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Statistical Methods for Estimating House Price Index

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Abstract

House Price Index (HPI) is the key barometer of house prices measured from the aggregated house sales transactions data. HPI provides summary of the housing market that is used to track the movement in the house prices through time and analyze the performance of housing market. It is one of the most closely monitored economic indicators in the United States. In US, HPIs are estimated and published at various levels of geographic region including US census divisions, states, Metropolitan Statistical Area (MSA), Core Based Statistical Area (CBSA), zip code. The most popular indices published in US are FHFA HPI, Standard & Poor's Case-Shiller Indices, Nahb.

Keywords: Statistical methods; House price index; Housing market

Introduction

Houses have set of different hedonic characteristics like number of bedrooms, number of bathrooms, square footage, school district, location, indicated condition, modernized, garage. Further, there are different types of properties: single family house, condonium, cooperative unit. The characteristics of the units sold may vary from period to period, resulting in change in representation of the population in the sample set used in estimating the appreciation or depreciation in prices. For example, at one period if the population represents high-end houses and in next period, it represents low-end houses, the changes in sales price as a measure for house price movement would give an indication of house price depreciation, though in reality, the house prices might have appreciated if the population sample set has been kept standard. A naive statistical approach of simple moving average of house prices does not provide the true measure of house price movement due to above-mentioned reasons. The numbers of studies have been done to solve this problem and it narrowed down to two methodologies that are widely used: 1) Hedonic regression, 2) Repeat Sales Method.

In Hedonic regression approach, first introduced by Griliches, Ball, Rosen [1-3], the differences in the characteristics of units in various samples are statistically controlled. The sales price is regressed on a set of variables that describe the unit characteristics like number of rooms, square feet of interior space, lot size, quality of construction, condition. The house price indexes are constructed in number of ways by using the sensitivity of coefficients from the hedonic regression. First, the estimated equations from each period can be used to predict the value of a standard unit in each period. The characteristics of the unit do not change over the estimating period. This is similar to constructing a basket of goods for Consumer Price Index calculation. Alternatively, dummy variables are introduced in the equation to capture change in price over time while controlling for characteristics. In this alternative way, the prices for different characteristics are implicitly not allowed to change with time whereas in the first one, individual characteristic gets its own price and changes with time. The hedonic approach requires a large quantity of data on individual units sold including their characteristics.

In Repeat Sales Method, developed by Bailey, Muth, and Nourse [4], the data is restricted to the properties that have actually sold more than once during the estimation period. The method has the major advantage of isolating actual increases in the price of housing without requiring detailed information about the characteristics of individual properties. The groups of studies have shown that controlling the population to repeat sales gives the more accurate measure of changes in house prices. This approach does not require the measurement of the quality but requires that quality does not change over time. Much research have been further done to improve the indices, most notable by Case and Shiller [5,6] where they extended the method to incorporate heteroscedastic error due to gap time between sales and called it weighted repeat sales method (WRS). Due to limitation to using properties that have been sold more than once, only small percentage of the total sales data is usable for this approach. Though, repeat sales method is widely used in research studies and commercially as well, it has received lot of criticism too that it only provides information about a very specific type of home and may not apply to the entire housing market – England et al, Meese and Wallace [7,8].

A hybrid model has been proposed by Case and Quigley [9] that combined repeat sales methodology with hedonic regression so that all the sales transaction data could be made usable and the issues with repeat sales method could be addressed to some extent. Clapp and Giacotto [10] developed an assessed value method by constructing a modified repeat sales method which incorporated assessed values of homes as a hedonic variable coupled with actual sales. Knight, Dombrow, and Sirmans [11] proposed another variant of a hybrid index in which the hedonic coefficients were allowed to vary over time.

Survey of Prominent US House Price Indices

Freddie Mac and Fannie Mae are government sponsored enterprises (GSEs) chartered by Congress to provide a secondary market in conventional mortgages and increase lending for home ownership. Federal Housing Finance Agency (FHFA) is the regulatory agency responsible for oversight of these GSEs. FHFA publishes HPI based on weighted repeat sales methodology on monthly and quarterly basis. The mortgage data includes single family properties whose mortgages have been purchased or securitized by Fannie Mae or Freddie Mac since January 1975. The HPI includes house price figures for the nine

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Census Bureau divisions, for the 50 states and the District of Columbia, and for Metropolitan Statistical Areas (MSAs) and Divisions (Figure 1).

The standard and Poor's Case-Shiller house price indices are based on repeat sales methodology. There are multiple indices from Case-Shiller including National home price index, a 20 city composite index, a 10 city composite index, and 20 individual metro area indices. The index includes only single-family, detached residences and excludes new construction. There are futures and options available for investment community based on Case-Shiller index. This index was first developed by Karl Case and Robert Shiller is now considered as industry's standard (Figure 2).

Nahb Housing Market Index is reported by the National Association of Home Builders. It is based on a monthly survey of home builders. They are asked to rate current sales of single-family homes and sales expectations for the next six months and to rate traffic of prospective buyers. Scores for responses to each component are used to calculate a seasonally adjusted overall index. This concept tracks sentiment among participants in the housing industry. A reading above 50 indicates more builders view conditions as good than poor. Contrary to previous two indices discussed, this index is based on qualitative methodology (Figure 3).

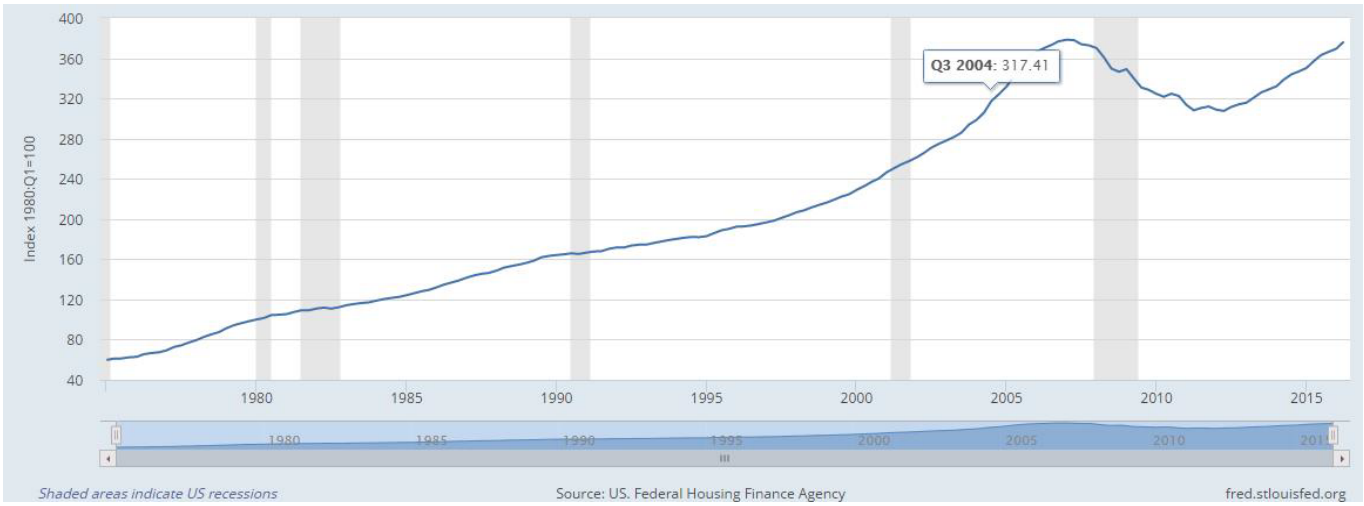

Figure 1: House price figures.

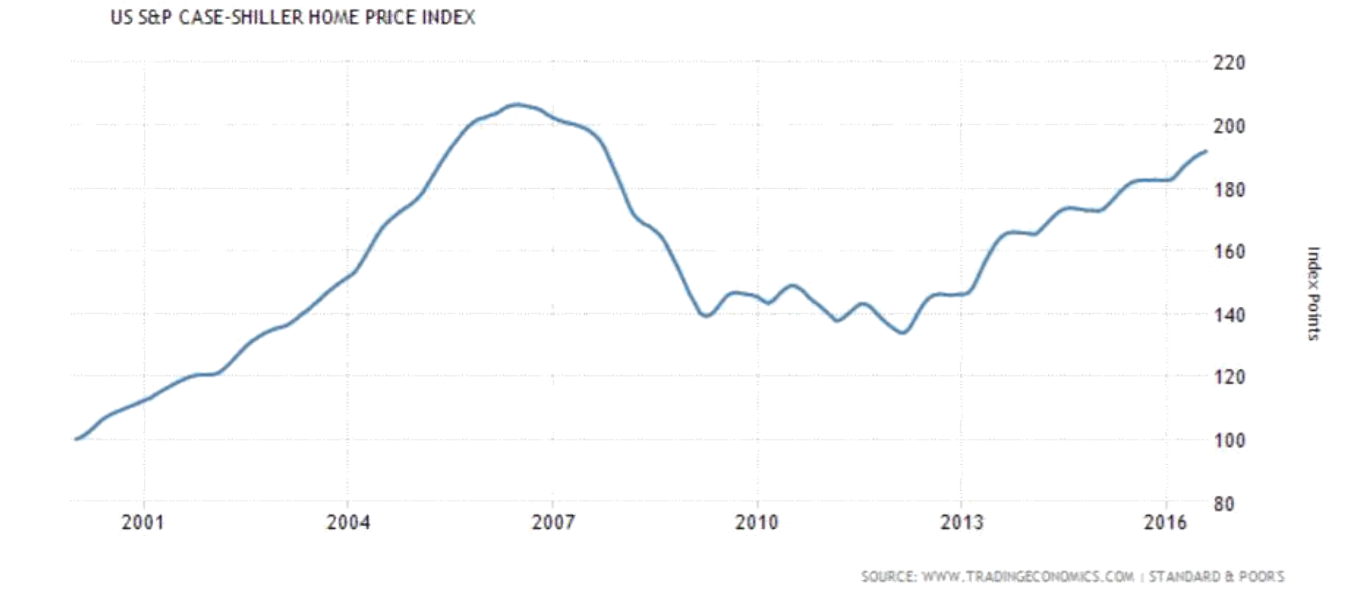

Figure 2: Case-Shiller Home price index.

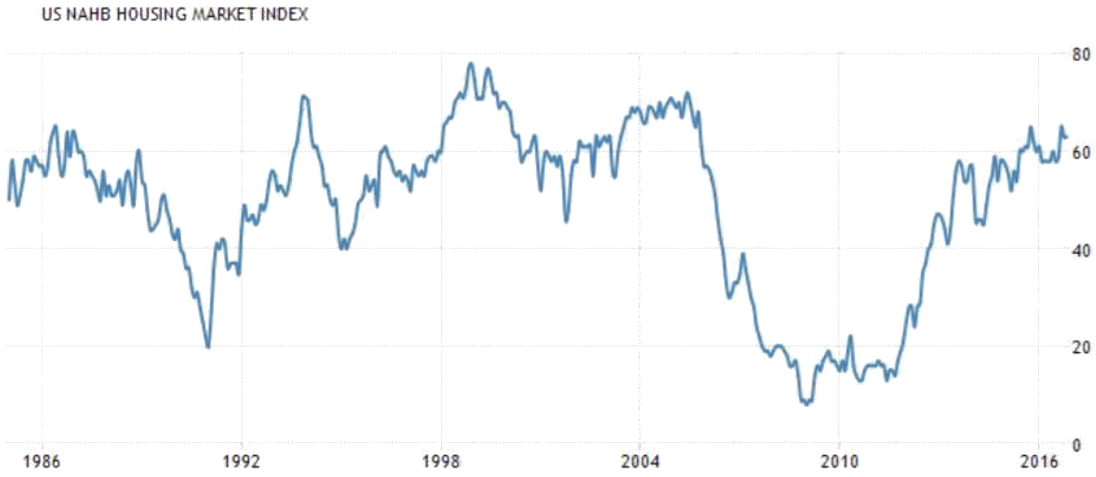

Figure 3: Hosuing market index.

Conclusion

House price index has found its application widely in mortgage prepayment and default modeling. Prepayment defines the ability of the borrower to pay early and default indicates inability of borrower to pay its scheduled payments of principal and interest. These models are extensively used in valuation and risk analysis of mortgage backed securities, pooled mortgages. The house price index is forecasted using econometric models, artificial neural network models, and time series models like auto regression. Some of the significant macro-economic variables used in modeling and forecasting HPI are interest rate, oil price shock, currency movement, business cycle, legislative and regulatory policy, inflation.

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