Final Project Report: Housing Affordability in Massachusetts

Problem Statement

The aim of this project was to investigate whether the addition of multifamily housing and apartment buildings in Massachusetts cities can effectively address housing affordability. Housing affordability was calculated as the percentage of one's income relative to their housing expenses, including mortgage payments for owners and rent for renters.

Approach

The approach taken involved analyzing a dataset containing housing information for different regions in Massachusetts, broken down by housing type. The types of housing considered included:

- One-family house detached
- 2 Apartments
- 3-4 Apartments
- 5-9 Apartments
- 10-19 Apartments
- 20-49 Apartments
- 50 or More Apartments

For each housing type, the data included the number and percentage of owned and rented properties, the monthly owner costs with and without a mortgage as a percentage of income, the monthly renter costs as a percentage of income, and the total number of properties. The analysis involved:

- Comparing the distributions of housing costs as a percentage of income for each housing type.
- Comparing the total number of owned and rented properties for each housing type.

- Comparing the costs of owning with a mortgage versus renting for each housing type.

Further, we attempted a machine-learning approach to explore more information. Our approach involved several key steps. First, we loaded and explored the dataset to understand its structure and the nature of the features and target variables. Next, we split the dataset into a training set and a test set, which allowed us to evaluate our models' performance accurately.

We then built multiple regression models, including Linear Regression, Random Forest Regression, and Support Vector Regression, to predict each of the target variables. Each model was evaluated using Mean Absolute Error (MAE), Mean Squared Error (MSE), and R-squared.

To further improve our models' performance, we conducted hyper-parameter tuning using GridSearchCV. This method performs an exhaustive search over specified parameter values to find the best parameters for our models.

Note: Please see the files attached to the GitHub folder for further examination.

Findings

Housing Affordability

The box plots below (**Figure 1**) display the distribution of housing affordability percentages, represented as 'Monthly Owner Costs With Mortgage', 'Monthly Owner Costs Without Mortgage', and 'Monthly Renter Costs', across different types of housing.

Here are some observations:

- **Monthly Owner Costs With Mortgage**: For homeowners with a mortgage, the costs as a percentage of income are generally higher for one-family detached houses and 2-apartment buildings. The costs for larger apartment buildings (20 or more apartments) appear to be somewhat lower, suggesting that these types of housing might be more affordable for homeowners with a mortgage.
- **Monthly Owner Costs Without Mortgage**: For homeowners without a mortgage, the costs as a percentage of income appear to be relatively consistent across different types of housing, with median values mostly around 15-20%.

- **Monthly Renter Costs**: For renters, the costs as a percentage of income are generally higher for one-family detached houses and 2-apartment buildings. The costs for larger apartment buildings (50 or more apartments) appear to be somewhat lower, suggesting that these types of housing might be more affordable for renters.

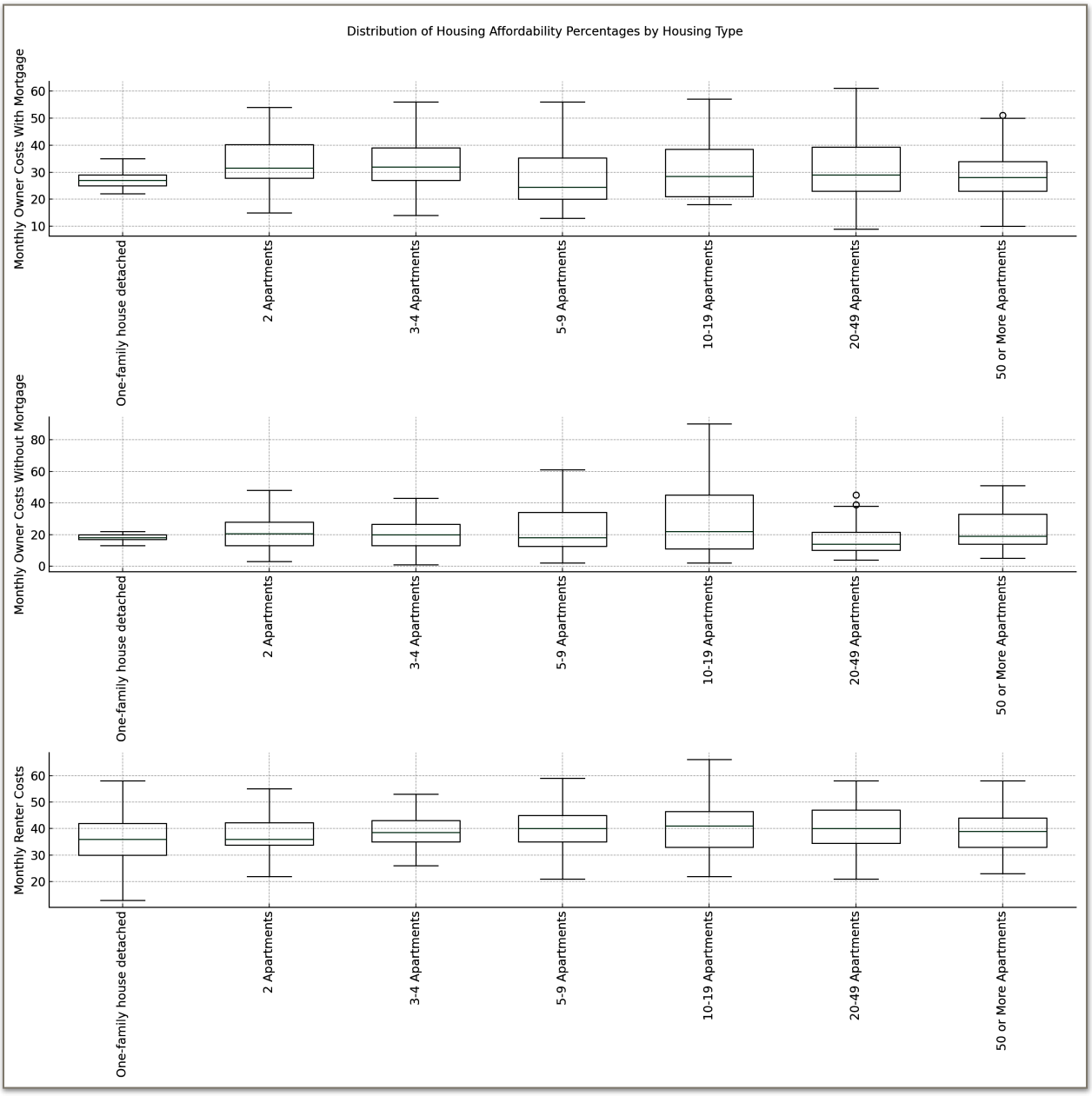

FIGURE 1: DISTRIBUTION OF HOUSING AFFORDABILITY PERCENTAGES BY HOUSING TYPE

It's important to note that these box-plots show a wide range of values for each type of housing, indicating significant variability in housing affordability within each category.

This could be due to a variety of factors, including differences in location, property size, property condition, and local housing market conditions.

Ownership vs. Renting

Here are some key takeaways from **Figure 2**:

- **Owned Properties**: One-family detached houses are the most common type of owned properties, followed by 2-apartment buildings. The number of owned properties decreases as the size of the apartment building increases.
- **Rented Properties**: When it comes to rented properties, the picture changes significantly. While one-family detached houses are still common, larger apartment buildings, especially those with 50 or more apartments, accommodate a substantial number of renters.

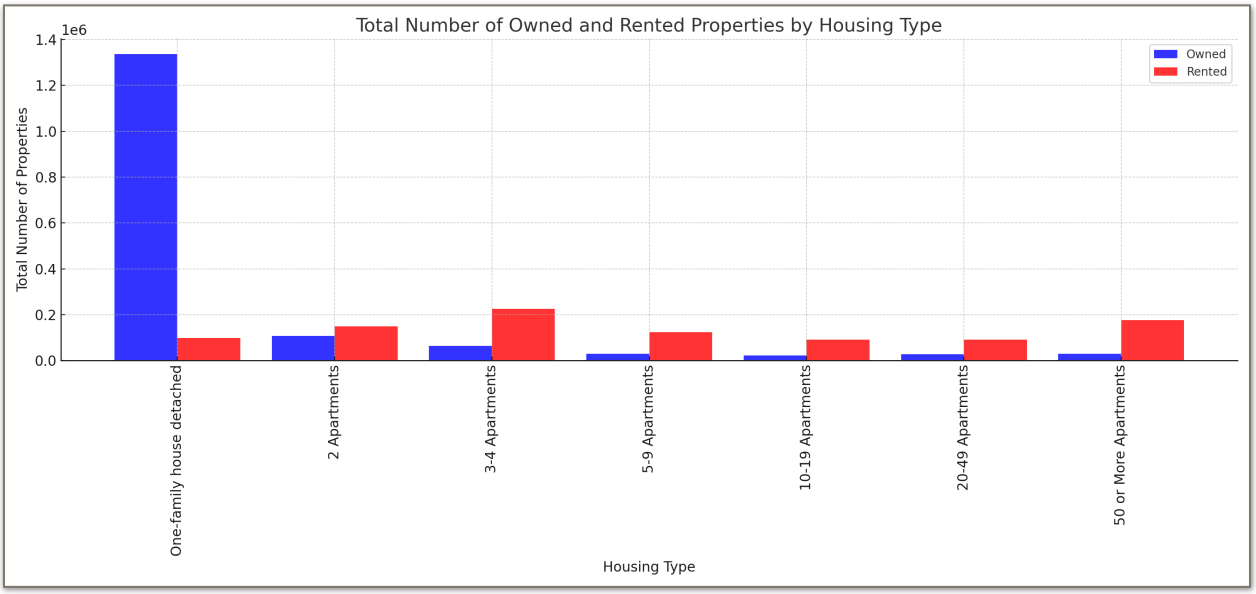

FIGURE 2: TOTAL NUMBER OF OWNED AND RENTED PROPERTIES BY HOUSING TYPE

While one-family detached houses are more commonly owned, larger apartment buildings (especially those with 50 or more apartments) play a significant role in the rental market. This suggests that adding more multi-family housing and additional apartment buildings could potentially increase the supply of rental properties, which might help to address housing affordability issues, especially for renters.

However, the table below (**Figure 3**) shows the median 'Monthly Owner Costs With Mortgage' and 'Monthly Renter Costs' for each housing type, as well as the difference between these two costs, expressed as a percentage of the 'Monthly Owner Costs With Mortgage'.

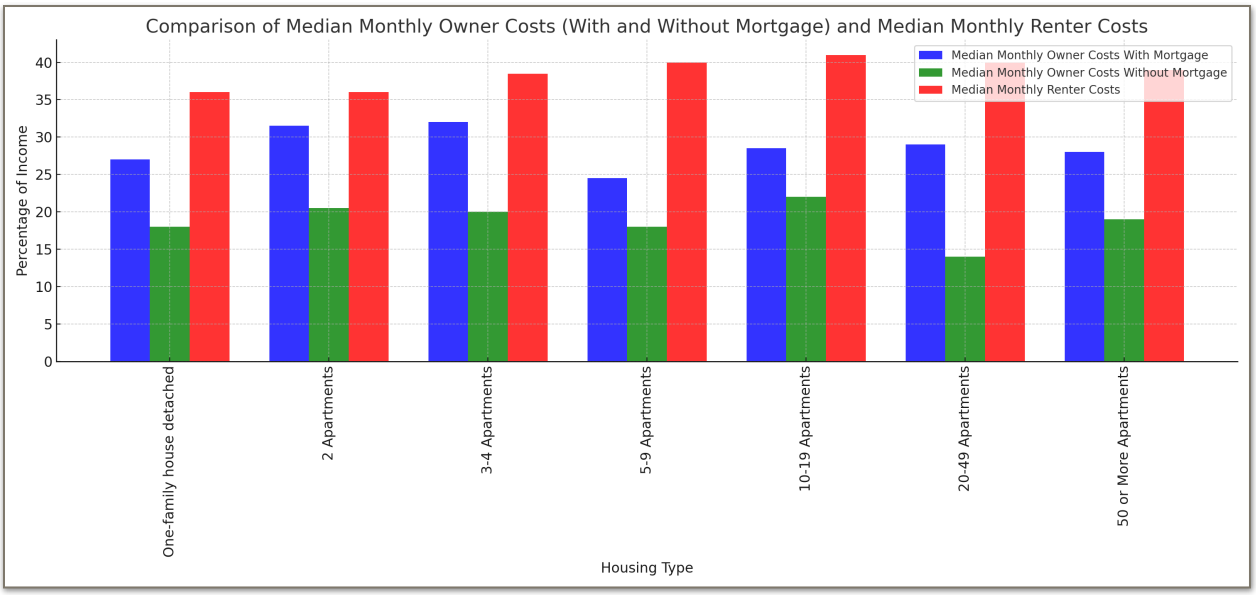

FIGURE 3: OWNERSHIP VS. RENTER COST COMPARISON

Here are some key takeaways:

- For all housing types, the median 'Monthly Renter Costs' are higher than the median 'Monthly Owner Costs With Mortgage'. This suggests that, on average, it is more affordable to have a mortgage than to rent in Massachusetts, regardless of the type of housing.
- The difference between the costs of owning with a mortgage and renting varies by housing type. For example, for 'One-family house detached', renting is around 33% more expensive than owning with a mortgage. For '5-9 Apartments', the difference is even larger, with renting being about 63% more expensive.

It's important to note that these results are based on medians, which might not accurately reflect the situation for all individuals. Additionally, these results do not account for other costs associated with homeownership, such as maintenance and repair costs, property taxes, and homeowner's insurance, which could make owning more expensive than the mortgage costs alone suggest, represented by the housing cost without a mortgage.

Furthermore, the decision to rent or buy a home depends on many factors beyond monthly costs, including the duration of stay, expected home price growth rate, expected rent growth rate, interest rate, and personal preferences. For a comprehensive analysis, all these factors should be taken into account.

Recommendations

- **Promote ownership in new housing developments**: To address housing affordability for long-term residents, it is recommended to tie ownership rates to new property developments, regardless of housing type. This means that when new multi-family homes are built, a significant proportion should be designated for ownership rather than rental. This strategy can help ensure that the benefits of new housing supply are accessible to potential homeowners and not just renters. However, many multi-family complexes are investment properties before they're built, so this policy could see less development.
- **Prioritize first-time home buyers and owner-occupiers**: In addition to promoting ownership in general, it could be beneficial to specifically target first-time home buyers or owner-occupiers when releasing new housing units on the market. This can be achieved by implementing policies that give these groups preferential access to new housing units. Such a policy could help increase the homeownership rate and make housing more affordable for those who are currently priced out of the market.
- **Understand the needs of different groups**: Differentiate between the housing needs of various groups, such as rental seekers who are often students or transitory workers, and long-term residents who might prefer the stability and potential financial benefits of homeownership. Tailoring housing policies and strategies to the specific needs of these different groups could lead to more effective solutions.

Further Research

This analysis could be extended by considering additional factors such as the impact of property size, property condition, location, and local housing market conditions on housing affordability. More detailed segmentation based on income levels could also be insightful, as housing affordability is often a greater concern for low- and middle-income households. Also, finding housing density relationship to mode of transport (how much time it takes to travel) and quality of lifestyle (purchasing power of residents).

Machine Learning Model Metrics

Our analysis revealed that Support Vector Regression (SVR) generally performed the best among the models tested for each of the target variables. The performance of the models was not ideal, as indicated by the negative or near-zero R-squared values, which suggests that the models do not explain much of the variability in the data.

The SVR models were also subjected to hyperparameter tuning, which improved their performance slightly, but the R-squared values remained negative or near zero.

Conclusion

While the addition of more multifamily housing and apartment buildings could be part of the solution to housing affordability issues in Massachusetts, a comprehensive strategy should consider various other factors including the costs associated with homeownership, the individual circumstances of renters and owners, and the conditions of the local housing market.

The analysis suggests that adding more multifamily housing and additional apartment buildings could potentially increase the supply of rental properties, which might help to address housing affordability issues, especially for renters. However, the impact on housing affordability would depend on a variety of factors, including the rental prices for these additional properties, the income levels of the renters, and the overall demand for housing in the market.

The comparison between the costs of owning with a mortgage and renting showed that, on average, it is more affordable to have a mortgage than to rent in Massachusetts, regardless of the type of housing. Therefore, it may be more impactful to prioritize home ownership rather than building rental properties, so that long-term residents have the opportunity to build equity and pay less monthly on housing.