

Governing Nested Externalities during a Pandemic: Social Distancing as a Coproduction Problem

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Abstract: Containing the spread of a virus during a pandemic requires citizens to self-discipline and adopt precautionary measures. This paper focuses on one such measure: social distancing. Governments can force citizens to comply with social distancing by imposing mandates and increasing penalties. However, constitutional restraints prevent governments in democratic societies from utilizing extreme measures. Thus, a pandemic presents an extreme case in which the goals of security (virus containment) and individual freedom appear irreconcilable. Moreover, a pandemic presents collective action problems, because a few defectors, who can remain undetected, can impose incalculable costs on a society. This predicament leads many to make a case for draconian measures to force compliance. We present an alternative take that views social distancing as a coproduction process; that is, virus containment requires active participation and a high degree of cooperation from citizens. Because external costs are difficult to measure and it is near impossible to monitor and sanction violations, coercive measures that do not account for coproduction processes are unlikely to succeed. Instead, strengthening existing mechanisms for mutual monitoring and sanctioning that are consistent with the norms and values of the populace may yield more favorable outcomes.

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1. INTRODUCTION

COVID-19 was first reported in early December 2019. After the first outbreak—in the city of Wuhan in China—it spread throughout the world, resulting in a global pandemic by March 2020. COVID-19 has an estimated reproduction number (R_0) of 2.87, which means that each infected individual infects another 2.87 individuals on average (Billah et al. 2020). This number can be much higher in areas with high population density.¹ COVID-19 infection is characterized by fever, shortness of breath, coughing, loss of smell, headache, fatigue, nausea, and diarrhea (Mao et al. 2020). However, it takes another 5.1 days after infection² for the symptoms to manifest, during which time the infected individual may infect other individuals (Lauer et al. 2020). COVID-19 primarily spreads through close contact via respiratory droplets, but some studies indicate that spread can also occur through contaminated surfaces (Bai et al. 2020; Tindale et al. 2020). Research suggests that social distanc-

ing³ of one meter or more can reduce the risk of infection by 10.2 percent (Chu et al. 2020). Other effective preventative measures include mask wearing (14 percent risk reduction) and hand washing (Saunders-Hastings et al. 2017; Chu et al. 2020). Although much of our analysis also applies to mask wearing, hand washing, and other preventative measures, this paper focuses only on social distancing.

Effective social distancing reduces the overall transmission rate significantly (Anderson et al. 2020). Greenstone and Nigam (2020) estimate that the mortality benefits from social distancing are about \$8 trillion in the United States, or \$60,000 per household. However, the reduction—commonly referred to as “flattening the [infection] curve”—comes at the steep cost of an inevitable recession (Gourinchas 2020; Saez and Zucman 2020). At the micro level, the costs are job losses, reduced income and spending, impaired health, and human capital losses. Any roles that for-profit firms, nonprofit organizations, civil society, governments, and private citizens play in pursuing social-distancing goals come with economic trade-offs. Furthermore, social isolation causes lasting psychological harm (Brewer 2005; Coyle and Dugan 2012; Klinenberg 2016). Importantly, people’s beliefs, biases, and political affiliations influence their social-distancing behavior (Allcott et al. 2020; Brzezinski et al. 2020). Thus, varying trade-offs and belief systems result in different incentives for citizens to comply with social-distancing guidelines. Therefore, the forms of policy tools employed to attain social-distancing goals are critical (Briscese et al. 2020; Chen et al. 2020). Specifically, how well a given policy addresses heterogeneities in trade-offs and beliefs determines the rate of citizen compliance.

Most studies conceptualize social distancing as a social-planner problem (for example, Fenichel 2013). Although some have accounted for behavioral heterogeneity (Reluga 2010; Fenichel 2013) and micro factors that influence compliance (Briscese et al. 2020), these approaches underemphasize the central role that citizens play in the provision of social distancing. Because a pandemic, by nature, is a global externality problem, the conventional intellectual and policy approaches call for national or global solutions. Cross-country comparisons mostly focus on successes and failures of national governments and international organizations.⁴

However, social distancing, which is key to flattening the curve, is very much a local solution adopted by users at the micro level. Thus, this paper argues that, for a couple reasons, the dominant conceptualization of social distancing as a policy tool to be implemented through stay-at-home orders and to be enforced through top-down surveillance, monitoring, and sanctioning is misleading and potentially pernicious. First, the state lacks the ability to closely monitor infections without cooperative citizens. Second, steeper penalties to increase compliance can backfire in that would-be cooperators may defect in response to the coercion. Thus, these factors add challenges to implementing top-down solutions.

Countries deal with infectious diseases by using various policy measures, such as quarantines, curfews, mandatory tests, mandatory vaccinations, and contact tracing. It is often assumed that, in order to implement these measures, more coercion is required. Social scientists and policy makers find themselves trapped in an institutional dilemma: keep embracing liberal institutions and constitutionally constrained governments, and leave it to nonstate actors to take preventative measures, or capitulate to Leviathan to expedite the pandemic response (Geloso and Murtazashvili 2021). This narrow way of framing the problem is guided by the presumption that liberal democracies are less equipped to handle a pandemic than autocracies. That is, the advantages that liberalism offers—economic growth, protection of our liberties, and improved health outcomes—come at the price of the state’s ability to handle collective challenges such as pandemics. This paper argues that this is a false dilemma that stems from misconceptions regarding the nature of the externalities in a pandemic and the ability of governmental actors to internalize them. These misconceptions result in an overemphasis on the effectiveness of coercive measures and an underemphasis on the role that citizens play in *coproducing* social distancing from the bottom up.

By building on the works of Vincent and Elinor Ostrom and the Bloomington school, this paper breaks from those purporting mutual exclusivity between liberty and effective pandemic response by conceptualizing social distancing as a coproduction problem. The coproduction of social distancing requires inputs from citizens and government (Parks et al. 1981; Ostrom 1996). Instead of the production model commonly

used in microeconomics, in which all relevant inputs are commanded by a single producer that decides the combination of inputs based on their relative prices and marginal substitutability, the coproduction model emphasizes a synergy (or complementarity) between what a government does and what citizens do in the provision of local public goods and services (Ostrom et al. 1961; Ostrom 1996).⁵

Such a synergy is possible when the inputs from governments and citizens are complementary; when they are not, government input can crowd out citizen engagement (Ostrom 2000a). We discuss various roles that a government can play to encourage citizen input as well as those that can crowd out citizen input. Understanding pandemic response in this way sheds light on the fundamental, yet neglected, issue that the production of various public health services relies more on decisions and actions at the micro level and less on government policies. Preventative measures such as social distancing, self-isolation, and even quarantines require coproduction, wherein the role of social capital is crucial. Individuals, families, local communities, and businesses can foster new forms of social capital and reconfigure old forms to solve large-scale social dilemmas in a pandemic (Storr et al. 2021). While some coercive measures may be necessary, only those that are built on *ex ante* self-commitment are likely to be effective (Ostrom 1990).⁶ Where self-commitment is lacking, coercive measures can crowd out citizen engagement. Thus, we emphasize the vital role of civil society and nonstate actors in addressing many pandemic challenges from the bottom up, and thereby better matching the scale of the externality at hand.

Like the economic literature on other collective dilemmas, the literature on pandemics is broadly Hobbesian: it assumes that without governments imposing coercive measures from the top down, individuals cannot rise above their parochial interests to internalize large-scale externalities or solve social dilemmas. This view persists despite theories and evidence that suggest that bottom-up alternatives are not only feasible but also more efficient given favorable institutional conditions. Elinor Ostrom (2009, 2012), for instance, shows that global externalities are best framed as “nested externalities,” wherein small- to mid-scale institutional efforts have a vital role to play in the coproduction of nested and overlapping solutions. Like Ostrom, we do not argue that citizen efforts alone are sufficient. In certain cases, expedient and large-scale efforts such as surveillance of disease transmission, limiting risky cross-border travel, and facilitating research into treatment and vaccines require the government to take a direct role. This paper provides an Ostromian framework for understanding pandemics as nested-externalities challenges in which preventative measures such as social distancing are viewed as coproduction problems.

Framing pandemic response as a nested collective action problem helps us identify the limits and capacities of central authorities in dealing with a pandemic. While scholars generally agree that governments *should* deal with pandemic externalities, the relevant institutional question is whether governments *can* deal with them (Geloso and Murtazashvili 2021). This paper sheds light on the latter question by highlighting that top-down efforts by central authorities alone are not sufficient and may even be counterproductive in dealing with pandemic externalities. Our central thesis is that a government’s role in the coproduction of social distancing should be to disseminate accurate scientific information and to create and maintain general trust and a sense of solidarity conducive for citizen participation. We argue that social-distancing policies that do not foster mutual trust may create public resentment and produce detrimental results. The purpose of this paper is to underscore the centrality of the coproduction relationship between citizens and governments in attaining social-distancing objectives.

The remainder of the paper proceeds as follows. In section 2, we examine the nestedness of collective action problems associated with social distancing during a pandemic. We discuss various costs and considerations that present additional challenges in the provision of social distancing as a global or large scale public good. We argue that the central planner aiming to provide such a good faces insurmountable challenges. Section 3 presents social distancing as a coproduction problem. Producing any amount of social distancing requires active engagement by and coordination between citizens and the state. That is, the state and citizens are coproducers of social distancing. In section 4, we discuss the theoretical and policy implications of viewing social distancing as a coproduction problem. The final section concludes with some suggestions for future research on the governance of pandemics.

2. AN OSTROMIAN VIEW ON PANDEMICS: NESTED EXTERNALITIES AND GOVERNANCE CHALLENGES

The literature recognizes that social distancing can be characterized as a collective action problem (Cato et al. 2020; Meinen-Dick 2020). The divergence of the private and social costs and benefits of social distancing is particularly severe, with considerable heterogeneity based on sociodemographic and health factors (Glover et al. 2020; Hur 2020; Malkov 2020). Hur (2020), for example, points out that “young workers engage in too much economic activity relative to the social optimum” (p. 1), which increases overall infection and death rates. Because healthy cohorts do not pay the full costs of their actions, it is argued, they over-engage in productive and leisure activities. Meanwhile, the benefits of social distancing—low infection and death rates—cannot be denied to those who do not engage in it. They are dispersed across society, with the elderly demographic being the primary beneficiary group. Thus, social distancing is underprovided.

Building on similar analyses, economists conclude that the collective action problem associated with social distancing can be classified and addressed as a public good problem (Bethune and Korinek 2020; Hur 2020). Although the problem of achieving social distancing is similar to many public goods problems, classifying social distancing as a pure public good is not appropriate. Collective action problems can vary tremendously based on how costly or difficult it is to devise mechanisms for excluding individuals or fostering cooperation (Ostrom 1990; 2003). Consider the difficulty of exclusion, which is commonly considered a defining feature of public goods (Olson 1965). Ostrom (1990, 2000, 2003) notes that this attribute is also shared by common-pool resources (CPRs). Not only are CPRs and public goods theoretically different classes of goods, but individual behaviors in free-riding situations associated with the two classes of goods are markedly different (Ostrom et al. 1994; Ostrom 2003). For example, in CPR games, a participant’s non-cooperative actions have a big effect on others’ behavior, which is not the case in public goods games. Thus, it cannot be assumed that pandemics pose a pure public good challenge. This distinction is critical because the public good rationale is a principal justification for calling on central authorities to provide certain goods (Rayamajhee and Paniagua 2020).

To correctly identify the type of the collective action problem at hand, one needs to factor in institutional and demographic details of the subpopulation under consideration. Attributes of the virus itself, such as reproducibility, mutability, and contagiousness, chiefly but not wholly determine the problem. Pandemic problems, in fact, are social and economic dilemmas marked by nested governance challenges as much as they are biological problems. How humans individually or jointly respond to the global challenge matters a great deal in defining the nature of the problem. Various institutional factors can interact with the biophysical attributes of the virus to change the type of collective action problem (Rayamajhee and Paniagua 2020). Recognizing the institutionally contingent nature of the problem is the critical first step for effective policy design. In what follows we briefly analyze various considerations that present additional challenges in the provision of social distancing as a public good and in framing pandemic responses as a single central-planner dilemma.

a. Is Pandemic Response a Social-Planner Problem?

Standard economic models treat pandemic response as a social-planner problem (Gersovitz and Hammer 2004; Gersovitz 2011; Fenichel 2013; Alvarez et al. 2020). They assume, for instance, that a benevolent social planner is equipped with the knowledge and tools to act swiftly and is able to directly control “all preventative and therapeutic actions” (Gersovitz and Hammer 2004, p. 3). Because infectious diseases, by definition, are rife with externalities that are unlikely to be fully internalized through voluntary processes, modelers argue that decentralized solutions are not social welfare maximizing (Toxvaerd 2020). Thus, the planner’s role is to intervene, often coercively, to control the spread of the infectious disease so as to maximize the

social welfare function. This approach presupposes that preventative measures such as social distancing, quarantines, and curfews (and their associated outcomes) are produced from the top down.

While useful as the first step toward a more realistic policy analysis, the optimal-planning approach suffers from too many serious epistemic and public choice problems to generate any useful policy proposals for social distancing (Coyne et al. 2020). Because risk calculus and the size and scope of externalities are constantly evolving, the planner faces epistemic challenges in gathering relevant information with which to optimize (Pennington 2020). Moreover, the governance of large-scale externalities requires bundling different services produced at different scales. This poses severe challenges to forms of government that rely on top-down measures (V. Ostrom 2008). Indeed, as the seminal work by Vincent Ostrom, Charles Tiebout, and Robert Warren (1961) shows, “a consolidated, hierarchical administration would unavoidably lead to massive inefficiencies because the administrative units operate at rigid scales, while the scale of public issues are varied and always changing” (quoted in Tarko 2017, p. 40). Thus, any administrative unit confronts numerous challenges that do not fit its scale: some challenges require scaling up, whereas others require scaling down.

Moreover, a central planner, even a benevolent one, dealing with a pandemic often faces incentives and lack of information that lead it to make choices that could have malignant consequences. This is because complex phenomena such as pandemics entail interacting components (for example, attributes of communities, rules-in-use, and biophysical conditions) at various nested levels at which the direction and magnitude of the impacts of external policy change are difficult to determine (Pennington 2020). A great degree of subjective interpretation, differences in opportunity costs and discount rates, and a wide range of assumptions about contextual factors enter into any cost-benefit analyses in a pandemic, which makes precise predictions highly unreliable.

Thus, a pandemic response that is motivated by the theoretical predictions of the optimal-control framework, in which a benevolent planner designs and implements policies at zero transaction cost, is likely to overestimate the competence of governments and underestimate the possibility of policy blunders. After all, the optimal solution may be, in practice, outside the range of institutional possibilities for any government that uses a hierarchical approach to deal with externalities (Ostrom 2008). This holds true even if governments are able to implement coercive measures effectively.

b. Nested Externalities at Multiple Scales

The framework of nested externalities at multiple scales provides a more suitable foundation to analyze global challenges, including pandemics (Ostrom 2012). For large-scale externalities, a global or top-down policy response is frequently seen as the only strategy required. Yet we intuitively recognize that helpful actions can be taken at multiple smaller scales to mitigate externalities. As Elinor Ostrom reminds us, this overemphasis on top down solutions is, in part, because we have not made adequate scholarly investments in developing a more appropriate and realistic theory of global change “that offers a better explanation of micro-level incentives and outcomes” (p. 353). A productive step in this direction is to frame global challenges as nested externalities. Trying to solve cross-national or global externalities as if political units were organized at the exact levels at which externalities can be most efficiently internalized is misguided; it downplays the challenges of scale, heterogeneity, and institutional matching, which were centerpieces of the Ostroms’ analytical framework (Tarko 2017).

Nested externalities occur when “actions taken within one decision-making unit simultaneously generate costs or benefits for other units organized at different scales” (Ostrom 2012, p. 356). The COVID-19 pandemic has made it abundantly clear that the spread and containment of infectious diseases follow this pattern. Many actions and decisions taken at multiple scales—from those of the residents of Wuhan, China, to those of the World Health Organization—have directly affected the spread and control of the contagion at different times and places.

Whether social distancing yields intended results (diminishing the speed and rate of contagion) depends on the actions taken at various levels—counties, cities, states, regions, countries, continents, and the world. Decisions at each level, including those taken individually and within families, have spillover effects that permeate across all levels. In other words, the nodes of authority governing social distancing lie at all levels and are organized in a nested manner. Strategies and policies adopted by a city mayor generate costs and benefits for other cities and for states, regions, countries, and the world. At an even more micro level, decisions taken by families and businesses generate externalities within and across communities, regardless of macrolevel decisions. Thus, the high level of dispersion of nodes of authority governing social distancing implies that the problem is better viewed as one of achieving multilevel collective action than one of providing a national or global public good through implementing an optimal policy. Thus, the production of social distancing is more likely to emerge through bottom-up processes involving different levels of authority.

Moreover, the guiding assumption behind the centralized provision of social distancing as a national or global public good—that the service is nonexcludable and nonrivalrous—also needs to be reevaluated. To be sure, social distancing shares an important feature with public goods—namely, the benefits of social distancing are nonsubtractable. For instance, if county A is able to reduce infection rates as a result of successful social distancing, the benefit from the lowered risk⁷ that one resident receives from it does not subtract from the net benefit that another resident receives. However, social distancing cannot be deemed as a pure public good.

The *degree* of excludability in the provision of social distancing varies across scales of analysis; that is, authorities at all levels have different capacities and costs of exclusion. For instance, exclusion may be more feasible at the national level, with effective immigration restrictions already in place, than at the county or state level (Finn and Jakobson 2021). On the other hand, the literature on public goods shows that excludability is institutionally contingent and determined to a large extent by geography, technology, and other factors (Rayamajhee and Paniagua 2020). For instance, jurisdictions separated by a major river or sea (compared to those separated by land boundaries) or geographic regions under multiple political jurisdictions (compared to those under one political jurisdiction) have different degrees of excludability.

Thus, the challenges in providing social distancing are complex and nested in multiple scales with feedback loops and externalities between scales. This complexity poses insurmountable obstacles to the task of optimal policy design and implementation, which assumes a single node of authority and no coordination problems. Next, we discuss different costs incurred in the optimal production of social distancing.

c. Different Costs Incurred in Social-Distancing Policies

i. Exclusion/Boundary Costs

Establishing clear boundaries is the first step in organizing successful collective action (Ostrom 1990). Without well-defined boundaries, creating technological and institutional devices to exclude nonmembers or nonpayers can be prohibitively costly. In the case of COVID-19, jurisdictional boundaries have a discernable but limited ability to reduce infection rates. Although travel can be restricted to an extent, complete restriction is infeasible because it entails high political and economic costs. Moreover, for a couple reasons, simply closing the borders does not stop the spread. First, there are no clearly defined boundaries applicable to infectious diseases. Second, restricting movement between jurisdictions does not stop intrajurisdictional spread, which poses significant challenges in heterogeneous communities with diverse beliefs and risk perceptions. The pandemic thus presents a problem of shifting boundaries (Finn and Jakobson 2021). The so-called hotspots change over time, requiring relaxing and tightening of restrictions, which further complicates the task of implementing a single policy.

With regard to social distancing, political boundaries matter only to the extent that citizens trust their political leaders. A high level of trust is essential in fostering the collective action that is necessary to meet

social-distancing goals (Ostrom and Ahn 2008; Rayamajhee and Bohara 2020). Thus, the suitable scale of political boundaries lies at the level that citizens trust the most. A provincial or national authority with a history of betraying public trust is unlikely to effectively implement social-distancing policies. A mayor's office may be a more fitting scale in such a case. Meanwhile, if nongovernmental organizations such as churches and civic associations are able to promote public trust, their jurisdictions are more suitable both in analyzing and in fostering social distancing (Storr et al. 2021). Moreover, smaller organizational units such as private businesses may be better able to create and enforce boundaries to generate higher compliance, but the exclusion costs they incur are determined by the larger jurisdictional units within which they are nested. For example, a city ordinance encouraging social distancing in public spaces can reduce a grocery store's costs of excluding violators. With enough social capital, a weak form of exclusion can also be introduced through social norms that do not strictly follow spatially organized geographical or political boundaries.

Thus, the suitable jurisdictions and associated boundary costs incurred in providing social distancing cannot be determined *ex ante* by the policy maker (or planner) in an institutional vacuum. A simple model with one node of authority that maximizes a given social welfare function with a predetermined policy tool is inadequate to deal with nested pandemic externalities and may be counterproductive. A wide variety of institutions and associations influence social-distancing behavior. Thus, our choice of the suitable institution (including the governance structure) is crucial in determining how costly or cheaply violators can be excluded (Rayamajhee and Paniagua 2020).

ii. Decision Costs

Collective action taken to provide social distancing requires that individuals expend substantial effort to reach an agreeable decision (Buchanan and Tullock 1962). That is, collective action entails individual decision costs. An individual will enter the collective unit if she determines that doing so will increase her utility by sufficiently reducing external costs or increasing external benefits relative to the decision costs. In the case of social distancing, decision costs vary significantly depending on the level under consideration. At a smaller collective unit, it may be feasible to achieve unanimity (voluntary social distancing), thereby eliminating external costs. However, as the level of the political unit rises and the size of the populace increases, decision costs increase.

In the political domain, decision-making authorities exist at different levels (for example, local, state, and federal), and different levels correspond to different decision costs. But informal associations also have considerable authority in the pandemic response and can influence decision costs. Churches and religious leaders influence people's beliefs about the right course of action and set expectations necessary for collective action. For example, Chamlee-Wright and Storr (2009) document important roles that Father Vien and the Mary Queen of Vietnam Church played in reducing decision costs that could have precluded successful community return after Hurricane Katrina. Similarly, social entrepreneurs and civic leaders also play crucial roles in reducing decision costs.⁸ Rayamajhee et al. (2020) find that local entrepreneurs, Dhurmus and Suntali, played a decisive role in fostering citizen participation in post-earthquake reconstruction and rebuilding efforts in Nepal.

Of course, one could, in theory, rely solely on a benevolent despot to implement social distancing nationally or even globally by decree. This would reduce decision costs substantially and swiftly. However, it is not clear how effective such a decree can be in motivating a behavior that entails significant monitoring costs. While it can solve coordination problems for potential compliers, it may motivate potential violators to defect. Antilockdown protests witnessed across the world testify to that fact.

iii. *Monitoring Costs*

High levels of self-governance are required to resolve any social dilemma in which temptations to shirk are copious (Ostrom 1990). Because human prosociality stems from reflexive, and automatic processes, temptations to shirk on social distancing are ever present (Wilson et al. 2009; Zaki and Mitchell 2013). Thus, to have any hope at obtaining social-distancing goals, effective mechanisms for mutual monitoring must be in place. Without mechanisms for monitoring and achieving accountability agreeable to most actors, the potential for conflict can escalate in micro situations in which deep-seated human prosociality is suppressed.

Studies of CPR systems tell us that monitoring is prohibitively costly when central agencies force resource users to comply. Only when incentives for mutual monitoring are present—when “everyone is watching everyone else” because they all have skin in the game—can the costs of monitoring be made manageable (Ostrom 1990, p. 74). In other words, who is doing the monitoring directly affects monitoring costs because the participants’ sense of fairness and their level of compliance vary with the trust they have in the monitoring authority. Monitoring costs, in turn, can determine whether solving the collective action problem is feasible. For instance, because the health effects of COVID-19 are heterogeneous, those who expect minimal symptoms and low fatality rates, such as cohorts of fifty years of age and below, have weaker incentives to adopt preventative measures. Thus, communities can better monitor such subgroups through built-in social mechanisms and civil associations at relatively lower cost compared to distant central authorities.

Recognizing the centrality of monitoring problems in implementing social-distancing policies leads us to conclude that the focus should be directed away from central, coercive authorities and toward building and strengthening social capital (Storr et al. 2021). When social capital is high—that is, when individuals share bonds of trust and reciprocity with one another—the necessity (and associated costs) of external monitoring is greatly reduced. As Rayamajhee and Bohara (2020) find, this is essential in enabling self-governance and fostering resilience in crises in which collective action is needed.

iv. *Sanctioning Costs*

The presence and efficacy of sanctioning mechanisms determine whether a prescription is a rule or a norm (Crawford and Ostrom 1995; Ostrom 2005). A prescription can be considered to be a rule only if effective sanctioning mechanisms are present (Crawford and Ostrom 1995). Without sanctioning, the relevant authority can encourage an action but cannot enforce it. Violations are likely to go unpunished. Certain norms, if internalized, can act as ethical prescriptions and influence behavior even without direct sanctioning mechanisms (Basu 2000). But such norms often take years, or even generations, to form and are not in the policy maker’s toolkit. Moreover, norms supporting social distancing are not likely to be internalized broadly. Even if a small subpopulation internalizes them to an extent, they are not likely to propagate to the broader community. Thus, sanctioning violations of social distancing is not a trivial task.

There are additional factors that determine sanctioning costs. Sanctioning a social-distancing behavior requires a form of *quasi*-voluntary compliance, which is built on an explicit or implicit self-commitment to comply with established rules in a repeated-interaction setting (Ostrom 1990). If such conditions exist, violations are punishable because each party values compliance and understands that her violation can result in other parties violating the rules, which will have devastating consequences. Therefore, all parties agree *ex ante* to be sanctioned. Universities, hospitals, and even grocery stores in most urban centers are better able to impose sanctions when violations occur because they can formally or informally incorporate sanctions into their terms of service. In the absence of quasi-voluntary compliance, imposing nongraduated sanctions unilaterally can lead to violations escalating uncontrollably.

Indeed, when one begins to examine the intricacies of collective action problems in a pandemic and starts to identify the various costs and challenges in enacting different pandemic policies, one quickly realizes that elegantly optimized planning problems have very little to do with reality. They do not adequately account for the various costs and challenges of the central-planning approach. Additionally, they do not

consider potential crowding out, perverse incentives, and public resentment caused by top-down policies. As we argue, such ill-conceived approaches tend to overestimate what governments are able to achieve and underestimate potential policy blunders, which can have devastating consequences.

3. Social Distancing as a Coproduction Problem

Although the concept of coproduction appears frequently in the public-administration literature, it has garnered relatively little attention in economics and related social sciences.⁹ Nonetheless, the concept remains useful in describing the role of civil society and the “third sector” in delivering public services (Ostrom 1996; Brandsen and Pestoff 2006; Pestoff 2006; Aligica and Tarko 2013). In a study closely related to ours, Rayamajhee et al. (2020) use the concept to describe the role of citizen engagement in postdisaster recovery. They contend that postdisaster reconstruction and recovery requires the coproduction of goods and services that cannot be provided solely by either the state or markets; that is, they require efforts from citizens and civil society. Therefore, coproduction provides a better foundation to analyze the delivery of many goods and services in such contexts.

Our discussion thus far has shown that many preventative measures to contain the spread of infectious diseases require a great deal of citizen compliance and participation. We argued, for instance, that without mechanisms of mutual monitoring and sanctioning, social-distancing goals cannot be attained. Thus, efforts from the “regular” producers (that is, governments) do not amount to much if citizens’ input is missing. We also showed that a pandemic poses nested-externalities problems, similar to the case of climate change (Ostrom 2009, 2012). Because many of these externalities are dynamic, the optimal scale of administrative unit to internalize them is difficult to determine. This problem gets more severe once the administrative hierarchy gets multilayered and entangled (Rayamajhee and Paniagua 2020). Therefore, optimal coercive interventions by central or regional authorities might be “outside the range of institutional possibilities” during a pandemic (Geloso and Murtazashvili 2021). Thus, an alternative approach to theorizing pandemic policy is needed.

Our core argument is that the concept of coproduction is a more useful tool with which to analyze pandemic response. The concept was originally developed by scholars at the Workshop in Political Theory and Policy Analysis at Indiana University to describe the relationship between the regular producers of public services (for example, police officers, college professors, health care professionals) and their clients (for example, citizens, college students, patients) (Parks et al. 1981; Brandsen and Pestoff 2006). Unlike consumer goods, many services (both private and public) require significant input from clients; that is, “the person being served is inevitably part of the production process” (Parks et al. 1981, p. 1001). Most preventative measures we discussed, including social distancing, fit this description. Thus, we argue that social distancing is best described as a coproduction process that requires efforts from both the regular producers (government authorities) and consumer-producers (citizens).

Coproduction theory stipulates that coproduction is technically feasible¹⁰ when either of the two types of relationships exist between regular-producer and consumer-producer inputs: substitutive and complementary. When inputs are substitutable, either the regular producer or the consumer-producer can independently produce the service, whereas both inputs are required when they have a complementary (or interdependent) relationship.¹¹

Many preventative measures in a pandemic require both substitutive and complementary inputs. As for social distancing, it can, in theory, be produced by citizens alone, but governments, no matter how omniscient, cannot produce it alone. If governments use inputs that are substitutes for citizen engagement, they are likely to crowd out the latter (Ostrom 2000a). Moreover, dependence on national or federal government can also crowd out efforts at regional and local levels (ibid.). Top-down efforts by the central government such as military intervention, policing, mass surveillance, and severe sanctioning are examples of government inputs that can be thought of as being substitutes for mutual monitoring and sanctioning. However, while these inputs can increase the private cost of violations, they will fail if many citizens are unwilling to

comply.¹² Even when citizens are moderately compliant, the resources expended to achieve monitoring and sanctioning goals will be far too great and the societal costs of overreaching too devastating to justify such strategies. Furthermore, such strategies can have retaliatory effects such as mass protests and civil unrest. In short, even when we ignore its crowding-out and retaliatory effects, coercion alone is insufficient to provide social distancing. Thus, the popular presumption that authoritarian regimes are better able to cope with pandemics is built on the false premise that citizens' compliance (their coproductive role) is given or irrelevant.

However, governments can also employ noncoercive inputs that are complementary to citizen engagement. With such measures, both crowding-out and retaliatory effects can be avoided. Unsurprisingly, in employing such inputs, governments must include nonstate actors such as thought leaders who inspire and entrepreneurs who find novel ways to enhance citizen participation and compliance. After all, the coproduction of social distancing is not merely a matter of effective policy design and implementation. Nonstate actors such as artists, pundits, and social media influencers can all play critical roles in providing messaging. For instance, to curb a COVID-19-induced rise in online bullying, the New Zealand government deployed adult-film stars in a successful "Keep It Real" online media campaign (Graham-McLay 2020). Thus, in thinking about effective complementary strategies, it is important to consider the pivotal role of the third sector in the coproduction of social distancing.

At the onset of the pandemic, because of the virus's rapid spread, overwhelmed health systems in hard-hit places, and uncertainty regarding the virus's effects on humans, more restrictive nonpharmaceutical interventions (mrNPIs) such as mandatory-lockdown orders seemed justified (Bendavid et al. 2021). However, as Bendavid et al. (2021) note, once we discovered a host of potential detrimental effects of mrNPIs, such as increases in rates of hunger, opioid overdose, domestic abuse, and suicide, and the dire economic consequences of such measures, these justifications were no longer valid. They find that mrNPIs, relative to less restrictive NPIs (lrNPIs), do not significantly reduce case growth in any of the ten countries included in their study. They further conclude that any reductions achieved via mrNPIs could have been achieved with less restrictive interventions. In fact, Gupta et al. (2020) find that a substantial share of the decline in people's physical mobility was a result of private responses—that is, voluntary social distancing—based on the available information about risks, and they also find that mobility declined before states adopted stay-at-home mandates. Thus, even though stringent measures were followed by a decline in case growth in many instances, much of this effect is likely due to private and endogenous civic responses to the perceived threat.

Even though more research is needed to evaluate the relative efficacy of voluntary and mandatory preventative measures, we have shown that government and citizen inputs have an interdependent relationship in the coproduction of social distancing. That is, the scope, scale, and intensity of government involvement directly determine citizen participation. The works of the Ostroms and other Bloomington scholars show that most public services can be provided only when citizens willingly engage in their production, delivery, and maintenance. This is more likely to occur when local agencies and authorities work closely with citizens and less likely to occur with national or federal mandates enforced by central agencies through coercion.

4. Policy Response: A Comparative Evaluation

Social distancing, as we have argued, requires well-defined complementary inputs from local authorities and agencies playing context-specific supporting roles such as monitoring and coordination. A central authority also has an important role in dealing with a pandemic. Social distancing can be effectively coproduced only when governments at all levels adopt strategies that are complementary to citizen engagement and remain vigilant so as to not crowd out bottom-up efforts. In this section, we briefly examine three broad types of roles that governments play to influence social-distancing behavior: (a) restrictions and mandates, (b) information generating and sharing, (c) interagency and interjurisdictional coordination. We then discuss their effectiveness given the highly coproductive nature of social distancing.

a. Restrictions and Mandates

Imposing severe restrictions is a policy approach that disregards the coproductive character of social distancing. To be sure, such measures may result in increased compliance rates in the short term. The fear of punishment deters many would-be defiers from violating social-distancing rules. Furthermore, such measures can also encourage conditional cooperators—that is, individuals who would defect if their neighbors did not comply—to conform. However, if the state lacks the capacity and willingness to continually impose harsh punishments, the effects are likely to dissipate over time. In the long run, as pandemic frustration and related psychological effects set in among citizens, the costs of monitoring (for example, surveillance costs) and sanctioning will increase proportionately. As illustrated in table 1, panel A, as the rates of citizen engagement in social-distancing efforts diminish over time, harsher restrictions are not likely to remain effective. The state can prolong the period of compliance by imposing even harsher punishments, but without effective monitoring mechanisms in place, they are also likely to fail.

In a balanced scenario, we argue, restrictions are limited and consistent with ex ante self-commitment (discussed in section 2). That is, citizens engage at the collective-choice level, at which they self-commit to mutual monitoring and sanctioning rules, because they understand the risks and costs of noncompliance. In this scenario, the role of the state is equivalent to that of a third-party mediator that facilitates the collective choice agreement or that of a third-party enforcer that implements it. The collective-choice process may involve diverse methods in different jurisdictions. One way is for a state to solicit citizen input regarding the acceptable level of restrictions.

Table 1. Social-distancing coproduction matrix

| Coproduction (citizen participation) ➔ | Low | High |
|--|---|---|
| Government policies ↓ | | |
| A. Restrictions/mandates | | |
| High restriction | Short term: uptake of social distancing Long term: social distancing not followed, as surveillance and policing not possible | Short term and long term: Uptake of social distancing |
| Low restriction | Limited social distancing, failure to contain the spread of disease | Balanced outcome: social distancing implemented when necessary Consideration needed when disease latency is high and there is high chance of asymptomatic transmission |
| B. Information sharing | | |
| Trust-enhancing role | State's ability is diminished because of lack of citizen participation Citizen coproduction may increase over time | Maximum coproduction of information |
| Trust-depleting role | Government distrust leads to limited adherence to preventative measures | Ideal case: strong nonstate actors/agencies can mobilize citizens Non-ideal case: citizen coproduction declines |
| C. Coordination across organizational units | | |
| Effective coordination role | Low compliance Significant discontent ensues when citizens are unwilling to comply | High compliance because govt role complements citizen engagement |
| Ineffective coordination role | Failure to achieve goals Lack of accountability | Pockets of successes in the short term Long-term success is questionable |

Of course, where citizens have strong proclivities toward noncompliance, light restrictions will not yield favorable results. A high level of noncompliance and the resulting rise in case numbers in such a jurisdiction can impose negative externalities on neighboring jurisdictions. This is particularly problematic in the case of diseases that have long latency periods (time between exposure and appearance of symptoms) and high mortality rates. In the case of COVID-19, despite high transmission rates, mortality rates are relatively low, which leads to nonconformers downplaying the threat of the virus. Thus, nonconforming citi-

zens are likely to view light restrictions as nuisances and are likely to find ways to circumvent them. Thus, when citizens fail to comply, the state's (limited) restrictive role serves little to no purpose.

b. Information Sharing

Both states and citizens have critical roles in sharing information related to the transmission and severity of a disease. A state, through its various agencies, can compile and present accurate information to the public that can complement citizens' own knowledge generation and transmission. It can effectively communicate vital information regarding the etiology of the disease, preventative measures, treatment methods, and reporting mechanisms to local authorities and complement their information-transmission efforts. Effective communication of evolving conditions and new knowledge can help dispel myths and conspiracies that tend to take shape during crises. Meanwhile, citizens play an important information-sharing role by reporting incidences of exposure and infection to local health authorities.

It is helpful to think of a state's information-sharing role as either trust enhancing or trust depleting (see table 1, panel B). When state actors effectively and accurately communicate known facts and evolving conditions, citizens can have confidence in them. In such cases, citizens are more likely to reciprocate by reporting cases, exposures, and violations of rules. This creates a positive feedback loop, wherein the state is more likely to gather accurate information and provide better estimates of disease prevalence and risk that can inform appropriate guidelines. In contrast, when state actors deliberately misinform the public by downplaying or exaggerating risks, citizens' confidence in them is low. Citizens then have limited incentives to report cases and violations or to adopt appropriate preventative measures (Han et al. 2020). This leads to inaccurate estimates and uninformed policy guidelines.

c. Coordination across Organizational Units

The third role that a state can play—related to the above two—concerns coordination among businesses, agencies, and jurisdictions. When markets are present, the price mechanism serves to coordinate. Through decentralized mechanisms that allow both competition and cooperation, prices serve to allocate goods and services by signaling producers and consumers to adapt to changes in preferences and resource availability. However, for preventative measures such as social distancing, the price mechanism is unavailable. Thus, to attain social-distancing goals, different organizational units (for example, businesses) need to be able to coordinate their plans and decisions.

This is important for two reasons. First, unlike during nonpandemic times, when differences in individual behavior are cherished or at least tolerated, pandemics create conditions wherein consumers and citizens need to be able to set uniform expectations about people's interactive behavior. In the absence of clear behavioral expectations—for example, if university students are unsure whether their classmates will socially distance in classrooms, laboratories, or bookstores—compliance is less likely. Thus, organizations need to coordinate to set minimum standards. In some instances, commercial associations (for example, chambers of commerce), major business franchises (for example, Costco), or public agencies (for example, a city water department) can set best practices and protocols to promote social distancing within their local communities. However, their uncoordinated efforts may be insufficient, given the global scale of externalities and the differences in costs of adopting preventative measures.

Second, various governmental units (for example, government agencies) with competing or overlapping interests may need to coordinate their plans. Thus, a government can act as a center to reduce the costs of coordination. Specific policy actions include providing a common meeting platform, facilitating communication among governmental units, and creating mechanisms to complement bottom-up efforts.

The coordinating role of government is necessary but insufficient for attaining social-distancing goals. When citizens are willing to comply, the government can complement their efforts if it is able to create effective coordination mechanisms. However, with unwilling citizens, effective coordination alone will not

succeed. And when citizens are willing to engage in social distancing but coordination failures are rampant, social distancing may be achieved in the short run but compliance rates are likely to dwindle in the long run.

In summary, viewing social distancing as a coproduction problem allows us to evaluate how effectively each governmental role fosters citizen engagement and compliance. As we have discussed, although a central authority serves important functions during a pandemic, one needs to remain vigilant that certain coercive functions do not crowd out citizens' involvement and ultimately undermine citizens' engagement.

CONCLUSION

Despite the global scale of the pandemic, using national or global approaches to limit the spread of COVID-19, as if it is a national or global public good problem, disregards the coproductive nature of many preventative measures. Although a few countries have effectively contained the spread using a seemingly centralized approach, we must recognize that their successes are largely due to strong support from their own citizens (Jefferies et al. 2020; Summers et al. 2020). For instance, Wang et al. (2020) attribute Taiwan's early successes to two main factors: (1) its government adopted lessons from the country's 2003 SARS experience and developed robust public health response mechanisms to take rapid action, and (2) special attention was paid to ensure that government decisions were "both culturally appropriate and sensitive to the population" (p. 1342). Besides taking early policy actions, the government adopted measures to reassure the public by communicating "accurate and transparent information regarding the evolving epidemic" through daily briefings and health messaging (ibid.). Government actions were generally well received and reciprocated by citizens, and compliance with social-distancing and mask-wearing norms has remained high throughout the pandemic, even during the period when no fines were imposed for violations (Blanchard 2020).

Findings from the successes in Taiwan, New Zealand, and other countries currently inform the scientific community's core recommendations in combating the pandemic (Summers et al. 2020). As we have argued, despite clear evidence of the coproductive role of citizens, many of these recommendations overemphasize what governments can do. This is the reason why government policies based on successes in one country do not produce favorable results in different countries. In this paper, we present an alternative, Ostromian view of pandemic response as a set of bottom-up collective action problems with nested externalities at multiple scales. In contrast to the dominant theorizing of pandemic response—and of social distancing in particular—as one of optimal policy planning and implementation, we argue that social distancing is a coproduction problem. This approach regards citizens not as passive responders to government stimuli but as active participants or coproducers of preventative measures. Thus, citizen participation is essential for social distancing. The state also has a crucial and well-defined coproductive role to play in achieving social distancing goals. However, it is not as simple as manipulating policy parameters from the top and leveraging the state's coercive powers. Instead, analysts must carefully consider various etiological, cultural, and social factors, such as the nature of the virus, informational asymmetries, social norms, beliefs, socioeconomic heterogeneities, informal labor markets, and available scientific knowledge.

NOTES

- 1 The Diamond Princess cruise ship in Japan reported an R_0 of 14 (Billah et al. 2020).
- 2 The median incubation period is 5.1 days.
- 3 Some scholars debate whether the correct terminology is "physical distancing." We use "social distancing" because it is a more popular term and is well understood.
- 4 In this sense, pandemics present challenges similar to those of climate change. Climate change also presents a global challenge with externalities that transcend national and geographic boundaries (Ostrom 2012). As Elinor

- Ostrom (2000a, 2012) argues, this fact has been the basis of the inaccurate position that global problems necessarily have top-down global solutions.
- 5 Coproduction refers to the notion that many services are produced by both the producer (regular producer) and the client (consumer-producer). In other words, inputs from both regular producers and consumer-producers are essential. We further discuss coproduction in section 3.
 - 6 Ostrom's studies show that ex ante self-commitment to mutual monitoring and sanctioning mechanisms is an essential feature of robust CPR systems (Ostrom 1990).
 - 7 Risk here is defined as the probability that a person will get infected with a disease. Perceived risks and benefits are inherently subjective and can also influence behavioral outcomes (for example, Rayamajhee et al. 2020a).
 - 8 On the other hand, religious associations can also facilitate the spread of the virus (Ryall 2020; Vermeer and Kregting 2020). This indicates that they face relatively low decision costs; whether the decisions encourage or discourage social distancing is a different matter.
 - 9 Despite a growing body of empirical research, particularly in the fields of public administration and public policy, coproduction remains a loosely formulated concept and is described by some scholars as a "woolly-word" in need of better theorizing (Ryall 2020; Vermeer and Kregting 2020). For a systematic exploration of the concept within a polycentric framework, readers are directed to Aligica and Tarko (2013).
 - 10 Parks et al. (1981) note that technical feasibility is a weak constraint and that economic and institutional considerations influence whether a service can be coproduced.
 - 11 For example, inputs from municipal trash collectors and local citizens can be substituted for each other: trash will be collected if either of the two inputs is present. Education, on the other hand, requires efforts from both teachers and students, as they are tied in an interdependent relationship (Parks et al. 1981, p. 1003).
 - 12 Thus, while they may be technically substitutes for mutual monitoring and sanctioning, economic and institutional constraints (for example, basic human rights and international treaties) may deem them infeasible. For instance, with little to no citizen compliance, the costs of military intervention and policing reach prohibitive and dangerous levels. Furthermore, these measures have to rise to levels that are certain to entail trampling on fundamental rights, thus leading to civil unrest and further noncompliance.

REFERENCES

- Aligica, P.D., and Tarko, V. 2013. Co-production, polycentricity, and value heterogeneity: the Ostroms' public choice institutionalism revisited. *American Political Science Review* 107: 726–741.
- Allcott, H., Boxell, L., Conway, J., Gentzkow, M., Thaler, M., and Yang, D. Y. 2020. Polarization and public health: Partisan differences in social distancing during the Coronavirus pandemic. NBER Working Paper.
- Alvarez, F. E., Argente, D., and Lippi, F. 2020. A simple planning problem for covid-19 lockdown. National Bureau of Economic Research.
- Anderson, R. M., Heesterbeek, H., Klinkenberg, D., and Hollingsworth, T. D. 2020. How will country-based mitigation measures influence the course of the COVID-19 epidemic? *The Lancet* 395: 931–934.
- Bai, Y., Yao, L., Wei, T., Tian, F., Jin, D.-Y., Chen, L., and Wang, M. 2020. Presumed asymptomatic carrier transmission of COVID-19. *Jama* 323: 1406–1407.
- Basu, K. 2000. *Prelude to political economy: A study of the social and political foundations of economics*. Oxford: Oxford University Press.
- Bendavid, E., Oh, C., Bhattacharya, J., and Ioannidis, J. P. 2021. Assessing Mandatory Stay-at-Home and Business Closure Effects on the Spread of COVID-19. *European Journal of Clinical Investigation*: e13484.
- Bethune, Z., and Korinek, A. 2020. Covid-19 Infection externalities: Pursuing herd immunity or containment. *Covid Economics, Vetted and Real# Time Papers* 11: 1.
- Billah, M. A., Miah, M. M., and Khan, M. N. 2020. Reproductive number of coronavirus: A systematic review and meta-analysis based on global level evidence. *PloS one* 15: e0242128.
- Blanchard, B. 2020. Taiwan to push social distancing in coronavirus fight, but no fines yet. Reuters. Mar. 31. Available: <https://www.reuters.com/article/us-health-coronavirus-taiwan-idUSKBN21I0ZP>
- Brandsen, T., and Pestoff, V. 2006. Co-production, the third sector and the delivery of public services: An introduction. *Public Management Review* 8: 493–501.
- Brewer, M. B. 2005. *The Psychological Impact of Social Isolation: Discussion and Commentary*. Abingdon: Psychology Press.

- Briscese, G., Lacetera, N., Macis, M., and Tonin, M. 2020. Compliance with COVID-19 Social-Distancing Measures in Italy: The Role of Expectations and Duration. National Bureau of Economic Research.
- Brzezinski, A., Kecht, V., Van Dijke, D., and Wright, A. L. 2020. Belief in Science Influences Physical Distancing in Response to COVID-19 Lockdown Policies. SSRN Scholarly Paper, Social Science Research Network. Available: <https://papers.ssrn.com/abstract=3587990>.
- Buchanan, J. M., and Tullock, G. 1962. *The Calculus of Consent: Logical Foundations of Constitutional Democracy*. Ann Arbor: University of Michigan Press.
- Cato, S., Iida, T., Ishida, K., Ito, A., McElwain, K. M., and Shoji, M. 2020. Social distancing as a public good under the COVID-19 pandemic. *Public Health*. Amsterdam: Elsevier.
- Chamlee-Wright, E., and Storr, V. H. 2009. Club goods and post-disaster community return. *Rationality and Society* 21: 429–458.
- Chen, S., Yang, J., Yang, W., Wang, C., and Bärnighausen, T. 2020. COVID-19 control in China during mass population movements at New Year. *The Lancet* 395: 764–766.
- Chu, D. K., Akl, E. A., Duda, S., Solo, K., Yaacoub, S., Schünemann, H. J., El-harakeh, A., Bognanni, A., Lotfi, T., and Loeb, M. 2020. Physical distancing, face masks, and eye protection to prevent person-to-person transmission of SARS-CoV-2 and COVID-19: a systematic review and meta-analysis. *The Lancet* 395: 1973–1987.
- Coyle, C. E., and Dugan, E. 2012. Social isolation, loneliness and health among older adults. *Journal of Aging and Health* 24: 1346–1363.
- Coyne, C. J., Duncan, T. K., and Hall, A. 2020. The Political Economy of State Responses to Infectious Disease. Available at SSRN 3668934.
- Crawford, S. E., and Ostrom, E. 1995. A grammar of institutions. *American Political Science Review* 89: 582–600.
- Fenichel, E. P. 2013. Economic considerations for social distancing and behavioral based policies during an epidemic. *Journal of Health Economics* 32: 440–451.
- Finn, V., and Jakobson, M. 2021. Mobility during pandemics: Moving borders and citizenship into uncharted territories. *Cosmos + Taxis* 5+6:
- Geloso, V., and Murtazashvili, I. 2021. Can governments deal with pandemics? *Cosmos and Taxis* Forthcoming. *Cosmos+Taxis* 5+6:
- Gersovitz, M. 2011. The economics of infection control. *Annu. Rev. Resour. Econ.* 3: 277–296.
- Gersovitz, M., and Hammer, J. S. 2004. The economical control of infectious diseases. *The Economic Journal* 114: 1–27.
- Glover, A., Heathcote, J., Krueger, D., and Ríos-Rull, J.-V. 2020. Health versus wealth: On the distributional effects of controlling a pandemic. National Bureau of Economic Research.
- Gourinchas, P.-O. 2020. Flattening the pandemic and recession curves. Mitigating the COVID Economic Crisis: Act Fast and Do Whatever: 31.
- Graham-McLay, C. 2020. New Zealand government deploys nude “porn actors” in web safety ad. June 15. Available: <http://www.theguardian.com/world/2020/jun/15/new-zealand-government-deploys-nude-porn-actors-in-web-safety-ad>
- Greenstone, M., and Nigam, V. 2020. Does social distancing matter? University of Chicago, Becker Friedman Institute for Economics Working Paper.
- Gupta, S., Simon, K., and Wing, C. 2020. Mandated and voluntary social distancing during the COVID-19 epidemic. *Brookings Papers on Economic Activity* 25.
- Han, Q., Zheng, B., Cristea, M., Agostini, M., Belanger, J., Gutzkow, B., Kreienkamp, J., and Leander, P. 2020. Trust in government and its associations with health behaviour and prosocial behaviour during the COVID-19 pandemic. *PsyArXiv*.
- Hur, S. 2020. The distributional effects of covid-19 and mitigation policies. Globalization and Monetary Policy Institute Working Paper.
- Jefferies, S., French, N., Gilkison, C., Graham, G., Hope, V., Marshall, J., McElnay, C., McNeill, A., Muellner, P., and Paine, S. 2020. COVID-19 in New Zealand and the impact of the national response: a descriptive epidemiological study. *The Lancet Public Health* 5: e612–e623.
- Klinenberg, E. 2016. Social isolation, loneliness, and living alone: identifying the risks for public health. *American Journal of Public Health* 106: 786.
- Lauer, S. A., Grantz, K. H., Bi, Q., Jones, F. K., Zheng, Q., Meredith, H. R., Azman, A. S., Reich, N. G., and Lessler, J. 2020. The incubation period of coronavirus disease 2019 (COVID-19) from publicly reported confirmed cases: estimation and application. *Annals of internal medicine* 172: 577–582.
- Malkov, E. 2020. Nature of work and distribution of risk: Evidence from occupational sorting, skills, and tasks. *CEPR Covid Economics: Vetted and Real Time Papers* 34: 15–49.
- Mao, R., Qiu, Y., He, J.-S., Tan, J.-Y., Li, X.-H., Liang, J., Shen, J., Zhu, L.-R., Chen, Y., and Iacucci, M. 2020. Manifestations and prognosis of gastrointestinal and liver involvement in patients with COVID-19: a systematic review and meta-analysis. *The Lancet Gastroenterology & Hepatology* 5: 667–678.
- Meinzen-Dick, R. 2020. Collective action and “social distancing” in COVID-19 responses. *Agriculture and Human Values*: 1–2.
- Olson, M. 1965. *The Logic of Collective Action*. Cambridge MA: Harvard University Press.

- Ostrom, E. 1990. *Governing the Commons*. Cambridge: Cambridge University Press.
- _____. Crossing the great divide: coproduction, synergy, and development. *World Development* 24: 1073–1087.
- _____. 2000a. Crowding out citizenship. *Scandinavian Political Studies* 23: 3–16.
- _____. 2000b. Collective action and the evolution of social norms. *Journal of Economic Perspectives* 14: 137–158.
- _____. 2003. How types of goods and property rights jointly affect collective action. *Journal of Theoretical Politics* 15: 239–270.
- _____. 2005. *Understanding Institutional Diversity*. Princeton: Princeton University Press.
- _____. 2009. A polycentric approach for coping with climate change. The World Bank.
- _____. 2012. Nested externalities and polycentric institutions: must we wait for global solutions to climate change before taking actions at other scales? *Econ Theory* 49: 353–369. doi:10.1007/s00199-010-0558-6.
- Ostrom, E., and Ahn, T. K. 2008. The Meaning of Social Capital and Its Link to Collective Action. In: G. T. Svendsen and G. L. Svendsen, eds. *Handbook on Social Capital*. Northampton, MA: Elgar.
- Ostrom, E., Gardner, R., and Walker, J. 1994. *Rules, games, and common-pool resources*. Ann Arbor: University of Michigan Press.
- Ostrom, V. 2008. *The Intellectual Crisis in American Public Administration*. Tuscaloosa: University of Alabama Press.
- Ostrom, V., Tiebout, C. M., and Warren, R. 1961. The organization of government in metropolitan areas: a theoretical inquiry. *American Political Science Review* 55: 831–842.
- Parks, R. B., Baker, P. C., Kiser, L., Oakerson, R., Ostrom, E., Ostrom, V., Percy, S. L., Vandivort, M. B., Whitaker, G. P., and Wilson, R. 1981. Consumers as coproducers of public services: Some economic and institutional considerations. *Policy Studies Journal* 9: 1001–1011.
- Pennington, M. 2020. Hayek on complexity, uncertainty and pandemic response. *The Review of Austrian Economics*: 1–18.
- Pestoff, V. 2006. Citizens and co-production of welfare services: Childcare in eight European countries. *Public Management Review* 8: 503–519.
- Rayamajhee, V., and Bohara, A. K. 2020. Social Capital, Trust, and Collective Action in Post-earthquake Nepal. *Natural Hazards*. doi:https://doi.org/10.1007/s11069-020-04363-4.
- Rayamajhee, V., Guo, W., and Bohara, A. K. 2020a. Perception of Climate Change and the Demand for Weather-Index Microinsurance: Evidence from a Contingent Valuation Survey in Nepal.
- Rayamajhee, V., and Paniagua, P. 2020. The Ostroms and the Contestable Nature of Goods: Beyond Taxonomies and Toward Institutional Polycentricity. *Journal of Institutional Economics*. doi:10.1017/S1744137420000338.
- Rayamajhee, V., Storr, V. H., and Bohara, A. K. 2020b. Social entrepreneurship, co-production, and post-disaster recovery. *Disasters*. doi:https://doi.org/10.1111/disa.12454.
- Reluga, T. C. 2010. Game theory of social distancing in response to an epidemic. *PLoS computational biology* 6. Public Library of Science.
- Ryall, J. 2020. Coronavirus: Surge in South Korea virus cases linked to church ‘super-spreader.’ *The Telegraph* 20.
- Saez, E., and Zucman, G. 2020. Keeping business alive: the government will pay. *Social Europe* 18: 2020.
- Saunders-Hastings, P., Crispo, J. A., Sikora, L., and Krewski, D. 2017. Effectiveness of personal protective measures in reducing pandemic influenza transmission: A systematic review and meta-analysis. *Epidemics* 20: 1–20.
- Storr, V. H., Haeffele, S., Grube, L. E., and Lofthouse, J. K. 2021. Crisis as a source of social capital: Adaptation and Formation of Social Capital during the COVID-19 Pandemic. *Cosmos + Taxis* 9:5+6
- Summers, J., Cheng, H.-Y., Lin, H.-H., Barnard, L. T., Kvalsvig, A., Wilson, N., and Baker, M. G. 2020. Potential lessons from the Taiwan and New Zealand health responses to the COVID-19 pandemic. *The Lancet Regional Health-Western Pacific*: 100044.
- Tarko, V. 2017. *Elinor Ostrom: an intellectual biography*. London: Rowman & Littlefield International.
- Tindale, L. C., Stockdale, J. E., Coombe, M., Garlock, E. S., Lau, W. Y. V., Saraswat, M., Zhang, L., Chen, D., Wallinga, J., and Colijn, C. 2020. Evidence for transmission of COVID-19 prior to symptom onset. *Elife* 9: e57149.
- Toxvaerd, F. M. O. 2020. Equilibrium social distancing. Faculty of Economics, University of Cambridge.
- Vermeer, P., and Kregting, J. 2020. Religion and the Transmission of COVID-19 in The Netherlands. *Religions* 11: 393.
- Wang, C. J., Ng, C. Y., and Brook, R. H. 2020. Response to COVID-19 in Taiwan: big data analytics, new technology, and proactive testing. *Jama* 323: 1341–1342.
- Wilson, D. S., O’Brien, D. T., and Sesma, A. 2009. Human prosociality from an evolutionary perspective: Variation and correlations at a city-wide scale. *Evolution and Human Behavior* 30: 190–200.
- Zaki, J., and Mitchell, J. P. 2013. Intuitive Prosociality. *Curr Dir Psychol Sci* 22: 466–470. doi:10.1177/0963721413492764.