Institutional Origins of Protective COVID-19 Public Health Policy Responses: Informational and Authority Redundancies and Policy Stringency [1]

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Abstract:

A multitude of government forms proclaim the same aims of serving their countries and citizens but vary in outcomes. The ongoing COVID-19 pandemic creates new metrics for comparing government performance – the metrics of human deaths, or, alternatively and as we pursue it here, the metrics of government response in preventing human deaths through policy adoption.

We argue in this essay that institutional systems in which multiple policy-makers have overlapping jurisdictions are more likely to generate a rapid policy response to crises than more centralized systems. Furthermore, political institutions that promote multiple and high quality information channels enable the quick response. Because both informational and authority redundancies are institutionally determined, we theorize improved crisis response in democracies, and in more decentralized democracies.

We provide a mathematical model comparing the likelihood of speedy policy response in politically decentralized and centralized institutional systems. Further, we assess our theoretical expectations with an original dataset of stringency of policy measures that were adopted in response to COVID-19 by governments at different levels in 64 countries. We find that democracies and liberal democracies responded stronger faster. Federalism and decentralization in addition to democratic institutions played a less uniform, but still a positive role. Beyond their other acknowledged merits, democratic institutions have superior capacity to mount a quick policy response to unqualified threats.

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1.0 Baseline capacity of institutional systems to respond quickly to the unknown

A multitude of government forms and institutional variations compete around the world in terms of best serving their countries and citizens. What it means to best serve their citizens is, however, a matter of broad interpretation and so disagreements persist about which form of government is the best. The COVID-19 pandemic created new metrics for comparison of governments' performance – the metrics of human deaths, or, alternatively and as we pursue it here, the metrics of the intensity of government response in preventing human deaths through policy adoption (Hsiang et al. 2020, Pueyo 2020). The importance of this metric extends beyond the COVID-19 crisis – as it reflects how reliable the particular institutional forms are as the purported guardians of public health and well-being in a major emergency. Could it be that democracy perhaps makes life better under normal circumstances but fails to preserve it in an existential crisis? Or is democracy an adequate institutional form to the task of confronting existential threats too? These questions are bigger than us (Przeworski et al. 2000). Here we argue merely that decision-making and information gathering redundancies, which are built in into democracies, and decentralized democracies in particular, are the key to the governments' ability to *quickly* respond to an existential crisis. We argue that democracies and federations, which are presumably good for accountability and provide incentives to the politicians to act in the interests of their constituents, also have superior *structural* institutional capacity to more strongly deliver in a crisis.

Here within, we theoretically model and empirically assess the effect of the institutionally enabled informational and decision-making redundancies on the adoption of stringent public health policy as response to COVID-19 pandemic. We compare governments' observed efforts to respond to the crisis rather than the health outcomes that those efforts might have brought about. This study pertains to the early, onset (or *alert*, CDC (2016)) phase of the COVID-19 pandemic as public health policy response was escalating globally. We demarcate the onset phase of the pandemic as the time between January 24 and April 24, 2020.[2] The start of the onset period represents both the day of origin of the global crisis as well as the initial signal of the template for policy response. On January 24, 2020, the first case of COVID-19 was diagnosed in France, indicating that the virus was not contained in China. At the same time the Chinese authorities implemented the lockdown in Hubei to combat the original outbreak. The end of the onset phase corresponds to the first declines in the stringency of public health policy responses in a number of national and subnational jurisdictions worldwide. While we do not exactly know when the period of theoretical interest to us—the period of high uncertainty about the threat and when the threat was perceived as unqualified – ends, we do know that this threshold occurred during the onset phase. We know this because retraction of protective policies at the end of this

[2] Though the theoretical starting point for the response timeline is the date of the signal going out, we also add indicators of the intensity of the outbreak in each country measured as COVID-19 incidence rates in our estimations.

phase indicates information improvements. Thus, we assess several dates during the onset phase as possible early thresholds.[3]

Based on our theoretical expectations, there should be more stringent overall public health response to the COVID-19 crisis in democracies and decentralized polities than in more centralized states and in autocracies. Note that our expectations here are not strategy-based. They are capacity based. We theorize that the rules of policy making vary in the constraints that they impose on the system's ability to respond to the crisis within the limited window of opportunity and when information is extremely limited. We theorize that the baseline of what actors in institutional systems *can* do under such circumstances is variable. Leaders in democracies and federations should have had a greater capacity to adopt measures to mitigate the crisis.

We assess our theoretical expectations with an original dataset of stringency of public health policy measures that were adopted in response to COVID-19 by governments at different levels in 64 countries. With daily measures of overall public health policy stringency, the evidence supports our expectations.

Section 2 below draws from complex systems concepts to identify the prerequisites for political systems' capacity to deliver quick policy response. Section 3 connects these systemic

[3] Putting in stronger policies does not necessarily imply better outcome when information about effectiveness of the policies does not yet exist. This is why we look at what was believed to be strong policies in public health at the time, during the onset phase. Of interest to us is the answer to the question: who acted the earliest and the strongest – which level of government and which institutional agents, rather than the actual resulting reduction in infections (though see VanDusky-Allen et al 2020).

prerequisites with political institutional variables and derives institutional hypotheses. Section 4 describes the global dataset on institutional origins of COVID-19 public health protective policy response as well as the construction of our main dependent variable. Section 5 presents analysis, and section 6 concludes.

2.0 Information multiplexing and functional redundancy

Scholarship on information multiplexing and system redundancies in complex systems dates back to the groundbreaking work by Von Neumann (1956) on reducing error in information processing and output generation in automated systems – on the "synthesis of reliable organisms from unreliable components" (Von Neumann 1956, in the title). Fundamentally, assuming that error in every transmitted signal occurs with an independent probability, the monitoring of multiple signals improves the quality of information that a component receives and on which it acts. Furthermore, assuming that error in responding to a signal will occur with some independent probability in every receiving component, the rate of failure of the system to act on the signal will be reduced if there are multiple components in it that are collecting and processing the incoming information. Since then, it has become the point of consensus that a systems' ability to adequately withstand various shocks, including external attacks, depends on the system's topology (Newman, Barabasi, and Watts 2009), which in the case of government networks is the way in which the receiving and processing of information into decisions is institutionalized.

Even though there existed applications of the redundancy argument to policy since the 1960s (e.g., Landau 1969, Bendor 1985, Ting 2003), the bulk of the literature and the public at large have often viewed the duplication of authority as a source of inefficiency. Brown (1994) lists a number of dimensions of such inefficiency: an oversupply of government activities, conflicting objectives, lack of coordination, and failure to utilize the economies of scale. In addition to that, duplication limits transparency and political accountability in the system and creates opportunities for free-riding (Ting 2003). There were, however, acknowledgements of the benefits of structural redundancies in political institutional design including increased efficiency due to competition (Bendor 1985, Niskanen 1971) and increased opportunities for public debate (Hollander 2010). Consistent with our argument below, Bendor (1985), Landau (1969), Miranda and Lerner (1995), and Ting (2003) see structural institutional redundancies as a source of resilience in organizations. While constitutional level institutional organizations could not be a subject of systematic empirical study with respect to their capacity for rapid crisis response due to the lack of at-large systemic threats until now, the argument has been successfully applied in policy and industrial organization research.

Importantly, as noted earlier, the analogy with the non-strategic 'machines' means that we impute the agents in these institutional systems with several assumed characteristics that are heroic abstractions from reality, assuming away the agency problem. In our theory all decision-makers are singularly motivated and apply maximum effort to fulfil their mandate. Second, we have assumed for the early onset period that such mandate, the objective function of the agent's principal, is quite narrow, and is solely about protecting population health and only from COVID-19 threat.

Multiplexing in Von Neumann's (1956) original definition (pp. 63-64) refers to system design where an information signal is carried simultaneously "on a bundle of N lines" to the same 'machine' or in our case to the same policy authority. With faulty lines delivering a signal, a decision rule can be applied to discern the true message with improved quality. For the binary signal that either there is change in the environment and response is required or there is no change and no need to respond, the ‘machine’ can filter out most of the erroneous messages, as long as error is less likely than a correct signal. This is done by accepting and responding to a ‘majority’ message (possibly using a complicated system of weights on inputs to calculate what constitutes ‘majority’); in this way ‘majorizing’ “amplifies the prevalence of the presence as well as of the absence of impulses” (p.72).

In political systems with information multiplexing then a) a correct response of any single government in a given time period is more likely, and b) if the signal is repeated at a certain interval, a quick response (after fewer rather than more such intervals) by any single government is more likely. Notice that the number of information channels and their quality (interpreted as error probability) both matter.

[Figure 1 here]

As an illustration, consider the information processing in three types of systems shown in Figure 1. Figure 1a depicts the policy response to new information in fully centralized authority structures, without either information multiplexing of jurisdictional overlap. One ‘organ’, at the top, receives new information, ‘signals’, and makes policy decisions. As the ‘signal’ arrives, there is a probability of error in whether it actually reaches the decision-maker or is lost. Notice that the decision-maker itself does not add the probability of error, and accurately reacts to the message that it received: either ‘signal’ or ‘no signal.’ In the schematics in Figure 1a, the probability of policy error for the fully centralized policy authority thus equals the probability of signal error.

Figure 1b is a schematic representation of a centralized policy authority but with informational redundancies. It is a multiplex system, where multiple receptors of the single ‘organ’ independently attempt to receive the signal, each with probability 1-ε, which we assume to be the same probability as in Figure 1a. The inputs are then aggregated via some institutional rule, for example, simple majority, and that information state directs the policy decision that single Authority, A, will produce. Unless ε is too high, or the level of consensus required for action is too demanding, a multiplex will reduce output error relatively to the centralized system as in Figure 1a. Resulting policy error here is still the same as final signal error, but reduced from the base signal error which is exogenously set by the environment.

Figure 1c represents the system with both the input and output, information and policy-making redundancy. While each aggregating multiple information inputs, each 'organ' has a decision-making function constituting a separate policy authority. These policy authorities coexist insofar as their jurisdictions overlap, i.e., when either one of them can produce the policy that covers citizen i. Error probability in the policy output that reaches the individual is greatly reduced here as compared with the schema in Figure 1b.

To formalize the last point, consider a hypothetical political system and denote the set of all policy authorities in the system as G, while its subset, the set of all authorities with the jurisdiction over a representative citizen i, as $J_i \subseteq A$. Fully centralized authority system has $|G| = |J_i| = 1$. We discuss the specific institutional forms featuring different degree of authority redundancy in section 3.

Each authority in set J_i independently from other authorities, receives and responds to signals of threats to the citizen i. Here suppose there is a single threat with true severity θ and assume that this variable can only take values of 0 and 1. Assume also that there are only two types of policies each authority can choose: protect and not protect, $P_j = \{0,1\}$, and that this policy will affect a citizen if and only if the citizen is in that authority's jurisdiction.

The body of evidence presented to each authority consists of the messages of two types – the ones suggesting that the threat is severe ($\mu_j = 1$) and the ones suggesting that the threat is not severe ($\mu_j = 0$). The proportion of the messages that correctly reflect the true state generally depends on the true state. For the proportion of erroneous messages ε, with $\varepsilon \in (0, 1)$, and the threat high, θ=1, the probability of receiving the message that the threat is low is ε. Accordingly,

$$\Pr(\mu_j = 1 | \theta = 1) = 1 - \varepsilon \quad \forall\, j \in G$$

We will assume that each authority responds to the signal that it observes error-free, and is guaranteed to choose protective policies if observes that the threat is high. To state formally, $P_j(\mu_j) = \mu_j$.

Proposition 1. If citizen i is facing a severe threat, the probability that she will receive protective policy is $(1 - \varepsilon^m)$, where $m = |J_i|$.

Corollary 1. A citizen is more likely to enjoy protection from threats in a system with multiple overlapping authorities.[4]

Notice once again that Proposition 1 implicitly assumes that all politicians are the same: honest, educated, hardworking, and decisive. Also, we assume that they all have their constituents' full mandate to protect them from the extreme public health threat.

Of course, since Proposition 1 applies to a single information period, this conclusion also applies to a single information period. In the next period, if the next 'signal' arrives, governments that made an error in period 1 will have an opportunity to correct their policy choices.

[4] This result parallels the results for generally specified "performance levels" in Bender (1985, p. 46-48).

3.0 Institutional determinants of information and policy redundancies

The discussion above logically implies the following conjectures:

R1: Institutional systems that do not restrict information channels will have more stringent response by an early threshold date than those that do.

R2: Institutional systems that promote higher quality and more numerous information channels will have more stringent (public health) response by the early threshold date than those that do not.

R3: Institutional systems with higher level of authority redundancy will have more stringent (public health) response by the early threshold date than those with fewer redundancies.

As policy authority is institutionally defined, structural redundancies in policy authority correspond to specific institutional and constitutional forms which become our explanatory variables. Of course, such correspondence cannot be considered absolute, and informal rules as well as reaching a specific 'balance' in authority legitimacies can influence the presence of redundancies. Furthermore, as mentioned before, political agents, rational and strategic, can opt to either use or ignore the opportunities for policy making which institutions afford them. Still there is a rough correspondence between institutional designs and information and output redundancies,[5] and so here our focus is on which institutions *allow* more opportunities for both informational and authority redundancies in policy-making.

The breadth of information available to decision-makers, redundancies in information channels, are greatly influenced by the institutional framework. There is a marked difference in

[5] For a fascinating analysis of the correspondence between institutions and authority structures, see Cox and McCubbins (1997).

the way autocracies and democracies acquire and process information in policymaking. Civil liberties, such as the freedom of speech and association, allow for a free flow of information both in terms of how the information is acquired and how it propagates. As a result, democracies have the greater capacity to *compare* different sources of information and views (Knutsen 2015). Participatory political systems allow for the elicitation and aggregation of local knowledge, while autocratic governments have no incentives to do so (Rodrick 2000). Democratic institutions allow for an informational feedback between public, private, and civic sectors of society in “horizontal networking” information systems, and policies are informed by a “multiplicity of influences” (Halperin et al. 2005), leading to greater resilience and flexibility in policymaking, especially under time constraints. Autocracies arguably fail to maintain reliable channels of information both from and to actors outside as well as inside the political structure, “due to the imperatives of political control” (Cutler and Nectar 2020, Deudney and Ikenberry 2009).

As far as output redundancies are concerned, political institutions, constitutions and more, set up systems of decision-making which vary substantially in terms of how much redundancies they allow in their de jure and de facto policy authority. Political processes that arise from such institutions are characterized by authority structures ranging from extremely centralized to extremely diffused. Federal constitutions in particular inevitably give some concurrent powers to national and subnational governments, often as an intended element of the design (see Agranoff and McGuire 2001). In the language of complex systems, federations have not only the 'overlap', but also 'duplication'.[6] In such systems, each citizen responds to the authority of at least one government operating in each layer (thus to the authority of several governments at once), and officials operating those governments have mandates (and electoral incentives) to offer such protection.

Beyond these basic institutional juxtapositions, one can also find overlapping and even duplicating policy authority in many other instances, such as in systems with strong traditional leaders sharing authority with the formal leaders (see Baldwin 2014, Breslawski 2020, Mershon and Shvetsova 2019a, 2019b, Murtazashvili 2016). Separation of powers also creates an overlap in jurisdictions such as when the judiciary and the executive can both interpret the laws (Gersen 2007) and when the executive orders fill gaps in the legislation, and, in times of crises, executives can take on powers explicitly allocated to legislatures. Non-democracies as well as democracies lacking explicit federal provisions can create overlapping jurisdictions through devolution of powers from the center to subnational authorities.

Formally established overlapping jurisdictions account for some but not all authority nodes. Decentralization or federalism is but one institutional operationalization of authority redundancies. But since authority is more complex than what is enumerated as areas of competence that are or are not formally assigned to an agent of policy-making, nodes of authority may evolve or spontaneously emerge elsewhere. While explicit constitutional

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[6] According to Hollander's (2010) definition, overlap "occurs when multiple levels of government provide "*similar* goods and services to *similar* clients." Duplication is a subset of overlap and describes a situation where more than one level of government provides the "*same* goods and services to the *same* client" (p. 138, emphasis original).

provisions matter, and are endlessly debated in the literature on federalism, sources of authority and scope of agent's authority can be more than the formal constitutional delineation or even standing constitutional interpretation and practice. Authority can arise from traditional forms of governance, or from de facto coercive capacity (Breslawski 2020), and in a crisis situation – from the perceived accountability that the agent holds for the resolution of the crisis. In other words, in an emergency, policy authority is better defined by who is *not precluded* from dealing with the crisis and who is not explicitly without authority, rather than by who is specifically formally vested with the authority to create policies.

Thus democracy, with constrained government and with the residual powers not by default assigned to the national authority, must be generally seen as a higher authority redundancy system than autocracy and totalitarianism. Thus, measures of democracy in our analysis operationalize both the information and policy redundancy characteristics of institutional designs.

We are cognizant that policy response requires not just the institutional capacity to respond, but also the decision-makers' individual willingness to respond, and it is also strategy driven and not merely institutionally constrained. The question of whether democratic politicians have stronger or weaker incentives to issue a stringent pandemic response than their autocratic counterparts does not have a direct answer. For democratic incumbents there is a perceived trade-off between protecting the public health, and protecting the economy (Deb et al. 2020) and civil liberties (Cheibub, Hong, and Przeworski 2020).[7] Autocrats, on the other hand, may worry

[7] For example, Desierto and Koyama (2020) find that a government might be reluctant to pursue stricter public policies if the pivotal member of its coalition has a higher stake in

less about civil liberties but lack accountability to protect vulnerable groups in the population through the use of costly public-health measures.

Here we will simply assume that in the early weeks of the pandemic onset decision-makers are all perfect agents, and there are no competing coalitions of principals with preferences for different types of response.[8] The only type of the differences among the politicians is in their beliefs about the severity of the public health crisis. Divergent incentives among political leaders create additional variation among those best informed, which may make it harder for us to find the effect structural advantages of democracies and decentralized polities.

Restating now our conjectures about system properties in terms of the institutional determinants that enable them, we can formulate hypotheses for the empirical analysis.

H1: Democracies will have a more stringent response by an early threshold date than autocracies.

H2: Liberal democracies will have a more stringent public health response by the early threshold date than less advanced democracies.

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unrestricted economic activities and faces lower epidemiological risks. Pulejo and Querubin (2020) show that incumbents coming up for reelection adopt less restrictive policies.

[8] To assume that COVID-19 related health loss was the only concern is equivalent to assuming the precautionary reaction to the unknown threat with unmeasurable and possibly catastrophic impact. While this was certainly not the case in later months, since we focus on the early weeks in the pandemics, we believe that the assumption of precautionary response while information about the potential impact was simply not available is reasonable and justified.

H3: More decentralized democracies will have a greater stringency of response by an early threshold date than centralized democracies.

Below we proceed to empirically compare the stringency of the protective policies that pertain to an average country resident that was achieved by early threshold dates around the world and across political institutional systems.

4.0 The Global Dataset

To measure COVID-19 mitigation policy responses during the onset of the pandemic, we gathered data on policies that national and subnational policymakers adopted within fifteen public health categories: state of emergency, self-isolation and quarantine, border closures, limits on social gatherings, school closings, closure of entertainment venues, closure of restaurants, closure of non-essential businesses, closure of government offices, work from home requirements, lockdowns and curfews, public transportation closures, and mandatory wearing of PPE. We identify and code national and subnational public health policies for each subnational unit in 64 countries[9] -- including countries in North America, Central America, South America, Europe, the Middle East, and Asia. Our theory requires us to look at responses of more than one level of government in each country. Note that while subnational governments are not the only lower level authorities in many nations, we were unable to consistently collect municipal level public health policy response. We rely primarily on government resources, press releases, and news sources, dating policies based on first announcement. Note that between and within the policy categories, there is variation on stringency, with some policy adoptions being more stringent than others (i.e. self-isolation versus lockdowns, partial school closings versus full

[9] See the list of countries in S1 in Supplementary Information

school closings). To this end, we weighed more stringent policies in each category in the index more heavily.[10] See S2 in Supplementary Information for a complete list of the policy categories, policies, and their weights in the index.[11]

Our index measures government-adopted mitigation responses to slow the spread of COVID-19, and thus does not include policies that address other aspects of the pandemic, such as policies meant to help healthcare workers treat COVID-19 patients (purchases of medical equipment and supplies). Nor does it include economic policies addressing the negative

[10] Theoretically if a government adopted a less stringent policy or allowed a policy to expire, such as re-opening after a lockdown, the values for that policy area in our index would decline. However, since we are only examining the policies adopted at the onset of the pandemic stage, there are no cases where this occurred in our dataset.

[11] We validated index construction (Miller 2007) by enlisting practicing public health professionals in New York, Pennsylvania, and New Jersey to review and revise our selection of categories and the weighting of categories in the index and policy strength levels within categories. We further compared the COVID-19 PPI index with the OxCGRT project (Hale et al. 2020). Their index is similar to ours but has country-day rather than unit-day as the unit of coding. It combines the scores in 9 categories of policies, and 7 of them are similar to ours. As external validation, our estimations of mortality at response time (not reported) are consistent with Cheibub, Hong, and Przeworski's (2020) estimations.

economic effects of the pandemic. The index focuses solely on measurable subnational and national public-health COVID-19 mitigation policy responses during the pandemic's onset.[12]

As mentioned, the data do not contain information on municipal level responses. This should make it harder for us to find support for our hypotheses, as in the more democratic and decentralized states, during the initial chaos of the pandemic, municipalities were often the early adopters of COVID-19 policy. Thus, the PPI underestimates policy stringency in more democratic and decentralized countries with strong municipal responses. In the United States, for example, municipal authorities in major cities and counties that saw the first outbreaks became first policy responders, ahead of states (e.g. Los Angeles County, CA; Houston, TX; Cook County, WA; Boston, MA; Mobile, AL; San Jose, CA; San Francisco, CA; Seattle, WA).[13]

Based on public health policy responses to COVID-19, we calculate the Public Health *Protective Policy Indices* (PPI): Regional PPI for each subnational unit on each day; National PPI for a country on each day, based on national level policies; and Total PPI for each subnational unit on each day. The Total PPI reflects the strictest among the national and subnational policies adopted within each category in the unit. The indices are scaled to range

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[12] We cross-referenced our data against the global tracker by INGSA (2020), Breton-Tabbara database for Canada (Breton et al. 2020), and Raifman et al.'s database for the US (Raifman et al. 2020). We are largely in consensus on the policy measures and their dates of enacting that are coded in the overlapping categories.

[13] If one were to model policies impact on the actual health outcomes (e.g., mortality), one would have to consider policies at all levels of government. For emerging analyses of municipal policies during the COVID-19 pandemic see, e.g. Armstrong et al. (2020).

between 0 and 1. These three indices are mapped on five separate ‘early threshold’ dates in Figures A1, A2, and A3: we create biweekly snapshots starting on March 1 and ending on April 24, 2020. Finally, we compute our main dependent variable, the Average Total PPI (PPI in what follows) for each country-day by weighing the different units’ Total PPI values by the units’ population shares.

In our analyses, we impose a common calendar-based timeline for COVID response on all countries in our sample, on the period spanning from January 24, 2020, to April 24, 2020. Around the beginning of this period, the virus started spreading worldwide, and there were indications that the outbreak could reach global scale. Thus, governments that were lacking testing instruments and reliable threat assessments could launch protective policies in a precautionary fashion (such as border closures, isolation procedures, and quarantine requirements). As we are cognizant that the onset of an epidemic on the government’s own soil is a more informative signal (Cronert 2020; Cheibub, Hong, and Przeworski 2020), we also include those as controls in the estimations.[14]

5.0 Analysis

Our main dependent variable is the Average Total PPI. It roughly corresponds to the average stringency of public health policies that are in place as a result of response by both the national and all subnational actors. Our main explanatory variables are political institutions associated with levels of informational and authority redundancy. We use POLITY V (Marshall

[14] We include the versions of our charts with a country-specific starting date in the Supplementary Information.

2020) and Freedom House (2020) to measure democracy.[15] As a control, we include COVID-19 national incidence indicators.

[Figures 2 and 3 are here]

Using the POLITY V data (Marshall 2020), we divide the countries in our dataset into three categories. We identify democracies as countries with a POLITY score of 7 or higher, autocracies as countries with a POLITY score of -7 or lower, and all other countries as anocracies. Our sample includes 46 democracies, 5 autocracies, and 12 countries in the intermediate group. We exclude China from the analyses because we treat the Chinese case as the initial information signal, thus their initial response preceded the signal going out to the rest of the agents. Using the Average country-specific PPI as the dependent variable and the dates as the independent variable, we estimate generalized additive models with cubic splines for each type of country and plot the expected values of PPI against time in Figure 2.

The results from Figure 2 provide support for Hypothesis 1. As time approaches the middle of the onset period, democratic countries adopted more stringent policies than anocracies did, and anocracies adopted more stringent policies than autocracies did.

Next, according to Hypothesis 2, liberal democracies should have adopted more stringent policies than less advanced democracies. To ascertain whether this is the case, we use the Freedom House dataset to identify liberal and less advanced democracies in our sample, and divide countries in our sample into three groups: Free (34 cases), Partially Free (19), and Not Free (10). We plot the estimates of generalized additive models with cubic splines for each type

[15] We also report estimations with V-Dem's Polyarchy and Liberal Democracy indices (Coppedge et al. 2020) in the Supplementary Information to this essay.

of country against time in Figure 3. The results displayed in Figure 3 provide support for Hypothesis 2, but with a caveat. The difference between Free and Partially Free countries is not statistically significant, though both have higher estimated PPI values than countries that are Not Free.

At this point in the analysis, we can mark a finding of fundamental interest: democracies with their ostensible lack of a singular will, and democratic federations with their presumed lack of singular efficiency (due to the patchwork of how and what they do jurisdiction-by-jurisdiction), *are not worse* in rapidly responding to sudden and uncertain threats to their citizens. Whether they are indeed better at doing so is what we turn to evaluating next.

To ascertain whether the results from Figures 2 and 3 continue to hold after controlling for other relevant factors, we ran several ordinary least squares regressions for country level *PPI* values on March 15 and, separately, on April 1, 2020. As evident from Figures A1 and A2 in the Appendix, most public health policy activity at either national or subnational levels took place during the month of March 2020, with PPI levels holding mostly steady in the month of April. Thus, March 15 and April 1 are, in the sense of our hypotheses, early threshold dates.

[Tables 1 and 2 are here]

In the models in Table 1, we control for the number of COVID cases per million one week prior to the threshold applied to the dependent variable.[16] If the average number of cases in

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[16] True number of disease cases is unknown because of varying testing capability and therefore not a reliable measure in its own right. We use this variable here as information signal of pandemic threat, rather as a measure of medical outcomes. These data were obtained from Dong et al. (2020).

immediate vicinity was higher than the number of cases in the country under consideration, we used that average instead of the country's own incidence rate. We also control for *Percent of the Population Aged 65 and Above*, *Population Density*, *Globalization,* and *GDP per capita*[17] (Teorell et al. 2020), *Doctors per 100,000* and *Per Capita Healthcare Spending* (World Health Organization 2020). We also control for the number of nationally diagnosed *COVID-19 cases* one week prior to the date of the snapshot used for the dependent variable.

The estimates in Table 1 continue to provide support for Hypothesis 1. Models 4-6 and 10-12 include the POLITY V measure. Note that POLITY V data here is a continuous variable, -10 to 10. Models 1-3, 4-9 include the Freedom House measure. The results suggest that even after controlling for relevant factors, non-free countries had a lower PPI value than free countries did.

Based on the coefficients in the Freedom House models, the estimated difference in the index was between 0.11 and 0.34 higher for free countries. Recall that the PPI ranges from 0 to 1, so these differences are both statistically and substantively important. Democratic countries had a much higher PPI value than autocratic countries did. Additionally, going from the most autocratic country to the most democratic country in the sample based on the POLITY scores, the most democratic countries' PPI values were between 0.22 and 0.36 higher on average than the PPI values for most autocratic countries. Once again, these results are both statistically and substantively important.

In a further attempt to control for the unobservable country-level determinants of the COVID response (and capitalize on our panel dataset), we estimate linear regressions with two-

[17] In the 2011 PPP dollars.

way fixed effects (i.e., fixed effects for countries and dates) and include interaction terms for each date with the institutional variables.[18] Figure 4 shows thus estimated trajectories of the PPI values by each regime type. We reset the country-specific intercepts to the intercept of the United States. Based on the results, we can conclude that the jump in the level of PPI over the observed period is higher among the democracies than the autocracies, but is roughly the same between the democracies and the countries falling in the intermediate group (anocracies and Partly Free polities).

[Figure 4 is here]

Arguably, the prevalence of COVID-19 in a country is one of the possible determinants of the COVID-19 policy response. At the same time, this variable is endogenous to the adopted public health measures, and therefore it might fail to condition our estimates of the effect of the institutional variables if included in an OLS regression.

To account for this dual connection, we make use of our panel dataset and estimate a series of Arellano-Bond dynamic panel models (systems GMM). This approach was developed as a way to analyze dependent variables which values depend on their previous realizations and have endogenous predictors (Arellano and Bond 1991, Blundell and Bond 1998). It uses the lagged values of endogenous variables as the instruments for these variables and incorporates these relationships as moment conditions.

In the process under consideration, our dependent variable, Average PPI, follows a trajectory with clear signs of inertia. At the same time, one of the presumed predictors of the public health measures – the number of COVID-19 cases – itself depends on the measures

[18] We thank the anonymous reviewer for this suggestion.

already adopted by the government. Accordingly, we include the lagged value of the dependent variable and the current and lagged numbers of COVID-19 cases on the right hand side of the equation and treat them as endogenous, i.e., instrumenting them using their past values. The measures of democracy (Freedom Status, Polity Score, V-Dem's Index of Liberal Democracy), as well as the control variables described earlier, were included as regressors and standard instruments. Difference-in-Hansen tests support our decision to treat these variables as exogenous.

The estimates (shown in Table 2) further corroborate hypotheses H1 and H2; they show that not-free countries were slower to mount their response to the pandemic than free countries; the estimates also include a positive coefficient in front of the POLITY V and V-Dem's Liberal Democracy measures.

[Figure 5 is here]

Figure 5 addresses our second main institutional variable, decentralization. For visualization purposes, we use a dichotomous federal-unitary indicator, treating any polity with popularly elected regional governments that have constitutionally guaranteed authority as a federation. Consistent with H3, we exclude autocracies form this illustration. Figure 5 thus shows how joint national and subnational public health policy effort differs *within* non-autocracies, depending on their type of government. Our H3 hypothesis seems to be also borne out in this preliminary assessment.[19]

[Figure 6 is here]

[19] While separation of powers might be a source of authority redundancy in democracies, there is no immediate evidence to that end in the data (see S6 in Supplementary Information).

To assess hypothesis H3, we estimate linear regression with the dichotomous indicator of federations and the self-rule component of Regional Authority Index (Hooghe et al. 2016) as the independent variables. The latter is a continuous measure of the amount of financial and policy-making autonomy of subnational governments in a polity. We do not find support for hypothesis 3 stating that federalism and decentralization positively affect Total PPI.

In an attempt to see if this result holds at the regional and national levels, we analyze the relationship between the Regional and National PPIs, and the level of autonomy. We observe that, on the early threshold dates, the amount of subnational autonomy in the political system is positively associated with the Regional PPIs. Figure 6 shows a scatterplot of the weighted averages of Regional PPIs and National PPI against our measure of subnational autonomy, for which we use the self-rule component of Regional Authority Index (Hooghe et al. 2016). Further, we estimate multivariate multiple linear regressions with Regional and National PPIs as two dependent variables. The equations for both dependent variables include the same set of predictors, while the residuals are assumed to follow a bivariate normal distribution. The results (reported in section S2 of Supplementary Information) confirm the above conclusion.

The residuals from the equations for National PPI and Regional PPI have negative correlation of about -0.25 on April 1, when the cross-country differences in subnational activism are particularly visible. We speculate that this is because of a substitution effect between the national and subnational responses: regional governments do not pursue more stringent policies if the there are policies of sufficient stringency implemented at the national level; likewise, the national government might not need to implement additional measures if the regional government have acted. We suspect that this is one of the possible explanations of why the relationship between Regional PPIs and the autonomy of the subnational units does not fully translate into a significantly higher Total PPI in federations.

Having compared the means, we now examine the variance of PPI across different regime types on early threshold dates. We do not have strong expectations about the difference in variance between democracies and non-democracies. While our theory suggests that the response in autocracies is more susceptible to the variation in the initial signals they receive, we do suspect that there also may be higher variation in the response of democratic leaders due to differences in the composition of their coalitions and incentives (Desierto and Koyama 2020). We conduct F-tests of the difference in variance of country PPIs across the regime types and do not find significant differences (see section S5 in Supplementary Information).

The variance of PPI across federations appears to be 160-190 percent lower than in unitary states on our early threshold dates, with the difference but significant at 0.1 level. This gives some support to our theory as this suggests that the multiplicity of authorities in federations mitigate individual deviations in the resulting overall protection of citizens.

We further compute the variance of region-specific PPI for the subnational units of the countries in our sample (on April 1) and plot them against the self-rule component of the regional authority index (Hooghe et al. 2016 and our own calculations by their method for countries not in their dataset).

[Figure 7 is here]

As Figure 7 shows, the variance of regional PPI is higher among the countries with higher levels of regional autonomy. The highest variance is among the states of Australia and the US, and the provinces of Pakistan, and all three of them are federations.

Such difference in variance is quite expectable: when there are more authorities to make decisions, they will, on average, produce higher policy variety. Such mechanical effect is consistent with our theory as it emphasizes that polities with multiple authorities that rely on at least partially independent sources of information will see different authorities initially produce different policies. While low self-rule is a constraint on regional public health policy, the high values of self-rule do not necessitate policy heterogeneity within the country.

Note that such variation within a country does not translate into a higher variation across the federations. The multiplicity of signals might produce different responses across units, but, once aggregated, will produce more consistent policies at the national level.

6.0 Conclusion

In the early days of COVID-19 pandemic onset, the virus was perceived as an unqualified threat. As the threat became qualified with information from research and experience, the differential costs and benefits of public health mitigation inevitably led to coalition formation, contestation, and policy change by the governments. For the brief period before all that, though, COVID-19 response gave us the opportunity to judge political institutional arrangements on their baseline capacity for crisis response in low-information environment. Our findings suggest, that democracies and liberal democracies were ahead in this comparison. Their early responses were sttronger. Federalism and decentralization in addition to democratic institutions played a less uniform, but still a positive role.

As we assess the benefits of institutionally-enabled authority and information redundancies, it is only right to acknowledge (and future research will surely stress) that these come with potential efficiency losses. Aside from operating and electing multiple governments, extra costs might be accrued from policy inefficiencies due to replicating efforts within jurisdictions and such things as outbidding for resources (though see Bendor 1985). There may arise enforcement inefficiencies due to inter-jurisdictional policy discrepancies, along with 'arbitrage' opportunities for economic agents who operate across jurisdictional borders. Additional resource limitations might come from implementing a policy at a government level either below or above that which would be optimal for the task. Even the policy designs themselves may be inferior from the outset sue to the severity of the budget and resource constraints in isolated jurisdictions. And inconsistency in policy articulated for the same constituents by different levels of government may have not only enforcement, but also legitimacy implications. Another important consideration that we did not explore is the "quality" of the decision-maker; selection of low or high quality decision-makers might also be affected by the political institutions. It is worth an additional mention that democratic politicians face the need to accommodate to a plethora of conflicting interests, and some may feel reluctant to restrict economic activities at the cost of higher human losses (Desierto and Koyama 2020, Pulejo and Querubin 2020).

While many more features of institutional and decision-making structures could be brought into analysis, our conclusions enable the baseline comparison. In the short term, constitutional regimes with greater informational and authority redundancies have the structural capacity to offer citizens faster protective policy response from new uncertain threats. Thus, when not weeks, but days and even hours count, democracies have the structural capacity to save more lives.

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Figure 1. Information Processing in Three Types of Systems

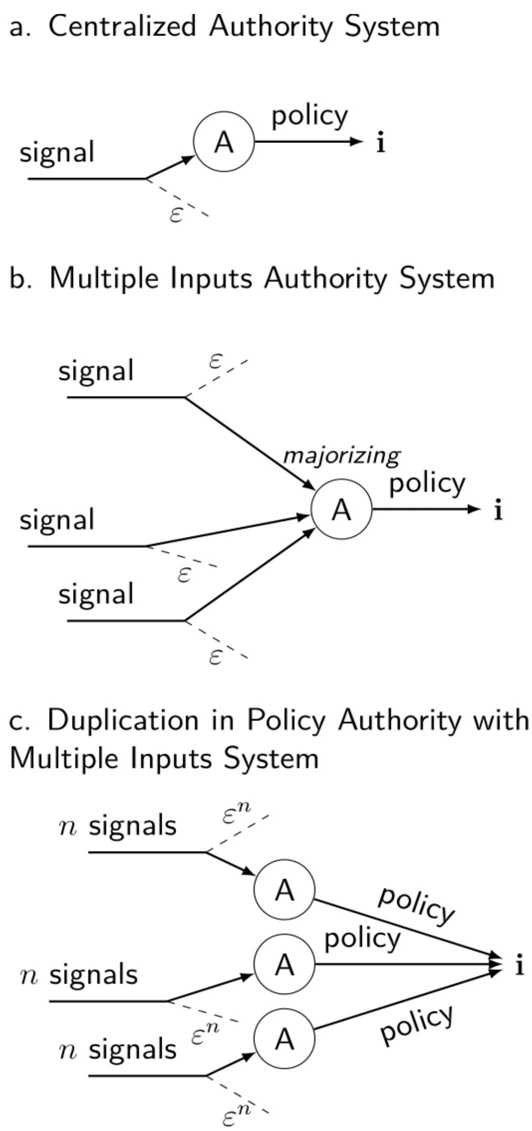


Figure 2. PPI by Regime Type (Polity V), over Time

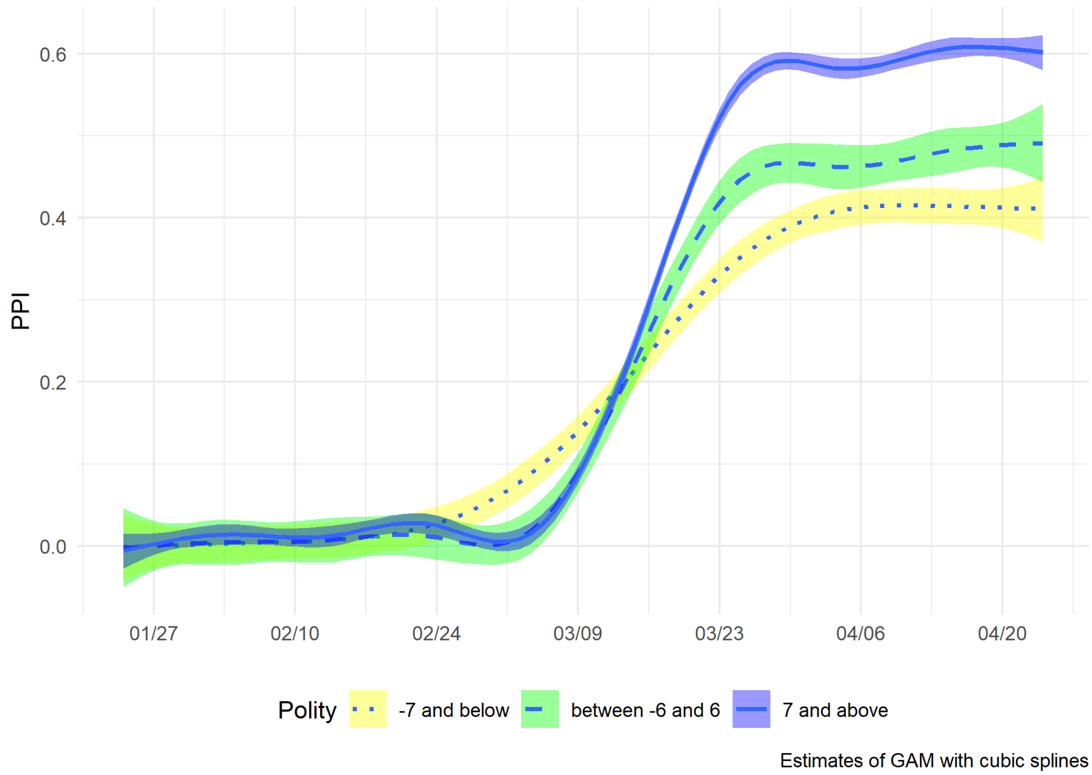


Figure 3. PPI by Regime Type (Freedom Status), over Time

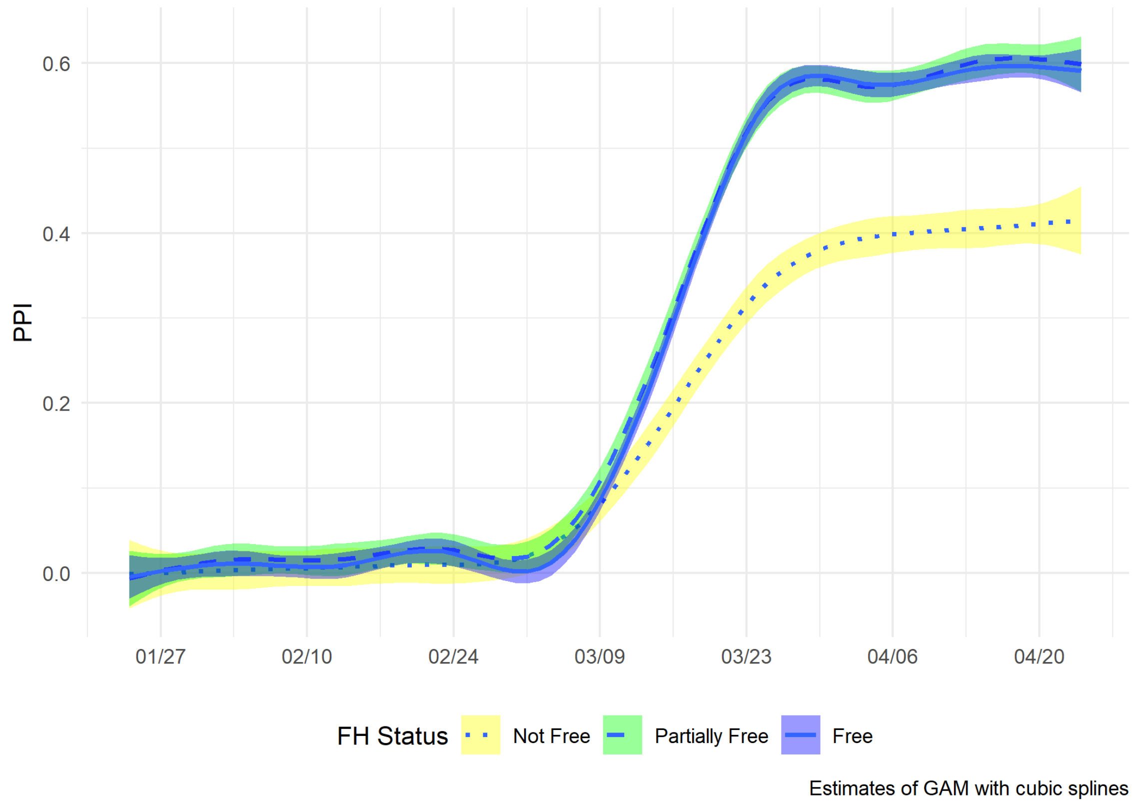
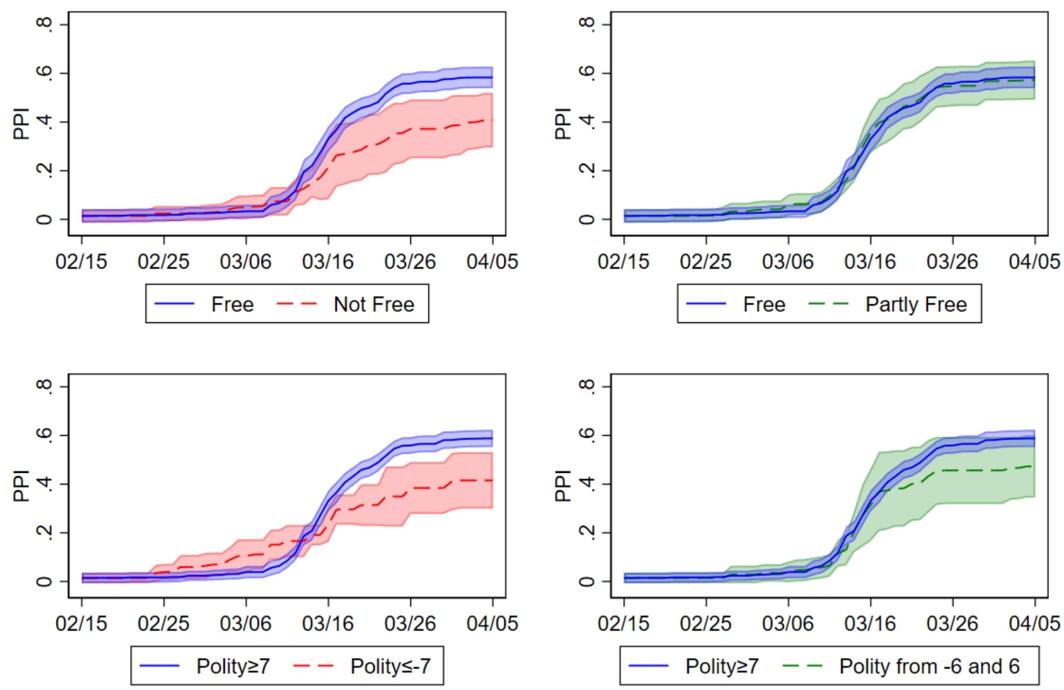
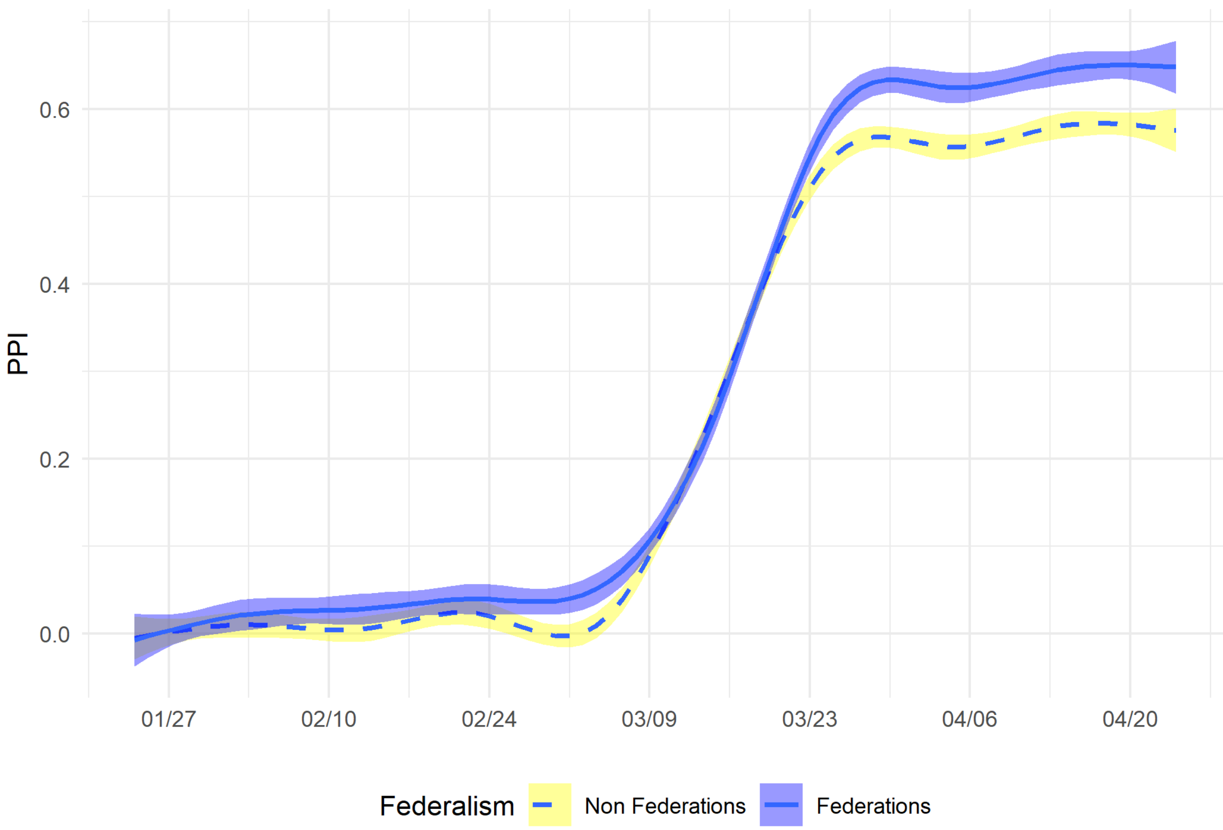


Figure 4. PPI Trajectory by Regime Type, over Time



Estimates of twoway fixed-effects model with interaction terms.
Country-specific intercepts are set to the intercept of the US.

Figure 5. Per Capita PPI by Federalism criterion, over Time



Estimates of GAM with cubic splines; 'not-free' polities are excluded.

Table 1 Regime Type and PPI, OLS Estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	PPI on March 15, 2020						PPI on April 1, 2020					
Not Free	-0.11*	-0.18*	-0.23**				-0.12***	-0.32***	-0.34**			
	(0.055)	(0.091)	(0.097)				(0.071)	(0.090)	(0.132)			
Partly Free	0.030	-0.039	-0.029				-0.007	-0.132*	-0.112			
	(0.048)	(0.076)	(0.081)				(0.052)	(0.067)	(0.071)			
Polity Score				0.005*	0.011**	0.018**				0.008**	0.011**	0.011
				(0.003)	(0.005)	(0.007)				(0.004)	(0.005)	(0.009)
COVID Cases		0.002**	0.002**		0.002**	0.002**		0.000	0.000		0.000	-0.000
1 week prior		(0.001)	(0.001)		(0.001)	(0.001)		(0.000)	(0.000)		(0.000)	(0.000)
Ages 65 and		-0.008	-0.010		-0.011	-0.016**		-0.010	-0.010		-0.006	-0.007
above		(0.006)	(0.006)		(0.007)	(0.007)		(0.007)	(0.008)		(0.007)	(0.008)
Population		0.012	0.019		0.024	0.039**		-0.011	0.001		0.002	0.019
density (ln)		(0.016)	(0.018)		(0.015)	(0.015)		(0.022)	(0.024)		(0.022)	(0.026)
Healthcare		-0.005	0.014		0.008	0.001		-0.022	0.010		0.000	0.042
spending (ln)		(0.025)	(0.049)		(0.022)	(0.054)		(0.028)	(0.060)		(0.025)	(0.063)
GDP per			0.006			0.052			0.002			-0.021
capita (ln)			(0.068)			(0.096)			(0.109)			(0.117)
Globalization			-0.000			-0.001			-0.001			-0.001
			(0.001)			(0.001)			(0.001)			(0.001)
Number of			-0.001			0.000			-0.002			-0.001
doctors			(0.002)			(0.003)			(0.004)			(0.004)
Constant	0.273***	0.361*	0.197	0.233***	0.146	-0.342	0.580***	0.936***	0.745	0.500***	0.542**	0.511
	(0.033)	(0.202)	(0.433)	(0.024)	(0.163)	(0.659)	(0.034)	(0.218)	(0.709)	(0.033)	(0.217)	(0.840)
R-squared	0.067	0.127	0.194	0.029	0.126	0.196	0.131	0.166	0.226	0.050	0.062	0.126
Obs	63	61	60	63	61	60	63	61	60	63	61	60

Robust standard errors in parentheses. * p<0.1; ** p<0.05; *** p< 0.01 for two-tailed tests

Table 2 Regime Type and the Dynamics of PPI, Arellano-Bond Estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Not free	-.005***	-.0069***	-.0076***						
	(.0018)	(.0022)	(.0029)						
Partially free	-3.7e-04	-.0027*	-.0022						
	(.0014)	(.0016)	(.0016)						
Polity Score				1.9e-04**	2.5e-04**	2.5e-04			
				(8.8e-05)	(1.2e-04)	(1.9e-04)			
V-Dem Liberal							.0052**	.0113***	.0109**
Democracy							(.0025)	(.0038)	(.0051)
PPI (lagged)	.992***	.993***	.993***	.992***	.993***	.993***	.993***	.993***	.993***
	(.0062)	(.0063)	(.0066)	(.006)	(.0063)	(.0064)	(.0061)	(.0062)	(.0064)
Cases per mln	8.7e-05	5.4e-05	5.3e-05	9.2e-05	5.5e-05	5.3e-05	7.2e-05	5.0e-05	4.8e-05
	(1.4e-04)	(1.4e-04)	(1.4e-04)	(1.3e-04)	(1.4e-04)	(1.4e-04)	(1.4e-04)	(1.4e-04)	(1.4e-04)
Cases per mln	-5.7e-05	-2.0e-05	-1.8e-05	-6.3e-05	-2.3e-05	-2.2e-05	-4.7e-05	-1.6e-05	-1.4e-05
(lagged)	(2.8e-04)	(2.8e-04)	(2.8e-04)	(2.7e-04)	(2.8e-04)	(2.8e-04)	(2.8e-04)	(2.8e-04)	(2.8e-04)
Cases per mln	-4.8e-05	-5.0e-05	-5.1e-05	-4.7e-05	-4.7e-05	-4.6e-05	-4.2e-05	-5.0e-05	-4.9e-05
(lagged twice)	(1.5e-04)	(1.5e-04)	(1.5e-04)	(1.5e-04)	(1.5e-04)	(1.5e-04)	(1.5e-04)	(1.5e-04)	(1.5e-04)
Ages 65 and above		-1.6e-04	-1.7e-04		-1.0e-04	-1.3e-04		-1.9e-04	-2.0e-04
		(1.7e-04)	(1.9e-04)		(1.7e-04)	(1.8e-04)		(1.6e-04)	(1.8e-04)
(ln) Population		-1.6e-04	1.0e-04		9.0e-05	4.6e-04		9.9e-05	4.0e-04
density		(4.6e-04)	(4.8e-04)		(4.7e-04)	(5.3e-04)		(4.6e-04)	(4.7e-04)
(ln) Healthcare		-2.9e-04	4.7e-04		1.2e-04	.0012		-7.2e-04	3.5e-04
spending		(6.3e-04)	(.0012)		(5.5e-04)	(.0013)		(5.5e-04)	(.0015)
(ln) GDP per			1.4e-05			-5.9e-04			-6.5e-04
capita			(.0023)			(.0025)			(.0021)
Globalization			-1.5e-05			-2.2e-05			-1.5e-05
			(1.7e-05)			(2.0e-05)			(1.6e-05)
Number of doctors			-4.7e-05			-3.5e-05			-4.3e-05
			(8.7e-05)			(8.9e-05)			(9.1e-05)

Constant	.0145***	.0198***	.0156	.0123***	.0121**	.0119	.0109***	.0143***	.0146
	(.0013)	(.0055)	(.0156)	(.0013)	(.0052)	(.0187)	(.0019)	(.005)	(.0143)
Wald Chi-squared	152273.2	179593.7	210951.4	142509.9	182401.2	213894.6	150962.6	167340.9	197957.6
p	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
N	2835	2745	2700	2835	2745	2700	2835	2745	2700
N groups	63	61	60	63	61	60	63	61	60
AR(1) test	-5.783	-5.677	-5.647	-5.787	-5.679	-5.650	-5.787	-5.677	-5.649
p	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR(2) test	-0.792	-0.767	-0.577	-0.792	-0.766	-0.577	-0.794	-0.767	-0.577
p	0.428	0.443	0.564	0.428	0.443	0.564	0.427	0.443	0.564

Robust standard errors in parentheses (adjusted for clusters by country). * p<0.1; ** p<0.05; *** p< 0.01 for two-tailed tests.
PPI and the number of COVID cases per million are treated as endogenous. The sample is limited to the period between February 15 and April 30 to accommodate the requirements of the Arellano-Bond model. Estimated with xtabond2 (Roodman 2009)

Figure 6. Self-rule component of the Regional Authority Index, and Regional and National PPI

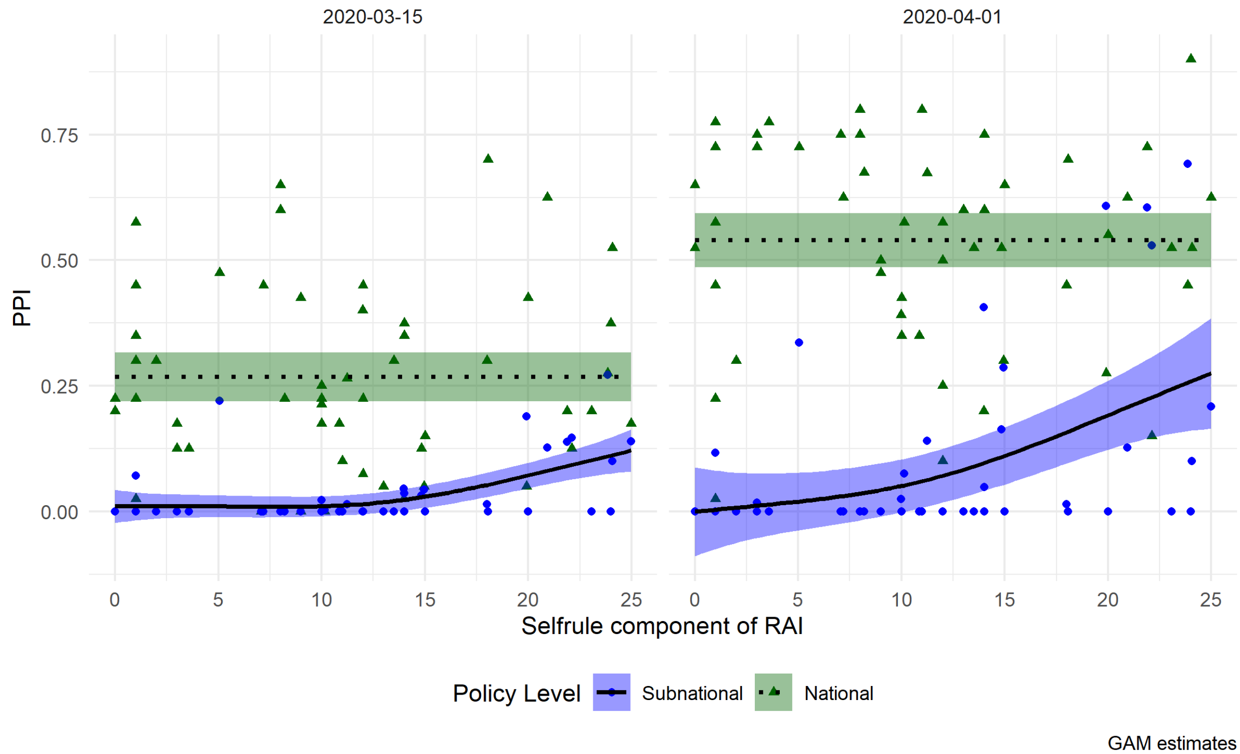
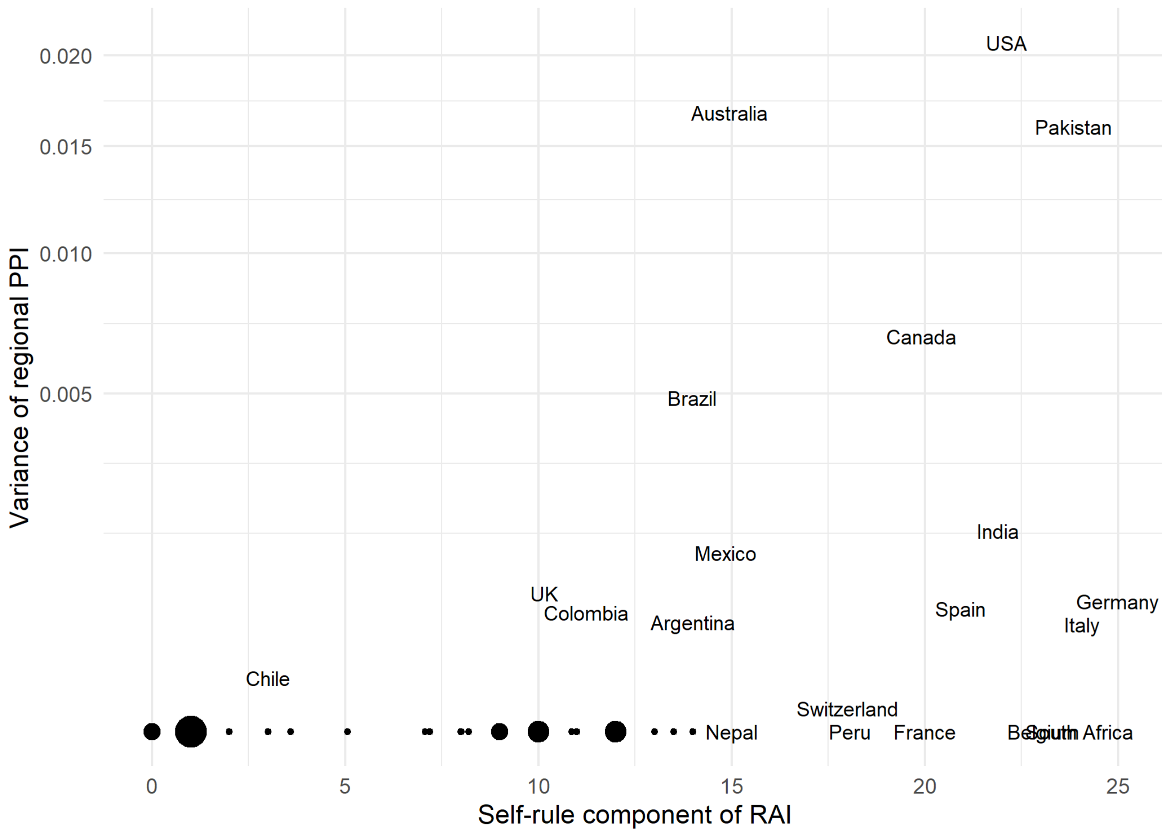


Figure 7. Self-rule component of the Regional Authority Index and variance of regional PPI



Appendix 1 Proof of Proposition 1 and Corollary 1

Proof of Proposition 1

Denote the event that authority j protects citizen i as Q_i^j. Since authority's response does not affect the citizens outside of its jurisdiction,

$$\bigcup_{j\in G} Q_i^j = \bigcup_{j\in J_i} Q_i^j = \left(\bigcap_{j\in J_i} \left(Q_i^j\right)^C\right)^C$$

Since $p_j(\mu_j) = \mu_j$, $\Pr\left(\left(Q_i^j\right)^C \middle| \theta = 1\right) = \Pr\left(\mu_j = 0 \middle| \theta = 1\right) = \varepsilon$. The messages sampled by a government are independent from the messages sampled by other authorities, therefore

$$\Pr\left(\cap_{j\in J_i}\left(Q_i^j\right)^C \middle| \theta = 1\right) = \prod_{j\in J_i} \Pr\left(\mu_j = 0 \middle| \theta = 1\right) = \varepsilon^{|J_i|}$$

Thus, the probability that the citizen i receives protection from any authority $j \in J_i$ is

$$\Pr\left(\cup_{j\in G} Q_i^j \middle| \theta = 1\right) = 1 - \Pr\left(\cap_{j\in J_i}\left(Q_i^j\right)^C \middle| \theta = 1\right) = 1 - \varepsilon^m,$$

where $m = |J_i|$, the number of authorities with a mandate to protect citizen i. □

Proof of Corollary 1

By assumption, $0 < \varepsilon < 1$, therefore $\frac{d}{dx}(1 - \varepsilon^m) = -\ln(\varepsilon)\,\varepsilon^m > 0$ and $1 - \varepsilon^m > 1 - \varepsilon \;\forall\; m > 1$. □

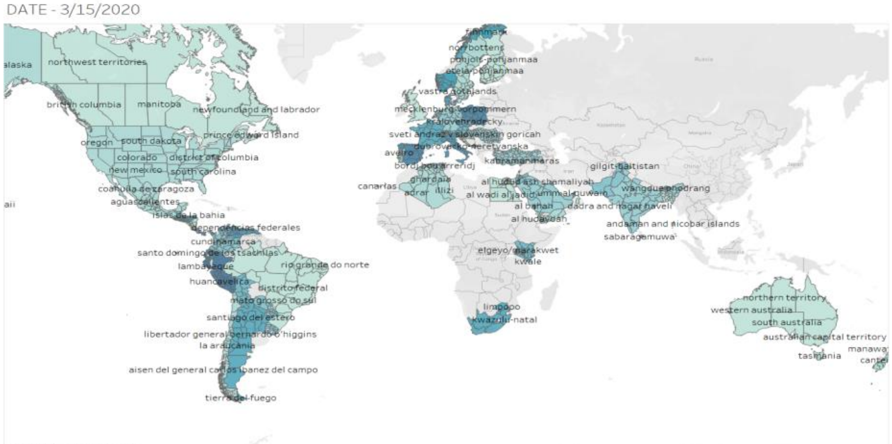
Figure A1 Protective Public Health Policies of National Origin

DATE - 3/1/2020

Map based on Longitude (generated) and Latitude (generated). Color shows Index Nat as an attribute. The marks are labeled by Name. Details are shown for ISO Country.

Index Nat
0.0000 0.8000

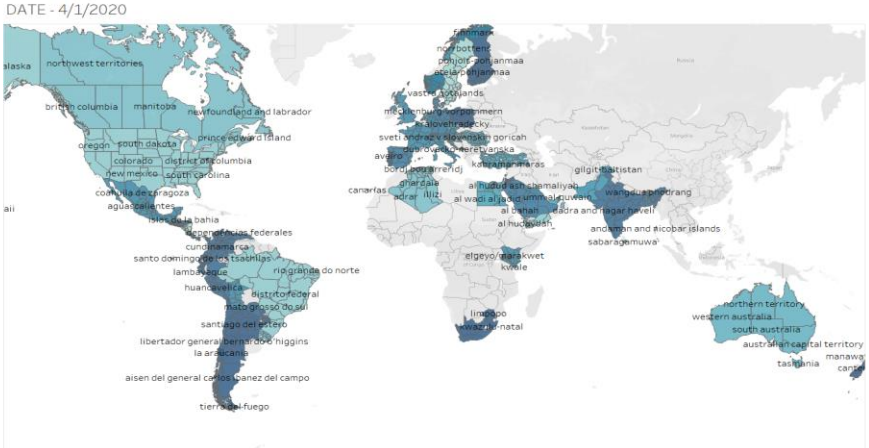
DATE - 3/15/2020



Map based on Longitude (generated) and Latitude (generated). Color shows Index Nat as an attribute. The marks are labeled by Name. Details are shown for ISO Country.

Index Nat
0.0000 0.8000

DATE - 4/1/2020



Map based on Longitude (generated) and Latitude (generated). Color shows Index Nat as an attribute. The marks are labeled by Name. Details are shown for ISO Country.

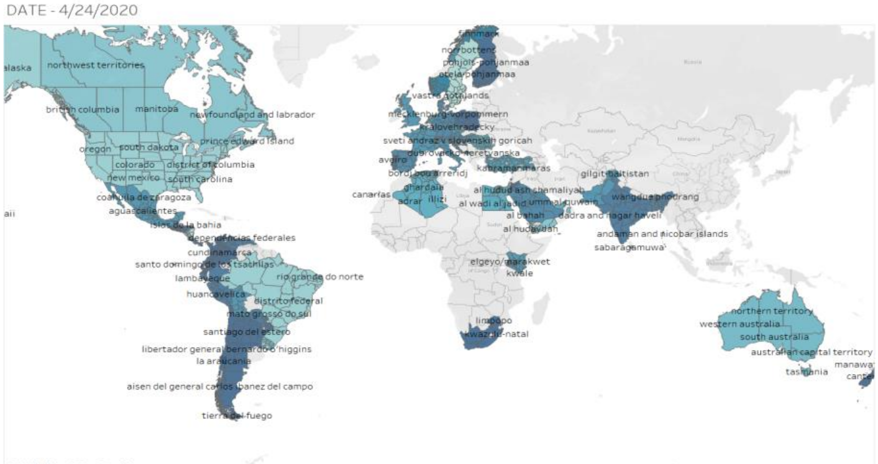
Index Nat
0.0000 0.8000

DATE - 4/15/2020

Map based on Longitude (generated) and Latitude (generated). Color shows Index Nat as an attribute. The marks are labeled by Name. Details are shown for ISO Country.

Index Nat
0.0000 0.8000

DATE - 4/24/2020



Map based on Longitude (generated) and Latitude (generated). Color shows Index Nat as an attribute. The marks are labeled by Name. Details are shown for ISO Country.

Index Nat
0.0000 0.8000

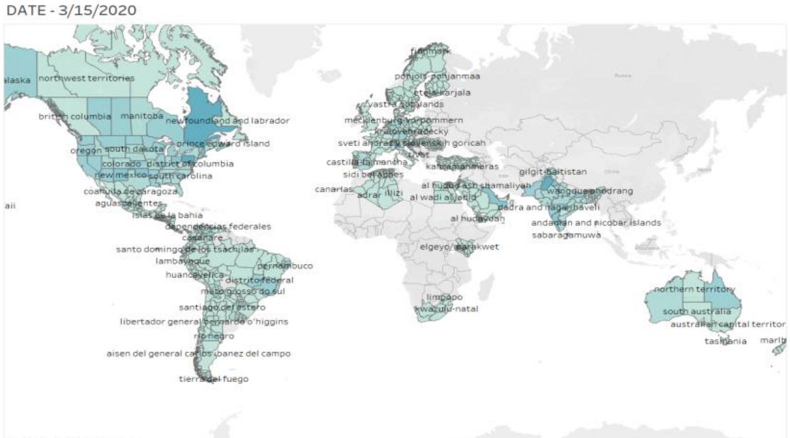
Figure A2 Protective Public Health Policies of Subnational Origin

DATE - 3/1/2020

Map based on Longitude (generated) and Latitude (generated). Color shows Index Terr as an attribute. The marks are labeled by Name. Details are shown for Affiliation.

Index Terr
0.0000 0.8000

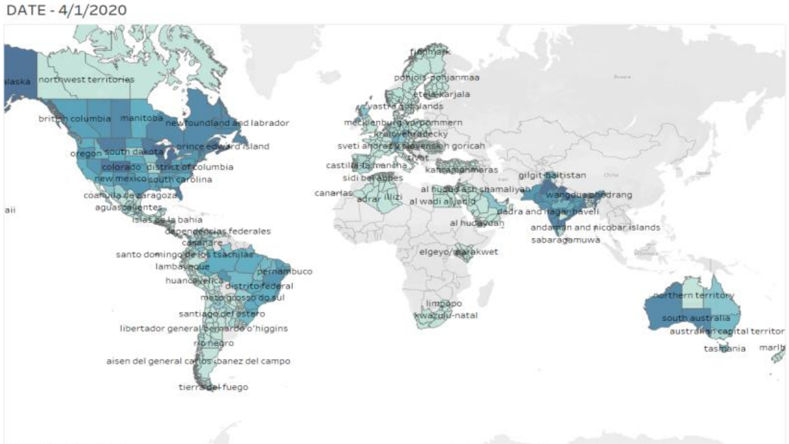
DATE - 3/15/2020



Map based on Longitude (generated) and Latitude (generated). Color shows Index Terr as an attribute. The marks are labeled by Name. Details are shown for Affiliation.

Index Terr
0.0000 0.8000

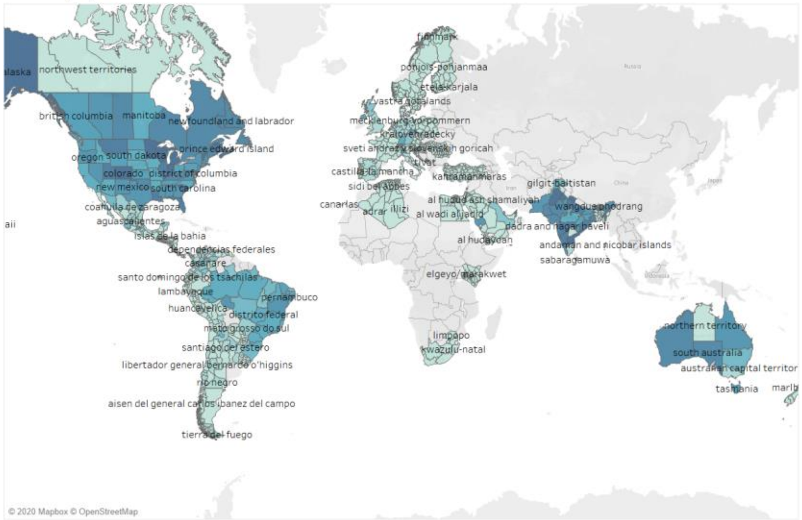
DATE - 4/1/2020



Map based on Longitude (generated) and Latitude (generated). Color shows Index Terr as an attribute. The marks are labeled by Name. Details are shown for Affiliation.

Index Terr
0.0000 0.8000

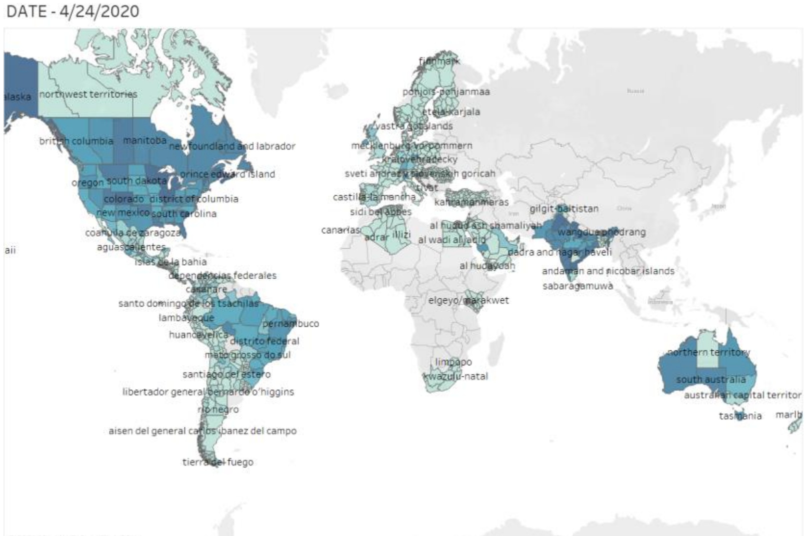
DATE - 4/15/2020



Map based on Longitude (generated) and Latitude (generated). Color shows Index Terr as an attribute. The marks are labeled by Name. Details are shown for Affiliation.

Index Terr
0.0000 0.8000

DATE - 4/24/2020



Map based on Longitude (generated) and Latitude (generated). Color shows Index Terr as an attribute. The marks are labeled by Name. Details are shown for Affiliation.

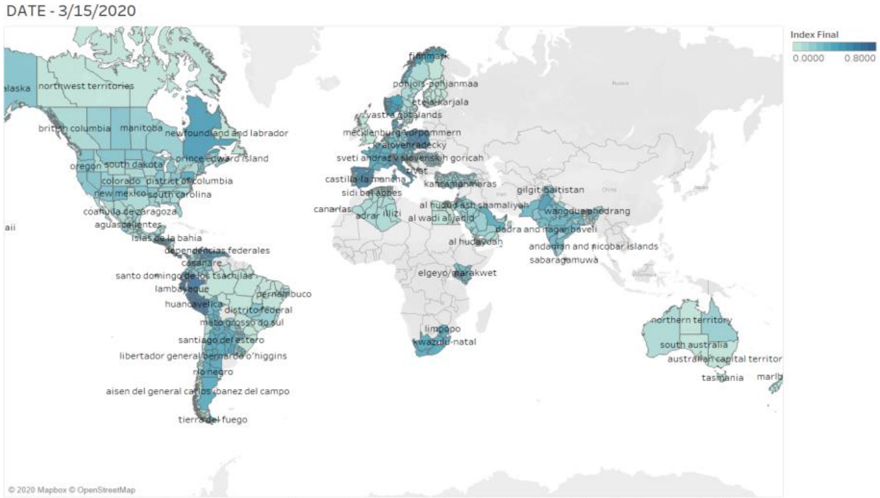
Index Terr
0.0000 0.8000

Figure A3 Protective Public Health Policies Originating at Either National or Subnational Levels

DATE - 3/1/2020

Map based on Longitude (generated) and Latitude (generated). Color shows Index Final as an attribute. The marks are labeled by Name. Details are shown for Affiliation.

DATE - 3/15/2020

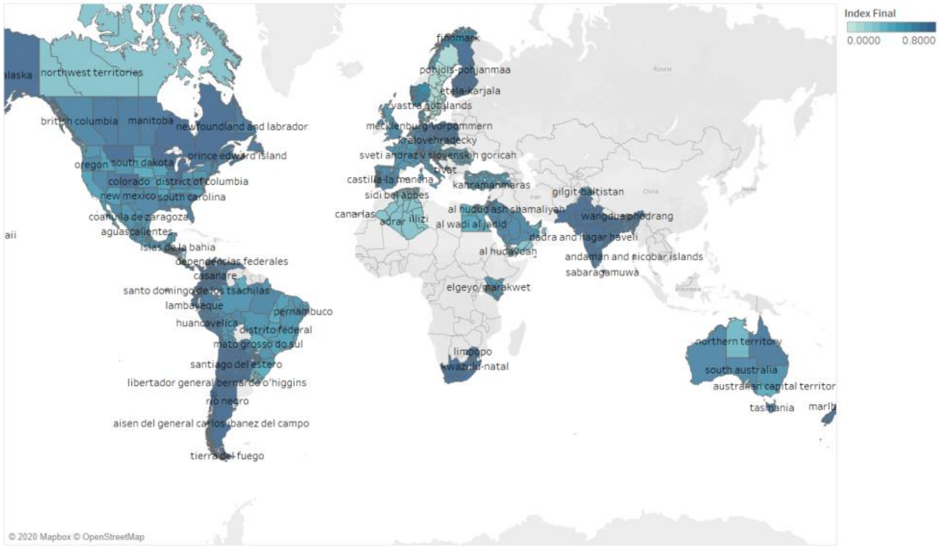


Map based on Longitude (generated) and Latitude (generated). Color shows Index Final as an attribute. The marks are labeled by Name. Details are shown for Affiliation.

DATE - 4/1/2020

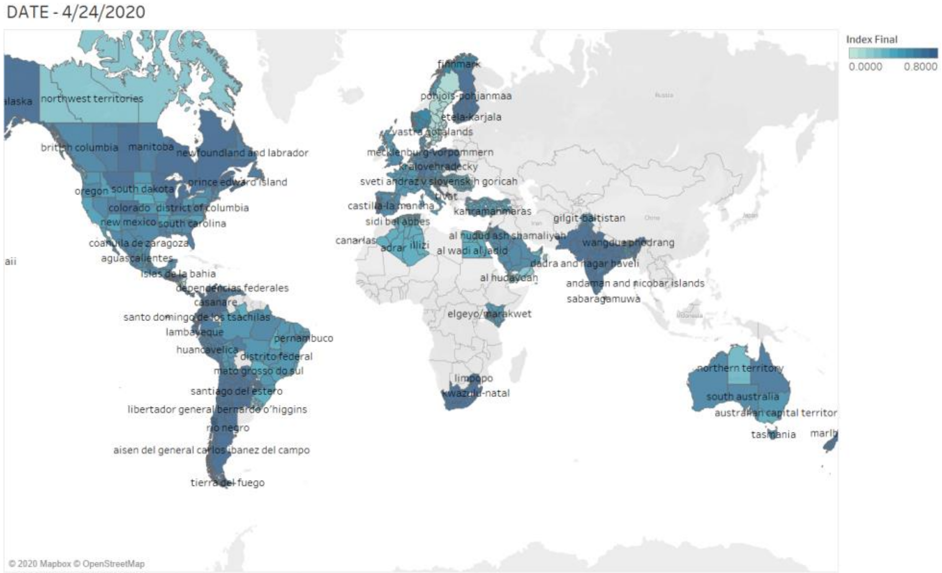
Map based on Longitude (generated) and Latitude (generated). Color shows Index Final as an attribute. The marks are labeled by Name. Details are shown for Affiliation.

DATE - 4/15/2020



Map based on Longitude (generated) and Latitude (generated). Color shows Index Final as an attribute. The marks are labeled by Name. Details are shown for Affiliation.

DATE - 4/24/2020



Map based on Longitude (generated) and Latitude (generated). Color shows Index Final as an attribute. The marks are labeled by Name. Details are shown for Affiliation.