**Final Project Summary: Housing Affordability & Investment Performance Using Zillow Datasets**

**OIM7502-Spring 2025 – Project Group2**

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**Project Objectives:**

This project explores long-term housing affordability and investment viability in the U.S. by comparing the performance of home prices (via Zillow’s HVI) to the stock market (via S&P 500 index). It also analyzes regional affordability for renting vs. buying and identifies anomalies in housing markets. The goal is to create an interactive, data-driven application to inform consumers, investors, and policy advocates.

**Datasets Used:**

1. **Zillow Home Value Index (ZHVI)**
   * Time span: 2000–2025
   * Granularity: Metro-level monthly price index for single-family homes and condos
   * Source: Zillow Research
2. **Zillow Observed Rent Index (ZORI)**
   * Time span: 2015–2025
   * Metro-level rental cost index trends similar to Zillow Home Value Index dataset
3. **S&P 500 Index from FRED (Federal Reserve Economic Data)**
   * Time span: 2020–2025
   * Used for comparison with property investment performance

**Data Exploration & Processing:**

* Time normalization was performed across datasets to ensure alignment (especially important when comparing property and stock returns).
* Monthly average prices were reshaped to long format (RegionName, Date, HVI*)*
* Derived variables included:
  + **Income needed to afford a home** (based on mortgage, taxes, and insurance)
  + **Income needed to afford rent** (based on 30% of gross income rule)

**Machine Learning & Forecasting Techniques:**

**1. Time Series Forecasting (Holt-Winters):**

* Applied on normalized Zillow HVI and S&P 500 data.
* Model components: **Level, Trend, Seasonality**
* Forecast horizon: 60 months (next 5 years)
* Insight: Property prices show smoother, long-term appreciation; stocks show greater volatility but higher returns in some periods.

**2. Clustering (K-Means):**

* Features: Average income needed to afford rent and buy
* Clusters: 3 affordability bands across U.S. metros
* Interpretation: Identified tiers of markets, such as low-cost (e.g., Danville, IL), high-cost (e.g., San Jose, CA), and transitional markets

**3. Anomaly Detection:**

* Technique: Based on deviation from the standard rent-buy affordability relationship
* Output: Identified markets like San Francisco, Jackson (WY), and Edwards (CO) as outliers, either due to luxury pricing or severe rent/home price volatility.

**Visualizations & Streamlit App Features:**

* Line plots comparing HVI and S&P 500 over 10 years
* Boxplots to compare Rental and Housing Affordability across US Metro Regions (averaging monthly data over 20 years)
* Scatter plots and heatmaps for regional rent vs. buy dynamics
* Clustering visualizations
* Interactivity:
  + Select metros by state
  + Filter based on affordability tiers
  + Compare home vs rent costs per region

**Key Insights & Conclusions:**

1. **Investment Performance**: Both housing and S&P 500 have grown since 2020, but stocks show more volatility. Housing, though slower, offers stability and long-term wealth building, especially in metro areas with strong appreciation.
2. **Affordability Trends**: In many U.S. metros, income needed to rent is rising faster than income needed to buy, indicating shrinking affordability.
3. **Market Clusters**: Urban and coastal areas generally form high-income clusters; interior metros offer more affordability.
4. **Anomalies Reveal Pain Points**: High income gaps between renting and owning signal markets ripe for policy intervention or investor caution.

**Recommendations & Future Work:**

* Incorporate mortgage rate fluctuations and inflation data for deeper macroeconomic analysis.
* Expand visual interactivity in the app by allowing geospatial mapping of clusters with similar characteristics of region selected.
* Include demographic overlays (e.g., population growth, income levels).

Public link to interactive app hosted for free on Streamlit cloud:

<https://housingappappcloudpy-9ghjxtrajvqe9b4rurnbwr.streamlit.app/>

Sources:  
<https://www.zillow.com/research/data/>

<https://www.zillow.com/research/affordability-methodology-34975/>