Appendix to "The COVID-19 Pandemic and the $16 Trillion Virus"

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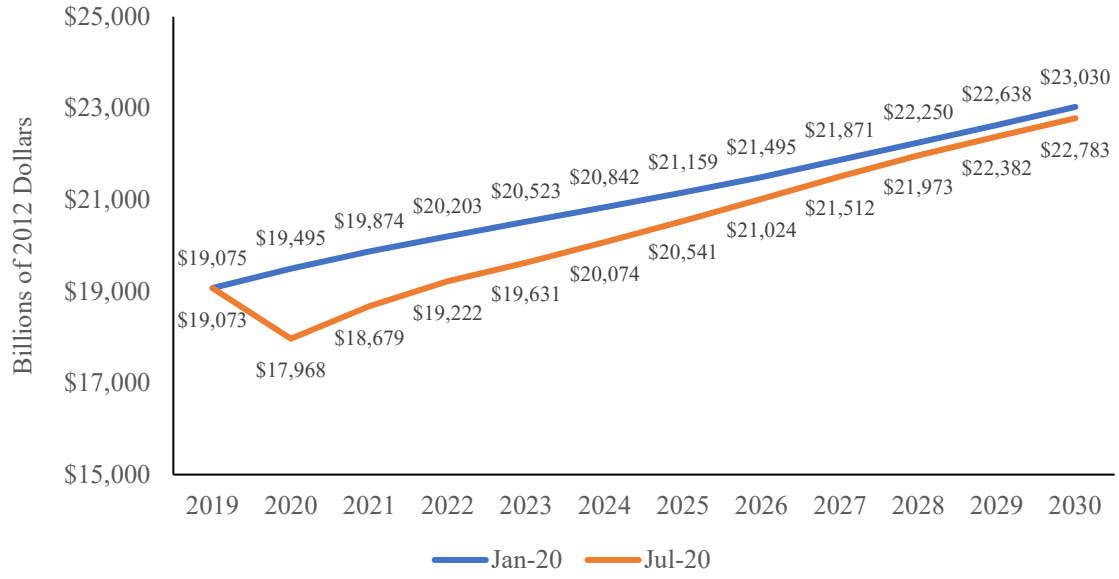
This appendix provides more detail on the calculations behind our estimate that the COVID-19 pandemic will cost the United States $16 trillion. The estimate has four parts.

1. Lost GDP

We take estimates of lost GDP from the Congressional Budget Office. Figure 1 shows the CBO projections of real GDP each year from 2020-2030 before and after the COVID-19 pandemic. The gap between the pre- and post-COVID estimates totals $7.592 trillion.

Figure 1: Estimates of Real GDP



Source: Congressional Budget Office, "An Update to the Economic Outlook: 2020-2030," July 2, 2020.

II. Cost of Premature Mortality

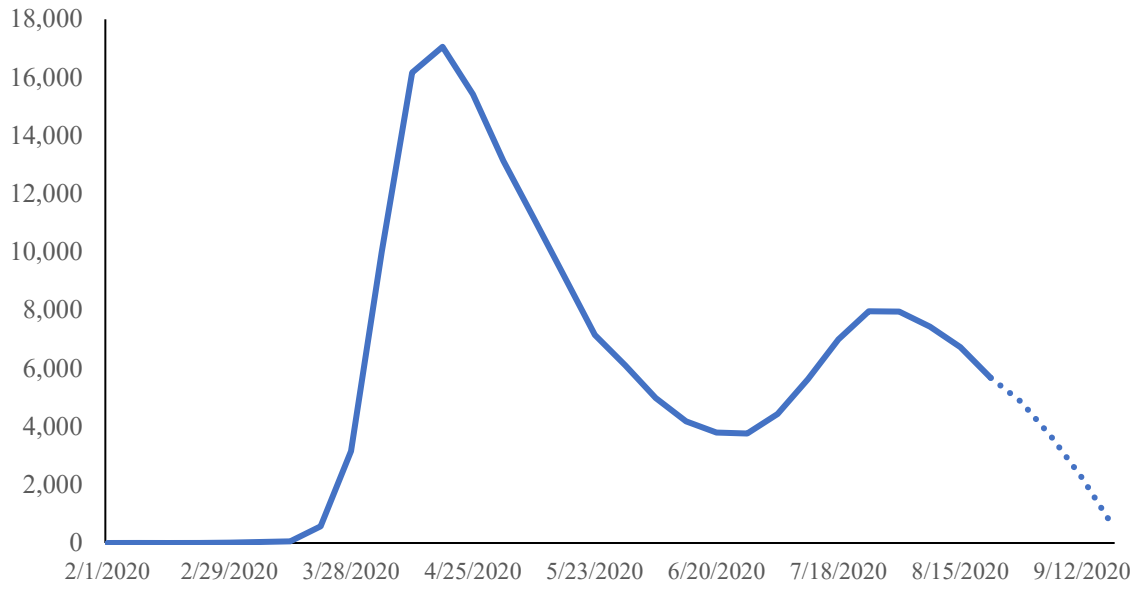
CDC data on COVID-19 deaths by week, as of September 25, 2020, are shown in Figure 2. Data in recent weeks are not complete as reporting times to the CDC vary across the country. We show the last month of data with a dashed line. As of September 25, 2020, the provisional death count is 190,076. Likely complete data from August show about 5,000 deaths per week, a bit above the level in the middle of the summer, when curtailment activity was greatest. To date, the US has not shown the ability to reduce deaths below that amount. Indeed, estimates of R_t are generally about 1, which would imply a continuation of deaths at the same level. We thus assume

deaths stay at this level. Over the next year, this would amount to 260,000 deaths. In total, therefore, COVID-19 deaths are forecast to be about 450,000 through the next year.

Non-COVID-19 deaths are higher as well. Woolf et al. suggest that excess total deaths are 55% higher than COVID-19 deaths. To be conservative, we assume the ratio over the entire time period will be only 40%. Thus, total forecast deaths are 625,000 (= 1.4*450,000).

As noted in the Viewpoint, the value of a year of life is estimated as high as $10 million. Again to be conservative, we use a value of $7 million per life. The cost of premature mortality is therefore $4.4 trillion (= 625,000 x $7 million).

Figure 2: COVID-19 Deaths by Week



Source: CDC, "Provisional COVID-19 Death Counts by Week Ending Date and State", September 2020.

III. Cost of Health Impairment

As noted in the Viewpoint, data from SARS suggest that about one-third of people with severe or critical disease will have long-term complications (typically respiratory and cardiac problems but also including blood disorders). Severe disease is generally implies hospitalization; critical disease is typically ICU admission. No data are available from SARS on long-term complications from people who were not hospitalized; we assume there are no long-term complications for the non-hospitalized group.

There are no national data on COVID-19 hospitalizations or ICU admissions. Thus, we employ data from the COVASIM model to estimate the number of such people. Table 1 shows probabilities of critical disease, severe disease, and deaths for COVID-19 positive people at each age employed in that model. We use the difference between the sum of severe/critical cases and deaths to estimate how many people with COVID-19 at each age would survive with severe or critical disease [(1)+(2)-(3)]. We take this as a ratio to deaths to estimate the number of such people

per death {[(4) = (1)+(2)-(3)]/(3)}. Using data on deaths by age from CDC (column (5)), we then estimate the total number of severe and fatal cases at each age age as the product of the ratio of such cases to deaths multiplied by the number of deaths [(4) x (5)]. This implies 1.2 million severe or critical cases of disease to date.

We forecast this through the next year by multiplying by the ratio of forecast total deaths to current total deaths (625,000 / 250,000). The forecast total is 3.2 million survivors with severe or critical disease.

Data on the long-term impairment associated with surviving SARS are not readily available. Instead, we use an estimate based on quality of life for people with chronic obstructive pulmonary disease (COPD). Among less severe COPD cases, quality of life lost is about 0.35. for more severe cases, the quality of life lost often exceeds .5. We assume a lost quality of life of 35%. Note that this is extremely conservative because it assumes no increased mortality for COVID-19 survivors with severe or critical disease. Shorter length of life would reduce the value of remaining life even more.[1] Data from people surviving acute respiratory distress syndrome (ARDS) show very high mortality rates relative to mortality for people without ARDS at those ages.

Our estimate of the economic lost associated with impaired health is the number of people affected (3.2 million) times the share with likely complications (1/3) times the lost quality of life (35% of $7 million). This product amounts to $2.6 trillion.

Table 1: Estimating Severe and Critical Cases of COVID-19

Age	Probability of Severe Disease (1)	Probability of Critical Disease (2)	Probability of Death (3)	Ratio: Critical or Severe : Death (4)	Deaths by age (5)
0-9	0.0001	0.00004	0.00002	6.0	62
10-19	0.0001	0.00011	0.00006	2.5	315
20-29	0.011	0.00040	0.0003	37.0	1,360
30-39	0.034	0.00123	0.0008	43.0	3,542
40-49	0.043	0.00214	0.0015	29.1	9,324
50-59	0.082	0.00800	0.006	14.0	22,254
60-69	0.118	0.02750	0.022	5.6	37,684
70-79	0.166	0.06000	0.051	3.4	46,487
80+	0.184	0.10333	0.093	2.1	54,838

Source: Kerr CC, et al., "Covasim: an agent-based model of COVID-19 dynamics and interventions," 2020. Deaths by age are from the CDC. The 10 year age groups are offset by 5 years – e.g., deaths for people aged 65-74 are matched to people aged 60-69.

[1] Suppose that without COVID-19 a person would live 10 years in perfect health; thus, QALE=10 years. Now suppose that the person lives one-third less long and each year has one-third lower quality. This implies 6.67 years with quality = 0.67, or QALE=4.5 years. The reduction in QALE is 55% because the length and quality of life compound.

IV. Mental Health Impairment

Data on mental health impairment are shown in Table 2. Tabulations for 2019 are from the National Health Interview survey; tabulations for July 2020 are from the Household Pulse Survey. These surveys are for the entire adult population, 263 million people. The increase in any symptom of anxiety or depression is 30%, or 79 million people.

Both anxiety and depression have very high disutility weights. Typical estimates are that depression has a disutility of -0.4 and anxiety has a disutility of about -0.15. To be conservative, we take a value of -0.2.[2]

We assume that these symptoms last only for one year, even though COVID-19 will clearly continue for over one year. Thus, the loss is 0.2 of one year. Estimates of the value of a year in good health range from $100,000 to $200,000. Taking the low end of this, the loss per affected person is $20,000 ($100,000 x 0.2). A $20,000 loss for 79 million people is $1.6 trillion in total.

Table 2: Estimates of Anxiety and Depression in the US Adult Population

Symptom of	2019: Q1-2	July 16-21, 2020
Anxiety disorder	8.2%	36.1%
Depressive disorder	6.6%	29.6%
Anxiety and/or depressive disorder	11.0%	40.9%

Source: Data for 2019 are from the National Center for Health Statistics, National Health Interview Survey Early Release Program. Data for July 2020 are from the Household Pulse Survey.

[2] Note that three quarters of people have some symptoms of depression (29.6%/40.9%) and only one-quarter have symptoms only of anxiety. Thus, if we took a weighted average of the highest disutility weight (depression or anxiety), the loss would be -0.33.