Title: Spatial Distribution of the Population and the Spread of COVID-19: Implications for the U.S. Economic Lockdown

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Abstract:
Since mid-March 2020, many governors in the United States put their states under lockdown in the form of stay-home orders to slow down the spread of COVID-19. This resulted in more than 16 million people applying for unemployment benefits. A key question regarding this policy is what role the spatial distribution of the population plays. In highly populated areas, people might interact more frequently with each other causing a faster spread of the virus relative to less populated areas. The goal of this research is to measure the impact of the distribution of the population on the spread of the corona virus in the US. The estimate of the distribution impact on the spread of the virus can then be used to assess the impact of the lockdown on the spread and help policy makers to design recovery plans at the sub-national level. This project would also compile a consistent dataset of the dates when states ordered stay-home orders or made other significant changes through the summer of 2020.

Data:
For our analysis, we mainly intend to use three data sources: The Global Human Settlement (GHS) data for 2014 from Freire et al (2016), which includes population data for a raster with cell sizes of 1km squared; the covid tracking project (https://covidtracking.com/data) for the cases in the US at the state level; and the stay home order announcements for each state from general news sources.
We use the GHS maps to estimate the Spatial Population Concentration (SPC) measure which we developed that measures how many people live within a given radius of every person on average:

$$SPC_d = \frac{\sum_{i=1}^{N} x_i * n_{di}}{\sum_{i=1}^{N} x_i} - 1$$

where SPC_d is the distribution measure for distance d, measuring how many people live on average within distance d of every person in a given area. x_i is the number of people at raster cell i and n_{di} is the number of people within distance d of cell i. In the context of the proposed project, the measure captures how many contacts an individual could potentially have on average. We used the George Washington Colonial One High Performance Computing System for our SPC calculations and we already calculated this measure for several distances.[1] Relative to other measures of population concentration like population density or urbanization, our measure ignores uninhabited areas like deserts or lakes and thus provides a more accurate representation of the concentration. For example, the population density in Australia is quite low but the majority of the population lives highly concentrated in cities along the coast. Also, it allows to distinguish various levels of concentration within urban and rural areas which makes it much better suited for the proposed analysis. For example, this allows to have different concentration measures for the highly concentrated lower Manhattan vs the more sparsely concentrated outskirts of New York.

JEL Codes: C53, H12, I18, R11

[1] https://colonialone.gwu.edu/

Key words: Spatial population distribution, Covid-19, economic lockdown, transmission speed, stay-home order