# PREDICTIVE MODEL FOR POST-COVID ECONOMIC STABILITY IN US CITIES


## ABSTRACT

The purpose of this investigation was to develop a covid-based model using large quantities of relevant data to predict economic stability in different U.S. cities. In this model, we implement factors such as a city's resilience, significant industries, and daily mobility patterns to discover a city's ability to fight against this deadly virus. In this study, we find that cities with smaller population densities and movement patterns not centered around retail (e.g. Raleigh and Durham) are better suited to deal with a pandemic. Conversely, our results show that busier cities that rely more on industries such as retail, tourism, etc. are likely to be hurt immediately and in the long run.


## INTRODUCTION

Due to the novel coronavirus (COVID-19), the United States and the world have instituted widespread lockdowns in an effort to slow the spread of the virus. Lockdowns and fear over contracting COVID-19 have to some extent limited the deaths and cases, but these policies have also ravaged a previously expanding global economy. In the United States alone, unemployment peaked during the pandemic at 14.7%[1], indicating that the reduction in social and economic activities drastically reduced the demand for labor. The immediate impacts of this pandemic are clear, but it remains to be seen how COVID-19 will affect major cities over the next 1,2, and 5 years. The National Bureau of Economic Research estimates "a year-on-year contraction in U.S. real GDP of nearly 11 percent as of 2020 Q4", further demonstrating that the economy has taken a huge hit resulting from COVID-19 lockdowns[2]. Studies also show that smaller college towns are likely to recover faster. This is due to their positions in the U.S. as growing tech-hubs. Additionally, well-established areas (e.g. Northeast) are predicted to suffer following the events of the coronavirus pandemic[3].

*Scope*

We decided to scope our analysis to major cities in the United States for two reasons:

1. The United States has the most robust set of data. Overall easier access to data.
2. Major cities are the most affected by COVID-19. High levels of population density require more restrictions and also increase the overall exposure to the virus
3. We have a better understanding of the political, economic, and social conditions

*Assumptions*

We made a number of assumptions to frame our analysis:

| *Assumption* | *Description* |
|---|---|
| In-person industries will be the most affected by COVID 19 Restrictions. | This includes Retail, Transit, and Tourism. Many of these jobs require less than a college degree. |
| Urban Areas are more affected than Rural Areas | Higher Population Density means more of the population will be exposed to COVID |

Hypothesis:

We believe cities in the U.S such as Las Vegas, Los Angeles, and Honolulu, focused on the Tourism and Retail Industry will be heavily affected. We believe cities like San Francisco, Salt Lake City, and Washington DC will be able to quickly rebound with a diverse set of industries, a higher percentage of the population with college degrees, and strong COVID-19 restriction policies.

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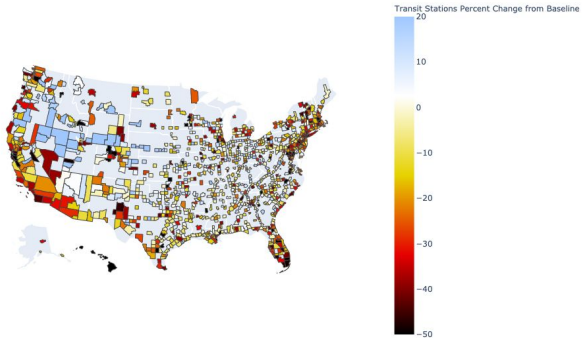
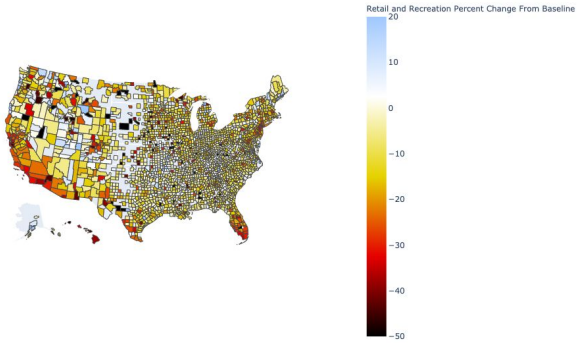
[1] https://www.bls.gov/charts/employment-situation/civilian-unemployment-rate.htm
[2] https://www.nber.org/papers/w26983
[3] https://www.forbes.com/sites/laurabegleybloom/2020/05/12/ranked-us-cities-coronavirus-recovery/?sh=fc162a2de920

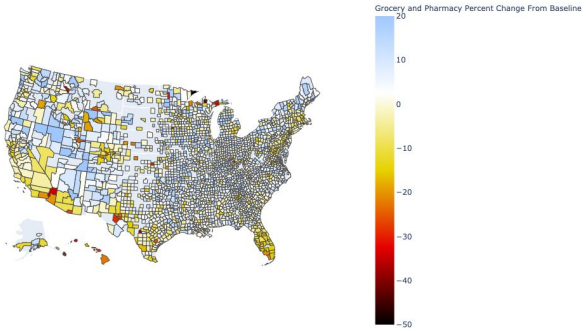
## METHODOLOGY

*Data Visualization*

To affirm our assumptions, we built visualizations. One example included mapping parameters to a map of the United States. We saw that areas with high density had significant decreases in transit, retail, and grocery/pharmacy mobility. We also saw that these areas had the highest rate of COVID death, thus supporting assumptions made before.





## PARAMETERS

| What we are measuring | Current | 1 year | 2 year | 5 year |
|---|---|---|---|---|
| **Resilience Measure - RM**<br>Community resilience is the capacity of individuals and households to absorb, endure, and recover from the health, social, and economic impacts of a disaster such as a hurricane or pandemic. Measurements obtained from US Census Bureau | 25.0% | 60% | 80% | 95% |
| **Exposure to the Virus - EXP (Death Count, COVID Cases)**<br>A measure of the infection rate and death count per state. A way to value the # of people affect by COVID, population shocks, and the current restrictions employed | 13.4% | 7% | 5% | 1% |
| **Demographic Measure - DM (Population Density and Age)**<br>A measure derived by aggregating population density and migration. It weighs residents that are 60+ higher in the overall value. Obtained from Moody | 13.4% | 7% | 5% | 1% |
| **Travel and Trade Disruption - TTD**<br>Aggregates the number of enplanements and exports as a share of GDP in the metro area. Areas reliant on trade and travel will see a drop in overall gross revenue. | 13.4% | 7% | 5% | 1% |

| | | | | |
|---|---|---|---|---|
| **Reliance on Tourism - RT**<br>Measures Tourism as a share of GDP. Includes the Accommodation and Food Services Sector total share of employment. With less travel and less tourism, the higher this value, the higher COVID's impact on the metro's economy | 13.4% | 7% | 5% | 1% |
| **Reliance on Finance - RF**<br>Measures and Aggregates both (1) Finance and Investment share of employment and (2) Dividends, interest and rent as share of total income. | 6.7% | 3.5% | 2.5% | .05% |
| **Reliance on Commodities - RC**<br>Measures (1) Mining, quarrying, oil and gas extraction sector share of employment and (2) the commodities industry share of GDP. | 6.7% | 3.5% | 2.5% | .05% |
| **Transit Mobility - TMob**<br>Mobility trends for places like public transport hubs such as subway, bus, and train stations. Data derived from Google. | 4.0% | 2.5% | 0% | 0% |
| **Retail Mobility - RMob**<br>Mobility trends for places like restaurants, cafes, shopping centers, theme parks, museums, libraries, and movie theaters. Data Derived from Google | 4.0% | 2.5% | 0% | 0% |

**COVID RISK SCALE**

$$0 \leq \Sigma_{i=0} w_i * \sigma(x_i) \leq 10$$

*Equation 1*

$$CRS = (2.5 * RM) + (1.34 * Exp) + (1.34 * DM) + (1.34 * TTD) + (1.34 * Exp) + (.67 * RF) + (.67 * RC) + (.4 * TMob) + (.4 * RMob)$$

The **Covid Risk Scale** is adjusted based on how different parameters should be logically weighted in the long-term. For long term calculations, the resilience measure carries far more weight than it does when computing for the current CRS. On the contrary, the parameters Exp, DM, TTD, RT, RF, and RC weaken over time as infections flatten out and industries are able to operate normally. Additionally, the parameters of mobility would seem to carry very minimal significance two to five years down the road. Taking these assumptions into account, our formulas for 1, 2, and 5 year predictions are as follows:

*Equation 2*

$$CRS_1 = (6 * RM) + (.7 * Exp) + (.7 * DM) + (.7 * TTD) + (.7 * Exp) + (.35 * RF) + (.35 * RC) + (.25 * TMob) + (.25 * RMob)$$

*Equation 3*

$$CRS_2 = (8 * RM) + (.5 * Exp) + (.5 * DM) + (.5 * TTD) + (.5 * Exp) + (.25 * RF) + (.25 * RC) + (0 * TMob) + (0 * RMob)$$

*Equation 4*

$$CRS_5 = (9.5 * RM) + (.1 * Exp) + (.1 * DM) + (.1 * TTD) + (.1 * Exp) + (.05 * RF) + (.05 * RC) + (0 * TMob) + (0 * RMob)$$

**FINDINGS & ANALYSIS**

*High Impact Cities*

**Short Term (Current - 1 year)**

1. New York City (7.5)
2. San Francisco (5.7)
3. Miami (5.5)
4. Las Vegas (5.5)
5. Honolulu (4.7)

**Long Term (Post 5 years)**

1. Miami (4.0)
2. Philadelphia (3.9)
3. Las Vegas (3.6)
4. Detroit (3.5)
5. New York City (3.4)

New York and San Francisco both are in the top 5 most dense areas in the United States. This indicates that in the **short-term**, population density and the # infections will outweigh any innate characteristics in the population's ability to recover from economics shocks.

Miami, Honolulu, and Las Vegas are not as dense as New York but are more reliant on the tourism and travel industries, both affected heavily in the short term. Furthemore, short-term factors such as virus exposure will be weighed higher in these areas where restrictions are lower, due to certain policies.

In the **long term**, we see San Francisco recover out of the top four affected cities. This makes sense as a large portion of cities' economic value comes from tech, which we've seen growth in during COVID times.

Both Miami and Las Vegas stay in the top four affected cities. This is justified by their relatively low reslinancy rate . Furthemore, these areas will see large population migrations out of these areas, coming with significant economic repercussions, due to a decrease in labor force morale.

Cities in Philadelphia and Detroit also come into the top four cities affected. Both these cities have low resilience rates, stemming from a high income to poverty ratio, unit level crowding, communication barriers, and limited health insurance. While such cities are not as affected by COVID at the beginning, they will have a hard time recovering from its effects.

New York City is still in the top five but has significantly recovered from 7.5 to 3.4 on the COVID Risk Scale. This makes sense as New York is not heavily reliant on industries affected by COVID 19 and have strong reslinancy rates. However, COVID will cause a fundamental shift away from urban areas, work commutes, and transit systems, all currently essential in New York. Hence, the city will see long term repercussions from a migration from its epicenter.

## CONCLUSION

We have (1) narrowed our scope to the U.S, (2) chose a subset cities (COVID 19 has limited impact in rural areas) with varying industry and population characteristics, and (3) applied our COVID 19 Risk Model based on the characteristics of the city and the surrounding metro area. The COVID 19 Risk model is based on a weighted aggregate of a location's resiliency, virus exposure, demographic characteristics, mobility characteristics, and the industry specifics.

In the short term, we found that to predict the economic impact of COVID, we don't have to make any large suppositions. The cities most affected will simply be those with the highest population density i.e. New York and San Francisco and cities whose main source of revenue comes from travel, tourism, and food i.e Miami, Las Vegas, and Honolulu. This is not anything surprising.

In the long term, the characteristics of the population, specifically the income gap, # single family households, unit level crowding, % of people with disabilities, and limited health care coverage, become increasingly important, no different than any other economic shock.

One major concern among the American population is evidently the timeline for the vaccine, which seemingly solves many of the short-term problems. But, after a vaccine, what will help those cities plagued by economic inequality, worsened by COVID 19 acute impact on low-income households?

**References**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