington Mutual, Fannie Mae, Freddie Mac to name a few. At the time of writing this paper, the US congress is actively addressing the issue of offering a bailout for the economy buying the distressed mortgage backed securities from the

1 For more details on the fact sheet see http://www2.standardandpoors.com/spf/pdf/index/SP_CS_Home_Price_Indices_Factsheet.pdf, Accessed July 14, 2008.

2 For more details, see http://www.fdic.gov/about/comein/files/foreclosure_statistics.pdf, accessed September 28, 2008.

financial market. The total bailout package offered by the government at various phases of the current financial crisis in America could easily reach trillions.

Buying a house, like any other investment, may be risky proposition too. Rise in interest rates may curtail household's ability to meet mortgage repayment obligations. Under difficult financial conditions involving job loss, large medical bills etc. rise in repayment obligations may lead the household towards bankruptcy. Recent spike in bankruptcies and property foreclosures point to inherent risk of the real estate investment.

Housing is also a significant segment of the overall portfolio of investment choices for the consumer. For example, there exists clear tradeoff between investment in stocks, bonds, and housing. According to the S&P/Case-Shiller Home Price Indices' fact sheet, bonds and housing may be viewed as substitutes in the investment portfolio of consumers.[3]

In this paper, we explore the long term movements in the housing prices in select American big cities. Using the monthly S&P/Case-Shiller Home Price Indices', we look at the stability of housing prices in 14 major American cities. We undertake the DF^{GLS} unit root test for the index in each city and find the optimal lag requirement for achieving stationarity using three criteria (Schwartz 1978; Ng and Perron 1995; Ng and Perron 2001).

In the next section we describe the data and methods employed in this paper. The following sections provide some discussions on the results and also offer some concluding remarks.

Data and Methods

We use the monthly S&P/Case-Shiller Home Price Indices' values for 14 US cities. The time period covered in our analysis spans from January, 1987 to April, 2008. Together, they cover 257 months' of continuous data.

The covered cities are Los Angeles (LXXR), San Diego (SDXR), San Francisco (SFXR), Denver (DNXR), Washington DC (WDXR), Miami (MIXR), Tampa (TPXR), Chicago (CHXR), Boston (BOXR), Charlotte (CRXR), Las Vegas (LVXR), New York (NYXR), Cleveland (CEXR), and Portland (POXR).

The data used in this paper may be downloaded from
http://www2.standardandpoors.com/spf/pdf/index/CSHomePrice_History_062418.xls, Accessed July 14, 2008.

[3] *For more details on the fact sheet see http://www2.standardandpoors.com/spf/pdf/index/SP_CS_Home_Price_Indices_Factsheet.pdf, Accessed July 14, 2008.*

We check to see if the housing price index is stationary for each city. We employ DF^{GLS} following (Ng and Perron 1995) for each city. We employ three criteria to find the lag required to reach stationarity. These are optimal lag (Ng-Perron sequential t), (Ng and Perron 1995), minimum SIC, (Schwartz 1978), and Modified AIC, (Ng and Perron 2001).

Following (Dickey and Fuller 1979; Said and Dickey 1984), an Augmented Dickey-Fuller regression may be written as

$$\Delta y_t = \beta_0 + \gamma t + \rho y_{t-1} + \sum_{j=1}^{k} \beta_j \Delta y_{t-j} + \varepsilon_t \;,\; t = 1,2,.........,T.$$

Following (StataCorp 2003) pp. 66-67, a DF^{GLS} testing steps may be summarized as followed

$$\tilde{y}_t = y_t - \alpha^e y_{t-1}\,,\; \tilde{y}_1 = y_1\,,\; t = 1,2,.........,T$$

$$x_t = 1 - \alpha^e\,,\; x_1 = 1\,,\; t = 1,2,.........,T$$

$$Z_t = t - \alpha^e (t-1)\,,\; Z_1 = 1\,,\; t = 1,2,.........,T$$

If y_t is stationary around a linear time trend, then $\alpha^e = 1 - (13.5/T)$. If y_t is stationary with no linear time trend then $\alpha^e = 1 - (7/T)$ (Ng and Perron 1995; Ng and Perron 2001; StataCorp 2003).

Let us define $y^* = y_t - (\hat{\delta}_0 + \hat{\delta}_1 t)$

where $\hat{\delta}_0$, and $\hat{\delta}_1$ are estimated from $\tilde{y}_t = \delta_0 x_t + \delta_1 z_t + \varepsilon_t$.

The DF^{GLS} model can then be presented as

$$\Delta y_t^* = \beta_0 + \rho y_{t-1}^* + \sum_{j=1}^{k} \beta_j \Delta y_{t-j}^* + \varepsilon_t$$

Following (Schwert 1989), the maximum lag may be set as

$$k_{\max} = \text{int}[12\{(T+1)/100\}^{(1/4)}]$$

Results & Discussion

Time series plot of the housing prices indices are presented in Figure 1. The figure confirms widespread variation in the housing price indices across the years. There is clearly a rapid rise in the price indices from 2000 and this trend continued until 2006. At this point housing market started showing signs of slowing down. Prices eventually started declining by the end of 2006 and beginning of 2007 and that downward trend is still continuing.

It is fair to say that recent declines have significantly eroded the gains in earlier periods. Since household wealth in the USA is strongly tied to the value of the housing, it seems that the American households have suffered through a significant wealth loss in recent times. Anecdotal evidences suggest that for many American families, outstanding mortgage obligations may be larger than the prevailing value of the house. This phenomenon alone represents a significant negative home equity for a large number of US households.

Summary statistics presented in Table 1 confirms that housing prices moved quite differently in different cities of the country. Large cities like Los Angeles, San Diego, San Francisco, Washington DC, Miami, Tampa, Las Vegas, and New York registered highest range of variations across the years. Charlotte, North Carolina has been the least volatile housing market in the sample.

Other big cities like Denver, Chicago, Boston, and Cleveland showed much less housing price volatility compared to Southern California or Southern Florida. In terms of variance, Cleveland is the second lowest volatile real estate market in the sample. Portland, Oregon recorded an intermediate range of volatility.[4]

Table 2 presents the DF^{GLS} test results for unit root for the housing price index for each city. There are wide variations in the optimal lag required to make the series stationary for different cities. (Schwartz 1978) criterion returns the lowest required lag to achieve stationarity for all the cities.

Criteria proposed by (Ng and Perron 1995; Ng and Perron 2001) mostly returned much longer lag requirement to achieve stationarity compared to Schwartz (1978). The only exception is San Francisco where the required lag prescribed by Schwartz (1978) and Ng and Perron (2001) are the same and one of the lowest in the sample.

Because of the strong linear trend present in the series, low volatility areas like Denver, Chicago, Boston, Charlotte, Cleveland, and Portland show largest lag requirement to achieve stationarity according to the Schwartz (1978) criterion. Las Vegas, Nevada showed the lowest overall lag requirement to achieve stationarity across all the cities in the sample.

We also computed the standard deviation of the housing price indices across the cities for each month. This plot is presented in Figure 2. The plot clearly presents three distinct regimes. From January 1987 until January 2000, variance in the housing prices clearly followed a mildly downward trend. This is an indication of classic convergence in the residential real estate prices both across time and space.

After January, 2000, the prices started diverging from one another as is indicated by the rising standard deviation across months presented in Figure 2. This trend continued until about the middle of 2006. At this point, housing prices across the 14 cities started rapidly

[4] Part of the reason for bad housing market performance or less volatility in the Mid-West regions lies in severe industrial disruptions in these locations. Cleveland in Ohio and Detroit in Michigan are some of the historically industrially strong areas in the country. Severe downturn in the auto industry in this region is partly responsible for more subdued performance in the housing sector in Mid-West.

converging to each other as is indicated by the falling standard deviation across months. This trend continues monotonically into the present time periods as the data indicate.

Conclusions & Future Research Direction

We draw several conclusions from our study. Housing prices are really heterogeneous across the nation. While California, Florida, Nevada, and New York represent some of the most volatile markets, housing prices more or less followed in secular trend in North Carolina, Massachusetts, Illinois, Ohio and Oregon regions.

Relative house prices varied widely across the nation. While housing prices rapidly converged across the nation between 1987 and 2000 the same started diverging wildly between 2000 and 2006. The next phase saw rapid declines in some of the hottest markets in Southern California and Florida and as a consequence, housing prices started converging again starting late 2006/early 2007. This trend continues according to the very latest data available.

Considering the close association between housing prices and household wealth in the US, it seems that millions of households have suffered significant value losses across the nation in recent times. We might see indications of current financial crisis in the housing market downturn in recent times.

Optimal lag periods necessary to achieve stationarity differ widely across the cities. This may be explained by different housing price volatility across different cities.

We find the convergence-divergence cycle to be very interesting. Future research should look into the causes that led to a rapid divergent movement in the housing prices starting early 2000. Also, future research is needed to explore the causes that led to a reversal of this diverging trend and beginning of another cycle of converging movement starting about the middle of 2006.

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Figure 1

S&P/CS Home Price Indices for 14 Selected US Cities

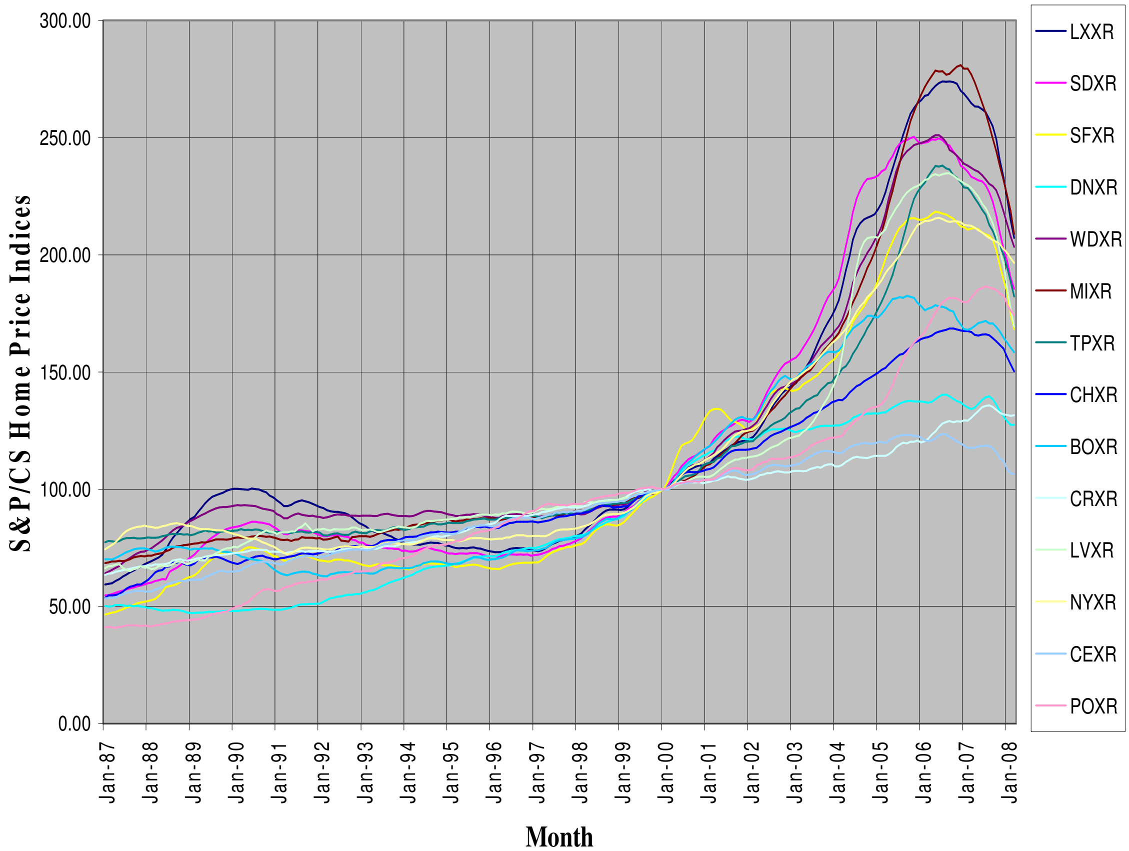

Figure 2

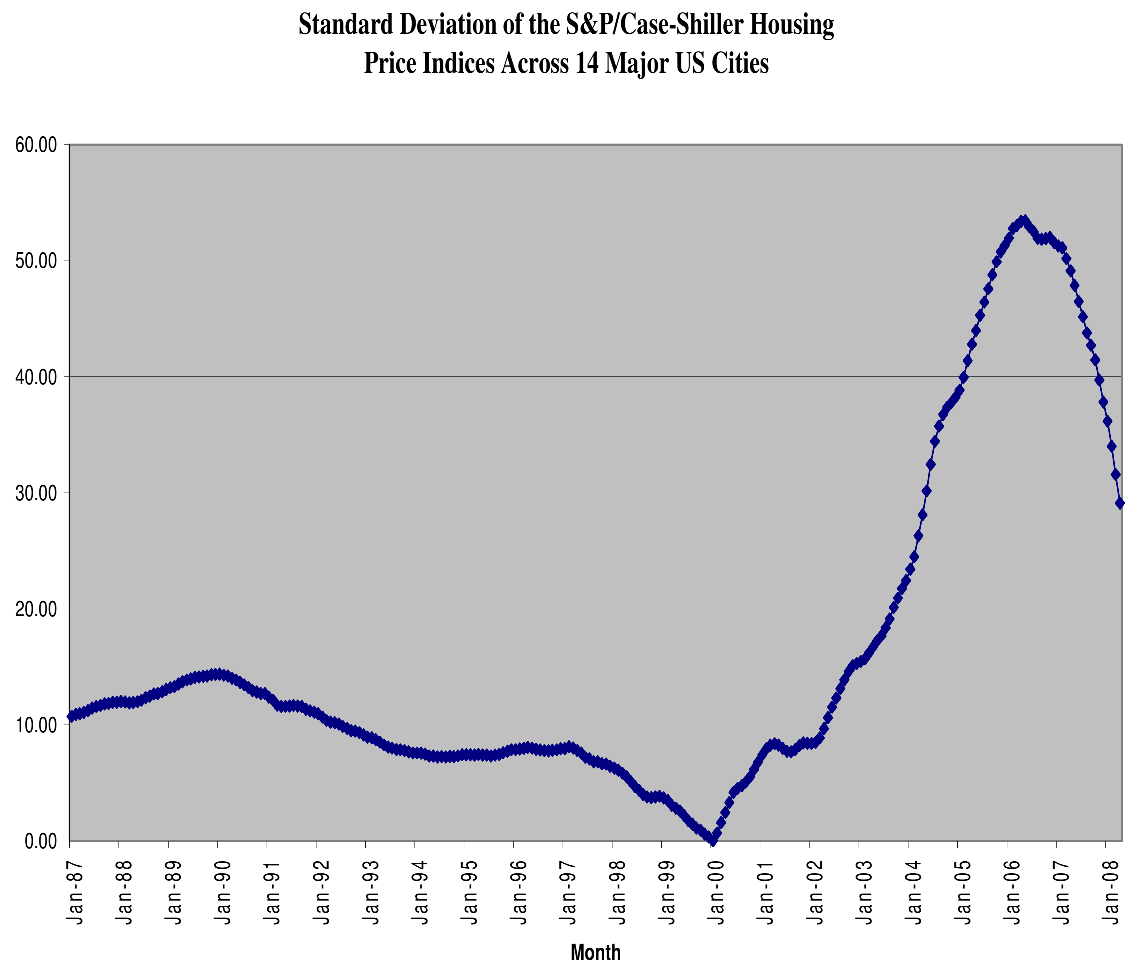
Standard Deviation of the S&P/Case-Shiller Housing
Price Indices Across 14 Major US Cities
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Month

Table 1

Summary Statistics for the S&P/Case-Shiller Housing Price Index for Various US Cities (Time Period Covered: Monthly Data Between January, 1987 to April, 2008)

City Name	Mean	Standard Deviation	Minimum	Maximum
Los Angeles	123.84	64.26	59.33	273.94
San Diego	118.68	62.38	54.67	250.34
San Francisco	107.59	53.28	46.61	218.37
Denver	88.20	33.93	47.21	140.27
Washington DC	123.27	55.05	64.11	251.07
Miami	122.35	63.33	68.50	280.87
Tampa	115.49	48.03	77.33	238.09
Chicago	101.48	33.79	53.55	168.60
Boston	104.19	42.27	62.94	182.45
Charlotte	93.25	19.95	63.39	135.88
Las Vegas	115.04	51.83	65.14	234.78
New York	113.72	48.19	72.29	215.83
Cleveland	90.89	21.14	53.50	123.49
Portland	95.60	40.84	40.96	186.51

Table 2

Results of the DF^{GLS} Tests for Unit Root in the S&P/Case-Shiller Housing Price Index for Various US Cities (Time Period Covered: Monthly Data Between January, 1987 to April, 2008)

City Name	Lag periods at which $DF^{GLS}-\tau$ statistic is statistically significant at 5% level according to various criteria (i.e. null hypothesis of a unit root is rejected)		
	By (Ng and Perron 1995) Criterion	By (Schwartz 1978) Criterion	By (Ng and Perron 2001) Criterion
Los Angeles	13	7	13
San Diego	13	7	13
San Francisco	14	2	2
Denver	11	11	15
Washington DC	13	2	14
Miami	13	2	15
Tampa	11	6	12
Chicago	12	10	10
Boston	12	11	14
Charlotte	13	13	12
Las Vegas	9	1	3
New York	11	7	7
Cleveland	15	12	12
Portland	15	11	15