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Further Estimations of the Likely Total Infections and Deaths Due to COVID19 in Select Countries (Version 2 dt. April 10, 2020)

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Further Estimations of the Likely Total Infections and Deaths Due to COVID19 in Select Countries (Version 2 dt. April 10, 2020)[1]

Sebastian Morris[2]

Abstract

We had earlier estimated the likely cases and deaths over the course of the pandemic for a number of countries. This was an early attempt and gave somewhat tentative results. With some 7 more days of data being now available, better estimates are possible which we bring out in this paper. As in the previous paper we use a logistic model of cumulative cases and deaths, to estimate the zero growth level of cases and deaths. We also provide an upper bound to these estimates. The earlier estimates are further reinforced, and new estimates are made for a select set of countries where the growth rates in the numbers of cases, and in deaths have begun to decline. We also give estimates of the current growth rates in cases and deaths that these countries are likely to witness.

The study as before presumes that the spread of infection is one-stage logistic process, once significant numbers of infections have taken place. This may not be true of countries which witnessed low deaths and cases. In countries that have witnessed much spread and deaths relative to their populations and with more sustainable approaches to containment may not witness significantly more deaths than what has happened thus far. This would be the case of Iran, Italy. China and Korea too with their rather highly coordinated approach despite low spread of cases and low number of deaths relative to their population would along with Iran, Italy and Denmark and Turkey would most likely not see a secondary wave of infections.

Argentina and South Africa show very high growth rate in deaths even the increase in cases have slowed down considerable. Spain has stabilized its growth in deaths to nearly zero levels bit since the cases are continuing to grow at around 5.7% the death rates could again turn positive after a while. Germany and Indonesia show continuing rise in deaths and cases at moderately high rates. Japan, Malaysia, Brazil and Singapore show low to moderate death rates, but since the rise in cases continues to be between 5 and 8%, these low(Japan) moderate growth rate in deaths are likely to continue for a while before they fall to zero. France, Sweden Australia and Thailand would see continuing growth in cases at moderate rates even though the growth in deaths continue to be at high rates.

The US most notably shows very high growth rates in both deaths and in cases indicating that the deaths at high rates are likely to continue for a while.

While estimates are made for Canada, India, Bangladesh, Russia, Mexico, UK and the Philippines, they are of limited value since it is too early for the logistic model to fit. However, all of these except Russia show high death rates and high case rates. These countries could all see continuing rise in cases before the decline in rates happen, so that their current decline in death rates even when statistically significant could change for the worse.

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[1] See the first paper in the series is https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3567776

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We have as in the previous paper used a logistic model to estimate the current growth rates, and made forecasts of the ultimate stable cases and deaths before these stop rising any further. For 26 countries (with a combined population of 3.8 billion) the total cases as on date 9th /10th April was where the logistic trend has been realized for cases, was 1.36 million. We expect the cases to rise to a maximum in the countries covered to 2.9 million.

The death trends in only 22 of the 29 countries considered had stabilized to a logistic model. In these 22 countries (with a combined population of 3.7billion) the deaths as on date were 87,472. These would surely rise to between 121,000 to 355,000 before stabilizing.

In the estimates above India most notably has not been included, since its trends have not yet stablised to a logistic unfoldment. At present it is engaged in a titanic struggle through near complete lock downs to restrict the cases and deaths to low levels. Whether this would work to quell the spread to very levels, or whether the problem explodes later is still an open question.

INTRODUCTION

Since the first paper more data has become available over the last 6 days. These added points of data as expected give further support to the use of logistic models to estimate the likely growth rates and the stable numbers of infections and deaths. However, if there is a secondary spurt following relaxation of effort, a second curve is again likely, building of a much larger base of active and contagious cases. [3]

The virulence is extremely high as evidenced by the fact that the initial growth rates before the decline in growth rates starts has been at the rate of between 14 to 20 % per day. The differences in growth rates across countries have been highlighted in the popular media and even by epidemiologists. However, what needs to be emphasized is that after some significant spread, and with testing beginning in earnest, as the cases rise to their high hundreds and thousands, there is a narrow range of growth rates, between about 10 to 23% which is expected in a logistic model as the growth rate increases and then decreases, so that when we see countries at different stages in their logistic unfoldment we see the differences in the revealed growth rates even though the parameters of the model are broadly the same.[4]

[3] Severe measures to limit the spread in some countries like India with near total lockdown would have to be carried through for considerable lengths to keep spread to the limited numbers that they are currently. However, the economic and social consequences of these measures may force it be scaled down which could results in a new wave of exponential growth and hence spread in much larger numbers than what are currently witnessed.

[4] This fairly similar parameters of the model, across so many different countries with differences in terms of social interaction, urbanization, social habits, transport systems, public places and their use, would suggest that the lockdown approach can at best allow a country to get a breather in terms of not being swamped by a very large number of serious cases. Any lockdown of the deep kind would have to be lifted, and that in itself is enough to leave hotspots that can then become the source for rapid spread during near normal activity. Extensive lockdowns cannot be on without destroying the economy and society, hence the time has come to think of strategies beyond lockouts.

Such an approach which does not try to completely lockdown a society but instead works with restrictions, social distancing, and precautions in social interaction when linked along with focus on cases that require serious attention could be far more fruitful. In any case if the infection has spread spatially with "index" cases having percolated to the main central places before the lockdown, i.e. in having gone down to the second and

METHODOLOGY

The estimate of the total number of infections and deaths, which are likely to happen though the course of the pandemic before it comes under control, could help not only governments to gear up with a sense of what they are up to, but also people and markets to make the correct anticipatory choices and responses, and more importantly calm the public, and reduce dysfunctional behavior.

The spread of the disease at the micro level would depend on a whole host of factors that are difficult to incorporate in any model. Such an approach would also require much timely and detailed data. Studies of this kind are necessary for informing action at the local level, and should have top priority among scientists and public managers analyzing and the spread.

THE LOGISTIC MODEL

Here as in the previous paper we do a quick and very gross estimate of the likely total number of cases of infection, using an aggregate statistical approach, that builds on the well-known understanding that many phenomenon (including the spread of disease, of new species, and growth in a new advantageous environment, spread of pests, growth of organs, besides other human phenomenon like new product adoption, brand penetration) follow a logistic growth equation, with marginal differences. This is because unconstrained growth is exponential but all varieties of growth (other than probably aggregate economic growth) are constrained quickly.

Thus if Y_t is the population (in our case of those infected at any time in the past), then $(\frac{1}{Y})\frac{dY}{dt} = \alpha(1 - \beta Y)$ is the differential equation that underlies the population. In steady state (when the population is not growing), the maximum value of Y reached through a process of growth from small numbers i.e. Y^{max} is given by $\frac{1}{\beta}$. Thus with data of mere COVID19 cases in a society which includes a period when the significant decline in the growth rates have happened, it is possible to estimate Y^{max}. Since societies improve their response with lockdowns and other methods to limit social contact, which affect the spread process, we can put an upper bound to the infections.[5] The method would be to estimate the following equation:

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third level of central places, the scope for lockdowns of anywhere above two weeks could be damaging while keeping alive a high probability of a bounce back when these are lifted. Ultimately, the virus will not rest unless the bulk of the society have been exposed. So the workable strategy for all countries with the state capacity to isolate and quarantine in a variety of ways all cases is to do so before the lockdowns are lifted and then to go for an orderly and phased exit from the lockdown. Without a vaccine in sight, and with high mortality continuing among the infected of those older, nothing else would seem feasible. Dramatically improved treatment strategies can change the approach to containment, reducing the need for secondary lockdowns.

Countries like India which have gone through a severe lockdown may have to rethink their strategy. Of course much more detailed analysis of the spread of the virus would be required, as also an assessment of the existing system treatment capacity and the capacity that can be quickly brought to bear to make any firm conclusions. In the next version we hope to cover both the US and India in some detail as the regional data becomes available.

[5] Of course this assumes that the efforts to contain the virus are not reduced from the present level. In societies with larger populations there could be pressures to prematurely relax the social distancing measures as the virus is contained, which then would find a fresh collection of individuals to attack. In societies with smaller populations where, no distinct sub-group has been left unaffected, relaxations may not bring back the

$(\frac{1}{Y})\frac{dY}{dt} = \ln\left(\frac{Y_t}{Y_{t-1}}\right) = \hat{\alpha} + \hat{\theta}Y_t + e_t$ where β is estimated by $-\hat{\theta}/\hat{\alpha}$. A very simple OLS can be used since the error terms are a priori known to be well behaved. Here we impose the idea of logistic growth on the phenomenon rather than let the data speak for itself[6]. The same is justified since we are sure that at the most abstract (birds eye view) any growth that starts has to be self-limiting in the biological world[7].

The data for the regressions are total number of confirmed COVID19 Cases to date, by absolute day, for nearly all countries as maintained and reported by "Our World in Data". The site has the merit that the data is organized as a readily used panel, for both deaths to date and cases to date. [8] We estimate the equation separately for each of the countries that have had significant days (after the first cases) over which the growth rate has begun to decline.

We also estimate the incremental (or current growth rates) from the model, which is superior to estimating the same as an average of the last three days' growth rate in deaths as

$$GrowthIncremental = \hat{\alpha}(1 - \hat{\beta}Y_{10thApril})$$

We report the analysis for a number of countries where the growth rate in the number of cases have begun to decline.

Some 29 countries were taken up for estimation of the parameters of both models for cases and deaths, and both are known to have logistic unfoldment.

THE RESULTS

Consider table 1 which brings out the results of the regression of the growth rates on the number of cases to estimate $\hat{\alpha}$, $\hat{\theta}$ and hence of β, the inverse of which is the lower estimate of the likely number of cases before its growth falls to zero.

Observe that the parameter $\hat{\alpha}$ varies over a rather small range of between 8.6% (Singapore) and 47% (Turkey) per day. Given the vast differences between countries in terms of urbanization, social habits, habits such as greeting and acknowledging each other, the use of public transport, the living conditions

spread if external restrictions continue. More importantly the spread of diseases has the characteristic of being a percolation phenomenon during normal times, leading to localization that is possible in percolation models. These require detailed data to be able to model. In a pandemic though a diffusion model with a rate reduction approach works best.

[6] Unlike what economists normally do. The contention here is that irrespective of the local factors that act, and the measures adopted to contain, the growth of infections would follow a logistic curve, with the parameters being depend on these measures and the variations in the potential to spread. No country's specific features can change the form of the curve.

[7] In animal populations that interact with each other, which is the reality in a complex ecosystem the population of organisms (animals, plants, bacteria and eve viruses) would vary with swings that in the abstract has been modeled as predator-prey, competition, generally giving rise to non-linear systems. Here stability of the population of a species is in the sense of Liapunov, in a dynamic non-linear system, i.e. as attractor points around which the population numbers would "orbit". Very early these systems were modeled by Volterra and Lotka. In the case of COVID19, since it is a new organism its population would rise (being paralleled by the rise in cases) to first reach a maximum after which the complex interactions would take place. Hence the validity in the use of the logistic or Verhulst equation.

[8] https://ourworldindata.org/coronavirus-data#confirmed-cases for Deaths; and https://ourworldindata.org/coronavirus-data#confirmed-cases for Confirmed cases.

and densities in urban places, and the varying actions that countries have made for containment, the widely differing approaches to testing, the overall numbers of infections as a proportion of population have varied as it must, since all diseases spread are akin to percolation. This is reflected in β of the model. However while the first parameter α in the logistic model estimated varies, it is not very large, thereby bringing home the point of the intrinsic very high virulence which society has to contend with. It also indicates that the best approach may be to isolate every case that is detected to be positive and to do the tests for all those who may have been in contact with those known to be affected. However this is easier said than done, and the US /Italy/UK like explosive realized growth (as β remains small), is likely unless many countries examine seriously the Korean and possibly Chinese models to strategize their approaches.

For those countries where the coefficients were significant with absolute t-values above 0.95 the range of the parameter $\hat{\alpha}$ is from 10 to 36% if one keeps aside Turkey for which it is as high as 47%.

In the case of the US, the likely upper bound of the infections predicted range from as high as 2.9 million in the case of the US, to the expected value of 0.9 million, when the cases have already reached 0.47 million. Canada has closely followed the US with the actual cases being nearly 21,000, and the cases expected to be between 0.1 million and 0.2 million.

The expected deaths per 1000 people (reported as a percentage) range from 0.1 to 202.4 for France, for which country the estimate is less reliable since the coefficient of θ is in absolute terms less than 1. However, the deaths that have already taken place in France amounts to 18.8% on the same measure which is close to those countries with very high rates. See Table 3

Considering only countries for which both coefficients are significant (essentially the coefficient of θ to be above 1.0) along with France, we can say that there are distinctly three groups in the set of 17 countries that qualify in terms of the expected deaths per 1000 people. Netherlands, Spain, Italy, US, UK, Sweden and France are in a very high category, even with the significant variations among them. Turkey, Iran and Germany are in an intermediate category of the rate being above 1.0% but below 10%. Others Brazil, India, Pakistan, Korea, China, Malaysia and Russia have very low rates of under 1%. However, we keep Russia out since its cases have not yet stabilized to the logistic model. Perhaps one could argue that in Pakistan, Indonesia and Brazil among this set of countries there could be a secondary explosion much bigger than the first, as the virus makes its way down from second order central places.

Perhaps therefore there are only two categories. The evidence even then points to strong differences in mortality on infections, the reasons for which could be many which this study cannot get into. Only on the elimination of the effect of differences in the age group of population can other factors such as prior resistance due to exposure viruses similar to COIVD19, difference in the use of prophylactics, prior inoculations, would the aspect of genetic differences need be considered.

The fact that the deaths as proportion of the population has been high in the most advanced countries would suggest that the prior immunity levels (related to exposure probabilities to diseases in general), besides the differences in the age composition of the population may be the two most important discriminating factors.

The proportion of people above the age of 65 can range from lows of 4.5% (Pakistan) to as high as 27% (Japan). See table 3 of deaths per 1000 persons and deaths per 1000 persons above the age of 65. Even here there is significant variation pointing to factors other than the age structure of the population. While for China, Korea, Japan and Singapore we may attribute the low levels of deaths /1000 of people above 65 years to high capabilities of the state, most other countries (other than Australia) are not developed economies, with ultra-clean environments. So the higher overall propensity for infections in general in the not so rich countries may have acted to moderate the effect of deaths, through the buildup of greater immunity.

Genetics could be a factor too, but this would need examination with more detailed data. The fact that Iran shows death rates per 1000 persons above 65 years close to those of the rich western countries is weakly suggestive, since there is much shared ancestry between Iranians and Europeans.

The forecasts of the cumulative cases and deaths position to be expected on April 13, based on data up to April 10 which this study uses, as also the new cases and deaths to be expected over the days from 11th to 13th April are given in table 3. The reader may check these with the data as they become available for robustness of the use of the logistic model. These have been based on using the incremental (as inferred from the model) of growth rates of cases and deaths given in table 2.

The incremental growth rates in deaths continue to be high (with statistical significance) in France, UK, Germany, Sweden, Germany, US, Brazil, Canada the incremental death rates continue to be very high. Only in Spain, Netherlands, Japan and Turkey have they fallen to relatively lower levels. Thus the negative shocks to the global capital markets since they sensitive to cases in the US, would continue into at least a week from the 10th April.

We have classified these countries in a two-way scheme using the continuing expected growth rates of deaths and cases. With much confidence it is evident that the situation would be grim for the US, as also for France, Sweden, Thailand and Australia some improvement is likely towards 15th or so of April. It could deteriorate for India, Bangladesh, Philippines. Singapore, Japan, Brazil and Malaysia with low death rates currently could see a rise in the cases, so that they are unlikely to converge to a zero growth in death dates for some time now.

CONCLUSIONS[9]

Using a logistic model of cumulative cases and deaths it is possible to give estimates to the final numbers of cases and deaths that are likely on account of COID19, for countries which have gone through about 60+ days since the first cases were recorded. Such estimates assume that the containment and preventive actions continue unabated. We also provide an upper bound to the final cases and deaths that are likely. Right now (with data up to April 10) the projections for 29 countries have been made of which the results are robust for about 22 countries. We hope to update the same in due course as the disease progresses. In the UK the deaths are bound to increase, and in Italy the cases could rise further.

[9] We hope to extend the analysis to these and other countries on weekly basis. Those interested my visit my blog site: http://iima.ac.in/~morris/blog.php . For the earlier paper using the same methodology see https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3567776

Table 1: Estimates of Likely Cases and Current Growth Rates in the Number of Cases in Select Countries (10th April)									
Country Code	R-sd	α̂	t-α̂	θ̂	t-θ̂	Y stable	Ystable(Upper)	Y 10thApril	Growth Rate 10thApril
CHN	0.2933	19.4%	8.75	-2.332E-06	-6.41	83362	115990	82925	0.1%
KOR	0.2054	20.1%	7.49	-1.983E-05	-4.52	10153	15465	10450	-0.5%
IRN	0.3439	35.0%	8.75	-6.800E-06	-5.02	51488	75434	66220	-8.8%
ITA	0.0527	20.1%	4.85	-1.406E-06	-1.95	143280	303940	143630	0.5%
FRA	0.0303	15.1%	7.27	-1.136E-06	-1.52	132740	313300	86334	5.7%
GBR	0.0115	15.6%	7.98	-9.509E-07	-0.89	164510	540600	65077	9.9%
DEU	0.0395	18.4%	6.39	-1.299E-06	-1.71	141970	315960	113530	4.4%
ESP	0.0664	20.4%	7.32	-1.148E-06	-2.18	178040	350350	152450	3.6%
SWE	0.0149	14.9%	4.82	-1.092E-05	-1.01	13636	41683	9141	5.7%
USA	0.0130	17.2%	7.88	-1.791E-07	-1.01	963210	2904400	466030	9.5%
NLD	0.3307	35.6%	8.89	-1.904E-05	-4.45	18700	28219	21762	-3.6%
BGD	0.1065	12.5%	2.84	7.113E-04	1.62			330	28.7%
PAK	0.0362	23.8%	3.20	-4.437E-05	-1.11	5367	15699	4601	4.6%
IND	0.0033	11.7%	3.98	8.684E-06	0.47			6412	16.7%
JPN	0.0100	10.6%	6.70	-1.118E-05	-0.92	9502	30547	4667	5.9%
PHL	0.0007	12.1%	4.10	-4.770E-06	-0.21	25414	267340	4076	10.3%
IDN	0.3079	24.0%	7.78	-6.948E-05	-3.40	3461	5709	3293	3.3%
SGP	0.0011	8.6%	7.60	-5.842E-06	-0.28	14677	120020	1909	7.6%
MYS	0.0125	10.4%	6.15	-1.069E-05	-0.96	9709	30500	4228	6.0%
THA	0.0038	10.1%	4.52	-1.385E-05	-0.54	7329	35186	2473	6.8%
MEX	0.3241	28.8%	9.94	-7.982E-05	-3.73	3613	5707	3441	3.9%

BRA	0.1188	28.6%	7.14	-1.466E-05	-2.23	19519	38053	17857	5.5%
ARG	0.1829	29.9%	5.15	-1.627E-04	-2.55	1839	3469	1894	0.6%
RUS	0.0492	9.6%	5.42	1.246E-05	1.75			10131	20.5%
AUS	0.0182	12.9%	5.42	-1.200E-05	-1.17	10750	29733	6152	5.6%
CAN	0.0025	13.6%	7.89	-1.288E-06	-0.43	105380	602860	20748	11.1%
TUR	0.4574	47.2%	9.74	-1.232E-05	-4.50	38340	57342	42282	0.3%
ZAF	0.4570	36.3%	8.46	-2.005E-04	-4.94	1812	2671	1934	-0.6%
EGY	0.0011	12.6%	2.77	-1.873E-05	-0.23	6711	66835	1699	9.7%
Growth rates are in % per day. Negative growth estimates in the last column are reset to zero.									

Table 2: Estimates of Likely Deaths and Current Growth Rates in the Number of Deaths in Select Countries (10thApril)

CountryCode	R-sd	$\hat{\alpha}$	t-$\hat{\alpha}$	$\hat{\theta}$	t-$\hat{\theta}$	Y stable	Ystable(Upper)	Y 10thApril	Growth Rate 10thApril
CHN	0.3534	23.9%	9.18	-7.537E-05	-6.94	3167	4325	3340	-1.3%
KOR	0.2869	23.6%	6.64	-1.371E-03	-4.35	172	268	208	-4.4%
IRN	0.4646	23.7%	12.71	-6.313E-05	-6.45	3746	5064	4110	-1.5%
ITA	0.3383	29.1%	9.61	-1.765E-05	-4.80	16513	24300	18281	-2.1%
FRA	0.0096	18.0%	6.87	-5.261E-06	-0.72	34244	131580	12210	12.2%
GBR	0.1253	30.1%	8.30	-2.890E-05	-2.17	10427	20462	7978	9.8%
DEU	0.0795	27.9%	5.45	-9.096E-05	-1.58	3069	7156	2373	8.8%
ESP	0.2028	40.0%	5.91	-2.923E-05	-2.94	13676	24188	15238	-2.5%
SWE	0.0363	26.6%	4.65	-2.042E-04	-1.01	1302	3977	793	12.6%
USA	0.0727	27.4%	8.14	-1.102E-05	-1.73	24843	54629	16690	11.2%
NLD	0.1650	30.8%	6.30	-1.239E-04	-2.51	2490	4647	2396	3.0%
BGD	0.0449	8.1%	1.37	5.479E-03	0.89			21	18.6%
PAK	0.0767	21.5%	4.29	-1.910E-03	-1.26	113	302	66	9.6%

IND	0.0005	19.2%	4.36	-7.290E-05	-0.11	2637	49137	199	18.0%
JPN	0.0134	9.7%	3.09	-7.200E-04	-0.86	135	464	85	3.8%
PHL	0.0056	7.6%	2.68	2.616E-04	0.59			203	12.5%
IDN	0.0571	23.3%	2.97	-7.291E-04	-1.23	320	889	280	5.4%
SGP	0.0062	3.6%	0.50	5.540E-03	0.33			6	6.9%
MYS	0.1560	28.5%	3.53	-3.933E-03	-1.97	73	158	67	3.0%
THA	0.0018	11.1%	1.64	1.033E-03	0.22			33	14.3%
MEX	0.0277	25.4%	4.83	-4.703E-04	-0.72	541	2086	194	17.5%
BRA	0.1807	40.1%	5.71	-4.115E-04	-2.15	974	1953	941	7.4%
ARG	0.0027	15.9%	3.52	-4.006E-04	-0.27	397	3382	79	13.2%
RUS	0.4128	43.5%	6.00	-5.271E-03	-2.90	82	146	76	9.1%
AUS	0.0012	9.4%	2.81	3.577E-04	0.21			52	11.1%
CAN	0.0041	21.3%	3.57	-1.193E-04	-0.35	1788	12321	509	16.1%
TUR	0.2424	45.9%	5.50	-5.268E-04	-2.53	870	1637	908	3.1%
ZAF	0.0054	13.8%	1.56	2.329E-03	0.25			18	17.6%
EGY	0.0082	16.4%	3.72	-4.962E-04	-0.50	331	1689	118	11.4%
Growth rates are in % per day. Negative growth estimates in the last column are reset to zero.									

Table 3: Cases and Deaths in Relation to Population, and Estimates of the Start of Infections and Deaths in Significant Numbers

Country Code	Category by Cases	Category by deaths	Population in millions	Cases 10th April/1000 persons (%)	Expected Upper Bound of Cases /1000 persons (%)	Deaths April 10th /1000 persons (%)	Deaths - Upper Bound Estimates /1000 persons (%)	% of Population Above 65 years	Population above 65 years - millions	Deaths 10th April/1000 persons above 65 years	Days from 31st Dec for the cumulative cases to reach 50	Date for cumulative deaths to reach 10	Expected cumulative cases estimated for 13thApril	Estimate of expected new cases over 11th,12th and 13th April	Expected Cumulative deaths estimated for 13th April
CHN	1	1	1439	5.8%	8.1%	0.2%	0.3%	10.6%	152.5	2.2%	6	23	83217	292	3340
KOR	1	1	51	20.5%	30.3%	0.4%	0.5%	13.9%	7.1	2.9%	52	58	10450	0	208
IRN	1	1	84	78.8%	89.8%	4.9%	6.0%	5.4%	4.5	90.6%	57	57	66220	0	4110
ITA	1	1	60	239.4%	506.6%	30.5%	40.5%	23.0%	13.8	132.5%	55	58	145930	2300	18281
FRA	3	4	65	132.8%	482.0%	18.8%	202.4%	19.7%	12.8	95.4%	61	70	102098	15764	17233
GBR	4	4	68	95.7%	795.0%	11.7%	30.1%	18.5%	12.6	63.4%	65	76	86421	21344	10559
DEU	2	3	84	135.2%	376.1%	2.8%	8.5%	21.5%	18.1	13.1%	61	77	129111	15581	3055
ESP	2	1	47	324.4%	745.4%	32.4%	51.5%	19.4%	9.1	167.1%	62	71	169627	17177	15238
SWE	3	4	10	91.4%	416.8%	7.9%	39.8%	19.9%	2.0	39.8%	67	82	10802	1661	1132
USA	4	4	331	140.8%	877.5%	5.0%	16.5%	15.4%	51.0	32.7%	57	66	612243	146213	22921
NLD	1	2	17	128.0%	166.0%	14.1%	27.3%	18.8%	3.2	75.0%	67	76	21762	0	2621
BGD	4	4	166	0.2%	0.0%	0.0%	0.0%	5.1%	8.5	0.2%	18	24	704	374	35
PAK	2	4	221	2.1%	7.1%	0.0%	0.1%	4.5%	9.9	0.7%	73	85	5268	667	87
IND	4	4	1380	0.5%	0.0%	0.0%	3.6%	6.0%	82.8	0.2%	72	86	10202	3790	327
JPN	3	2	127	3.7%	24.1%	0.1%	0.4%	27.0%	34.3	0.2%	48	72	5536	869	95
PHL	4	4	109	3.7%	245.3%	0.2%	0.0%	4.8%	5.2	3.9%	70	73	5464	1388	289
IDN	2	3	274	1.2%	2.1%	0.1%	0.3%	5.3%	14.5	1.9%	68	74	3629	336	328
SGP	3	3	58	3.3%	206.9%	0.0%	0.0%	12.9%	7.5	0.1%	46	101	2378	469	7
MYS	3	2	32	13.2%	95.3%	0.2%	0.5%	6.3%	2.0	3.3%	67	84	5035	807	73
THA	3	4	70	3.5%	50.3%	0.0%	0.0%	11.4%	8.0	0.4%	66	87	3012	539	49
MEX	2	4	129	2.7%	4.4%	0.2%	1.6%	6.9%	8.9	2.2%	69	81	3860	419	315
BRA	3	3	213	8.4%	17.9%	0.4%	0.9%	8.6%	18.3	5.1%	70	79	20989	3132	1165

ARG	1	4	45	4.2%	7.7%	0.2%	7.5%	11.2%	5.0	1.6%	10	21	1930	36	115
RUS	4	3	146	6.9%	0.0%	0.1%	0.1%	14.2%	20.7	0.4%	71	88	17718	7587	99
AUS	3	4	26	23.7%	114.4%	0.2%	0.0%	15.5%	4.0	1.3%	66	87	7252	1100	71
CAN	4	4	38	54.6%	1586.5%	1.3%	32.4%	17.0%	6.5	7.9%	68	82	28449	7701	796
TUR	1	2	84	50.3%	68.3%	1.1%	1.9%	8.2%	6.9	13.2%	5	9	42722	440	995
ZAF	1	4	59	3.3%	4.5%	0.0%	0.0%	5.3%	3.1	0.6%	9	30	1934	0	29
EGY	4	4	102	1.7%	65.5%	0.1%	1.7%	5.2%	5.3	2.2%	67	81	2244	545	163
For categories see table 4 below.															

Table 4: A Categorization of Countries in Terms of their Current Estimated Growth Rate in Deaths and in Cases

	No more growth in cases (less than 2%) (1)	Low rate of growth in cases (between 2 and 5%) (2)	Moderate growth in cases (between 5 and 8%) (3)	High growth rate in cases (above 8% going up to 29%) (4)
No more deaths (0%) (1)	China, Iran, Italy, Korea	Spain		
Low death rates (less than 5%) (2)	Netherlands, Turkey		Japan(C), Malaysia(C)	
Moderate death rates (between 5 and 8.9%) (3)		Germany, Indonesia	Brazil (D), Singapore(C)	Russia(C)
High death rates (above 8.9% going up to 18.6%) (4)	Argentina, South Africa(D)	Mexico, Pakistan	Australia, France, Sweden, Thailand	Bangladesh (C,D), Canada(C), Egypt(C) UK(C), India(C,D), Philippines(C,D), USA

D- Current death rate estimates are not statistically significant
C- Current case rate rise estimates are not statistically significant
Growth rates are in percent per day
Categories are in brackets on the row and column labels