COVID-19 Response: A Tentative Cost Benefit Analysis

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Benefits of Interventions

Based on the work of the Imperial College COVID-19 Response team in "Impact of non-pharmaceutical interventions (NPIs) to reduce COVID-19 mortality and healthcare demand", in the absence of intervention, 2.2 million deaths are predicted in the US. The same report suggests that, in the presence of the proposed interventions the number of deaths will be cut to 1.1 million in the US. For the cost-benefit analysis, I assume that 1 million lives are expected to be saved in year 0.

The lives saved are valued using the EPA Value of a Statistical Life of $7.4 million.

(Link: https://www.imperial.ac.uk/media/imperial-college/medicine/sph/ide/gida-fellowships/Imperial-College-COVID19-NPI-modelling-16-03-2020.pdf)

Costs of Interventions

To get a handle on the economic costs, the following real business cycle model was simulated:

$$Max \sum_{t=0}^{\infty} \beta^t (U(C_t) - \gamma L_t)$$

$$K_{t+1} + C_t = (1-\delta)K_t + z_t F(K_t, L_t)$$

$$z_{t+1} = \bar{z} + \rho(z_t - \bar{z}) + \varepsilon_t$$

$$U(C_t) = lnC_t$$

$$F(K_t, L_t) = K_t^{\alpha} L_t^{1-\alpha}$$

Parameters were set at these values in the baseline simulation: $\beta = 0.99$, $\gamma = 2.65$, $\delta = 0.025$, $\rho = 0.99$, $\bar{z} = 1$, $\alpha = 0.33$.

The model was solved for steady state, log-linearized, and then solved by the method of undetermined coefficients. The model gives changes compared to the steady-state. For purposes of this analysis, the steady state annual GDP was assumed to be $20 trillion.

For the baseline case, the model was calibrated based on a single productivity shock that led to an immediate decrease in employment of 1.25% compared to steady state. The resulting annual losses in GDP are in the following table.

Year	% change in GDP v steady state	$ change in GDP (not discounted)
0	-2.10%	-$0.42T
1	-2.01%	-$0.40T
2	-1.93%	-$0.39T
3	-1.86%	-$0.37T
4	-1.78%	-$0.36T
5	-1.71%	-$0.34T
6	-1.64%	-$0.33T
7	-1.58%	-$0.31T
8	-1.51%	-$0.30T
9	-1.45%	-$0.29T
10	-1.40%	-$0.28T

Net Results

Year	Benefit from lives saved	$ change in GDP (not discounted)	Net Benefit	Discounted at 5%/yr
0	$7.4T	-$0.42T	$6.98T	$6.98T
1		-$0.40T	-$0.40T	-$0.38T
2		-$0.39T	-$0.39T	-$0.35T
3		-$0.39T	-$0.37T	-$0.32T
4		-$0.37T	-$0.36T	-$0.29T
5		-$0.36T	-$0.34T	-$0.27T
6		-$0.34T	-$0.33T	-$0.24T
7		-$0.33T	-$0.31T	-$0.22T
8		-$0.31T	-$0.30T	-$0.20T
9		-$0.30T	-$0.29T	-$0.19T
10		-$0.29T	-$0.28T	-$0.17T

So, the Net Present Value of the interventions is $4.33T over the next 10 years.

Sensitivity Analysis

As is always the case with cost-benefit analyses, the results are strongly affected by the assumptions. In this case, the following assumptions are worth highlighting, and alternatives considered:

(1) That saving the lives from preventing the spread of COVID-19 will not result in further loss of life. Mankiw suggests that each 1% increase in unemployment leads to 37,000 more deaths. Based on our model, the following extra deaths would occur on the basis of lost employment:

Year	Net Lives Saved	Value
0	958535.2	$7.09T
1	-30556.1	-$0.23T
2	-22291	-$0.16T
3	-16036.9	-$0.12T
4	-11312.4	-$0.08T
5	-7750.85	-$0.06T
6	-5073.32	-$0.04T
7	-3067.48	-$0.02T
8	-1571.72	-$0.01T
9	-463.065	$0T
10	352.0743	$0T

Under this new set of assumptions, **the net present value of the restrictions falls by $0.94T to $3.39T.**

(2) The unemployment effects used to calibrate this model are uncertain, and set at the minimum known unemployment effect based on recent initial unemployment claims. **If the ultimate impact on employment mirrors that of the great recession, then, the losses will be 4x as large, and the net present value of the restrictions falls by $12.11T to a net present value of -$7.78T.**

(3) This model assumed that the underlying shock is one to productivity, and that the productivity shock will be just as persistent as such shocks typically are. **If this shock is easily reversed next year, then losses in future GDP will be negligible, and the net present value of the restrictions rises by $2.65T to $6.98T.**

(4) The discount rate of 5% is perhaps a bit high compared to many cost benefit analyses. **Using a2% discount rate, net present value falls by $0.4T to $3.93T.**

(5) The time frame may be a bit short, given the persistence of the shock. **If we expand the window for our analysis to include the next 20 years, then net present value falls by $1.08T to $3.25T.**

(6) The Value of a Statistic Life is highly uncertain, though $7.4 trillion is a median of a number of studies using different methodologies, and is close to the implied value based on wage premiums for high-risk jobs. However, the UK and Australia use values between $2M and $3M. **If we changed the value of a statistical life to $3M, then the net present value falls by $4.4T to -$0.07T.**

(7) This study assumes the adoption of all of the proposals in the Imperial College report. It does NOT consider each intervention individually. It is, of course, possible (in fact, likely, if we believe in diminishing marginal returns) that a small handful of interventions (closing schools and universities and encouraging working from home) could be nearly as effective as widespread shelter-in-place orders. Unfortunately, is is unclear how to model these changes with any precision.

(8) The number of lives saved is an estimate. **If the number of lives saved is 400,000 instead of 1,000,000, then the net present value falls by $4.44T to -$0.11T.**

Conclusions

Based on the sensitivity analysis above, it seems that the most important factors are (1) the size of the employment effects, (2) the estimate for value of a statistical life, and (3) the estimate for the number of lives saved.

Given the fact that the baseline estimate is quite optimistic about the employment effects, and employment effects similar to the Great Recession are plausible, it seems likely that the net present value is actually negative, unless the persistence of the shock is extremely low.