

HOUSING MARKET FORECASTING AND ANALYSIS IN CALIFORNIA

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SIGNATURE PAGE

PROJECT:

HOUSING MARKET FORECASTING
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ABSTRACT

One of the objectives of this project is to develop a system for modeling and predicting residential real estate that considers connections between property types, time-series characteristics within a region or city, and socio-economic elements of preferred real estate locations. The residential real estate market and the numerous types of properties that are accessible are the primary focus of the project. Instead of focusing on seasonality in real estate indexes, the thesis examines seasonality in property types and time series characteristics in a particular area or city. This project is the first to utilize modern information systems methodologies, such as Geographic Information Systems (GIS) and socio-economic factors. It contributes to understanding causal relationships that may be used to anticipate real estate prices (Bassett, K., & Short, J., 2021). According to the results, it is simpler to predict the price of a property in a single city than to estimate the cost of a home in the whole country's real estate market. According to findings from geographic information systems and socio-economic modeling, higher property values are rewarded in areas with more green space, residents with higher discretionary income, lower council tax bands, fewer tax benefit claimants, and better health services, among other factors. Previous research has looked at indexes of real estate prices at the macroeconomic level (the general, all real estate house price indices). No study has looked at the price projections for different property types inside a city. We would want to see such a study. The contribution of this work is centered on time series analysis and causal modeling inside a city to shed light on the dynamics of real estate price determination and change via the use of the Holt-Winters approach.

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INTRODUCTION

Forecasting has grown more critical in the real estate market as a component of the more extensive business planning and strategic management process, among other things. To predict future asset performance across various markets and regions, several different types of investors, such as pension and insurance funds and real estate funds, will make long-term investments in real estate. Rents, returns, and prices are key factors to consider when investing in real estate. For investors with loan portfolios, particularly those backed by real estate, an objective and transparent forecast of future trends is critical to making informed decisions (Bassett, K., & Short, J., 2021). Also necessary are future rent and cash flow scenario evaluations, which must be completed. Real estate forecasting is a logical progression in the real estate industry as more data becomes available for many markets, particularly with the additional insights provided by GIS on essential real estate value elements such as locations, transportation, and infrastructure.

The model proposed in the article is novel in that it takes an integrated approach to forecast price variations in real estate. This technique utilizes time-series methodologies such as the Holt-Winters with GIS. The research is the first to provide a framework that connects social and economic variables to the price of different property types in a city. It is also the most comprehensive. No study has used geographic information systems to draw causal relationships between real estate values and defining characteristics such as higher income, council tax claimants, good health, and green space. Because it lays down a straightforward platform for future research, the study contributes to the body of information on the fluctuations in real estate prices (Boeing, G., & Waddell, P., 2017). If data from one model is not available, causal models and GIS may be used in their stead,

and vice versa. As a whole, this approach is comprehensive in that it provides an extensive array of possibilities in terms of evaluating previously collected information.

LITERATURE REVIEW

Many real estate investors looked for correlations between different properties in a region or a city to see if they may lower risk per unit of return for investors. Investments are made to maximize profit while limiting risk, or vice versa, to achieve financial success. The primary emphasis of this objective is the correlation between the different assets in a portfolio. A low or negative correlation between returns and risk will lower risk for a given return in diversification benefits. Another purpose, in addition to modeling time series characteristics of a particular property type within a given area or city, is to examine the seasonality of that property type rather than the seasonality of real estate indexes. Real estate buyers are, by definition, focused on a particular location and are thus attracted to specific neighborhoods. Individual house buyers cannot diversify their portfolios as effectively as real estate investors, who acquire many homes in a given location intending to do so. This is due to the best individual homebuyers having budgets and limited financing capacity of also investigating innovative techniques for forecasting real estate values, including time-series approaches, causal models, and the use of a GIS. There is a significant relationship between socio-economic characteristics and the demand for and supply of real estate in the United States. On the other hand, these forces are not limited to demography, education, income, inflation, and other factors. GIS can be used to build maps of these elements, making it simpler to make investment choices when looking at the data.

Real estate can include any improvements made to the property or the land itself that is permanently tied to it. Real estate may be regarded as a financial asset in and of itself. This research aims to thoroughly evaluate the literature on real estate investments, appraisals, and projections. The vast bulk of real estate investment research is focused on

publicly traded real estate investment trusts (REITs), which are companies that invest in real estate. Academics use time series models to better understand the price of volatility and its influence on the average return of REITs. The volatility and average returns of REITs will be examined later in this section. This chapter also includes discussions of the discounted cash flow and price-to-earnings techniques for valuing real estate. The GIS will be used to discuss and connect potential locations for real estate development with socio-economic aspects that impact the decision-making processes of real estate buyers and other relevant information.

When consumer demand is the primary driving force behind real estate growth, there will always be cyclical swings in the market. Changes in the external environment, such as changes in construction costs, user activity, and the availability of financing, may cause the price trend to rise or fall, depending on their impact. The constant buying and swelling in the real estate market improve market liquidity, but the market is also open to intervention by the federal and state governments. When it comes to investing in real estate is a dangerous undertaking that requires the formulation of a plan that safeguards the interests of investors. The returns on real estate investments are discussed in detail in this section. When it comes to the stock and bond markets, the location of a property's return has minimal significance. Housing assets are a significant component of real estate assets, and their values are generally correlated with the market's volatility. Sellers and buyers would agree on a reasonable price in an ideal market. Real estate prices can deviate in either a positive or negative direction from their usual trend. Compared to the stock market, the real estate market is regarded to have less liquidity.

HISTORICAL BACKGROUND OF REAL ESTATE MARKET IN CALIFORNIA

Land in California has appreciated at a rate unprecedented anywhere else in the history of the United States. It wasn't until many years later that the residents of this beautiful and fruitful region became aware of the world's fast-changing nature. Consequently, the property was almost worthless throughout Spanish and Mexican power during the rancho period. There were no other options for acquiring land other than via the king of Spain (through his governor in Mexico City) and later, the Mexican government (via the governor of California). The Gold Rush, which began in 1849, marked the beginning of a new age. At the time of the gold rush, the state of California had a population of about 15,000. In 1846, the "Bear Flag Revolt" in Sonoma, California, declared the condition to be a republic, and the United States of America was born (Hedlund, A., & Garriga, C., 2022). In the immediate aftermath of the commencement of the Mexican-American War, California was put under the protection of the United States military, even though no sovereign government had ever been created in the state. The Treaty of Cahuenga was signed on January 13, 1847, in Campo de Cahuenga, located across the street from Universal Studios. Consequently, the value of California was forever transformed precisely one year after the discovery of gold at Sutter's Mill in Sacramento. The western Sierra Nevada Mountains were inundated with property and mining claims. This territory became available for development outside the rancho boundaries outside of the initial land allocations.

Former Spanish colonies in the West (such as New Mexico and Wisconsin) have embraced the concept of community ownership. Mexico's financial community system descended from Spanish law (derived from Roman civil law) and finally from the

Visigothic code (which combined Roman law with Catholic law and Germanic tribal custom), which descended from the Mexican financial community system (Hernandez, J., 2018). In English common law and Roman law, wives were considered the property of their husbands, but, in Germanic Frankish folk tribal tradition, women were generally considered co-owners on an equal footing with their husbands. By chance, Hammurabi's Code, written in ancient Sumeria (modern-day Iraq), had a concept of community property. When one spouse dies, all assets held as community property are taxed at a twofold step-up basis, making California an attractive location to reside.

Mining-related agriculture quickly surpassed gold mining as a financially successful enterprise. The cities of San Francisco, Los Angeles, and Sacramento have transformed themselves from sleepy outposts into flourishing urban commerce centers throughout the years. In the absence of laws that recognized previous deeds awarded during Spanish and Mexican control, law firms from the East Coast have taken advantage of the situation. This has left a bitter taste in the mouth of many people. The Treaty of Cahuenga preserved the land concessions made previously by the Spanish and Mexican governments. The Californios, who owned all of California's lush territory, were unlucky in that they were born at the wrong time. In the history of the state of California, the droughts of 1841 and 1861 were among the most severe ever recorded. Thousands of people fled their homes in fear for their lives, while more than 300,000 individuals arrived from all over the world at the same time. They came from places as far-flung as New England, Mexico, Hawaii, Peru, Chile, Spain, France, Italy, Australia, and China. Before the gold rush, Californians depended on the sale of cow skins as their primary source of money. In California, droughts have decimated many of the state's animal herds (Hylton, S., 2017). Land disputes between

Californians and Americans often result in the establishment of a land commission in the state of California. Rancho was victorious in 67% of the patent lawsuits, and other areas, like Ventura County, were victorious in 100% of the cases. Because the claimant was responsible for the costs associated with adjudicating each land grant, the land had to be surveyed after being awarded to the claimant. The claimants were compelled to hire attorneys as a protracted legal process. In addition, there were a lot of expensive attorneys, and many ranches were not making a lot of money. Because the patenting process has become prohibitively expensive, attorneys have been compelled to rely on predatory lending to cover their legal bills. Ranchos throughout the nation had already been highly indebted due to the drought, which resulted in widespread foreclosures and blatant title fraud. Due to these circumstances, most Californians lost their immense property holdings to immigrants over time.

When the transcontinental railroad was built in 1869, it enabled many people to immigrate to the United States for the first time. The invention of the refrigerated rail car in 1890 resulted in a boom in the produce sector, which resulted in an increase in property prices across the state. Farmer-operated large-scale industrial farms were first built to supply food for the miners. As recently as the 1950s, Los Angeles County produced more food per capita than any other county in the United States of America. It was necessary to build a substantial infrastructure to support the farms' operations because of their large scale. A year-round supply of water, paved roads, rail connections, warehouses, and a workforce were all provided on what was formerly desolate desert terrain. The San Joaquin Valley, also known as the Central Valley, is home to the world's most concentrated and prolific food supply, with agricultural products worth more than \$20 billion generated each

year. Oil was the only commodity that could be produced for a profit and was more expensive than gold during the revolution. From the 1880s and the 1960s, Los Angeles was known as the "Dubai of the world." California was responsible for producing one-third of the world's oil production. As a consequence, a substantial amount of money and power was amassed. Homes were the most valuable output of the land. Multi-billion dollar real estate prospects exist in California's mining, agricultural, and oil sectors in today's economic climate. The gold rush served as a spur for agricultural development. The agricultural industry contributed to the development of modern California by providing water and rail infrastructure.

Choosing a location is the most crucial step in purchasing a property. As a result of its success, California's real estate market has contributed to the state's demise: economically crippling traffic and real estate appreciation leading to a housing crisis. People cannot afford to reside near their places of employment. California may have purposely exacerbated the most critical issue that it will confront in the future in many different ways. In recent years, the government has become so large and unwilling to accept the reality that it has taxed most successful large California firms out of the state, resulting in many jobs being moved to neighboring states like Texas. This has resulted in a progressive diminishing of the 1950s suburban vision of every family having their piece of land, swimming pool, and English lawn as the area's unsustainable population growth continues over the next 200 years.

During the next fifty years, the terrain of western California is expected to experience significant transformation. In the long run, dense urbanity will supplant the expansive, awe-inspiring cityscapes that made California so enticing to immigrants from

colder regions of the United States and other economically and politically insecure nations in the first place. A total of four additional high-rise clusters might be constructed for Woodland Hills' Warner Center (a massive business park), which some feel has the potential to become the city's Century City. Not bad for a town that used to be nothing more than orchards and dirt roads forty-five years ago. The scenario at Warner Center serves as a strong predictor of what is to come across the state in the near future. A horse ranch had already been established on the property, and there was also an abundance of citrus orchards nearby. Coldwell Banker and Aetna Life and Casualty Company entered into a deal in 1968 to purchase the Warner family's land for \$30 million to develop it further. Kaiser eventually became a co-investor in Aetna after being courted by the company. In the face of earthquakes and economic downturns, commercial districts were constructed and have shown to be successful. Topanga Plaza, built by Westfield in 1964, was the first enclosed shopping mall west of the Mississippi River. It is still one of the most successful retail destinations in the United States today. During the late 1970s and early 1980s, the headquarters of Rocketdyne and Litton Industries was situated in Warner Center, establishing it as a significant aerospace industry center in the area. A more transit-oriented mixed-use development, where people can walk to work instead of spending three to four hours a day stuck in traffic, is now being sought by Los Angeles.

Single-family homes are being destroyed all around the state to make way for multi-story apartment complexes with ground-floor retail space and restaurants. Over the previous decade, the city of Los Angeles has progressively increased in height. As interest rates rise and more healthy capitalization rates are established, it is projected that real estate values will drop over the next few years. Examples include coping with the rising number

of homeless people and an unsustainable tax environment, which are all challenges that must be resolved. Streamlining entitlements and giving financial assistance to build more affordable dwellings is a straightforward and financially viable approach to addressing the housing crisis. Until the federal government permits the implementation of remedies to these challenges, California real estate will continue to exceed every other asset class in the history of the world.

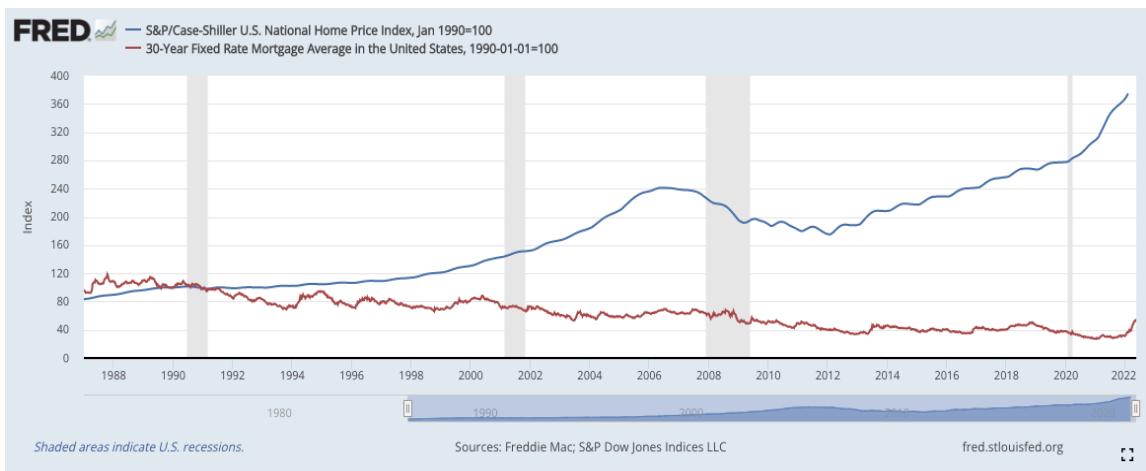


Figure 1: Home price vs 30-year fixed rate mortgage

Figure 1 is a graph of the US national home price compared to the 30 year fixed rate mortgage average in the US. It shows that overtime as the interest rate has gone down the price of homes have gone up. As the population grows more people will need to buy homes to live in, so this has led to interest rates decreasing so that more people can afford homes. However, as the supply cannot keep up with the demand the house prices are forced to go up. As of 2022 the mortgage rate and the house prices are continuously rising but it will have to come to a point where it crashes a little as we are currently in a bubble.

**THEORETICAL BACKGROUND OF HOLT-WINTERS FORECASTING
METHODOLOGY AND HOW IT IS USED IN FORECASTING HOUSING
MARKETS IN CALIFORNIA.**

Time series data that demonstrates both a trend and seasonal fluctuation may be predicted using Holt-Winters Exponential Smoothing (HWES). In a weighted average, each number is assigned a specific weight, and the denominator of the average is the total of all the weights. If the weights have some kind of measurement purpose, they're generally given that way. Logarithmic, linear, quadratic, cubic, and exponential functions are often used in weighing applications. Time series forecasting approach averaging offers the advantage of removing a significant amount of volatility from previous readings. When estimating future values of the time series, the forecaster uses past values weighted with the appropriate weighting function.

Exponential Smoothing (ES) uses a weighted average of all past values, decreasing weights from the most recent to the oldest historical significance, to anticipate the upcoming value. When you use ES, you assume that recent time series values are more important to you than older ones (Hansun, S., Charles, V., & Indrati, C. R., 2019). This is a crucial assumption. The ES method has two significant drawbacks: For example, if your data has a pattern or seasonal changes, you can't utilize it. Using Holt Exponential Smoothing, one of the ES method's flaws may be addressed. Time series data with a trend may be predicted using Holt ES. On the other hand, Holt ES fails when the time series contains seasonal fluctuations. As a result of modifying the Holt-Winters Exponential Smoothing approach, the Holt-Winters ES may be utilized for trend and seasonality analysis. Holt-Winters Exponential Smoothing relies on the following four-time series

properties to function correctly. It is claimed that a time series has a trend when its value varies predictably. We call a random trend to describe a time series with random fluctuations around a mean value. When the trend is random, the idea of a trend is less helpful than when the trend can be characterized by some function.

Other prominent trends include linear and square polynomials, logarithmic, and square root polynomials. You may simulate these patterns using the proper mathematical function such as $\log(x)$, linear, x^2 , $\exp(x)$, etc (Jiang, W. et al., 2020). Complex modeling approaches like artificial neural networks are needed to simulate highly non-linear patterns. Considering trend as the rate or velocity of the time series at a certain level is an effective technique to assess it. This creates a trend vector with a magnitude (change rate) and a direction (increasing or decreasing). The Holt-Exponential Winter's Smoothing technique's forecasting equations may now be examined. When seasonality is multiplicative, we'll start by looking at trends contributing to where we are right now. In real-world time series data, this is a regular occurrence. We'll exclude the noise element from the equations we're providing for the forecasting model.

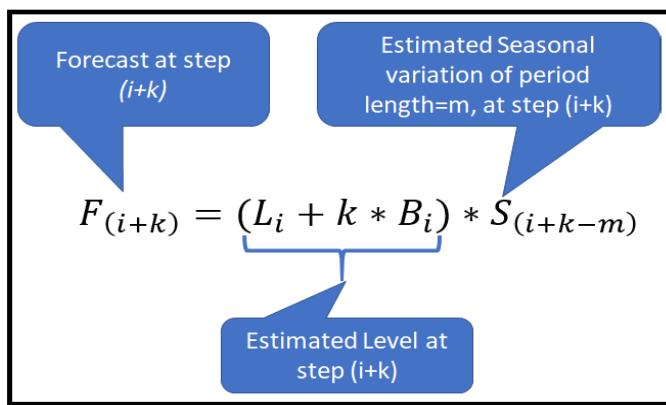


Figure 2: Time series forecasting

The above equation forecasts the value of a time series k , time steps into the future, beginning with an arbitrary step, i . It is assumed that the seasonal fluctuation has a defined

period length of m time steps. For instance, if the flux is annual, m=12. Consider the following methods for estimating L_i , B_i , and S_i . Let us begin by estimating the trend B_i at step I.

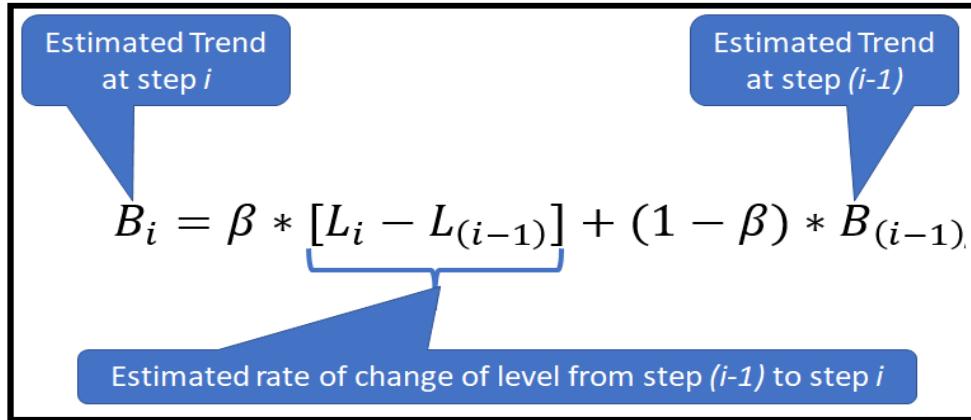


Figure 3:Trend estimation

By computing it in two distinct methods, the following equation predicts the trend B_i seen at step I [$L_i - L_{(i-1)}$]: This is the difference between two successive levels, and it shows the level's rate of change at level $L_{(i-1)}$. One way to conceive this phrase is the data's velocity at level L_i , flowing in at the same rate as at level $L_{(i-1)}$. $B_{(i-1)}$: This is just the recursively stated level change rate at $L_{(i-1)}$. To compute $B_{(i-1)}$, we apply the same equation as B_i , but replace I with (i-1) and repeat until we hit B_0 , considering the starting condition (Tirkeş, G., Güray, C., & Çelebi, N. E., 2017).

It is possible to model and predict time series behavior using Holt-Winters forecasting. One of the most widely used time series forecasting methods is Holt-Winters. For decades, it's been utilized in a wide range of applications, including monitoring and capacity planning, where it's used to spot anomalies and prepare for the future. Modeling time series behavior, Holt-Winters is one example. Whenever you want to make predictions, you need a model. Holt-Winters is one technique to represent three different

characteristics of time series data: an average value, a trend, and a cycle (seasonality). Anomaly identification in time series is difficult, although several workable approaches exist (Kays, H. M. et al., 2018). Because it covers so many themes, it's easy to become disoriented. Although mastering them is difficult, it is far more complicated to put them into practice. Predicting future values is an essential part of anomaly detection—using what you already know about time-series data, whether from a model or its past, makes predictions about what will happen in the future.

The Holt-Winters approach employs exponential smoothing to encode many initial values to anticipate "typical" values for the present and future. Weighted moving averages (EWMA) are used to "smooth" time series data. Creating a new one may define a smoothed version of an existing time series: $st = \alpha xt + (1 - \alpha)st - 1$

Charles Holt first noticed a problem with the basic EWMA model with a time series containing trends in the late 1950s. He included a linear trend into the basic exponential smoothing algorithm he had previously developed. Exponential smoothing is the term for this method. It's a bit more involved with this model (Kays, H. M. et al., 2018). An EWMA represents the smoothed values, and an additional EWMA represents its slope. There are similar phrases like level and trend in use.

$$1. st = \alpha xt + (1 - \alpha)(st - 1 + bt - 1)$$

$$2. bt = \beta(st - st - 1) + (1 - \beta)bt - 1$$

The values are significantly better at tracking the original time series using double exponential smoothing. As a result, you'll be able to make more accurate estimates

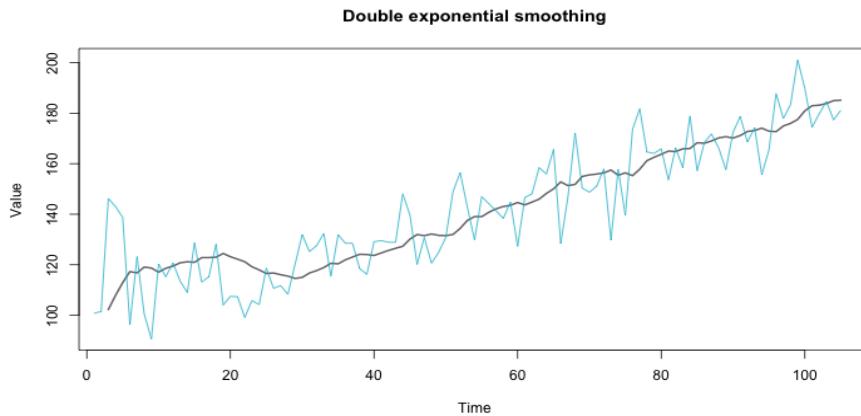


Figure 4: Double exponential smoothing

To predict using this model, a slight change is required. Because there is another name for slope, you must include it in your prediction. Assume you're attempting to anticipate the value in m future time steps. The formula for the prediction m steps ahead, F_{t+m} , is $F_t + m = st + mbt$.

Take note of how this is simply the line formula. If your time series lacks a linear trend and instead exhibits seasonality, then this will need another EWMA. Peter Winters, a student of Holt's, modified his teacher's model by adding an extra period to account for seasonality. Take note of the additional variable L , which is dependent on the seasonality period and must be determined in advance.

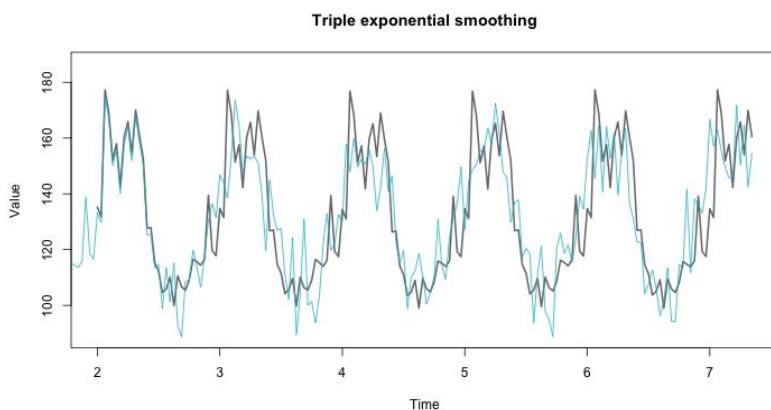


Figure 5: Triple exponential smoothing

Holt-Winters Triple exponential smoothing expresses the three characteristics of time series behavior—value, trend, and seasonality—as three forms of exponential smoothing. The model computes the cumulative impact of these three factors to arrive at a present or future value (Trull, O., García-Díaz, J. C., & Troncoso, A., 2020). To run the model, you'll need to input values for the smoothing coefficients (represented by alpha, beta, and gamma), the season duration, and the number of periods in a season.

METHODOLOGY

Holt-Winters Exponential Smoothing was used to examine and anticipate the future direction of the Los Angeles, California, and Southern California real estate market utilizing pricing data from 1991 to 2022. The same methodology was also used to forecast the future of both the 15-year and 30-year fixed mortgage interest rates, utilizing interest rate data from 1991 to 2022. The forecasted values were checked against the existing data and optimized to have the smallest possible Mean Absolute Deviation (MAD). This forecasted data was then used to calculate the present value of a potential investment, as well as the monthly payment both in a 15-year or 30-year option in 15 different scenarios. A sensitivity analysis was conducted altering the down payment amount, mortgage rate interest, and loan duration.

FINDINGS

A surprising finding of the research done using the Holt-Winters method was that prices on the real estate market may be predicted months or even years in advance. If you have this kind of influence, investors will put their money into your hands, knowing that they'll receive a good return and avoid the usual risks of investing. Hundreds of thousands of investors have suffered significant losses in the past. The good news is that Holt-Winters Exponential Smoothing, a predictive data analysis technique, may be able to prevent these tragedies. House prices, new home sales, and existing home sales are expected to rise over the next five years, based on a study of more than 20 economic and housing experts conducted by NAR in 2018. According to the organization, this year's increase in property prices is expected to be 5.7%. It is predicted that in 2022, the number of new homes sold will grow to 920,000, an increase over last year's estimated total of roughly 800,000. The number of existing-home sales is likely to fall to 5.9 million this year, down from 6 million last year.

DISCUSSION AND ANALYSIS OF FORECASTING RESULTS USING HOLT WINTERS METHODOLOGY

For our analysis, we used the Holt-Winters Method to forecast the interest rates and the cost of the houses. We gathered our data from the California Association of Realtors (CAR) website for all of California and used data specifically for Los Angeles, Southern California, and California. To verify our data we got from CAR, we looked at the historical data of 10 homes from Zillow and compared the sales prices to that of the median sales price we had gathered from our CAR data. The difference in the home prices was within a 10% range. This confirmed that our values were accurate.

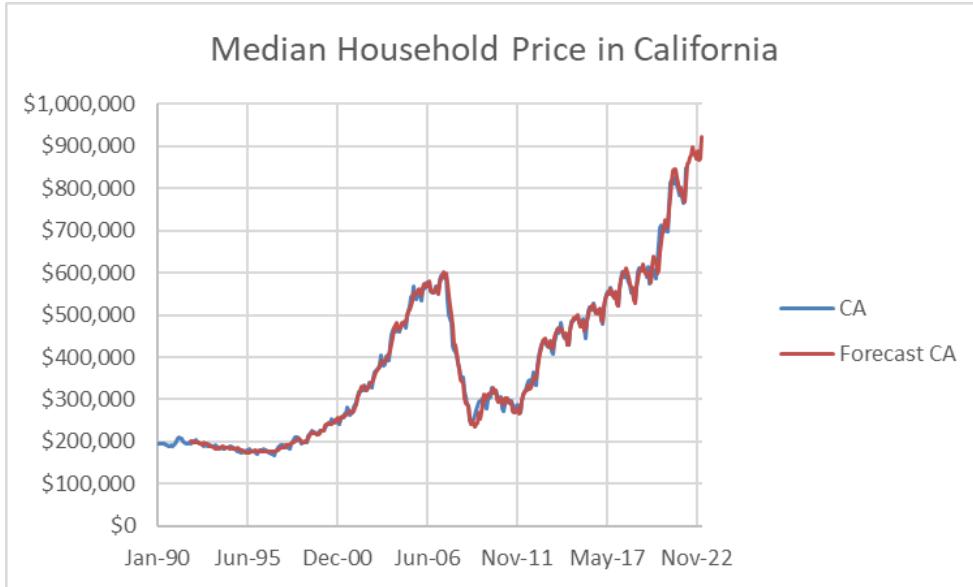


Figure 6: Median household price in California

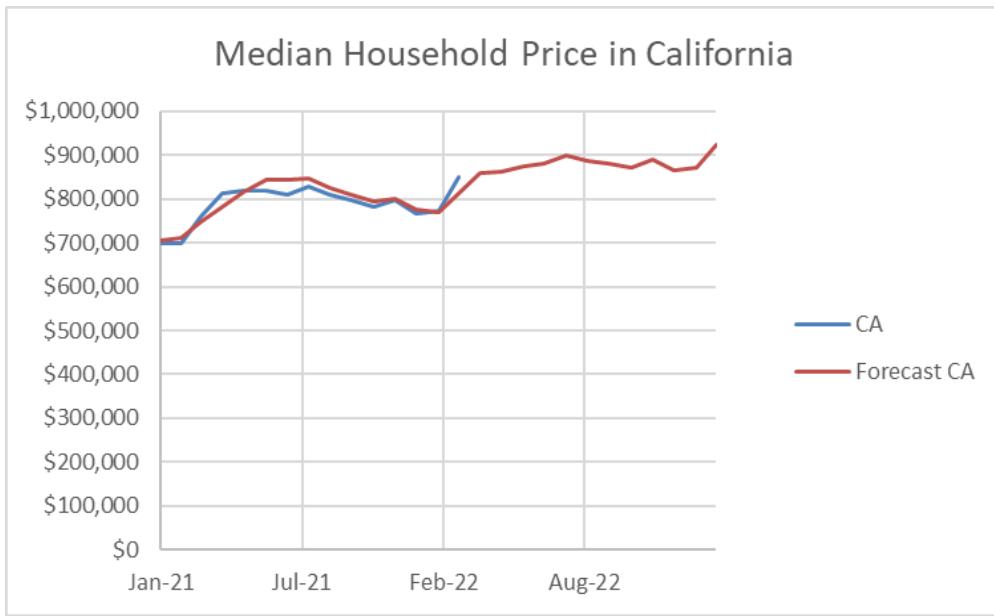


Figure 7: Focused median household price in California

Figure 6 contains both existing data on the median household price in California from 1991 to 2022, gathered from CAR, as well as the optimized Holt-Winters forecasting data. The correlation between both datasets is virtually identical, with a Mean Absolute Deviation (MAD) of \$7,634. Figure 7 is a focused version of Figure 6, concentrating on values from 2021 to 2023.

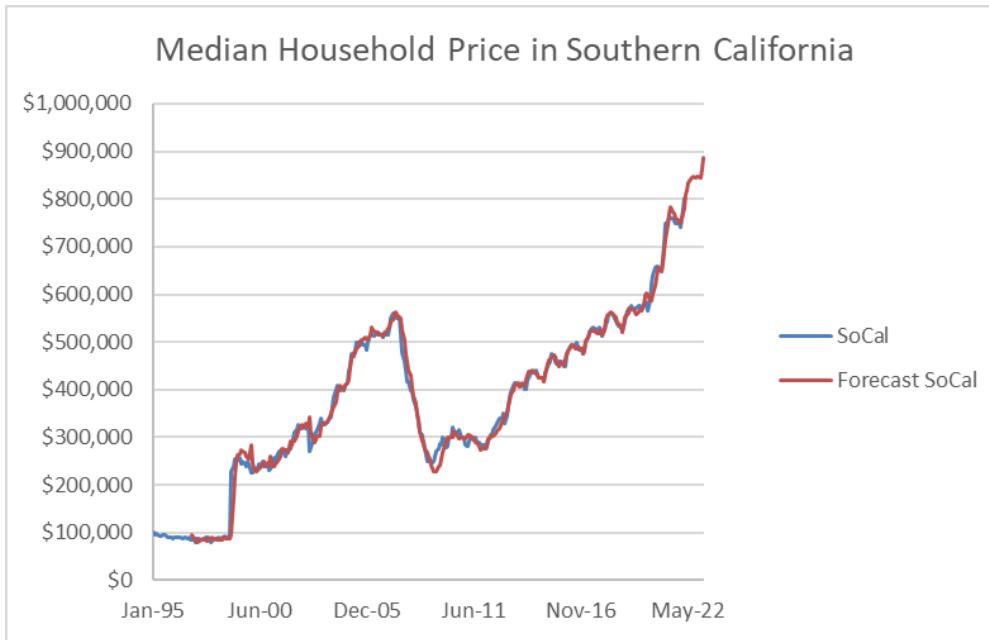


Figure 8: Median household price in Southern California

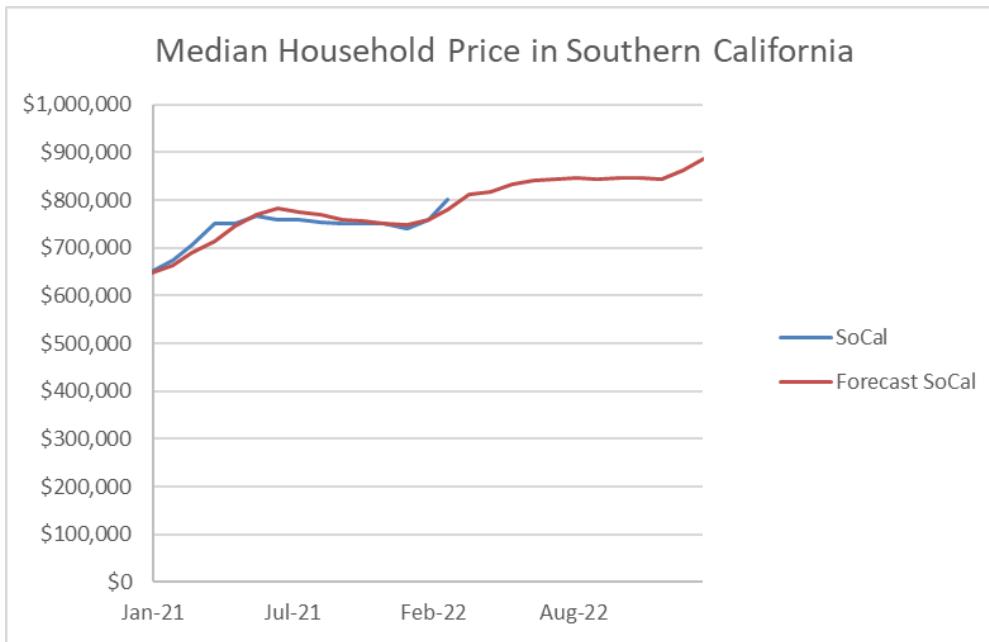


Figure 9: Focused median household price in Southern California

Figure 8 contains both existing data on the median household price in Southern California from 1991 to 2022, gathered from CAR, as well as the optimized Holt-Winters forecasting data. The correlation between both datasets is virtually identical, with a MAD of \$10,193.

Figure 9 is a focused version of Figure 8, concentrating on values from 2021 to 2023.

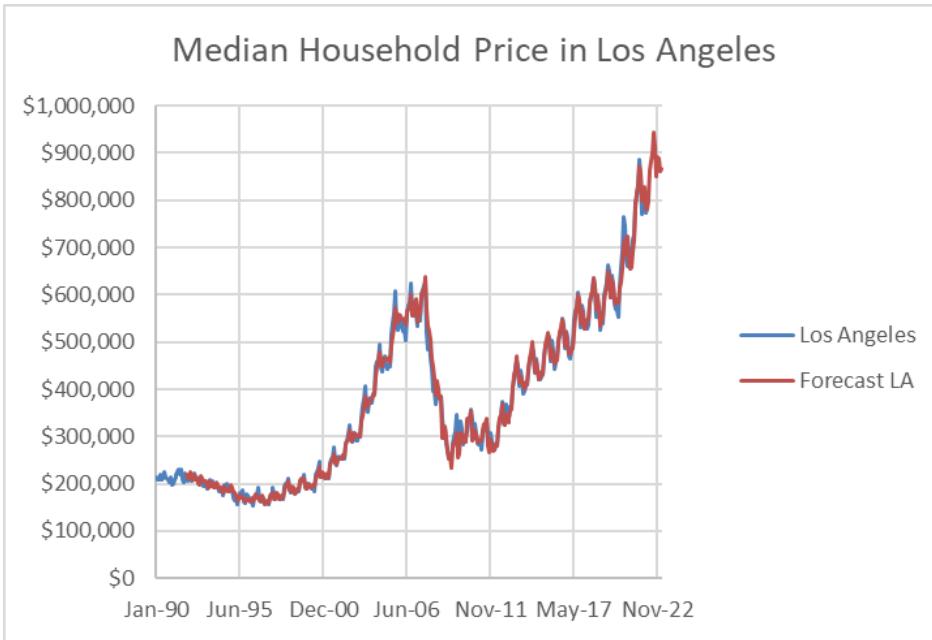


Figure 10: Median household price in Los Angeles

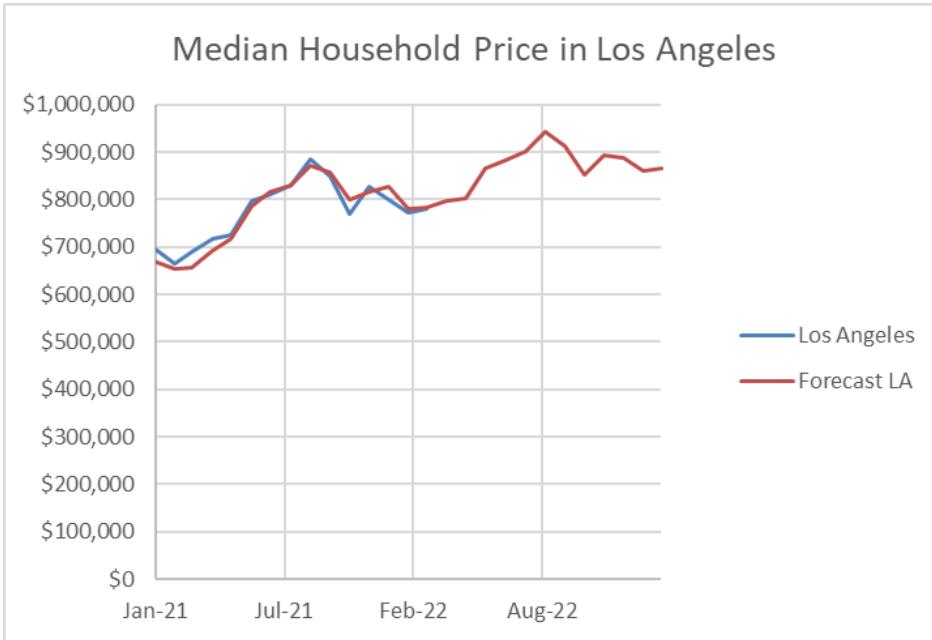


Figure 11: Focused median household price in Los Angeles

Figure 10 contains both existing data on the median household price in Los Angeles from 1991 to 2022, gathered from CAR, as well as the optimized Holt-Winters forecasting data. The correlation between both datasets is virtually identical, with a MAD of \$10,093. Figure 11 is a focused version of Figure 10, concentrating on values from 2021 to 2023.

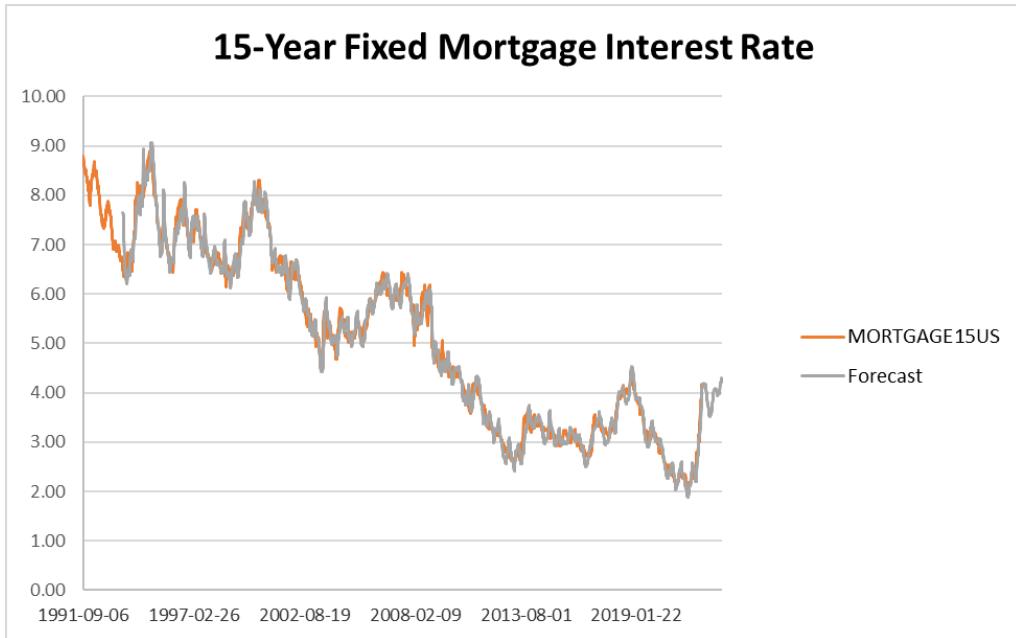


Figure 12: 15-year fixed mortgage interest rate

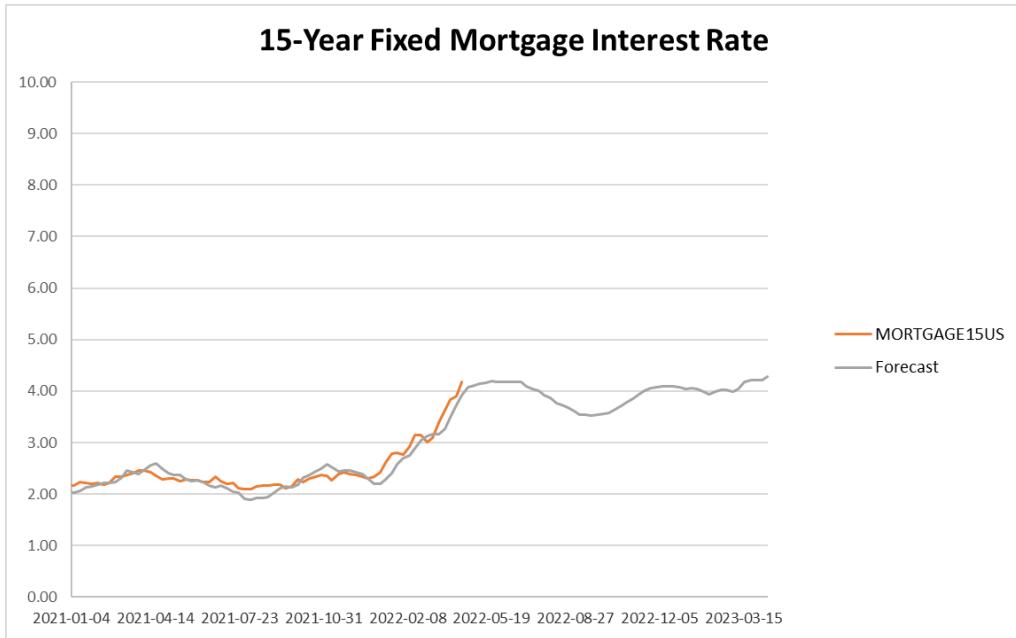


Figure 13: Focused 15-year fixed mortgage interest rate

Figure 12 contains both existing data on the 15-year fixed mortgage rate from 1991 to 2022, gathered from FRED, as well as the optimized Holt-Winters forecasting data. The correlation between both datasets is virtually identical, with a MAD of 0.17%. Figure 13 is a focused version of Figure 12, concentrating on values from 2021 to 2023.

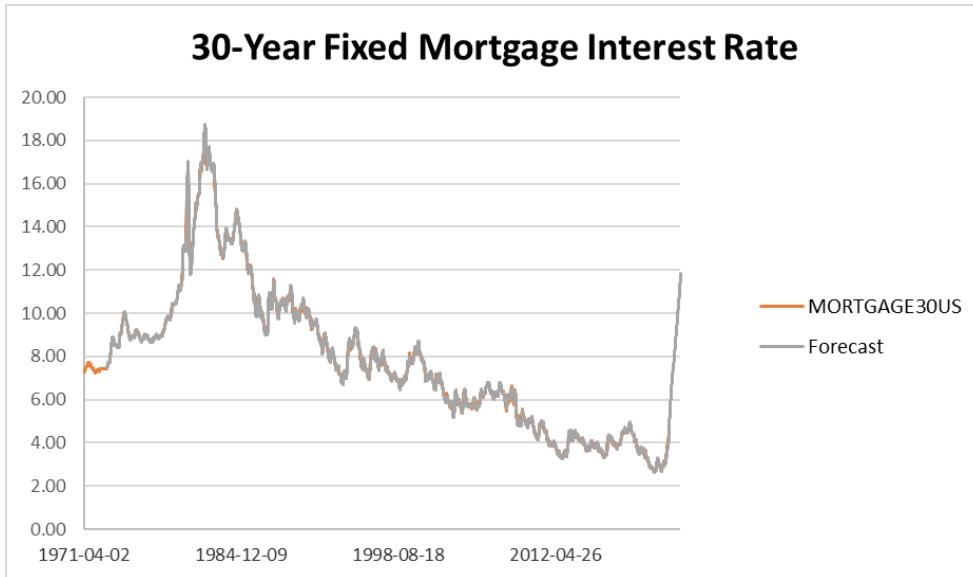


Figure 14: 30-year fixed mortgage interest rate

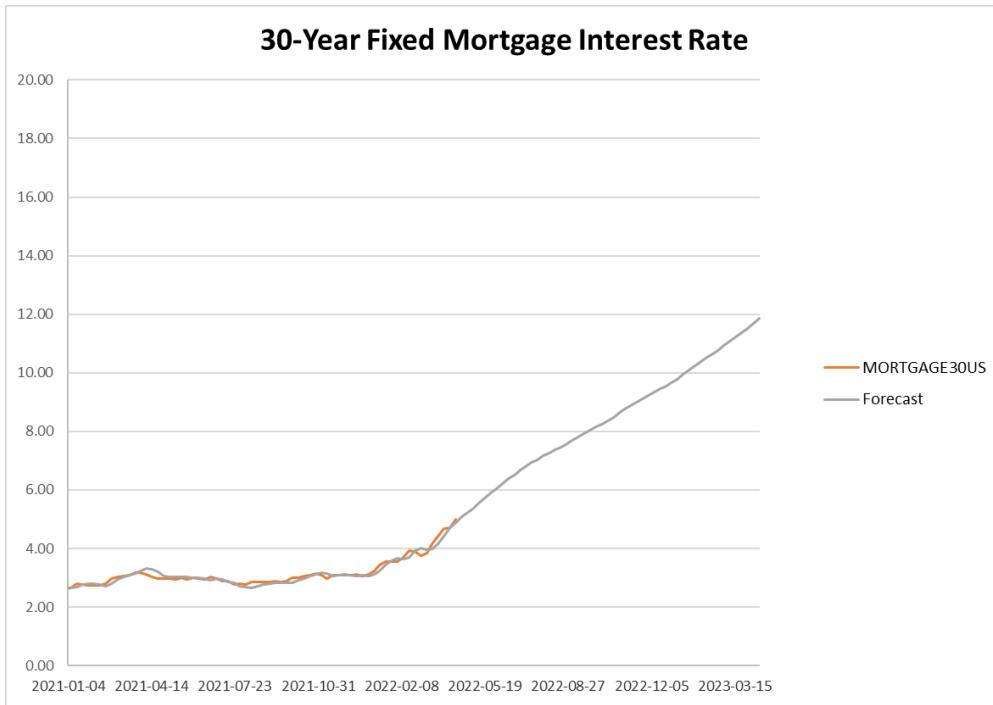


Figure 15: Focused 30-year fixed mortgage interest rate

Figure 14 contains both existing data on the 30-year fixed mortgage rate from 1971 to 2022, gathered from FRED, as well as the optimized Holt-Winters forecasting data. The correlation between both datasets is virtually identical, with a MAD of 0.11%. Figure 15 is a focused version of Figure 14, concentrating on values from 2021 to 2023.

Using the forecasted data above, our next step was to calculate the possible monthly payments of a potential investment. To do that we used the following equation:

$$PMT = PV * \frac{\frac{i}{per} (1 + \frac{i}{per})^n}{(1 + \frac{i}{per})^n - 1}$$

Where:

PMT = Monthly payment value (\$)

PV = Present Value of the Loan (\$)

i = Annual interest rate

per = Number of interest periods per year (i.e. 12 for monthly)

n = Total number of interest periods

To determine the PV used we calculated the loan value necessary using the following equation:

$$PV = HV - DP$$

Where:

HV = Market value of the house (\$)

DP = Down payment (\$)

The total amount spent on interest over the length of the mortgage was calculated using the following equation:

$$T_i = PMT * n$$

Where:

T_i = Total interest paid over the duration of the loan (\$)

Using the equations listed above and the forecasted median household price and interest rates from the month of November 2022, the monthly payment and T_i for both 15-year and 30-year loans in Los Angeles was calculated. Using these calculated values as our baseline we conducted a One Factor at a Time (OFAT) analysis. OFAT is a way to identify the critical causes for an effect. The analysis is done by changing one parameter while keeping all other parameters constant.

Table 1: OFAT results of down payment alteration

	Percent Change	
Down Payment	+10%	-10%
15-year monthly pmt	-2.50%	2.50%
30-year monthly pmt	-2.50%	2.50%
Overall interest 15yr	-2.50%	2.50%
Overall interest 30yr	-2.50%	2.50%

The results in table 1 reflect the OFAT when the interest rate, and median house price are fixed, and the down payment was altered by increasing it and decreasing it by 10%. This resulted in a drop of 2.5% in the payments and the total interest paid when increasing the down payment and a hike of 2.5% in the payments and total interest paid when decreasing the down payment.

Table 2: OFAT results of interest alteration

	Percent Change	
Interest	+10%	-10%
15-year monthly pmt	2.71%	-2.66%
30-year monthly pmt	8.12%	-7.91%
Overall interest 15yr	10.96%	-10.79%
Overall interest 30yr	12.44%	-12.12%

The results in table 2 reflect the OFAT when the down payment, and median house price are fixed, and the interest rate was altered by increasing it and decreasing it by 10%. Increasing the interest rate resulted in a hike of almost 3% on the 15-year monthly

payment and 8% on the 30-year monthly payment, as well as a hike of almost 11% and 12% in the overall interest paid in 15 years and 30 years, respectively.

Table 3: OFAT results of median house price alteration

	Percent Change	
Median House Price	+10%	-10%
15-year monthly pmt	10.00%	-10.00%
30-year monthly pmt	10.00%	-10.00%
Overall interest 15yr	10.00%	-10.00%
Overall interest 30yr	10.00%	-10.00%

The results in table 3 reflect the OFAT when the down payment, and interest rates are fixed, and the house price was altered by increasing it and decreasing it by 10%. Both experiments resulted in a change of 10% on both monthly payments and overall interest paid.

The OFAT analysis results suggest that altering the interest rate has the strongest effect on the amount of money spent on interest throughout the duration of a loan, followed by the house price.

After completing the OFAT Analysis, we did a sensitivity analysis, where we would mix and match 15 different combinations of Interest rate, median house price, and down payment, using the forecasted values for that specific month in 2022 or 2023. Three different sets of five calculations were done, representing the three different regions in our study. Each set consisted of three specific cases and two cases that were random. The first specific case was using the lowest forecasted median house price for that region accompanied with its forecasted interest rates to that specific month. The second case was using the lowest forecasted 15-year mortgage rate accompanied with its respective forecasted median house price and 30-year mortgage rate for that specific month. The third case was using the lowest forecasted 30-year mortgage rate accompanied with its

respective forecasted median house price and 15-year mortgage rate for that specific month. The fourth and fifth cases were randomized data from the forecasted months using realistic down payment values that were picked arbitrarily.

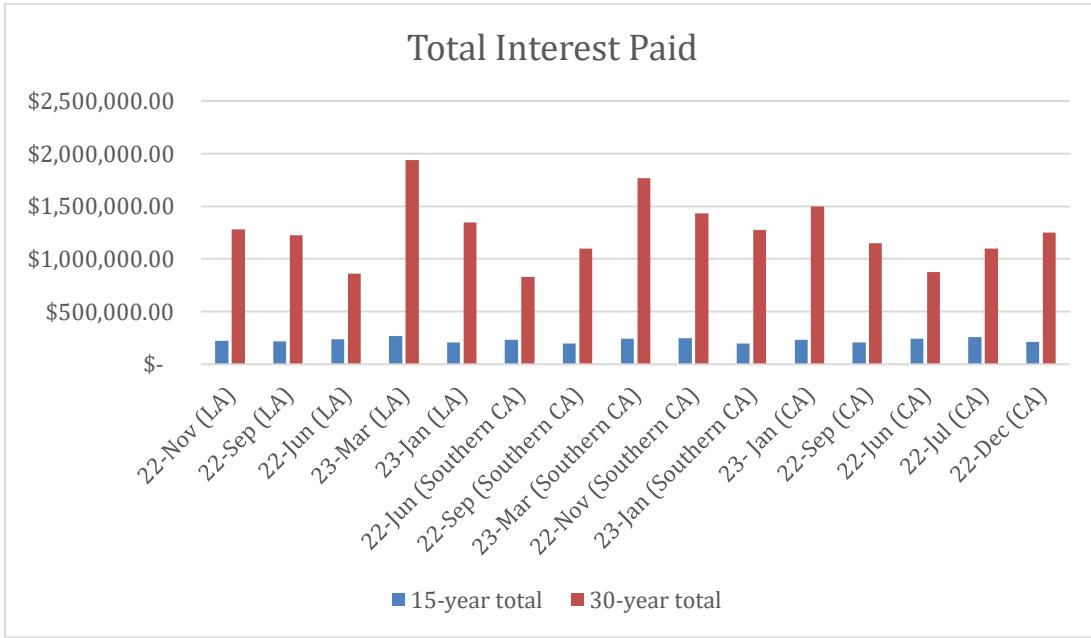


Figure 16: Total interest paid sensitivity results

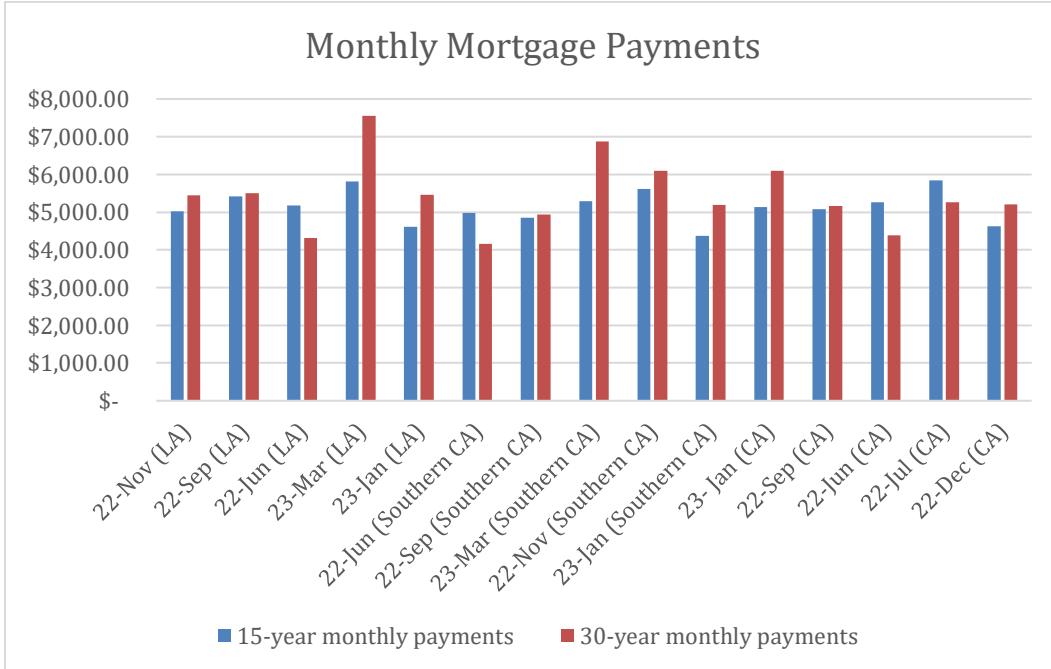


Figure 17: Monthly mortgage payments sensitivity results

Figures 16 and 17 are bar charts that represent the 15 different combinations we calculated, we have grouped the 15-year and 30-year options of each combination together. The monthly payments were relatively close when it came to the 15-year versus 30-year comparison. The difference between both monthly payments is that in a 15-year mortgage payment the majority is the loan principal, whereas the 30-year loan payment's majority is interest.

Depending on the investor's goal, we came up with different recommendations. We suggest purchasing a house in the month of June 2022 using a 30-year loan for Los Angeles, Southern California, or California, if the goal is to pay the lowest possible monthly payment. If the goal is to pay the least amount of interest over the length of the mortgage, then we recommend purchasing a house using a 15-year loan in the month of September 2022.

CALIFORNIA'S CURRENT REAL ESTATE MARKET

In anticipation of higher mortgage rates, buyers are flooding the market in California, which is helping the state's housing market do well. Last year's market blazed to new heights. The real estate market was ripe for the taking. With a total value of \$9.24 trillion, California's housing market is still the most valued in the country at the state level, accounting for more than a fifth of the overall national total. California's overall value gain in 2021 of \$1.38 trillion represents just "20.1%" of a \$6.9 trillion national increase (Mast, E., 2019). January 2022 was the first time since July 2020 that the median price of homes in the state didn't rise by double digits on an annual basis. However, the statewide median price will likely rise as the market approaches spring homebuying season. With increased interest rates yet to impact California's housing market, the state's median house price established a new record in March 2022, driven by an increase in sales of more expensive properties. As of March, California's median house price was \$849,080, a new all-time high and the first time in six months that the price had broken the \$800,000 threshold. It was 11.9% more expensive than March 2021's \$758,990. It was the first time in nine years that the monthly price increase topped 10% as a percentage of the median price, and the 10.1% increase from February was the fastest monthly increase since March 2013. A 0.5% rise in sales in March versus February indicates a significant desire to purchase (McPherson, E. G., 2017). There were 446,410 residences sold, a 4.4% decrease from the previous year. This was the ninth consecutive decline in year-over-year sales and one of the worst in eight months.

Many buyers submit sales bids more significantly than the asking price because of the supply-demand mismatch. In February, the level of market competition was lower than

it had been a few months before, but it remained high. Median sale-to-list price ratios in California remained over 100% at 103.9 percent. In March, 71.2% of homes sold for more than the asking price, the highest percentage in nine months. The demand for new homes continues to outpace supply. Tight supply and low mortgage rates, consistent with national trends, are driving the surge in California house prices (Mei, Y., Hite, D., & Sohngen, B., 2017). Higher house prices will encourage more sellers to advertise their properties for sale, which will moderate the pace of appreciation, notwithstanding the negative effect on housing affordability. An increase has influenced the state of California's housing affordability in the state's housing expenses.

A median-priced existing single-family home in California could be purchased by 25% of California homebuyers in the fourth quarter of 2021, up from 24% in the third quarter of 2021 but down from 27% in the fourth quarter of 2020, based on CAR's Traditional Housing Affordability Index (HAI). This is less than half of the affordability index peak of 56% in the first quarter of 2021. The proportion of families in California that can afford to buy a median-priced single-family home is known as the CAR's HAI. Affordability indices are also available for regions and specific counties in the state. The index is regarded as an essential indicator of housing well-being for homebuyers (Mei, Y., Hite, D., & Sohngen, B., 2017). When it came to the state's central areas, the median price increased year over year. In March 2022 it increased by double digits, and four central areas reached a new record high. Prices of single-family homes in every county in the state have gone up. Low borrowing rates and an imbalance between supply and demand drove up the cost of real estate.

For the year 2022, California's housing market is predicted to rise. California Housing Sentiment Index: CAR polls 1,000 Californians each month on their views on different housing market areas and the economy that directly affects housing. The total housing mood index was 67 in March 2022. (unchanged from the previous month). A survey found that consumers were aware of the present market problems and were becoming more gloomy about home buying options. In March, consumers who said it was a "good time to purchase" rose to 17%, up from 16% the month before. Nearly two-thirds of buyers expect house prices to grow over the next year, but one out of every four consumers still has faith that finding a home will be more straightforward in the near future.

Despite the recent surge in house prices and the rise in borrowing rates, demand for new homes outstrip supply. Evidence suggests that inventories may be beginning to warm up, but the real estate market confronts a wide range of uncertainties in the near future. As a positive sign, the number of new listings uploaded to the MLS each day has overtaken completed sales, and CAR is still projecting at least a 10% increase in house sales this year. This is how the general public feels right now. 83% of consumers say that now is not a good time to buy a home, according to the CAR's monthly Consumer Housing Sentiment Index for March 2022. As a whole, homebuyers' outlook remains the same as it was a month ago. Only 26% of consumers believe that finding a house in the future year will be simpler. Now we will look at Zillow's pricing patterns throughout this period. According to the Zillow Property Value Index, home values in California have increased by roughly 155% in the previous decade (as of April 2012). ZHVI does not represent the average monthly sale price of properties in a particular area. Many factors go into this calculation,

including seasonality and estimation mistakes, such as the median value of all estimated house prices in a specific area for a given month (also known as Zestimates).

According to CAR's 2022 forecast, the US economy will grow by 4.1% in 2022, after a 6% increase in 2021. By 2022, California's unemployment rate will be 5.8%, down from 7.8% in 2021, due to an expected nonfarm job growth rate of 4.6%. Weekly housing statistics from CAR through April 9, 2022, reveal that buyer demand is still strong while being lower than last year's record highs; however, this is expected. There is an increase in the number of new items added to the inventory. The market expects the Fed to raise rates aggressively in the coming months to battle inflation, so mortgage rates have continued to rise. As of April 2022, the average 30-year fixed-rate mortgage rate has risen to 4.72% from 4.71%, the highest level since December 2018 (Singh, A., Saphores, J. D., & Bruckner, T., 2018). Despite increasing mortgage rates and the Federal Reserve's impending rate hike, the housing market remains fiercely competitive. This year's California housing market has remained solid despite rising mortgage rates, and there are signs that the following months may see an active homebuying season. At a slower rate than earlier this year, housing prices are expected to rise. Many economists are worried that the central bank's balancing act in 2023 might lead to a recession. Whether the Fed's approach will lead to a soft landing or a recession remains visible.

For the week ended April 9, 2022, California's market competitiveness breakdown is below. A median listing price of \$749,900 was achieved. Median Price Per Square Foot on the market = \$425. Median Closed Price = \$0.81 million. \$453 is the median closed price per square foot. 17.8% of active listings with reduced prices. For reduced-price listings, the median reduction in percentage is 5.1%. Sales closed at or below list price

account for 17.8% of total sales. 74% of homes sold at or over their asking price. Overage on homes that close over their list price is 7.4% on average. Median Days on the Market is 10 days. According to the CAR's Traditional Home Affordability Index, California's housing affordability will improve in the fourth quarter of 2021 (Xiao, Y., & Webster, C., 2017). The affordability forecast for Californians in the fourth quarter of 2021 was enhanced by a moderate rise in property prices and a good gain in family earnings. A quarter of California families could afford the median-priced home of \$797,470 in the fourth quarter of 2021, compared to only 24% in the third quarter of 2021 and 27% in the fourth quarter of 2020. A 30-year fixed-rate mortgage with a 3.28% interest rate required a minimum yearly income of \$148,000 to make monthly payments of \$3,700, including principal, interest, and taxes. A median-priced condo or townhouse of \$610,350 was within reach for 36% of home purchasers. A salary of at least \$113,200 was necessary to make a \$2,830 monthly payment. For the fourth quarter of 2021, home affordability decreased in 19 counties, improved in 19, and was steady in 13 compared to the previous quarter.

Businesses reopening and lower mortgage payments are just some of the factors contributing to a rise in home sales. Even though it is the off-season, sales are still solid, and the outlook for the new year is positive throughout the area. According to the organization, CAR recorded a decrease in home sales in February 2022, but the California housing market remained stable. The listings bottleneck seems to be easing as median prices rose across all major areas. Timing the local market is a vital component of real estate investing, regardless of whether you're buying or selling. It's a terrific time to sell if you're a homeowner in California right now. Prices would not decline if there was a shortage of inventory.

CONCLUSION

The Holt-Winters forecasting technique enables users to smooth time series and anticipate regions of interest using that data. Exponential smoothing applies exponentially decreasing weights and values to historical data to lessen the weight's worth. In other words, the Holt-winters model gives greater weight to more recent data for predicting rather than to earlier data. With the continuing trends in the California housing market in 2021, it seems that delaying a purchase until 2022 might be a better decision. Purchasing new properties to add to your rental portfolio will be more expensive than in the past, and now may not be the best time to do it.

Our goal was to find the best time to purchase a house using the 15-year and 30-year loan periods, in Los Angeles, Southern California and California as a whole. We used the data that was gathered from CAR, as well as the optimized Holt-Winters forecasting data, to graph the median household price in Los Angeles, Southern California, and California from 1991 to 2022. Overall, the forecasted median household prices were very similar when comparing Los Angeles, Southern California and California as a whole. On average the median household price forecasted in Los Angeles was \$5,765 more than California, which in comparison was \$34,428 more than Southern California's median house prices. Once we had all of this information, we made a sensitivity analysis for 15 different scenarios in order to find the best time to invest. We altered the overall scope by changing the location, down payment percentage, interest rates, median household price and date of purchase. Finally, we came up with two solutions for the best time to invest. The first being in June of 2022 if you want to have the lowest monthly payment possible

over a 30 year period, and the other option being September 2022 with a 15-year loan if the goal is to pay the least amount of interest over the length of the mortgage.

REFERENCES

- Bassett, K., & Short, J. (2021). Housing and residential structure: alternative approaches. Routledge.
- Boeing, G., & Waddell, P. (2017). New insights into rental housing markets across the United States: Web scraping and analyzing craigslist rental listings. *Journal of Planning Education and Research*, 37(4), 457-476.
- Canela, M. Á., Alegre, I., & Ibarra, A. (2019). Holt-Winters Forecasting. In *Quantitative Methods for Management* (pp. 121-128). Springer, Cham.
- Hansun, S., Charles, V., & Indrati, C. R. (2019). Revisiting the Holt-Winters' Additive Method for Better Forecasting. *International Journal of Enterprise Information Systems (IJEIS)*, 15(2), 43-57.
- Hedlund, A., & Garriga, C. (2022). Crises in the Housing Market: Causes, Consequences, and Policy Lessons. The Center for Growth and Opportunity.
- Hernandez, J. (2018). California Environmental Quality Act Lawsuits and California's Housing Crisis. *Hastings Envt'l LJ*, 24, 21.
- Hylton, S. (2017). How Real Interest Rates Affect Housing in California.
- Jiang, W., Wu, X., Gong, Y., Yu, W., & Zhong, X. (2020). Holt-Winters smoothing enhanced by fruit fly optimization algorithm to forecast monthly electricity consumption. *Energy*, 193, 116779.
- Kays, H. M., Karim, A. N. M., Daud, M. R. C., Varela, M. L., Putnik, G. D., & Machado, J. M. (2018). A collaborative multiplicative Holt-Winters forecasting approach with dynamic fuzzy-level component. *Applied Sciences*, 8(4), 530.

- Mac, F. (n.d.). Fred Graph Download. FRED. Retrieved May 16, 2022, from <https://fred.stlouisfed.org/graph/?g=BqPb>
- Mast, E. (2019). The effect of new market-rate housing construction on the low-income housing market. Upjohn Institute WP, 19-307.
- McPherson, E. G., Xiao, Q., van Doorn, N. S., de Goede, J., Bjorkman, J., Hollander, A., ... & Thorne, J. H. (2017). The structure, function and value of urban forests in California communities. *Urban Forestry & Urban Greening*, 28, 43-53.
- Mei, Y., Hite, D., & Sohngen, B. (2017). Demand for urban tree cover: A two-stage hedonic price analysis in California. *Forest Policy and Economics*, 83, 29-35.
- Mullally, C., & Lusk, J. L. (2018). The impact of farm animal housing restrictions on egg prices, consumer welfare, and production in California. *American Journal of Agricultural Economics*, 100(3), 649-669.
- Mussa, A., Nwaogu, U. G., & Pozo, S. (2017). Immigration and housing: A spatial econometric analysis. *Journal of Housing Economics*, 35, 13-25.
- Sen, J. (2017). A time series analysis-based forecasting approach for the Indian realty sector. *International Journal of Applied Economic Studies*, 5(4).
- Silver, L. D., Ng, S. W., Ryan-Ibarra, S., Taillie, L. S., Induni, M., Miles, D. R., ... & Popkin, B. M. (2017). Changes in prices, sales, consumer spending, and beverage consumption one year after a tax on sugar-sweetened beverages in Berkeley, California, US: A before-and-after study. *PLoS medicine*, 14(4), e1002283.
- Singh, A., Saphores, J. D., & Bruckner, T. (2018). A spatial hedonic analysis of the housing market around a large, failing desert lake: the case of the Salton Sea in

- California. Journal of Environmental Planning and Management, 61(14), 2549-2569.
- Tirkeş, G., Güray, C., & Çelebi, N. E. (2017). DEMAND FORECASTING: A COMPARISON BETWEEN THE HOLT-WINTERS, TREND ANALYSIS AND DECOMPOSITION MODELS. Tehnicki vjesnik/Technical Gazette, 24.
- Trull, O., García-Díaz, J. C., & Troncoso, A. (2020). Initialization methods for multiple seasonal Holt–Winters forecasting models. Mathematics, 8(2), 268.
- Wegmann, J., & Mawhorter, S. (2017). Measuring informal housing production in California cities. Journal of the American Planning Association, 83(2), 119-130.
- Xiao, Y., & Webster, C. (2017). Urban morphology and housing market. Springer Singapore.
- 30-year fixed rate mortgage average in the United States. FRED. (2022, May 5). Retrieved May 7, 2022, from <https://fred.stlouisfed.org/series/MORTGAGE30US>