Grant Jackson

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Data Project

**Northwest Arkansas Rental Housing Market Analysis**

For this project, I analyzed the Northwest Arkansas rental housing market using microeconomic principles to understand pricing dynamics and market efficiency better. I established several primary objectives before my analysis. First, I wanted to examine the relationship between property size and rental rates. I also sought to analyze the geographic variation in rental prices and uncover possible seasonal patterns in this rental market. Lastly, I wanted to evaluate the independent value contribution of the total number of bedrooms in a house listing. To investigate these objectives, I analyzed a comprehensive dataset of rental properties.

The dataset for this project was provided by our instructor, containing 3,487 rental property listing observations in Washington County, Arkansas from the years 2017 to 2023. The key variables I focused on within this dataset are Address, Zip Code, Town, List Price, Deposit, Date Available, Total Beds, Heated Square Footage, and Sold Price. Before conducting the analysis, extensive data preprocessing was necessary to ensure data quality and consistency.

To begin the data cleaning and processing, I identified observations with missing values in the 'Deposit' and 'Sold Price' values but determined that dropping these observations would not be necessary for data testing. There was a total of 1,099 instances of the same properties being listed in multiple different observations and recorded in the dataset, so duplicate observations were identified. I converted the price and heated square footage columns to numeric values and the removal of any non-numeric text qualifier or commas was done. Next the 'Date Available' column was standardized to datetime format, and I created additional temporal features for month, year, and season (1 = winter, 2 = spring, 3 = summer, 4 = fall). The city names were also standardized, and a consistent full address was created showing the address, town, and zip code of each listing observation. I checked for outliers in list price, heated square footage, and bed total columns, where 2 outliers with extremely low or high values were identified and dropped from the dataset. Lastly, for later analysis, I calculated the price per square foot values for each observation by dividing the listing price by heated square footage. With the cleaned dataset in hand, I conducted a thorough exploratory analysis to understand the market characteristics.

Through exploratory data analysis, I was able to form a clear picture of the market structure, property characteristics, price trends, initial patterns, and market implications. After cleaning, there are a total of 3,485 listing observations from 11 cities in this dataset – Bentonville, Elkins, Farmington, Fayetteville, Lincoln, Lowell, Prairie Grove, Springdale, Tontitown, West Fork, and Winslow. Two main cities hold a majority of the listings, the top being Fayetteville with 2,553 observations (73.3% of listings) and Springdale with 646 observations (18.5% of listings). The rest of the cities all have under 150 listings each and make up 8.2% of the listings. The overall average listing price is $1,460, with the premium markets in Tontitown, Lowell, and Bentonville. The mid-price markets are in Fayetteville, Farmington, Prairie Grove, and Springdale. Elkins, Winslow, West Fork, and Lincon make up the low-price markets. The average price per square foot is $0.94, with Tontitown at the highest, Prairie Grove, Farmington, Fayetteville, and Bentonville around the middle, and the lowest in Lowell. The average number of bedrooms per household is 3.08 and the range is 1 to 6. Most cities average between 3.4 to 3 bedrooms, only Winslow and Lowell are above the 3.4 average. In terms of square footage, the average is 1,596 sq ft, the range is 500 to 7,200 sq ft, and the standard deviation is 505 sq ft. There are overall pricing trends that show a base period (2018 to 2020) with relatively stable trends and then a growth period (2021 to 2023) with significant appreciation. The median listing price is $1,400, the range is $550 to $7,200, and the standard deviation is $475. From checking correlations, I believe they indicate an inverse relationship between size and price per square foot, along with a positive relationship between bedroom count and total price. This market is dominated by listings in university or urban areas and has a limited inventory in smaller cities. There is a clear premium for urban locations, but recent market volatility could suggest changing conditions. For property standards, the 3-bedroom format is most common and house size variations are significant between cities. Based on these initial observations, I developed several hypotheses to test key relationships in the rental market.

Do larger properties have lower prices per square foot? This will indicate if the theory of economies of scale is present in housing. Do rental prices vary significantly between each city? This relates to the urban economic theory of location-based pricing. Do rental prices show significant seasonal patterns? Does the number of bedrooms in a household command a premium beyond the square footage? This question relates to the theory of premiums for separate living spaces.

To evaluate these hypotheses, I employed various statistical testing methods appropriate for each question. For the size-price analysis, I used a simple linear regression with the 'Heated Square Footage' and 'Price per Square Feet' variables. In the geographic analysis, I opted for ANOVA testing using the 'Town' and 'List Price' variables. A time series decomposition with seasonal index calculations and monthly averaging was applied to the seasonal analysis with 'Month' and 'List Price' as variables. The bedroom count analysis was done with multiple regression, implementing interaction testing between the variables 'Heated Square Footage' and 'Beds Total' over 'List Price'. The analysis yielded several significant findings regarding each hypothesis.

The first hypothesis test was set up with a null hypothesis that there is no relationship between property size and price per square foot. With a significant p-value, I rejected this null hypothesis and confirmed a negative correlation between property size and price per square foot. The coefficient suggests that for each additional square foot of living space, the price per square foot decreases by $0.0002. The relationship is statistically significant but moderate in magnitude. These results strongly support the theory of economies of scale in rental housing and that larger properties are more cost-effective per square foot. However, the r-squared value suggests that other factors significantly influence pricing. The null hypothesis for the next test was there were no significant price differences between cities. I found significant differences with the p-value, rejecting the null hypothesis, so it was confirmed there are significant price differences between cities. This test revealed a market hierarchy in listing price terms with the top-tier market (Fayetteville, Bentonville, Tontitown), mid-tier market (Farmington, Lowell, Prairie Grove), and the low-tier market (Elkins, Lincoln, West Fork). The results also suggest there is a 'price floor' in each city market but more flexibility at the upper end. The next null hypothesis to test was there are no seasonal patterns in rental prices. These results indicated a weak but present seasonal impact in play, significant enough to reject the null hypothesis. Prices slightly peaked in November, suggesting possible market timing opportunities although seasonality varies little across different town markets. The last test used the null hypothesis that bedrooms add no value beyond square footage. With a significant p-value, we could reject the null hypothesis and conclude that bedrooms add independent value to a house listing. The base square footage of $0.56 per sq ft maintains an independent value, while the 'Beds Total' coefficient indicates for each additional bedroom on a listing the listing price increases by $60.12. This model supports the theory of a premium on separate living spaces and explains 52% of the variation in listing prices. These statistical findings have important practical implications for various market participants.

Drawing from all aspects of this analysis, several key conclusions emerge about the Northwest Arkansas rental housing market. In terms of pricing strategy for property owners, they should implement size-based and location-based price adjustments and value the bedroom count outside of square footage. For future investments, they should focus on location quality over size, consider bedroom additions in renovations, keep in mind a balance of total size with functional space division, and account for seasonal timing in property acquisition. Renters participating in the market should keep in mind larger properties offer better value per square foot, timing can affect rental rates marginally, and the premiums that come with location and additional bedrooms. Participating developers in the market should keep in mind location selection is crucial for pricing power, the bedroom count significantly impacts rental potential, size efficiency matters more than absolute size, and seasonal timing has a limited impact on returns. This data analysis could help improve the efficiency of the Northwest Arkansas rental housing market and overall supports both traditional microeconomic theory and practical market observations.

**References**

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