The Other Knowledge Problem: Public Choice and the Marvels of Modern Medicine Shut Down the World

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Abstract: While the global COVID-19 pandemic of 2020 was far from unprecedented in severity relative to prominent historical outbreaks, its arrival in the wake of explosive growth in scientific understanding, epidemiology, information and communications technology has led to unprecedented political, economic and social disruptions. At the heart of the disruptions were problematic political incentives well-documented in public choice theory when faced with a classic knowledge problem of costly, imperfect, and nonexistent information. Politicians demanded immediate information in order to appear proactive, favoring particularly dire predictions from experts incentivized to oversell or be overconfident in their results. Resulting forecasts, most notably from the Imperial College London model, created public and media outcry for comprehensive and highly costly responses resulting in extensive global economic harm. While this fraught nexus of uncertainty, dispersed knowledge, and problematic political incentives has complicated government responses to many modern issues, three factors in particular magnified the resulting harm. First, the rapid spread of the virus spurred decisive government responses without the usual time for debate. Second, real-time mass and social media back-and-forth between responders, politicians, commentators, and individuals created their own ever-spiraling web of incentives and recrimination. Finally, and perhaps most importantly for future response to crises, the knowledge problem was likely worsened rather than improved by technological and scientific advances that presented a fast-moving scenario in the grey area between routine and historically catastrophic that resulted in large-scale confusion over the trade-offs at hand. In this study, we will investigate the interaction of information asymmetries, political incentives, and institutional constraints in bringing about the COVID-19 shutdown, and the implications of the same for our path forward.

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1. INTRODUCTION

An emergency global initiative to tightly control movement outside the home at state/provincial or a national level is an effort that would have been impossible for governments to seriously attempt until quite recently. Advances in medical and scientific knowledge were necessary to treat disease and ultimately immunize populations. But more recent develop-

ment of computational methods in social sciences, communication, and information technology allowed government policy to lead and even dominate societal response to the Covid-19 pandemic.

If many of the achievements in fighting and treating Covid-19 are enabled by modern science and technology, many of the unprecedented political, social, and economic disruptions observed are inevitable consequences of the same complex, technology-driven society. Pennington (2020) for example highlights potential problems with government response to what Hayek (1967) classified as complex rather than simple phenomena.

At the heart of the disruptions were problematic political incentives well-documented in public choice theory when faced with a classic knowledge problem of costly, imperfect, and nonexistent information. Moreover, the advances in science and technology that enabled attempts for governments to act so quickly and comprehensively, as this paper argues, often created or exacerbated the disruptions experienced worldwide.

Many assume the primary constraint on even lower Covid-19 case rates and deaths is human compliance with government guidance or mandate. But the Covid-19 pandemic, as a case of 21st-century governments attempting to govern quickly, actively, and based on expert advice, demonstrates the limits to top-down attempts at control of complex societies.

We fortunately cannot observe any counterfactuals of things done differently in 2020, and this paper makes no claim to the superiority of any type of response especially with respect to cases and deaths. In the aftermath of Covid-19, it is the authors' hope that we can learn from successes, mistakes, and failures and do better in the lamentable event of a next time.

This article proceeds in five sections. Section 2 more specifically describes examples of recent scientific and technical advances along with an idealized version of the type of response many did and do think they make possible. The next sections then demonstrate how the same knowledge created or worsened problems at every stage. Section 3 discusses the Covid-19 pandemic's first observation and planning, with an emphasis on the well-known problem of government and experts. Section 4 discusses government implementation and maintenance of nonpharmaceutical (NPI) responses such as shelter-in-place orders (SIPOs) and business closures. Section 5 discusses issues arising in the ongoing unwind of these responses, concluding with their implications for pandemic policy.

2. A TECHNOLOGY-ENABLED GOVERNMENT RESPONSE

The Covid-19 pandemic of 2020 might be characterized as the first pandemic in history where mitigation efforts and response were first and foremost treated as matters of government policy. Governments, acting on the advice of epidemiological experts (discussed below) attempted to reduce the number of cases and deaths by actively controlling the movement of people outside the home through various direct and indirect channels (see section 4 below).

Social distancing and other SIPOs did not figure heavily into governmental or societal responses to the global influenza epidemics of 1957 and 1968-1970. Neither was the response to either pandemic heavily politicized, despite both killing millions worldwide and at least 80,000 and 100,000 in the United States (Honigsbaum 2020).

Some recent scholarly works have attempted to discern the effectiveness of NPIs during the 1918 Spanish Flu pandemic by comparing them with precursor measures, including quarantines and school closures. While initial investigations of this type asserted the effective deployment of parallel policies at the local level in 1918 (Markel et al. 2007), ongoing research into this subject spawned a long-running dispute about whether modern analyses have accurately interpreted historical records (Barry 2007). Other case studies of the 1918 outbreak in Canada found that quarantine measures were largely ineffective (Sattenspiel and Herring 2003).

Remarking on this literature, medical historian John M. Barry (2009) conducted a comparative analysis of quarantines in military camps during the 1918 outbreak as a precursor to SIPOs. He concluded that

"Historical data clearly demonstrate that quarantine does not work unless it is absolutely rigid and complete...If a military camp cannot be successfully quarantined in wartime, it is highly unlikely a civilian community can be quarantined during peacetime." More recent empirical analysis by economist Robert Barro (2020) concluded that NPIs in 1918 may have "flattened the curve" for peak influenza deaths in specific cities, but also had no statistically significant effect on overall influenza mortality—i.e. they were either insufficient to reduce death itself, or merely delayed rather than prevented it.

As a result of these prior experiences as well as regional data from smaller epidemics in more recent decades, a large body of epidemiological literature explicitly cautioned against SIPOs and similar heavy-handed lockdowns prior to the Covid-19 outbreak. A 2006 study by leading epidemiologists at Johns Hopkins University (Inglesby et al. 2006) strongly advised against "large scale quarantine measures"—a term they used synonymously with the modern SIPO measure. Reviewing the evidence from previous influenza pandemics, they concluded "There are no historical observations or scientific studies that support the confinement by quarantine of groups of possibly infected people for extended periods in order to slow the spread of influenza." "The negative consequences of large-scale quarantine are so extreme," they continued, "that this mitigation measure should be eliminated from serious consideration."

A 2019 report on NPI measures for pandemic influenza (WHO 2019) offered conditional support for border restrictions, but strongly advised against "home confinement of non-ill contacts of a person with proven or suspected influenza." "Most of the currently available evidence on the effectiveness of quarantine on influenza control," they continue, "was drawn from simulation studies, which have a low strength of evidence." When combined with the lack of empirical evidence and the high social costs of such measures, the WHO deemed them "not recommended." The same report offered a conditional recommendation on optimally timed regional school closures, but similarly noted that "the quality of evidence [for such measures] is very low."

A September 2019 report by the Johns Hopkins Center for Health Security (Nuzzo et al. 2019) reached similar conclusions on the effectiveness of NPIs. "In the context of a high-impact respiratory pathogen, quarantine may be the least likely NPI to be effective in controlling the spread due to high transmissibility," they noted. Such measures would likely delay the spread of the disease, but not prevent it. Difficulties with localized quarantines during recent outbreaks of Ebola and SARS further attested to the "added difficulty of implementing such measures on a large scale." Perhaps most notably, they warned that "implementation of some NPIs, such as travel restrictions and quarantine, might be pursued for social or political purposes by political leaders, rather than pursued because of public health evidence," and urged the WHO to "clearly articulate its opposition to inappropriate NPIs."

Likely reflecting this pre-2020 epidemiological literature, top US infectious disease administrator Anthony Fauci even cautioned against SIPO-style measures after China implemented them in the Wuhan region to control the Covid-19 outbreak (Kaufmann 2020). Speaking to CNN on January 24, 2020, Fauci remarked, "That's something that I don't think we could possibly do in the United States, I can't imagine shutting down New York or Los Angeles...Whether or not [China's lockdown order] does or does not is really open to question because historically when you shut things down it doesn't have a major effect."

By March 2020, Fauci had come to support the very same SIPO measures he deemed unlikely and ineffective less than two months prior in the context of China. Fauci's changing position reflected a sudden and sharp shift in epidemiological opinion. By late March, large scale SIPOs became the preferred policy response to Covid-19 in almost all developed nations with only a few notable holdouts such as Sweden. The shift reflected the rapid ascendance of the previous minority position noted in the 2019 WHO report wherein the epidemiological benefits of such measures were calculated from simulation studies rather than tangible evidence (WHO 2019). The most influential of these simulations by far was the epidemiological model produced by Imperial College London (ICL), which directly induced the governments of the United Kingdom and United States to shift their policy responses over to large scale lockdowns (Adam 2020).

If large-scale, active, government-led social distancing was not a feasible option until quite recently, one reason is likely that neither governments nor any group in society had developed the combination of scien-

tific and technical know-how to observe the disease near its origin point in China, consult with each other and experts in a matter of days, and instruct entire populations to drastically alter their lives, again, in a matter of days.

Advances in hospital-based medical care required to treat the worst cases of Covid-19 are a mostly modern development. Modern ventilator-based intensive care, for example, is a development of the 1950s (Wunsch 2020). The capacity-constrained nature of the US Healthcare system with respect to ICU beds and ventilators was a frequently used justification for shelter-in-place orders (SIPOs) and the closure of businesses and other public gatherings (Gavin 2020).

Many would cite advances in the field of epidemiology as a top factor making active government response possible. As an empirical social science and influencer of policy, the development of epidemiology has mirrored economics. Both fifty years ago already made extensive use of mathematical modelling, but neither could incorporate significant amounts of real data until advances in computing.

Epidemiology, like economics, is also highly prone to expert failure. Epidemiological modeling of large, complex systems requires the modeler to make strong assumptions about the nature of the disease, the effectiveness of specific NPIs, and the likely course of transmission—all in the context of a high-uncertainty environment. If correctly calibrated to appropriate inputs, a model could theoretically anticipate the course of a pandemic with reasonable precision. Each uncertainty reduces the accuracy of the model though, and in the case of a novel virus the necessary inputs may amount to little more than guesswork.

The influential Covid-19 modeling out of ICL (Ferguson et al. 2020) is highly illustrative of this problem. Adapted from a 2006 influenza model by ICL team leader Neil Ferguson, their March 2020 model purported to predict the effects of a suite of NPIs at reducing transmission and mortality rates from Covid-19. NPI effectiveness in this model, however, is determined by its own assumptions about the rates at which specific measures such as school and business closures, social distancing guidelines, and ultimately sheltering at home alter the rate of daily contacts within the population and thus the chance of transmission. As ICL lacked observational data about these measures, their assumptions amounted to little more than rough guesswork.

To further complicate the matter, ICL's modeling derived from an earlier paper that omitted what would become a crucial context for Covid-19 transmission: nursing homes. As Ferguson's paper (Ferguson et al. 2006) from which the model derived noted, "Lack of data prevent us from reliably modelling transmission in the important contexts of residential institutions (for example, care homes, prisons) and health care settings." As we've now observed from Covid-19, such facilities represent an acute vulnerability for transmission. After one year of the pandemic, nursing homes account for almost 40% of all Covid-19 deaths in the United States (Covid Tracking Project 2020; *The New York Times* (McKinley and Ferre-Sadurni 2021) reported that this figure is likely an undercount due to inconsistencies in reporting from New York state, one of the hardest-hit locales). Similar patterns have been observed in other countries, and early data returns from the first wave of the pandemic confirm that country-level mortality patterns varied widely based on how successful they were at shielding their nursing home infrastructure from outside contacts (Ioannidis 2021).

Viewed in this context, the lack of a mechanism to account for nursing home transmission represents a significant expert failure in the ICL Covid-19 model, deriving entirely from mistaken or missing assumptions about the nature of its spread. Empirically tested performance of subsequent ICL model releases for other countries has painted a similar picture of predictive bias that severely overestimated weekly mortality (Friedman et al. 2021). While other models used more conservative parameters resulting in better, or at least more cautious, predictive ability, the experience with ICL as well as its preeminent role in shaping the global policy response directly attests to the intrinsic limitations presented by the rise of the modeling approach in epidemiology.

Also of crucial importance to government responses were even more recent advances in information and communication technology, broadly characterized as the suite of technology available to any home-based computer or smartphone user. Honigsbaum (2020) notes that in the 1950s and 1960s scientists were

unable to observe influenza viruses developing in Asia. Information technology was central to this first and every following step in 2020.

Fast communication between and among governments, experts, media outlets, and people was essential for the large-scale lockdowns first recommended by Ferguson et al in their paper released March 16, 2020 and implemented especially in the Spring of 2020. Some, including the Imperial College authors well-connected to governments, believed that millions would die if authorities waited merely days or weeks.

This suite of technology was also necessary for individuals to communicate and inform themselves while their movement was restricted to the home, and allowed some individuals to work. Without the practical and comfort-based benefits of technology, the costs of lockdowns would have been even higher, perhaps to the point of infeasibility.

This wide array of scientific and technological developments created an orthodox set of tactics to respond to the virus, including aggressive SIPOs or lockdowns of individuals at home except for pre-approved "essential" tasks, closure of businesses and most public gatherings, and individual behavior outside the home including mask-wearing and maintaining six feet of distance from others. For the most ardent supporters of this strategy, compliance and leadership appeared to be the main hurdles.

But the global response to Covid-19 was implemented in a complex world of heterogeneous individuals, dispersed and incomplete knowledge, politics, and social media. For example, building on the work of F. A. Hayek (1967), Pennington (2020) argues that: "while government action may be a justifiable response to the pandemic, there may be few systemic mechanisms that enable policymakers to avoid large scale errors and to assess the effectiveness of alternative policy measures."

As the next sections discuss, many of the above technological advantages were at the heart of limits to implementing such tactics in the real world.

3. EARLY 2020: PLANNING AND EXPERT ADVICE

As noted in the previous section, the original ICL model for the US and UK presented a range of scenarios for the Covid-19 pandemic tied to the implementation of specific NPIs. Its baseline projections revolved around an admittedly unlikely but also catastrophic "do nothing" scenario in which an unmitigated pandemic ravaged both countries. Although ICL's report stressed that even mild interventions could avert this outcome, press coverage as well as Neil Ferguson's own public comments tended to stress its headline-grabbing death tolls. The unmitigated UK model projected over 500,000 deaths, whereas the United States model projected 2.2 million. As late as March 20th, Ferguson repeated the 2.2 million figure to a *New York Times* columnist and stressed that a "best case" scenario could perhaps halve that to 1.1 million (Kristof 2020). Although Ferguson did not specify mitigation scenario projections for the US in his published report, it too repeated an expectation of "1.1-1.2 million [deaths]" under a general mitigation scenario, barring a rapid increase in hospital capacity. Daily deaths in both countries were projected to peak around June 2020. One year after the Imperial model's release, the US had recorded about 550,000 deaths and the UK had reached 125,000.

The political appeal of the ICL models came from a combination of this alarm and their prescriptive simplicity. By enacting successively stringent NPIs—social distancing, school and workplace closures, and ultimately successive levels of home quarantine—the death count projection in both countries could be dramatically reduced. Both the American and British governments adopted these recommendations, ultimately leading to the widespread adoption of SIPOs for most of late March and April.

The premise of these policies was their assumed effectiveness at reducing mortality, as neatly described and projected by the models. Execution presented challenges, but intuitively derived from the lockdown orders themselves. Governments can directly enforce a shelter-in-place order with varying degrees of cost, effort, and stringency. In theory, a government could post an armed soldier at every door in an attempt to make the lockdown almost "complete," likely with both monetary and political costs too high to bear. The Wuhan region of China adopted extreme and militarized implementation that approached this level of

stringency. A greater amount of policy variation was observed in East Asia and the Pacific. Australia and New Zealand paired strict border closures with heavy-handed lockdowns. South Korea, Taiwan, and Japan used border measures, but otherwise avoided or strictly limited the use of lockdowns. Lockdowns became a preferred policy in most of the United States and Europe, albeit with one caveat. These western governments chose a markedly lower level of direct enforcement than China's Wuhan region, ordering populations home other than for "essential" reasons, then compiling lists of what "essential" businesses and other activities were.

Governments choosing to enforce SIPOs primarily through indirect means employed tactics including limiting the potential benefit of individuals leaving the home by forcing closed businesses not on "essential" lists and banning other public gatherings. Though governments may have had the ability to monitor and physically force individuals in their homes, they largely did not do so, and in fact generally expected people would leave their house regularly for "essential" activities. Businesses and public gatherings, fewer in number and far easier to observe than the movements of every individual, could be enforced by governments far more effectively and at lower cost.

With everyday businesses like grocery stores and gas stations often on "essential" lists, and "front-line" workers at these establishments and healthcare facilities cheered as heroes, SIPOs were never intended to be 100 percent complete—a fact underscored by the phrase "flatten the curve" to justify the orders.

This complicated mixture of government recommendations and orders to individuals, shutdowns of businesses and gatherings, and individual choice resulted in what in aggregate might be characterized by a percentage reduction in individuals' trips outside the home. Multiple factors contributed to these reductions:

1. Individuals might seek to avoid direct government or law-enforcement reprisal, perhaps in the form of ticketing or arrest.
2. Individuals might agree with governments' advice rather than being coerced by them, choosing to reduce trips outside the home.
3. There might be fewer places individuals wish to travel due to business and public closures.
4. Individuals may wish to avoid social reprisal, fueled indirectly by government action as well as the mass and social media climate.

Among the newly-imposed costs of leaving the home, the first—potential for reprisal by authorities directly on individuals for their decisions—is rendered next to impossible by the "essential" clause found in most SIPOs. Home-based SIPOs as constructed by governments in the United States and most of Europe could not and were not intended to eliminate all travel outside the home.

These governments were therefore left mostly with blunt-instrument tactics to enforce SIPOs indirectly. Regarding the second tactic, governments can serve as reliable repositories, curators, and broadcasters of information. They are also vulnerable to pitfalls such as their interaction with experts, discussed above, and due to the same advances in information and communication technology, will inevitably face both well- and poorly-intentioned competitors for the dissemination of information.

Indirect enforcement through mandatory closures of businesses and public spaces—more directly enforced—proved among governments' most reliable tools in reducing their populations' number of trips outside the home. Such closures came at phenomenal economic cost, which two economists estimated to be $16 trillion (Cutler and Summers 2020). Contrary to the view of many, these costs were not wholly "unavoidable," and more decentralized and voluntary tactics by governments might have significantly reduced these costs, while, unlike the "do nothing" scenario of the Imperial College, also mitigating disease spread.

Suppose governments had not issued orders on business closures at all, and instead created voluntary guidelines for individuals to dramatically reduce their trips outside the home. On the disease mitigation side, outcomes could in theory be identical—a targeted percentage reduction in individuals' trips outside the home. But the economic costs, while remaining large, might have been substantially lowered.

Such a voluntary and decentralized approach would put to use the knowledge dispersed among individuals. Presumably, the trips outside the home individuals decide to take are those with the greatest benefit. Such decisions might have looked very different than they ended up in the Spring of 2020, when authorities mostly made those decisions for individuals through forced closures. In the alternative approach, business owners could observe demand and reduce their hours, even cooperating with communities on logistics that reduced people out and about while still allowing more of the economy to run.

Political incentives, however, prevented such tactics from authorities, even if lowering economic costs while delivering the same outcome in terms of Covid-19 cases and deaths. As the pandemic continued, opposing politicians would reap great gains from accusing an incumbent using the voluntary approach of not "doing enough."

Such pressures would be magnified by the scientific, government, and media climate of the early 21st century, where people can read new cases and deaths every morning like sports scores and social media can quickly weave narratives that blame the severity of the pandemic on whoever one politically opposes.

Therefore, unlike 1957 and 1968-1970 where governments worried more active responses would scare populations (Honigsbaum 2020), the overall climate in 2020 was conducive to governments presenting the threat of the pandemic as starkly as possible and arresting economic activity to avoid or minimize factional criticism of not taking an active enough role. In the United States, a confused and misleading depiction of fatality rate estimates by Dr. Anthony Fauci in congressional testimony on March 11, 2020 likely led to an exaggerated perception of the disease's deadliness, paving the way for a political response that catered to panicked emergency measures (Brown 2020).

4. UNWINDING PANDEMIC RESPONSES

Authorities implemented extraordinary measures that promised to drastically reduce the number of Covid-19 cases and deaths. Given that these measures were fundamentally limited by the knowledge and technology required to implement them, there exist strong incentives for leaders not to be first in rolling back the most visible responses. For example, the return of public gatherings, no matter how well managed, will inevitably cause at least some spike in cases. With major media outlets like the *New York Times* virtually shaming states with the largest weekly-moving-average increases in bright red as part of a prominent infographic, what governor would invite such criticism?

When governments did begin to roll back perhaps the most draconian and costly steps taken, the forced closure of most businesses and workplaces, the emphasis was once again on presenting themselves to the public as active and capable leaders as opposed to mitigating either virus spread or economic cost. Evidence of this bias may be found in public approval ratings of state governors from the start of the pandemic through the summer of 2020. Approval ratings in this period showed little discernible connection to successful public health performance at containing the pandemic—indeed, somewhat counterintuitively, a weak positive relationship appeared between higher mortality rates in a state and a governor's approval rating for these months (Magness and Earle 2021). One possible explanation is that approval numbers reflected an action bias toward policy interventions, whether those interventions worked or not.

Most US states adopted phased reopening plans where selected categories of businesses were allowed to reopen on earmarked dates across weeks or months. Many of the selections of businesses for earlier or later dates appear arbitrary. For example, in Massachusetts, barber shops and pet grooming businesses were allowed to reopen in late May, while tattoo parlors and tanning salons were shut down until well into June (Gulker 2020). Similar arbitrariness afflicted the design and enforcement of specific SIPO policies. In Michigan, big box retailers were instructed to rope off "nonessential" product aisles such as gardening, sporting goods, and entertainment, while these items remained freely available in neighboring Ohio. In California, some local authorities began ticketing pedestrians on public beaches and even arrested a lone paddleboarder for entering the ocean during the early weeks of the SIPO policy. Far from basing their enforcement decisions on scientific evidence, police appealed to a newspaper interview in which a biologist speculated that

storm drain runoff had carried Covid-19 particles into the ocean where it could be stirred up by seaside breezes (Fry 2020).

In a final twist, public officials in several states began relaxing their second wave of lockdown measures in January and February 2021 amid signs of faltering political support for these policies, rather than evidence that the pandemic itself was waning. California Governor Gavin Newsom relaxed his state's prohibition on outdoor dining while facing the growing threat of a recall election, while New York Governor Andrew Cuomo announced the lifting of dining restrictions while facing a breaking scandal about his state's underreporting of nursing home fatalities the previous spring. In both cases, California and New York were posting significantly higher daily Covid-19 fatality counts at the time these orders were relaxed than they displayed several months earlier when they were first imposed (Palmieri and Court, 2021).

A final example of seeming arbitrariness occurred in late January 2021 when the Centers for Disease Control implemented an executive order requiring mask-wearing on interstate modes of transportation. Although the order was heralded at the time as a science-based policy, its actual effects were almost entirely redundant. Every major airline in the United States as well as Amtrak had existing policies requiring their customers to wear masks, dating to the previous spring. As an added complication, the epidemiology model invoked by the National Institutes of Health to justify the mask order was premised on an outdated survey from the early months of the pandemic, erroneously suggesting that fewer than half of all Americans regularly wore masks in public. More recent data placed the actual number at 80%, causing the model in question to severely overestimate the claimed benefits of the policy (IHME 2020 and Magness 2020).

Far from a carefully executed and science-based plan, these and other policies suggested a combination of political pressures, human error, and unwarranted pretensions of knowledge amid uncertainty became dominant factors in government decision-making. In general, governments made no attempt to cast such distinctions as anything more than a general feeling of what might be more and less risky, if not indeed completely arbitrary as part of slowing the overall process and flattening the curve. Although presented as science-guided policies, the arbitrary nature of state and local edicts, their inconsistent enforcement, and their changing justifications amid political pressures each gave the appearance of veering far astray from any grounding in scientific evidence or data.

But what appeared arbitrary to government planners may have dramatically increased the economic costs of the Covid-19 response. Again, the complete lack of allowance for heterogeneity along any dimension or local knowledge by business owners and customers was primarily to blame. Just like the shutdowns, governments could instead have worked with populations to limit trips outside the home with businesses learning, cooperating, and adjusting through a combination of public information campaigns, voluntary safety measures, and a preponderance of caution against hastily enacted measures that lacked clear scientific evidence.

It is difficult to avoid the conclusion that government overreliance on modeling for SIPOs and other NPI measures created a political path dependency around faltering projections. The central influence of the ICL model, as noted in the foregoing sections, is illustrative. The first clear signs of problems with the underlying design in ICL's approach appeared in mid-April when a team of researchers at Uppsala University in Sweden adapted Ferguson's US/UK model from March 16th to their own country's population and policy responses (Gardner et al. 2020). The Uppsala adaptation was intended to spur the Swedish government into following the route taken by the US, UK, and most of Western Europe by imposing stricter NPIs including a SIPO order. Their results—released on April 15—predicted a catastrophic scenario in which Sweden could exceed 80-90,000 deaths by the summer under its present course without a lockdown. Immediate adoption of these stricter measures, the authors continued, could dampen mortality to a best case scenario of just over 20,000 deaths.

Sweden did not alter course, thereby setting the stage for a natural experiment to test the Uppsala adaptation of the ICL model. Although Sweden experienced a severe Covid-19 outbreak, its mortality pattern fell well beneath even the strictest NPI scenario of the model. The country had just under 6,000 deaths by

mid-summer rather than the projected 80-90,000. After a year, Sweden had experienced 12,000 deaths, placing it below even the "best case" scenario anticipated under a lockdown.

Although the ICL team later distanced itself from the Uppsala adaptation of their model, their own subsequent forecasts continued to display a similar pattern of severely overstating expected mortality in the absence of SIPOs. On May 21, Ferguson's team published a second model to approximate state-level reopening in the United States. Using five states chosen because of their populations and early outbreaks, the ICL model compared three scenarios: (1) retaining lockdowns in place, (2) a moderate reopening with a 20% increase in public space mobility from the SIPO baseline, and (3) a more aggressive reopening that increased mobility by 40%. In all five states their scenarios predicted a rapid spike in mortality by mid-July. New York, Florida, and California were each projected to exceed 1,000 deaths per day in the 40% scenario, and possibly even 3 to 5 times that amount on the upper confidence band (Unwin et al. 2020). The projections proved wildly inaccurate for all 5 states, not only during the summer but also the pandemic's stronger second wave in the fall and winter months.

Despite the repeated real-time failures of their predictions, the ICL modeling scenarios remain a primary framework for NPIs almost a year after their release—including in several states that reimposed lockdowns in the fall, as well as subsequent nationwide lockdown cycles in the United Kingdom.

Values that honor human life as priceless are important and decent ideas underlying many societies, but we are used to expressing those values on a small scale, through medical treatment and research, for example. When the number of lives in question tragically pushes its way into the millions, some peoples' instinct is to ignore the costs and impacts of measures taken to save lives, potentially causing even more harm.

Cost estimates vary wildly and must, like epidemiological projections, be approached with caution. In terms of pure economic output, the United States Congressional Budget Office predicts a loss of $7.6 trillion over ten years in the US alone. Separating the impact of voluntary measures taken by individuals to Covid-19 versus SIPOs and business closures mandated by the government will be a matter for ongoing research. Devereaux (2020) finds evidence consistent with government measures adding substantially to economic damage, over and above the occurrence of the virus.

Even more difficult to measure but no less devastating are the costs stemming from the billions of individual disruptions worldwide. Bianchi et al (2020) project an unemployment shock two to five times greater than the average US recession. Mulligan (2020) predicts deaths of despair, stemming from suicide, drug abuse, and other mental health crises to increase 10 to 60 percent (Mulligan 2020). Preliminary statistics from the Centers for Disease Control already portend a troublesome pathway to recovery. Substance abuse deaths spiked at an unprecedented rate during the first three months of the Covid-19 pandemic and accompanying lockdowns (CDC 2020).

As one drills down from high-level data to ground-level human experience, it appears virtually everyone has experienced a unique disruption from policy decisions related to Covid-19. Family budget constraints have been altered, with parents forced to stay home with children, while outcomes from the virus can also be added to the tragic litany of problems that have impacted poor and underrepresented minority groups disproportionately.

5. CONCLUSION

Scholars and practitioners of public policy generally think in terms of trade-offs—the costs and benefits of proposed government actions. For most of human history, those trade-offs were less relevant with respect to medicine and public health—very little could be done. The bitter irony is that the development of science alongside other technology at last with Covid-19 presented societies with trade-offs for which they lacked the governance institutions, cultural values, and understanding of complex systems to process in a manner that wouldn't ensure tremendous economic and social cost, while cases and deaths from the virus nonetheless rocketed to a level of historic tragedy.

The standard view on responding to Covid-19 seemed to mirror how a country would approach a major war—mobilization of resources, compliance, and sacrifice. A large number of those who believe the death toll could have been significantly reduced will likely blame a lack of such unity, enabled by opportunism and amplified by social media.

This article puts forth a different view—that the modern developments in science and technology that enabled these trade-offs any degree of feasibility also ensured governments doing tremendous economic damage to their countries, an overheated social-media climate that prevented sober discussion, and experts with the computing power (but not the understanding of the world) to give governments the badge of approval.

As the dissemination of vaccines reduces public concern and provides political incentives to end NPIs, there remains much to be learned that might help create more effective and less costly responses to inevitable future pandemics. Researchers will study these events for decades, an unprecedented and profound picture of governments and their people forced to create, implement, maintain, and unwind responses to a deadly crisis.

In today's climate, many are likely to take for granted that future improvement hinges on more and better government control and citizen compliance. Instead, we may have seen the breaking point for this model. With time and education, it is imperative that more people understand issues like dispersed knowledge and expert failure. Tragedies such as pandemics on the level of Covid-19 can never be fully eliminated—the challenge is to prevent understandable efforts to reduce lives directly lost in future pandemics from imposing side effects of grave cost on individuals, communities, and economies.

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