

Supporting information of a novel method to detect the early warning signal of Covid-19 transmission

Mingzhang Li, Shuo Ma and Pei Chen

Supplementary Figures



Figure S1: The country network of Spain. Based on the adjacency information of the geographic location, we can construct a regional network of Spain with 15 nodes and 28 edges. Each node represents a province or state and the edge represents the geographical adjacency between the two nodes or states. The detailed list of correspondences between regions/autonomous provinces and nodes is shown in Figure S1.

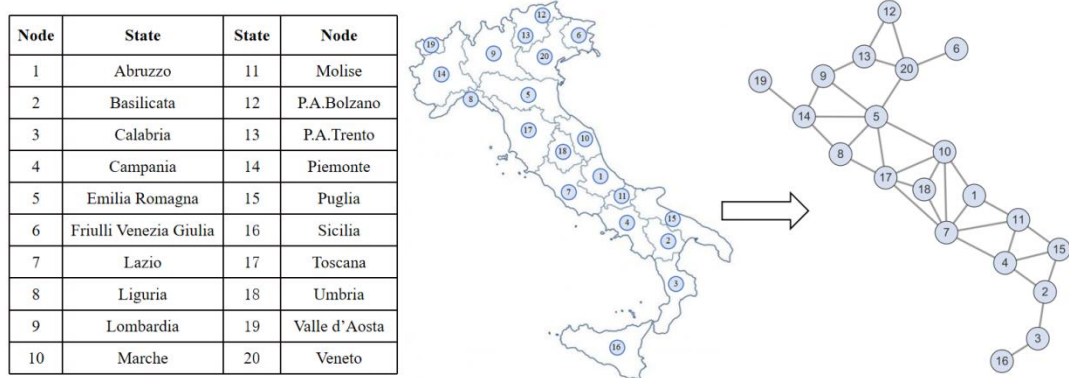


Figure S2: The country network of Italy. Based on the adjacency information of the geographic location, we can construct a regional network of Italy with 21 nodes and 34 edges. Each node represents a province or state and the edge represents the geographical adjacency between the two nodes or states. The detailed list of correspondences between regions/autonomous provinces and nodes is shown in Figure S2.

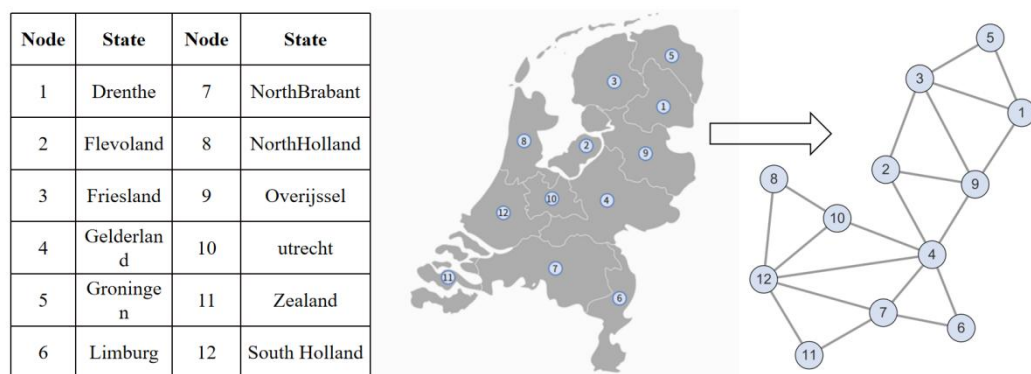


Figure S3: The country network of Netherlands. Based on the adjacency information of the geographic location, we can construct a regional network of Netherlands with 12 nodes and 20 edges. Each node represents a province or state and the edge represents the geographical adjacency between the two nodes or states. The

detailed list of correspondences between regions/autonomous provinces and nodes is shown in Figure S3.

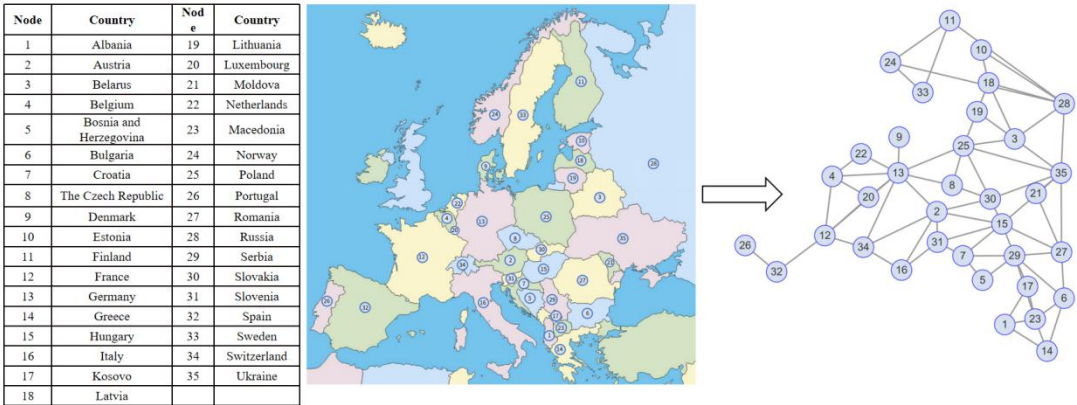


Figure S4: The regional network of Europe. Based on the adjacency information of the geographic location, we can construct a regional network of Europe with 35 nodes and 69 edges. Each node represents a country and the edge represents the geographical adjacency between the two nodes (or countries).The detailed list of correspondences between regions/autonomous provinces and nodes is shown in Figure S4.

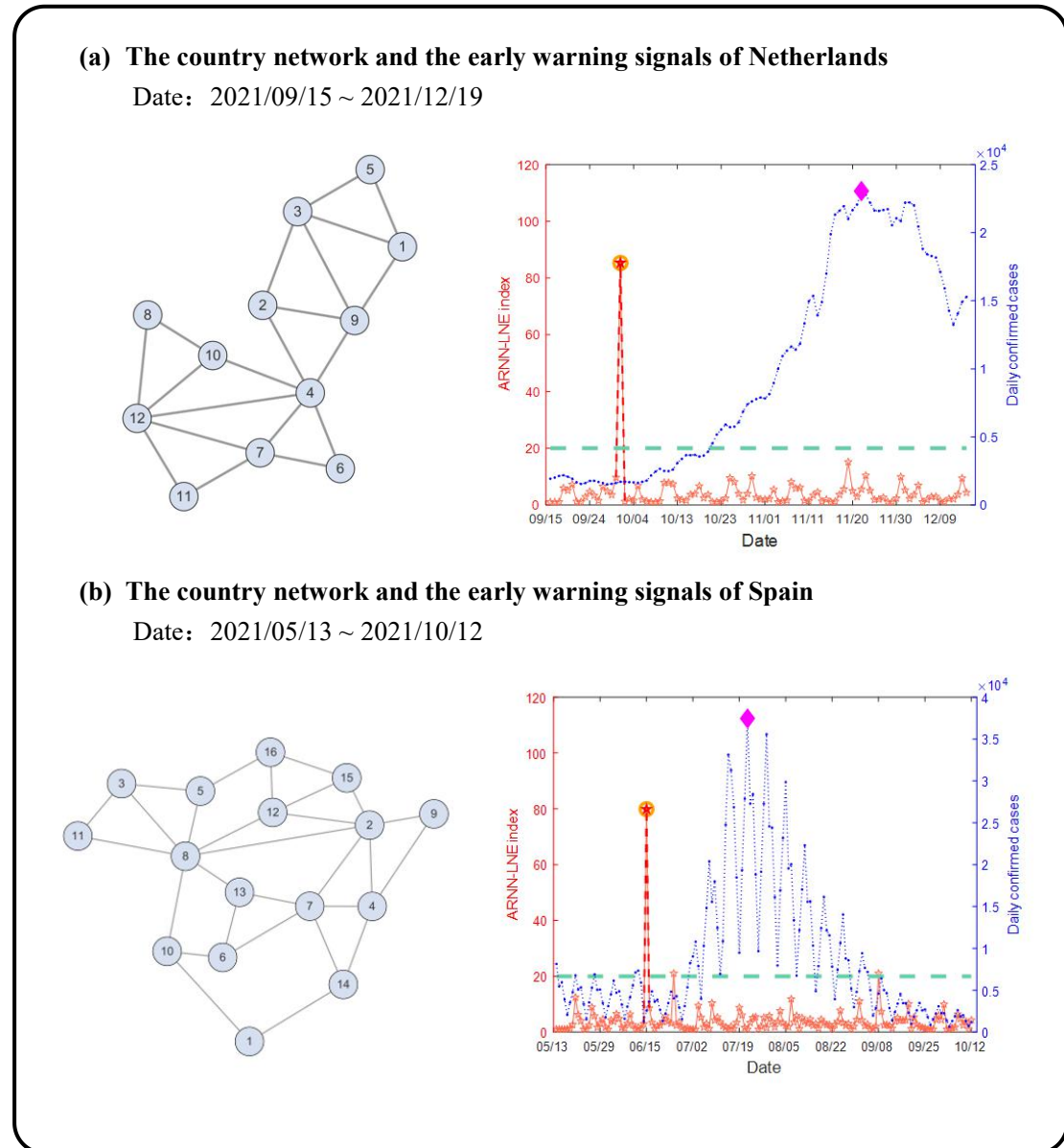


Figure S5: The early signals of Covid-19 in Netherlands and Spain.

(a).For Netherlands, based on the adjacency information of the geographic location, we can construct a regional network with 12 nodes and 20 edges. As can be seen from Figure S5.(a), a yellow warning signal was given on October 1st, which indicates that the new Covid-19 epidemic would be entering an outbreak stage. As a matter of fact, the Dutch government announced new Covid-19 prevention and control measures on September 25, lifting most of the prevention and control measures. With the relaxation of prevention and control measures, the number of new confirmed cases of

new Covid-19 in Netherlands increased rapidly, reaching an average of more than 5,000 cases per day by late October as shown in the blue curve in Figure S5.(a) and the number of new hospital admissions and severe cases also increased significantly. **(b).**For Spain, we collected the daily new Covid-19 epidemic data from May 13th in 2021 to October 12th in 2021.it can be seen from Figure S5.(b) that an early warning signal can be obtained by ARNN-LNE algorithm on June 13, indicating that Spain will soon enter the outbreak phase of the new crown epidemic in the future. Actually, despite the strong progress of the vaccination campaign, Spain began to enter a new round of the epidemic in early July. Since Spain vaccinates by age group, most young people were not vaccinated. At the end of June, the government gradually lifted some epidemic prevention measures. Frequent social activities among young people exacerbated the spread of the new Covid-19 virus. The number of new Covid-19 cases per day in Spain had been steadily rising since late June and the overall trend showed an explosive growth, reaching a peak in early August, as shown in the blue curve in Figure S5.(b).