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Human Centered Data Science

An Analysis of COVID-19, Unemployment, and Infection Numbers

Introduction

The Coronavirus pandemic has pushed medical resources to the limit and caused many small businesses, such as restaurants, salons, and fitness centers to close. This report analyzes the pandemic's impact on unemployment rates in Pima County, Arizona and provides valuable information to policymakers. It examines unemployment rates from 2014 to 2021 and then shows how unemployment rates have varied monthly since the pandemic began. It also compares unemployment rates before and after the beginning of the pandemic. The final portion of the analysis examines the relationship between new infection cases and unemployment rates.

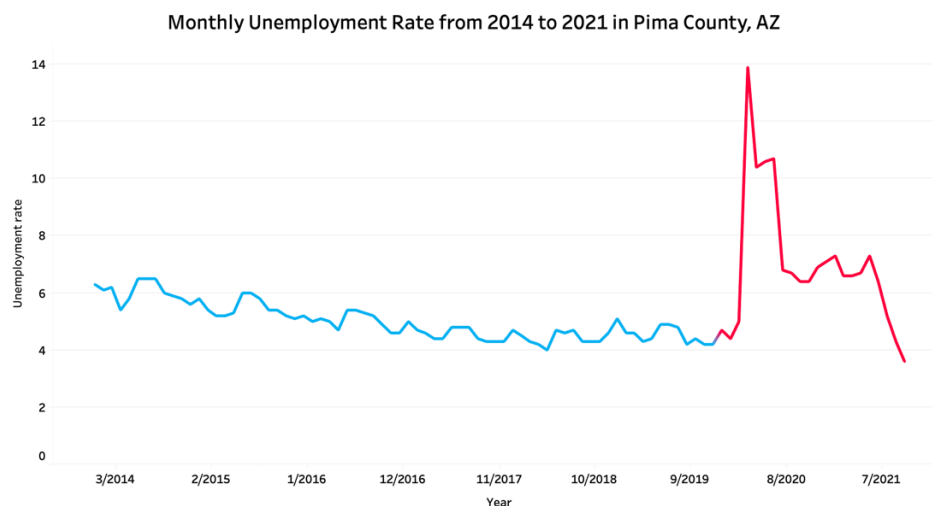
Background

Much research exists on unemployment rates during the COVID-19 pandemic, domestically and globally. However, no research could be found using hypothesis testing to verify that unemployment rates were impacted by the COVID-19 pandemic and investigate the correlation between infection numbers and the unemployment rate. This report hypothesized that 1) the COVID-19 pandemic severely affects the unemployment rate and 2) the unemployment rate is positively correlated with the number of COVID-19 cases (specifically, when COVID-19 cases rise, the unemployment rate will likely rise). The deduction is an increase in COVID-19 cases will lead to more businesses closing and fewer jobs being available. Therefore, the increase in infection numbers will cause unemployment rates to rise, showing there is a linear correlation between COVID-19 infections and unemployment rates.

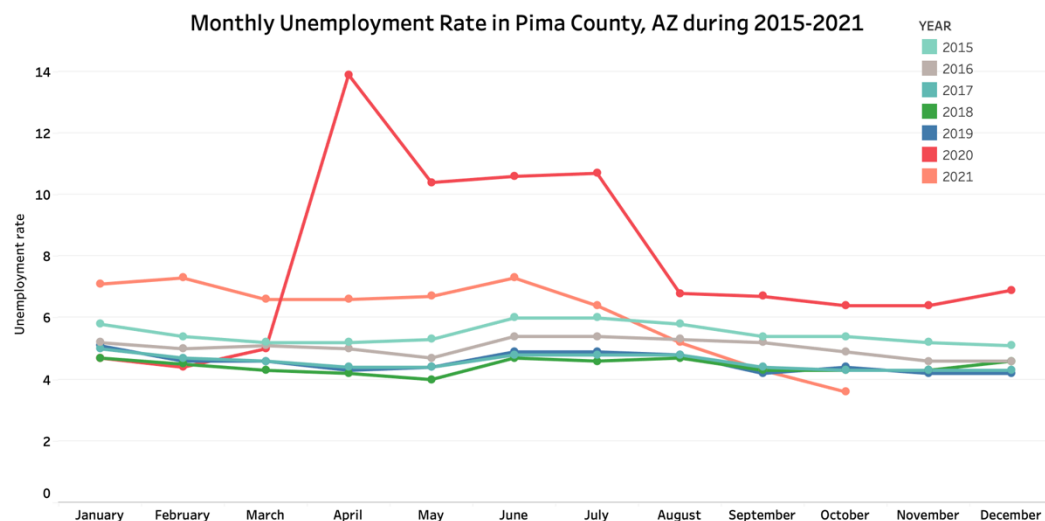
Methodology

The methodology used in this analysis is data visualization and hypothesis testing. To verify the first hypothesis, a time series plot with unemployment rates was created to determine whether unemployment rates have varied since the pandemic began in Pima County. The unemployment rates were plotted on a month-by-month basis for different years to see whether there was a difference between unemployment rates before and after the beginning of the pandemic in Pima County. Then, hypothesis testing was applied to determine whether a statistically significant difference exists for unemployment rates before and after the beginning of the pandemic. This report then analyzes data and creates visualizations. The trend analysis compares new cases numbers to unemployment rates. A scatter plot is used to conclude whether there are any linear correlations between new infection numbers and unemployment rates. Since new case numbers are provided daily and influenced by the different days in a week, the COVID-19 cases and unemployment rates were compared by averaging the numbers on a monthly level. These methods possibly remove the impact of the different days in a week and instead focus on human-centered perspectives.

Findings



This plot displays the monthly unemployment rates from 2014 to 2021 in Pima County, AZ. The plot uses blue to indicate the period before the pandemic and red to indicate the period after the pandemic began. This time series plot shows unemployment rates have increased dramatically since the pandemic began and have begun dropping discontinuously as the pandemic continues.



This chart examines monthly unemployment rates in Pima County from year to year. In pre-pandemic years, monthly unemployment rates changed only slightly from year to year. However, the data shows that monthly unemployment rates have fluctuated dramatically in the pandemic years of 2020 and 2021 compared to prior years.

```
cont_val = data[(data['Year'].dt.year>=2015)&(data['Year'].dt.year<2020)][ 'unemployment_rate'].values
cont_mean = cont_val.mean()

p_val = ttest_ind(test_val, cont_val, equal_var=False).pvalue

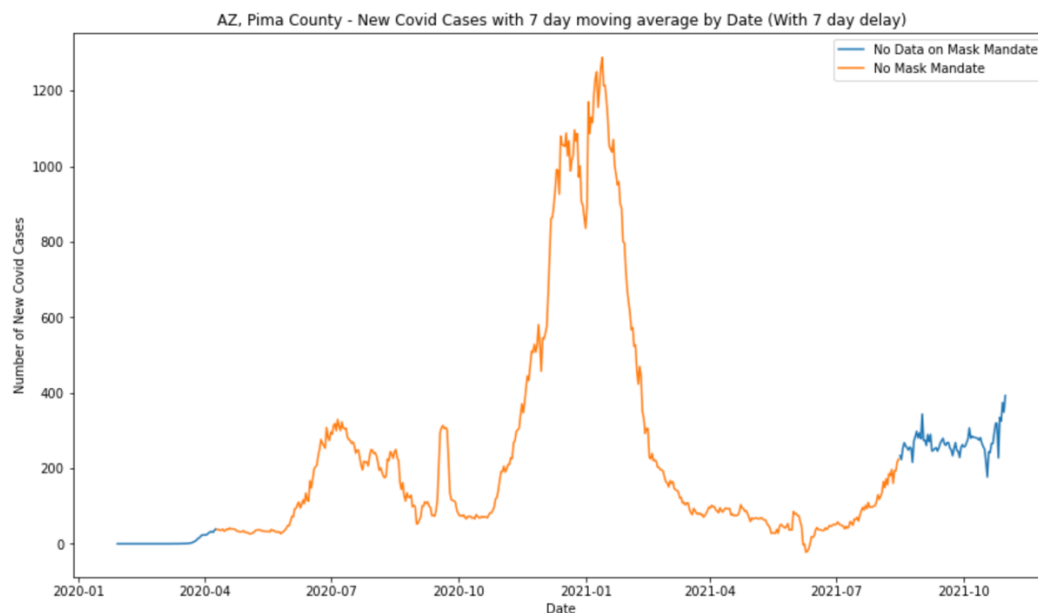
ttest_ind(test_val, cont_val, equal_var=False)

Ttest_indResult(statistic=4.482555381236891, pvalue=0.0002142447289640118)

print('{0:20s} {1:>30s} {2:>35s}'.format('Unemployment Rate b Covid-19', 'Unemployment Rate f Covid-19', 'P-Value'))
print('-' * 90)
print('{0:15f} {1:30.5f} {2:45.5f}'.format(test_mean, cont_mean, p_val))
```

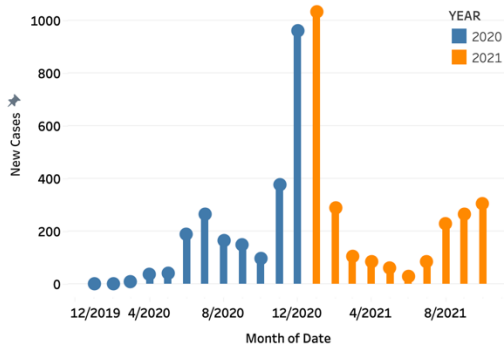
| Unemployment Rate b Covid-19 | Unemployment Rate f Covid-19 | P-Value |
|------------------------------|------------------------------|---------|
| 7.161905 | 4.81333 | 0.00021 |

The above is the output for the hypothesis testing with the null hypothesis that the monthly unemployment rate remained the same before and after the pandemic. It is assumed the observations in sample sets, consisting of monthly unemployment rates for different years, are independent of each other. They follow the normal distribution. The P-value is 0.00021, which provides strong evidence against the null hypothesis. Thus, unemployment rates have statistically significant differences before and after the pandemic, and it can be concluded that unemployment rates have been affected by the COVID-19 pandemic. The above findings verified this report's first hypothesis.

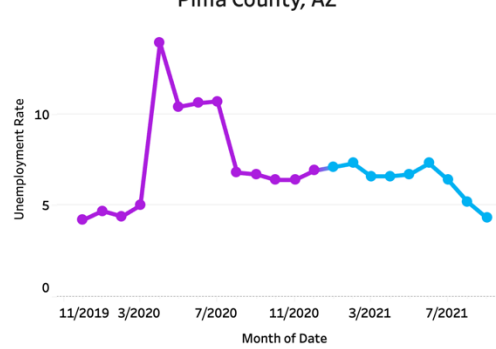


In the graph of Arizona, Pima County-New Covid Cases with 7 day moving average by Date, it shows the number of new cases in Pima County in Arizona. Two colors were used to indicate the time that this county implemented mask mandates in retail businesses and restaurants. As we can see from this visualization, mask mandates were put into place during high infection rate periods. It is possible that masks could have helped decrease the number of cases after the first wave of the virus. Also, there is no mask mandate later in time due to vaccines being available for citizens.

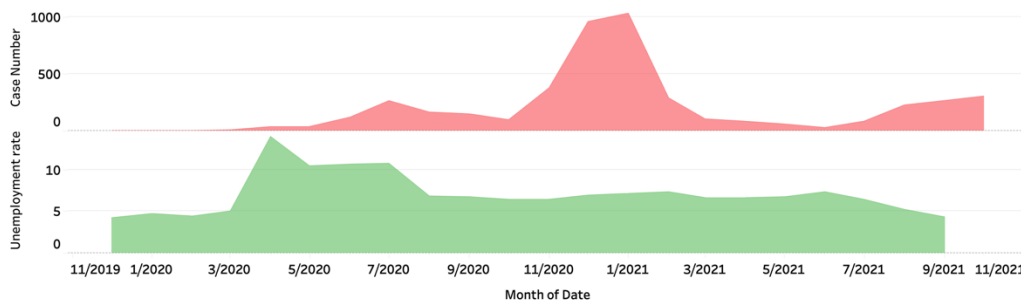
Monthly New COVID Cases in Pima County, Arizona



Monthly Unemployment Rate after COVID-19 in Pima County, AZ

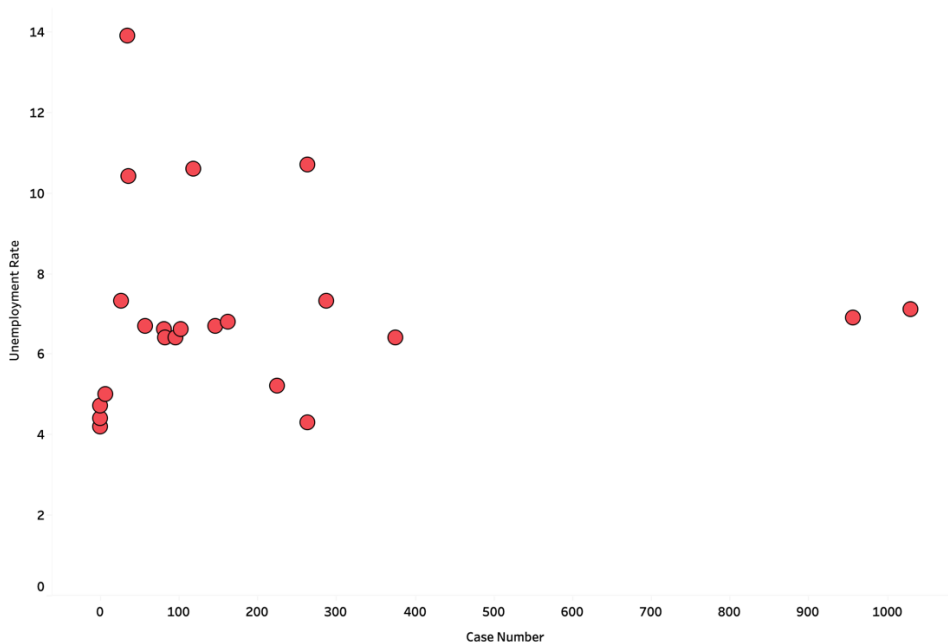


Comparison New COVID Cases and Unemployment Rate in Pima County, AZ from 2020 to 2021



The bar plot above on the left illustrates monthly new COVID-19 cases in Pima County in 2020 and 2021. There was a spike in new infection numbers in late 2020 and early 2021. However, the line chart above on the right shows there was a peak in the unemployment rate in April 2020 in Pima County, AZ. The graph below it demonstrates the unemployment rate is not expected to rise as infection numbers increase.

The Number of Infected Cases and Unemployment Rate in Pima County, Arizona



This scatter plot further verifies there is not a linear correlation between unemployment rates and new case numbers. These findings provide strong evidence to reject this report's second hypothesis that as infection numbers increase, the unemployment rate rises.

Discussion and Implications

Visualizations and statistical methods show unemployment rates have been impacted by the COVID-19 pandemic. This conclusion can assist policymakers in implementing strategic regulations to stimulate the economy and decrease the unemployment rate. This analysis also finds that the unemployment rate does not rise with an increase in infection numbers, implying unemployment rates are not directly affected by infection case numbers. Additional research could be done to determine what factors influence unemployment rates during this pandemic.

Limitations

This analysis has its limitations. First, the unemployment rate data only exists up to September 2021, while data regarding the reported number of COVID-19 cases exists up to November 2021. Thus, two months do not overlap. In addition, sample points used for hypothesis testing only come

from Pima County, Arizona. However, it is assumed these observations represent sample points from other counties nationwide. More analysis is needed to test these assumptions.

Conclusion

In conclusion, there is a significant difference in the unemployment rate between pre-pandemic and post-pandemic periods. This was verified with exploratory data analysis and hypothesis testing. However, there is no linear correlation between the unemployment rate and the number of infections. The number of new cases appears to not directly affect the unemployment rate. Although the COVID-19 pandemic caused many local businesses to close, resulting in fewer job positions, any increase in new cases of infection will not cause a rise in the unemployment rate in Pima County, AZ.

References

- [1] “Unemployment Rates during the COVID-19 pandemic”. Available at <https://sgp.fas.org/crs/misc/R46554.pdf>
- [2] “Unemployment Rose Higher in Three Months Of COVID-19 Than It Did In Two Years Of The Great Recession”. available at <https://www.pewresearch.org/fact-tank/2020/06/11/unemployment-rose-higher-in-three-months-of-covid-19-than-it-did-in-two-years-of-the-great-recession/>

Data Sources

- [1] US confirmed cases COVID-19 data from John Hopkins University. Available at https://www.kaggle.com/antgoldbloom/covid19-data-from-john-hopkins-university?select=RAW_us_confirmed_cases.csv
- [2] U.S State and Territorial Public Mask Mandates from April 10, 2020 through August 15, 2021 by County by Day. Available at <https://data.cdc.gov/Policy-Surveillance/U-S-State-and-Territorial-Public-Mask-Mandates-Fro/62d6-pm5i>
- [3] Mask Wearing Survey Data. Available at <https://github.com/nytimes/covid-19-data/tree/master/mask-use>
- [4] Unemployment Rate in Pima County, AZ. Available at <https://fred.stlouisfed.org/series/AZPIMA9URN>