# Value of a COVID-19 Death

—How much is a society willing to pay in order to reduce a COVID-19 death?—

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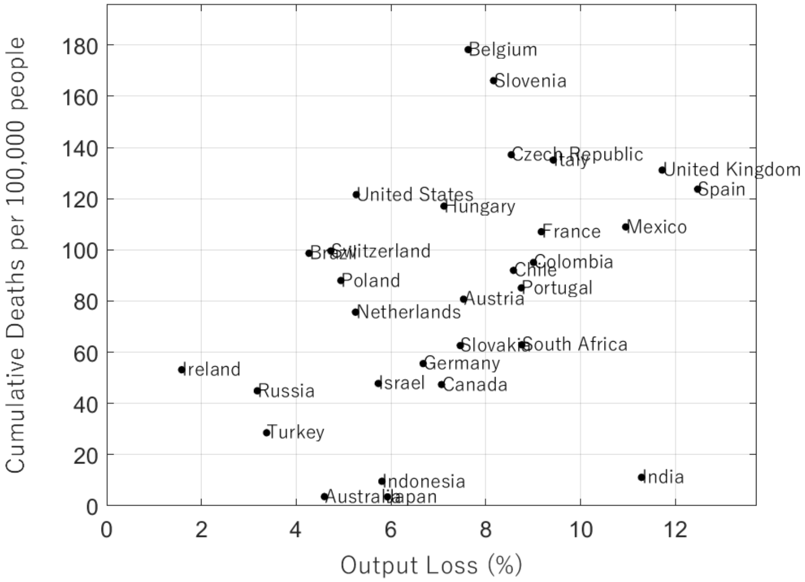
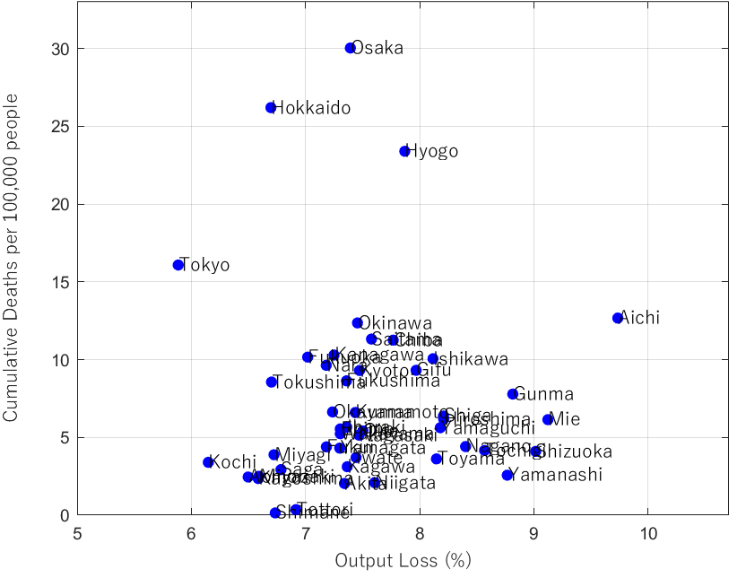
# Question

What accounts for cross-country (or -region) differences in health and economic outcomes during the COVID-19 crisis?

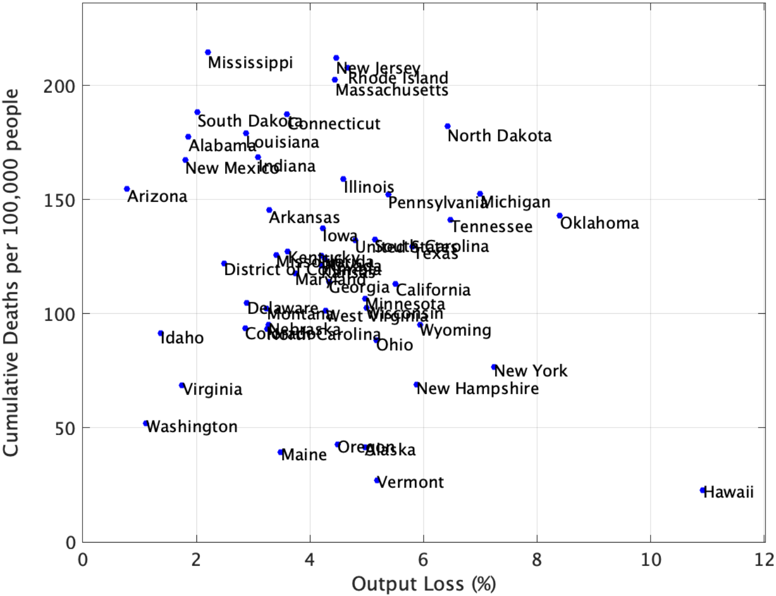
# Cross-country



# Cross-region in Japan



# Cross-region in the U.S.



# Question

What accounts for cross-country (or -region) differences in health and economic outcomes during the COVID-19 crisis?

- Many factors are likely to have mattered.
  - Medical capacity/flexibility, Non-Pharmaceutical Interventions (NPIs), behavioral/cultural differences ("hugs and kisses" versus "handshaking and bows"), people's susceptibility to the disease (for example, proportion of people with high BMI), economic policy (various fiscal and monetary policies), economic structures (proportion of contact-intensive workers and easiness of teleworking), luck, etc.
  - We call them "technology and policy" factors

- This paper: Value

# What We Do—A Revealed-Preference Exercise—

- For each country, we construct a "conditional health-economic possibility frontier."
  - ...using an esimated macro-SIR model fitted to each country's time-series data on infection and economy.
- We assume that each society has "optimally" chosen the path of economic activity and COVID-19 deaths subject to various constraints.
  - ..."constraints" in the broadest sense of the word.
- We interpret the marginal rate of substitution at the realized pair of economic activity and COVID-19 deaths as the society's willingness-to-pay (WTP) in order to reduce a COVID-19 death.
  - Of course, a heroic interpretation subject to various caveats.

Our WTP measure is intended to capture the following things:

- how much a person values living a long life (value of a life).
- desire to avoid tragedy associated with dying from COVID-19.
  - patients might have to pass away in isolation from loved ones.
- desire to avoid stigma associated with COVID-19 in certain societies that value comformity.
  - In some societies, there might be the opposite stigma (stigma of wearning masks).
- desire to avoid being quarantined for several days by getting infected with COVID-19.
- fear of the unknown.
- misspecification of our model.
- ...among many others.

Our WTP measure controls for many of “technology, policy, and luck” factors:

- By estimating a country specific path of infection rates and mortality rate, we take into account the differences in medical capacity/flexibility, behavioral/cultural differences, people’s susceptibility to the disease across countries/regions.
- By estimating the elasticity of infection rate to economic activity, we take into account the differences in economic policy and economic structures across countries/regions.
- Our framework can be used to decompose the difference in to health-economic outcomes into parts attributable to the differences in (1) infection rate, (2) mortality rate, (3) elasticity of infection to economic activity, (4) policy, and (5) WTP.

# Idea

Difference in the health and economic outcomes between two regions

=

- Difference in technology
  - ...or everything that influences the location and the shape of the conditional trade-off curve.
  - ...which is estimated from **weekly time-series data** on infection, death, and output in each region.

+

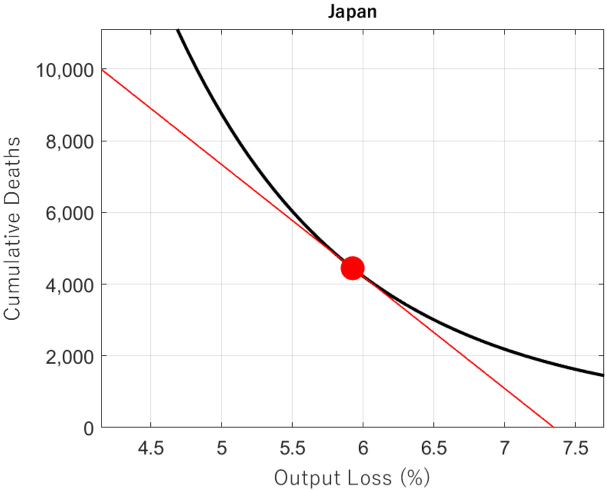
- Difference in the willingness to pay in order to reduce a COVID-19 death.
  - ...captured by the slope of the "indifference curve/line."

# Why You May Care

Our analysis can be used in the following ways:

- To predict economic activity in the future.
  - All else equal, a country/region with a higher WTP is likely to experience a more sluggish recovery.
- To put into perspective your view towards how to balance infection risk and an ordinary life.
  - After seeing these regional differences, you may think that you has put too much (little) weight on reducing COVID-19 deaths over protecting an ordinary life .

# Idea




- Black: Conditional health-economic possibility frontier
- Red: Society's indifference line

# Key Results

- There is a large heterogeneity of WTP across countries and regions.
  - 80 million dollars in New Zealand; 19.5 million dollars in Japan; 0.9 million dollars in the U.S.; 0.4 million dollars in the U.K.
  - 730 oku-yen in Shimane; 560 oku-yen in Tottori; 5.5 oku-yen in Tokyo; 4 oku-yen in Osaka

- WTP is weakly (strongly) correlated with the ratio of output loss to COVID-19 deaths across countries or across states in the U.S. (across prefectures in Japan).

# Literatures

- Cross-country comparisons: Fernandez-Villaverde and Jones (2020)
  - Our paper seeks to understand the sources of cross-country differences
- Macro-epidemiological models: Eichenbaum, Rebelo, and Trabandt (2020) and many others
  - Our paper: a model estimated with data from a number of countries and regions.
- Willingness-to-pay to reduce a COVID-19 death: Hall, Jones, and Klenow (2020)
  - Our paper: a revealed preference approach.

# Outline of the Talk

# Model

- Formulated in discrete time with infinite horizon.
- SIRD model in which infection rate depends on economic activity.
- Weekly frequency.

# Model

$$
\begin{aligned}
S_{t+1} &= S_t - N_t - V_t \\
I_{t+1} &= I_t + N_t - N_t^{IR} - N_t^{ID} \\
R_{t+1} &= R_t + N_t^{IR} + V_t \\
D_{t+1} &= D_t + N_t^{ID} \\
N_t^{IR} &= \gamma_t I_t \\
N_t^{ID} &= \delta_t I_t
\end{aligned}
$$

$S_t$: Susceptible, $I_t$: Infected, $R_t$: Recovered, $D_t$: Dead

$N_t$: Newly infected, $N_t^{IR}$: Newly recovered, $N_t^{ID}$: Newly dead

$V_t$: Newly vaccinated (effective)

$\gamma_t$: recovery rate, $\delta_t$: death rate

# Matching function

$$N_t = \frac{\tilde{\beta}_t}{POP_0} I_t S_t$$
$$\tilde{\beta}_t = \beta_t (1 - h\alpha_t)^2$$

- $POP_0$: Total population at time 0
- $\alpha_t$: Decline in economic activity (from pre-crisis trend)
- $\beta_t$: Raw infection rate that would prevail in the absence of any decline in economic activity
  - $\beta_t$ also captures the extent to which our model is misspecified (the Solow residual or "wedge").
- $\tilde{\beta}_t$: Infection rate

# Output

$$Y_t \quad := \quad (1-\alpha_t)\bar{Y}_t$$

- $\bar{Y}_t$: Trend output that would have prevailed in the absence of the COVID-19 crisis

# Estimation

Observed variables/parameters:

$$N_t, N_t^{ID}, V_t, M_t, Y_t, \bar{Y}_t, POP_0$$

- $M_t$: Mobility

Variables or time-varying parameters we estimate:

$$\{S_t, I_t, R_t, D_t, N_t^{IR}, \alpha_t, \beta_t, \tilde{\beta}_t, \delta_t\}_{t=1}^{T}$$

We assume a sequence of $\gamma_t$ (recovery rate).

$$
\begin{aligned}
S_{t+1} &= S_t - N_t - V_t \\
I_{t+1} &= I_t + N_t - N_t^{IR} - N_t^{ID} \\
R_{t+1} &= R_t + N_t^{IR} + V_t \\
D_{t+1} &= D_t + N_t^{ID} \\
N_t^{IR} &= \gamma_t I_t \\
N_t^{ID} &= \delta_t I_t \\
N_t &= \frac{\tilde{\beta}_t}{POP_0} I_t S_t \\
\tilde{\beta}_t &= \beta_t (1 - h\alpha_t)^2 \\
Y_t &:= (1 - \alpha_t) \bar{Y}_t
\end{aligned}
$$

Assume initial conditions $(S_0, I_0, R_0, D_0)$. Then, we can find $\{S_t, I_t, R_t, D_t, \alpha_t\}_{t=1}^{T}$.

$$
\begin{aligned}
S_{t+1} &= S_t - N_t - V_t \\
I_{t+1} &= I_t + N_t - N_t^{IR} - N_t^{ID} \\
R_{t+1} &= R_t + N_t^{IR} + V_t \\
D_{t+1} &= D_t + N_t^{ID} \\
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N_t^{ID} &= \delta_t I_t \\
N_t &= \frac{\tilde{\beta}_t}{POP_0} I_t S_t \\
\tilde{\beta}_t &= \beta_t (1 - h\alpha_t)^2 \\
Y_t &:= (1 - \alpha_t)\bar{Y}_t
\end{aligned}
$$

Combined with an estimate of $h$ (obtained by regressing $M$ on $\alpha$), we can find $\{\delta_t, \beta_t, \bar{\beta}_t\}_{t=1}^{T}$.

$$
\begin{aligned}
S_{t+1} &= S_t - N_t - V_t \\
I_{t+1} &= I_t + N_t - N_t^{IR} - N_t^{ID} \\
R_{t+1} &= R_t + N_t^{IR} + V_t \\
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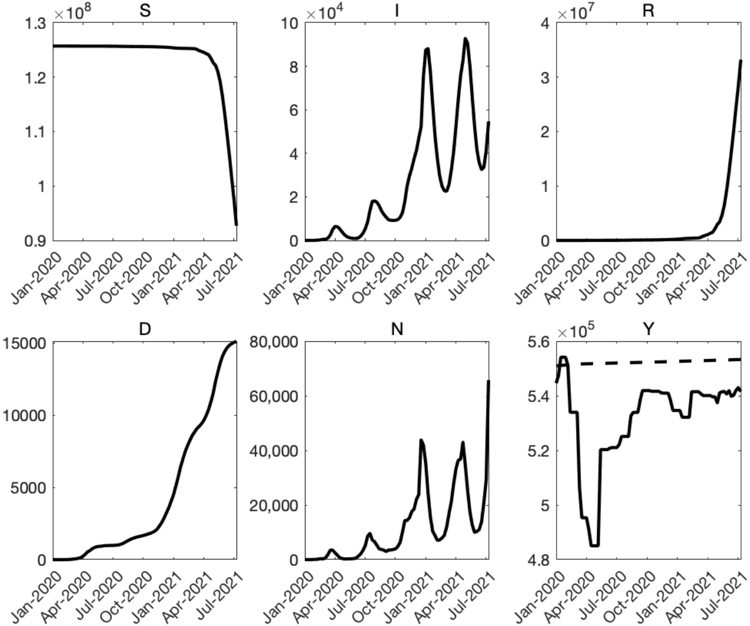
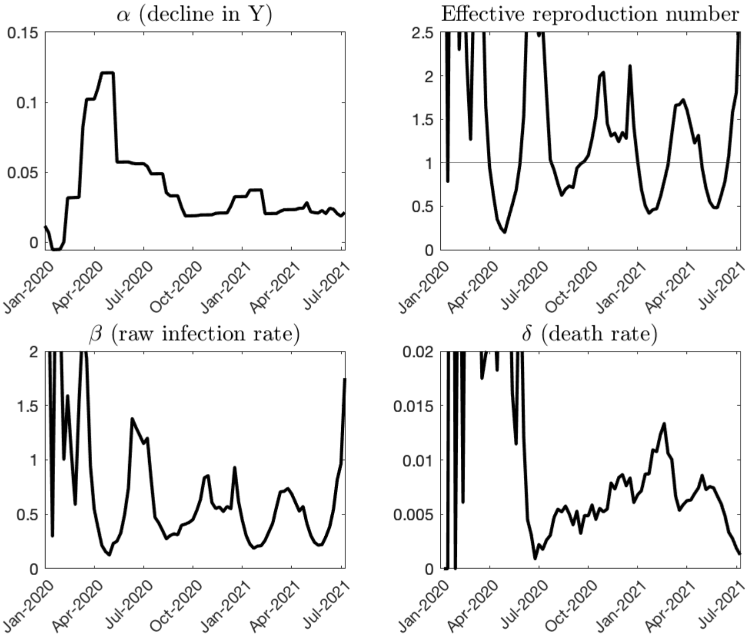
N_t^{IR} &= \gamma_t I_t \\
N_t^{ID} &= \delta_t I_t \\
N_t &= \frac{\tilde{\beta}_t}{POP_0} I_t S_t \\
\tilde{\beta}_t &= \beta_t (1 - \mathbf{h}\alpha_t)^2 \\
Y_t &:= (1 - \alpha_t)\bar{Y}_t
\end{aligned}
$$

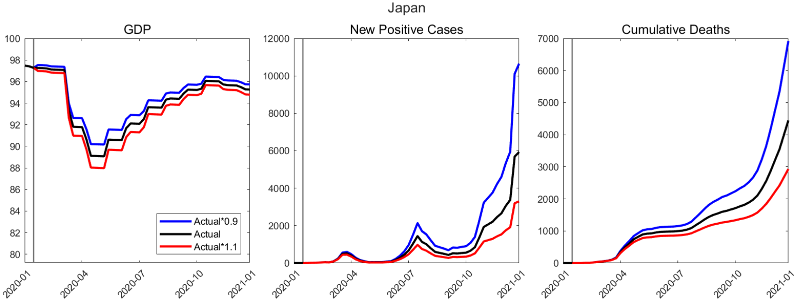
# An Example: Japan



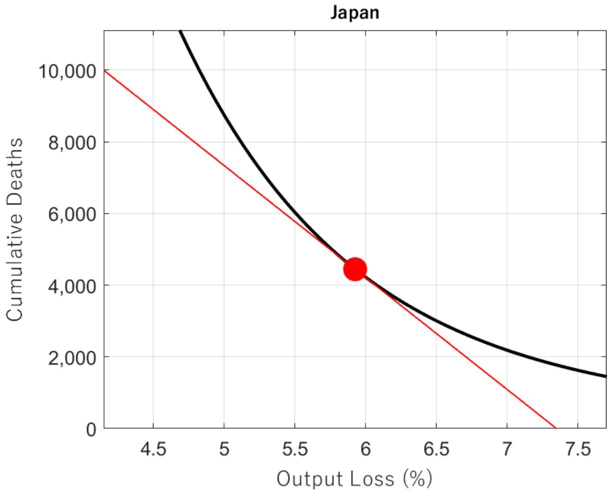
# An Example: Japan



# Counterfactuals




- We only consider proportional changes to $\alpha$ path. We keep the path's shape/pattern unchanged.
  - We interpret the pattern as partly capturing "strategy" (for example, front-loadedness of lockdown).




- Black: Conditional health-economic possibility frontier
- Red: Society's indifference line

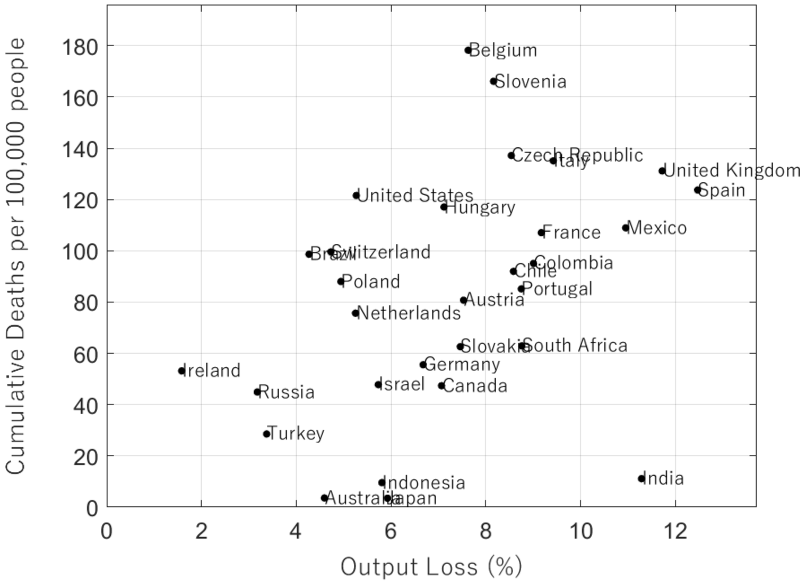
# Outline of the Talk

# Cross-Country Analysis

# Data Sources

- New Cases and Deaths—WHO COVID-19 Dashboard
- Vaccination—A global database of COVID-19 vaccinations (Mathieu et.al., 2021)
- Monthly GDP—OECD Main Economic Indicators Publication
  - Create monthly GDP by multiplying trend and ratio to trend
- Mobility—Google COVID-19 Community Mobility Reports
  - Mobility on retail, parks, stations, workplaces, and residential
- Population—World Population Prospects

Sample period: From the fourth week of January 2020 to the second week of January 2021. (52 weeks)



Cumulative Deaths per 100,000 people
Output Loss (%)
0
20
40
60
80
100
120
140
160
180
0
2
4
6
8
10
12
Belgium
Slovenia
Czech Republic
Italy
United Kingdom
Spain
United States
Hungary
France
Mexico
Brazil
Switzerland
Colombia
Chile
Poland
Portugal
Austria
Netherlands
Slovakia
South Africa
Germany
Ireland
Israel
Canada
Russia
Turkey
Indonesia
India
Australia
Japan

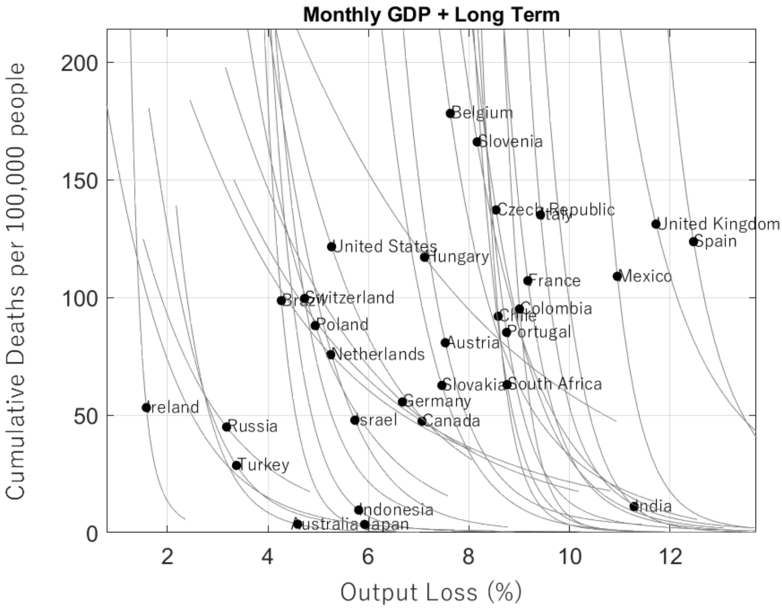
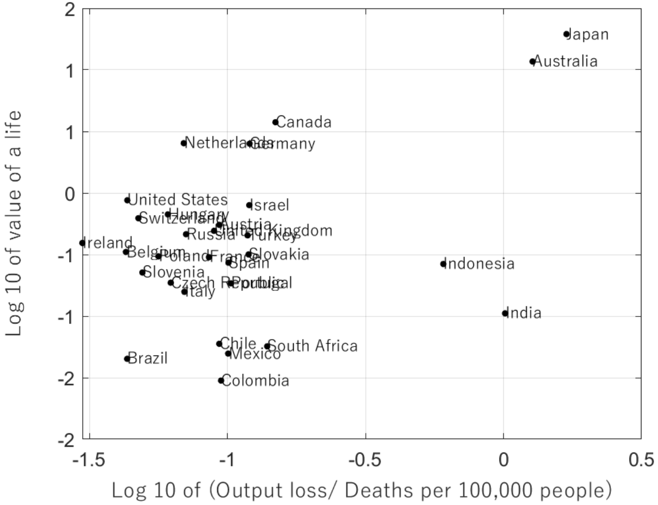
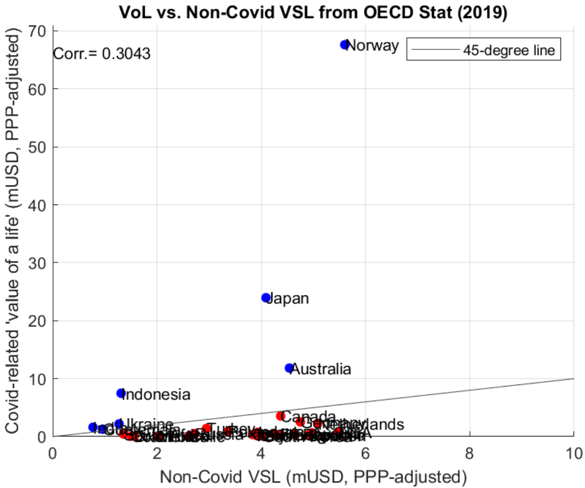

Monthly GDP + Long Term
Cumulative Deaths per 100,000 people
Output Loss (%)
0
50
100
150
200
2
4
6
8
10
12
Belgium
Slovenia
Czech Republic
Italy
United Kingdom
Spain
United States
Hungary
Mexico
France
Brazil
Switzerland
Colombia
Chile
Poland
Portugal
Austria
Netherlands
Slovakia
South Africa
Germany
Ireland
Israel
Canada
Russia
Turkey
India
Indonesia
Australia
Japan

Table: Table on the Values of Life (per million, 2010 USD)

| Country | VoL | Country | VoL | Country | VoL |
|---|---|---|---|---|---|
| Japan | 19.52 | United Kingdom | 0.49 | Slovenia | 0.23 |
| Australia | 11.68 | Russia | 0.46 | Czech Republic | 0.19 |
| Canada | 3.75 | Turkey | 0.45 | Portugal | 0.18 |
| Netherlands | 2.54 | Ireland | 0.39 | Italy | 0.16 |
| Germany | 2.51 | Belgium | 0.33 | India | 0.11 |
| United States | 0.87 | Slovakia | 0.32 | Chile | 0.06 |
| Israel | 0.80 | Poland | 0.31 | South Africa | 0.06 |
| Hungary | 0.67 | France | 0.30 | Mexico | 0.05 |
| Switzerland | 0.62 | Spain | 0.27 | Brazil | 0.04 |
| Austria | 0.55 | Indonesia | 0.26 | Colombia | 0.03 |

| Mean | Variance | 50% | 5% | 95% |
|---|---|---|---|---|
| 1.61 | 4.03 | 0.32 | 0.05 | 11.69 |

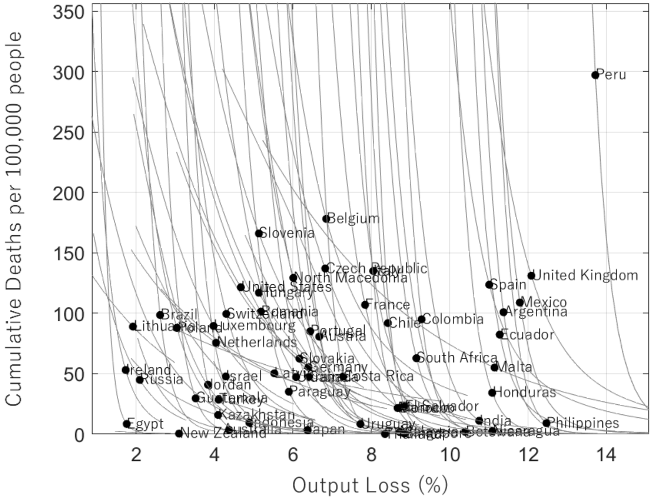

Japan
Australia
Canada
Netherlands
Germany
United States
Israel
Hungary
Switzerland
Austria
United Kingdom
Russia
Turkey
Ireland
Belgium
Poland
France
Slovakia
Spain
Indonesia
Slovenia
Czech Republic
Portugal
Italy
India
Chile
South Africa
Mexico
Brazil
Colombia
Log 10 of value of a life
Log 10 of (Output loss/ Deaths per 100,000 people)


VoL vs. Non-Covid VSL from OECD Stat (2019)
Corr.= 0.3043
45-degree line
Norway
Japan
Australia
Indonesia
Canada
Ukraine
Turkey
Netherlands
Covid-related 'value of a life' (mUSD, PPP-adjusted)
Non-Covid VSL (mUSD, PPP-adjusted)
0
10
20
30
40
50
60
70
0
2
4
6
8
10

# Robustness

- Quarterly GDP
- Alternative Power of Matching Function, $k$

Figure: Tradeoff curve: quarterly GDP




Source: The World Bank - Global Economic Monitor

Table: Table on the Values of Life (per million, 2010 USD)

| Country | VoL | Country | VoL | Country | VoL |
|---|---|---|---|---|---|
| Singapore | 118.10 | Lithuania | 0.58 | India | 0.09 |
| New Zealand | 81.87 | Turkey | 0.42 | Egypt | 0.08 |
| Thailand | 36.87 | United Kingdom | 0.41 | Paraguay | 0.08 |
| Japan | 18.56 | Belgium | 0.40 | Costa Rica | 0.06 |
| Australia | 13.26 | Nicaragua | 0.39 | Ukraine | 0.06 |
| Canada | 6.31 | Austria | 0.35 | Morocco | 0.06 |
| Malaysia | 4.46 | Slovenia | 0.32 | Chile | 0.06 |
| Botswana | 3.86 | Hungary | 0.32 | South Africa | 0.05 |
| Netherlands | 2.51 | France | 0.31 | North Macedonia | 0.05 |
| Malta | 2.40 | Spain | 0.28 | Mexico | 0.05 |
| Germany | 2.12 | Czech Republic | 0.27 | El Salvador | 0.04 |
| Luxembourg | 1.96 | Russia | 0.24 | Argentina | 0.04 |
| Israel | 1.31 | Romania | 0.23 | Brazil | 0.04 |
| Latvia | 1.13 | Indonesia | 0.20 | Guatemala | 0.03 |
| Kazakhstan | 1.05 | Slovakia | 0.20 | Ecuador | 0.03 |
| United States | 1.03 | Italy | 0.18 | Colombia | 0.03 |
| Bahrain | 0.97 | Portugal | 0.17 | Honduras | 0.02 |
| Uruguay | 0.88 | Poland | 0.16 | Jordan | 0.02 |
| Ireland | 0.75 | Philippines | 0.12 | Peru | 0.01 |
| Switzerland | 0.67 | | | | |

| Mean | Variance | 50 % | 5 % | 95 % |
|---|---|---|---|---|
| 5.28 | 19.20 | 0.30 | 0.03 | 29.55 |

Figure: WTP (Monthly GDP vs Quarterly GDP)

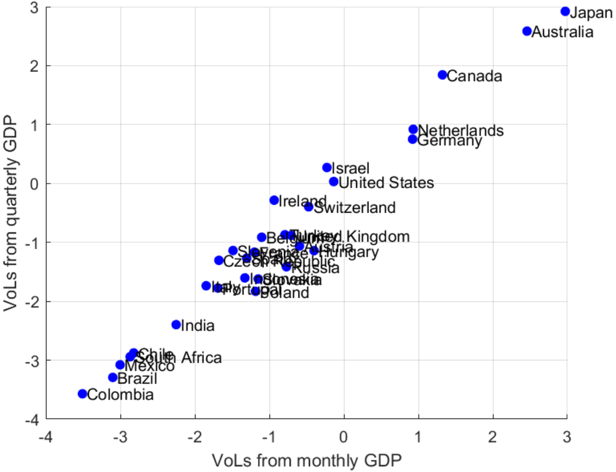


Figure: VoL with alternative valuse of $k$—power of matching function

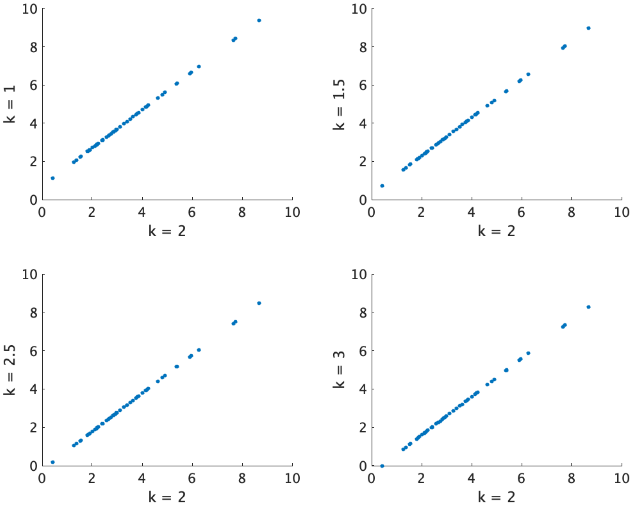
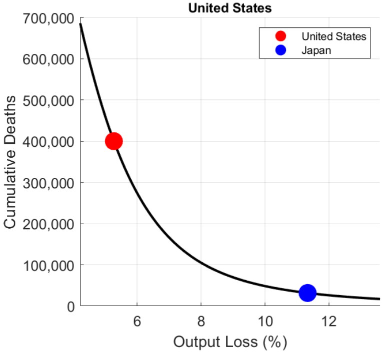
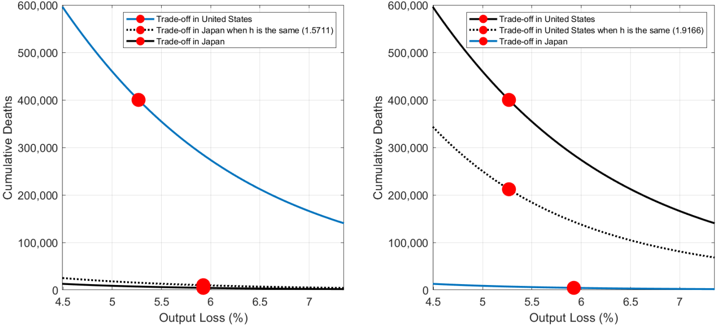


Figure: Hypothetical outcomes



# Decomposition

Figure: Original tradeoff curves and tradeoff curve with the same *h*




Note: The left panel shows the tradeoff curve with the United States' *h* and the original parametrization in Japan for the others. The right panel shows the tradeoff curve with Japan's *h* and the original parametrization in the United States for the others.

Table: Decomposition of VoL for the United States and Japan

| Country | *h* | $\beta_t$ | $\delta_t$ | shape of $\alpha_t$ |
|---|---|---|---|---|
| United States (original VoL) | 0.87 | 0.87 | 0.87 | 0.87 |
| United States (one parameter swapped) | 1.41 | 15.28 | 0.82 | 0.73 |
| Japan (one parameter swapped) | 9.71 | 1.10 | 27.69 | 23.76 |
| Japan (original VoL) | 19.52 | 19.52 | 19.52 | 19.52 |

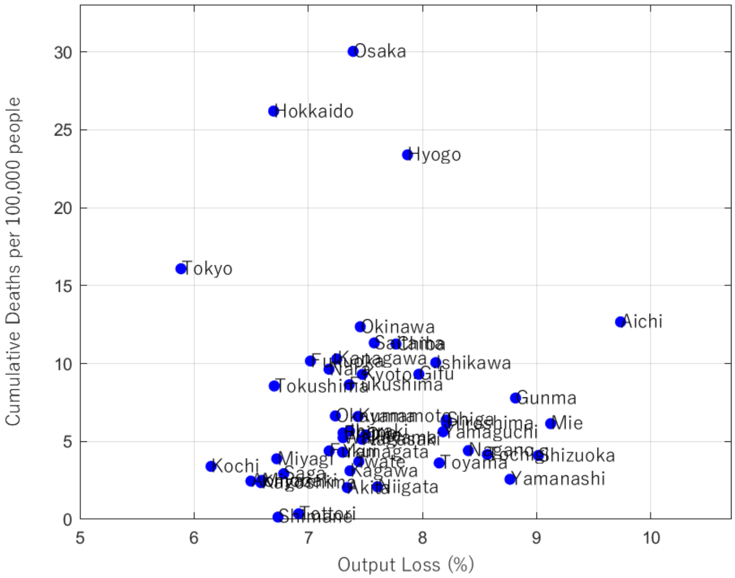
Variables on the top raw indicate the swapped variables.
Values from the second raw to the last raw indicate the outcomes of VoLs.

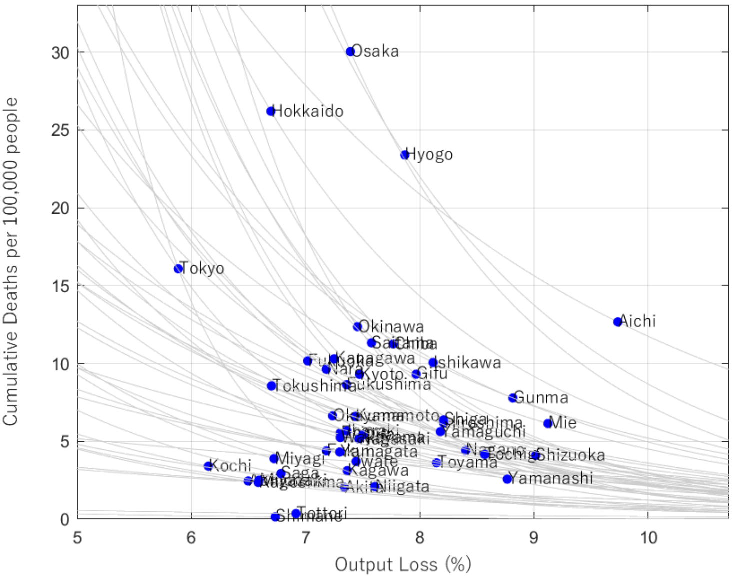
# Regional Analysis in Japan

# Data Sources

- New Cases and Deaths—Ministry of Health, Labour and Welfare
- Vaccination—The Prime Minister's Official Residence
- Monthly GDP—"A Measure of Monthly State-Level Output in Japan" (Fujii and Nakata, 2021)
- Mobility—Google COVID-19 Community Mobility Reports
  - Mobility data on retail, parks, stations, workplaces, and residential
- Population—Vital Statistics in e-Stat

Sample period: From the fourth week of January 2020 to the fourth week of June 2021. (75 weeks)


Cumulative Deaths per 100,000 people
Output Loss (%)
0
5
10
15
20
25
30
5
6
7
8
9
10
Osaka
Hokkaido
Hyogo
Tokyo
Aichi
Okinawa
Ishikawa
Gifu
Tokushima
Gunma
Mie
Yamaguchi
Shizuoka
Toyama
Yamanashi
Kochi
Miyagi
Kagawa
Niigata
Saga


Cumulative Deaths per 100,000 people
Output Loss (%)
0
5
10
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5
6
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8
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10
Osaka
Hokkaido
Hyogo
Tokyo
Aichi
Okinawa
Chiba
Kanagawa
Ishikawa
Nara
Kyoto
Gifu
Tokushima
Fukushima
Gunma
Shiga
Mie
Yamaguchi
Yamagata
Shizuoka
Miyagi
Iwate
Toyama
Kochi
Saga
Kagawa
Yamanashi
Niigata
Tottori

Table: Table about the Values of a Life (Oku-yen, 2017)

| Prefecture | VoL | Prefecture | VoL | Prefecture | VoL |
|---|---|---|---|---|---|
| Shimane | 730.4 | Kochi | 36.0 | Aichi | 21.3 |
| Tottori | 563.2 | Tochigi | 35.9 | Tokushima | 19.7 |
| Akita | 134.0 | Shizuoka | 34.2 | Ishikawa | 15.7 |
| Iwate | 108.8 | Nagano | 32.6 | Gifu | 10.3 |
| Aomori | 101.1 | Oita | 31.1 | Fukuoka | 10.2 |
| Niigata | 86.7 | Mie | 30.4 | Kyoto | 8.9 |
| Toyama | 78.8 | Miyagi | 30.1 | Nara | 7.5 |
| Miyazaki | 52.7 | Hiroshima | 29.7 | Kanagawa | 7.2 |
| Kagoshima | 52.6 | Nagasaki | 27.3 | Chiba | 7.0 |
| Yamagata | 50.4 | Shiga | 24.5 | Saitama | 6.6 |
| Fukui | 41.3 | Ibaraki | 24.1 | Tokyo | 5.6 |
| Ehime | 41.0 | Wakayama | 23.3 | Hyogo | 5.1 |
| Yamaguchi | 38.5 | Okayama | 22.3 | Hokkaido | 4.3 |
| Yamanashi | 38.3 | Kumamoto | 22.2 | Okinawa | 4.2 |
| Kagawa | 38.0 | Gunma | 21.8 | Osaka | 4.0 |
| Saga | 36.4 | Fukushima | 21.8 | | |

| Mean | Variance | 50% | 5% | 95% |
|---|---|---|---|---|
| 57.9 | 128.5 | 28.5 | 4.2 | 176.9 |

Figure: WTP and output loss over cumulative deaths

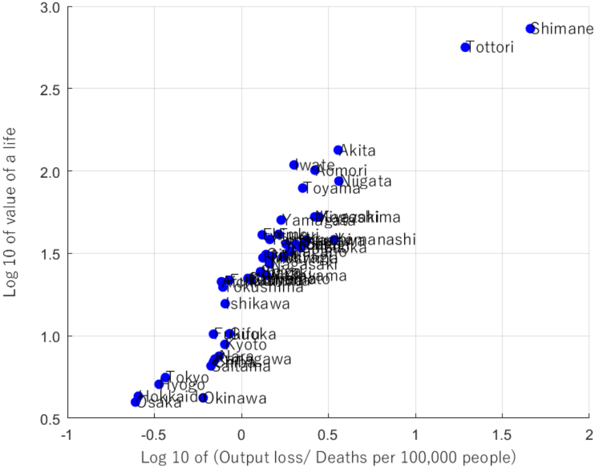
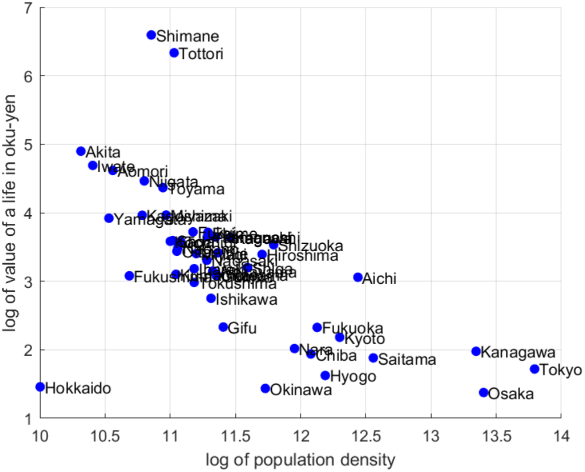
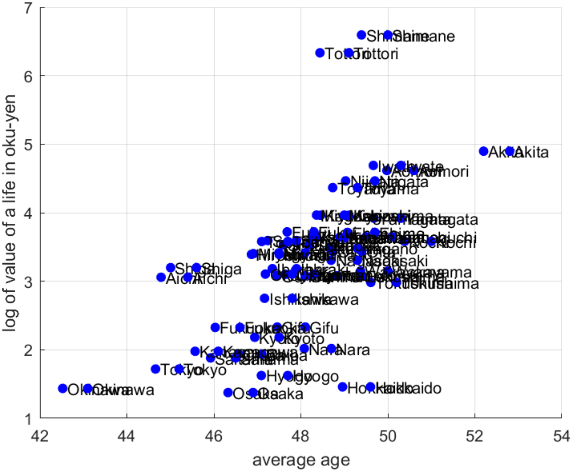


Figure: WTP and population density




Source: Vital Statistics and System of Social and Demographic Statistics

# Figure: WTP and average age



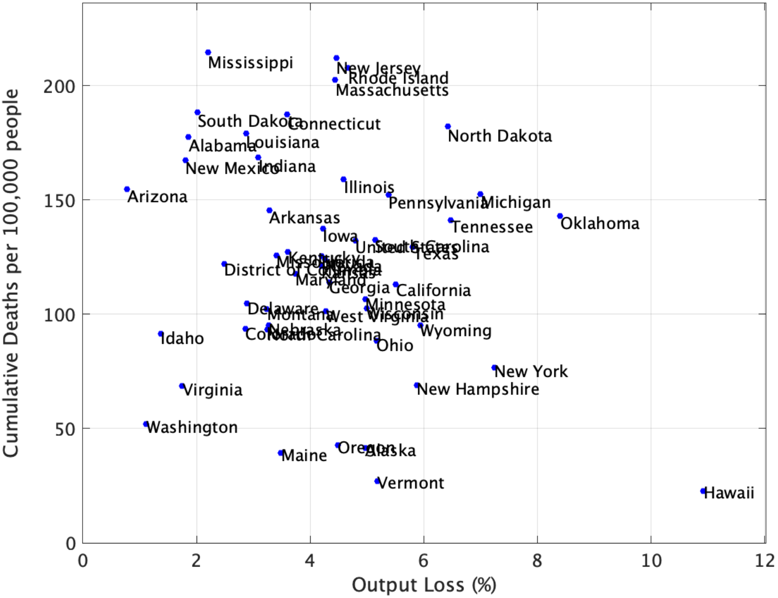

Source: National Institute of Population and Social Security Research

# Regional Analysis in the U.S.

# Data Sources

- New Cases and Deaths—Centers for Disease Control and Prevention
- Vaccination—Centers for Disease Control and Prevention
- Quarterly GDP—Bureau of Economic Analysis
- Mobility—Google COVID-19 Community Mobility Reports
  - Mobility data on retail, parks, stations, workplaces, and residential
- Population—Source: U.S. Census Bureau, Population Division

Sample period: From the fourth week of January 2020 to the second week of January 2021 (52 weeks)


Cumulative Deaths per 100,000 people
Output Loss (%)
0
50
100
150
200
0
2
4
6
8
10
12
Mississippi
New Jersey
Rhode Island
Massachusetts
South Dakota
Connecticut
North Dakota
Alabama
Louisiana
New Mexico
Indiana
Illinois
Arizona
Pennsylvania
Michigan
Arkansas
Tennessee
Oklahoma
Iowa
South Carolina
Texas
Maryland
Georgia
California
Minnesota
Delaware
Montana
West Virginia
Wisconsin
Nebraska
North Carolina
Wyoming
Idaho
Ohio
New York
Virginia
New Hampshire
Washington
Maine
Oregon
Alaska
Vermont
Hawaii

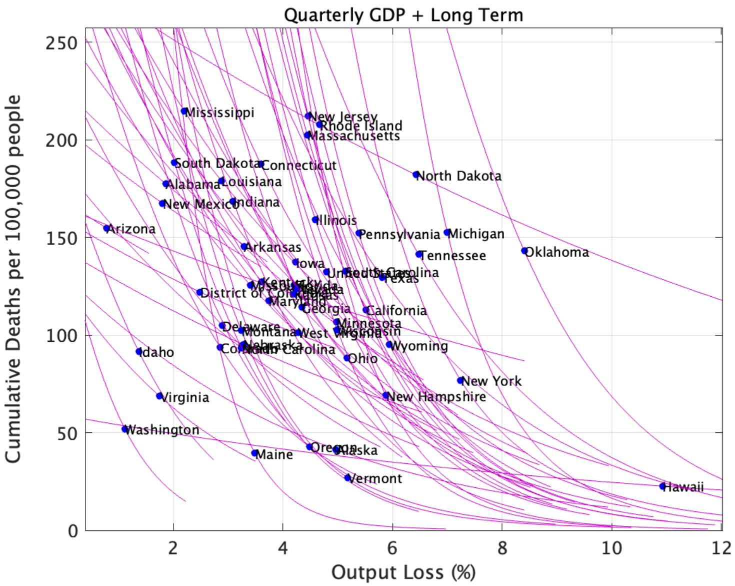
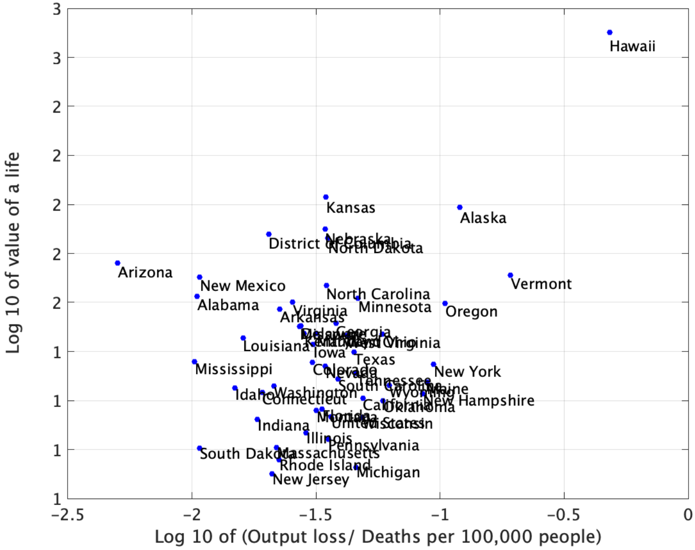

Quarterly GDP + Long Term
Cumulative Deaths per 100,000 people
Output Loss (%)
0
50
100
150
200
250
2
4
6
8
10
12
Mississippi
New Jersey
Rhode Island
Massachusetts
South Dakota
Connecticut
Alabama
Louisiana
North Dakota
New Mexico
Indiana
Illinois
Arizona
Pennsylvania
Michigan
Arkansas
Tennessee
Oklahoma
Iowa
Texas
California
Maryland
Georgia
Minnesota
Delaware
Montana
Wisconsin
Idaho
Wyoming
Ohio
New York
Virginia
New Hampshire
Washington
Maine
Alaska
Vermont
Hawaii

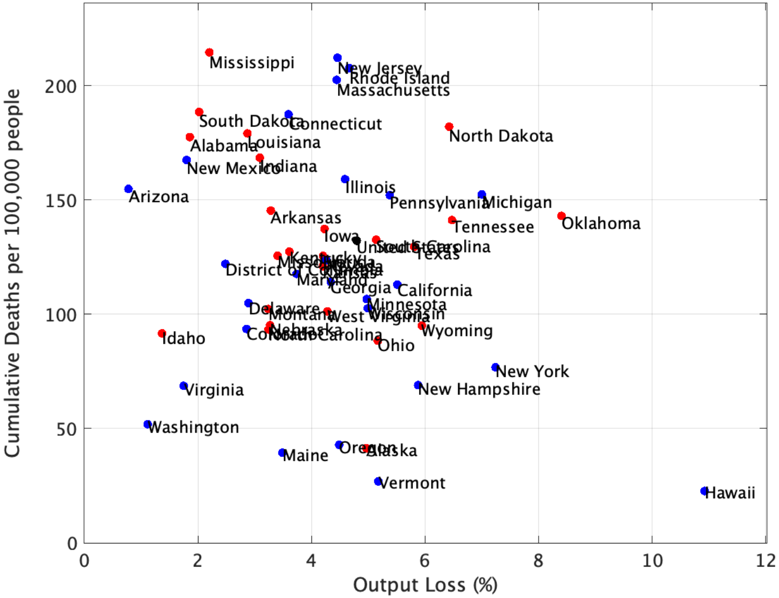
Table: Table of the Values of a Life (per million, Chained 2012 dollars)

| Country | VoL | Country | VoL | Country | VoL |
|---|---|---|---|---|---|
| Hawaii | 117.4 | Georgia | 6.7 | Maine | 3.3 |
| District of Columbia | 53.2 | Ohio | 6.2 | South Carolina | 3.2 |
| Alaska | 28.3 | Texas | 6.1 | United States | 3.2 |
| Kansas | 23.6 | Missouri | 6.0 | Oklahoma | 3.2 |
| North Dakota | 20.6 | Iowa | 5.9 | Mississippi | 3.2 |
| Nebraska | 19.2 | Louisiana | 5.9 | Massachusetts | 3.1 |
| Arizona | 10.3 | Arkansas | 5.8 | Idaho | 3.0 |
| Minnesota | 10.0 | Colorado | 5.6 | Wisconsin | 2.9 |
| Vermont | 9.9 | Washington | 5.3 | Illinois | 2.9 |
| New Mexico | 9.5 | Kentucky | 5.1 | Indiana | 2.7 |
| Virginia | 9.1 | Wyoming | 4.9 | Florida | 2.6 |
| North Carolina | 9.1 | Connecticut | 4.8 | Montana | 2.6 |
| Oregon | 8.4 | West Virginia | 4.7 | Pennsylvania | 2.5 |
| Delaware | 8.4 | California | 4.6 | South Dakota | 2.2 |
| Maryland | 7.4 | Nevada | 4.4 | New Jersey | 2.0 |
| Alabama | 6.9 | Tennessee | 3.9 | Rhode Island | 1.8 |
| New York | 6.8 | New Hampshire | 3.8 | Michigan | 1.6 |

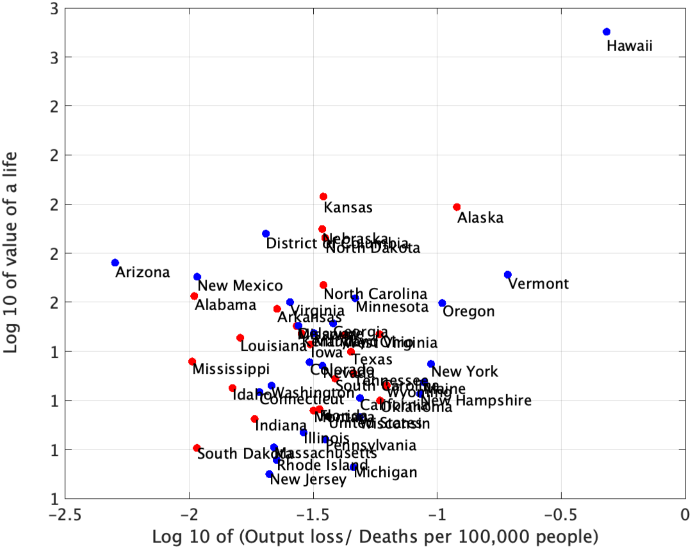
| Mean | Variance | 50 % | 5 % | 95 % |
|---|---|---|---|---|
| 9.5 | 17.5 | 5.2 | 1.9 | 27.9 |


Log 10 of value of a life
Log 10 of (Output loss/ Deaths per 100,000 people)
3
3
2
2
2
2
2
1
1
1
1
−2.5
−2
−1.5
−1
−0.5
0
Hawaii
Kansas
Alaska
District of Columbia
Nebraska
North Dakota
Arizona
New Mexico
Vermont
North Carolina
Alabama
Minnesota
Oregon
Virginia
Arkansas
Georgia
West Virginia
Louisiana
Iowa
Texas
Mississippi
New York
Colorado
Nevada
Tennessee
South Carolina
Maine
Wyoming
Idaho
Washington
Connecticut
New Hampshire
California
Oklahoma
Florida
Montana
Wisconsin
Indiana
Illinois
Pennsylvania
South Dakota
Massachusetts
Rhode Island
Michigan
New Jersey

# Red and blue states



# Red and blue states



# Concluding Remarks

- There is a large heterogeneity of the willingness to pay (WTP) for reducing a COVID-19 death across countries and regions.
  - 0.9 million dollars in the U.S.; 19.5 million dollars in Japan
  - 730 oku-yen in Shimane; 5.5 oku-yen in Tokyo
- WTP is weakly (strongly) correlated with the ratio of output loss to COVID-19 deaths across countries or across states in the U.S. (across prefectures in Japan).

# Concluding Remarks

Our analysis can be used in the following ways:

- To predict economic activity in the future.
  - All else equal, a country/region with a higher VoL is likely to experience a more sluggish recovery.
- To put into perspective your attitude towards how to balance infection risk and an ordinary life.
  - After seeing these regional differences, you may think that you has put too much (little) weight on reducing COVID-19 deaths over protecting an ordinary life .