Trading Off Consumption and COVID-19 Deaths

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Basic Idea with a Representative Agent

- Pandemic lasts for one year

- Notation:
  - $\delta =$ elevated mortality this year due to COVID-19 if no social distancing
  - $v =$ value of a year of life relative to annual consumption
  - $LE =$ remaining life expectancy in years
  - $\alpha =$ % of consumption willing to sacrifice this year to avoid elevated mortality

- Key result:
  $$\alpha \approx v \cdot \delta \cdot LE$$
Simple Calibration

- $v =$ value of a year of life relative to annual consumption
  - E.g. $v = 5 \approx \$237k/\$45k$ from the U.S. E.P.A.’s recommended value of life
    $\Rightarrow$ each life-year lost is worth 5 years of consumption

- $\delta \cdot LE =$ quantity of life years lost from COVID-19 (per person)
  - $\delta = 0.81\%$ from the Imperial College London study
  - LE of victims $\approx 14.5$ years from the same study

- Implied value of avoiding elevated mortality

$$\alpha \approx v \cdot \delta \cdot LE = 5 \cdot 0.8\% \cdot 14.5 \approx 59\% \text{ of consumption}$$

(Too high because of linearization and mortality rate)
Welfare of a Person Age $a$

Suppose lifetime utility for a person of age $a$ is

$$V_a = \sum_{t=0}^{\infty} S_{a,t} \cdot u(c)$$

- No pure time discounting or growth in consumption for simplicity
- $u(c)$ = flow utility (including the value of leisure)
- $S_{a,t} = S_{a+1} \cdot S_{a+2} \cdot \ldots \cdot S_{a+t}$ = the probability a person age $a$ survives for the next $t$ years
- $S_{a+1}$ = the probability a person age $a$ survives to $a + 1$
Welfare across the Population in the Face of COVID-19

- $W(\lambda, \delta)$ is utilitarian social welfare (with variations $\lambda$ and $\delta$)

- In initial year: scale consumption by $\lambda$ and raise mortality by $\delta_a$ at each age:

$$W(\lambda, \delta) = \sum_a N_a V_a(\lambda, \delta_a)$$

$$= Nu(\lambda c) + \sum_a (S_{a+1} - \delta_{a+1}) N_a V_{a+1}(1, 0)$$

where

- $N = \text{the initial population (summed across all ages)}$
- $N_a = \text{the initial population of age } a$
How much are we willing to sacrifice to prevent COVID-19 deaths?

\[ W(\lambda, 0) = W(1, \delta) \]

\[ \Rightarrow \quad \alpha \equiv 1 - \lambda \approx \sum_a \omega_a \cdot \delta_{a+1} \cdot \tilde{V}_a \]

- \( \omega_a \equiv N_a/N = \text{population share of age group } a \)

- \( \tilde{V}_a \equiv V_a(1, 0)/[u'(c)c] = \text{VSL of age group } a \text{ relative to annual consumption} \)
More intuitive formulas

\[ \alpha = \sum_a \omega_a \cdot \delta_{a+1} \cdot v \cdot LE_a \]

- \( V_a(1, 0)/ [u'(c)c] = v \cdot LE_a \) = the value of a year of life times remaining life years
- \( v \equiv u(c)/ [u'(c)c] \) = the value of a year of life (relative to consumption)

In the representative agent case this simplifies to

\[ \alpha = \delta \cdot v \cdot LE \]
COVID-19 Mortality by Age Group

Mortality rate rises by ~11.2 percent per year of age
### Willing to Give Up What Percent of Consumption?

<table>
<thead>
<tr>
<th>Average mortality rate $\delta$</th>
<th>Value of Life, $\nu$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>0.81%</td>
<td>47.0</td>
</tr>
<tr>
<td>0.30%</td>
<td>17.5</td>
</tr>
</tbody>
</table>

**Using Taylor series linearization:**

- 0.81%: 47.0, 58.7, 70.5
- 0.30%: 17.5, 21.8, 26.2

**Using CRRA utility with $\gamma = 2$:**

- 0.81%: 32.0, 37.0, 41.3
- 0.30%: 14.9, 17.9, 20.7
Points worth emphasizing

- 59% is the same as with a representative agent because of linearization

- 37% under CRRA due to diminishing marginal utility
  - Willing to sacrifice less when rising marginal pain from lower consumption

- The mortality rates are unconditional; rates conditional on infection would be higher

- With 0.3% mortality and CRRA (our preferred case), willing to give up 18%
Why entertain lower death rates?

- Undercounting may be more serious for cases than for deaths

- See studies in Italy, Iceland, and Germany, and in California counties

- Jones and Fernandez-Villaverde (2020):
  - Estimate SIRD model by country, state, and city using deaths across days
  - Find best-fitting $\delta$ is closer to 0.3% than 0.8%

- Need to test representative sample of population as emphasized by Stock (2020)
Contribution of Different Age Groups to $\alpha$

PERCENT CONTRIBUTION TO ALPHA (SUMS TO 100)
Comparison to a few other estimates

- CRRA and 0.3% mortality $\Rightarrow$ willing to forego $\sim$ $2.6$ trillion of consumption

- Zingales (2020) estimated $65$ trillion
  - 7.2 million deaths vs. 1 million in our calculation
  - 50 life years remaining per victim vs. 14.5 years for us

- Greenstone and Nigam (2020) estimated $8$ trillion
  - 1.7 million deaths vs. 1 million in our calculation
  - $315k$ value per year of life vs. $225$ for us
Some factors to incorporate

• GDP vs. consumption

• Capital bequeathed to survivors

• Lost leisure during social distancing

• Leisure varying by age

• Competing hazards

• The poor bearing the brunt of the consumption loss
Taking into account consumption inequality

\[ \alpha \approx \delta \cdot v \cdot LE - \gamma \cdot \Delta \sigma^2 / 2 \]

- \( \gamma \) is the CRRA
- \( \sigma \) is the SD of log consumption across people
- See Jones and Klenow (2016)

If \( \gamma = 2 \), each 1% increase in consumption inequality lowers \( \alpha \) by 1%