Two general models for the analysis of the dynamics of COVID-19 in several countries

Results in June 6, 2020

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Two simple models (see Annex) were applied to various countries with data of daily new cases provided in: https://www.ecdc.europa.eu/en/publications-data/download-todays-data-geographic-distribution-covid-19-cases-worldwide.

Results for China and South Korea show that the episodes are practically controlled, even if new episodes might always occur. For Iran the numbers are now increasing after a first decrease. The second model is not able to capture these two episodes. The values for Turkey show a decrease. The numbers are still increasing in Pakistan and India, and the curve seems already started to level or to decrease in Ukraine and Russia (Figure 1).

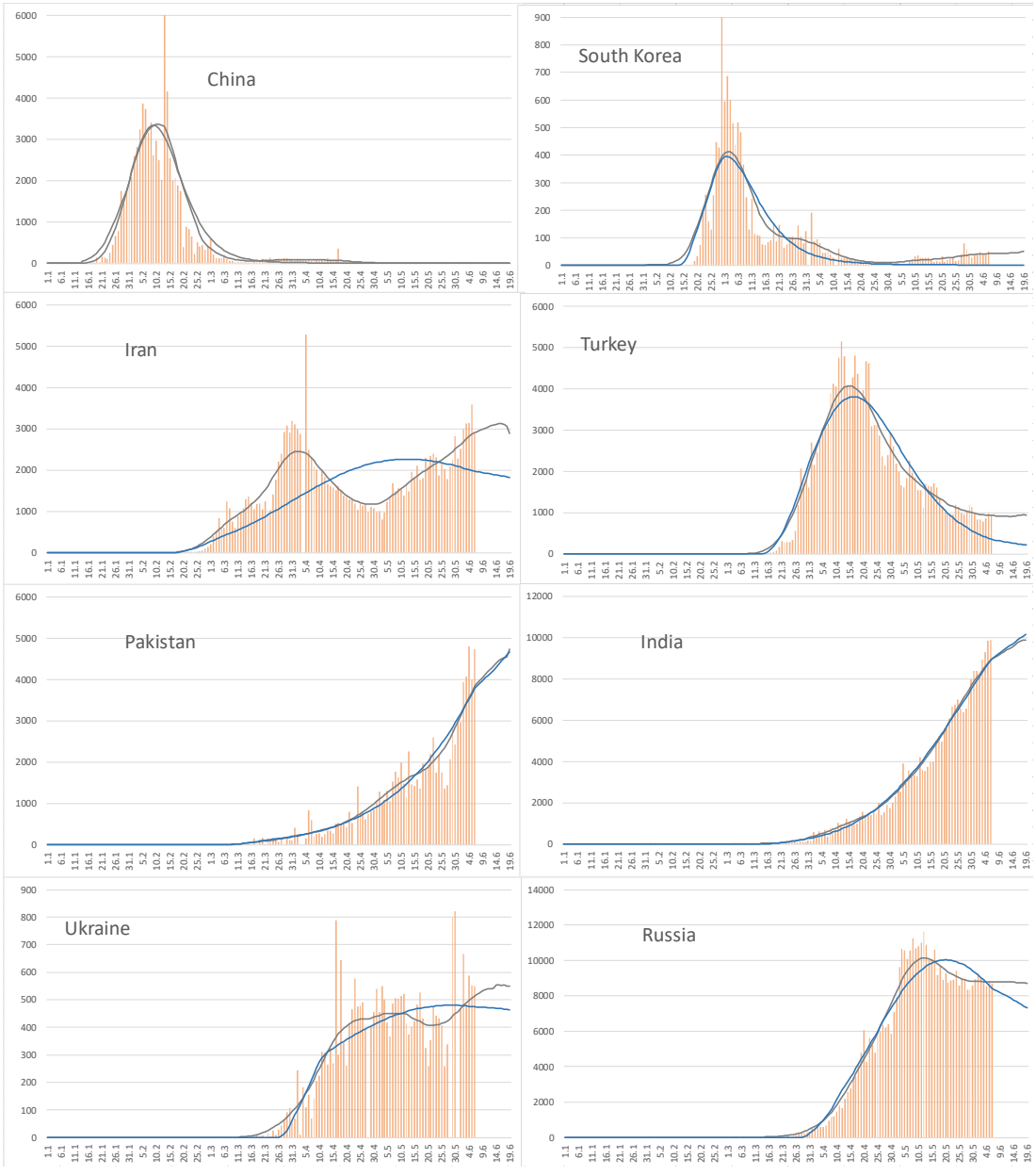

Figure 1. Observed and estimated cases in China, South Korea, Iran, Turkey, Pakistan, India, Ukraine and Russia.

The same analysis was done in other continents with more recent episodes, from North to South America and Australia. The numbers are already decreasing but not very rapidly in the USA and Canada, they are still increasing rapidly in Mexico, and show a tendency to slow down in Peru, Brasil, and Chile. In Argentina there is a strong increase. In Australia the episode already occurred for a long time and the numbers are very small (Figure 2).

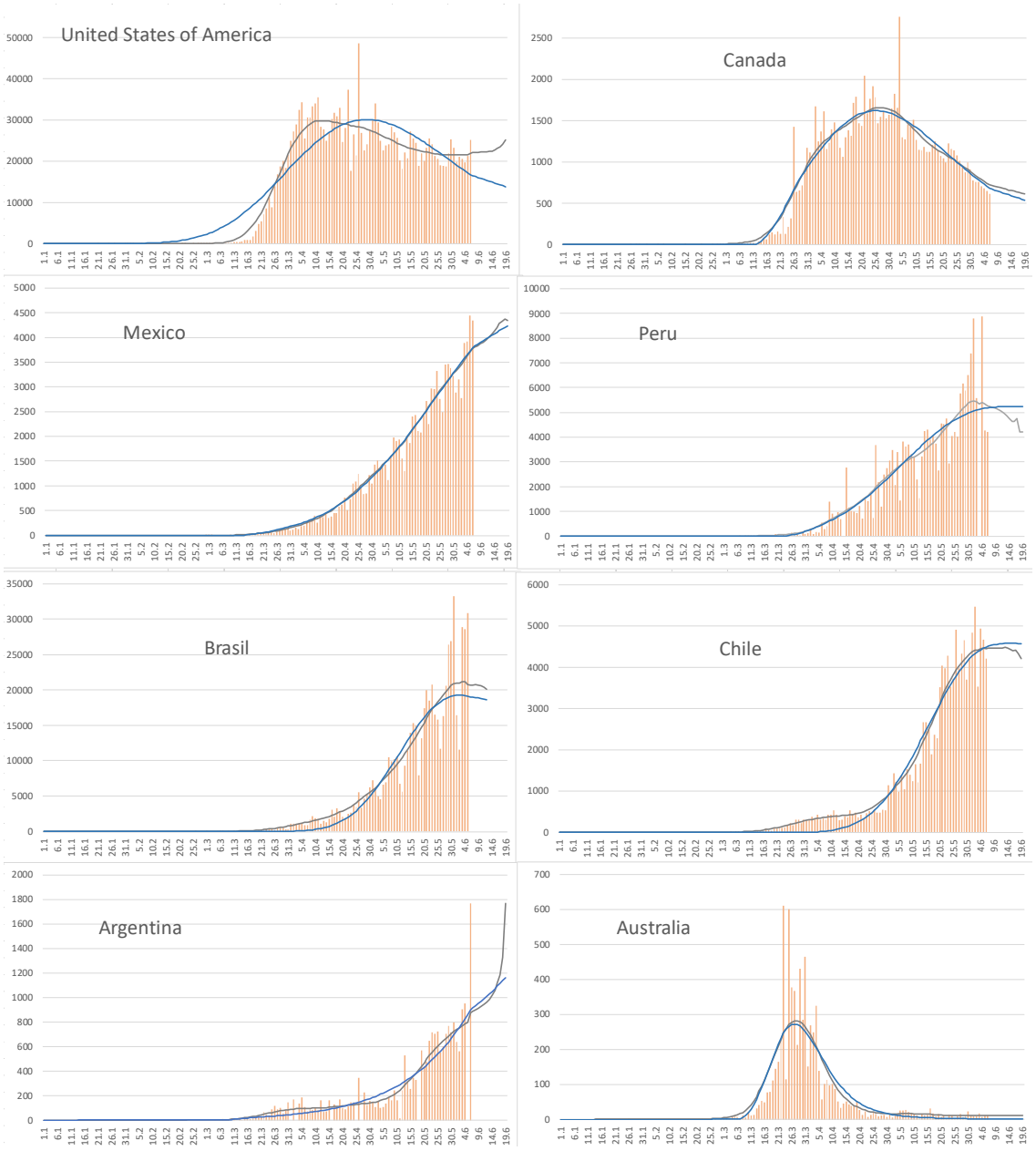

Figure 2. Observed and estimated cases in some countries from North to South America and Australia.

In Western Europe, the number of cases decreased significantly in most countries at various rates, with the exception for Sweden (Figure 3).

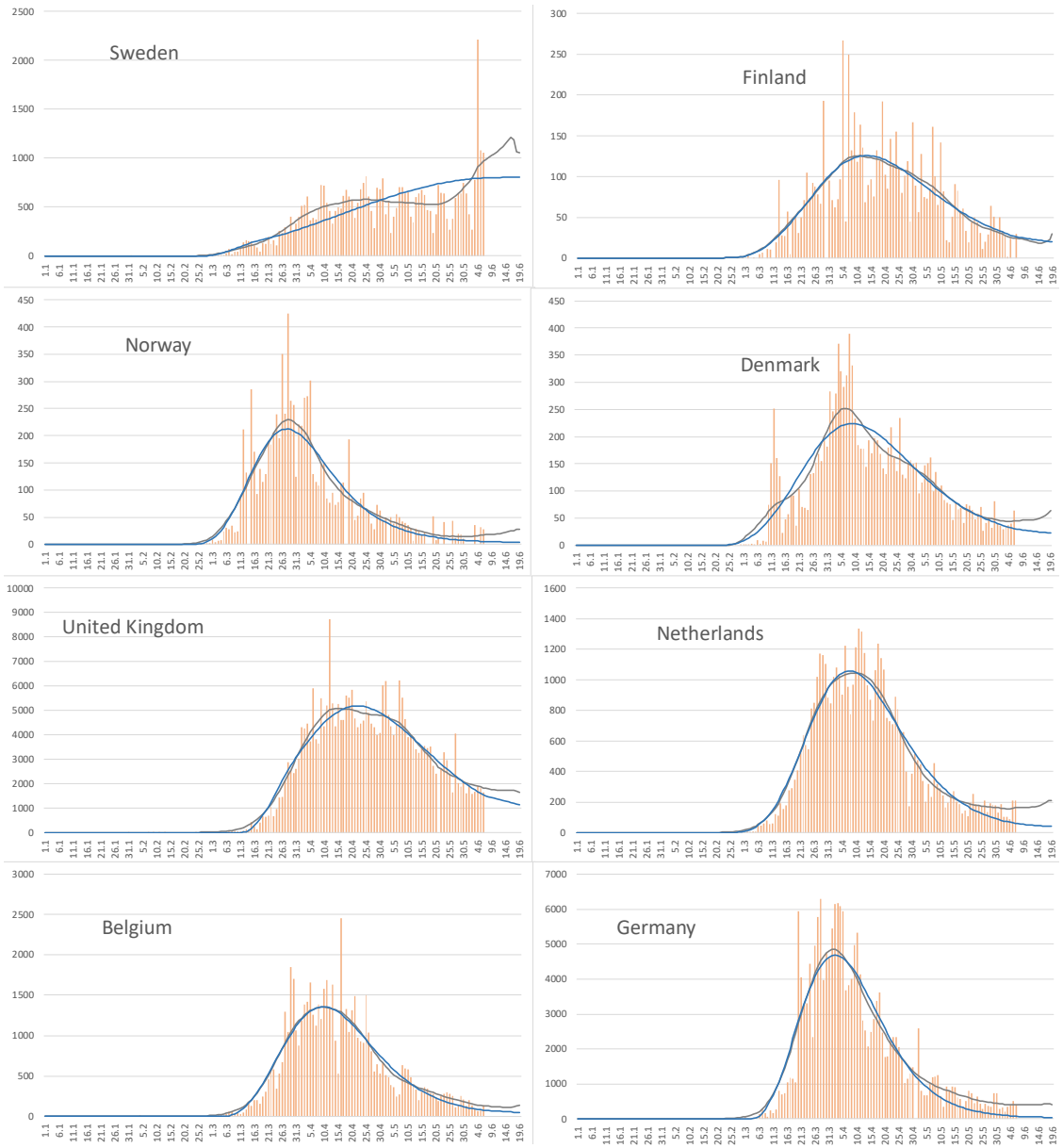

Figure 3. Observed and estimated cases in North and Central Europe.

Finally, the analysis of the situations in Southern Europe including Switzerland. The number of cases already decreased significantly in all cases but less clearly in Portugal where the two models diverge (Figure 4).

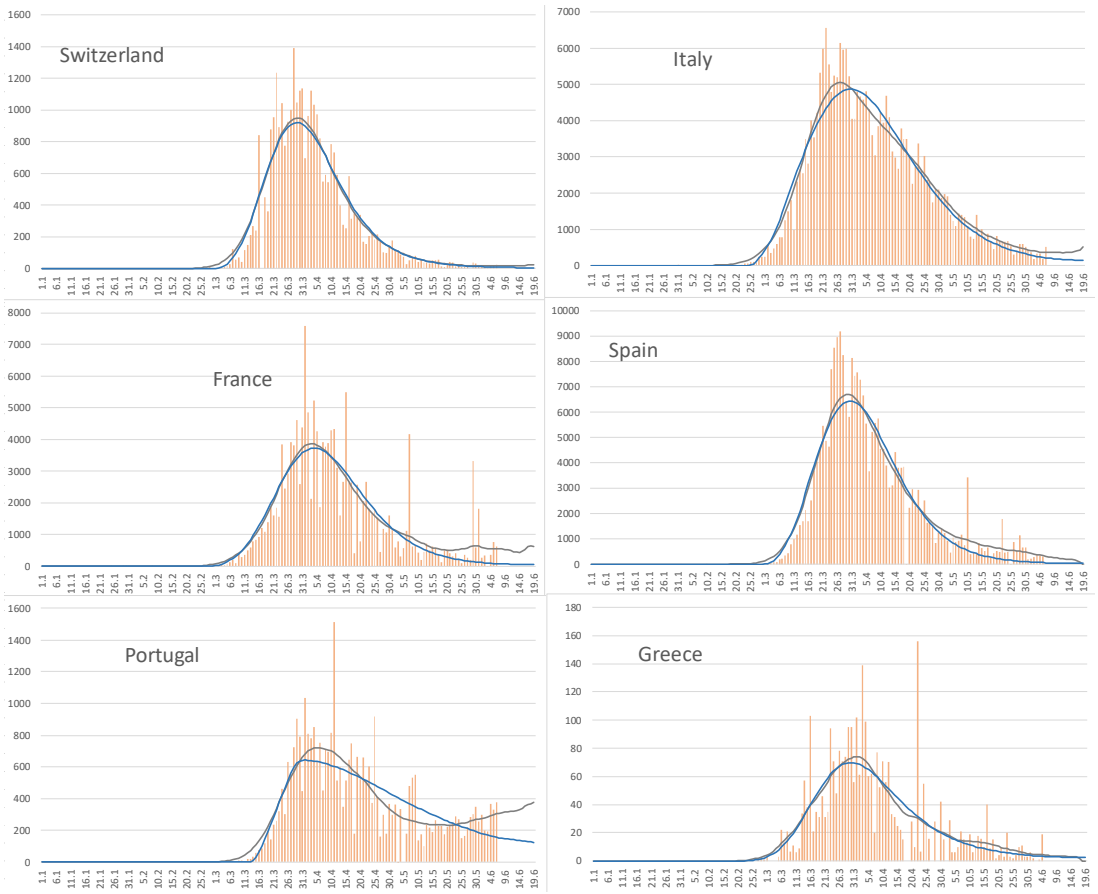

Figure 4. Observed and estimated symptomatic cases and number of infections in Southern Europe.

Annex: The two models

1. The first model is simply a reciprocal averaging system. The number of infections is estimated from the number of new cases by the moving average of the cases of the following 14 days. Then, the number of estimated cases, including the projection, is estimated from the moving average of estimated infections of the previous 14 days. This is a special smoothing procedure. The model is sensitive to changes in the trends and it is more adjusted when there are multiple episodes, as in Iran, or in general when the conditions are greatly changing through time;

2. The second model adjusts a global equation to the whole episode from the estimated number of infections (N) calculated as in model 1 from the moving average of the number of cases of following 14 days.

   The equation used was of the form:

$$N = (a)^{(t-i)\,(b\,)^{t-j}}$$

The coefficients are interpreted as the initial infection rate (a) starting in time t=i, and a reaction rate (b where 1 represents no reaction) starting at time t=j. This equation implies that t>i and j>i. The values of the coefficients a, b, i, and j, together with the coefficient of determination R^2 are presented for various countries in the table below. After adjusting the estimated number of infections, the number of cases is obtained from the moving average of the estimated number of infections of the previous 14 days.

Table 1. Coefficients of the equation for model 2 for various countries.

País	a	b	i	j	R^2
Argentina	1,056	0,999	1	66	0,945
Australia	1,698	0,956	58	66	0,978
Belgium	1,402	0,978	49	65	0,992
Brazil	1,418	0,987	74	82	0,942
Canada	1,197	0,987	34	71	0,993
Chile	1,306	0,987	78	92	0,989
China	2,353	0,960	8	12	0,972
Denmark	1,316	0,980	44	54	0,954
Finland	1,276	0,980	47	57	0,992
France	1,540	0,977	46	58	0,969
Germany	1,469	0,976	45	63	0,983
Greece	1,495	0,969	51	53	0,977
India	1,156	0,993	38	73	0,999
Iran	1,134	0,992	1	48	0,633
Italy	1,330	0,982	29	55	0,983
Mexico	1,139	0,993	36	71	0,999
Netherlands	1,440	0,978	47	58	0,986
Norway	1,455	0,971	47	56	0,980
Pakistan	1,078	0,997	1	67	0,994
Peru	1,183	0,991	46	82	0,986
Portugal	1,104	0,988	1	73	0,893
Russia	1,228	0,988	50	87	0,988
South Korea	1,470	0,962	28	44	0,933
Spain	1,527	0,975	44	60	0,984
Sweden	1,093	0,994	1	59	0,866
Switzerland	1,569	0,970	50	61	0,996
Turkey	1,364	0,980	51	73	0,963
Ukraine	1,075	0,993	1	86	0,963
United Kingdom	1,236	0,986	35	71	0,986
United States of America	1,337	0,990	11	11	0,924