COVID-19 and Mecklenburg Residential Building Permits

Ross Friscia

rafrisci@uw.edu

1. Introduction

COVID-19 shutdown the working world. Specifically, in the United States, unemployment rates spiked and most who were lucky enough to keep their jobs were told not to commute to work. Only those who had jobs considered "essential" were allowed to do in-person work. To combat the financial difficulties people and companies were facing with this sudden shift, the Federal Reserve cut interest rates on loans to 0% to encourage people and businesses to borrow money and introduced quantitative easing to encourage banks to lend the money [1]. To further assist with financial difficulties Congress passed the CARES Act [2]. This legislation introduced the Paycheck Protection Program loans distributing loans to companies with the intention that they use that money to pay their employees [3]. With borrowing money becoming both cheap and available, both hopeful homeowners and investors [4] raced to purchase available homes driving up their prices. With this race, a housing shortage began [5], causing an increase in housing and rental prices still being felt today.

While we can see the national trends of new housing constructions [6] and home price changes [7], this does not tell us if it is the case on a more local level. Mecklenburg is the second largest county in North Carolina and contains Charlotte, the largest city in North Carolina. A report from their Strategic Planning and Evaluation Director claims that over 12,000 single family homes in the county are owned by large corporate landlords, that these investors can make all cash offers over listing to drive up the rental prices, and that 93.5% of single-family homes purchased by corporations were $300,000 or less [8]. The corporations are targeting the more affordable homes and pricing out the lower to middle income families from becoming homeowners.

The goal of this project is to see how Mecklenburg is combating housing shortages by issuing permits to build more housing. This will be done by evaluating the Daily Building Permits Issued in Mecklenburg county [a] hosted by Mecklenburg County Open Data [9]. The hope is to learn if the rate of residential building permits changed from before COVID, during COVID, and after the county was done enforcing COVID mandates and restrictions (COVID ignored). These COVID periods will be based on Mecklenburg mask mandates using CDC data [b].

This is a human centered issue, because economically vulnerable residents of the county are being priced out of homeownership at the same time that rent is increasing in the largest city in the

county [10]. Shelter is a basic need for all humans, and if these trends continue some residents of the county will be displaced from their homes and forced to move elsewhere or become homeless. Allowing more housing to be built is one way the county can fight this worrying trend and the hope is to find that the county is reacting to this problem by creating the housing their citizens need.

2. Background/Related Work

As mentioned in the introduction, there have been tracking of new housing constructions [6] and home price changes [7]. While there is not peer-reviewed research on housing construction trends and COVID-19, there are a number of websites that have explored the relationship between COVID-19 and new constructions. One website reported a national year-over-year increase of 22% in new US housing constructions in February 2022 [11]. Despite this, building permits only increased 7.7%. The article concludes with various conflicting opinions on whether this surge of new construction will impact housing costs and which way.

While this is a good look into how construction changed during COVID, other research has focused on the changes of "post-COVID" construction [12]. Comparing Q3 2021 to Q3 2022, the housing market saw a change from strong growth of at least 20% new constructions in every density of living to decreases in every density excluding Micro County and Non Metro/Micro County. Dense population communities even saw a negative trend when comparing Q1 2020 new constructions to Q3 2022. It appears that new constructions went through a rapid boom to halt in a matter of two years.

The second article does not discuss building permits, but still displays a building slowdown in the "post-COVID" times. While both articles focus on the national trends and do not discuss these issues at the county level, specifically for Mecklenburg, they still inform the hypothesis: Mecklenburg county will have an increase in building permits during COVID compared to pre-COVID and COVID ignored.

3. Methodology

The methodology for this research is split into three different sections: date range selection for permits, data exploration, and analysis. The date range selection for permit data requires Mecklenburg mandate data from the CDC [b]. **Figure 1** shows Mecklenburg's mask mandates are all consecutive. This allows for three distinct COVID periods in Mecklenburg based on masking policies: pre-COVID, COVID, and COVID ignored. To construct the date range for permit data the length of mask mandates (322 days) is subtracted from the start date of the mask mandates (June 26th, 2020) and added to the end of the mask mandates (May 14th, 2021). This is done to make the three COVID classes balanced in the data. The final date range is August 9th 2019 through April 1st 2022.
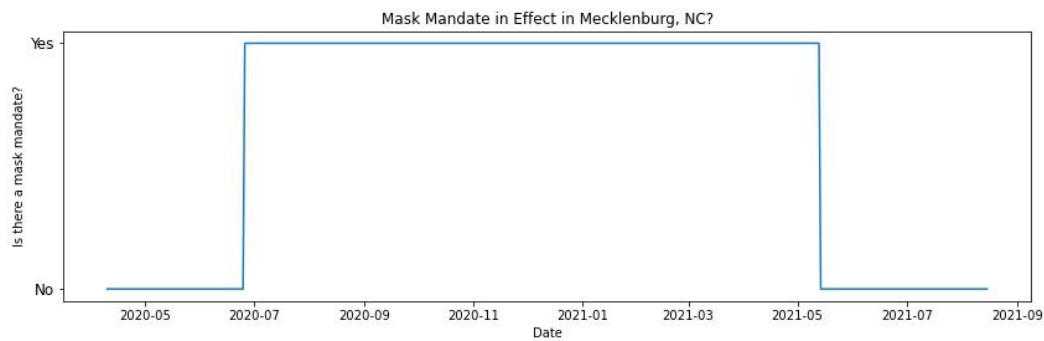
Figure 1

For data exploration, 112 features in the Mecklenburg building permit issuance data [a] are explored. Most are not useful and ultimately discarded. Next, non-residential permits are removed from the data as they are not of interest when analyzing housing shortages. Summing the Number of Units feature to determine housing units approved for building is chosen instead of counting columns, because the numbers appear to accurately represent the amount of residential units in a building. This decision involves exploring permits from the Owner/Tenants with the most multi-family permits approved. Finally, outlier values of the Number of Units feature are set to one for single family housing. An ethical consideration was made when deciding to analyze aggregations instead of individual results. This is because the permit data contains the contractor phone number, home address, and name of the contractor. This means if an individual is doing a home improvement project, they must provide your address, name, and phone number to a publicly available data source. People might be providing their personal information online without knowing it, so it is better to leave that information out of the data, and thus the analysis.

Finally, the analysis section of reporting takes two different approaches. The first is to perform an Analysis of Variance (ANOVA) test. This test is useful for comparing more than two population means and determining if at least one is different from the group [13]. Then, Z-tests are used on all three COVID group combinations (pre-COVID to COVID, pre-COVID to COVID ignored, and COVID to COVID ignored) to see which pairings are significantly different [14]. A Z-test is chosen to compare group pairings as each group has a large number of observations. A Bonferroni correction is applied to the Z-test analysis as multiple-comparisons are occurring and spurious positive results need to be accounted for [15]. While the hypothesis is expecting COVID to be larger than pre-COVID and COVID ignored, all combinations of groups are included in the analysis to evaluate if other relationships exist.

The second approach is to fit a time-series model to the permit data. The model of choice is a SARIMAX model, as it can account for seasonality as well as include exogenous variables [16]. This allows for the COVID groups to be dummy variables that are included in the model. COVID is chosen as the base case as it is the COVID stage of focus in the hypothesis. After exploring if the time series is stationary and performing model selection on the various SARIMAX hyperparameters, the pre-COVID and COVID ignored coefficients are analyzed for significance.

4. Findings

The two analyses tell very different stories. For ANOVA, significance is found with a p-value = 0.0012. Further, a significant difference is found comparing pre-COVID to COVID ignored with a p-value = 0.0006. The Z-test comparing COVID to COVID ignored has a p-value = 0.0205, which is less than 0.05, but the Bonferroni correction sets the threshold to reject the null hypothesis at 0.0167. While it is important to note that Bonferroni corrections are conservative and lead to a less than desired type I error probability, the null hypothesis is not rejected for COVID to COVID ignored.

The SARIMAX model requires more work before getting to the results. The first step is exploration of the data to see if it contains seasonality. **Figure 2** shows no clear trends, changing levels, or changes in variance, so the data is considered stationary and the seasonal aspect of SARIMAX is not needed. Next, **Figures 3 and 4** plot autocorrelations and partial autocorrelations to determine the maximum values of the AR term (p) and MA term (q) respectively. These values (both are 23 as those are the largest values to positively lie outside the confidence interval) are then used in the model selection to find the model that minimizes AIC (Akaike information criteria). The resulting SARIMAX model, SARIMAX(4,1,1) is fit and the summary of its coefficients and significance are in **Figure 5**. The results are discouraging, neither the COVID ignored nor the pre-COVID coefficients are significant. Further, the size of the coefficients are tiny compared to the sigma2, or volatility, of the model.
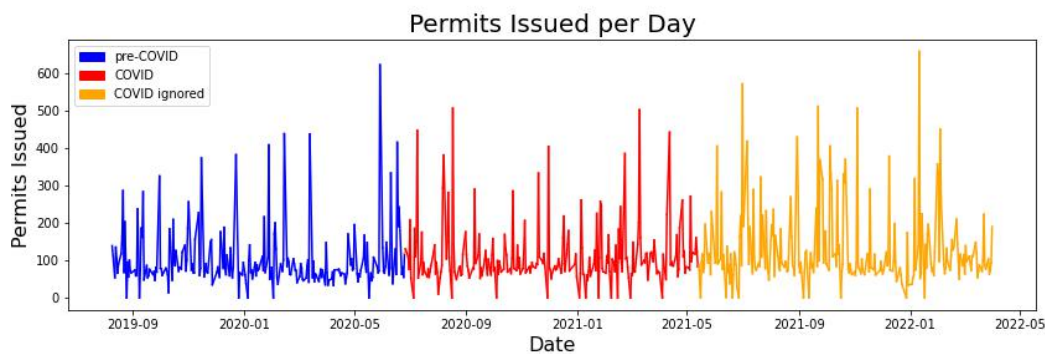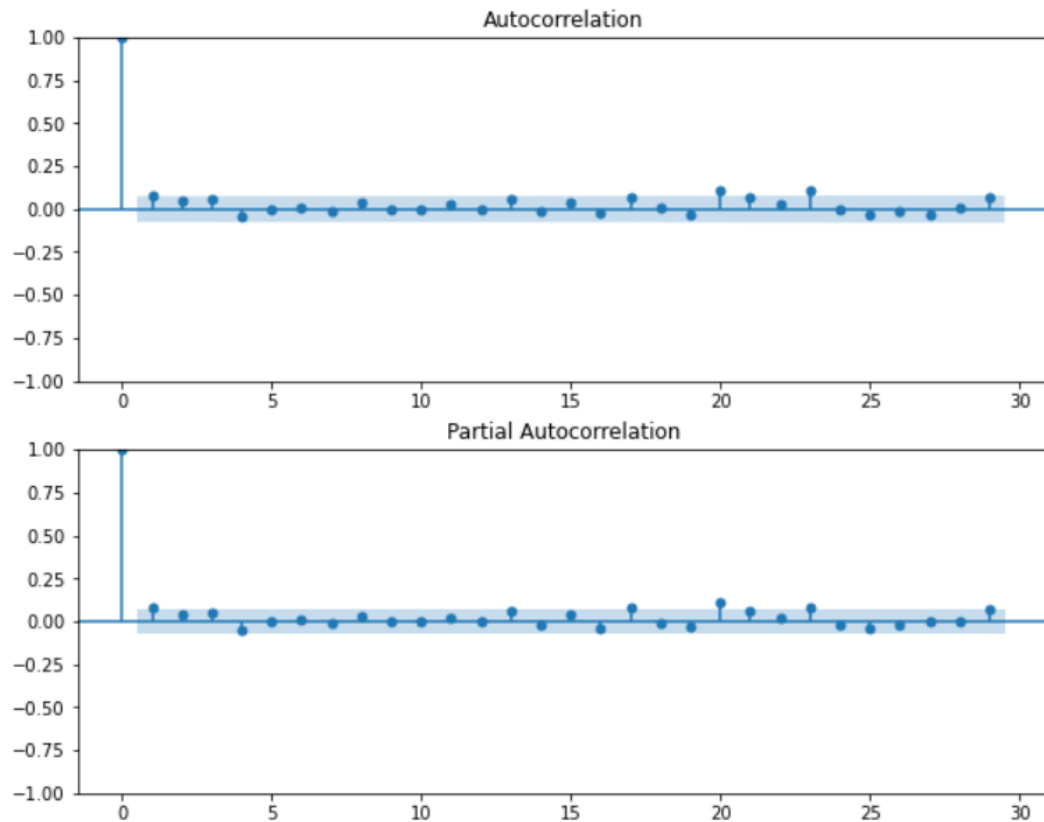

Figure 2

Figures 3 and 4

	coef	std err	z	P>|z|	[0.025	0.975]
COVID ignored	19.8043	16.590	1.194	0.233	-12.711	52.319
pre-COVID	5.5783	20.412	0.273	0.785	-34.428	45.585
ar.L1	0.0661	0.042	1.570	0.117	-0.016	0.149
ar.L2	0.0256	0.037	0.692	0.489	-0.047	0.098
ar.L3	0.0434	0.038	1.148	0.251	-0.031	0.117
ar.L4	-0.0632	0.048	-1.323	0.186	-0.157	0.030
ma.L1	-0.9884	0.012	-85.385	0.000	-1.011	-0.966
sigma2	8298.1665	271.318	30.585	0.000	7766.394	8829.939

Figure 5

With the two analyses showing such different results it is important to figure out which methodology can be trusted more. The largest difference in the two approaches lies in their assumptions. ANOVA and Z-test both require the data to be independent. However, since the data is time series that assumption is violated. This is the most important assumption for both tests, so the

results from them in this context are called into question. SARIMAX models account for the correlations between days, removing that issue from its analysis. Therefore the SARIMAX results are more trustworthy and they state that significant changes in residential building permit issuance did not occur between different COVID stages.

5. Discussion/Implications

The implications of the findings are discouraging but important. The county did not meaningfully change its amount of permits issued during a housing shortage which continues to price its residents out of the county. The hypothesis going into this project is that residential building permits would increase during the worst of the shortage, the COVID stage. While this would not have fixed housing prices on its own, it would be a significant step towards helping. With the national trends showing a boom in construction, a lack of permit increase is disappointing.

This whole project is centered on the concern of residents losing their ability to afford shelter and remain in their community. Specific human centered data science principles this project follows are: algorithm design transparency, model comprehensibility for readers, and scientific thinking to responsibly craft and test the research question. The goal of this analysis is not just to report the answer to the research question, but to make the process and discussion around the methods clear and accessible to readers of different knowledge levels. Further research should be done to confirm the lack of change between COVID stages with different techniques. A different methodology evaluating permits to COVID cases should also be considered.

6. Limitations

The biggest limitations of the analysis are discussed in the last paragraph of section 4. The ANOVA and Z-test results are not reliable as they fail the assumption of independence. Another limitation of the analysis is only considering permit issuance when determining if Mecklenburg politicians are attempting to combat the housing shortage. Laws, money, and tax breaks could all be implemented to encourage additional housing developments in the county. Permits are the focus of this analysis as the data is openly available. Other analytical limitations include: the assumption that stages of COVID can be determined by mask mandates, not knowing if the permit approvers stopped working or started working from home, the changes to working might not coincide with mask mandates, and the proportion of denied permits

The largest data limitation is the choice of setting all Number of Unit values for single family permits to one if the value is greater than two. There may be valid reasons to input those larger values, but the decision was made to do so based on preventing large outliers from skewing the data. Another

limitation is the flawed Number of Unit values that remained in the data. There are some included, but no way of determining which are inaccurate and what the accurate value is. Another limitation is relying on the assumption that the Number of Unit feature is the appropriate feature to sum for housing unit totals. The lack of a data dictionary makes it difficult to know. The last data limitation is that neither data source provides a license or terms of use. Since both are provided by the government it is assumed that using the data for non monetized work is allowed.

7. Conclusion

The goal of this project was to see how Mecklenburg is combating housing shortages by issuing permits to build more housing during COVID. After training a SARIMAX model on the residential building permits issued by Mecklenburg, NC, it was determined that the different stages of COVID made no impact on the number of permits issued. More needs to be done to help the residents of Mecklenburg with their housing costs. Even with the limitations on the analysis, the current housing shortage should encourage counties to aim for constructing as much new housing as possible, leading to viewing clear trend increases in the data. However, at least on a permit issuance level, this is not the case in Mecklenburg. Fortunately there is some hope on the horizon. Charlotte politicians passed three referendums this November to issue bonds which funds will go towards building affordable housing in the city [17]. While this will not fix the housing shortage alone, it is a step in the right direction towards securing their residents that their place in the community is secure. The goal going forward is for this research to reach readers with this human centered analysis and have them collaborate on other solutions to Mecklenburg's housing shortage. With more people knowledgeable about this ongoing issue, other professions and community leaders can use this information to argue and fight for further residential development.

8. References

[1] https://www.cnbc.com/2020/03/15/federal-reserve-cuts-rates-to-zero-and-launches-massive-700-billion-quantitative-easing-program.html

[2] https://home.treasury.gov/policy-issues/coronavirus/about-the-cares-act

[3] https://www.sba.gov/funding-programs/loans/covid-19-relief-options/paycheck-protection-program

[4] https://www.pewtrusts.org/en/research-and-analysis/blogs/stateline/2022/07/22/investors-bought-a-quarter-of-homes-sold-last-year-driving-up-rents

[5]
https://www.npr.org/2022/07/14/1109345201/theres-a-massive-housing-shortage-across-the-u-s-heres-how-bad-it-is-where-you-l

[6] https://fred.stlouisfed.org/series/UNDCONTSA

[7] https://fred.stlouisfed.org/series/CSUSHPISA

[8]
https://www.mecknc.gov/CountyManagersOffice/SPE/Community%20Pulse%20Reports/2022%20Mecklenburg%20County%20Community%20Pulse%20Report.pdf

[9] https://meck-ent-power-bi-reports-public-web.azurewebsites.net/

[10] https://www.redfin.com/news/redfin-rental-report-december-2021/

[11] https://fortune.com/2022/03/17/new-home-construction-soars-us-housing-market/

[12]
https://scrantongillette.com/closer-look-covid-19s-effects-home-construction-what-builders-need-know

[13] https://www.investopedia.com/terms/a/anova.asp

[14]
https://www.investopedia.com/terms/z/z-test.asp#:~:text=A%20z%2Dtest%20is%20a%20statistical%20test%20to%20determine%20whether,result%20from%20the%20z%2Dtest.

[15] https://mathworld.wolfram.com/BonferroniCorrection.html

[16] https://medium.datadriveninvestor.com/time-series-prediction-using-sarimax-a6604f258c56

[17]
https://www.wcnc.com/article/news/politics/elections/charlotte-ballot-midterm-2022-referendum-election/275-53f3aeb3-77d8-433e-bb99-3b9c2c7d00e6

9. Data Sources

[a]
https://meck-ent-power-bi-reports-public-web.azurewebsites.net/Viewer?groupId=2ca2c01c-5658-4ee2-8a4f-5bdda8be94b7&reportId=6a4603a2-d1d1-47b7-9898-3575ed3758c6

[b]
https://data.cdc.gov/Policy-Surveillance/U-S-State-and-Territorial-Public-Mask-Mandates-Fro/62d6-pm5i