Mortality from COVID

Danny Wong

19/03/2020

## Mortality Models from COVID-19

.

We would like to see what the mortality might be going forward. We can do a log transformation of the total deaths and regress against the Days since 10 deaths.

Table 1: Coefficients of linear regression models for log(DEATHS) against DAYS since 10 deaths.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Country.Region | term | estimate | std.error | statistic | p.value |
| France | (Intercept) | 1.164 | 0.03799 | 30.63 | 3.227e-11 |
| France | Days | 0.1142 | 0.005851 | 19.52 | 2.722e-09 |
| Germany | (Intercept) | 1.09 | 0.01126 | 96.73 | 0.0001069 |
| Germany | Days | 0.01043 | 0.006021 | 1.732 | 0.2254 |
| Italy | (Intercept) | 1.04 | 0.03259 | 31.91 | 2.8e-19 |
| Italy | Days | 0.1183 | 0.002537 | 46.61 | 1.092e-22 |
| South Korea | (Intercept) | 1.131 | 0.03071 | 36.84 | 1.443e-20 |
| South Korea | Days | 0.0424 | 0.002391 | 17.73 | 4.095e-14 |
| Spain | (Intercept) | 1.42 | 0.03385 | 41.96 | 1.147e-10 |
| Spain | Days | 0.156 | 0.00634 | 24.61 | 7.949e-09 |
| Switzerland | (Intercept) | 1.035 | 0.01962 | 52.75 | 1.5e-05 |
| Switzerland | Days | 0.07265 | 0.008011 | 9.068 | 0.002833 |
| United Kingdom | (Intercept) | 0.9483 | 0.05511 | 17.21 | 1.214e-05 |
| United Kingdom | Days | 0.179 | 0.01528 | 11.71 | 7.971e-05 |
| United States | (Intercept) | 0.9947 | 0.018 | 55.26 | 8.223e-17 |
| United States | Days | 0.07853 | 0.002188 | 35.89 | 2.172e-14 |

Table 2: Fit statistics of linear regression models for log(DEATHS) against DAYS since 10 deaths. (continued below)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Country.Region | r.squared | adj.r.squared | sigma | statistic | p.value |
| France | 0.9744 | 0.9719 | 0.06997 | 381 | 2.722e-09 |
| Germany | 0.6 | 0.4 | 0.01346 | 3 | 0.2254 |
| Italy | 0.9904 | 0.99 | 0.08071 | 2173 | 1.092e-22 |
| South Korea | 0.9374 | 0.9344 | 0.07605 | 314.5 | 4.095e-14 |
| Spain | 0.987 | 0.9853 | 0.05759 | 605.5 | 7.949e-09 |
| Switzerland | 0.9648 | 0.9531 | 0.02533 | 82.23 | 0.002833 |
| United Kingdom | 0.9648 | 0.9578 | 0.08088 | 137.2 | 7.971e-05 |
| United States | 0.99 | 0.9892 | 0.03662 | 1288 | 2.172e-14 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| df | logLik | AIC | BIC | deviance | df.residual |
| 2 | 15.98 | -25.97 | -24.51 | 0.04896 | 10 |
| 2 | 12.94 | -19.88 | -21.72 | 0.0003625 | 2 |
| 2 | 26.3 | -46.6 | -43.19 | 0.1368 | 21 |
| 2 | 27.67 | -49.33 | -45.93 | 0.1215 | 21 |
| 2 | 15.47 | -24.94 | -24.03 | 0.02653 | 8 |
| 2 | 12.56 | -19.12 | -20.29 | 0.001925 | 3 |
| 2 | 8.849 | -11.7 | -11.86 | 0.0327 | 5 |
| 2 | 29.4 | -52.79 | -50.67 | 0.01743 | 13 |

Table 3: Coefficients of linear regression models for log(DEATHS\_PER\_CAPITA) against Days since 10 deaths.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Country.Region | term | estimate | std.error | statistic | p.value |
| France | (Intercept) | -1.662 | 0.03799 | -43.75 | 9.351e-13 |
| France | Days | 0.1142 | 0.005851 | 19.52 | 2.722e-09 |
| Germany | (Intercept) | -1.829 | 0.01126 | -162.4 | 3.792e-05 |
| Germany | Days | 0.01043 | 0.006021 | 1.732 | 0.2254 |
| Italy | (Intercept) | -1.741 | 0.03259 | -53.43 | 6.363e-24 |
| Italy | Days | 0.1183 | 0.002537 | 46.61 | 1.092e-22 |
| South Korea | (Intercept) | -1.582 | 0.03071 | -51.5 | 1.368e-23 |
| South Korea | Days | 0.0424 | 0.002391 | 17.73 | 4.095e-14 |
| Spain | (Intercept) | -1.249 | 0.03385 | -36.92 | 3.18e-10 |
| Spain | Days | 0.156 | 0.00634 | 24.61 | 7.949e-09 |
| Switzerland | (Intercept) | -0.8951 | 0.01962 | -45.61 | 2.32e-05 |
| Switzerland | Days | 0.07265 | 0.008011 | 9.068 | 0.002833 |
| United Kingdom | (Intercept) | -1.874 | 0.05511 | -34.01 | 4.13e-07 |
| United Kingdom | Days | 0.179 | 0.01528 | 11.71 | 7.971e-05 |
| United States | (Intercept) | -2.52 | 0.018 | -140 | 4.745e-22 |
| United States | Days | 0.07853 | 0.002188 | 35.89 | 2.172e-14 |

Table 4: Fit statistics of linear regression models for log(DEATHS) against DAYS since 10 deaths. (continued below)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Country.Region | r.squared | adj.r.squared | sigma | statistic | p.value |
| France | 0.9744 | 0.9719 | 0.06997 | 381 | 2.722e-09 |
| Germany | 0.6 | 0.4 | 0.01346 | 3 | 0.2254 |
| Italy | 0.9904 | 0.99 | 0.08071 | 2173 | 1.092e-22 |
| South Korea | 0.9374 | 0.9344 | 0.07605 | 314.5 | 4.095e-14 |
| Spain | 0.987 | 0.9853 | 0.05759 | 605.5 | 7.949e-09 |
| Switzerland | 0.9648 | 0.9531 | 0.02533 | 82.23 | 0.002833 |
| United Kingdom | 0.9648 | 0.9578 | 0.08088 | 137.2 | 7.971e-05 |
| United States | 0.99 | 0.9892 | 0.03662 | 1288 | 2.172e-14 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| df | logLik | AIC | BIC | deviance | df.residual |
| 2 | 15.98 | -25.97 | -24.51 | 0.04896 | 10 |
| 2 | 12.94 | -19.88 | -21.72 | 0.0003625 | 2 |
| 2 | 26.3 | -46.6 | -43.19 | 0.1368 | 21 |
| 2 | 27.67 | -49.33 | -45.93 | 0.1215 | 21 |
| 2 | 15.47 | -24.94 | -24.03 | 0.02653 | 8 |
| 2 | 12.56 | -19.12 | -20.29 | 0.001925 | 3 |
| 2 | 8.849 | -11.7 | -11.86 | 0.0327 | 5 |
| 2 | 29.4 | -52.79 | -50.67 | 0.01743 | 13 |

Table 5: Coefficients of linear regression models for log(CASES) against DAYS since 100 cases.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Country.Region | term | estimate | std.error | statistic | p.value |
| France | (Intercept) | 2.054 | 0.0283 | 72.59 | 1.238e-22 |
| France | Days | 0.1127 | 0.002686 | 41.96 | 1.308e-18 |
| Germany | (Intercept) | 2.045 | 0.02757 | 74.18 | 8.583e-23 |
| Germany | Days | 0.1085 | 0.002617 | 41.46 | 1.601e-18 |
| Italy | (Intercept) | 2.414 | 0.04533 | 53.26 | 1.352e-25 |
| Italy | Days | 0.09645 | 0.003238 | 29.79 | 7.092e-20 |
| Portugal | (Intercept) | 2.07 | 0.01261 | 164.1 | 8.273e-09 |
| Portugal | Days | 0.1484 | 0.004166 | 35.61 | 3.713e-06 |
| South Korea | (Intercept) | 2.835 | 0.08598 | 32.97 | 9.643e-23 |
| South Korea | Days | 0.05228 | 0.005465 | 9.567 | 5.287e-10 |
| Spain | (Intercept) | 2.038 | 0.03065 | 66.49 | 5.972e-20 |
| Spain | Days | 0.1384 | 0.003267 | 42.36 | 4.989e-17 |
| Switzerland | (Intercept) | 2.31 | 0.02233 | 103.4 | 8.63e-18 |
| Switzerland | Days | 0.1026 | 0.003159 | 32.5 | 2.793e-12 |
| United Kingdom | (Intercept) | 2.091 | 0.01764 | 118.5 | 8.716e-20 |
| United Kingdom | Days | 0.1012 | 0.002306 | 43.88 | 1.276e-14 |
| United States | (Intercept) | 2.007 | 0.01178 | 170.4 | 4.498e-26 |
| United States | Days | 0.1215 | 0.001256 | 96.78 | 2.167e-22 |

Table 6: Fit statistics of linear regression models for log(CASES) against DAYS since 100 cases. (continued below)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Country.Region | r.squared | adj.r.squared | sigma | statistic | p.value |
| France | 0.9904 | 0.9899 | 0.06413 | 1761 | 1.308e-18 |
| Germany | 0.9902 | 0.9896 | 0.06248 | 1719 | 1.601e-18 |
| Italy | 0.9747 | 0.9736 | 0.1167 | 887.3 | 7.092e-20 |
| Portugal | 0.9969 | 0.9961 | 0.01743 | 1268 | 3.713e-06 |
| South Korea | 0.7788 | 0.7703 | 0.2336 | 91.53 | 5.287e-10 |
| Spain | 0.9917 | 0.9912 | 0.06599 | 1794 | 4.989e-17 |
| Switzerland | 0.9897 | 0.9888 | 0.04261 | 1056 | 2.793e-12 |
| United Kingdom | 0.9938 | 0.9933 | 0.03478 | 1926 | 1.276e-14 |
| United States | 0.9984 | 0.9983 | 0.02536 | 9366 | 2.167e-22 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| df | logLik | AIC | BIC | deviance | df.residual |
| 2 | 26.29 | -46.58 | -43.74 | 0.06991 | 17 |
| 2 | 26.78 | -47.56 | -44.73 | 0.06637 | 17 |
| 2 | 19.26 | -32.52 | -28.87 | 0.3135 | 23 |
| 2 | 17 | -28 | -28.63 | 0.001215 | 4 |
| 2 | 2.023 | 1.953 | 5.95 | 1.419 | 26 |
| 2 | 23.15 | -40.3 | -37.8 | 0.06532 | 15 |
| 2 | 23.66 | -41.33 | -39.63 | 0.01997 | 11 |
| 2 | 28.23 | -50.47 | -48.55 | 0.01452 | 12 |
| 2 | 39.41 | -72.82 | -70.32 | 0.009648 | 15 |

Table 3: Coefficients of linear regression models for log(CASES\_PER\_CAPITA) against DAYS since 100 cases.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Country.Region | term | estimate | std.error | statistic | p.value |
| France | (Intercept) | -1.662 | 0.03799 | -43.75 | 9.351e-13 |
| France | Days | 0.1142 | 0.005851 | 19.52 | 2.722e-09 |
| Germany | (Intercept) | -1.829 | 0.01126 | -162.4 | 3.792e-05 |
| Germany | Days | 0.01043 | 0.006021 | 1.732 | 0.2254 |
| Italy | (Intercept) | -1.741 | 0.03259 | -53.43 | 6.363e-24 |
| Italy | Days | 0.1183 | 0.002537 | 46.61 | 1.092e-22 |
| South Korea | (Intercept) | -1.582 | 0.03071 | -51.5 | 1.368e-23 |
| South Korea | Days | 0.0424 | 0.002391 | 17.73 | 4.095e-14 |
| Spain | (Intercept) | -1.249 | 0.03385 | -36.92 | 3.18e-10 |
| Spain | Days | 0.156 | 0.00634 | 24.61 | 7.949e-09 |
| Switzerland | (Intercept) | -0.8951 | 0.01962 | -45.61 | 2.32e-05 |
| Switzerland | Days | 0.07265 | 0.008011 | 9.068 | 0.002833 |
| United Kingdom | (Intercept) | -1.874 | 0.05511 | -34.01 | 4.13e-07 |
| United Kingdom | Days | 0.179 | 0.01528 | 11.71 | 7.971e-05 |
| United States | (Intercept) | -2.52 | 0.018 | -140 | 4.745e-22 |
| United States | Days | 0.07853 | 0.002188 | 35.89 | 2.172e-14 |

Table 4: Fit statistics of linear regression models for log(CASES) against DAYS since 100 cases. (continued below)

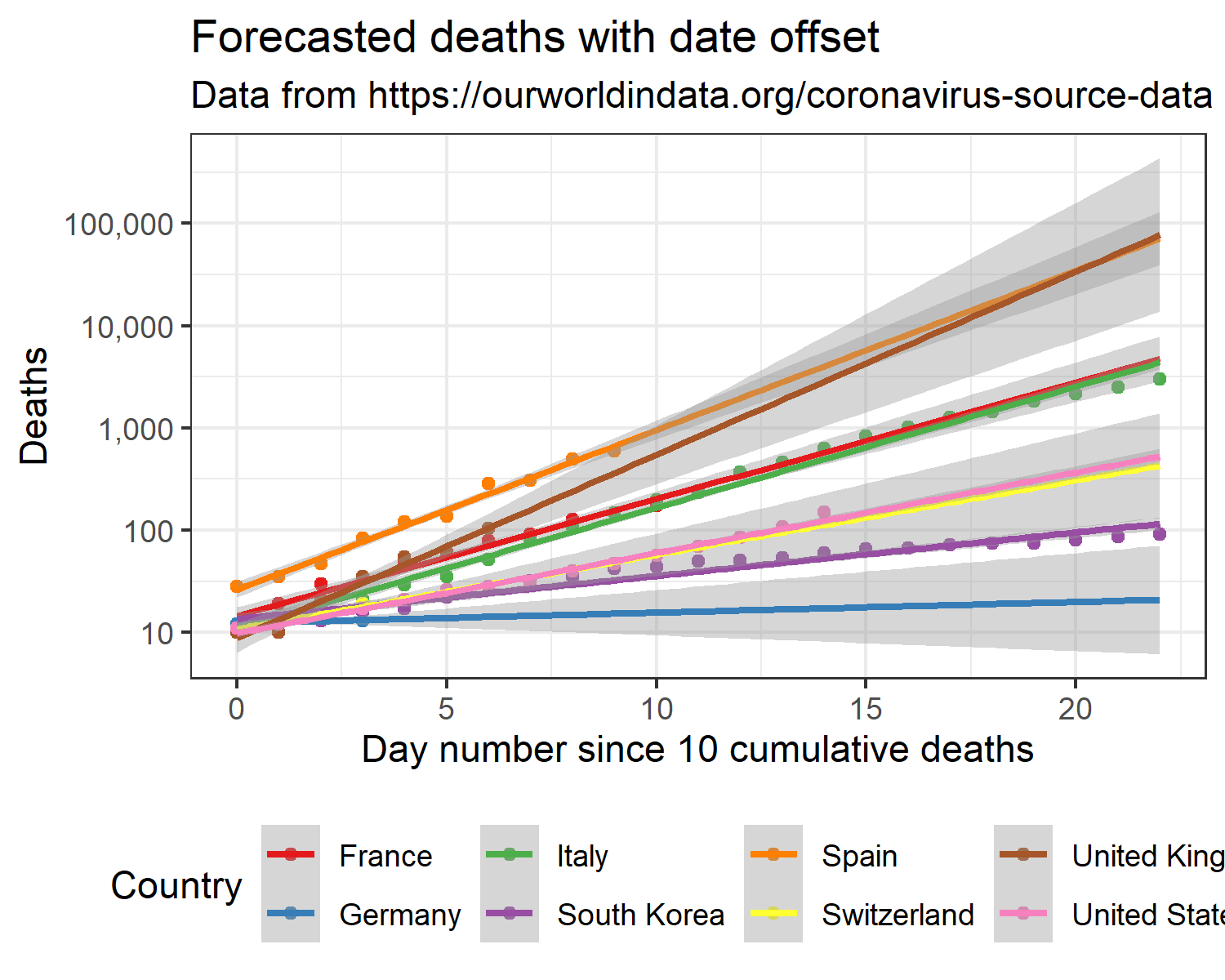
|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Country.Region | r.squared | adj.r.squared | sigma | statistic | p.value |
| France | 0.9744 | 0.9719 | 0.06997 | 381 | 2.722e-09 |
| Germany | 0.6 | 0.4 | 0.01346 | 3 | 0.2254 |
| Italy | 0.9904 | 0.99 | 0.08071 | 2173 | 1.092e-22 |
| South Korea | 0.9374 | 0.9344 | 0.07605 | 314.5 | 4.095e-14 |
| Spain | 0.987 | 0.9853 | 0.05759 | 605.5 | 7.949e-09 |
| Switzerland | 0.9648 | 0.9531 | 0.02533 | 82.23 | 0.002833 |
| United Kingdom | 0.9648 | 0.9578 | 0.08088 | 137.2 | 7.971e-05 |
| United States | 0.99 | 0.9892 | 0.03662 | 1288 | 2.172e-14 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| df | logLik | AIC | BIC | deviance | df.residual |
| 2 | 15.98 | -25.97 | -24.51 | 0.04896 | 10 |
| 2 | 12.94 | -19.88 | -21.72 | 0.0003625 | 2 |
| 2 | 26.3 | -46.6 | -43.19 | 0.1368 | 21 |
| 2 | 27.67 | -49.33 | -45.93 | 0.1215 | 21 |
| 2 | 15.47 | -24.94 | -24.03 | 0.02653 | 8 |
| 2 | 12.56 | -19.12 | -20.29 | 0.001925 | 3 |
| 2 | 8.849 | -11.7 | -11.86 | 0.0327 | 5 |
| 2 | 29.4 | -52.79 | -50.67 | 0.01743 | 13 |

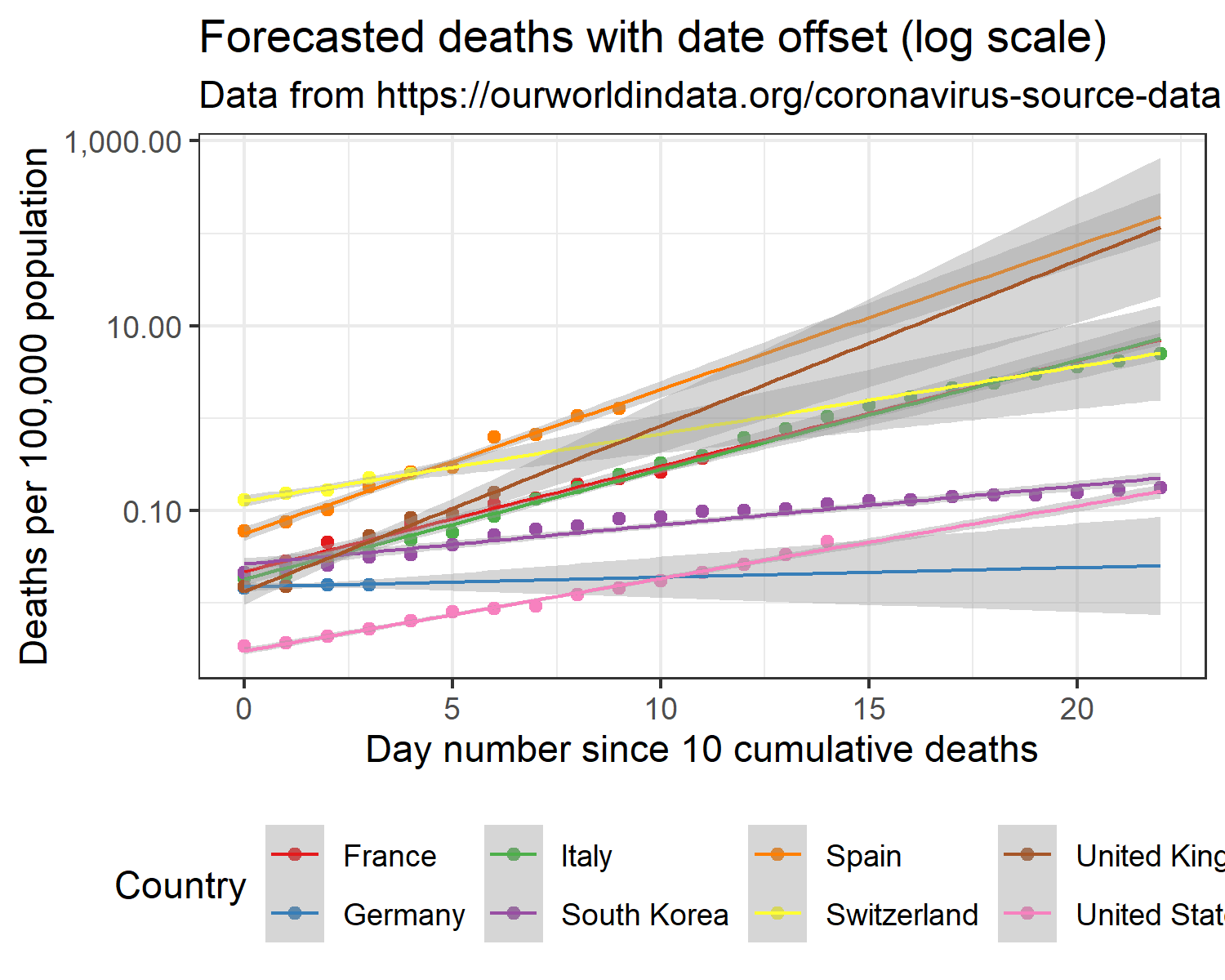
## Plots

Now we can plot the data and the models.

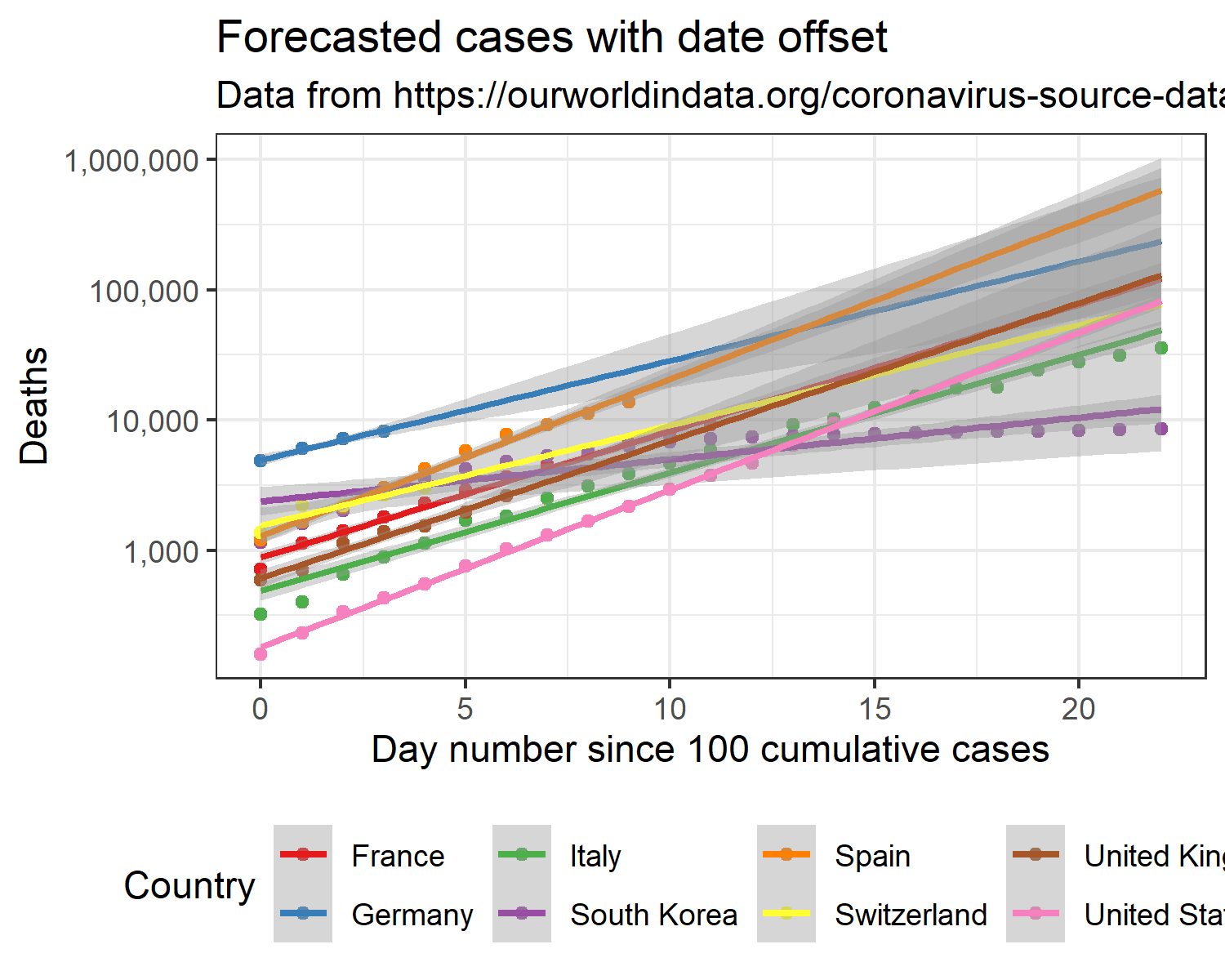
### Deaths



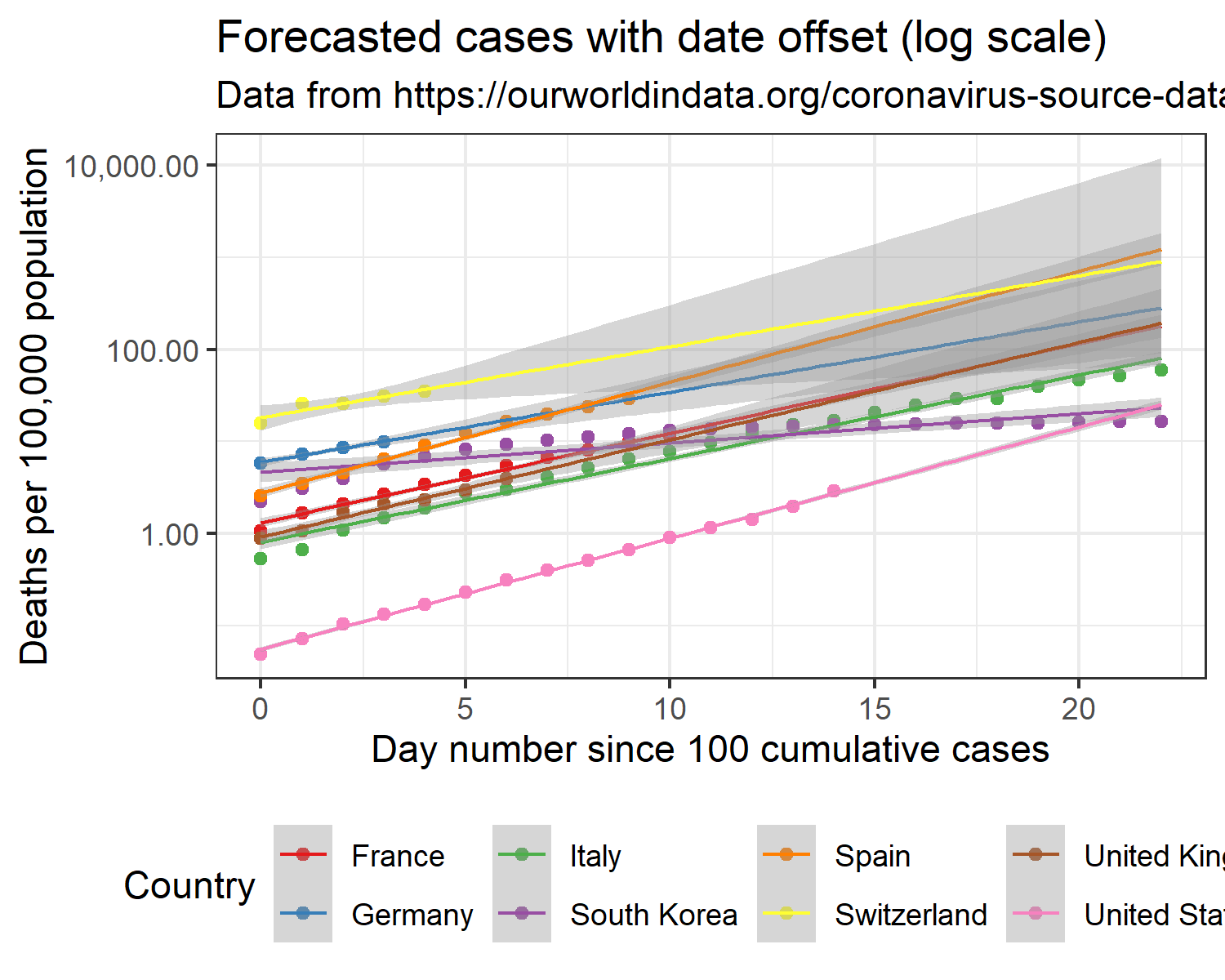
### Deaths Per Capita



### Cases



### Cases Per Capita



### Result Table

Results Table 1: Daily rate of increase of deaths and cases per capita for each country analysed. The United Kingdom shows a daily rate of increase in the number of deaths per 100,000 population of 51.0199071487831%, based on our model.

|  |  |  |
| --- | --- | --- |
| Country.Region | Daily increases in Deaths per 100,000 population (%) | Daily increases in Cases per 100,000 population (%) |
| United Kingdom | 51.02 | 26.24 |
| Spain | 43.22 | 37.52 |
| Italy | 31.3 | 24.87 |
| France | 30.08 | 29.63 |
| United States | 19.82 | 32.29 |
| Switzerland | 18.21 | 26.66 |
| South Korea | 10.25 | 12.79 |
| Germany | 2.43 | 28.39 |