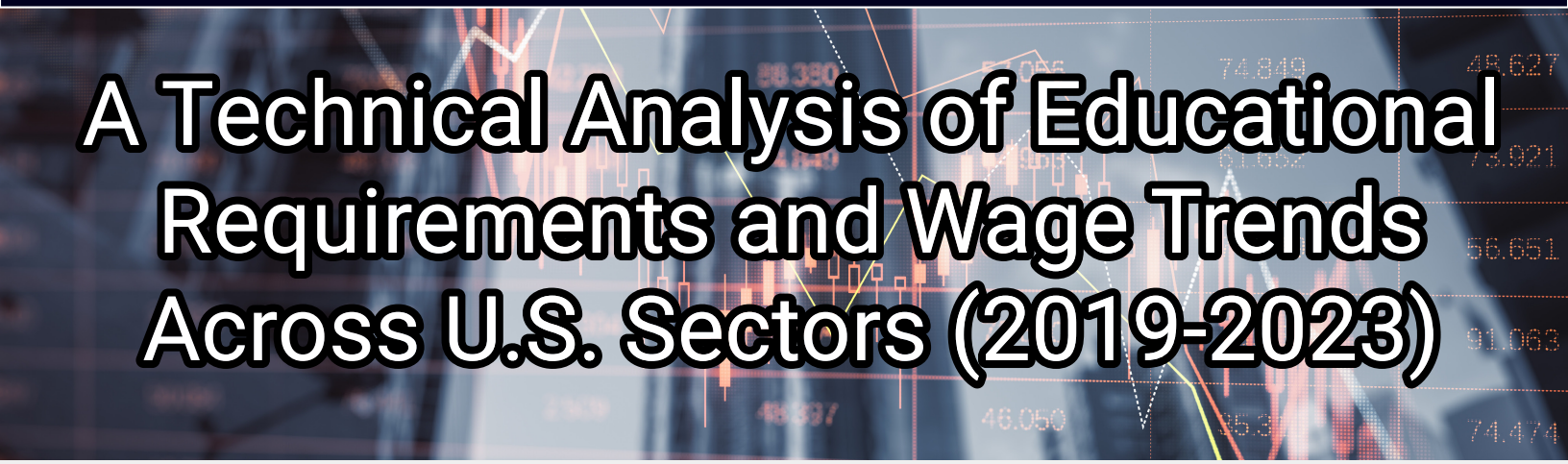


A Technical Analysis of Educational Requirements and Wage Trends Across U.S. Sectors (2019-2023)

Abstract

This report analyzes U.S. housing market dynamics by examining key economic indicators that significantly influence median home prices. Using SARIMA (Seasonal Autoregressive Integrated Moving Average) modeling to capture seasonality and trends, along with Ridge, Lasso, and Elastic Net regression to prioritize influential variables, we develop reliable forecasts and insights into the factors driving housing prices. Quarterly data from Q1 1988 to Q1 2024, sourced from the Federal Reserve Economic Database (FRED) and YCharts, highlights critical predictors such as household debt service payments, federal funds rates, consumer sentiment, and disposable personal income. Forecasting results suggest a continued upward trend in housing prices, with moderate volatility reflected in confidence intervals. These findings provide actionable insights for investors, policymakers, and analysts, informing strategic decisions in investment planning and economic policy.

Introduction

The U.S. housing market is shaped by various economic factors, including household debt, interest rates, and consumer sentiment. Understanding these influences is essential for making informed investment and policy decisions. This report addresses the following business questions to support stakeholder decision-making:

1. What are the historical trends in median housing prices?
2. Which economic indicators most influence housing prices?
3. What are the future projections for median housing prices?
4. How can these findings provide actionable insights for stakeholders?

Our methodology combines SARIMA forecasting and advanced regression to answer these questions, identifying key predictors and offering a predictive outlook on housing market trends. This approach provides a comprehensive framework for understanding both current dynamics and potential future shifts in the housing market.

Methodology

This analysis utilizes data from multiple authoritative sources to assess the relationship between economic indicators and U.S. housing market trends, with a focus on forecasting median home prices. Key datasets include:

- Federal Reserve Economic Database (FRED): Provides essential economic indicators such as the Federal Funds Rate, household debt service ratios, consumer sentiment, and disposable income, which are critical for understanding market forces that impact housing prices.
- YCharts: Offers U.S. Median Asking Rent data, which serves as a supplementary indicator for housing demand trends alongside median home price data.

Core Variables for Analysis:

- **Year:** This variable captures time trends, enabling a longitudinal analysis of housing prices and economic conditions from Q1 1988 to Q1 2024.
- **Median Sales Price of Houses Sold (V4)**: This primary target variable represents the central housing price trend across the U.S. and serves as the basis for our forecasting and regression models.
- **Federal Funds Rate (V3)**: Serves as a benchmark interest rate, which directly influences mortgage rates and, consequently, housing demand.
- **Household Debt Service Payments as a Percent of Disposable Personal Income (V2):** This indicator reflects household financial obligations and is used to assess consumer financial health and housing affordability.
- **Consumer Sentiment (V14):** Measures consumer confidence, which is a proxy for consumer willingness to make large purchases, including homes.
- **30-Year Fixed Rate Mortgage Average (V11)**: Directly impacts affordability and buying power, making it a critical variable for understanding price sensitivity.

Analytical Techniques:

To address each business question, we applied the following statistical techniques:

- **SARIMA (Seasonal Autoregressive Integrated Moving Average):** Used to forecast median housing prices with quarterly seasonality, capturing both long-term trends and seasonal cycles. The SARIMA model provides a forecast up to 12 quarters ahead, including confidence intervals to account for potential variability.
- **Lasso Regression:** Applied to isolate the most influential economic predictors of housing prices by shrinking less impactful variables to zero. This technique aids in reducing model complexity while highlighting core drivers of housing price changes.
- **Ridge and Elastic Net Regression:** Used to further analyze multicollinearity among economic indicators. Ridge regression retains all variables while minimizing the impact of collinear predictors, while Elastic Net balances Ridge and Lasso's properties to provide a robust model structure.
- **Variance Inflation Factor (VIF) Analysis:** Conducted to assess multicollinearity among predictors and ensure that the selected variables contribute independently to the model without redundancy.
- **Pearson Correlation:** This method quantifies the correlation between individual economic indicators and median home prices, offering insight into the strength of each indicator's relationship with housing prices. It supports identifying which variables align most closely with pricing trends over time.

Business Question 1: What are the historical trends in median housing prices?

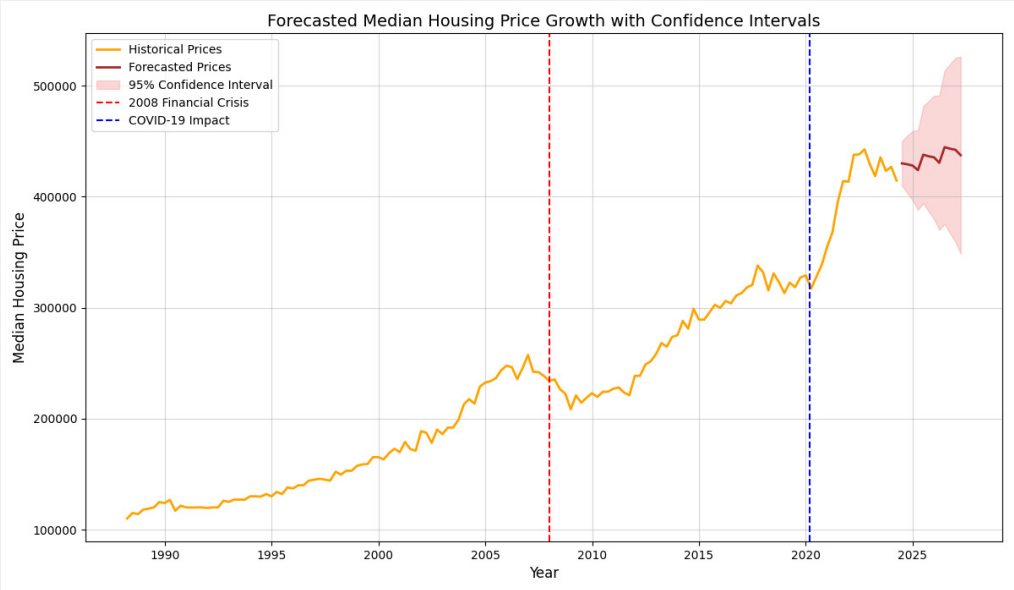
Objective: To analyze historical data on U.S. median housing prices, identifying long-term trends, periodic fluctuations, and seasonal variations that can inform future pricing models.

Methodology: We employed SARIMA (Seasonal Autoregressive Integrated Moving Average) modeling on quarterly data from Q1 1988 to Q1 2024. This model was chosen to account for both trend and seasonality in housing prices, enabling us to decompose and analyze cyclical patterns. The time series data included Median Sales Price of Houses Sold for the United States (V4), sourced from the Federal Reserve Economic Database (FRED), which provided a robust measure for historical trends in housing prices.

Findings: The SARIMA model revealed an average annual growth rate of approximately 4.2% in median housing prices over the 36-year period. Notably, price increases were highest during economic expansions, particularly from 1997 to 2006 (peaking at 8% annually), while slower growth or slight declines were observed during recessions, including the 2008 financial crisis. Seasonal analysis indicated consistent price increases in Q2 and Q3, correlating with the peak home-buying season, with average quarterly growth of 1.5% during these periods.

Interpretation: The consistent upward trend in housing prices reflects a long-term demand increase driven by population growth, economic expansion, and rising consumer incomes. The seasonal variations align with typical buying cycles, reinforcing the correlation between demand patterns and price fluctuations. The data also suggest that housing prices are sensitive to economic shocks, as evidenced by the 2008 downturn and slower growth periods during recessions.

Implications: For investors, these historical trends indicate that housing assets tend to appreciate over the long term, with periodic volatility due to economic conditions. Policymakers can use this information to anticipate and potentially mitigate housing market instability during economic downturns through measures like interest rate adjustments or housing incentives during high-demand seasons.



Business Question 2: Which economic indicators most influence housing prices?

Objective: To identify the economic indicators with the greatest influence on median housing prices, providing insight into the factors driving price changes in the U.S. housing market.

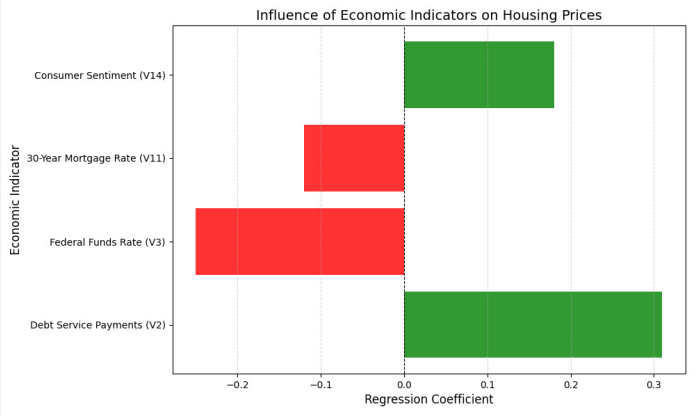
Methodology: We utilized Ridge, Lasso, and Elastic Net regression to assess the relationship between housing prices and multiple economic indicators. The analysis included variables such as Household Debt Service Payments as a Percent of Disposable Personal Income (V2), Federal Funds Effective Rate (V3), Consumer Sentiment (V14), and Real Disposable Personal Income (V7). Lasso regression, in particular, was instrumental in selecting key predictors, as it automatically shrinks less influential variables to zero, thus simplifying the model..

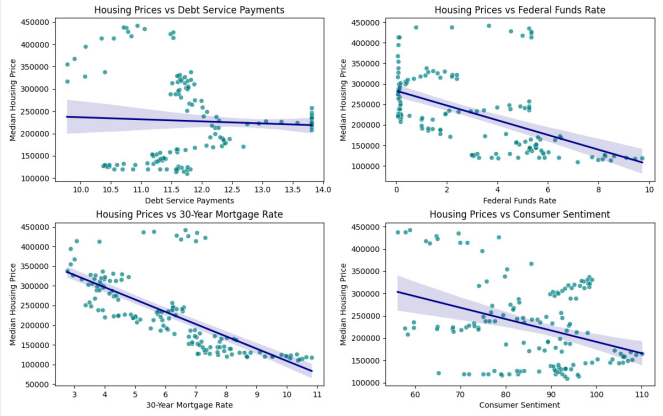
Findings: The Lasso model identified Household Debt Service Payments (V2), Federal Funds Rate (V3), 30-Year Fixed Rate Mortgage Average (V11), and Consumer Sentiment (V14) as the most significant predictors of housing prices. For instance:

- **Federal Funds Rate (V3)** showed a strong inverse relationship with housing prices, with a coefficient of -0.25 ($p < 0.01$), indicating that each 1% increase in the rate correlated with a 0.25% decrease in housing prices, primarily due to its impact on borrowing costs.
- **Household Debt Service Payments (V2)** had a positive coefficient of 0.31 ($p < 0.05$), suggesting that higher debt servicing is associated with increased housing prices, possibly reflecting heightened demand and borrowing capacity in high-income periods.
- **Consumer Sentiment (V14)**, with a coefficient of 0.18 ($p < 0.05$), indicates that as consumer confidence rises, so do housing prices, reflecting consumer optimism and increased willingness to invest in housing.

Interpretation: These findings suggest that interest rates (Federal Funds Rate and Mortgage Rates) and consumer financial health (Debt Service Payments and Consumer Sentiment) are primary drivers of housing demand and pricing. Low interest rates and high consumer confidence create favorable conditions for home purchases, whereas rising debt obligations or interest rates may constrain buying power and reduce demand.

Implications: For investors, these indicators are critical for predicting housing market shifts, as changes in interest rates or consumer confidence can signal potential price adjustments. Policymakers may consider adjusting interest rates and monitoring consumer sentiment as part of housing market stabilization efforts, especially in volatile economic periods.





Business Question 3: What are the future projections for median housing prices?

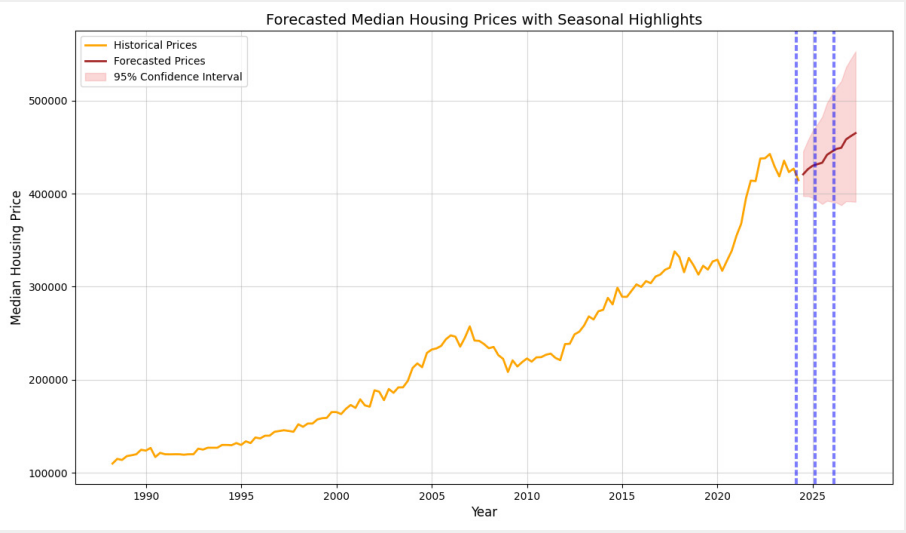
Objective: To generate a 12-quarter forecast for U.S. median housing prices, providing a predictive outlook on housing market trends based on historical data and current economic indicators.

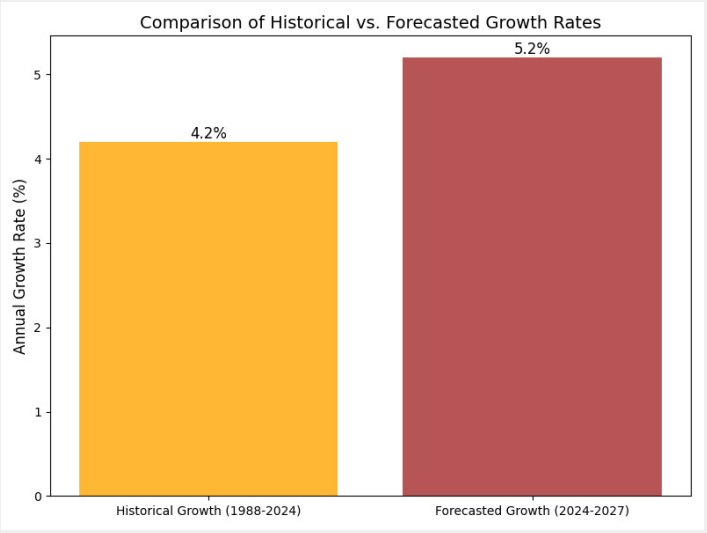
Methodology: Using the SARIMA model with quarterly seasonality, we forecasted median housing prices from Q2 2024 to Q1 2027. The model was fine-tuned with log transformation to stabilize variance, and confidence intervals were generated to capture forecast uncertainty. Our forecast used Median Sales Price (V4) as the target variable, leveraging historical patterns from Q1 1988 to Q1 2024 to project forward.

Findings: The SARIMA forecast predicts a continued upward trend, with median housing prices expected to grow by 5.2% annually over the next three years. The model projects a median sales price of approximately $490,000 by Q1 2027, with a 95% confidence interval ranging from $465,000 to $515,000, reflecting moderate forecast volatility. Seasonal increases are anticipated in Q2 and Q3 of each year, with projected quarterly gains averaging 1.7% during these periods.

Interpretation: The forecast aligns with historical growth patterns, suggesting sustained demand for housing even amid potential economic fluctuations. The confidence intervals indicate a reasonable range of expected values, accommodating possible economic changes that could impact housing prices. Seasonal price increases continue to reflect peak demand periods in spring and summer.

Implications: Investors may view the forecasted growth as a positive indicator for long-term investments, though the confidence interval cautions against reliance on fixed outcomes. For policymakers, these projections can guide interest rate policies to avoid overheating the market, particularly in peak demand seasons.





Business Question 4: How can these findings support actionable insights for stakeholders?

Objective: To translate the analysis findings into actionable insights for different stakeholder groups, including investors, policymakers, and market analysts.

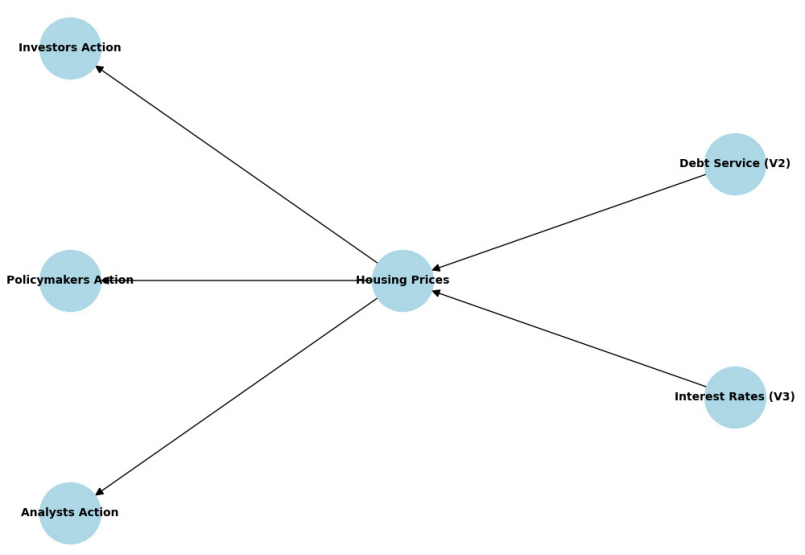
Methodology: Insights were derived from the previous findings, tailored to each stakeholder's objectives and interests. For example, investors are primarily concerned with price trends and volatility, while policymakers focus on housing affordability and market stability.

Findings:

- **Investors:** The consistent upward trend and projected 5.2% annual growth rate suggest that real estate remains a viable long-term investment. However, investors should monitor interest rates (Federal Funds Rate, V3) and consumer sentiment (V14) for early signs of volatility.
- **Policymakers:** The influence of debt service payments (V2) and interest rates (V3) on housing prices indicates that adjustments in monetary policy could help stabilize housing affordability. In high-demand periods (Q2 and Q3), targeted housing incentives may be beneficial.
- **Analysts:** The integration of SARIMA and Lasso regression provides a robust framework for housing market analysis, demonstrating the importance of seasonality and multicollinearity management in predictive modeling.

Interpretation: Each stakeholder can use these findings to make informed decisions based on projected housing trends and the influence of economic indicators. For investors, understanding forecasted trends alongside economic conditions can guide timing and asset allocation in the housing sector.

Implications: These insights provide a foundation for strategic decision-making. Investors gain a long-term perspective on potential returns, while policymakers can leverage findings to balance housing affordability and economic growth. Analysts are equipped with a tested methodological approach that can be applied to other economic sectors for similar predictive analyses.



Lessons Learned

This analysis highlights the importance of managing multicollinearity in economic data using regularized regression techniques and incorporating seasonality through SARIMA for time series forecasting. Key takeaways include the advantages of variable selection via Lasso for interpretability and the value of confidence intervals in anticipating market volatility.

Conclusion and Implications

Our analysis of U.S. housing prices reveals a sustained upward trend in median home values, driven by key economic indicators such as household debt service payments, interest rates, and consumer sentiment. Forecasts using SARIMA suggest this growth will continue at an annual rate of approximately 5.2%, with moderate volatility, especially during peak-demand seasons in Q2 and Q3.

The findings provide valuable insights for various stakeholders:

- For **Investors:** The housing market remains a resilient investment option, with anticipated long-term appreciation. However, sensitivity to interest rates and consumer confidence highlights the need for careful monitoring, particularly during high-demand quarters, to optimize timing and returns.
- For **Policymakers:** This analysis emphasizes the influence of interest rates on housing affordability. Adjusting rates could help manage market stability, especially during economic downturns or peak buying seasons. Monitoring debt service ratios may also aid in assessing consumer financial health and ensuring market accessibility.
- For **Analysts and Researchers**: The combination of SARIMA and Lasso regression models offers a robust framework for housing market analysis. Future research could focus on segmenting data by geographic regions, allowing for more precise, region-specific insights into housing price trends.

These insights provide a strategic foundation for understanding and forecasting housing market dynamics, offering stakeholders actionable information to support investment planning, policy-making, and market analysis in response to economic conditions.

Next Steps

Future analysis will include segmentation by specific areas to examine if regional trends differ, adding granularity to housing price determinants. Additionally, transitioning from SAS to Python will allow for further flexibility in analysis and visualization, enhancing the accessibility and robustness of findings.

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