Determinants of Rental Income per Square Foot in Manhattan

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Abstract

This study delves into the dynamics of rental income per square foot in Manhattan, leveraging the **DOF: Cooperative Comparable Rental Income (Citywide)** dataset from the NYC Open Data portal. By applying statistical methods to analyze factors affecting rental prices, the research aims to provide insights that will help renters, landlords, and policymakers understand the complexities of housing affordability and market trends. The findings are intended to enhance decision-making for all stakeholders involved in Manhattan's real estate market.

KEYWORDS: Manhattan Real Estate, Rental Income Per Square Foot, Housing Affordability, Urban Economics, Real Estate Valuation

1 Introduction

Manhattan, known for its high real estate values due to its status as a global economic and cultural hub, presents a complex rental market landscape. This study narrows down from a general perspective on New York City to focus specifically on Manhattan, examining rental income per square foot as a critical indicator of market dynamics.

The objective of this research is to clarify the factors influencing rental income variability, such as "Housing Size", "Year of Build", "Elevator or Not", "Safety Index", which are essential for renters seeking value, landlords setting prices, and policymakers developing

housing strategies. Through a detailed statistical analysis, the study will explore how these factors contribute to rental prices.

2 Data

This study utilizes a dataset from the NYC Open Data portal, an authoritative resource provided by the New York City municipal government.

2.1 Dataset Description

The primary dataset used is titled **DOF: Cooperative Comparable Rental Income (Citywide)**, which encompasses income data from properties comparable in structure and location to condominiums and cooperatives. The Department of Finance leverages this dataset to appraise the values of such properties across the city.

The focus is narrowed to rental apartments within this dataset, specifically to determine the `Gross Income per Square Foot`, a metric reflective of rental market trends and economic vitality. The time frame covered by this analysis spans from 2015 to 2024, enabling a comprehensive review of trends over nearly a decade.

2.2 Variable of Interest

The dependent variable under investigation is `Gross Income per SqFt`. This measure was chosen due to its effectiveness in reflecting the financial performance of rental properties on a per-square-foot basis, which is essential for assessing profitability and market conditions.

2.3 Analytical Approach

The subsequent analysis will focus on quantifying the influence of various variables on `Gross Income per SqFt`. This will involve detailed statistical analysis to isolate the impact of individual factors and understand their interrelations within the broader market dynamics.

3 Rental Income Distribution Across Manhattan

This section delves into the distribution and variance of rental income per square foot across Manhattan, highlighting the diverse economic landscape shaped by location, building characteristics, and neighborhood desirability.

3.1 Overview of Rental Income Disparities

Initial analysis of the dataset reveals significant disparities in rental income per square foot. The mean rental income across Manhattan is calculated at 36.89, with a median of 38.32, indicating a skewed distribution that hints at the presence of high-value outliers. Such outliers are often luxury apartments in high-demand areas, which command premium rents compared to more modest accommodations in less sought-after neighborhoods. The standard deviation, sitting at 11.23, further attests to Manhattan's vast rental market range, from high-end residences in central locales to more affordable options uptown.

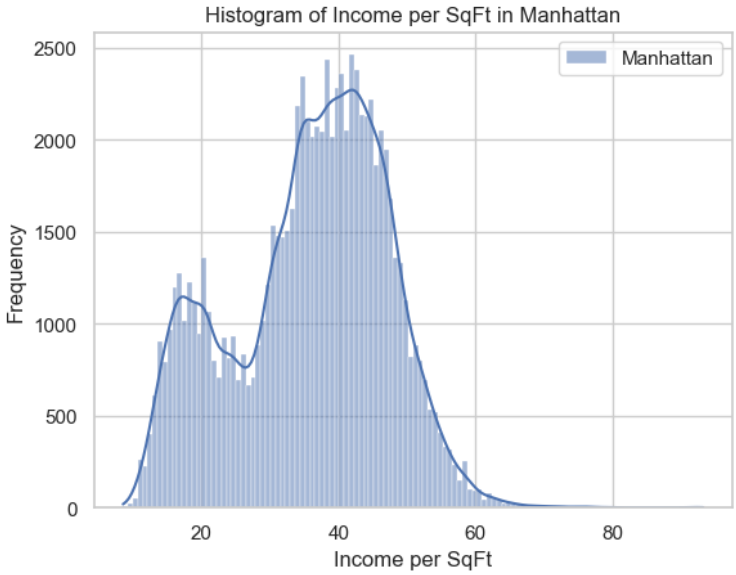

Figure 1: Histogram of Income per SqFt in Manhattan

3.2 Distribution Patterns

The histogram of Gross Income per SqFt in Manhattan exhibits a bimodal distribution, reflecting the dual nature of the rental market. One peak represents more affordable housing sought by lower-income residents, while the other highlights areas with a high concentration of luxury apartments. This pattern underscores the socio-economic diversity within Manhattan, where both blue-collar workers and high-income professionals coexist, contributing to a dynamic and segmented housing market.

3.3 Neighborhood Analysis and Comparative Statistics

An in-depth analysis of the Gross Income per SqFt across various neighborhoods in Manhattan reveals pronounced variances that are indicative of the complex interplay between geography and rental prices. Neighborhoods known for affluence, such as the Upper East Side and the Midtown Central Business District, naturally skew towards the higher end of the income spectrum. In contrast, neighborhoods like Harlem and Washington Heights, positioned further from the bustling economic centers, tend to represent the lower end of the rental market.

The comparative statistics, illustrated through bar plots, underscore the disparity within the rental landscape of Manhattan. Traditionally sought-after neighborhoods command premium rents due to factors such as proximity to business districts, safety, cultural amenities, and overall desirability.

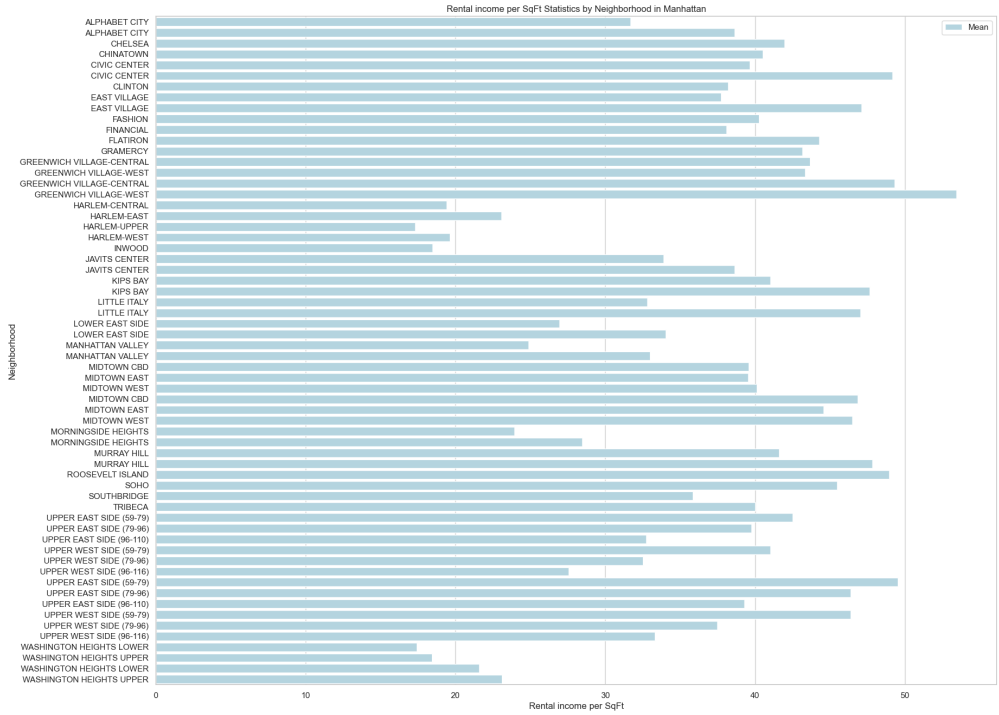

Figure 2: Rental income per SqFt Statistics by Neighborhood in Manhattan

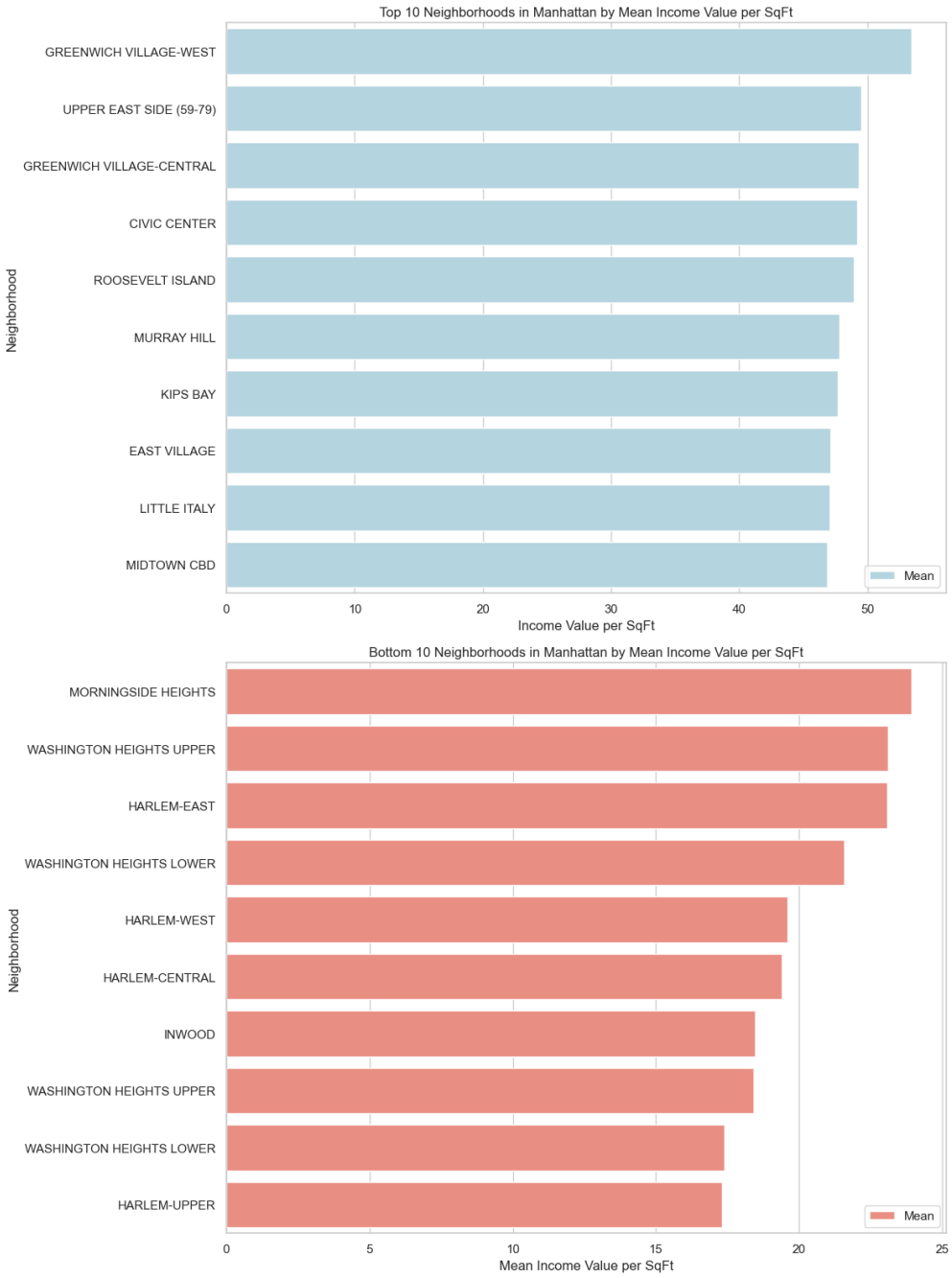

Figure 3: Top and Bottom 10 Neighborhoods in Manhattan by Mean Income Value per SqFt

This segmented market paints a picture of Manhattan's hierarchical spatial economics, where location significantly influences the perceived value and, consequently, the rental income per square foot. The top ten most and least expensive neighborhoods distinctly showcase the economic spectrum, from luxury and high-demand locales to areas considered more

affordable.

4 Methodology

The analysis specifically focuses on the factors influencing rental income per square foot within the borough of Manhattan. By narrowing our scope, we intend to capture the unique characteristics of Manhattan's real estate market.

4.1 Factors Affecting Rents in Manhattan

4.1.1 Age of the Building

Commonly, it is believed that newer houses are more valuable. A survey indicates that New Yorkers have significantly different preferences for new construction versus renovated apartments. In the context of Manhattan, the age of a building is a variable of interest due to its potential impact on rental values. Buildings in Manhattan are categorized based on their construction year, with each category reflecting the architectural styles and building practices of its time. This allows for an exploration of how historical significance, architectural styles, and the era of construction influence current rental values.

The buildings are categorized as follows:

- **Pre-1900**: "Nineteenth Century" buildings, often carrying historical significance.
- **1900–1918**: "Pre-War" era, capturing the building boom before World War I.
- **1919–1945**: "Interwar" period, including the Roaring Twenties and the economic effects of the Great Depression.
- **1946–1965**: "Post-War" era, marked by reconstruction and modernization efforts.
- **1966–1979**: "Late Modern" period, featuring a variety of architectural innovations.

- **1980–1999**: "Contemporary" or "Pre-Millennium" buildings, reflecting the styles leading up to the turn of the century.
- **2000–2018**: "Modern" era, characterized by advancements in high-tech and sustainable building practices.

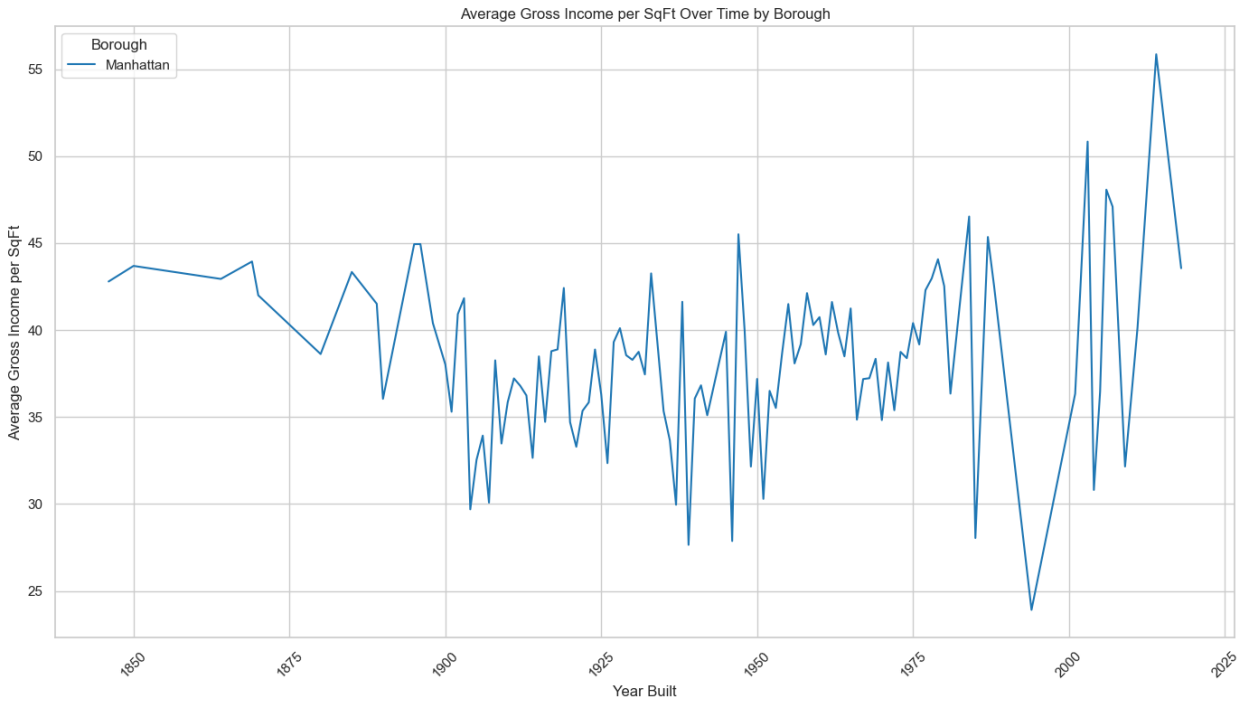

Figure 4: Average Gross Income per SqFt Over Time in Manhattan

As depicted in Figure 4, the relationship between the age of buildings and average rental income per square foot in Manhattan is complex and warrants a detailed analysis. Unlike the other boroughs where newer might imply more valuable, Manhattan exhibits a more intricate pattern where historical buildings are also highly valued.

4.1.2 Building Classification

In the bustling real estate market of Manhattan, the dichotomy of building classifications, "ELEVATOR" versus "WALK-UP", serves as a distinctive factor in the valuation of rental

properties. A statistical analysis was conducted to quantify the impact of this classification on the gross income per square foot.

A t-test was performed to compare the mean rental incomes between elevator and walk-up buildings, yielding a highly significant p-value of 1.29×10^{-68}. This result underscores a substantial difference in rental values, with elevator buildings commanding a higher income per square foot.

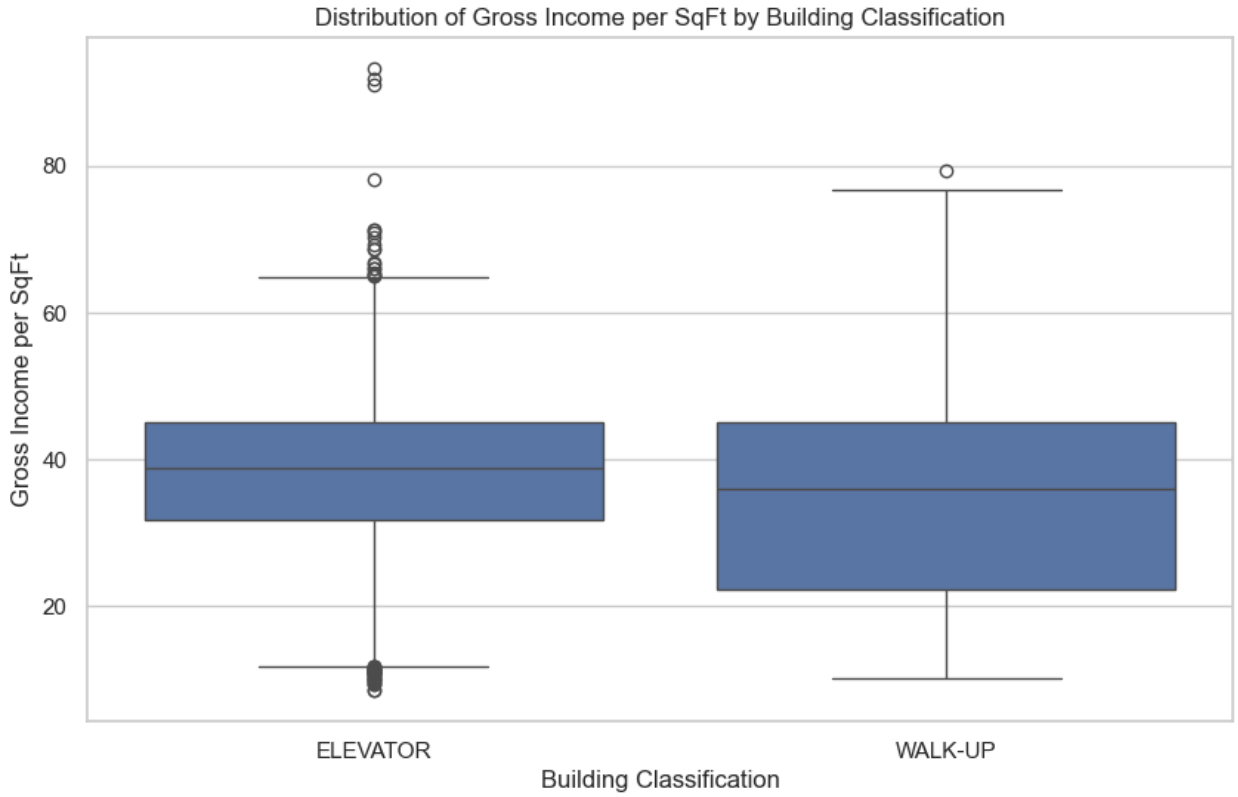

Figure 5: Distribution of Gross Income per SqFt by Building Classification in Manhattan

As illustrated in Figure 5, elevator buildings tend to generate greater rental income compared to walk-ups. This finding is in line with market expectations that amenities such as elevators can significantly boost the desirability and, therefore, the rental price of a property. In the context of Manhattan, where vertical living is the norm, this amenity is highly valued, reflecting in the property's market valuation.

4.1.3 Apartment Size Category

In Manhattan's dense and varied housing market, the size of an apartment emerges as a critical factor in its rental income potential. To quantify the influence of apartment size, we categorized units into five size groups, then applied t-tests to discern differences in average gross income per square foot.

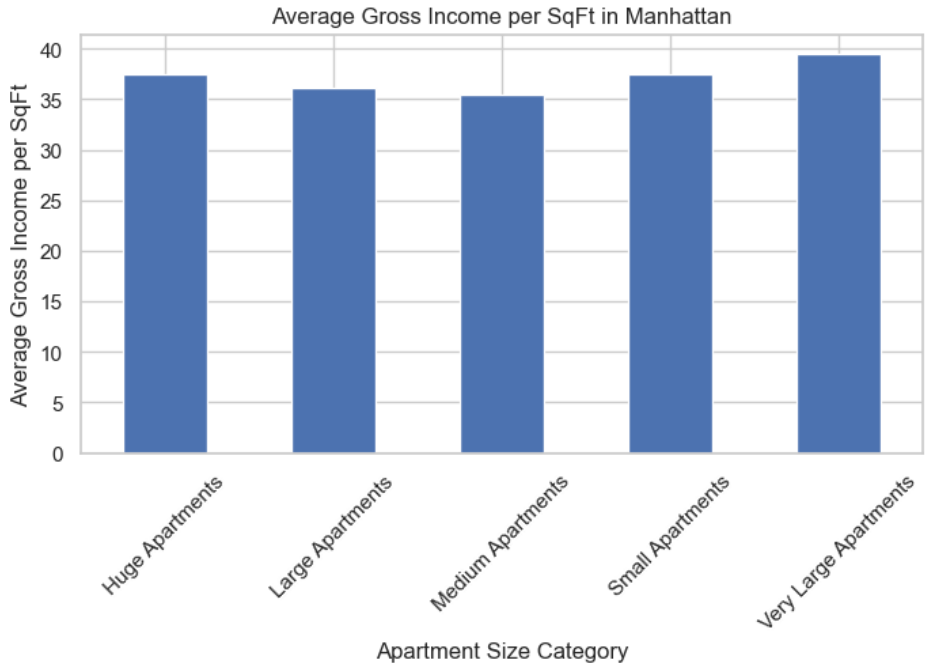

Figure 6: Average Gross Income per SqFt in Manhattan by Apartment Size Category

The t-tests reveal a complex pattern. While some size categories show no significant difference in rental income, such as between 'Small' and 'Huge' apartments, others demonstrate substantial discrepancies. Notably, 'Small Apartments' exhibit a statistically significant difference in rental income compared to 'Medium', 'Very Large', and 'Large Apartments'. These findings suggest that while extreme sizes do not necessarily command differing rental prices, there is a discernible impact of size on rental income within the more commonly encountered apartment sizes in Manhattan.

As the figure 6 suggests, the relationship between apartment size and rental income is not strictly linear but rather shaped by a combination of factors.

4.1.4 Safety

The influence of neighborhood safety on rental prices in Manhattan is explored by examining the correlation between safety indices and average gross income per square foot. This analysis is particularly relevant given Manhattan's diverse and densely populated environment.

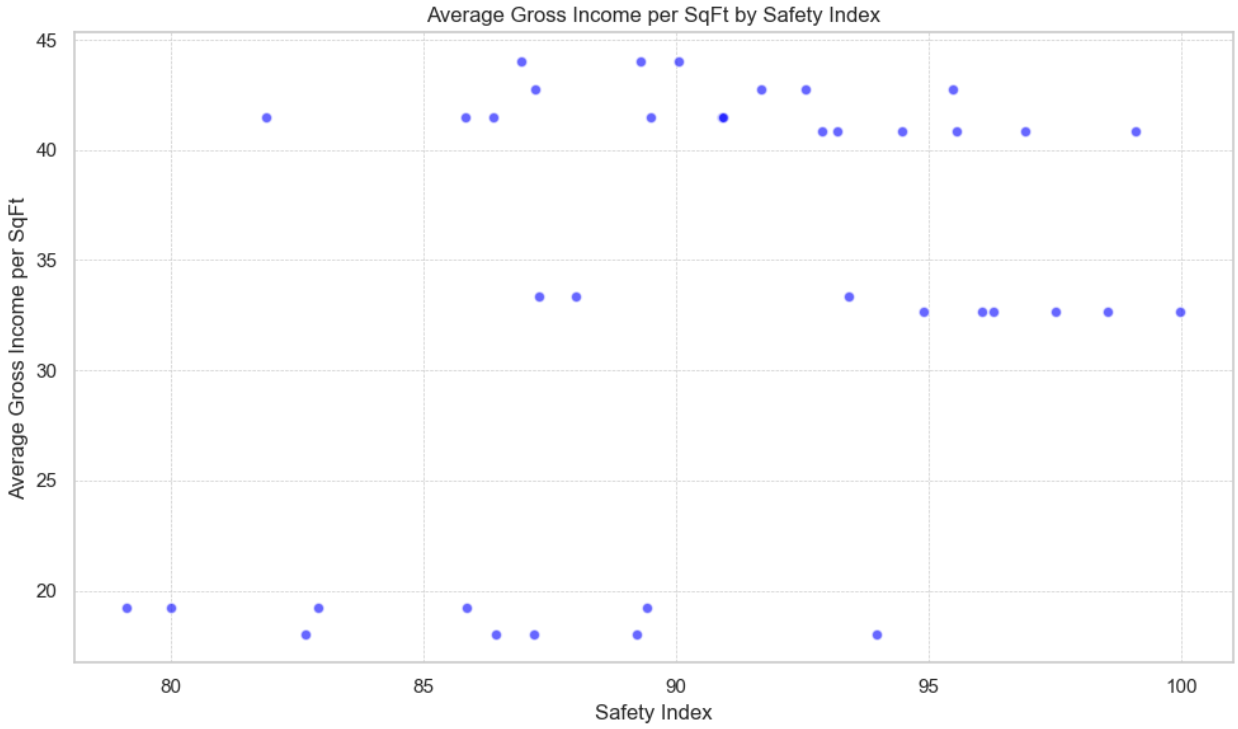

Figure 7: Correlation of Safety Index with Average Gross Income per SqFt in Manhattan

Figure 7 illustrates a pattern where neighborhoods with higher safety indices tend to have elevated rental incomes, though the correlation coefficient of 0.373 suggests a moderate relationship. Despite the numerical modesty of this correlation, its significance is underscored by the context of urban real estate markets, where numerous variables simultaneously impact rental rates.

Our targeted analysis comparing the safest and most dangerous neighborhoods demonstrates that safer neighborhoods consistently achieve higher rental incomes. This trend highlights the premium tenants place on safety, a key factor in residential desirability and

pricing.

Furthermore, the disparity in rental incomes across different safety levels within Manhattan supports the integration of safety metrics into predictive models for real estate pricing. By doing so, stakeholders can better understand the premium attributed to safety and incorporate this into investment and pricing strategies.

4.2 Random Forest Regression

With key factors like building classification, apartment size, and neighborhood safety identified as significant influences on rental income per square foot in Manhattan, we now proceed to develop a predictive model. This model will incorporate these variables to forecast rental prices more accurately.

A Random Forest regression model will be employed to synthesize these insights and quantify their impacts.

4.2.1 Model Overview

The Random Forest regression model utilizes an ensemble of decision trees to predict the Gross Income per Square Foot, leveraging the robustness of multiple trees to reduce variance and avoid over-fitting. This model is particularly well-suited for our dataset, which includes a mix of categorical (Elevator Binary, Apartment Size Category) and numerical (Safety Index) variables.

```
Algorithm: Random Forest Regression for Gross Income Prediction
Input: Dataset (df), number of estimators (100), random state (42)
Output: Predictions (y_pred), Model Performance Metrics

1: Encode categorical features using OneHotEncoder, dropping the first category to avoid
2: Prepare feature matrix (X) by combining encoded categorical features with 'Safety_Ind
3: Define target variable (y) as 'Gross Income per SqFt'.
```

```
4: Split the dataset into training (80%) and testing (20%) sets to validate the model's
5: Initialize Random Forest Regressor with 100 trees and a set random state for reproduc
6: Train the model on the training dataset.
7: Predict 'Gross Income per SqFt' on the testing set.
8: Evaluate the model using Mean Squared Error (MSE) and R-squared Score.
```

4.2.2 Model Performance

The performance of the Random Forest regression model is quantified using the Mean Squared Error (MSE) and R-squared value. The MSE of 54.323 suggests the model predictions deviate from the actual values on average by about 54.323 units squared. The R-squared value of 0.570 indicates that approximately 57% of the variance in Gross Income per SqFt is predictable from the model's features.

4.2.3 Visual Representation

Figure 8 below illustrates the scatter plot of actual versus predicted Gross Income per SqFt. The red dashed line indicates perfect prediction accuracy, where the predicted values exactly match the actual values.

5 Conclusion

This study has identified key factors affecting rental income per square foot in Manhattan, such as building classification, apartment size, and neighborhood safety. Our analysis demonstrates that amenities like elevators significantly influence rental prices, larger apartments tend to yield higher income, and safety is a critical concern affecting rental desirability and pricing.

The Random Forest regression model applied to these variables showed a moderate ability to predict rental income, with an R-squared value of 0.570, suggesting substantial potential

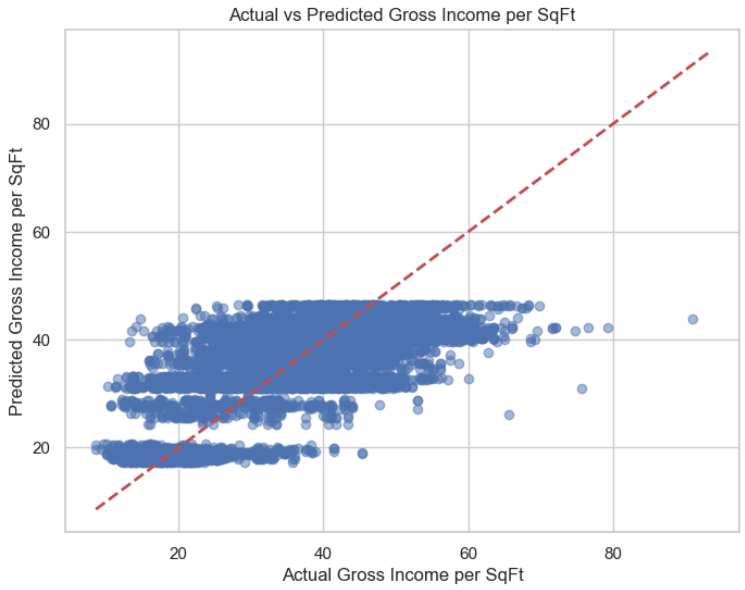

Figure 8: Scatter plot of actual versus predicted Gross Income per SqFt. The red dashed line indicates perfect prediction accuracy.

for future refinement. This model serves as a foundational tool for real estate investment and urban planning strategies in Manhattan. Future studies could incorporate additional predictive factors, such as zoning changes or economic indicators, to refine the model's accuracy.

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