Trading Off Consumption and COVID-19 Deaths

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Basic Idea with a Representative Agent

• Pandemic lasts for one year

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

• 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
  $\alpha \approx v \cdot \delta \cdot LE = 5 \cdot 0.8\% \cdot 14.5 \approx 59\%$ 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

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

- No pure time discounting or growth in consumption for simplicity
- $u(c) = \text{flow utility (including the value of leisure)}$
- $\overline{S}_{a,t} = S_{a+1} \cdot S_{a+2} \cdot \ldots \cdot S_{a+t} = \text{the probability a person age } a \text{ survives for the next } t \text{ years}$
- $S_{a+1} = \text{the probability a person age } a \text{ survives to } a + 1$
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?

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

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

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

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

\[ \alpha = \delta \cdot v \cdot LE \]
Life Expectancy by Age Group

LIFE EXPECTANCY (YEARS)

0-4 5-9 10-14 15-19 20-24 25-29 30-34 35-39 40-44 45-49 50-54 55-59 60-64 65-69 70-74 75-79 80-84 85+

0 10 20 30 40 50 60 70 80
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?

| δ   | Value of Life, ν |
|-----|-----------------|
|     | 4 | 5 | 6 |

Using Taylor series linearization:

| 0.81% | 47.0 | 58.7 | 70.5 |
| 0.30% | 17.5 | 21.8 | 26.2 |

Using CRRA utility with γ = 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 $\alpha$
Comparison to a few other estimates

• CRRA and 0.3% mortality ⇒ willing to forego ∼ $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\%