**Objective 1.)** (Random Forest Analysis of Feature Importance)

The results of the random forest analysis of feature importance were based on the accuracy of the models tuned with the best mtry, along with the sensitivity and specificity measures. **Sensitivity** measure’s the model’s ability to classify, in this case, if the effective rent was above $1,000 per month (Swift et al., 2020). The higher the sensitivity measure is, indicates that the occurrence of false-negative classifications is minimal, and more cases above $1,000 effective rent were present (Swift et al., 2020). **Specificity** measure’s the model’s ability to classify, in this case, if the effective rent was below $1,000 per month (Swift et al., 2020). The higher the specificity measure is, indicates the occurrence of false-positive classifications is minimized, so that more cases below $1,000 were not missed (Swift et al., 2020).

Table 1.1 below breaks down each model’s accuracy, sensitivity measure, and specificity measure. Overall, the models performed sufficiently, given the small sample of data available for 2019. The 3-bedroom model had the best accuracy and specificity, but the worst sensitivity value, suggesting that the model was better able to predict when the effective rent was below $1,000/month based on the high specificity measure. The models for 1- and 2-bedroom segments experienced relatively high specificity measures and adequate sensitivity measures with moderate accuracy levels.

|  |  |  |  |
| --- | --- | --- | --- |
| **Property Segment** | **Accuracy** | **Sensitivity** | **Specificity** |
| 1-Bedroom | 65.85% | 66.67% | 65% |
| 2-Bedroom | 76.19% | 60% | 85.19% |
| 3-Bedroom | 81.08% | 12.50% | 100% |

Table 1.1: Random Forest Model Performance for each Segment

The top three important features for all segments were characteristics of the population. This suggests that the effective rent in 2019 was predominately influenced by job type and income level, and not necessarily by amenities, like shops or restaurants that a submarket had to offer. This is a fair assumption because sometimes income levels can be associated with job types, and renters can only afford to pay rent within their respective income levels. If someone earns a significant sum of money per month, this indicates they can afford to spend more per month on rent and ultimately increases the overall effective rent in a submarket. The results of the models support the notion that at least for 2019, specific industries and income levels were influencing the effective rent across submarkets. This suggests that to comfortably afford housing in certain submarkets, at least for rentals, residents must belong to a specific income group and or job type. In the future, the county could investigate the wage gaps across submarkets and potentially impose rent ceilings to prevent lower-income residents from being unable to afford rent.

**Objective 2.)** (Local Moran’s I Analysis of Rent Pricing)

The initial clustering trends for all three segments were very similar. Clusters of “high” effective rent were predominately located in the “wedge” — or in Uptown down through Dilworth and Myers Park, of Mecklenburg County. On the other hand, clusters of “low” effective rent were predominately located in the “crescent” surrounding Uptown towards the edges of the county and near the airport. However, after the 2008 recession, 1-bedroom properties started to see an increase in clustering of “low” in the “crescent”, while 3-bedroom properties started to see a decrease. Suggesting a shift in the demand for more affordable 1-bedroom units, as opposed to 3-bedroom units. These trends continued until around 2015 and 2016 when changes in both “high” and “low” clusters began to occur. New clusters of “high” effective rent for 1- and 2-bedroom properties began to form in the southern part of the county near the Ballantyne and Providence submarkets. But, unlike the 2- and 3-bedroom segments, the 1-bedroom properties saw an additional change in the “high” clustering. The initial cluster in the “wedge” began to break away, and this trend continued through 2020. This suggested that with the post-light-rail construction and installation, 1-bedroom “high” residents began to move away from Uptown. However, all three segments saw similar patterns of “low” clusters beginning to fade away in the eastern part of the county through 2020. Implying that once affordable submarkets have been slowly disappearing from the eastern part of the county and those looking for an affordable place to live will have to start looking in between I-485 and I-77 in the western part of Mecklenburg County.

**Objective 3.)** (Heat Map Analysis of Effective Rent Growth)

From 2001 up until around 2011, all three segments followed similar patterns of mostly growth followed by a period of decline and then a period of growth through the 2008 recession followed by an additional period of decline. This showed signs that the effective rent growth was initially experiencing a seasonal pattern with phases of growth followed by decline. Then, after 2011, this pattern suddenly disappeared, and the growth rate trends became more difficult to distinguish. For most of the submarkets across the segments, the quarters of growth and decline occurred more frequently, sometimes changing from growth to decline and vice versa within the same year. It appears that until 2011, the rental market was able to address rising growth rates after a short period of time. However, as the population continued to increase across the county, demand began to outpace supply creating volatility in the effective rent growth.

More recently, nearly 30% and 38% of submarkets for 1- and 3-bedroom properties have experienced 6 or more quarters of growth. Over 60 submarkets for 2-bedroom properties experienced 6 or more quarters of growth in recent years, with the Ponderosa Wingate submarket in the “crescent” of Mecklenburg County experiencing its peak effective rent growth rate of 138.10% in quarter three of 2020. However, the general distribution of effective rent growth rates does not seem to be concentrated in a particular area of the county, suggesting additional submarkets could become affected in the future.

**Objective 4.)** (Time Series Analysis of Vacancy Rate)

Like the results of the heat map analysis, the vacancy rates across submarkets in each segment follow a seasonal pattern up until 2011. The general pattern for all submarkets begins to rise in 2000, then fall after 2003, then in 2005 rise again, after 2008 fall again through 2011. However, after 2011, the trends become hard to distinguish due to the significant increases and decreases in the vacancy rate until late 2020. This suggests the vacancy rate is following a similar pattern to that of the effective rent growth rate with significant fluctuations. Initially making it hard to difficult to identify submarkets with an overall high vacancy rate.

To better classify the vacancy rates for each submarket, the county’s average quarterly vacancy rate for each segment was first computed. For 1-, 2-, and 3-Bedroom properties, the average quarterly vacancy rates were 5.1%, 5.3%, and 5.6%, respectively. This meant that 75 submarkets for 1-bedroom properties, 85 submarkets for 2-bedroom properties, and 61 submarkets had average vacancy rates above their segments’ average vacancy rate. But accounting for buffer included with the Jenks method, only 28, 29, and 32 submarkets for each respective segment had consistently “high” vacancy rates spread across the county. This indicates that there were quite a few submarkets with a number of available units sitting on the market for rent that have the potential to help assist with the increased housing demand.

Despite competing in an unbalanced environment, landlords still have ample opportunity to increase their vacancy rates. To do this, landlords should first research the comps in their submarket, and see if they are priced above the competition for similar properties (“AllBusiness”, 2010). If they find that they are priced above the competition, they can offer a promotion that undercuts competitors such as reducing the monthly rent for signing certain leases (“AllBusiness”, 2010). Also, by including utilities such as water and internet, landlords are more likely to retain current renters and attract new ones (“AllBusiness”, 2010). If these options don’t improve the occupancy ratio, the landlord should investigate renovating their units (“AllBusiness”, 2010). Properties that appear to be rundown, antiquated, or lacking in curb appeal have the potential to deter future lessees from signing and may persuade current tenants to look elsewhere after the lease expires (“AllBusiness”, 2010). And lastly, for properties in high crime areas, landlords can give tenants peace of mind by providing added security measures such as alarm systems, and guards to protect complexes (“AllBusiness”, 2010). A few of these suggestions may be costly at first, but in the long run, the increased occupancy rate should help offset any encountered additional costs.

For clarification, table 2.1 summarizes the vacancy rate classification using the Jenks method.

|  |  |  |  |
| --- | --- | --- | --- |
| Classification | 1-Bedroom Vacancy Rates | 2-Bedroom Vacancy Rates | 3-Bedroom Vacancy Rates |
| Extremely High | >= 12.4% | >= 13.9% | >= 16.4% |
| Very High | Between 12.39% and 9% | Between 13.89% and 9.7% | Between 16.39% and 10.6% |
| High | Between 8.99% and 6.5% | Between 9.69% and 6.9% | Between 10.59% and 7.1% |
| Standard | Between 6.49% and 4.6% | Between 6.89% and 4.9% | Between 7.09% and 4.8% |
| Low | Between 4.59% and 2.7% | Between 4.89% and 2.8% | Between 4.79% and 2.5% |
| Very Low | Between 2.69% and 0% | Between 2.79% and 0% | Between 2.49% and 0% |

Table 2.1: Segment Vacancy Rate Classification