HOUSING AVAILABILITY IN DENVER NEIGHBORHOODS

University of Colorado Denver

Adelle Price

Applied Linear Regression D2P Project, Department of Mathematical and Statistical Sciences, University of Colorado Denver

University of Colorado Denver

MOTIVATION

- Denver, CO can be identified as a "High-Opportunity City" with high median income and high job growth. However, Denver, CO is also facing low numbers of single family permitting housing. [1]
- The number of new home listings in Denver, CO has been reported to decrease 11.5% from 2020 to 2021. [2]
- Median home buying costs in Denver, CO have been reported to rise 12.6% from 2020 to 2021.[3]

LINEAR REGRESSION MODEL

$$\widehat{(Vacant\ Housing)}^{\frac{1}{2}} = -4.054 + 0.251(THU)^{\frac{1}{2}} - 0.003MGR + 0.011(MHV)^{\frac{1}{2}}$$

Standard Linear Regression Fitted Model

$$\hat{Y} = \hat{\beta}_0 + \hat{\beta}_1 X_1 + \hat{\beta}_2 X_2 + \cdots + \hat{\beta}_{p-1} X_{p-1}$$

$\hat{Y} = Estimated\ Mean\ Response$
$X_i = Observed\ Values\ of\ each\ Regressor$
$\hat{\beta}_0 = Model\ Intercept$
$\hat{\beta}_i = Estimated\ Cofficients\ for\ Regressors\ X_{p-1}$

$\widehat{Vacant\ Housing} = Estimated\ Amount\ of\ Vacant\ Housing$
$THU = Total\ Housing\ Units$
$MGR = Median\ Gross\ Rent$
$MHV = Median\ Home\ Value$

METHODS

American Community Survey Nbrhd (2013-2017)
- Neighborhoods within the City and County of Denver
- 5 year average
- 78 sampled neighborhoods
- 146 observations per neighborhood

Observations Investigated
- Number of vacant houses
- Percent of two or more races
- Median age per neighborhood
- Total housing units
- Number of family households
- Median gross rent
- Median home value
- Percent of families in poverty

Applied Linear Regression
- Neighborhoods with missing values excluded, 76 neighborhoods analyzed

Statistical Methods Include:
- Akaike Information Criterion (AIC); considers fit of model and parameters used to determine model with lowest prediction error
- R-squared; goodness of fit measure
- Cook's distance; distances above .5 suggest an influential leverage point

MODEL SELECTION

Figure 1. Adjusted R^2plot for model with three regressors: *sqrt(THU), MGR, & sqrt(MHV).*

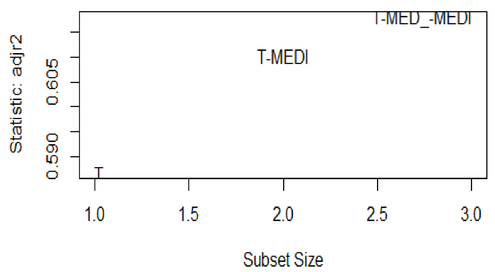


Figure 2. Plot of observed response values vs. estimated response values.

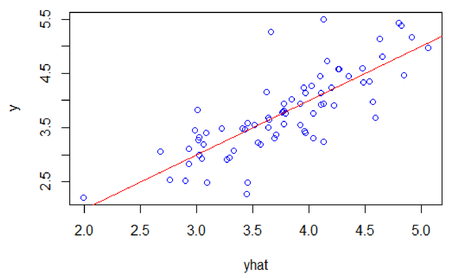


FIGURE 3. Index plot of Cook's distances in the model.

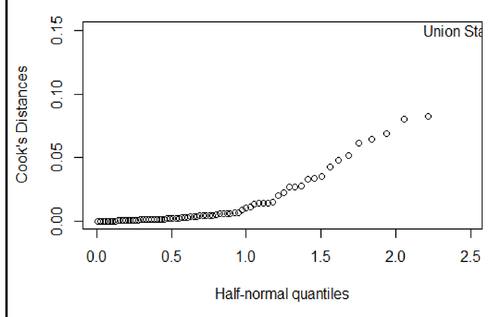


FIGURE 4. Residuals vs. Leverage Points + Cook's distance thresholds.

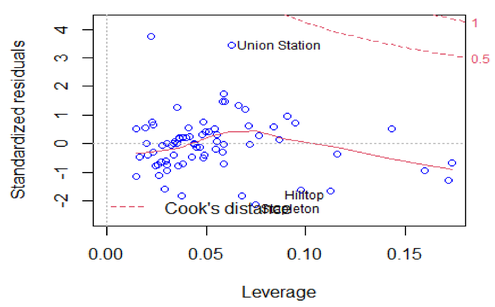


Table 1. Summary of selected model.

	Estimate	Std Error	t value	P value
Intercept	-4.054	2.737	-1.481	0.143
sqrt(THU)	0.251	0.025	10.204	1.462e-15
MGR	-0.003	0.002	-1.385	0.170
sqrt(MHV)	0.011	0.004	2.662	0.010

n	Residual SE	R-Squared
75	3.827	0.61

Table 2. 95% Confidence Intervals for the estimated regression coefficients.

	Estimate	2.5%	97.5%
Intercept	-4.054	-9.510	1.403
sqrt(THU)	0.251	0.202	0.300
MGR	-0.003	-0.006	0.001
sqrt(MHV)	0.011	0.003	0.020

EXPLORATORY DATA ANALYSIS

FIGURE 1. Density plot of the sqrt transformation of vacant housing in Denver neighborhoods.

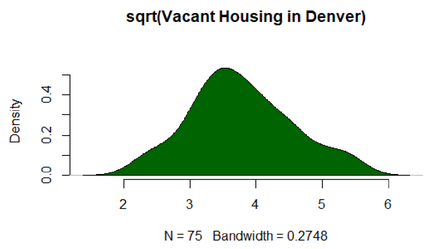
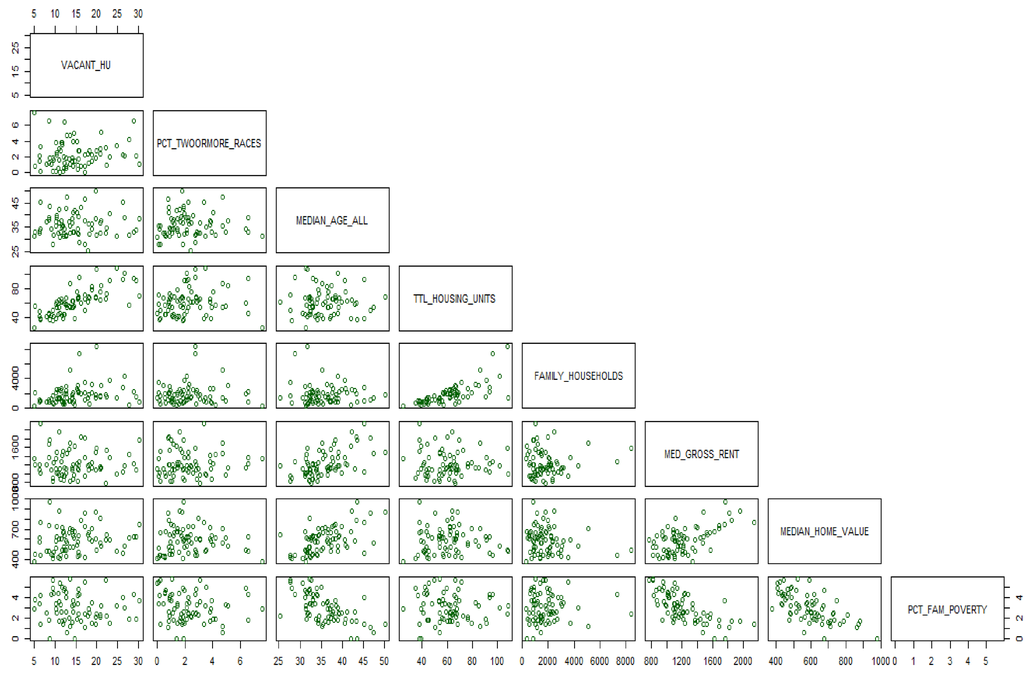


Table 1. Numerical summaries of each observation investigated.

	Min.	Median	Max.
sqrt(Vacant Houses)	4.899	13.528	30.166
sqrt(Percent of Individuals of Two or more Races)	0.000	1.924	7.563
Median Age	25.30	35.10	50.10
sqrt(Total Housing Units)	24.98	60.11	108.23
Number of Family Households	308.0	1511.0	8403.0
Median Gross Rent	772	1160	2143
sqrt(Median Home Value)	378.9	590.9	978.5
sqrt(Percent of Families in Poverty)	0.00	2.91	5.76

FIGURE 2. Scatterplot matrix showing pairwise correlation of all observations investigated.
Observation titles to the right of each graph denote y-axis labels;
Observation titles in the column of the graph denote x-axis labels.



POLICY RECOMMENDATIONS

- Per our fitted model, an increase in total housing units corresponds to an increase in vacant housing, an increase in median gross rent corresponds to a decrease in vacant housing(although this is not observed to be significant), and an increase in median home value corresponds to an increase in vacant housing.
- Policy recommendations involve increasing the availability of affordable housing. Denver's Community Planning and Development committee has proposed an "Expanding Housing Affordability" plan that looks to "allow projects to build taller buildings if more affordable units are included, update the city's linkage fee, which requires all new development to either include affordable housing or pay a fee that supports Denver's affordable housing fund, and change to state law on "inclusionary housing," which refers to requirements that cities can establish for new for-sale or for-rent developments." [4]

REFERENCES

1. *A Comprehensive Look at Housing Market Conditions Across America's Cities,* Cityscape , 2020, Vol. 22, No. 2, Two Essays on Unequal Growth in Housing (2020), pp. 111-132.
2. *Metro Denver housing market selling homes faster and faster,* https://www.denverpost.com/2021/03/03/denver-housing-market-high-costs-low-inventory/
3. *Latest Denver-area housing market stats: Median single-family home price reaches $560K*, https://www.9news.com/article/money/markets/real-estate/denver-metro-housing-market-stats/73-18e4f86a-1a06-48d6-9212-72ef24a4bd35
4. *Expanding Housing Affordability*, https://www.denvergov.org/Government/Departments/Community-Planning-and-Development/Denver-Zoning-Code/Text-Amendments/Affordable-Housing-Project#section-2