**Notes on A Daily Model for COVID-19 V2.2 applied to the UK.**

1 In “A daily model for infections such as Covid-19, Version 2.2” I described my daily model for COVID-19 and how to use the accompanying Excel file. I have now done some experiments with the UK data in another Excel file “CV19DailyModel-UK-02.xlsx” and I explain what I have done.

2 First, I have used a very useful data source published by the European Centre for Disease Control at:

<https://www.ecdc.europa.eu/en/publications-data/download-todays-data-geographic-distribution-covid-19-cases-worldwide>

I transform this data into a tidy format, in “COVID-19-Countries-2020-03-25.xlsx”, which gives the ECDC data up to the latest date, for example “25 March 2020”. This is one day behind the published UK data, so their data for 25 March was published in the UK on 24 March, and may well apply to actual cases and deaths that took place on 23 March.. Other countries may have similar delays.

3 I copy the ECDC data for the UK into worksheet “Comparisons” in my workbook “Cv19DailyModel-ADW-02.xlsx”, adjusting it so that starts on what ECDC calls 29 January 2020, placed in Columns B to I.

4 I then set up my model in worksheet “CalculationsUK01” and in Columns K to R of “Comparisons” I copy the relevant items from the calculations. These are New Cases from column N of the calculations, Total Cases (including deaths) from column K, the R7 ratio for Total Cases from column L, the New Deaths from column BJ, Total Deaths from column BK, then the R7 ratio for Total Deaths from column BL and finally the Deaths as a percentage of Cases from column BM. Note that the R7 ratio is the ratio of the total number on one day divided by the corresponding number seven days earlier.

5 Then I calculate in columns T to Z of “Comparisons” the values of “100A/E”, that is the ratio of the Actual data value to that Expected by the model, expressed as a percentage. This is a standard actuarial comparison statistic. If the model fits the data well enough the ratios should be close to 100%, but because of random variation they will not be exactly so.

6 I use 21 March as the base at present, because I described it in my first note, and it gives me a few days extra for trials. I adjust the parameters in the calculations for UK01 to replicate the actual data, both on 21 March, and if possible on the way there. .This required quite lot of trial and error. The first UK cases were on 31 January, but if I put my starting unit on that date, I can’t replicate the rate of growth, the R7, later on. So I put one initial case on 15 February, by which time there were actually 9 cases recorded. However, the ECDC web site records no more cases till 24 February, by which time the model has 9.73 cases, so not so far out.

7 I assume that *j*(*d*), the intensity of infectiousness each day, is unity for *j* = 1 to 10; that is, an infected person is fully infections for the first 10 days of the disease, and not at all infectious later. I don’t know whether this is medically correct or not. A person might not pass on the infection for a day or more after being infected, and might then be fully infectious until symptoms develop and he or she is isolated. But if the sum of the *j*(*d*) values is reduced, then the infection rate *r*(*t*) needs to be increased to compensate if the observed data is to be replicated.

8 I now adjust the rate of infection, *r*(*t*), and the mortality rates, *m*(*d*), so as to replicate in the model the actual data. I start with one value of *r*(0), in cell E12, and leave the values of *r*(*t*) later and below that the same so far. I start with some number for *m*(1) in cell N6, and zero for the rest of the values. This assumes that all deaths take place at the end of the first day of infection, which is unlikely to be true, but if we delay the deaths to some later day, then we need a bigger number for *m*(*d*) to replicate the deaths that have occurred, which results in a bigger number of deaths overall.

9 I end up with 0.3 for *r*(*t*) and 0.06 for *m*(1). These are higher than I expected, and very different from other numbers I have seen quoted, but without numbers like this I cannot match the totals for 21 March, nor the rate of growth up to then. In the comparisons I get 100A/E of 101.0 for Total Cases (3,893 actual against 3,942.47 expected), which is good, and 94.1 for Total Deaths (177 against 188.19), so the model is a little high. The numbers of New Cases and New Deaths are lower than expected. The R7 for Cases is quite good, but I cannot replicate the actual R7for Deaths, which is 17.7 against my 4.96. The model has almost the same R7 figures for Deaths as for Cases.

10 One could perhaps use a formal optimising procedure for this, with some defined target to optimise, but I have not tried this yet.

11 Having fitted parameters that replicate the observed data approximately one can look ahead and see what would happen if these parameters were to continue unchanged. Going down the columns in worksheet UK01, we see that the New Cases rise to over 300,000 a day by 21 April, then start going down in a fairly symmetrical way. The numbers of New Deaths also rise to a peak about 22 April, with over 18,000 a day. Note there are about 600,000 or so deaths per year normally in the UK, or less than 2,000 a day, so these extra deaths are about 10 times the normal number.

12 The expected number of New Cases drops below 1 by 11 June. By then the total number of deaths has risen to 284,496, about 5.69% of the original population, *H*(0). There about the same number, 258,394 who remain healthy throughout. This may seem odd, but it is because of the infectiousness is limited to the first 10 days. Indeed, if one puts the values of *j*(*d*) to zero for each day except for the “over 21 days” category, still everyone, in due course, is infected.

13 With these projections it is not surprising that urgent measures are being put in place in order to try to reduce the size of the peak, and also delay it, and preferably reduce the total number of deaths. There are two parameters in the model that could affect this. One is the base rate of infection, *r*(*t*). Reducing this does spread out the peak, but does not reduce the total deaths. The other is the number of “Healthy” who are potentially exposed to infection. If this is reduced the total number of deaths is reduced correspondingly.

14 I have no knowledge of whether the measures put in place, or any further measures, will have these effects, or by how much. All I can do is look at how the numbers of cases develop. At the time of writing I now have ECDC data up to “25 March”, as shown in “Comparisons”. The New Cases in the four days 22 to 25 March are:1035, 665, 967 and 1427, taking the total to 8,077. These expected under UK01 are 1013, 1273, 1599 and 2008 with a total up to 9,825. The actual cases are a good bit lower than the expected after the first day. Perhaps the rate had reduced before the stricter measures were introduced on 23 March.

15 I put new projections into worksheet UK02 which is identical with UK01 up to 21 March. I reduce *r*(*t*) to 0.15 on 22 March and thereafter. I show alterations in bold. I put half of the value of *H*(*t*) on 21 March into *X*(*t*) for 22 March so that *H*(*t*) is halved.

16 The projected New Cases for 22 to 25 March are now: 1013 (unchanged), 635, 703, and 780 making Total cases of 7,074. So I have gone much too far with the reductions.. The reduction in *H*(*t*) makes little short-term difference, but a big long-term one, so I miss it out and reduce *r*(*t*) to 0.15 on 23 March.. The new projected cases rise to 7,912 on 25 March, so quite close to the actual. Note that after the fall because of the change in *r*(*t*), the number of New Cases rises again, but at a lower level than in UK01. I have not yet put UK02 into the Comparisons worksheet, but that could be done.

17 On the UK02 basis, the peak of the epidemic moves to early June and is at a much lower level than before. The peak is now in early June and at nearly 50,000 cases and nearly 3,000 deaths a day. Overall there are about 165,000 deaths, but over 2.2 million remain healthy/

18 I now try a cut in *H*(*t*). I copy UK02 into UK03, restore the halving of *H*(*t*), but on 23 March. The peak is again lower than in UK02, with a peak at about the same time, early June, but at about half the level of before. The number of New Case is under 25,000 a day and the number of New Deaths is under 1,500 a day. The total number of deaths is reduced to about 83,000. The number that remain Healthy is recorded as over 1.1 million, but we need to add the nearly 2.5 million taken out in March, so over 3 .5 million are unaffected (but not immune, if having the disease creates permanent immunity).

19 I emphasize that these are not forecasts, but projections on the basis of the values of the parameters chosen. We will need to see how effective the various measures put in place are. And there are various assumptions I have made that may be quite wrong. The number of hidden Covid-19 cases that have been postulated, and which I have treated as “immune”, cannot be counted and may be much lower, or zero, or much higher. If one assume that this hidden Covid-19 does not exist, and starts by putting H(0) = 67 million, with the whole population of the UK available for infection, then the results up to 21 March are quite similar, but beyond that, on the basis of UK01, we get a later peak in early May, with over 4 million New Cases a day, and about 250,000 deaths a day, with Total Deaths over 4,0000,000. This catastrophic outcome cannot be refuted on the basis of the figures so far. Depressing for us all!

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