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Analyzing the U.S. Housing Market Using Time Series Data

Executive Summary

This study presents a comprehensive quantitative analysis of the U.S. housing market spanning over six decades (1963–2025).
By integrating time-series data from the Federal Reserve Economic Data (FRED), the research investigates the evolution of median home prices, mortgage interest rates, and housing inventory to identify cyclical patterns, long-term correlations, and the impacts of major macroeconomic events.
Advanced visualization and statistical techniques were employed to interpret the interdependencies among variables, assess affordability dynamics, and evaluate how economic shocks such as the 2008 financial crisis and the COVID-19 pandemic reshaped market behavior and housing accessibility.

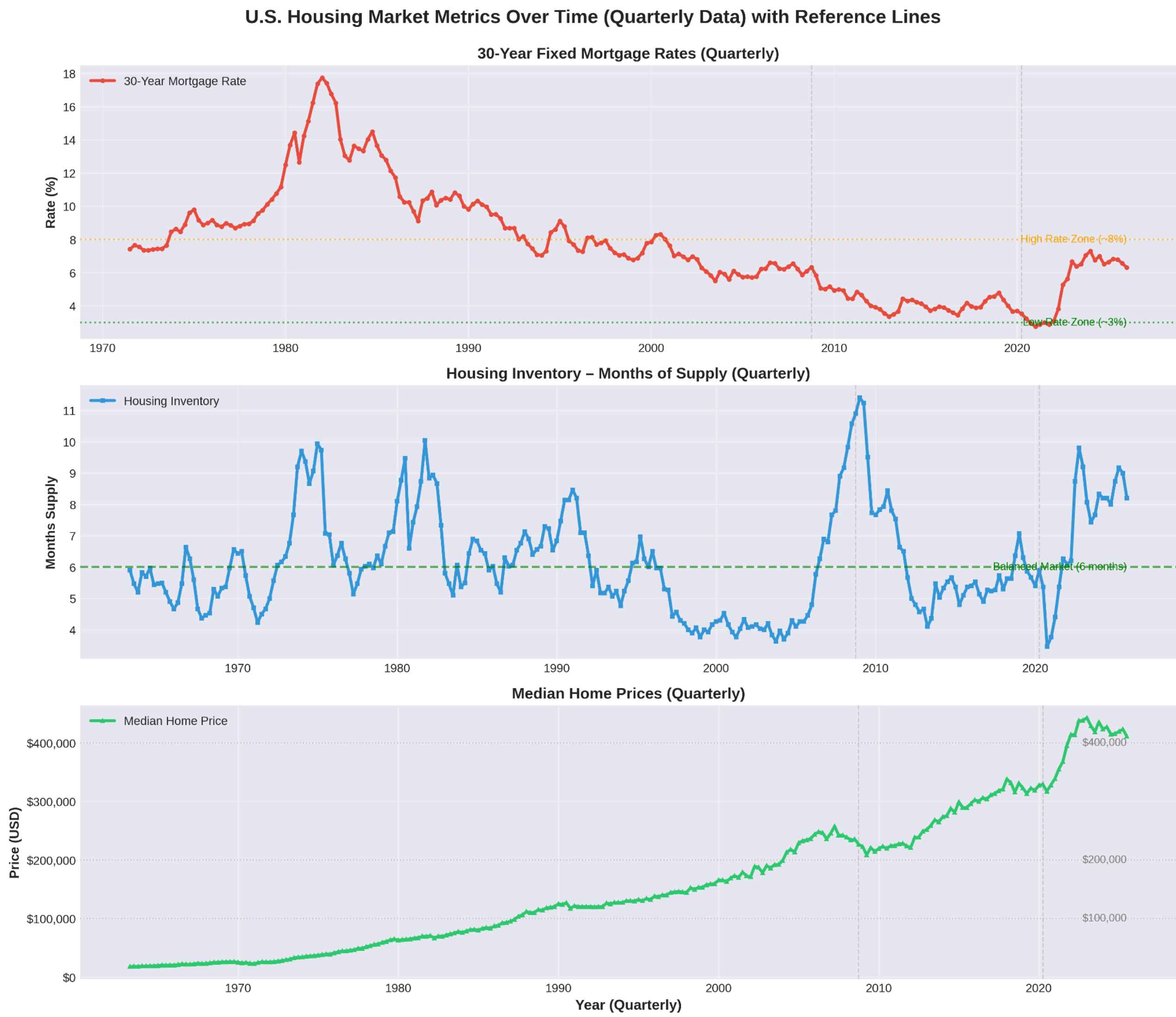
1. Objective

The principal aim of this project is to explore long-term market trends, inter-variable relationships, and affordability shifts within the U.S. housing sector.
Through the application of time-series modeling and exploratory data analysis, the project highlights how fluctuations in mortgage rates, supply constraints, and policy interventions have influenced home prices, demand, and overall housing affordability.

2. Data Selection and Methodology

Data were obtained from FRED, encompassing national housing indicators recorded monthly or quarterly.
All series were cleaned, standardized, and resampled to a quarterly frequency to ensure temporal alignment. Derived features such as year-over-year growth, moving averages, and a Housing Affordability Index (HAI) were calculated to facilitate comparative analysis.

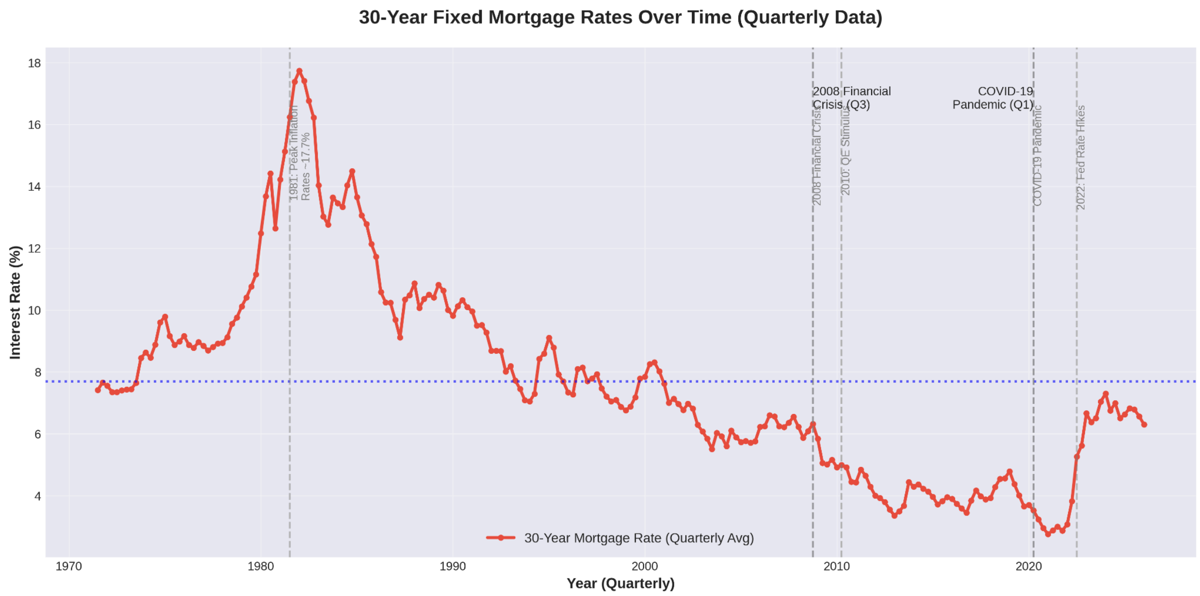
Data visualization and computation were performed using Python (Pandas, Matplotlib, Seaborn, Plotly).
The analysis framework combined descriptive statistics, correlation analysis, and event-based interpretation to derive insights on price behavior, rate sensitivity, and cyclical movement.



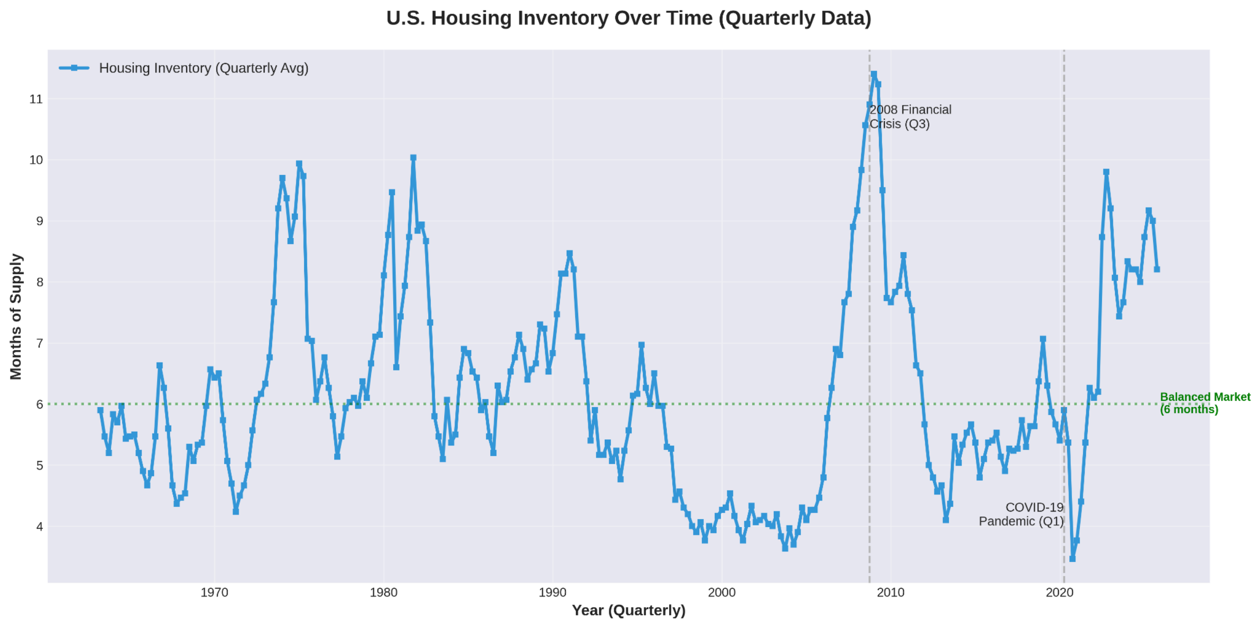
3. Key Findings

3.1 Long-Term Market Trends

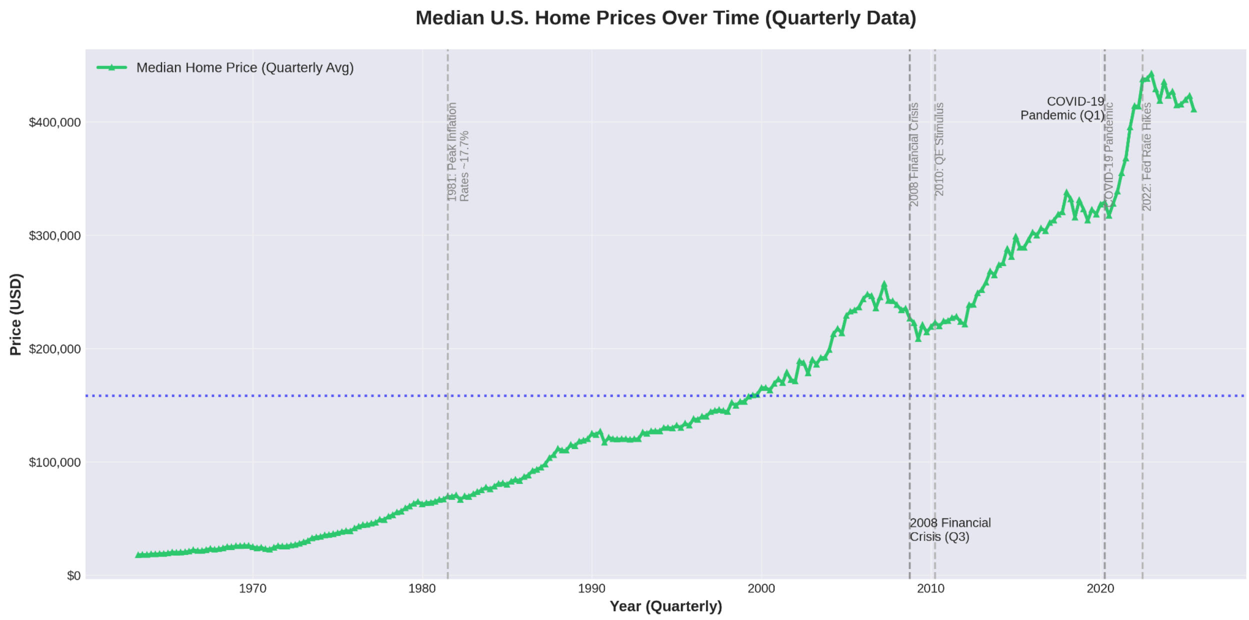
Median home prices show a sustained upward trajectory, increasing more than 22-fold since 1963, despite intermittent corrections.
Mortgage rates peaked near 17.7 percent in 1981 and declined sharply until 2021, when they reached historical lows.
Housing inventory followed cyclical movements, tightening during demand booms and expanding during recessions



30-Year Fixed Mortgage Rates Over Time (Quarterly Data)
Interest Rate (%)
18
16
14
12
10
8
6
4
1970
1980
1990
2000
2010
2020
Year (Quarterly)
1981: Peak Inflation Rates ~17.7%
2008 Financial Crisis
2010: QE Stimulus
2008 Financial Crisis (Q3)
COVID-19 Pandemic (Q1)
COVID-19 Pandemic
2022: Fed Rate Hikes
30-Year Mortgage Rate (Quarterly Avg)

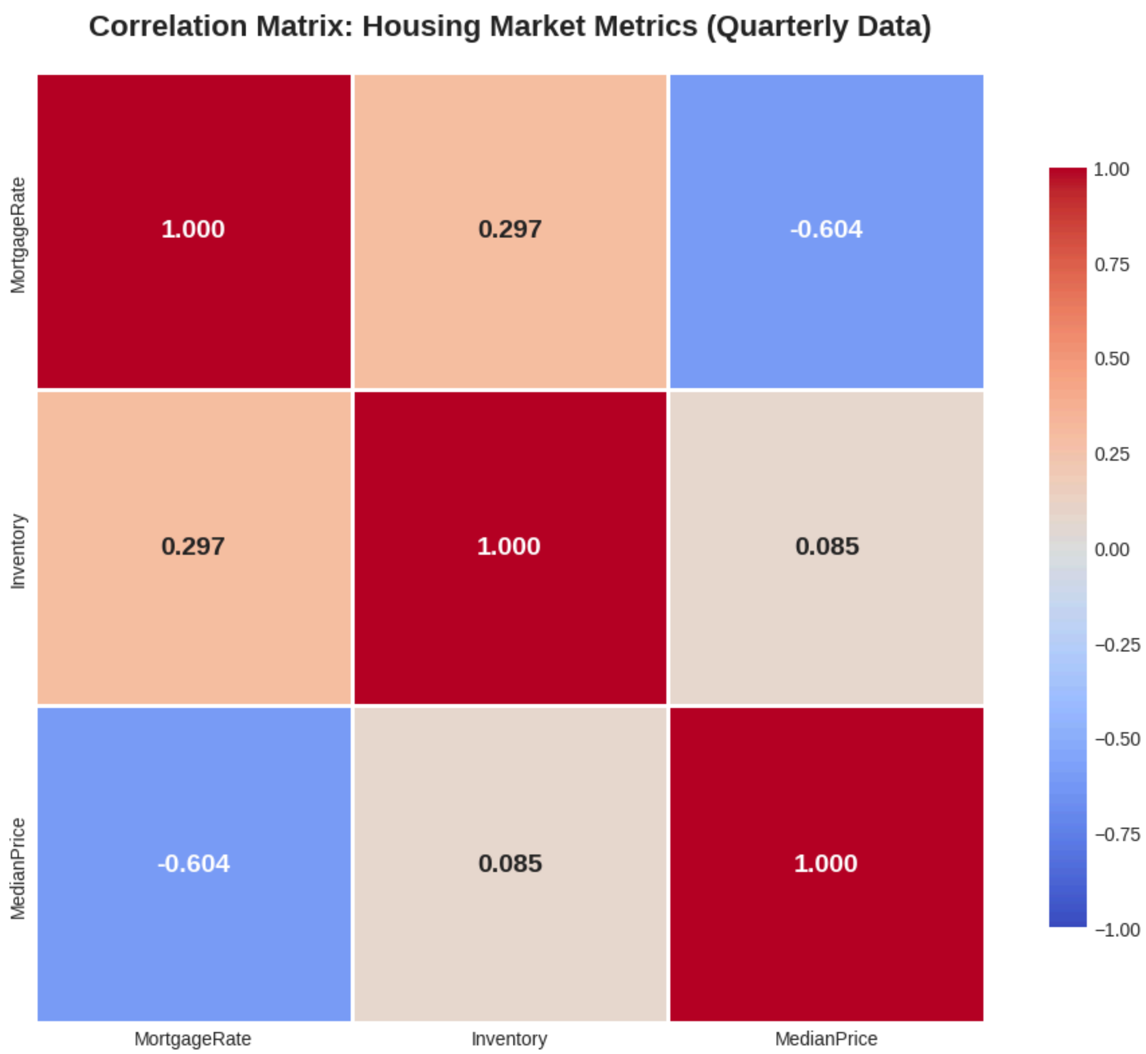


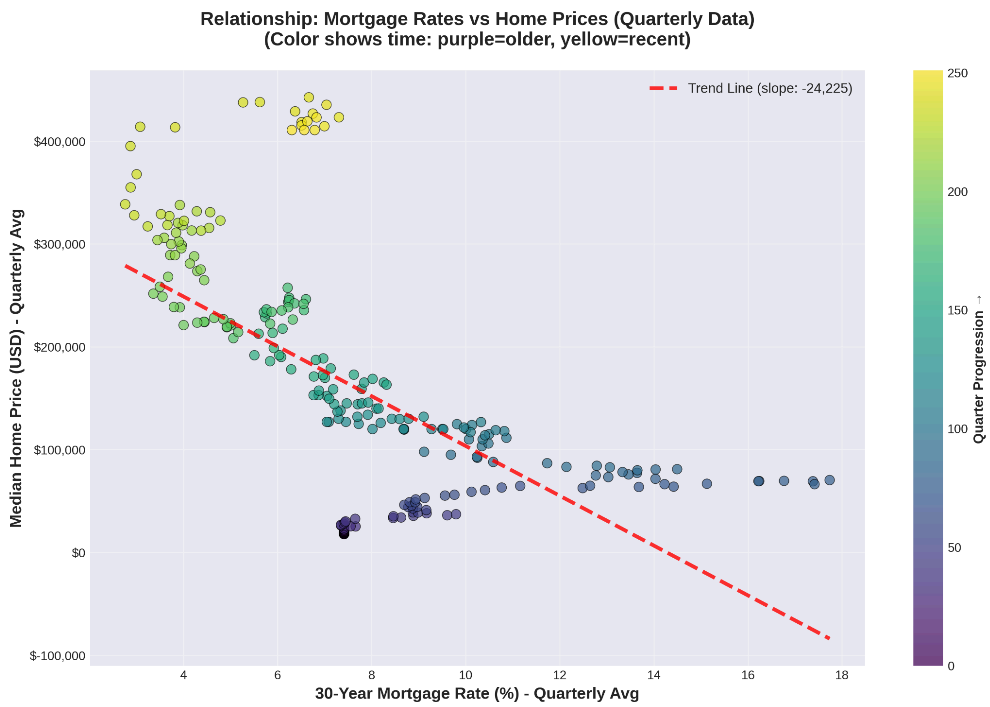
U.S. Housing Inventory Over Time (Quarterly Data)
Housing Inventory (Quarterly Avg)
Months of Supply
11
10
9
8
7
6
5
4
1970
1980
1990
2000
2010
2020
Year (Quarterly)
2008 Financial Crisis (Q3)
COVID-19 Pandemic (Q1)
Balanced Market (6 months)



3.2 Inter-Variable Relationships

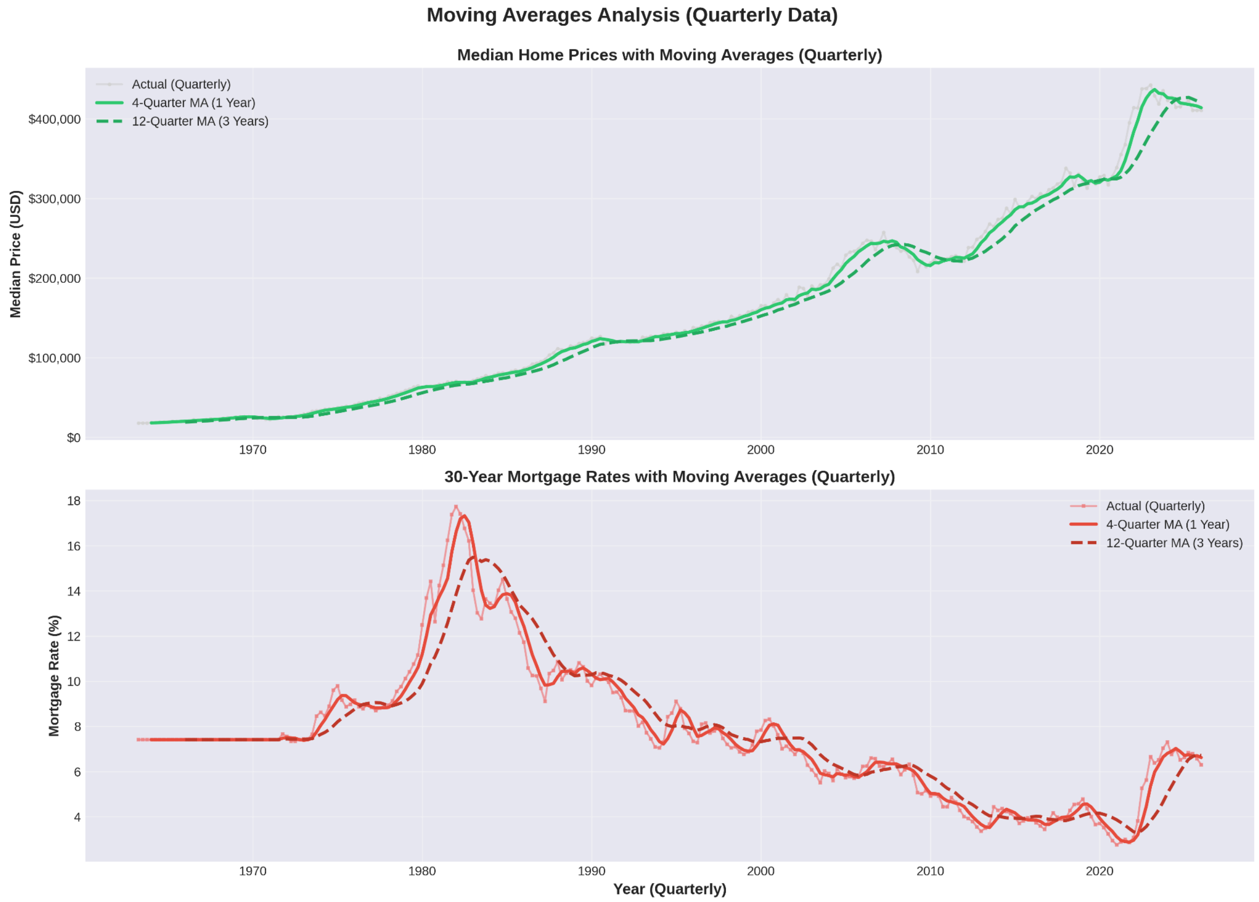
A strong inverse correlation (r = −0.60) exists between mortgage rates and home prices, implying that higher rates reduce demand and downwardly pressure prices.
Regression analysis indicates that a one-percentage-point increase in mortgage rates corresponds to an estimated $24 000 reduction in median home price.
Housing inventory correlates mildly positively with interest rates (r ≈ 0.30), suggesting slower absorption when borrowing costs rise.

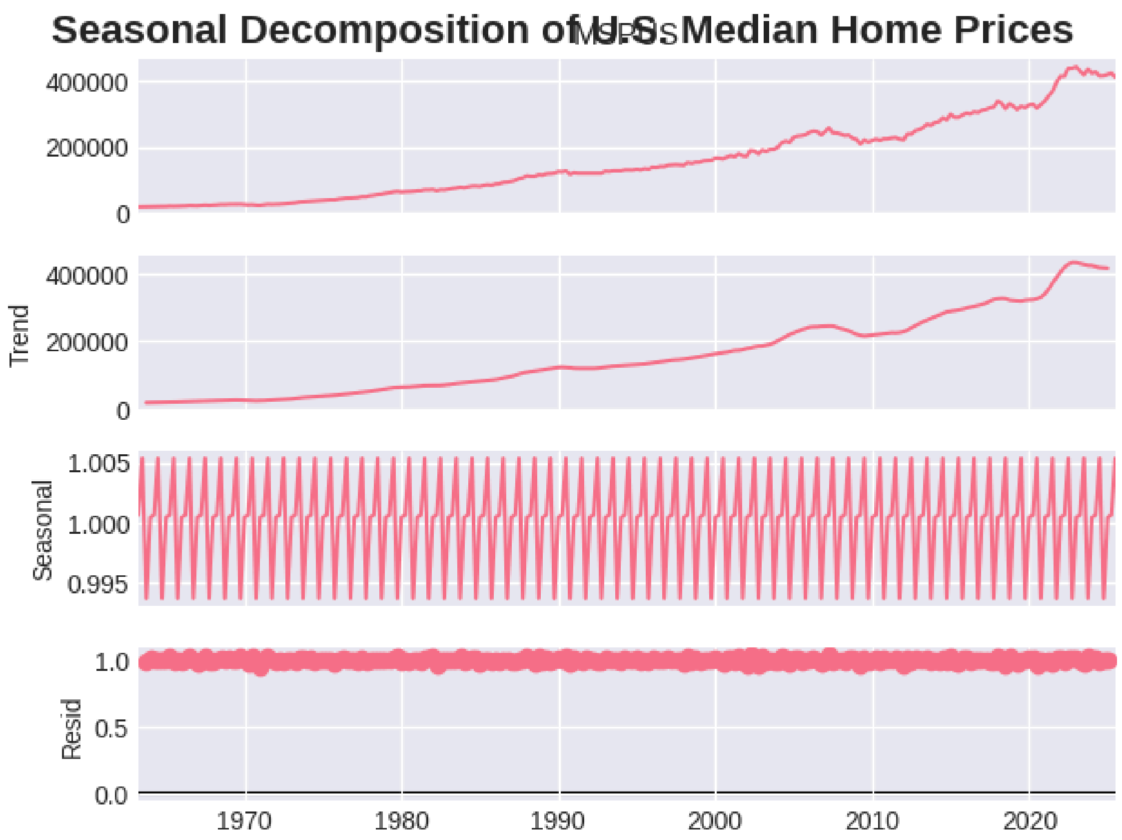

Correlation Matrix: Housing Market Metrics (Quarterly Data)
MortgageRate
Inventory
MedianPrice
1.000
0.297
-0.604
0.297
1.000
0.085
-0.604
0.085
1.000
MortgageRate
Inventory
MedianPrice
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00


Relationship: Mortgage Rates vs Home Prices (Quarterly Data)
(Color shows time: purple=older, yellow=recent)
Trend Line (slope: -24,225)
Median Home Price (USD) - Quarterly Avg
$400,000
$300,000
$200,000
$100,000
$0
$-100,000
4
6
8
10
12
14
16
18
30-Year Mortgage Rate (%) - Quarterly Avg
Quarter Progression →
250
200
150
100
50
0

3.3 Cyclicality and Seasonality

Moving-average smoothing and seasonal decomposition reveal multi-year cyclical patterns spanning approximately **8 to 10 years**, while short-term seasonality remains negligible. These findings confirm that housing fluctuations are predominantly driven by credit availability and macroeconomic policy rather than seasonal factors.





3.4 Impact of Economic Events

Time-series analysis indicates that major economic disruptions have significantly shaped U.S. housing market dynamics. The 2008 Global Financial Crisis triggered a sharp correction, with home prices falling nearly 20% and housing inventory spiking as credit tightened and foreclosures rose. This period reflects a demand collapse driven by financial instability and reduced lending capacity.

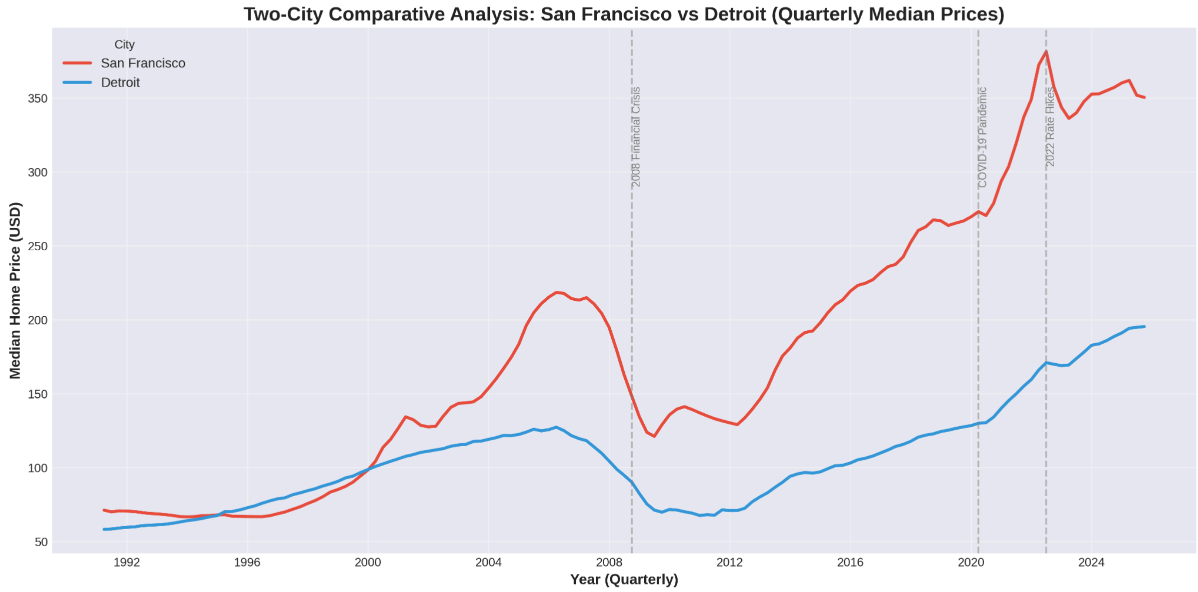
In contrast, the COVID-19 pandemic (2020–2021) produced a rapid upswing fueled by record-low mortgage rates, remote work trends, and fiscal stimulus. Prices surged while supply remained constrained, creating one of the most competitive housing markets in history. However, the 2022 interest rate hikes abruptly cooled demand, eroding affordability and slowing price growth.

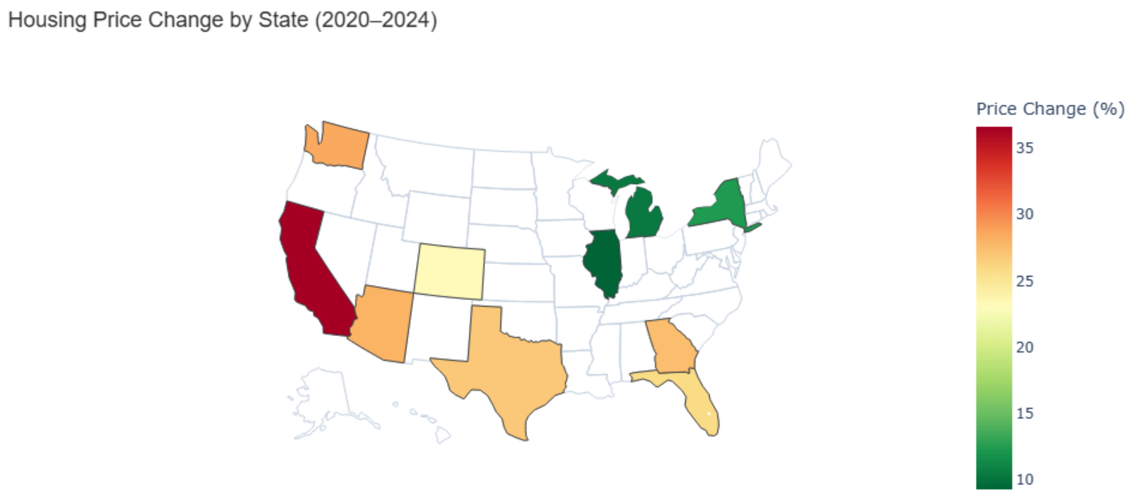
Overall, these shifts demonstrate how monetary policy and macroeconomic shocks directly influence housing affordability, with price movements typically lagging interest rate changes by several quarters.

3.5 Affordability and Regional Disparities

The constructed Housing Affordability Index (HAI) reveals a persistent long-term decline, with 2024 marking the least affordable period since the early 1980s.
Millennials face an average price-to-income ratio of 5.6×, nearly double that experienced by Baby Boomers.

Regional analysis underscores divergent trajectories San Francisco exhibits extreme volatility and price escalation, whereas Detroit demonstrates steadier and more attainable housing values.





4. Interpretation and Discussion

The results underscore a cyclical yet structurally upward-drifting housing system wherein monetary policy serves as the dominant short-term catalyst.
Home-price responses typically lag mortgage-rate adjustments by two to three quarters, indicating delayed behavioral and market reactions.
The 2020s mark an unprecedented affordability crisis driven by disproportionate price acceleration relative to income growth.
Regional divergence and generational inequality are becoming defining characteristics of the modern U.S. housing market.

5. Conclusion

This research demonstrates how time-series visualization can effectively trace the evolution of complex economic systems.
The U.S. housing market's trajectory reflects the interaction between interest-rate policy, demand cycles, and income constraints.
While overall price levels continue to rise, affordability deterioration poses a significant macroeconomic risk.
Sustaining long-term equilibrium will require balanced monetary regulation, expanded housing supply, and income-responsive affordability strategies.