Expert failure and pandemics: On adapting to life with pandemics

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Abstract: In a pandemic, citizens and policy makers must rely on expert opinion. What are the institutional arrangements that allow for the best advice to come forward? Using the framework established by Koppl (2018) on expert failure, we analyze the COVID-19 pandemic to see where missteps in expertise occurred and suggest institutional arrangements to improve expert advice in future pandemics.

1. INTRODUCTION

During pandemics, both policymakers and private citizens depend upon expert advice. The opinions of epidemiologists and public health experts are crucial for devising pandemic responses. Nevertheless, while experts have important specialized knowledge about infectious diseases, they are not infallible. Whether they offer accurate and useful advice will depend in part on the institutional environment within which they produce and disseminate knowledge.

Often, economists who analyze pandemic responses take expert opinion as given. The literature on economic epidemiology and the optimal control of infectious diseases tends to focus on market failures such as infection externalities and posits that the state can act as a benevolent social planner to correct these market failures and optimize according to a social welfare function (Weimer 1987; Gersovitz 1999, 2011; Francis 2004; Gersovitz & Hammer 2003, 2004, 2005; Barrett & Hoel 2005; Rowthorn, Laxminarayan, & Gilligan 2009; Goldman & Lightwood 2002). This approach treats pandemic policymaking as a black box and ignores how the expert advice that guides policy comes about. We fill this gap in the literature, analyzing how institutions, incentives, and social epistemology shape the expert opinion that guides public health policy.

Our analysis builds upon a substantial literature in the political economy of knowledge production.[1] The core of our theory comes from Roger Koppl's (2018) work on expert failure. Expert failure theory emphasizes the contextual nature of knowledge production and how alternative institutional arrangements influence the quality of expert opinion and advice. Using this framework, we show that experts not only shape public policies, but public policies and institutions also shape expert advice. Given the incentive and knowledge constraints faced by experts, they are unlikely to advise policymakers in a manner that allows for the optimal control of infectious disease. A realistic analysis of infectious disease policy requires placing experts within the

model, rather than assuming that idealized experts and policymakers can intervene upon the mere mortals that interact within markets and civil society.

The paper proceeds as follows. The Section 2 explains the theory of expert failure. Section 3 discusses some of the scenarios that contribute to expert failure. Building on Section two's theoretical framework, Sections 4, 5, and 6 analyze expert failure examples during the COVID-19 pandemic and institutional factors that increased the risk of expert failure during this pandemic. We conclude in Sections 7 and 8 by discussing some implications of our analysis and possible directions for future research.

2. INFORMATION CHOICE THEORY AND THE DIVISION OF LABOR

Given the inherent scarcity of time and constraints on actors' computational ability, we face a division of labor and knowledge in society: we do not have enough time or capacity to do or know everything. Expertise develops as a consequence of the division of labor. The division of labor entails specialization and trade with other specialists to maximize the satisfaction of our indefinite wants. Similarly, specialization entails the division of knowledge. As Adam Smith discusses, no one knows how to make a woolen coat (Smith 1981, p. 22). That knowledge is dispersed throughout the entirety of the process. Only through the combination of efforts of many people, each with their own unique and specialized knowledge, does the woolen coat get made and distributed.

Much of the knowledge obtained from specialization is tacit; one cannot centralize, collect, and analyze tacit knowledge like technical knowledge (Polanyi 1951, 1958; Lavoie 2016). It resides in the habits and skills of the individual and it may depend on the particulars of time and place. Experts do not have the advantage of aggregating all knowledge needed for an optimal decision. Some of that knowledge is tacit and difficult or impossible to articulate. Sometimes the amount of relevant knowledge exceeds experts' ability to aggregate in a timely manner or, perhaps, at all. And the experts may not know what knowledge and information to aggregate or where to find all the bits they know to be relevant. Also, it can be hard to draw the right inference from your knowledge, especially when the volume of such knowledge is large. Even the best-trained expert cannot consider all the significant and relevant effects of their advice in a complex system.

The division of knowledge can be deepened and abstracted into categories. Those who master one or more of these categories are colloquially called experts. An economist has expertise on matters economic. Likewise, a welder has expertise in welding. This expertise is developed in a similar manner as the technical skills are developed through the division of labor: repeated interactions with the underlying knowledge base allow for the innovation and development of new ideas. Just as the mechanic who continually works with cars can develop new ways to accomplish their tasks, the division of knowledge allows for innovation. Thus, the social epistemology we are briefly sketching is also a theory of the growth of knowledge.

The mainline economics tradition recognizes that knowledge is dispersed among the participants of a given system (Boettke, Haeffele-Balch, & Storr 2016; Mandeville 1988; Smith 1981; Hayek 1937, 1945). Much of the literature focuses on the tacit knowledge aspect of the knowledge problem (for example, see Lavoie 2016). However, we expand the consideration to include other aspects of the knowledge problem. As elaborated upon by Koppl (2018, pp. 118-122), knowledge may be Synecological, EvoLutionary, Exosomatic, Constitutive, and Tacit, or SELECT for short. Briefly, knowledge is "synecological" if the knowing unit is not an individual, but a collection of interacting individuals. It is "evolutionary" if it emerges from an undirected or largely undirected process of variation, selection, and retention. It is exosomatic if it is somehow embodied in an object or set of objects such as a book or egg timer. It is constitutive if it constitutes a part of the phenomenon. The "knowledge" of Roman augurs studying bird flights was constitutive because it influenced events such as when or whether an enemy was attacked. And, finally, knowledge is tacit if it is not "discursively effable." The acronym SELECT is a memory aid. The "L" in SELECT is meant to represent the L in "evolutionary." Thus, knowledge is Synecological, EvoLutionary, Exosomatic, Constitutive, and Tacit.

While there are these multiple types of knowledge, any given piece of knowledge need not be pigeonholed into a single type. For example, the constitutive knowledge of how to throw a curveball may be tacit as well. Frequently we see great sports players become subprime coaches. Instead, we wish to emphasize the complexity of knowledge itself, and the impossibility of aggregation of the sort experts often need. Knowledge is impossible to aggregate because it cannot be understood outside of the order in which is arises (Buchanan 1982), is subjective (Hayek 1945), and is often inarticulable (Lavoie 2016).

Our definition of an expert is not merely one who possesses specialized knowledge, but one who is paid for their opinion (Koppl 2018, p. 154). Thus, our definition of expert differs from the colloquial one. A forensic scientist is an expert; a race car driver is not. Both possess specialized knowledge, but only the former is paid for their opinion. Additionally, a single person can at times be an expert and, at times, not. An engineer is not an expert when she discusses an architectural problem at the dinner table. However, she is an expert when she is paid to evaluate whether a product was designed poorly and testify in court on the matter. Thus, the commodity we analyze is expert opinion.

We follow the same "analytical egalitarianism" advocated by Levy and Peart (2017), where the same behavioral assumptions apply to participants regardless of which side of the market they are on. The expert responds to incentives, just like the purchaser of opinion does. While there are unique aspects to the market for expert opinion, the market participants are not unique. Likewise, the expert faces many of the same constraints as the consumer of expert opinion; the expert judgment is as much subjective as it is objective. The expert must decide what literature is relevant, how much information to reveal, what relevant models to use. The consumer must also make decisions on whose expert opinion to consume.

Given the kinship with public choice, we refer to the theory of experts we are using as "information choice theory," since the expert must choose what information they will dispense. Furthermore, given that failure can result when there is a choice to be made, information choice theory includes a theory of expert failure. Koppl (2018, p. 189) provides a purposefully open-ended definition of expert failure as "any deviation from a normative expectation associated with the expert's advice." Often, perhaps typically, expert failure is some sort of deviation from the full truth. One or more relevant and important truths may be omitted from the failing expert's opinion or one or more relevant and important untruths may be included in the failing expert's opinion.

Analytical egalitarianism is essential for the theory of experts. Previous theorists, such as Mannheim (1936) and Cole (2010), emphasize a hierarchical view of knowledge: experts tend to be reliable in their field, and nonexperts are powerless. Analytical egalitarianism stresses behavioral symmetry among the participants in a given market (in this case, the market for expert opinion). Experts are fallible and need not be perfidious or corrupt to be unreliable, as demonstrated in the case of forensic expertise in Whitman and Koppl (2010). Likewise, in the right institutional setup, nonexperts are not powerless before the expert but may take steps to protect themselves from expert failure.

Analytical egalitarianism means we do not rely on poor motivations of actors to get failure. While expert failure could be caused by lying on the part of experts, it need not be. Akin to market failure, where the focus deals with systemic issues like monopoly, legal restrictions, or improper incentives, expert failure theory relies on institutional and systemic explanations for expert failure. Institutional issues like siloing, monopoly of opinion, and high regulatory barriers to entry help us better understand situations in which expert failure is likely to occur.

3. SCENARIOS CONTRIBUTING TO EXPERT FAILURE

As with other forms of failure (market, government), expert failure is likely to occur in certain types of market structures. Scenarios where there is siloing of opinion and skill, where there exists a monopoly/monopsony on expert opinion, or isolation from dissenting/critical voices all contribute to expert failure.

However, we note that certain market structures in a specific field of expert opinion do not imply that expert failure is more likely in the given field. Just as a monopoly in a market with externalities does not imply market failure is certain, neither does a monopoly in expert opinion imply the expert failure is certain. Instead, the structures and their effect on expert failure we discuss here are *probabilistic*.

Koppl (2018, p. 190) notes two great influences on the risk of expert failure. First, expert failure is more likely if the expert is largely or wholly free of competition. Second, expert failure is more likely if the expert choses for the nonexpert rather than merely advising the nonexpert. Thus, the highest chance of expert failure exists under the "rule of experts," in which a monopoly expert chooses for the nonexpert. And the lowest chance of expert failure exists under "self-rule or autonomy," in which experts compete to provide advice to a nonexpert who chooses for themselves based, perhaps, on the advice they receive.

Expert silos are a further and important contributor to expert failure. Koppl (2018) does not explicitly discuss siloing as a source of expert failure, but it is made explicit in Koppl (2020a). Specialization allows us to all exist within our own silos. There are many benefits to the division of labor and knowledge, as highlighted most famously by Adam Smith, but there are dangers.

> In the progress of the division of labor, the employment of the far greater part of those who live by labour…comes to be confined to a few very simple operations…The man whose whole life is spent in performing a few simple operations…has no occasion to exert his understanding, or to exercise his invention in finding out expedients for removing difficulties which never occur (Smith 1981, pp. 781-782).

Hayek put it more succinctly when he pointed out that an economist who is only an economist is a positive danger (1956). Both authors describe siloing, whereby one becomes so engrossed in one's silo that one fails to consider, or may even be unaware of, other salient issues. As we discuss below, the COVID pandemic is rife with examples of siloing.

Situations where the expert has a monopoly of opinion, either through high start-up costs or through high barriers to entry, can increase the likelihood of expert failure. Certifications, degree requirements, or membership requirements can enforce homogeneity of opinion and contribute to expert failure (Callais & Salter 2020). Indeed, the goal of these barriers is often to create homogeneity of opinion (Azocar and Ferree 2016; Koppl 2018, pp. 56-67). The "role" of the Scientific Advisory Group for Emergencies (SAGE), for example, is "to provide "unified scientific advice" to the British government (The Scientific Advisory Group for Emergencies 2020). SAGE is not charged with conveying the range of scientific opinion to the British government. Its job, instead, is to provide a uniform opinion, "unified scientific advice." But failure to heed dissenting voices can contribute to expert failure. Just as traditional monopolies may face less incentive to innovate and reduce costs, expert monopolies may be resistant to change in their opinions and even unintentionally squash necessary innovation or adjustment.

Similarly, when monopoly experts have the power to impose their opinion on an unwilling party, expert failure can arise. The "consumer" of expert opinion has no viable exit option, nor can they seek a second opinion. Neither can they effectively voice any objection. Exit and voice are the two primary ways one can signal failure to another economic agent (Hirschman 1970), and imposed expert opinion shuts off that communication avenue. With no practical way to signal, the expert may continue their failing actions, unaware that it is even failing.

Monopsony increases the likelihood of expert failure. When there is a single "Big Player" in the market for expert opinion, experts may shape their opinion (unintentionally or not) to align with the Big Player (Koppl 2002). For example, if a local crime lab is the only buyer of forensic opinion, then experts may be biased in such a way to use tests or theories that better align with the goal of the crime lab, such as a conviction (Whitman & Koppl 2010). Similarly, as a major employer and funder of monetary economists, the Federal Reserve influences the market for scholarly research in economics (White 2005). Even without unconscious bias, experts whose opinions and theories do not align with the Big Player may be excluded from the

market. Absent funding from the Big Player, they may not be able to cover their costs. They may also face fewer benefits to participating in the field due to network effects that increase the benefits of doing work that interests experts employed or funded by the Big Player.

4. EXPERT FAILURE DURING THE PANDEMIC: AN EXAMPLE OF FORECASTING

Experts from various disciplinary silos, including epidemiology, economics, public health, and psychology, have offered their opinions on the COVID-19 crisis. Sometimes they are paid to make quantitative predictions: How many new cases will we see? Will hospitalizations exceed capacity? How many people will die? Sometimes they are asked to explain what has happened so far. In other cases, they are asked to recommend actions that government officials, university administrators, business owners, and individual consumers can implement to reduce harms associated with the pandemic. These formally distinct positive and normative questions are often intertwined, and the same expert offers their opinion on multiple questions.

So far, many forecasts regarding the pandemic have been incorrect. Ioannidis, Cripps, and Tanner (2020) discuss various mistaken forecasts. As stated famously by statistician G. E. P. Box (Box, Hunter, & Hunter 1978), "The most that can be expected from any model is that it can supply a useful approximation to reality: All models are wrong; some models are useful." COVID-19 modeling is no exception: as what is left out of the model can be as important as what is included. The more complex the behavior under study, the harder it is to model how manipulating a small number of variables—like mask usage and mobility—affects outcomes like deaths. Since social and biological phenomena are complex (Beckage, Kauffman, Gross, Zia, & Koliba 2013), the danger in social and biological modeling is often one of over-simplification.

Experts, in this case, simplify their models to make connections between policy-amenable variables and desired outcomes. One of the primary simplifications in pandemic modeling during the COVID-19 pandemic was to assume that societies are homogeneous. The assumption of homogeneity implies that anyone can infect anyone else with equal probability absent specific behavioral characteristics or regional barriers. On the other hand, societies tend to exhibit tremendous heterogeneity, particularly if one considers the most at-risk demographic during COVID-19: seniors in fragile health. Many of this demographic live in long-term care facilities (LTCFs) set apart from the general population. Visitors and staff comprise the relatively weak link between LTCFs and the general population.

As of January 7, 2021, over 37% of all COVID deaths in the United States were attributed to cases that originated in LTCFs even though less than 1% of the population live in these facilities (Harris-Kojetin et al., 2020). Note that 37% is the reported and not the actual number. For instance, in New York State, fatal COVID cases that originated in LTCFs but resolved in death when the patient was later hospitalized are not counted as deaths originating in LTCFs (Curiskis & Oehler 2021). LTCFs are relatively isolated from the general population, with visitors and staff the only links to patients from the general population. The probability of infection depends primarily on whether infected people are visiting or staffing the facility. Policy measures to reduce deaths in LTCFs would not do much to inform policy on general population transmission and vice-versa.

Similarly, in a report dated December 20, 2020, an average of 1 in 5 prisoners in the United States had been infected with COVID, about double the infection rate of the general population, and in some states, the proportion was sharply higher (Schwartzapfel, Park, & DeMillo 2020). As of the second week of January, prisons' death rate was about 23% higher than the general population death rate outside LTCFs and prisons. Prisoners are arguably even more isolated from the general population than LTCF patients.

Therefore, assuming society is homogeneous tends to overstate the probability of members of the general population infecting patients of LTCFs and *understate* the protective effect in terms of reduction in deaths of policies targeting protections to LTCFs. By implication, the protective effects of policies like general quarantines will be systematically overstated by studies that assume society is homogeneous relative to targeting protections to the most vulnerable populations.

The lack of attention to heterogeneity may explain why COVID models tend to underperform in terms of predictability. A paper published June 30, 2020 by Chin et al. (2020) tested the accuracy of early models, in particular, the models constructed by the Institute of Health Metrics and Evaluations (IMHE) (IHME COVID-19 health service utilization forecasting team, 2020), the University of Texas at Austin, and the Los Alamos National Laboratory, and found that only 10.2% of the predictions fall within 10% of the actual reported numbers. Ioannidis, Cripps and Tanner (2020), using data from many European countries, U.S. states, and Canada, found that early models wildly overshot the risk of infection fatality in populations under 65, particularly in populations under 65 with no underlying predisposing conditions. They note that one of the key wrong assumptions in the models studied was the assumption of homogeneity.

5. EXPERT FAILURE AND THE DYNAMICS OF INTERVENTIONISM

Expert failure directly interfaces with the dynamics of interventionism during a pandemic. (For a broad overview of the dynamics of interventionism literature, see Ikeda (2005)). Traditionally, the focus is on how interventionism within an economic dimension leads to more intervention given the initial interventions (predictably) fail (Mises 2011). Information choice theory helps us explain these dynamics and resolve part of the Misesian paradox of why interventions persist even after the initial failure(s). The experts cannot interpret signals from the catallaxy due to siloing. Indeed, they may not even be aware such signals exist.

Information choice theory and the dynamics of interventionism suggest that expert failure can have contagion effects as well; expert failure in one industry can spill over into other industries, leading to expert failure in those as well. For example, on the advice of the CDC, the Trump Administration invoked the Defense Production Act of 1950 to require firms to prioritize personal protective equipment (PPE) and COVID test kits for governmental contracts regardless of price paid. Additionally, to handle an anticipated shortage of tests, the CDC ordered that COVID tests only be given initially to those exhibiting symptoms or recently returned from China (Murphy 2021). Coupled with price controls, these actions led to the predictable shortage of such equipment in the market. As of September 6, nearly six months after the federal government invoked the Act, many labs face difficulties getting tests (Patterson & Simons, 2020). Additionally, randomized testing, a necessity to determine the spread of a disease through the population, was never conducted, partly due to the CDC's orders. The shortages of testing equipment created by the Defense Production Act's invocation help us explain these two seemingly different failures. Given the Act's goal was to increase the production of necessary equipment, but instead, it led to shortages as prices failed to adjust, we can reasonably claim the Act's invocation was an expert failure as the actual results deviated from the normative results desired by the experts. Nevertheless, testers' inability to get the needed equipment likely led to the decision (or non-decision) to not randomly test the population at any point during the pandemic. Consequently, no reliable data has been collected on the spread of the disease in the United States (Ioannidis 2020; Murphy 2021). Since policymakers use data on cases and deaths to justify lockdowns and their relaxation, the lack of reliable comparison data has, in turn, made these lockdowns arbitrary; the experts on public health do not have adequate information to inform their choices, which is increasing the likelihood of expert failure in those areas. We can see how an initial case of expert failure (invocation of an Act that causes shortages of equipment) can cause other failures in other seemingly unrelated areas (Murphy 2021).

6. FURTHER EXAMPLES OF EXPERT FAILURE IN THE PANDEMIC

We also have issues of expert failure when the expert deliberately misleads to achieve some larger goal. For example, Dr. Anthony Fauci has admitted that he has altered his recommendations to achieve some alternative goal on multiple occasions. His initial statement that masks were unnecessary for the average American, something which he did not believe at the time, was meant to prevent a shortage of masks early in the pandemic (Fauci 2020). Likewise, he has stated he has misrepresented the number needed to achieve herd immunity because he was afraid many Americans were hesitant about the COVID vaccine (McNeil, Jr.

2020). In both cases, we have examples where an expert failed to give proper advice aligning with his expert opinion on the matter.

Furthermore, the two examples just discussed revolve around issues of siloing as well. Fauci acted in the manner he felt was best from his expert opinion, but the issue is not solely an immunological one. Issues of PPE manufacturing and distribution are economic issues. Issues of how the public might react to this or that policy recommendation are matters of sociology, political science, and psychology. As an expert immunologist and advisor to the government, he necessarily had to play amateur economist, sociologist, political scientist, and psychologist. Unfortunately, his siloed knowledge led to undesirable outcomes. From an economic perspective, one way to alleviate shortages and help ensure goods go to where they are most valued is to allow prices to rise. However, price controls, coupled with the explosive demand for masks and other PPE once the recommendation to wear masks went out, guaranteed a shortage. Fauci, lodged in his silo, lacked the necessary knowledge and information to connect these dots.

As discussed above, monopolization of expert opinion can lead to or perpetuate expert failure. In the United Kingdom, SAGE has considerable monopoly power in providing the national government scientific advice on the pandemic. SAGE acts as a gatekeeper on what information and opinion can make it to the decision-makers in this capacity. This monopolization and control of information may be leading to poor decisions made by the British government. Some critics of the government have complained of on-again, off-again policies to fight Covid. Mark Harper, for example, has decried the "devastating cycle of repeated restrictions" (Blewett 2020). The vacillating opinion of a monopoly expert under the "rule of experts" contrasts with the steady regularity and predictability of the "rule of law" traditionally characterizing the Anglo-American legal system (Fallon, Jr. 1997).

7. DISCUSSION

The ultimate question is: how do we prevent expert failure? Given the economic framework we have developed here and in Koppl (2018), the primary method addresses institutional issues. Problems of siloing, monopoly, monopsony, and other conditions of expert failure can never be eliminated, but we can discuss institutional changes that better align incentives, and, more generally, improve outcomes.

The most considerable change that can occur, and occur rapidly, is increased competition among experts. Drawing on Milgrom and Roberts (1986) and others, Gentzkow and Kamenica (2017) show that when competitive experts are introduced into a market, the incumbents improve their information quality even if the newcomers' information is relatively low in quality. To "win" the "business" of the advisee, experts will divulge more information in the presence of competition. Furthermore, as Bain (1956), Baumol, Panzar, and Willig (1982), Boudreaux and Folsom (1999) and others have shown, the mere threat of competition induces firms to behave as if they face a perfectly competitive marketplace, even if they are nominally a monopoly. In Anglo-American tort law competition among experts comes from the fact that both sides can call expert witnesses. Likewise, experts in the private sphere (like doctors, priests, mechanics) face competition from other expert opinion suppliers and strive to provide as much information as possible. Competition among experts is not totally absent in politics if only because politically opposed legislators may draw seek advice from competing experts. This form of competition among the experts is limited to be sure. But it may have some value in vetting alternative arguments. Unfortunately, the unavoidable monopsony power of a national government makes it impossible for an organization like SAGE to be just one competitor among many in a relatively free market for expert opinion. It seems possible, however, to *simulate* market competition within SAGE as Koppl (2020b) has proposed. A simulated market is not a real market, but it may be better than a system designed to provide "unified scientific advice."

We have noted above that expert failure is less likely when the consumers of expert opinion can choose among various providers. The element of choice is critical in developing competition among experts. If experts can impose their opinion, the incentive to divulge information and achieve a desirable outcome is diminished. When consumers of expert opinion can decide which advice to follow, the expert will try to be

as helpful as possible. If the consumer cannot choose, the expert may tend to be more arcane. Drawing on Milgrom and Roberts (1986), Koppl and Cowan (2010, p. 254) explain why "Competition turns wizards into teachers."

Competition is not a silver bullet, however. As Callais and Salter (2020, p. 73) note, "Ideas do compete, but oftentimes on margins unrelated to truth." Experts may become enraptured with various ideas to the exclusion of others for reasons that may be entirely unrelated to how accurate or truthful they are. Success in the marketplace of ideas does not guarantee that the idea is more truthful than others. But we must avoid the Nirvana fallacy of comparing existing reality to imagined perfection (Demsetz 1969). Your reform may improve things, but it won't bring on Nirvana. No matter what, experts will still fail. But every market failure also represents market opportunities. In part for this reason, market competition among experts tends to improve the quality of expert advice. The rule of experts makes expert failure more likely and "self-rule" makes it less likely. In other words, reforms that reduce expert power tend to reduce the chance of expert failure. We should value expertise, but fear expert power.

8. CONCLUSION

The Covid pandemic thrust us all into unfamiliar territory, which seems to have increased the demand for expert advice. However, as seen here, the market for expert opinion often features monopoly, monopsony, siloing, and other flaws that give rise to expert failure. These failures can result in inaccurate information, incorrect forecasts, and the implementation of costly and ill-advised policies and adaptations. While experts can help us survive pandemics, expert failure can make a bad situation even worse.

Correctly understanding expert failure during pandemics has several implications. First, it suggests that pandemic response cannot be administered by a benevolent despot that accesses a social welfare function and devises an optimal infection control policy. Experts and policymakers are human beings who interact within an institutional context. Realistic modeling of pandemic response requires placing policymakers and experts within the model and examining how institutions influence their actions and knowledge. Doing so allows us to understand situations where pandemic policy will not reach an optimum and even situations where expert failure and government failure may be worse than market failure.

Second, understanding expert failure suggests a variety of reforms to existing pandemic policymaking. Some policymakers rely on concentrated committees of experts who possess monopoly power and produce "unified scientific advice." To reduce the risk of expert failure associated with monopoly, policymakers could consult more diverse groups of experts. They may also benefit by employing "red teams" tasked with critiquing the initial experts' advice. This skeptical expert advocacy can help stress test existing expert opinion, resulting in more robust analyses.

Third, from a more long run perspective, policymakers should consider reforming science funding. When a research network relies heavily on a particular funding source, this may create expert failure through associated monopsony power (Butos & McQuade 2015; Scheall, Butos, & McQuade 2019). In his farewell address on the "military-industrial complex," Eisenhower (1961) warned "The prospect of domination of the nation's scholars by Federal employment, project allocations, and the power of money is ever present and is gravely to be regarded." Future research should examine the market structure of funding for epidemiological and public health research.

Fourth, our theory suggests that disciplinary siloing can give rise to unrecognized expert failure. While familiarity with a specialized field is often necessary to understand, evaluate, and critique research, an expert from another field might recognize a problem that is not apparent from within one's disciplinary silo. Koppl's (2020b) suggestions for reforming SAGE include the requirement that competing teams of experts be multidisciplinary. "With multiple areas represented on each team, they would have been forced to deal with the complex interactions linking infection rates to other things that matter, such as joblessness, substance abuse, and suicide rates." Epstein (2019) reviews evidence that outsiders and amateurs can often solve problems that stump siloed experts. Strategies to mitigate the harms of siloing include contests, crowd

sourcing, and grants requiring cross-disciplinary teams. Disciplines are specialisms. And the gain from specialization come from trade. In the end, then, openness and free intellectual exchange may be the key to mitigating the harms of expert siloing. To achieve such openness and free exchange, however, researchers must resist the call to unity issued by the American Association for the Advancement of Science (American Association for the Advancement of Science 2016). Without irony, they proclaim, "Scientist, unite!"[2]

A wealth of research questions remains to be answered when it comes to expert failure during pandemics. Future researchers could more closely examine the market structure of epidemiological and public health expert opinion. They could study the bidirectional influence between policymakers and experts to understand better the complex and entangled relationships between expertise and power. After the pandemic concludes, scholars could more closely examine whose predictions seem vindicated and whose do not, and then study the incentives and feedback mechanisms facing successful and unsuccessful experts. The crucial thing to do in all this research is to emphasize that experts are human and carefully study how fallible humans learn, research, advise, influence, and control one another within complex institutional environments.

NOTES

1 For example, see Polanyi (1941), Paniagua (2018), and Petracca & Gallagher (2020)

2 See timestamp 1:08: https://youtu.be/Ja1TPlBqiP8

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