Potential roles of social distancing in preventing the spread of coronavirus disease 2019 (COVID-19) in South Korea

Since its first appearance in Wuhan, China, in December 2019, the novel coronavirus disease (COVID-19) has spread internationally, including to South Korea. The first COVID-19 case in South Korea was confirmed on January 20, 2020, from a traveling resident of Wuhan, China. The epidemic then took off in mid-February when COVID-19 began to spread within a church from a city of Daegu — as of March 18, 2020, 8,413 cases have been confirmed, of which 60% are linked to the church. While its success in controlling the epidemic has been widely attributed to its intensive testing, other factors also played a role. Here, we describe potential roles of social distancing in mitigating the spread of COVID-19 by comparing epidemics in two geographically separated major cities in South Korea.

1 Data description

We analyze epidemiological data, collected bewteen January 20–March 16, 2020, describing the COVID-19 outbreak in Korea. Daily number of reported cases in each geographic region was transcribed from press releases by Korea Centers for Disease Control and Prevention (KCDC) (2020). Partial line lists were transcribed from press releases and reports from KCDC and various local and provincial government websites. All data and original reports are stored in a publicly available GitHub repoository: `https://github.com/parksw3/COVID19-Korea`.

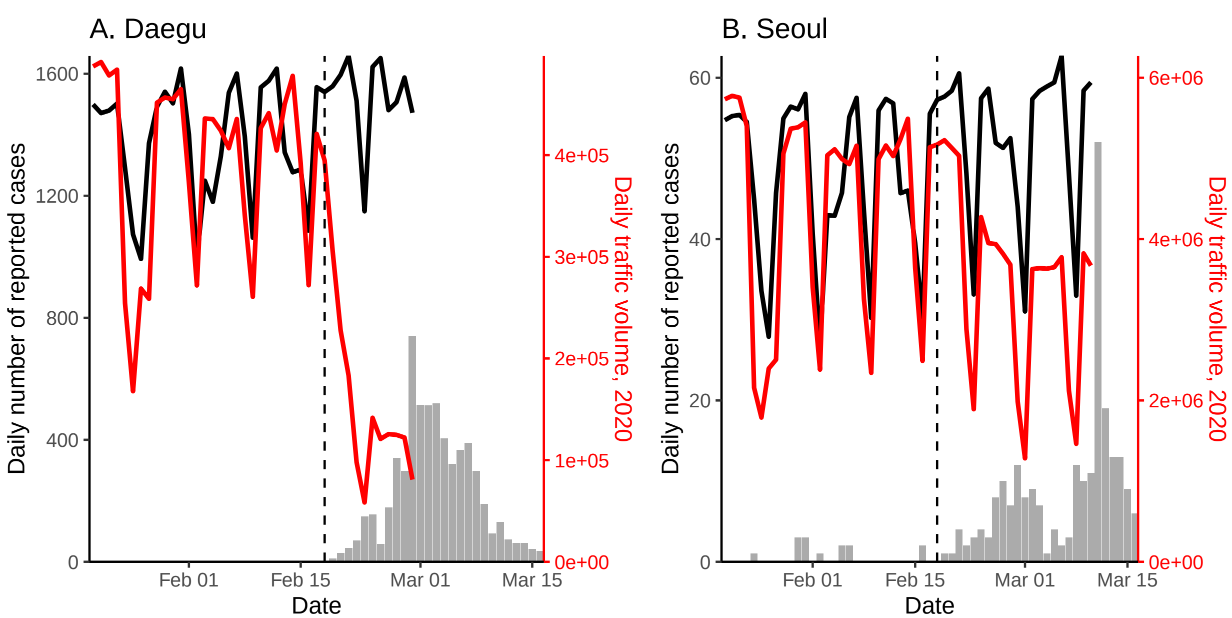

Figure 1: **Comparison of epidemiological and traffic data from Daegu and Seoul.** Red lines represent the daily metro traffic volume in 2020. Black lines represent the average daily metro traffic volume in previous years, 2017–2019. Daily traffic from previous years have been shifted by 1–3 days to align day of the week.

We compare epidemiological dynamics of COVID-19 from two cities in which the biggest number of COVID-19 cases have been reported: Daegu and Seoul. Bewteen January 20–March 16, 2020, 6,083 cases were reported from Daegu and 248 from Seoul. Unlike the epidemic in Daegu, which is characterized by a single, large peak followed by a persistent decrease, the epidemic in Seoul consists of several small outbreaks (Fig. 1).

Daily metro traffic in Daegu and Seoul between 2017–2020 was obtained from their corresponding government websites.

Fig. 1 About 80% decrease in Daegu and 50% decrease in Seoul after the identification of the church-related case.

2 Effective reproduction number

We estimate the time-varying effective reproduction number R_t for both epidemics. We account for changes in case definition by scaling the number of reported cases by the relative detection rate (i.e., a proportion of cases tested positive based a case definition divided by the mean detection rate among case definitions); using a narrow case definition is more likely to have a higher detection rate and a lower reporting rate than a wide one. Likewise, we account for changes in the number of tests by scaling the number of reported cases again by the relative number of tests performed on each day; this step is performed separately for each case definition because the widening of a case definition necessarily increases the number of tests.

We then reconstruct the incidence time series from the scaled time series of reported cases by using the backward confirmation-to-onset delay distribution, inferred from the partial line list, and previously estimated incubation period distribution. To account for right-censoring (i.e., cases that are infected but have not been reported yet), we estimate the forward onset-to-confirmation delay distribution and estimate the probability that a case infected on a given day will be reported before March 16, 2020. Then, we divide the reconstructed incidence time series by this probability and estimate the effective reproduction number using the renewal equation using a 14-day sliding window. We only calculate the effective reproduction number until March 10, 2020 because the degree of right-censoring too large afterwards.

Fig. 2 compares the estimates of R_t in Daegu and Seoul. While R_t drops below 1 in Daegu shortly after its first case was confirmed (February 18, 2020), the decrease is unclear in Seoul. Similar patterns in R_t can be found in adjacent provinces – a sharp decrease in Gyeongsangbuk-do, which surrounds Daegu, and a persistent R_t around 1 in Gyeonggi-do, which surrounds Seoul (Supplementary Materials).

3 Effect of social distancing on the effective reproduction number

- Traffic negatively correlated with R_t
- Geographically differential effect of traffic on R_t; other routes of transportation, other factors we don't consider

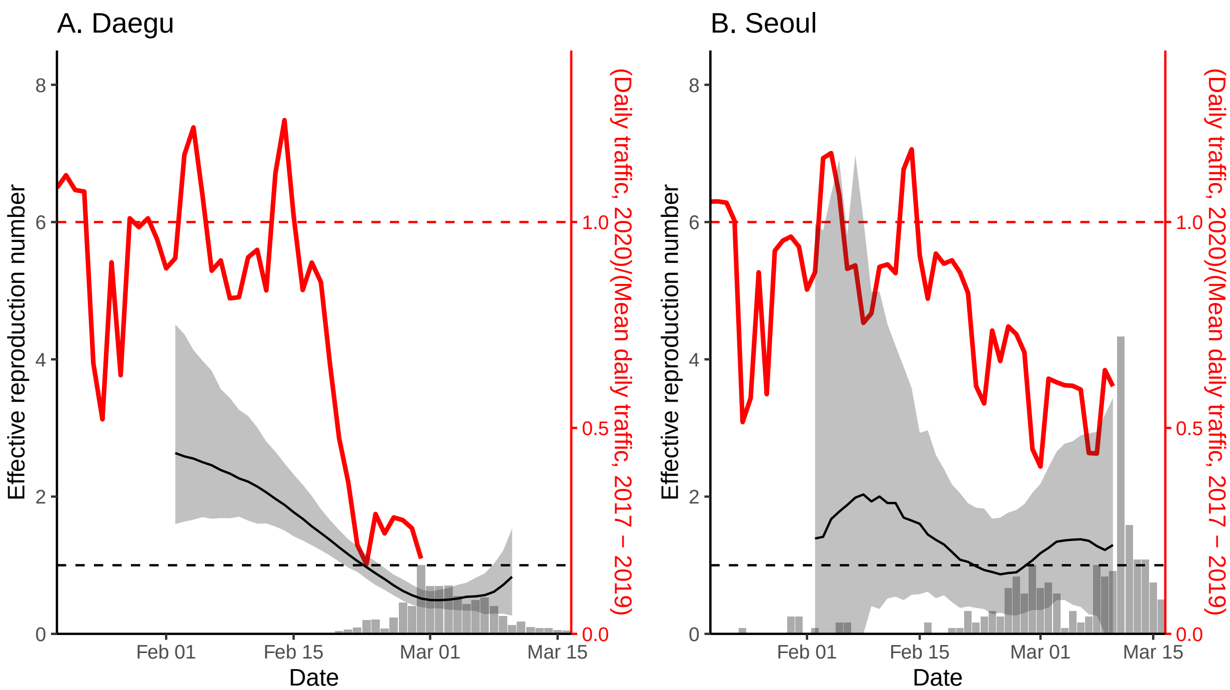

Figure 2: **Comparison of effective reproduction number and reconstructed incidence time series in Daegu and Seoul.**

- Even if we can get traffic to 0 in Seoul, R_t is not less than 1...?

4 Discussion

- Provides indirect evidence of effect of social distancing on epidemic dynamics
- But social distancing alone might not be sufficient... others have said something
- SK might need stronger intervention in some places

Caveats:

- Only two cities...although two coupled provinces show strikingly similar patterns
- Correlation not causation
- Did not account for geographic heterogeneity in testing or etc. Estimation of delay distribution etc all based on national line list.

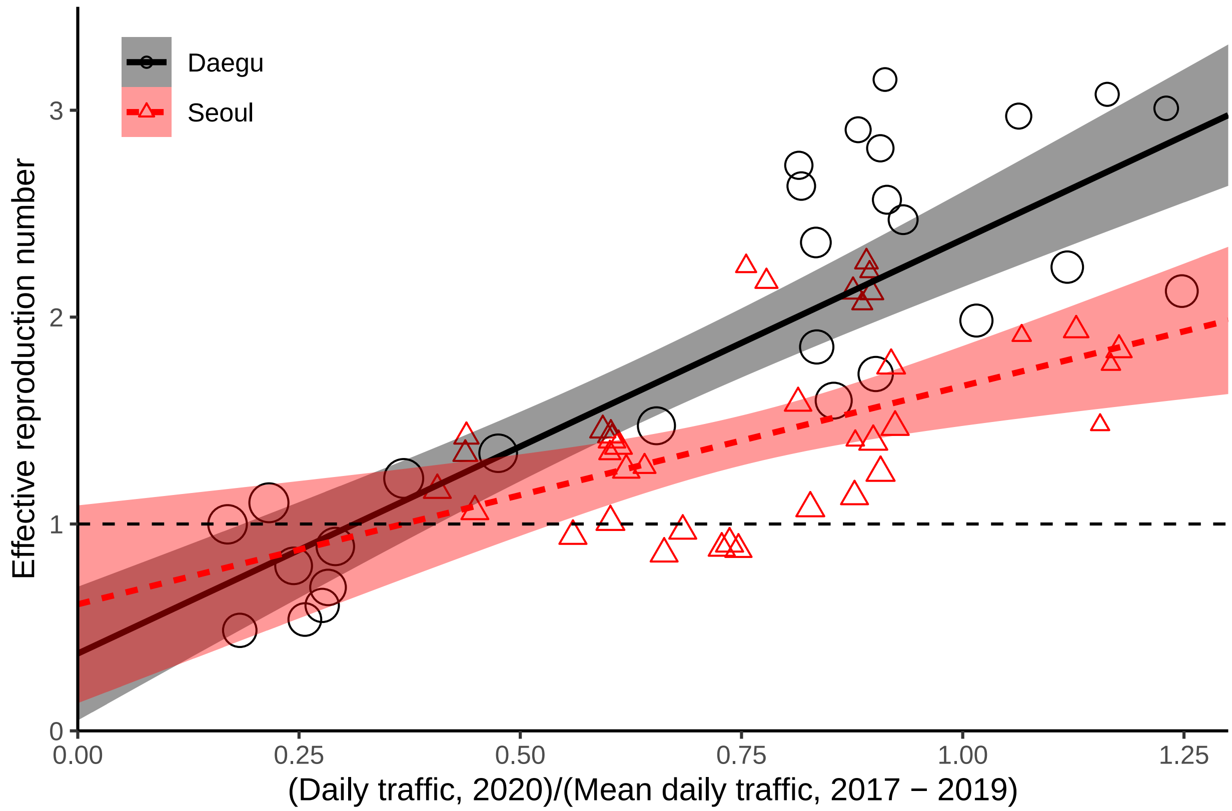

Figure 3: **Other effects.**

References

Korea Centers for Disease Control and Prevention (KCDC) (2020). Press release (in Korean). `https://www.cdc.go.kr/board/board.es?mid=a20501000000&bid=0015#`. Accessed Jan 20 – Mar 16, 2020.

5 Supplementary Materials

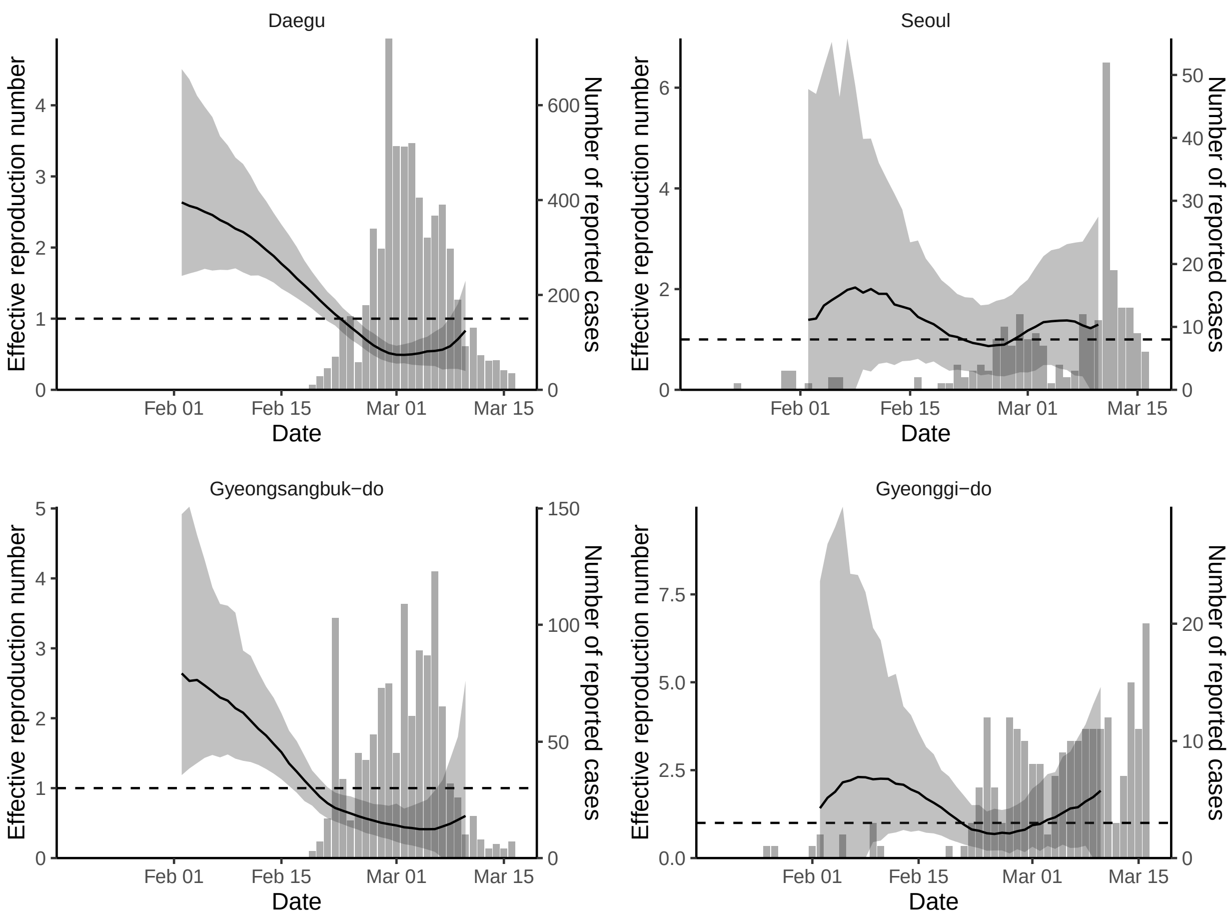

Figure 4: **Comparison of effective reproduction number in Daegu, Seoul, Gyeongsangbuk-do, and Gyeonggi-do.**