# Determining the Tangible Conclusions that Can Be Drawn from COVID-19 Case Data for Strategic Supply Chain Decisions

# 确定可以从新冠肺炎案例数据得出的战略供应链决策的有形结论

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# Outline

# Topic

# Research Objective



Determine the tangible conclusions that can be drawn from the COVID-19 case data for future strategic supply chain decision making by:

1. Deriving metrics from the COVID-19 case, death, and testing data
2. Comparing these metrics to pandemic preparedness metrics to determine their accuracy
3. Comparing these metrics to other global metrics to uncover confounding variables
4. Comparing these metrics to the stringency of steps taken to mitigate COVID-19

*Potential*: Create a ranking system of every country's pandemic preparedness based on the generated COVID-19 metrics.

COVID-19 drastically affected global supply chains

Table: Increase in Lead Times due to COVID-19 [1]

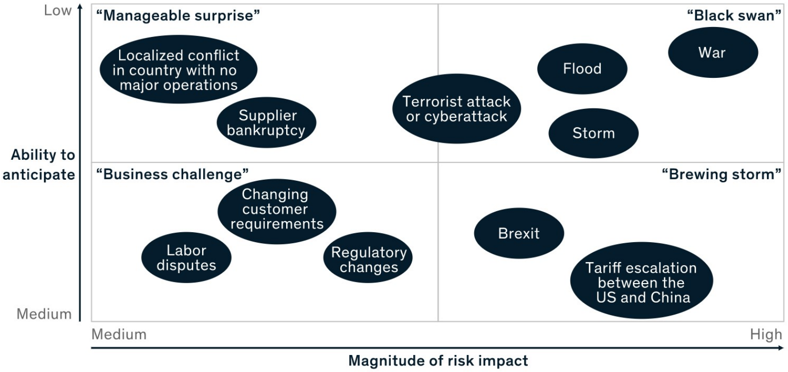
| China | Japan | South Korea | European Union | United States |
|---|---|---|---|---|
| 222% | 209% | 217% | 201% | 200% |

Table: Manufacturing Capacity due to COVID-19 [1]

| China | European Union | United States |
|---|---|---|
| 53% | 50% | 79% |

COVID-19 is a new and unique *black swan* supply chain risk

Figure: A simple classification of supply chain risks [2]



# Background



COVID-19 's overall economic impact has been estimated to be $4.57 trillion [5] which is:

- 13-times more costly than the most expensive natural disaster
  - 2011 Tōhoku Earthquake and Tsunami - $353 million* [3]
- 6.5-times more costly than the most expensive man-made disaster
  - 1986 Chernobyl Nuclear Disaster - $700 billion* [4]

*adjusted for inflation

# Literature Review Summary



- COVID-19 disrupted global supply chains and was fundamentally different from other types of supply chain disruptions firms were equipped to handle
- Firms will look to modernize their supply chains to make them more resilient post-COVID-19
- A lack of supply chain diversification was a root-cause of many COVID-19 related supply chain issues
- Firms will look to diversify their supply chains geographically, industry-wise, and product-wise in the future
- Supply chains overly concentrated in specific countries were the most impacted

The *black swan* supply chain risk of a pandemic outbreak will not go away

- "Between 2011 and 2018, WHO tracked 1483 epidemic events in 172 countries" [5]

Although the different strategies to combat supply chain disruptions have been thoroughly researched, a quantitative analysis of every country's pandemic preparedness based on the COVID-19 data has not been performed

- Without such an analysis, the geographic diversification of global supply chains cannot be done while considering pandemic prepardness

# Methodology

COVID-19 Case and Death Data

- *Johns Hopkins Whiting School of Engineering's Center for Systems Science and Engineering* [6]

COVID-19 Testing Data

- *Our World in Data* [7]

Pandemic Preparedness Metrics

- *Johns Hopkin's 2019 Global Health Security Rankings* [8]

Prevention Steps Stringency

- *The University of Oxford's COVID-19 Stringency Index* [9]

# Data Sources



Global Economic Data

- *International Monetary Fund's 2020 World Economic Outlook Database* [10]

Healthcare Data

- *World Health Organization's Measuring Overall Health System Performance for 191 Countries* Report [11]

Press Freedom

- *Reporters without Borders 2020 World Press Freedom Index* [12]

# Metrics



All of the following metrics would be collected from the COVID-19 data on a per country basis:

- Total Cases
- Total Deaths
- Total Tests
- Peak Stringency
- Total Cases Prior to Peak Stringency
- Total Deaths Prior to Peak Stringency

# Metrics

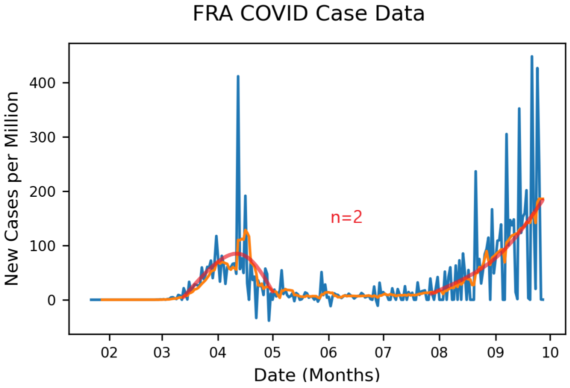
- Case to Death Ratio Average

$$\frac{TotalCases}{TotalTests} \tag{1}$$

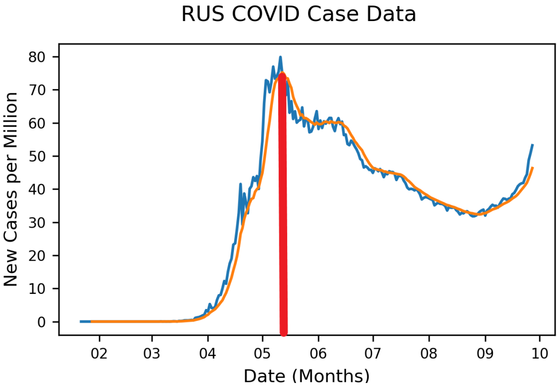
- Case to Test Ratio Average

$$\frac{TotalCases}{TotalTests} \tag{2}$$

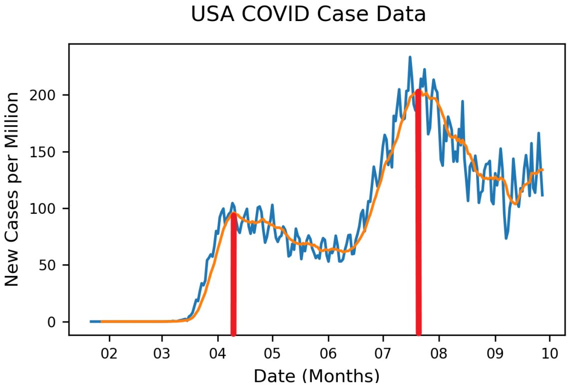
- Number of Outbreaks



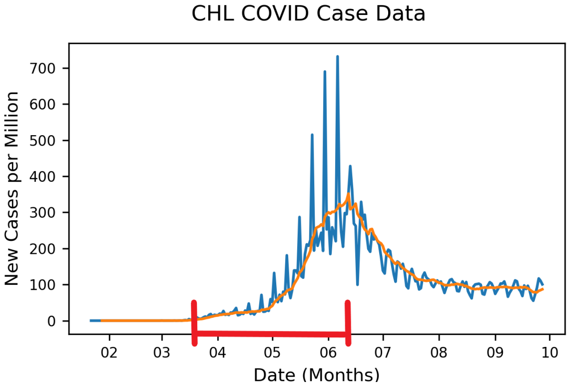
- Severity of Initial Outbreak



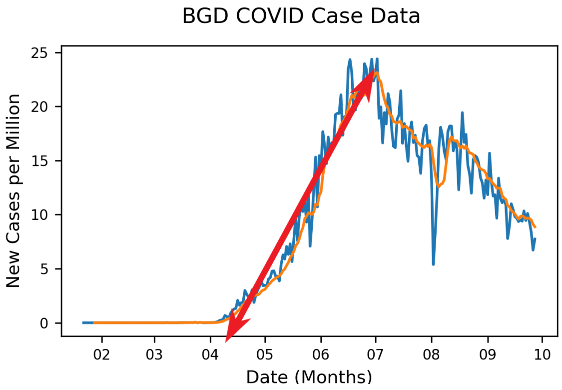
- Severity of Subsequent Outbreaks



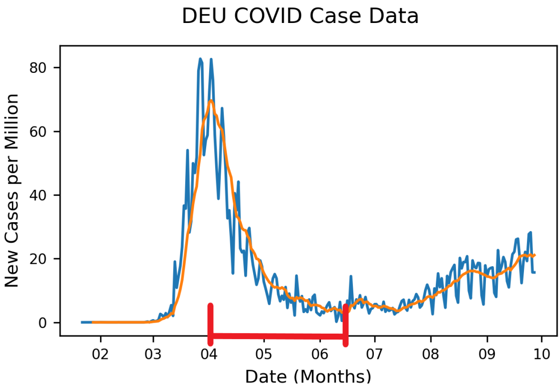
- Time until Submission



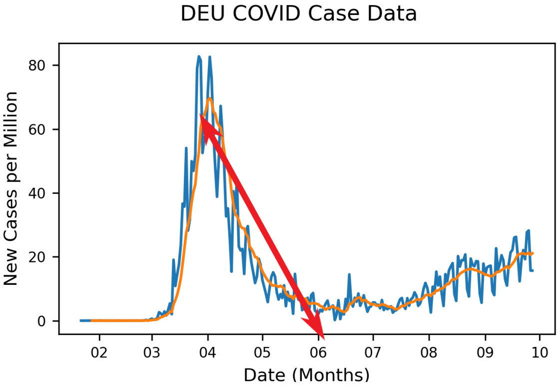
- Rate of Outbreak



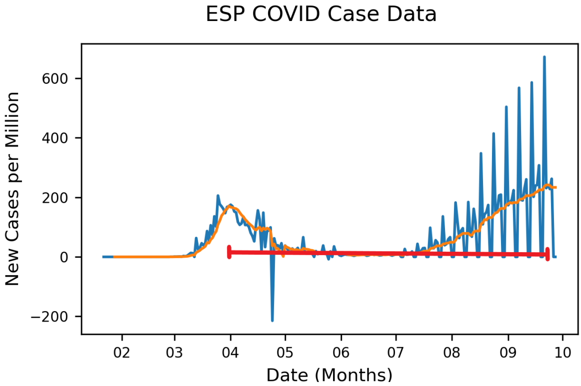
- Time of Submission



- Rate of Submission



- Length between Outbreaks



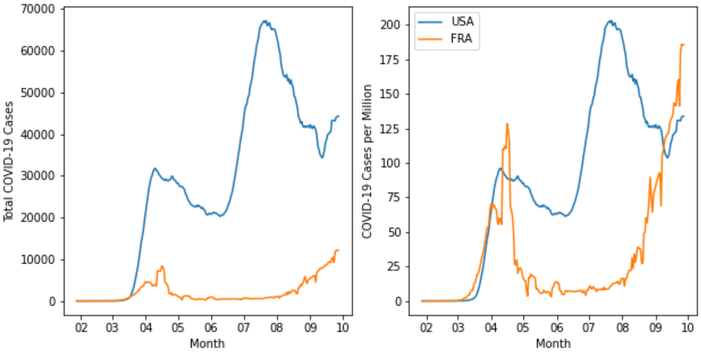
# Analysis Methods



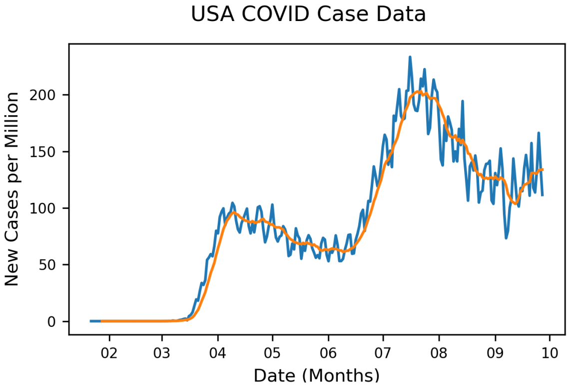
- Regression Analysis
  - Simple linear regression allows us to look at the linear relationship between one normally distributed interval predictor and one normally distributed interval outcome variable [13]
- ANOVA Analysis
  - A one-way analysis of variance (ANOVA) is used when you have a categorical independent variable (with two or more categories) and a normally distributed interval dependent variable and you wish to test for differences in the means of the dependent variable broken down by the levels of the independent variable [13]

# Anticipated Problems and Proposed Solutions

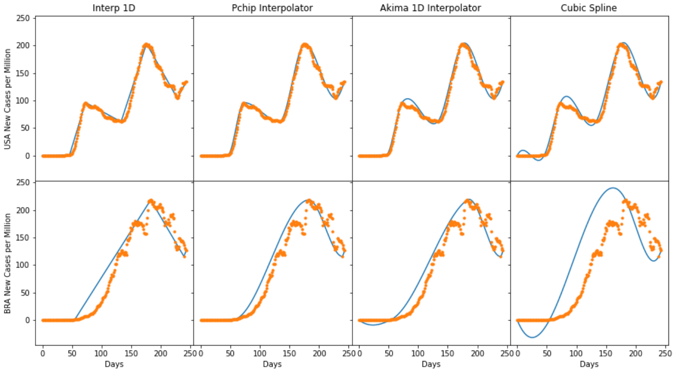
To make the data analysis equitable across countries, COVID-19 frequency must be considered, not COVID-19 incidence.



To combat the weekly periodicity of the COVID-19 data, a 7-day moving average needs to be used for metric generation.

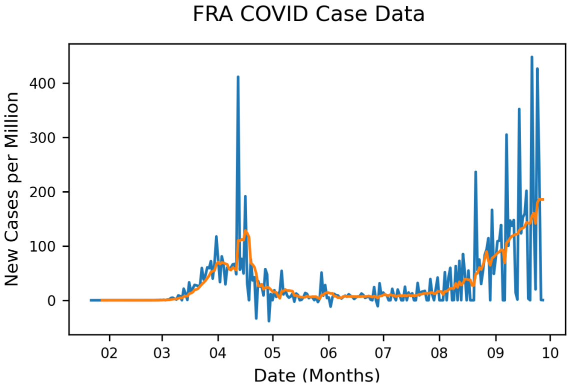


Four different interpolation methods (Interp1d, Pchip, Akima, and Cubic Spline) are all differentiable



# Handling Outliers

Due to data periodicity, outliers cannot be separated from the noise algorithmically and must be handled case-by-case



# Data Accuracy and Availability



It is generally assumed that the COVID-19 case, death, and testing data is not accurate for every country.

| Country | Population | Cases | Deaths |
|---|---|---|---|
| Argentina | 45.2 mil. | 711,325 | 15,749 |
| Sudan | 43.8 mil. | 13,606 | 836 |

Thus, such data accuracy and availability must be mitigated by

- The search of confounding variables to contextualize the results
- The acceptance that, while the data is inaccurate, the analyses are still vital to do

# Thank You and Q&A

# References

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[1] Jessica Boyd and Institute for Supply Management. *COVID-19 Global Supply Chain Disruptions Continue.* English. publisher: Cision Distribution. Apr. 2020. URL: https://www.prnewswire.com/news-releases/covid-19-global-supply-chain-disruptions-continue-301040385.html (visited on 10/06/2020).

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[5] Global Preparedness Monitoring Board. "A world at risk: annual report on global preparedness for health emergencies". In: *Geneva: World Health Organization; 2019. Licence: CC BY-NC-SA 3* 0 (2019).

[6] Ensheng Dong, Hongru Du, and Lauren Gardner. "An interactive web-based dashboard to track COVID-19 in real time". In: *The Lancet Infectious Diseases* 20.5 (May 2020), pp. 533–534. ISSN: 1473-3099. DOI: `10.1016/S1473-3099(20)30120-1`. URL: `https://doi.org/10.1016/S1473-3099(20)30120-1`.

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[11] Ajay Tandon et al. "Measuring overall health system performance for 191 countries". In: *Geneva: World Health Organization* (2000).

[12] *2020 World Press Freedom Index | Reporters Without Borders*. en. URL: https://rsf.org/en/ranking (visited on 10/06/2020).

[13] J. Bruin. *newtest: command to compute new test @ONLINE*. Feb. 2011. URL: https://stats.idre.ucla.edu/stata/ado/analysis/.