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Discussion of "Evaluate the Risk of Resumption of Business for the States of New York, New Jersey and Connecticut via a Pre-Symptomatic and Asymptomatic Transmission Model of COVID-19"

Corbin Quick[1] and Xihong Lin[1]

[1]*Department of Biostatistics, Harvard T. H. Chan School of Public Health, Cambridge, MA, USA*

Tian et al. (2021b) modeled changes in COVID-19 transmission using a compartmental epidemic model, which accounts for unascertained and asymptomatic cases, and developed a Bayesian approach for model inference. They analyzed COVID-19 case rate data from 4 key regions in the US (California, New York, New Jersey, and Connecticut), compiled detailed timelines of intervention measures in these regions, and discussed implications for reopening business. This work provides a valuable contribution to the literature.

The impact of resuming business on COVID-19 transmission and the economy is a critical but nuanced issue. Even under strict lockdown, essential businesses have remained open in the US. Furthermore, as Tian et al. (2021b) describe, reopening is generally staged-restrictions are often lifted in specific regions, and for select categories of businesses and events at a time. When businesses do reopen, it is not business as usual. Social distancing policies are generally in place, consumers and employees behave more cautiously, and foot traffic is reduced. State interventions have been estimated to account for only 12% of the decrease in consumer traffic in the US pandemic (Goolsbee and Syverson, 2020). Therefore, the effect of "reopening" may not mirror the effect of closure in practice. These nuances do not easily figure into a statistical model of transmission rates, and cannot be teased apart in a small number of regions. The analyses of Tian et al. (2021b) and others (Li et al., 2020; Hsiang et al., 2020; Goodman-Bacon and Marcus, 2020; Davies et al., 2020; Cho, 2020) provide useful forecasts.

Tian et al. (2021b) model the change in COVID-19 transmission rate following intervention using a scalar parameter η to characterize the effect of intervention on transmission, and a logistic curve to account for delayed implementation. The model assumes constant transmission rate in the absence of state intervention. Social norms,business practices, and individual behaviors have changed markedly over the course of the pandemic (Park et al., 2020). These changes have cooccurred with changes in policy, and it is unclear whether estimates of parameters such as η capture the causal effects of state intervention on transmission rates, which is a critical consideration for policy. Several recent works have estimated interventions effects using causal inference techniques such as difference in differences and the synthetic control method (Li et al., 2020; Goodman-Bacon and Marcus, 2020; Cho, 2020), including a more recent analysis by Tian et al. (2021a). Further commentary on the causal interpretation of the intervention effect parameter η would be useful.

Evaluating the impact of policy on COVID-19 transmission rates is challenging due to delayed implementation (Tian et al., 2021b; Cho, 2020), lags between infection and symptom onset (incubation period) (Lauer et al., 2020), and lags between onset, testing, and confirmation (CDC COVID-19 Response Team, 2020). The logistic curve used by Tian et al. (2021b) reflects a smooth change in transmission rates following intervention, as might be expected due to these factors. Several related parameters characterizing case ascertainment and the incubation period are not identifiable from the data. Here, Tian et al. (2021b) used prior distributions with hyper-

parameters informed by previous literature. Further discussion of identifiability and sensitivity analysis to evaluate the impact of hyperparameters on model inference would be valuable.

Following Tian et al. (2021b) analysis, the US has experienced multiple waves of COVID-19 outbreaks. In addition, many US states have implemented stricter policies on face-coverings and other preventive measures, and various measures have been intermittently relaxed and redeployed throughout the US and elsewhere. The resumption of business has continued to be a central topic in US public discourse, economics, and public health. The analysis presented in this paper provides a valuable assessment of the impact of the resumption of business on COVID-19 spread.

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