# House Price Index Analysis - Affordability and Expectation

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## Abstract

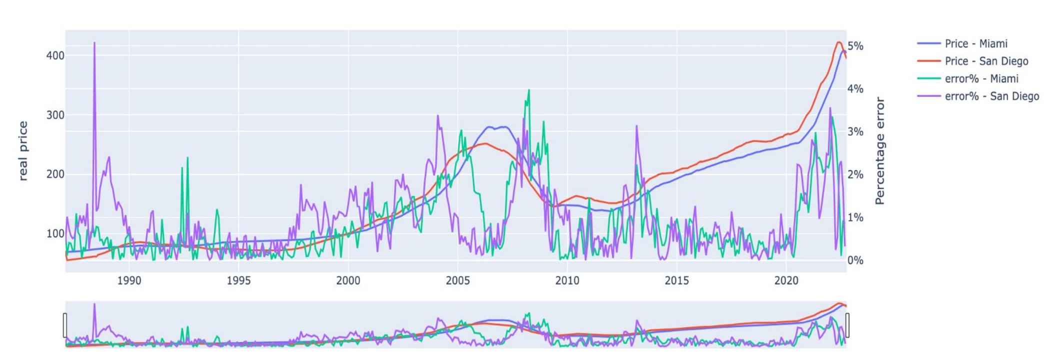
**House Price Index (HPI)** is a broad economic measure of the movement of single-family house prices in the United States and it plays an essential role in capturing the dynamics in the real estate market. From the historical trend of the House Price Index, the property bubble and its burst can be observed from 2005 to 2010. Investors are now more concerned about **whether we will experience similar housing bubbles shortly** and, even more precisely, **when is the turning point**. However, in previous studies, market difference was a main obstacle to establish a general model. In this project, we examine markets separately and try to understand HPI in **city level.**

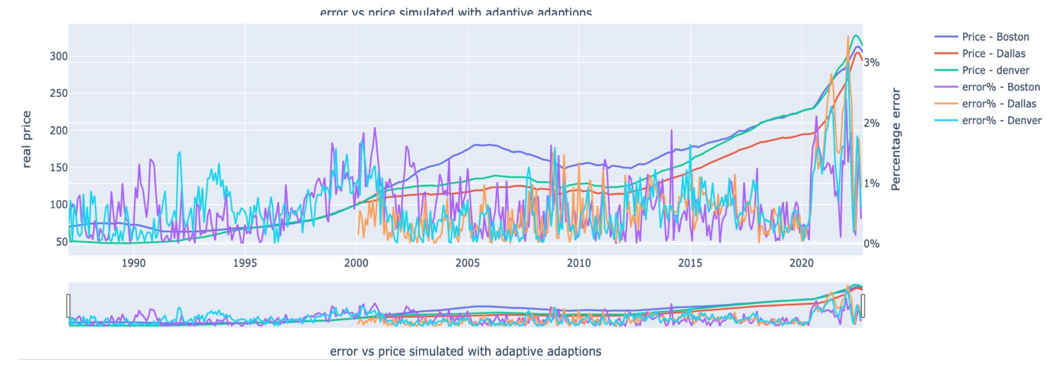

## Study Goal

In this project, we try to fully understand the mechanism of housing bubbles by focusing on affordability and credit availability. By **decomposing the affordability** into purchase affordability and repayment affordability, we will show the relationship between **housing price, interest rate, and householders' income**. Combined with **expectation theory**, we try to explain bubble accumulation and its final burst considering people's psychological factors. We try to analyze the trend of housing prices and potential bubbles embedded in three different approaches: affordability and credit ability as a basic benchmark, expectation theory to incorporate psychological effects and the residual income perspective to dig deeper into household-wise affordability.

## Expectation Theory

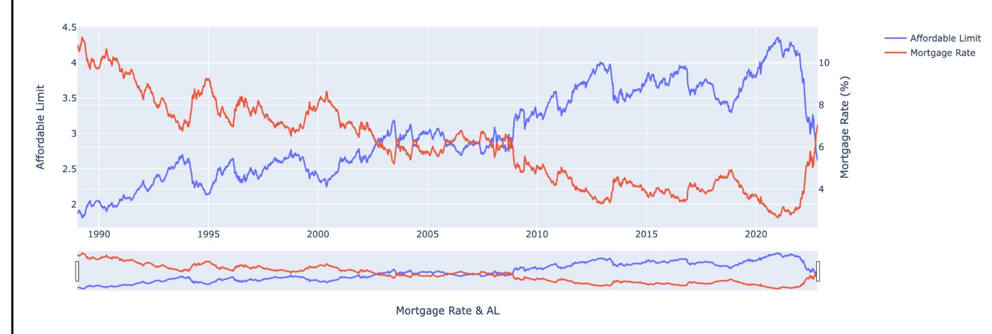
Through income sensitive **adaptive expectation** model and **k-means clustering**, we discover that price expectation will fluctuate with the actual price of houses in all cities but there are other independent factors that also exaggerate the cycles. In volatile markets, errors are expected to be larger. It takes longer to reach the top of the bubble and fall creating a concave shape of the price during the crisis period. This does not present in less volatile markets.




## Affordability Decomposition

| **M1** Affordable Limit (AL) | **Category:** Repayment Affordability |
|---|---|
| **Definition:** The ratio of the maximum allowable loan to income. | |
| **Formula:** $AL = (\frac{\alpha}{1-\beta})(\frac{1-(1+i)^{-N}}{i})$ where i is the monthly mortgage rate, N is remaining payment periods, denotes the proportion of gross income a household can allocate to mortgage payments, and denotes the down-payments ratio. | |




**Observation:** Affordable limit and mortgage rate are negatively correlated since a higher mortgage imposes higher borrowing costs which will surely worsen the largest allowable loan regarding a fixed income.

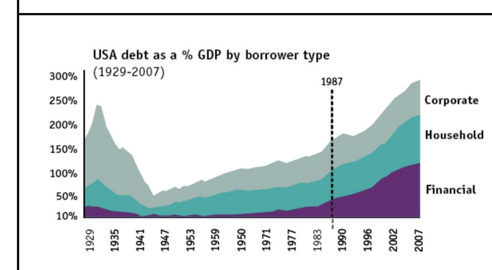
| **M2** Affordability at Risk (AaR) | **Category:** Purchase Affordability |
|---|---|
| **Definition:** The proportion of houses traded in a given period that are unaffordable for a household with a given income level. | |
| **Formula:** $AaR(x) = \int_{xAL}^{y} f(y)dy = 1 - F(xAL)$ | |
| **Example:** Suppose a household's annual income is \$30,000, and the corresponding AL is 4. Therefore, the maximum affordable house price is \$30,000 * 4 = \$120,000. AaR(x), in this case, computes the proportion of houses available on the market with a price higher than \$120,000. | |
| **Rationale:** Compared to AL, AaR considers movements in house prices. | |


**Observation:** Between low-volatile and high-volatile markets, the AaR lines have a relatively large gap.

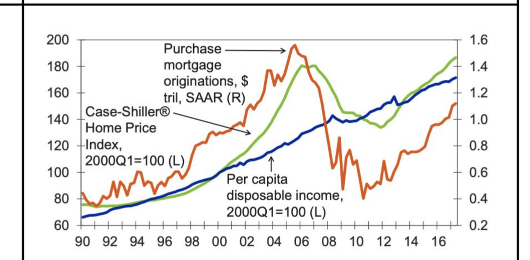

**Observation:** Due to the missing data on housing price distribution before 2010, we simulated the price distribution and, therefore, more uncertainty involved in the green line for Miami, which is a typical high-volatile real estate market.

## Credit availability

**F1** *US debt-to-GDP ratio by borrower type, %, 1929-2007, Source: IMF*




**F2** *Loan Cycle Disrupted Price Trend Sources: CoreLogic Inc., BEA, MBA, Moody's Analytics*

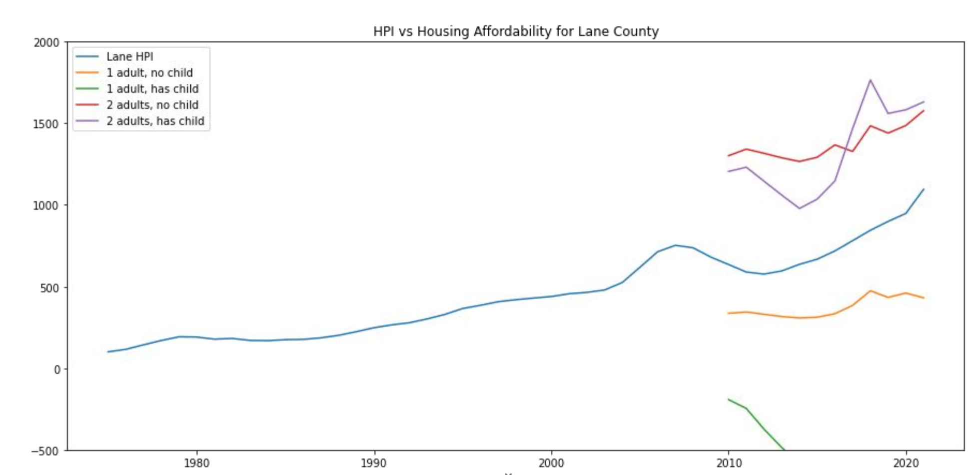



**F3** *Credit availability: cumulative sum of ABS, commercial mortgages and REITs*


With more loan credit available in the market, people are able to obtain funds for purchasing or investing in houses much easier and thus **reinforce the trend of increasing housing prices**. As we can observe in **F2**, factors such as disposable income growth govern long-term price trends, while business cycles and construction cycles impose short-term fluctuations around long-term trends. Mortgage lending and loans, however, **generate deviations from long-term price trends** resulting in the house price bubble accumulation and its burst, as illustrated by the red dividing line in **F3**.

## Residual Income Approach

The key idea of this approach is to analyze the household balance sheet, namely the income, taxes, and minimal non-housing expenditures. **We can derive the maximal housing expenditure, which is the housing affordability, by subtracting the minimal non-housing expenditures and taxes from income.** This method is by nature logically sound and can produce precise estimations for different types of households.



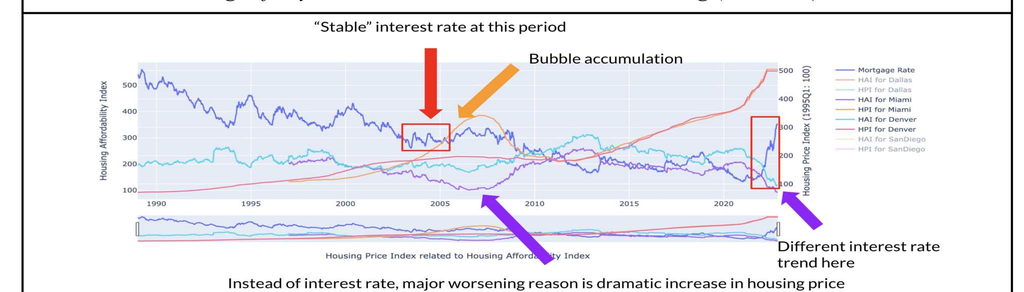

Through preliminary investigations, most counties display similar phenomenon where the household type "**1 adult, has child**" starts with extremely low maximal housing affordability and keeps declining, showing that on average this type of household is even unable to afford basic surviving non-housing expenditure and has nearly no housing affordability.

Although the method is theoretically promising, there are tremendous difficulties in realization including securing suitable datasets, calculating taxes, and integrating different datasets together.

## Combination & Discussion

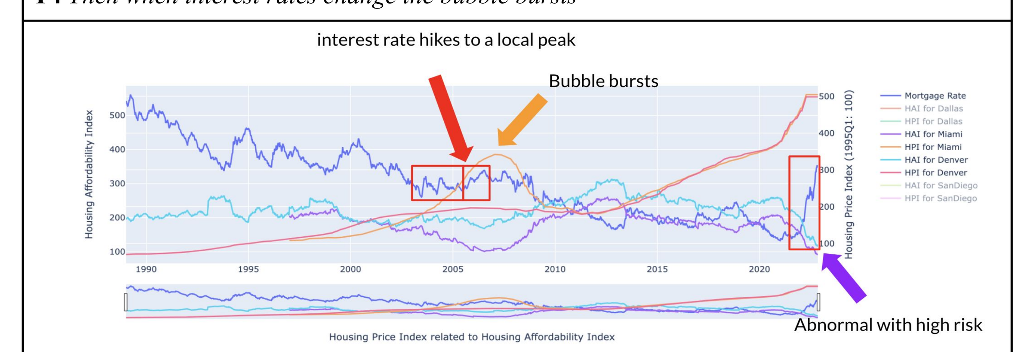
**T1** *The necessary condition for a bubble is a low affordability index*


**T2** *Bubbles can linger for years when interest rates are decreasing (or stable)*




**T3** *Expectation theory comes in and reinforce the bubble accumulation*


**T4** *Then when interest rates change the bubble bursts*




**T5** *Rising interest is the catalyst, but a bubble must first be present for a crash to take place*


## Future Work

- **Data Frequency:** A high-quality dataset with better granularity may improve accuracy.
- **Distribution Estimation.** The dataset only includes 10-year period for housing price distribution, so a better estimation for other years is required.
- **Regional Test**. More regions with different features could be tested.
- **Psychological Effects.** We assume adaptive expectation in the market; however, adaptive, naive and rational expectation may exist at the same times. Future research can also extend the model to incorporate multi-period analysis.