Automatons or Individuals?

Voluntary Responses to COVID-19-Related Epidemic Externalities

BYRON B. CARSON III

> As long as analysts presume that individuals cannot change such situations themselves, they do not ask what internal or external variables can enhance or impede the efforts of communities of individuals to deal creatively and constructively with perverse problems such as the tragedy of the commons.
>
> —Elinor Ostrom, *Governing the Commons*

Bastiat's warning about the seen and the unseen also applies to the external effects of behavior related to infectious diseases. We can easily observe behaviors that create negative and positive externalities, which lead to higher prevalence and mortality rates (Gersovitz and Hammer 2004). For negative externalities, people might engage in too much infectious behavior because they are unaware of the costs they impose on others. For positive externalities, people might engage in too little preventative behavior because they are unaware of the benefit such behaviors provide for others. These effects lead uncoordinated groups of people to be more infectious and less preventative. In the context of coronavirus disease 2019 (COVID-19), for example, we observed spring break parties, large church gatherings,

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and worrisome *superspreader* events such as the Sturgis bike rally and associated those events with the spread of COVID-19.[1]

What goes unnoticed, however, is that people are responsive to outbreaks and epidemics. As diseases spread throughout real-world populations, people are not automatons who act according to a predetermined set of parameters defined in a model; they can change the parameters they face. People can seek relevant information about diseases, how they spread and are prevented, and which people might be already infected or susceptible. With such information, they adjust their behavior so as to avoid infection or prevent a disease from spreading to others on the margin. For example, gay men became more cautious in their sexual behaviors as the prevalence of HIV/AIDS increased (Philipson and Posner 1993). In response to the H1N1 epidemics of 2008–9, similarly, people in Mexico voluntarily improved their hygiene (Aguero and Beleche 2017), and people voluntarily took fewer flights (Fenichel, Kuminoff, and Chowell 2013).

Ignoring responsiveness leads to a poor understanding of the role individuals play in epidemics, how they discover novel means of prevention, and how they partially internalize epidemic externalities. Just as we understate prevalence rates when we ignore large gatherings of people who spread a disease through air droplets, we overstate prevalence rates when we ignore individuals who are responsive. To avoid such errors, we should recognize that individuals are not automatons when confronted with epidemics.

The varied responses to COVID-19 by individuals and by governments offer added importance for understanding responsiveness as a way to influence disease transmission. In the early days and weeks of the COVID-19 epidemics, however, few scholars and policy makers recognized that people were more than automatons or individuals who are unable to change their behavior. Policies were enacted based on epidemiological models that assumed individuals might mix with others only at a predetermined rate or based on a predetermined set of differential equations with given parameters (Adam 2020).[2] Such assumptions are striking in that they ignore voluntary behavioral changes in response to changing prevalence and mortality rates. Although some scholars did recognize the role of responsiveness (Gupta et al. 2020; Luther 2020;

1. More mundane behaviors might also be a significant cause of infections—for example, working in multiple nursing homes (Chen, Chevalier, and Long 2020).

2. Such modeling techniques are appropriate to understand some aspects of epidemiology; however, deriving policy responses from models that ignore human behaviors leads to an overestimation of the effectiveness of any particular policy. Referencing lockdown orders, school closures, and bans on large gatherings across Europe, for example, Seth Flaxman and his colleagues state, "Our model relies on fixed estimates of some epidemiological parameters (such as the infection fatality rate), does not include importation or subnational variation and *assumes that changes in R_t are an immediate response to interventions rather than gradual changes in behaviour*" (2020, 257, emphasis added). This is the definition of begging the question, whereby the authors assert without support that interventions caused a decline in COVID-19. The authors do admit, "We do not account for changes in behaviour; in reality, even in the absence of government interventions we would expect R_t to decrease and therefore would overestimate deaths in the no-intervention model" (260; this article is the published academic version of a similar report the authors issued on March 30, 2020).

Maloney and Taskin 2020), the full range of individuals' responsiveness remains underexplored.

To develop the logic of disease responsiveness and to make meaningful public-health improvements for infectious-disease prevention, this paper highlights the conditions under which individuals choose to be responsive. The primary condition of disease responsiveness is that individuals engage in preventative behavior, as they define preventative behavior, until the marginal cost of prevention outweighs the marginal benefit of prevention. Furthermore, individuals can alter the costs and benefits they face to encourage prevention by changing their behavior in novel ways, through innovation, and by adopting and changing rules. The ongoing COVID-19 epidemic clarifies and supports this framework, but the framework is also applicable to other infectious diseases. For example, a similar framework has been developed to explain how individuals in the United States during the early twentieth century lowered their transaction costs to internalize the preventative externalities associated with mosquito control and malaria prevention (see Carson 2020). These approaches draw from Elinor Ostrom (1990, 2005) and her work on collective-action problems, which shows how individuals are creative, active participants in resolving complex social dilemmas, including the outbreak of infectious diseases.

This paper proceeds as follows. The first section develops a subjective approach to disease responsiveness, which recognizes that responsiveness is a function of a person's beliefs, goals, and perceived means to achieve those goals. Importantly, responsiveness suggests that people are likely to change their behavior and discover innovative means of prevention, which includes changing rules, as prevalence and mortality rates change. The second and third sections develop this approach in the context of the COVID-19 epidemic in the United States. These sections describe the changing prevalence and mortality rates of COVID-19 during the first half-year of the pandemic and associate those changes with changes in responsiveness—for example, behavioral changes, innovative responses, and changing rules. Finally, the paper discusses implications for infectious-disease policy and public health in light of voluntary responsiveness.

A Subjective Theory of Disease Responsiveness

Individuals are responsive to infectious diseases as they perceive changes in prevalence and mortality rates; people change their behavior and become more cautious as the probability of infection and perhaps death rises. The main components of responsiveness include a person's beliefs regarding disease transmission, goals, and perception of opportunities to improve personal welfare. If people believe that wearing two face masks and generously applying bleach cleaning products to everything they touch are appropriate means of prevention, we should observe a rise in that behavior as prevalence rates rise. The same logic follows for people who believe wearing one mask is an appropriate means of prevention. For example, Joel Mokyr (2000) shows how changing

beliefs related to germs led to a rise in personal hygiene and cleaner homes in the nineteenth century.

People have various goals and values, only some of which might include disease prevention. People might want to maintain a steady job; they might want to pursue leisurely activities for themselves or with friends and family; they might want to invest in a new business or in their own education. Others might want to improve their diet or exercise more. People also desire to care for others, which might include giving charity to others and improving the health of loved ones. All of these goals are valuable ends, but they are mutually exclusive depending on available resources and time. The general condition of responsiveness still applies; to avoid infection for themselves and for others, people change their values and goals on the margin as the risk of infection rises. Overall, people weigh how they value being safer in terms of a lower risk of infection and the value of what they sacrifice to be safer.

Individuals might also have myriad ways to engage in preventative behavior depending on their beliefs, values, and goals. These choices expand once we recognize that people are *alert* (Kirzner 1973, 15–16) to opportunities to engage in prevention by utilizing cheaper alternatives or previously unrecognized means of prevention.[3] We might be able to articulate some of these preventative behaviors, but only individuals can fully make use of their tacit knowledge, consider these options, and make them relevant for their situation. Responding to sexually transmitted diseases such as HIV/AIDS, for example, individuals might limit their sexual partners to those they perceive as safer, but they also might use more condoms, reduce the number of times they have intercourse, alter their sexual behaviors, and so on (Philipson and Posner 1993).

The following "if" statements clarify some of the conditions under which people are more likely to be responsive to preventative measures, depending on differences in marginal values and contexts. People are more likely to engage in preventative behavior if prevention is tied to a financial incentive; if they have other health conditions that leave them more predisposed to infection or death; if they work in a place where there are many interactions and opportunities to spread disease; if they are more likely to interact with strangers in a context where information on health status is difficult to acquire; if they face a lower probability of losing their job because of their preventative behavior; and if they have more income to spend on various kinds of preventative inputs.

In addition to behavioral responses, individuals can alter preexisting production processes and change rules to encourage prevention. Toward the latter part of the nineteenth century, for example, people began to clean more within their homes. That is, they valued a cleaner home because they learned of germs and their influence on health as well as of the effects of private hygiene and nutrition (Mokyr 2000). Similarly, firms in the private sector altered their production of goods such as textiles and railroad

3. Israel Kirzner (1973) refers to alertness as the recognition that exploiting price differences and creating novel products are potential profit opportunities. Here alertness refers to novel opportunities to engage in preventative behavior, which might increase individual profit and welfare.

services to control mosquito populations and lower prevalence rates of malaria (Carson 2016). Individuals, entrepreneurs, and the owners and managers of firms are particularly suited to discover novel means of responsiveness because they receive the benefits of their innovations. This is a key difference from automaton-based epidemiological models: automatons do not voluntarily change their behavior because they do not and cannot consider the net benefit of their actions.

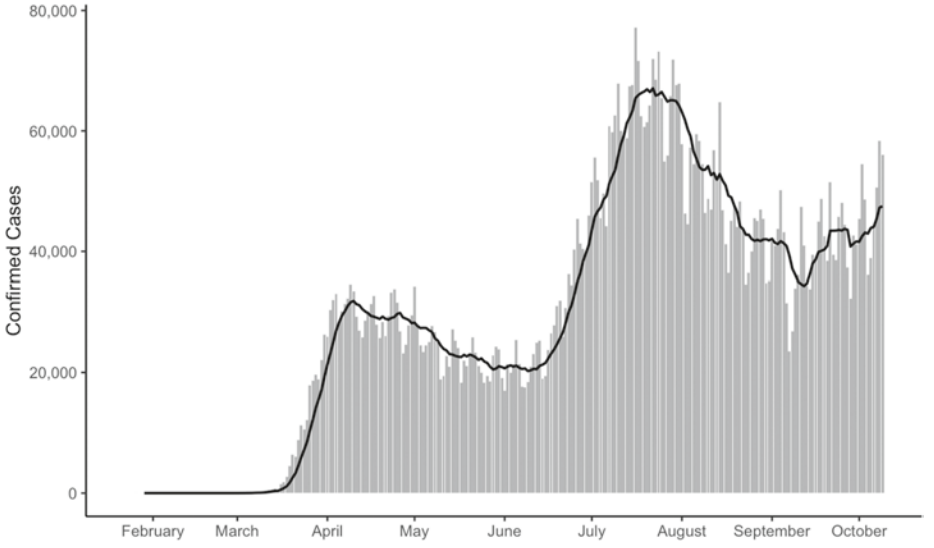
Individuals also perceive changing rules to be relevant, innovative means of responsiveness. Whereas automaton-based epidemiological models specify behavior according to fixed parameters—which indicates that the rules are fixed—responsiveness suggests that people benefit and are aware that they benefit from altering the rules they face. Rules also partially internalize epidemic externalities because they can raise the marginal cost of infectious behavior and the marginal benefit of preventative behavior. Generally, rules are humanly devised constraints that specify which behaviors are appropriate and permissible (North 1990; Ostrom 2005). For example, quarantine raises the marginal cost of infectious behavior by forbidding interactions between people who are infected and people who are susceptible but not yet infected. Although quarantine and other public-health measures are formal *governmental* rules, individuals—as individuals, members of civil society, and owners of businesses—have opportunities to create, monitor, and enforce formal and informal rules that encourage preventative behavior.[4] Furthermore, rules are scalable in that individuals can tailor them to pursue their goals. Tailoring rules can reward or punish specific behaviors, which individuals might value if they perceive specific behaviors as relevant inputs into preventative behavior. Thus, rules are indicative of the subjective approach given that people have different values and perceptions of their surroundings.

Rules become more relevant to encourage preventative behavior when individuals value prevention and when they can lower the transaction costs of creating, monitoring, and enforcing the rules. Private individuals, for example, do not have the legal authority to announce a citywide quarantine and consistently enforce that rule. Individuals, firms in the private sector, and other private organizations, however, might be more willing to create and enforce rules based on their values. For example, the owner of a café might be willing to impose a rule regarding the use of face masks because the rule allows the café to maintain operating hours and protects customers and servers.

For all these responses, people will internalize some but not all of their preventative externalities, especially when transaction costs make person-to-person agreements, negotiations, and contracting difficult. That is, it might be prohibitively costly to discover the identities of people who bear the benefits of your preventative behavior, especially with higher degrees of separation. Yet people can alter the transaction costs

4. Here I follow Geoffrey Brennan and his colleagues (2013) in their distinction between formal and informal rules, whereby a formal rule does not necessarily pertain to governmental rules: a formal rule specifies a primary command and the conditions under which it applies; it leaves enforcement to a centralized, legitimate authority; and it does not necessarily correspond to a group of people's normative values.

Figure 1
New Confirmed COVID-19 Cases by Day in the United States, 2020



Source: Graph made by the author in R Studio and the covid19.analytics package, which uses data from Johns Hopkins University (Ponce 2020).

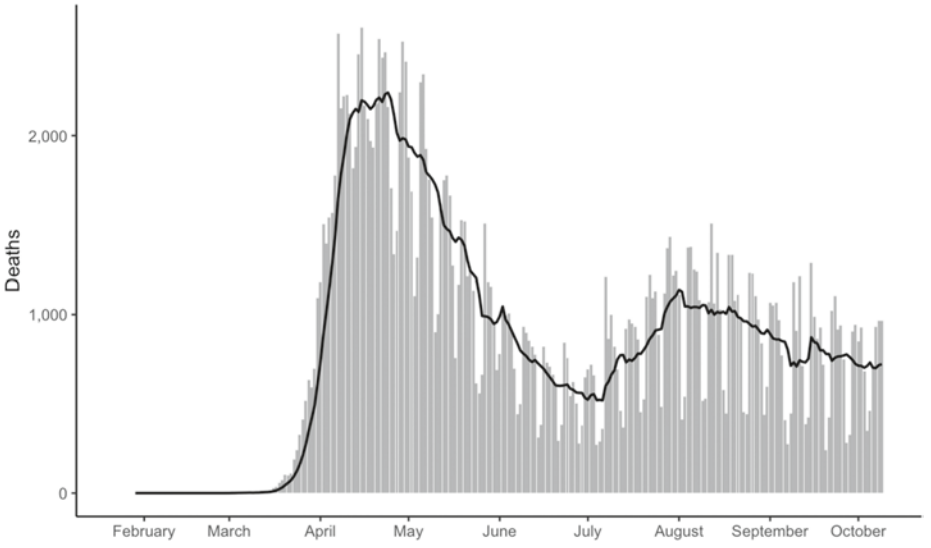
they face—and coordinate prevention—when they tie prevention to the sale of private goods and when they use organizations in civil society or in the private sector (Carson 2020). Lowering transaction costs on some margins facilitates prevention and allows people to internalize more of an externality. Externalities will still persist and are likely to be larger when people are in larger groups, especially with strangers, when there are few residual claimants, when there are few opportunities to tie prevention with the sale of a private good, and when there are fewer relevant organizations to coordinate prevention.

Marginal Values Change with COVID-19 Rates

In the context of COVID-19, individual responsiveness indicates that the net benefit of potentially infectious and preventive behavior changes as prevalence and mortality rates change. If the COVID-19 prevalence rate rises—as in figure 1—people will tend to be more cautious when they interact with others; and if the mortality rate rises—as in figure 2—people tend to be even more cautious.

Figures 1 and 2 show confirmed COVID-19 cases and deaths, respectively, in the United States from January 22 to October 9, 2020. Each figure shows the number of new cases and deaths per day, respectively, and a weekly average of each from the

Figure 2
New COVID-19 Deaths by Day in the United States, 2020



Source: Graph made by the author in R Studio and the covid19.analytics package, which uses data from Johns Hopkins University (Ponce 2020).

previous seven days. These data might be underestimates of actual cases and deaths due to imperfect monitoring, but they indicate general changes in prevalence and mortality.

New cases and deaths by day are one way to observe incremental changes in how people perceive the net benefit of prevention. Figures 1 and 2 suggest that the perception of the private net benefit of preventative behavior was negligible in February and early March. As the number of daily cases and deaths began to rise in March and throughout April, however, the perception of the private net benefit of prevention began to rise.[5] Although these numbers represent prevalence and mortality rates for the entire country, people perceive risk differently depending on their own context—for instance, by location, by comorbidities, by age group, by race, and so on. When COVID-19 data based on these particular perceptions were available, we expect to see more responsiveness from individuals who perceive greater risks.[6]

To the extent people observe and use aggregate data on risk to inform their decisions, we can associate changes in behavior with changes in aggregate data. For a relatively small net benefit of prevention in the early days and weeks of the epidemic,

5. On April 1, for example, there were 25,682 new confirmed cases and 1,172 new reported deaths.

6. Klaus Desmet and Romain Wacziarg (2020) suggest that important correlates of COVID-19 cases and deaths include population density, age, income, political affiliation, and so on.

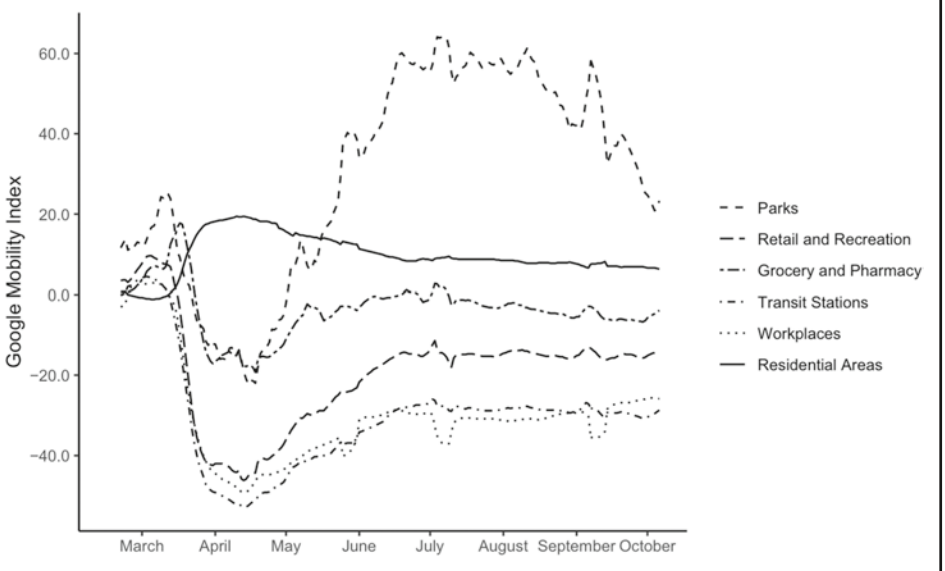
thus, we should observe relatively small amounts of responsiveness. Similarly, we should observe a greater change in preventative behavior as the numbers of daily cases and deaths increased. Furthermore, we should observe different kinds of responses based on a person's beliefs, goals, and values and on the means of prevention at his or her disposal. Some individuals might be willing only to limit their time in their workplace; the owner of a business might be able to respond by retooling its production process; other individuals might be willing to enact or follow alternative sets of rules.

Responsiveness to COVID-19

Behavioral and Innovative Responses

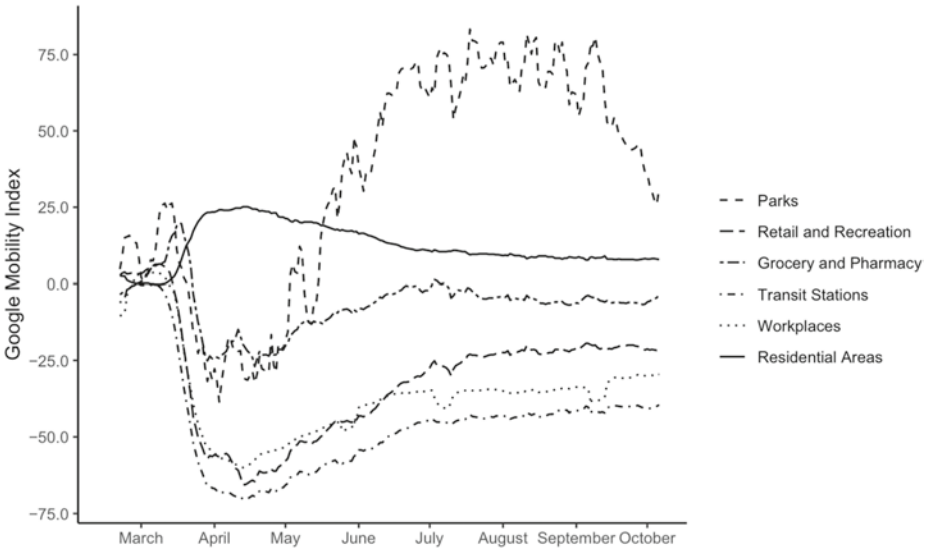
COVID-19 cases and deaths began to rise in March and more so in early April, which corresponds to decreases in mobility—as measured by Google Mobility data. Figure 3 shows mobility data for the following categories in the United States from February 15 to October 6: parks, retail and recreation outlets, groceries and pharmacies, transit stations, workplaces, and residential areas. Each series indicates a weekly mean of percentage changes from a baseline of earlier in 2020 (January 3 to February 6).

Figure 3
Changes in Mobility in the United States during the COVID-19 Pandemic, 2020



Source: Graph made by the author in R Studio using COVID-19 Community Mobility Reports (Google LLC 2020).

Figure 4
Changes in Mobility in New York State during the COVID-19 Pandemic, 2020



Source: Graph made by author in R Studio using Covid-19 Community Mobility Reports (Google LLC 2020).

These series indicate multiple ways in which people increased preventative behavior according to their values. The weekly averages obscure when these indices first reflect responsiveness, but the indices for transit stations, workplaces, and retail and recreation outlets show negative percentage changes beginning on March 9, March 10, and March 14, respectively. Time at home began to increase consistently on March 13. People decreased their time at grocery stores, too (but by a smaller amount). Sumedha Gupta and her colleagues (2020) also provide evidence on significant declines in transportation in March and April.

Figure 4 presents mobility data for New York State, which provides additional evidence of responsiveness. As people in New York, especially in New York City, faced a more severe outbreak and were more at risk of infection, we should observe larger changes in behavior. The trends in New York are similar to those trends throughout the United States shown in figure 3, except that the changes in New York are larger.

Mobility in and around parks as shown in both figure 3 and figure 4 fell in the middle of March, remained low for most of April, and then rose throughout May and June. The greater use of parks after April likely reflects seasonal use, but it does not indicate that people were unresponsive to COVID-19. Rather, it is consistent with our understanding that COVID-19 is less likely to spread in well-ventilated spaces such as outdoor areas.

It might be apparent that people changed their behavior earlier in March and in April due to changes in COVID-19, but figures 3 and 4 do not show commensurate responses after the middle of June when (1) new daily cases were much higher than they were in March and early April and (2) when the number of new daily deaths was rising but at lower levels. On the contrary, these figures show a gradual resumption of normal activity, albeit at lower amounts. First, falling estimates of infection and fatality rates—which are imprecise during an ongoing epidemic—indicate that steady increases in mobility are appropriate responses (Gu 2020; World Health Organization 2020).[7] As these rates have fallen over time, generally, figures 3 and 4 are consistent with individual responsiveness in that people began to resume pre-COVID-19 activities as they perceived less risk. Second, people might have discovered better ways to be responsive, which indicates that mobility is an imperfect way to observe responsiveness. Early in an epidemic, people might value strict isolation because they are unsure how a disease spreads, yet later on they substitute toward various preventative behaviors—such as distancing themselves socially, wearing face masks, using plexiglass, and so on—as they learn more about disease transmission. This process of substitution allows individuals to pursue their goals while encouraging preventative behavior.

There are additional ways people can be responsive aside from changes in mobility. Individuals perceive the world differently, which widens the scope for responsiveness. Consider all of the different ways to make an effective mask, from producing them by cutting up old T-shirts and socks to purchasing them in a market or online. Similarly, the rise of Zoom to conduct virtual meetings is a relevant response that encourages interactions at a safer distance.

Responsiveness also includes innovation, primarily from the private sector because of the financial incentives people face to remain open and care for their customers at the margin. The installation of plexiglass is one example of a preventative innovation, whereby few people knew of its efficacy for prevention early on in March 2020 or were in a position to make such knowledge useful, but then plexiglass emerged as a standard procedure in many spaces—for example, retail stores, offices, schools, and universities.

Many firms in the private sector were also alert to new profitable (and charitable) opportunities during the COVID-19 epidemics. For example, a company that previously made coffee filters switched to making face masks (Schuetze 2020); firms that previously used plastic to make cubicles or kayaks switched to making face shields (DePass 2020); and many breweries switched to making hand sanitizer (Gribbins 2020). Finally, consider the restaurants, cafes, and delivery services that catered to significant increases in to-go orders. All are examples of innovative, context-specific responses to higher prevalence and death rates of COVID-19 in order to maintain business operations and to limit the spread of COVID-19.

7. One estimate of infection fatality rates fell from 1 percent in March to 0.6 percent in May to 0.25 percent in July (Gu 2020).

Voluntary Rules of Prevention

Many retailers issued and enforced rules to encourage preventative behavior among their customers and employees. These rules varied from restricting entry to only people wearing a mask to requiring that customers walk in the same direction in aisles. Walmart and other grocery chains such as Food Lion and Kroger devised specific hours for elderly shoppers and extended shopping times for all customers, which are rules that limit contact (Garrity 2020; Tyko 2020). Walmart (2020b) reports that by August 17, 2020, more than 4,000 of its 4,700 stores expanded their operating hours from 8:30 to 10:00 p.m. More than forty national and regional grocery and retail chains also changed their operating hours for elderly populations (Kassraie 2020).

Organizations with hierarchical governing structures also changed the rules individuals faced. Walmart issued a consistent set of public-health rules to apply to all Walmart stores.[8] (For rule changes within Walmart and Sam's Club, see Smith 2020 and Smith and de la Rosa 2020.) For an organization that spans many municipal, state, and federal governments—each with varying sets of rules—a unilateral rule change indicates the importance of private rules for responding to infectious diseases.

Many American sports leagues and teams also took a rules-based approach in response to COVID-19 (Beer 2020). For example, the minor-league United Soccer League (USL) issued a "return-to-play protocols" report on June 24, 2020 (amended on August 11, 2020) that encourages its teams to follow public-health guidelines consistent with advice pulled from medical experts and public-health agencies such as the World Health Organization (USL 2020). In addition to various social distancing measures, the USL report develops a general rule that directs teams to follow the rules of their local public-health authorities or those of the report, *whichever are stricter*. In situations where there might be varying sets of rules from public-health agencies and a private organization, confusion might exist over which rules should apply. However, the general USL rule mitigates this confusion: if the USL rules are less restrictive than those of a local public-health agency, the public-health rules apply; otherwise, USL health protocols should be followed.

The National Basketball Association's (NBA) "bubble" approach to COVID-19 is a rules-based approach to disease prevention. The basic rule requires players to relocate to a place where entry is restricted to people who do not have COVID-19. In this case, players and teams relocated to the ESPN Wide World of Sports Complex in and around Disney World in Orlando, Florida. Players were allowed to opt out, but doing so came with a cost of not playing for the upcoming season; some players nevertheless chose not to play (Yahoo Sports Staff 2020). The players who decided to play agreed to follow announced public-health protocols whereby officials monitor entry into each complex and often require testing, temperature monitoring, and contact tracing, especially for players and other team and league members. The bubble plan also barred fans from

8. The corporate response to COVID-19 is given in Walmart 2020a.

entry. These rules are enforced; the NBA ejected one player from the complex for allegedly violating these protocols (ESPN 2020). The endeavor was successful at both shielding players from COVID-19 and encouraging play (Haislop 2020).

Revising Disease Prevention in Light of Responsiveness

Individual behavioral and innovative responses to diseases, which include changing rules, should encourage scholars and policy makers to revise their understanding of the role individuals play in the transmission and prevention of infectious diseases. Voluntary responses imply that individuals are not just the agents of infection and sources of externalities but also agents of prevention who face incentives to internalize externalities. The effects might still remain, but the point is to recognize how people mitigate epidemic externalities because they are responsive individuals, not the automatons depicted in epidemiological models. This approach offers implications for governmental public-health policy, for scholarship related to infectious diseases, and for our current responses to COVID-19.

The focus on voluntary behavior suggests greater complementarity with governmental public-health rules, especially when the latter receive more public and analytical attention. That people tend to be responsive to infectious diseases does not mean governmental rules are not important, especially when externalities might still exist. Individual responses and governmental interventions have marginal effects on prevalence and mortality rates. Indeed, the emerging literature on the effectiveness of governmental responses to COVID-19 provides suggestive evidence that policies tend to lower prevalence and mortality rates (Dave et al. 2020; Desmet and Wacziarg 2020; Jinjarak et al. 2020). However, we overstate the effectiveness of public-health policies when we ignore voluntary responsiveness. There is a growing recognition that individual behaviors changed in response to greater awareness of the quick spread of COVID-19, especially in early March even before many state-issued lockdown orders were issued (Gupta et al. 2020; Luther 2020; Maloney and Taskin 2020). In South Korea, for example, no lockdown orders were issued initially; instead, once people knew where infected people had been, they were more likely to avoid those places (Argente, Hsieh, and Lee 2020; Porter and Vigeland 2020).[9] The *global* changes in COVID-19 cases and deaths also cast doubt on the effectiveness of country- and state-specific public-health policies (Atkeson, Kopecky, and Tao 2020).

The extent to which we overestimate the effectiveness of any governmental policy depends on the extent of responsiveness and our ability to measure responsiveness. However, we might be unable to account for the full range of responsiveness with observable measures. We can observe changes in Google Mobility indices, for example,

9. Unfortunately, the South Korean approach came at the expense of serious privacy violations. Discovering ways to collect private health information and disseminate it—to encourage disease responsiveness—while maintaining privacy would be a valuable, profitable innovation.

but we might be unable to observe how people engage in preventative behavior along other margins that are unanticipated or unknown to individuals themselves. Responses that result from learning, from a substitution toward better means of prevention, and from changing production processes and rules are difficult to measure systematically. This bias indicates that existing estimates of responsiveness might underestimate responsiveness.

Governmental public-health policies should revise current approaches to bolster voluntary responses. Individual efforts can be spurred by governmental interventions such as emergency declarations and informational public-health campaigns that provide information on prevalence and mortality rates. To the extent information and testing are vital components of individual preventative behaviors—as they are for COVID-19 (Levitt, Romer, and Severts 2020)—public-health authorities should advocate greater testing *and* a reassessment of the efficacy of the regulatory process over COVID-19 tests. U.S. Food and Drug Administration regulations, for example, might ensure that tests are largely effective, but following such regulations strictly comes at the expense of delayed testing, even if it is less effective (Javitt et al., 2020; McGinley and Abutaleb 2020).

More coercive public-health rules might be required to internalize perceived externalities. Note, however, that for governmental rules to be effective, they have to influence the behavior of people who would not engage in preventative behavior otherwise. Effectiveness varies depending on the extent to which governments can monitor and enforce rules and how responsive people are. As the costs of monitoring and enforcing governmental rules rise, adherence might be lower. Behavioral responses and voluntary changes in rules are particularly important when public-health authorities are nascent, dysfunctional, or too small to effectively monitor and enforce public-health policies. This situation applies to rich and poor countries alike, given the complex ways people interact in social and commercial settings. Outside of relatively small outbreaks, few public-health agencies might be able to actively monitor whether individuals follow public-health rules. This is not meant to denigrate these agencies but to recognize there are complementary ways to prevent infectious diseases—for example, with the aid of voluntary changes in behavior and in rules.

Comparative advantage suggests a delegation of creating, monitoring, and enforcing some public-health rules to individuals, organizations of civil society, and firms, who tend to face lower costs in creating some rules that encourage preventative behavior. Many public-health officials are aware of the general influence voluntary behaviors might have (Weber 2020), but they can better understand preventative behavior by recognizing that people respond to incentives, follow rules, and change rules depending on their goals and values. Public-health authorities can facilitate voluntary responses by encouraging individuals to pursue their objectives and engage in experimentation, like the NBA bubble. This requires an explicit recognition of contracting and property-rights institutions and their relevance for commercial activity.

Finally, it seems appropriate to view herd immunity as a function of behavior (Sumner 2020), but it is also a function of discovery and humanly devised rules. Responsiveness implies that the herd-immunity threshold (the percentage of the population who are not susceptible to infection) is lower than typically estimated. One overall estimate of the herd-immunity threshold for COVID-19 in the United States is now at 35 percent, which recognizes there have already been changes in behaviors and in public-health policies (Gu 2020; Wallace-Wells 2020). Although we might worry that herd immunity is temporary or that relatively susceptible populations face a higher rate of transmission (relative to an average rate of transmission [see Cowen 2020]), responsiveness and voluntary rules might be effective means toward sustaining and bolstering herd immunity.

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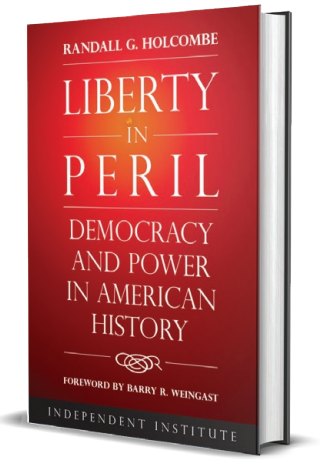

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