**PROJECT 5: EXECUTIVE REPORT**

1. **PROJECT DESCRIPTION**

This project is to analyze the Home Price Index data and detect the house bubbles in the past, show when it started and burst. Also, give analysis of the bubble impact to current house price, and give advice to a friend about to buy or to rent right now. Fig 5-1 shows the plot of the original house price index time series.

  

Figure 5-1 House Price Index Figure 5-2 Rent Index Data Figure 5-3 Rent-Price Ratio

1. **CHOSEN METHOD TO DETECT BUBBLE**

|  |  |  |
| --- | --- | --- |
| History Bubble | Start Time | End Time |
| 1 | 1990-01 | 1990.02 |
| 2 | 1993-10 | 1997.05 |
| 3 | 2002-03 | 2006.04 |
| 4 | 2015-03 | 2015.08 |

Based on the analysis of Taipalus, K(2012), the house bubble can be signaled by the marketing fundamentals, i.e, Rent-Price Ratio. Here I got the rent index data are from BLS: <http://www.bls.gov/home.htm>. And use logged rent-price ratio to make indicators of bubble. Inspired by Taipalus, K(2012), the bubble detecting method here is a Rolling ADF test, using ADF coefficients test statistic in rolling OLS regression. The rolling window is selected to be 36 according to the article, it’s the reliable window length. Below graph is bubble analysis result. Bubble start and end history is shown in the table.



1. **FORECAST NEXT 12 MONTHS BUBBLE**

I fitted AR(6) model to the logged Rent-Price Ratio data, and make predictions of the future 12 months and did the bubble anylysis again . The model is , . We can see the previous bubble still impact the current house price. And there is another bubble from 2016-08 to 2016-10. So I would suggest the friend to rent a house instead of buy one.

**Reference:**

Taipalus, K. (2012). *Detecting asset price bubbles with time-series methods.*

Peng, Huang. (2008). *Rolling ADF test: detecting rational bubbles in greater china stock market*.

Philip Hans Franses. (2013). *Are we in a bubble: a simple time-series based diagnostic*

**PROJECT 5: TECHNICAL APPENDIX**

1. **Data and Methods Exploration**

After exploring some articles on bubble test, generally, there are two ways of analyzing bubble.

First one is to use some marketing fundamentals to signal if the house price is overheating or not. Second is to use only the house price index, analysis the growth pattern to detect bubble. In this project, I tried 3 different methods with the Method 1 belongs to the first category, and Method2 and Method 3 belongs to the second category.

1. **Method 1: Marketing Fundamentals + Rolling ADF test (actual coefficients)**

According to Taipalus, K(2012), economists have defined many ways of “Marketing Fundamentals”, as there are many economic variables affect the real estate price, like household income, interest rates, supply, taxes, public policies etc. The author argued that rent-price ratio is a reasonable fundamental. Using the rent-price ratio, the bubble-concept is defined: “the developments in house prices or rents should not differ greatly from each other; otherwise this would mean that a bubble is developing in the housing markets”.

The rolling OLS-regressions are applied to log rent/price series to get the least squares estimates to ADF- coefficients. In regressions the lag was defined by the AIC, trend was not included, but constant was allowed. Window lengths here are all based on sample size 36, based on the author’s final recommendation.

1. **New Rent Data and Rent-Price Ratio**

The rent data is from Bureau of Labor Statistics website. And below figure is the plot of logged rent-price ratio.



1. **Rolling ADF Test**

The test is implemented in R using the package “fTrading”. The rolling function is to implement regressive OLS for sample size 36. The test is to find whether coefficients are 0 or not. Below is the test result of this ADF-36 test, and the correlated indicator of bubbles in original house price data. Detail results are also shown in the report.





1. **Forecast Future 12 months Bubble**

Using the logged rent-price ratio data, I fit an AR(6) model to forecast. The AR(6) model is chosen among many candidates models like ARMA(2,1)-ARMA(6,2), AR(2)-AR(8), considering the ACF, pACF, residual diagnostics etc. The final model is , .

Below are the residual diagnostics and 12 months forecast of this model.



1. Combing the new forecasted data with original rent-price ratio data, employ the ADF-36 test again to detect bubbles for the new dataset. Result is shown in the report.
2. **Method 2: Rolling ADF test (t-value)**
   1. Peng Huang(2008) suggested a traditional Rolling ADF test to detect bubbles in stock market, which is similar but much easier than the previous method. Here I employed the same idea on the house data, and only the house price index data will be used.
   2. General idea is: the ADF tests are implemented for every sub-sample and the outcome is an ADF statistic for each subsample. Here for the sub-sample size we also choose 36, which is about 10% of original dataset. And each significant ADF statistic is related to the sample which is experiencing bubble. Critical value to evaluate explosive evidence in recursive and rolling ADF tests is conventionally defined using the 95 percentile, calculated here by qunitroot(0.95,36,trend=c("c")).



And the main detected bubbles are:

|  |  |  |
| --- | --- | --- |
| History Bubble | Start Time | End Time |
| 1 | 1989-12 | 1991.03 |
| 2 | 1998-4 | 1998.10 |
| 3 | 2004-03 | 2004.10 |
| 4 | 2006-05 | 2007.03 |

1. **Method 3: One-step Ahead Test (Preliminary Trial)**

Philip Hans Franses(2013) proposed another method called “one-step-ahead simple test” to detect bubble, which has a high test power indicated by Monte-carlo simulation. The idea is also to test for deviations from stability. Usually, economic bubbles are associated with price series showing explosive behavior for a short period, and once the bubble bursts, there is a return to a lower level(Philip hans Franses,, 2013).

**a. Concepts are:**

i. Based on the notion of the balance between acceleration(second difference) and growth(first difference).

ii. Positive growth and acceleration drives the data to explosive behavior. i.e. (1-B)Yt, and (1-B)^2\*Yt are both positive at the same moment.

iii. When growth and acceleration are at balance, it can be shown that a specifically transformed time series should be stable and not show bubble-like patterns.

iv. A simple time-series-based test for the presence of a bubble (and perhaps for a warning of an upcoming collapse) can be based on a regression of the variable (1-B^2) \*Yt on an intercept and the associated one-step-ahead forecast errors based on the recursive residuals.

Implemented the one-step ahead simple test in R by the package ”structchange”.

**b. Implementation in R:**

We could notice some structure change from the graph below. There shows a bubble between 2000-2006. And the current value is very close to boundary.

This method has not be fully implemented. More analysis and R implementation are still needed in the future.

