Appendix C: Public Health Policy Categories in the Protective Policy Index

Public health measures are deployed according to their expected efficacy. Under normal circumstances, previous outbreaks involving similar pathogens have enabled evaluation of the effectiveness of such policies on the basis of observed transmission within and between communities. These responses are pre-considered to the extent possible, although they generally focus on influenza (Henry 2018; Iskander et al. 2013; Rosella et al. 2013). Considering the unique virulence of the coronavirus responsible for coronavirus disease 2019 (COVID-19), the public health community’s initial perception of what constituted a stringent response was based as much on the evolving expectations of the disease’s unique features as on historical experience with related outbreaks (such as Middle East respiratory syndrome and severe acute respiratory syndrome; see Centers for Disease Control and Prevention 2020, 554, for a discussion of the uncertainty around transmission during the early months of the pandemic). Policy-makers are also human and face a variety of information issues and cognitive biases in developing policies (Halpern et al. 2020). In assigning weights as part of our index construction, we used categories based on dimensions of public health response used in previous outbreaks and, within categories, coded the responses ordinally by stringency of response. Cardinal weights were assigned through consultation with public health and medical professionals. Note that these weights were deemed appropriate during the alert phase (the very first days or weeks of rising global infections) and the early weeks of the pandemic phase. See Centers for Disease Control and Prevention (2016) for a description of the pandemic phase continuum. The following describes the weights applied to each sector as listed in Table C.1:

- The border closures categories were of paramount importance in responding during the alert period (the very first weeks) of the pandemic and remained important in preventing new infections due to interterritorial externalities in public health response. These represent 22.5 percent of the maximum possible value of the index. Note that some jurisdictions do not have any sea borders (e.g., Manitoba) or land borders (e.g., Hawaii). Also, the national government has a larger selection of border closure options at its disposal than do sub-national governments. We do not correct for this structural asymmetry in the present analysis. This bias toward the federal government in the construction of the borders category accounts for much of the marginal contribution of the federal Protective Policy Index (PPI) to the total PPI.
- Limits on or closures of schools, large venues, restaurants, non-essential businesses, public transportation, government offices, and places of employment are policies aimed at reducing infections from community spread. Each of these is also graduated on the basis of the strictness of the restriction implemented. We code them separately because different governments chose to close some but not others or implemented closures of each at different times. Together, they represent 35 percent of the maximum possible value of the index.
- Restrictions on mobility for the healthy population (personal mobility, social gatherings) is similarly aimed at reducing infections from community spread. Again, these categories are graduated on the basis of the stringency of the measures put in place. These measures are distinct from the previous set because they represent an infringement on individuals’ liberties. They do, however, function similarly from an epidemiological perspective to limit community spread and represent 22.5 percent of the maximum possible value of the index. When combined with the previous set of measures, limiting community spread accounts for 57.5 percent of the maximum possible value.
- Publicly mandated hygiene practices—mandatory personal protective equipment (PPE) and quarantine for suspected exposures—are intended to minimize or prevent community spread. In the case of PPE, this works by severely limiting the ability of the virus to spread through droplets expelled by those who are infected but might not know that they are and, in the case of quarantine, by physically isolating the carrier from the rest of the population. These practices represent 12.5 percent of the maximum possible value of the index. Note that they do not include changing requirements imposed on medical facilities during the pandemic because we measure only public health policies, not medical practices.
- Last, states of emergency is a category that captures the government’s commitment to handling the crisis through policy. It enables the adoption of some policies that may violate civil liberties and enables enforcement of many of the hygiene practices and business restrictions. This category represents 7.5 percent of the maximum possible value of the index.

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Table C.1: Public Health Policy Categories and Their Weights in the Index

| Category                        | Variable Name | Values                                                                 | Maximum Value in Category | Weight in Index, % |
|---------------------------------|---------------|------------------------------------------------------------------------|---------------------------|--------------------|
| 1. International and domestic air borders closure | air_bord      | All air borders are closed (3). All international air borders are closed (2). Air borders with select countries are closed (1). All air borders are open (0). | 3                         | 7.5                |
| 2. International and domestic land borders closure | land_bord     | All land borders are closed (3). All international land borders are closed (2). Land borders with select countries are closed (1). All land borders are open (0). | 3                         | 7.5                |
| 3. International and domestic sea borders closure | sea_bord      | All sea borders are closed (3). All international sea borders are closed (2). Sea borders with select countries are closed (1). All sea borders are open (0). | 3                         | 7.5                |
| 4. Limits on size of social gatherings | soc_gath      | All social gatherings are prohibited (4). Social gatherings of 10 or more people are prohibited (3). Social gatherings of 50 or more people are prohibited (2). Social gatherings of 100 or more people are prohibited (1). Social gatherings are not restricted (0). | 4                         | 10                 |
| 5. Closing of schools | schools       | Full closure of K–12 schools (4). Partial closure of K–12 schools (2). K–12 schools are not required to close (0). | 4                         | 10                 |
| 6. State of emergency | emerg         | State of emergency (3) No state of emergency (0)                        | 3                         | 7.5                |
| 7. Closure of entertainment venues and stadiums | venues        | Closure of entertainment venues/stadiums (1) Entertainment venues and stadiums are not required to close (0) | 1                         | 2.5                |
| 8. Closure of restaurants | restrts       | Restaurants are closed except for takeout and delivery (2). The operation of restaurants is not restricted (0). | 2                         | 5                  |
| 9. Closure of non-essential businesses | ne_busn      | Non-essential businesses are required to close (2). The operation of non-essential businesses is not restricted (0). | 2                         | 5                  |
| 10. Closure of government offices | gov_offs      | Government offices are closed to the public (2). Government offices are open (0). | 2                         | 5                  |
| 11. Working from home requirement for businesses and organizations | wfh           | Working from home requirement (1) No working from home requirement (0) | 1                         | 2.5                |
| 12. Personal mobility restrictions | ind_mob       | Residents require a pass to leave home (5). Residents are to stay at home except for essential needs (4). Curfew (1) No restrictions on leaving home (0) | 5                         | 12.5               |

(Continued)
Table C.1: Continued

| Category                        | Variable Name | Values                                                                 | Maximum Value in Category | Weight in Index, % |
|---------------------------------|---------------|------------------------------------------------------------------------|---------------------------|--------------------|
| 13. Self-isolation or quarantine requirements | med_stay      | Mandatory quarantine for specific categories of residents (3). Quarantine is advised for specific categories of residents (1). No policies require quarantine (0). | 2                         | 5                  |
| 14. Public transportation closures | publ_tr       | Public transportation is closed (2). The operation of public transportation is not restricted (0). | 2                         | 5                  |
| 15. Mandatory wearing of PPE or masks | masks        | Wearing of masks and other PPE is required (2). Wearing of masks and other PPE is not required (0). | 3                         | 7.5                |
| **Total**                       |               |                                                                       |                           | 40                 | 100                |

Notes: PPE = personal protective equipment.

1 Because of their singular presence and in fact, feasibility, in but a few out of our sample of 62 countries, some public health measures that drew attention in the US or in European nations (e.g., closing of nurseries, closing of nursing homes, etc.) are not included in the global PPI.

Source: Authors’ compilation.
Appendix D: Institutional Origins of COVID-19 Public Health Protective Policy Response (PPI) Data Set Version 1.2

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Codebook

May 2020
The Protective Policy Index (PPI) project compiles comprehensive data on variation in governments’ response to the spread of coronavirus disease 2019 (COVID-19) around the globe. We generalized the policy responses and coding as much as possible. However, variations in coding between countries is possible because of the wording of policy announcements. The project is driven by theoretical expectation that institutional factors drive the difference in states’ actions. The codebook presents the list of coded variables as well as the coding rules that were followed during the data collection process.

Case Identification Variables
1. cname: Country name according to the Correlates of War (COW) project
2. ccode: COW country code
3. cabbr: COW country abbreviation
4. isocode: International Organization for Standardization (ISO) 3166 country code
5. isoabbr: country abbreviation according to ISO 3166
6. state_province: the name of the corresponding administrative division in which the policy action takes place
7. iso_state: ISO 3166 code of the administrative subdivision
8. city_name: contains information on the name of the city where the action takes place
9. less_city: this field is for the cases in which the place is smaller than the city (e.g., town, village)

Announcement Variables
1. report_year, report_month, report_day: intended to capture the exact day when the authorities started taking actions to fight the spread of the disease. Even though we cannot guarantee that it was the first report issued announcing a specific government action of interest, given how news reporting works, the day of the report should be indicative of the day of announcement.
2. report_time: codes the time of the report. To ensure that time is standardized, we convert all local time to Eastern Standard Time.
3. who: contains information on who announced the policy (e.g., Andrew Cuomo).
4. institution: contains information on what institution announced the policy (e.g., governor)
5. year_poleff, month_poleff, day_poleff: codes the day on which the policy will start being effective.
6. school_closure_full: this variable indicates K–12 school closures. It is coded as 1 if the country or unit implemented the full school closure policy and 0 if otherwise.
7. school_closure_partial: this variable indicates K–12 school closures; coded as 1 if the country implemented the school closure policy for some grades but not all and 0 if otherwise.

Border Shutdown
1. air_shut: the variable codes whether the authorities put restrictions on domestic and international flights in general. It is a dichotomous variable, coded as 1 if there is an air shutdown implemented and 0 if otherwise.
2. land_shut: the variable codes whether the authorities put restrictions on domestic and international flights in general. It is a dichotomous variable, coded as 1 if there is a land shutdown and 0 if otherwise.
3. sea_shut: the variable codes whether the authorities put restrictions on domestic and international flights in general. It is a dichotomous variable, coded as 1 if there is a sea border shutdown and 0 if otherwise.
4. intair_shut_full: the variable indicates whether the international air border shutdown is full or not: 1 indicates a full shutdown, 0 otherwise.
5. intair_shut_part: the variable indicates whether the international air border shutdown is partial or not: 1 indicates a partial shutdown, 0 otherwise. In the case of a partial shutdown, the borders are open only for essential travel, traveling from certain high-risk countries is banned, or both.
6. intland_shut_full: the variable indicates whether the international land border shutdown is full or not: 1 indicates a full shutdown, 0 otherwise.

International Borders
1. air_shut: the variable codes whether the authorities put restrictions on domestic and international flights in general. It is a dichotomous variable, coded as 1 if there is an air shutdown implemented and 0 if otherwise.
2. land_shut: the variable codes whether the authorities put restrictions on domestic and international flights in general. It is a dichotomous variable, coded as 1 if there is a land shutdown and 0 if otherwise.
3. sea_shut: the variable codes whether the authorities put restrictions on domestic and international flights in general. It is a dichotomous variable, coded as 1 if there is a sea border shutdown and 0 if otherwise.
4. intair_shut_full: the variable indicates whether the international air border shutdown is full or not: 1 indicates a full shutdown, 0 otherwise.
5. intair_shut_part: the variable indicates whether the international air border shutdown is partial or not: 1 indicates a partial shutdown, 0 otherwise. In the case of a partial shutdown, the borders are open only for essential travel, traveling from certain high-risk countries is banned, or both.
6. intland_shut_full: the variable indicates whether the international land border shutdown is full or not: 1 indicates a full shutdown, 0 otherwise.

Note that we coded international air border shutdown as full even if the borders remained open for citizens and permanent residents.
Note that we coded international land border shutdown as full even if the borders remained open for citizens and permanent residents.

7. intland_shut_part: the variable indicates whether the international land border shutdown is partial or not: 1 indicates a partial shutdown, 0 otherwise. In the case of a partial shutdown, the borders are open only for essential travel, traveling from certain high-risk countries is banned, or both.

8. intsea_shut_full: the variable indicates whether the international sea border shutdown is full or not: 1 indicates a full shutdown, 0 otherwise.

Note that we coded international sea border shutdown as full even if the borders remained open for citizens and permanent residents.

9. intsea_shut_part: the variable indicates whether the international sea border shutdown is partial or not: 1 indicates a partial shutdown, 0 otherwise. In the case of a partial shutdown, the borders are open only for essential travel, traveling from certain high-risk countries is banned, or both.

**Domestic Borders**

10. domair_shut: the variable indicates whether the domestic air travel was shut down: 1 indicates a shutdown, 0 otherwise.

11. domland_shut: the variable indicates whether domestic land travel was shut down: 1 indicates a shutdown, 0 otherwise.

12. domsea_shut: the variable indicates whether domestic sea travel was shut down: 1 indicates shutdown, 0 otherwise.

**Social Gatherings**

Restrictions were put on the size of public gatherings to contain the spread of the disease. Variables are coded on the basis of the maximum number of people that are allowed to gather.

1. soc_gathering_100: fewer than 100
2. soc_gathering_50: fewer than 50
3. soc_gathering_10: fewer than 10
4. soc_gathering_2: fewer than 2

**Stay-at-Home Orders**

1. curfew: The variable codes orders that require citizens to abstain from leaving their houses between certain hours of the day.

2. shelter_in_place_pause: requirement for citizens to stay home besides traveling for essential needs (e.g., groceries, seeking medical help, or daily workout); 1 indicates shelter in place or pause, 0 otherwise.

3. lockdown: the variable indicates a situation in which citizens need written permission to leave their house other than walking a dog or going to the nearest grocery or pharmacy.

**Business Closures**

1. noness_bus_close: the variable indicates policies that require non-essential businesses to close; 1 indicates non-essential businesses are closed, 0 otherwise (non-essential businesses are, e.g., hair salon, gym, shops).

2. rest_close: the variable indicates restaurant, cafe, and bar closures; 1 indicates public dining places are closed, 0 otherwise.

• Note that even restaurants, cafes, and bars are open for takeout and delivery, we coded as closure.

3. ent_close: the variable indicates whether entertainment businesses such as malls, night clubs, and casinos are closed; 1 indicates entertainment sector is closed, 0 otherwise.

**Other Policy Responses**

1. self_iso: the variable codes that people showing symptoms of COVID-19 or people who recently traveled (domestically or internationally) are suggested to stay at home for a period of time; also includes self-isolation for certain age groups. The variable takes the value of 1 if there is a policy of self-isolation in place and 0 otherwise.

2. mand_quarantine: the variable codes that people showing symptoms of COVID-19 or people who recently traveled (domestically or internationally) are required to quarantine in their house or in a place designated by policy-makers for a period of time; also includes quarantine for certain age groups. The variable takes the value of 1 if there is a policy of mandatory quarantine in place and 0 otherwise.

• Note that the main difference between self-isolation and mandatory quarantine is that the mandatory quarantine variable includes some sort of enforcement mechanism. In Canada, self-isolation and mandatory quarantine are the same. However, we look not at the strength of enforcement mechanism but rather at the intention of enforcement.

3. state_emergency: the variable codes whether a state of emergency is implemented. It takes the value of 1 if the state of emergency was announced and 0 otherwise.

4. govoff_close: the variable indicates that government offices are closed to the public or the offices are
closed. It is a dichotomous variable and takes the value of 1 if the government offices were closed and 0 otherwise.

5. home_office: the variable indicates whether workers are required to work from home. The variable is dichotomous and takes the value of 1 if workers are required to work from home and 0 otherwise.

6. restrict_ptrans: the variable codes whether there are restrictions on public transportation. The variable takes the value of 1 if there are such restrictions and 0 otherwise.

7. ppe: the variable codes whether citizens are required to wear masks or other protective gear while in public places (e.g., grocery stores). The variable takes the value of 1 if there are such measures and 0 otherwise.
Appendix E: Comparison of the Protective Policy Index with the Item Response Theory–Based Index

With scores for each category of policies as ordinal responses, we applied the \textit{ordIRT} function (Imai et al. 2016, 640). The model underlying this function is

\[
Pr\left(y_{ij} = 0\right) = \Phi\left(-\tau_j \alpha_j^* - \tau_j x_i \beta_j \right)
\]

\[
Pr\left(y_{ij} = 1\right) = \Phi\left(-\tau_j \alpha_j^* + \tau_j x_i \beta_j \right) - \left(-\tau_j \alpha_j^* - \tau_j x_i \beta_j \right)
\]

\[
Pr\left(y_{ij} = 2\right) = 1 - \Phi\left(-\tau_j \alpha_j^* + \tau_j x_i \beta_j \right),
\]

where \(y_{ij}\) is the level of response of a government on a particular date (i) in a given category (j), \(\beta\) reflects the discriminating power of the item, and \(\alpha^*\) and \(\tau\) are auxiliary parameters (jointly fixing the thresholds defining the observed categories). \(x_i\) is the aggressiveness of the policies. The procedure estimates \(x_i\) as well as \(\beta\), \(\alpha^*\), and \(\tau\). We treat the estimates of \(x_i\) as the estimates of the stringency of public health measures for the purpose of comparison with the Protective Policy Index (PPI).

The resulting sub-national version of the index is correlated with the sub-national PPI at 0.987, whereas the resulting overall score is correlated with the overall PPI at 0.990.

\[\text{Figure E.1: Comparison of PPI Values with IRT-Generated Values: (a) IRT-Based Index in Canada, (b) IRT-Based Index in the US, (c) PPI in Canada, and (d) PPI in the US}\]

Notes: PPI = Protective Policy Index; IRT = item response theory.

Sources: Shvetsova et al. (2020) and authors’ calculations.

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### Table E.1: Granger Causality Tests (Effect of Death Rate or Incidence Rate on Sub-National IRT-Based Index): Canada and the United States

| Province or State | IV = Cases per 1 Million |  | IV = Deaths per 1 Million |
|-------------------|--------------------------|--------------------------|--------------------------|
|                   | Depth = 5 Days            | Depth = 10 Days           |                          |
|                   | $F$ | p-value | $F$ | p-value | $F$ | p-value | $F$ | p-value |
| Canada            |  |  |  |  |  |  |  |  |
| AB                | 0.32 | 0.900 | 0.11 | 1.000 | 0.44 | 0.820 | 0.16 | 0.998 |
| BC                | 0.63 | 0.681 | 0.45 | 0.916 | 0.25 | 0.941 | 0.39 | 0.945 |
| MB                | 1.74 | 0.136 | 1.61 | 0.127 | 5.52 | 0.000 | 2.44 | 0.018 |
| NB                | 3.55 | 0.007 | 1.75 | 0.092 | 3.55 | 0.007 | 1.75 | 0.092 |
| NL                | 0.00 | 1.000 | 0.00 | 1.000 | 0.00 | 1.000 | 0.00 | 1.000 |
| NS                | 0.05 | 0.998 | 0.07 | 1.000 | 0.96 | 0.447 | 0.30 | 0.979 |
| ON                | 0.18 | 0.968 | 0.06 | 1.000 | 0.79 | 0.562 | 0.29 | 0.980 |
| PE                | 2.20 | 0.064 | 0.85 | 0.581 | 2.20 | 0.064 | 0.85 | 0.581 |
| QC                | 0.04 | 0.999 | 0.00 | 1.000 | 0.14 | 0.982 | 0.03 | 1.000 |
| SK                | 0.12 | 0.987 | 0.15 | 0.999 | 0.75 | 0.586 | 0.32 | 0.972 |
| United States     |  |  |  |  |  |  |  |  |
| AK                | 1.49 | 0.203 | 0.91 | 0.530 | 1.38 | 0.242 | 1.49 | 0.170 |
| AL                | 0.05 | 0.998 | 0.14 | 0.999 | 0.05 | 0.999 | 0.04 | 1.000 |
| AR                | 0.15 | 0.979 | 0.13 | 0.999 | 0.44 | 0.822 | 0.70 | 0.718 |
| AZ                | 0.17 | 0.974 | 0.08 | 1.000 | 0.09 | 0.993 | 0.20 | 0.995 |
| CA                | 0.17 | 0.973 | 0.29 | 0.981 | 0.14 | 0.981 | 0.31 | 0.976 |
| CO                | 0.54 | 0.744 | 0.30 | 0.978 | 0.74 | 0.599 | 0.35 | 0.963 |
| CT                | 0.34 | 0.889 | 0.58 | 0.824 | 0.10 | 0.992 | 0.15 | 0.999 |
| DE                | 0.14 | 0.983 | 0.06 | 1.000 | 0.08 | 0.996 | 0.03 | 1.000 |
| FL                | 0.72 | 0.607 | 0.51 | 0.874 | 0.49 | 0.785 | 0.38 | 0.948 |
| GA                | 0.99 | 0.432 | 1.37 | 0.217 | 0.66 | 0.654 | 0.25 | 0.988 |
| HI                | 0.12 | 0.988 | 0.17 | 0.998 | 0.04 | 0.999 | 0.06 | 1.000 |
| IA                | 0.20 | 0.961 | 0.49 | 0.887 | 0.17 | 0.974 | 0.45 | 0.915 |
| ID                | 0.45 | 0.810 | 1.70 | 0.105 | 0.62 | 0.683 | 0.49 | 0.892 |
| IL                | 0.15 | 0.980 | 0.05 | 1.000 | 0.06 | 0.997 | 0.04 | 1.000 |
| IN                | 0.39 | 0.855 | 0.92 | 0.522 | 0.20 | 0.962 | 0.23 | 0.991 |
| KS                | 0.21 | 0.958 | 0.17 | 0.997 | 0.18 | 0.970 | 0.10 | 1.000 |
| KY                | 0.63 | 0.680 | 0.61 | 0.797 | 1.35 | 0.254 | 0.65 | 0.767 |
| LA                | 0.74 | 0.593 | 0.38 | 0.948 | 0.29 | 0.918 | 0.14 | 0.999 |
| MA                | 0.71 | 0.620 | 0.27 | 0.984 | 0.30 | 0.908 | 0.05 | 1.000 |
| MD                | 0.19 | 0.966 | 0.10 | 1.000 | 0.08 | 0.995 | 0.10 | 1.000 |
| ME                | 1.30 | 0.274 | 0.90 | 0.538 | 0.70 | 0.622 | 0.37 | 0.953 |
| MI                | 0.61 | 0.690 | 0.35 | 0.964 | 0.33 | 0.892 | 0.04 | 1.000 |
| MN                | 0.22 | 0.954 | 0.27 | 0.986 | 0.20 | 0.961 | 0.40 | 0.940 |
| MO                | 2.26 | 0.058 | 1.75 | 0.094 | 0.39 | 0.856 | 0.75 | 0.679 |
| MS                | 0.72 | 0.608 | 0.37 | 0.956 | 1.25 | 0.297 | 0.10 | 1.000 |
| MT                | 0.62 | 0.686 | 0.14 | 0.999 | 0.36 | 0.873 | 0.10 | 1.000 |
| NC                | 0.88 | 0.501 | 0.14 | 0.999 | 0.35 | 0.881 | 0.08 | 1.000 |
| ND                | 0.03 | 0.999 | 0.23 | 0.992 | 0.03 | 1.000 | 0.03 | 1.000 |
| NE                | 0.04 | 0.999 | 0.03 | 1.000 | 0.02 | 1.000 | 0.03 | 1.000 |

(Continued)
### Table E.1: Continued

| Province or State | IV = Cases per 1 Million |  | IV = Deaths per 1 Million* |  |
|-------------------|--------------------------|---|----------------------------|---|
|                   | **Depth = 5 Days** | **Depth = 10 Days** | **Depth = 5 Days** | **Depth = 10 Days** |
|                   | **F** | **p-value** | **F** | **p-value** | **F** | **p-value** | **F** | **p-value** |
| NH                | 0.14  | 0.981      | 0.23  | 0.993      | 0.21  | 0.959      | 0.21  | 0.994      |
| NJ                | 0.19  | 0.965      | 0.63  | 0.782      | 0.05  | 0.998      | 0.09  | 1.000      |
| NM                | 0.08  | 0.995      | 0.14  | 0.999      | 0.05  | 0.998      | 0.13  | 0.999      |
| NV                | 0.34  | 0.888      | 0.02  | 1.000      | 0.23  | 0.947      | 0.01  | 1.000      |
| NY                | 0.53  | 0.756      | 0.43  | 0.924      | 0.17  | 0.971      | 0.02  | 1.000      |
| OH                | 0.02  | 1.000      | 0.02  | 1.000      | 0.02  | 1.000      | 0.01  | 1.000      |
| OK                | 0.09  | 0.994      | 0.34  | 0.967      | 0.14  | 0.982      | 0.26  | 0.988      |
| OR                | 0.93  | 0.468      | 0.53  | 0.862      | 0.55  | 0.737      | 0.52  | 0.870      |
| PA                | 0.09  | 0.993      | 0.01  | 1.000      | 0.04  | 0.999      | 0.01  | 1.000      |
| RI                | 0.26  | 0.931      | 0.11  | 1.000      | 0.24  | 0.946      | 0.05  | 1.000      |
| SC                | 0.78  | 0.566      | 0.53  | 0.858      | 0.30  | 0.911      | 0.39  | 0.946      |
| SD                | 0.08  | 0.995      | 0.32  | 0.973      | 0.87  | 0.505      | 0.81  | 0.622      |
| TN                | 0.60  | 0.703      | 0.92  | 0.526      | 0.54  | 0.748      | 0.69  | 0.729      |
| TX                | 0.46  | 0.808      | 0.03  | 1.000      | 0.34  | 0.889      | 0.03  | 1.000      |
| UT                | 0.68  | 0.638      | 1.34  | 0.233      | 0.61  | 0.695      | 1.01  | 0.446      |
| VA                | 0.34  | 0.889      | 0.66  | 0.755      | 0.17  | 0.972      | 0.29  | 0.980      |
| VT                | 0.79  | 0.559      | 0.61  | 0.797      | 0.45  | 0.810      | 0.32  | 0.973      |
| WA                | 0.56  | 0.731      | 0.33  | 0.970      | 0.58  | 0.716      | 0.28  | 0.983      |
| WI                | 2.26  | 0.058      | 0.94  | 0.502      | 0.34  | 0.885      | 0.04  | 1.000      |
| WV                | 0.62  | 0.683      | 0.42  | 0.932      | 0.10  | 0.992      | 0.19  | 0.996      |
| WY                | 0.92  | 0.473      | 0.90  | 0.540      | 0.11  | 0.990      | 0.12  | 0.999      |

*Because for some jurisdictions the measured death rate would be constant at zero, for these tests we have added \(0.01 \times (\text{incidence rate})\) to all death rate observations.

Notes: IRT = item response theory; IV = independent variable.

Sources: Shvetsova et al. (2020) and authors’ calculations.
Appendix F: Comparison of the Protective Policy Index with the Oxford COVID-19 Government Response Tracker Index

The Oxford COVID-19 Government Response Tracker (OxCGRT) project at Oxford (Hale et al. 2020) maintains an index of the stringency of the government response to coronavirus disease 2019 (COVID-19). This index is similar to our index in that it aggregates information about policies along various dimension of non-medical public health response. The total number of policy categories used in the computation of OxCGRT’s stringency index is nine, and seven of these categories are similar to the ones used in the computation of the Protective Policy Index (PPI). The similar categories are as follows:

- C1_School closing
- C2_Workplace closing
- C4_Restrictions on gatherings
- C5_Close public transport
- C6_Stay at home requirements
- C7_Restrictions on internal movement
- C8_International travel controls

The PPI analogue of “C3_Cancel public events” is “closing of public venues.” The PPI additionally accounts for the closure of non-essential businesses, PPE requirements (such as masks), and required self-isolation and quarantine for individuals travelling from COVID-19 hotspots or who are known to have been exposed.

In our global sample, the overall PPI is correlated with the OxCGRT index at 0.901. Figure F.1 reports the comparisons of the values of the two indices for each of the threshold dates in our analysis.
Figure F.1: Comparison of PPI and OxCGRT Values

Notes: PPI = Protective Policy Index; OxCGRT = Oxford COVID-19 Government Response Tracker.
Sources: Hale et al. (2020); Shvetsova et al. (2020).
Appendix G: The Early Threat Indicators and the Sub-National Protective Policy Index

Table G.1: Granger Causality Tests (Effect of Death Rate and Incidence Rate on Sub-National PPI) in Canada and the United States

| Province or State | Depth = 5 days | Depth = 10 days | Depth = 5 days | Depth = 10 days |
|-------------------|----------------|-----------------|----------------|-----------------|
|                   | F   | p-value | F   | p-value | F   | p-value | F   | p-value |
| Canada            |     |         |     |         |     |         |     |         |
| AB                | 0.72 | 0.611   | 0.30 | 0.979   | 0.57 | 0.724   | 0.37 | 0.953   |
| BC                | 0.75 | 0.586   | 0.67 | 0.748   | 1.05 | 0.392   | 1.18 | 0.322   |
| MB                | 4.24 | 0.002   | 2.13 | 0.035   | 2.15 | 0.069   | 3.87 | 0.000   |
| NB                | 1.09 | 0.373   | 0.66 | 0.754   | 1.09 | 0.373   | 0.66 | 0.754   |
| NL                | 0.00 | 1.000   | 0.00 | 1.000   | 0.00 | 1.000   | 0.00 | 1.000   |
| NS                | 1.01 | 0.420   | 0.58 | 0.822   | 0.05 | 0.998   | 0.05 | 1.000   |
| ON                | 3.49 | 0.007   | 1.46 | 0.175   | 0.64 | 0.671   | 0.13 | 0.999   |
| PE                | 2.80 | 0.023   | 2.22 | 0.028   | 2.80 | 0.023   | 2.22 | 0.028   |
| QC                | 0.40 | 0.850   | 0.24 | 0.991   | 0.09 | 0.994   | 0.04 | 1.000   |
| SK                | 1.08 | 0.378   | 0.63 | 0.783   | 0.14 | 0.983   | 0.15 | 0.999   |
| United States     |     |         |     |         |     |         |     |         |
| AK                | 0.77 | 0.573   | 0.57 | 0.830   | 1.76 | 0.131   | 2.42 | 0.017   |
| AL                | 0.15 | 0.978   | 0.40 | 0.943   | 0.20 | 0.963   | 0.13 | 0.999   |
| AR                | 0.39 | 0.855   | 0.41 | 0.934   | 1.06 | 0.388   | 1.65 | 0.113   |
| AZ                | 0.52 | 0.760   | 0.53 | 0.864   | 0.32 | 0.900   | 1.16 | 0.335   |
| CA                | 0.04 | 0.999   | 0.22 | 0.994   | 0.00 | 1.000   | 0.19 | 0.996   |
| CO                | 0.55 | 0.739   | 0.28 | 0.984   | 0.46 | 0.802   | 0.23 | 0.992   |
| CT                | 0.37 | 0.867   | 0.64 | 0.775   | 0.16 | 0.977   | 0.16 | 0.998   |
| DE                | 0.17 | 0.973   | 0.10 | 1.000   | 0.09 | 0.994   | 0.03 | 1.000   |
| FL                | 1.55 | 0.183   | 2.06 | 0.042   | 0.78 | 0.569   | 1.21 | 0.301   |
| GA                | 0.86 | 0.514   | 1.13 | 0.354   | 0.70 | 0.622   | 0.36 | 0.960   |
| HI                | 0.08 | 0.995   | 0.06 | 1.000   | 0.01 | 1.000   | 0.03 | 1.000   |
| IA                | 0.54 | 0.744   | 0.69 | 0.732   | 0.30 | 0.912   | 0.46 | 0.908   |
| ID                | 0.54 | 0.749   | 5.19 | 0.000   | 1.35 | 0.254   | 1.18 | 0.325   |
| IL                | 0.20 | 0.960   | 0.07 | 1.000   | 0.12 | 0.987   | 0.07 | 1.000   |
| IN                | 0.20 | 0.963   | 0.70 | 0.717   | 0.15 | 0.979   | 0.20 | 0.996   |
| KS                | 0.38 | 0.864   | 0.40 | 0.942   | 0.28 | 0.923   | 0.25 | 0.989   |
| KY                | 1.03 | 0.406   | 0.36 | 0.840   | 4.16 | 0.002   | 1.98 | 0.051   |
| LA                | 2.78 | 0.023   | 1.04 | 0.420   | 0.89 | 0.492   | 0.48 | 0.899   |
| MA                | 0.53 | 0.756   | 0.27 | 0.986   | 0.21 | 0.958   | 0.03 | 1.000   |
| MD                | 0.09 | 0.993   | 0.68 | 0.739   | 0.40 | 0.848   | 0.59 | 0.815   |
| ME                | 4.79 | 0.001   | 3.61 | 0.001   | 2.60 | 0.032   | 2.06 | 0.042   |
| MI                | 0.61 | 0.689   | 0.65 | 0.762   | 0.38 | 0.864   | 0.09 | 1.000   |
| MN                | 0.72 | 0.609   | 0.48 | 0.900   | 0.24 | 0.943   | 0.41 | 0.938   |
| MO                | 7.64 | 0.000   | 6.40 | 0.000   | 0.16 | 0.976   | 0.65 | 0.766   |
| MS                | 1.57 | 0.179   | 0.70 | 0.722   | 1.98 | 0.090   | 0.16 | 0.998   |
| MT                | 0.49 | 0.782   | 0.48 | 0.896   | 0.38 | 0.859   | 0.21 | 0.994   |
| NC                | 0.70 | 0.627   | 0.12 | 0.999   | 0.28 | 0.923   | 0.04 | 1.000   |
| ND                | 0.05 | 0.999   | 0.51 | 0.880   | 0.10 | 0.993   | 0.08 | 1.000   |
| NE                | 0.03 | 1.000   | 0.06 | 1.000   | 0.01 | 1.000   | 0.06 | 1.000   |
| NH                | 0.29 | 0.917   | 0.45 | 0.917   | 0.45 | 0.811   | 0.40 | 0.943   |

(Continued)
### Table G.1: Continued

| Province or State | IV = Cases per 1 Million |  |  | IV = Deaths per 1 Million<sup>a</sup> |  |  |
|-------------------|--------------------------|------------------|------------------|--------------------------|------------------|------------------|
|                   | Depth = 5 days | F | p-value | Depth = 10 days | F | p-value | Depth = 5 days | F | p-value | Depth = 10 days | F | p-value |
| NJ                | 0.07 | 0.996 | 0.25 | 0.990 | 0.01 | 1.000 | 0.03 | 1.000 |
| NM                | 0.12 | 0.987 | 0.19 | 0.996 | 0.09 | 0.994 | 0.22 | 0.994 |
| NV                | 0.76 | 0.580 | 0.20 | 0.995 | 0.45 | 0.811 | 0.06 | 1.000 |
| NY                | 0.56 | 0.733 | 0.31 | 0.976 | 0.04 | 0.999 | 0.01 | 1.000 |
| OH                | 0.06 | 0.998 | 0.02 | 1.000 | 0.06 | 0.997 | 0.01 | 1.000 |
| OK                | 0.42 | 0.830 | 1.45 | 0.181 | 0.34 | 0.886 | 1.04 | 0.420 |
| OR                | 2.35 | 0.049 | 1.09 | 0.384 | 0.88 | 0.498 | 1.08 | 0.394 |
| PA                | 0.11 | 0.989 | 0.08 | 1.000 | 0.06 | 0.997 | 0.03 | 1.000 |
| RI                | 0.23 | 0.948 | 0.14 | 0.999 | 0.19 | 0.964 | 0.18 | 0.997 |
| SC                | 2.27 | 0.056 | 1.53 | 0.152 | 0.79 | 0.560 | 0.90 | 0.538 |
| SD                | 0.35 | 0.884 | 1.73 | 0.095 | 0.50 | 0.778 | 1.60 | 0.127 |
| TN                | 0.86 | 0.509 | 1.69 | 0.104 | 0.88 | 0.500 | 1.33 | 0.236 |
| TX                | 0.71 | 0.621 | 0.05 | 1.000 | 0.62 | 0.688 | 0.06 | 1.000 |
| UT                | 0.85 | 0.521 | 2.13 | 0.035 | 0.57 | 0.725 | 0.94 | 0.503 |
| VA                | 0.51 | 0.767 | 0.55 | 0.847 | 0.21 | 0.956 | 0.13 | 0.999 |
| VT                | 1.81 | 0.121 | 1.74 | 0.093 | 0.90 | 0.489 | 0.74 | 0.682 |
| WA                | 1.34 | 0.257 | 1.47 | 0.173 | 1.24 | 0.300 | 0.67 | 0.743 |
| WI                | 2.57 | 0.033 | 1.28 | 0.260 | 0.36 | 0.872 | 0.06 | 1.000 |
| WV                | 1.88 | 0.108 | 0.97 | 0.477 | 0.22 | 0.951 | 0.64 | 0.774 |
| WY                | 2.55 | 0.034 | 1.79 | 0.081 | 0.14 | 0.983 | 0.27 | 0.986 |

Notes: IV = independent variable; PPI = Protective Policy Index.

<sup>a</sup> Because for some jurisdictions the measured death rate would be constant at zero, for these tests we have added 0.01 × (incidence rate) to all death rate observations.

Sources: Dong et al. (2020), Shvetsova et al. (2020), and authors’ calculations.