

Methods of Advanced Data Engineering

Case Study of Top 10 Metropolitans of USA: Relation of Macroeconomic Indicators (Inflation, Interest Rates, and Income) & Housing Affordability

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Main Question

Analyzing the Relationship of Selected Macroeconomic Indicators & Housing Affordability in the USA.

Why?

1. Impact of globalization on skilled workers' relocation.
2. Housing affordability: a critical factor for expats in developed economies like the USA, Germany etc.
3. Housing trends along Selected Macroeconomic indicators to analyze the economic health.
4. Focus: 10-year analysis of housing affordability in top 10 US metropolitans.

Data Used

1. Merged Housing and Macroeconomic data in time-series format (monthly timestamps).
2. Covers 10 years for the top 10 metropolitan regions of USA.

Data Features

1. Housing Data [[Zil24](#)]:
 - Rental/Home Prices
 - Rental Demand
 - Heat Index.
2. Macroeconomic Indicators [[FRE24](#)]:
 - CPI (Inflation)
 - Monthly Disposable Income
 - 30/15-Year Fixed Mortgage Rates (Interest Rates)

Samples From Final Data

DATE	Region	SF Home Prices	All Home Prices	SF Rental Prices	All Rental Prices	SF Rental Demand	All Rental Demand	Heat Index	CPI	Inflation	30Y Fixed Rate	15Y Fixed Rate	Income
2015-01-01	United States	183832.254851	184918.050518	1253.339325	1208.652197	95.4	50.8	50.4	233.707	-0.1	3.7	3.0	13797.7
2015-02-01	United States	184623.569981	185714.707627	1259.779349	1214.197215	127.8	83.4	52.0	234.722	-0.0	3.7	3.0	13848.0
2015-03-01	United States	185430.820473	186524.115022	1268.343734	1220.153703	151.4	104.8	52.6	236.119	-0.1	3.8	3.0	13811.3
2015-04-01	United States	186317.956037	187409.136805	1278.430726	1225.102763	158.5	105.6	52.8	236.599	-0.2	3.7	2.9	13842.0
2015-05-01	United States	187294.071588	188385.459545	1287.859367	1229.581922	158.5	105.6	52.3	237.805	-0.0	3.8	3.1	13865.6

Figure: Samples From Final Data

Methodologies

1. Exploratory Data Analysis
2. Correlation Analysis.

1. Exploratory Data Analysis

1. Methodology:
 - Double-axis line plots: Housing features (blue) vs Macroeconomic Indicators (red).
 - Focus: Long-term trends and correlation
 - Visuals excluded for Rental Demand due to noisy/weak trends.
2. Key Observations:
 - Rental and home prices doubled in almost all regions over 10 years.
 - Income levels rose concurrently and were able to offset rising prices.

Exploratory Data Analysis: Results

1. CPI/Inflation vs Housing Features:
 - Strong positive correlation with home/rental prices.
 - Weak negative correlation with rental demand.
 - Visuals excluded for Rental Demand due to noisy/weak trends.
2. Income vs Housing Features:
 - Income and home/rental prices show a concurrent upward trend.
 - Visuals excluded for Rental Demand due to noisy/weak trends.
3. Interest Rates vs Housing Features:
 - Non-linear relationship observed.
 - Visuals excluded for Rental Demand due to noisy/weak trends.

EDA Results: CPI vis-a-vis Housing Features

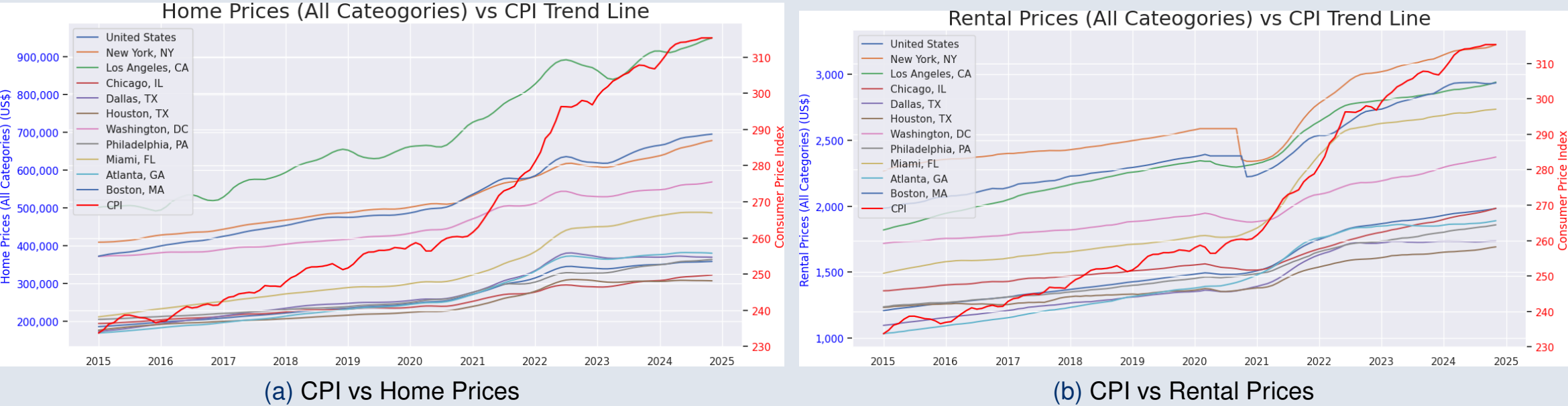


Figure: CPI vs Housing Market Features

EDA Results: Income vis-a-vis Housing Features

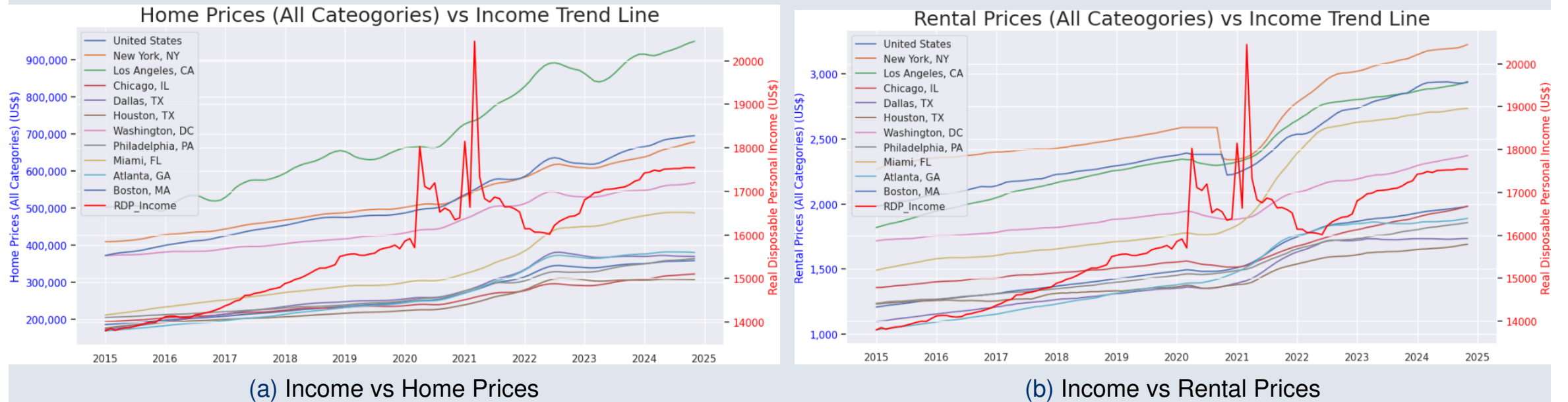


Figure: Income vs Housing Market Features

EDA Results: Interest Rates vis-a-vis Housing Features

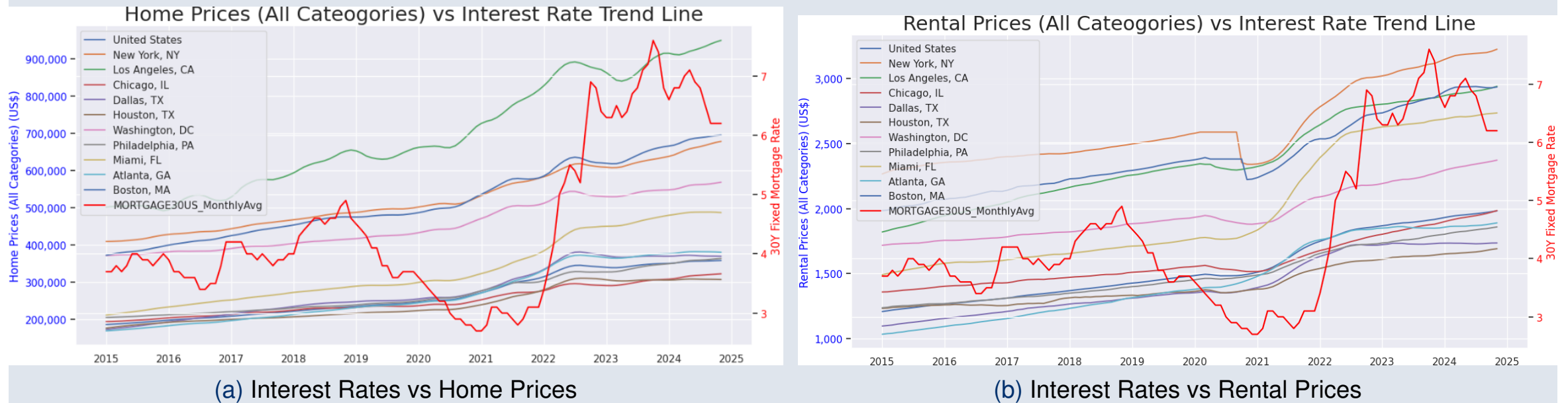


Figure: Interest Rates vs Housing Market Features

2. Correlation Analysis

1. Methodology:

- Spearman Correlation for monotonic relationships and robustness to outliers.
- Clustered metropolitans into two groups based on correlation patterns.

2. Key Observations:

- Cluster 1: Cities with similar trends to the US Average Case.
- Cluster 2: Outliers (e.g., Los Angeles, Chicago) influenced by regional factors.

Correlation Analysis: Results

1. USA Average Case:

- Strong positive correlation between home/rental prices and income (0.93-0.94).
- Perfect correlation (1.0) between prices and CPI.
- Moderate correlation with mortgage rates (0.42).

2. Cluster 1:

- All Cluster 1 metropolitans exhibit very similar trends to USA Average case.

3. Cluster 2:

- Only Different behavior in rental demand and interest rates.

Correlation Matrix: USA Average Case

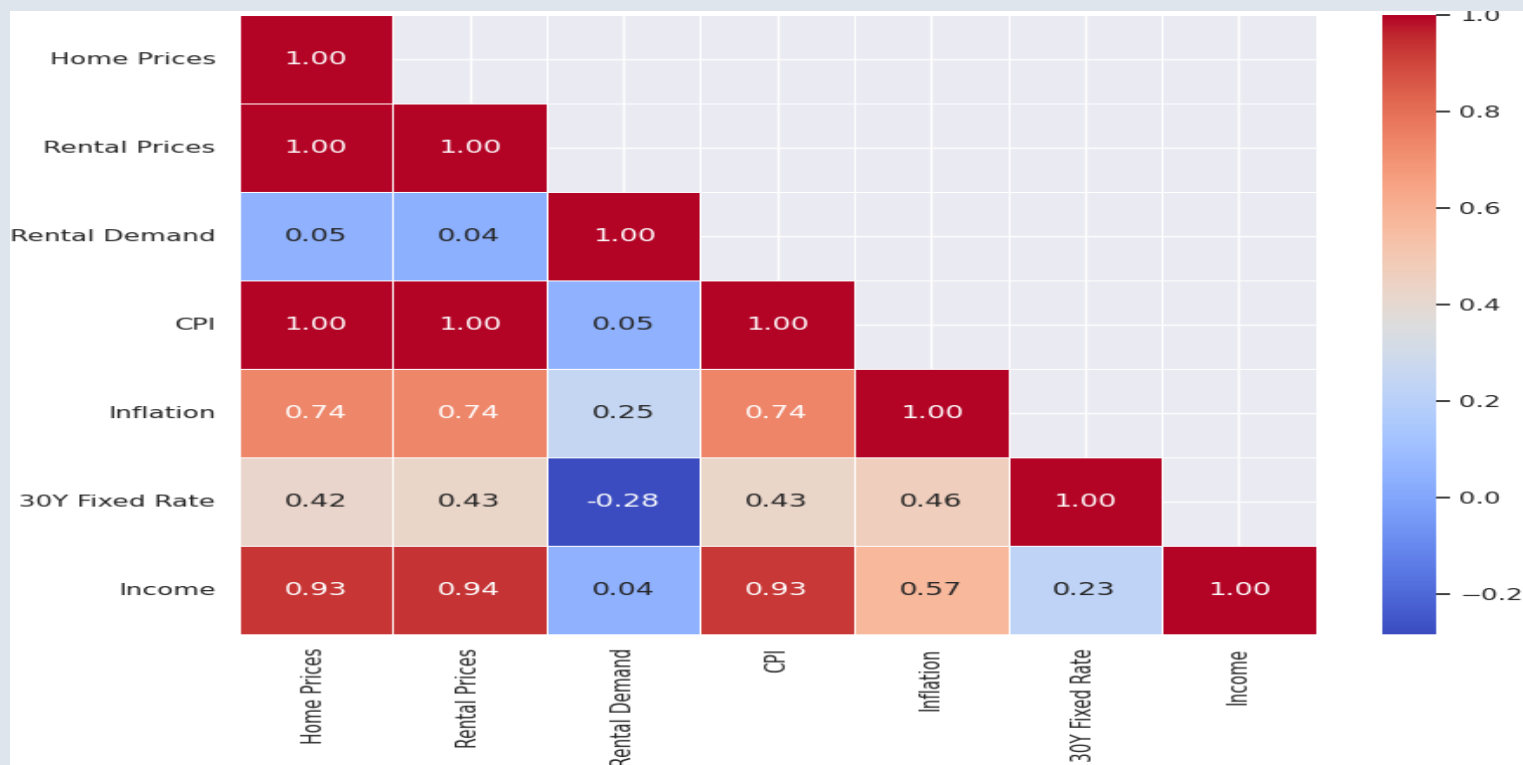
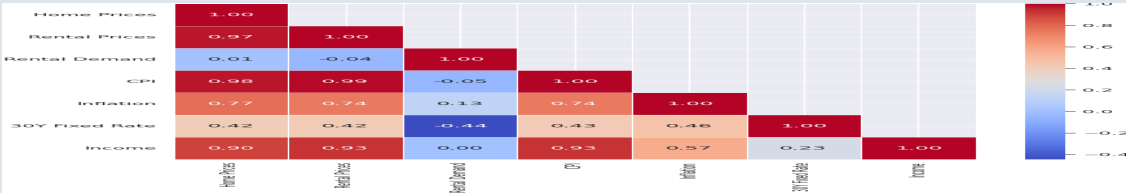
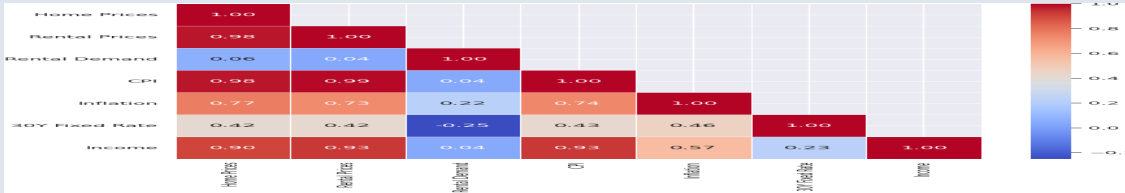


Figure: Correlation Matrix: USA Average Case

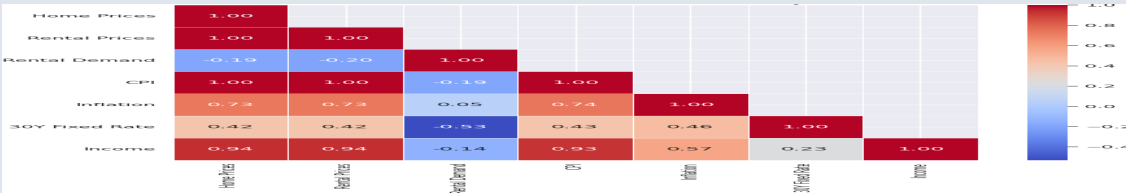
Correlation Matrices: Cluster 1



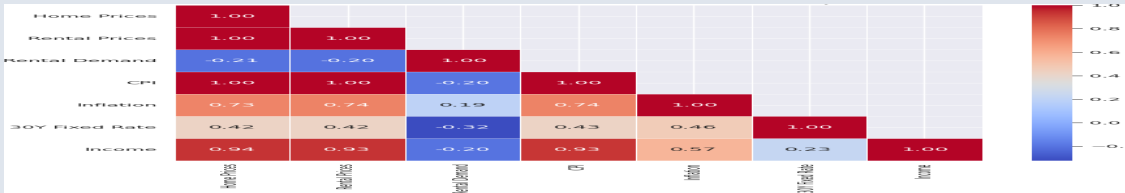
(a) Dallas



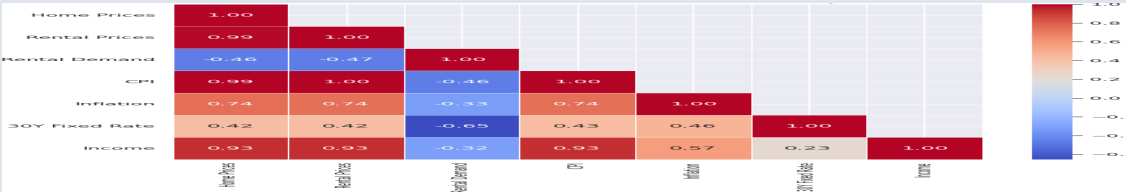
(b) Houston



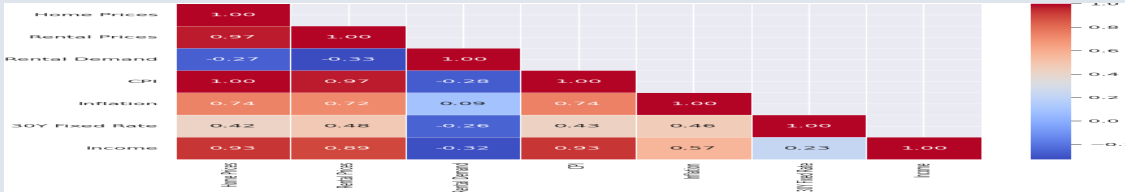
(c) Philadelphia



(d) Miami



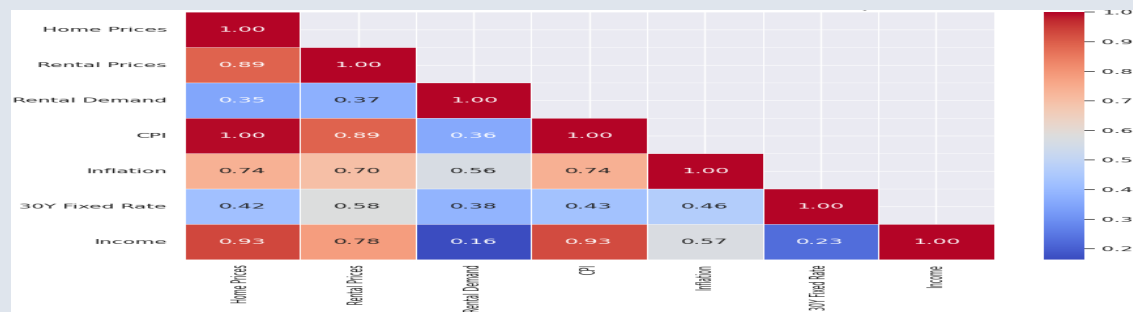
(e) Atlanta



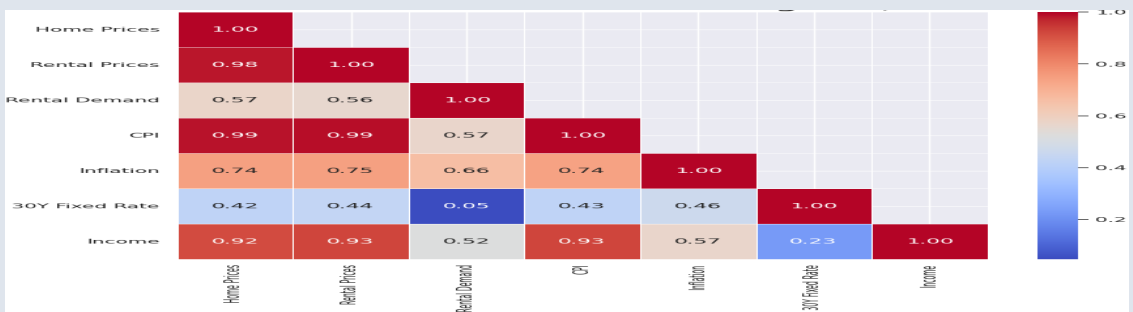
(f) Boston

Figure: Correlation Matrices: Cluster 1 Metropolitans

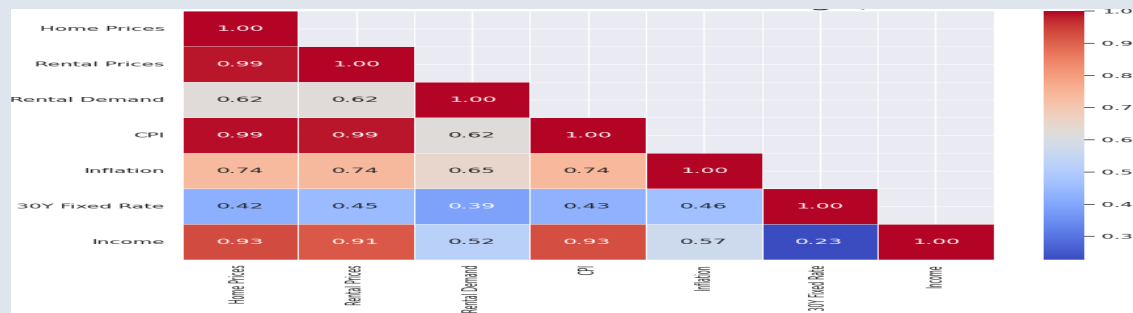
Correlation Matrices: Cluster 2



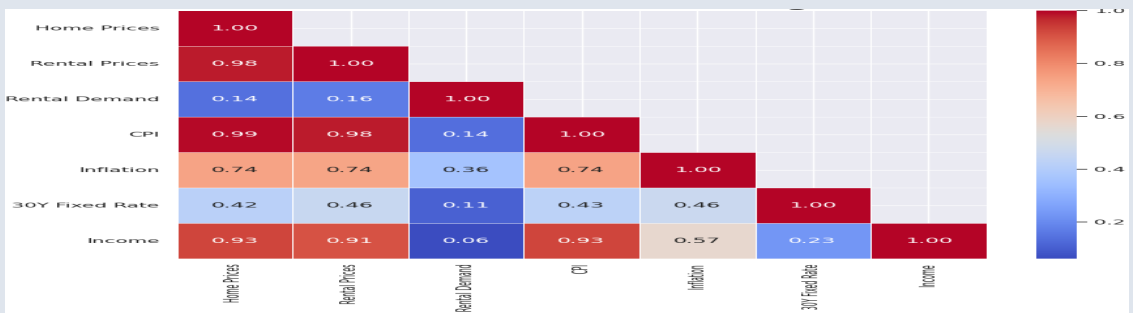
(a) New York



(b) Los Angeles



(c) Chicago



(d) Washington DC

Figure: Correlation Matrices: Cluster 2 Metropolitans

Limitations

1. Correlation \neq Causation:
 - Complex mechanisms, unmeasured variables.
2. Data Aggregation:
 - Obscures regional/local variations.
3. Excluded Factors:
 - Employment, demographics, consumer sentiment.
4. COVID-19 Anomalies:
 - Unique conditions during 2019-2022.

Conclusion

- Strong relationships between Macroeconomic Indicators and housing market trends.
- Housing affordability challenges persist despite rising incomes.
- A consistent increase in Income levels alongside rising CPI/Inflation and Housing Prices over the last 10 years suggests that most people have been able to keep up with economic pressure. Based on this analysis, at least in the short-run, we can consider the USA not a promising but viable destination for relocation.

References

- [FRE24] FRED. *Federal Reserve Economic Data (FRED)*. Accessed: 2024-11-13. 2024. URL: <https://shorturl.at/rhKa6>.
- [Zil24] Zillow. *Zillow Research*). Accessed: 2024-11-13. 2024. URL: <https://shorturl.at/nSgQ1>.