Inductive Risk, Science, and Values: a reply to MacGillivray

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ABSTRACT: The Argument from Inductive Risk (AIR) is perhaps the most common argument against the value-free ideal of science. Brian MacGillivray (2019) rejects the AIR (at least as it would apply to risk assessment) and embraces the value-free ideal. We clarify the issues at stake and argue that MacGillivray's criticisms, although effective against some formulations of the AIR, fail to overcome the essential concerns which motivate the AIR. There are inevitable tradeoffs in scientific enquiry which cannot be resolved with any formal methods or general rules. Choices must be made, and values will be involved. It is best to recognize this explicitly. Even so, there is more work to be done developing methods and institutional support for these choices.
KEYWORDS: argument from inductive risk; risk assessment; uncertainty analysis; value-neutral; values in science

MacGillivray (2019) argues that risk analysts should hew to a value-free ideal of science. In order to defend this ideal, he attempts to undercut an argument which has great currency among philosophers of science— the Argument from Inductive Risk (AIR). In section 1, we discuss different versions of the AIR. Although MacGillivray's argument engages some of them, there are other considerations which he does not address. In section 2, we consider a defense of the value-free ideal given by MacGillivray (and others) which holds that violating it would be undemocratic. Although the imposition of values by elites would be undemocratic, that does not show how scientific enquiry could actually be value-free. In section 3, we suggest that the resolution to this tension is to situate the requisite values in an institutional context.

We begin with two notes about terminology. First, some philosophers of science have emphasized a distinction between *epistemic* and *non-epistemic* values (McMullin 1982, Steel 2010), where the former are truth-promoting or truth-conductive and the latter are not. Standard examples of epistemic values include consistency with accepted theories, simplicity, and falsifiability (in Popper's sense); standard examples of non-epistemic values include feminist and political values. However, other philosophers of science have criticized this distinction, arguing both that purported epistemic values can be laden with political significance (Longino 1995) and that purported non-epistemic values can be truth-promoting. For example, a commitment to feminist values might lead scientists to uncover and mitigate sexist bias (Harding 2015). While there is broad consensus that epistemic values can legitimately influence scientific research, the debate over values in science primarily focuses on the influence of (purported) non-epistemic values. Specifically, as it is usually understood, the value-free ideal calls for the exclusion of non-epistemic values from the core of scientific inquiry; epistemic values are perfectly acceptable. In the remainder of this response, we use "values" to refer to non-epistemic values.

Second, some writers use the terms *value-free* and *value-neutral* interchangeably, while others propose to distinguish these two concepts. Among philosophers of science today, *value-free* is the standard term. Lacey (1999, ch. 4) proposed a distinction between impartiality, autonomy, and neutrality.

Impartiality refers to the non-influence of non-epistemic values in the core of scientific inquiry, i.e., the value-free ideal. *Autonomy* means that the scientific community operates independently of "outside influences," and is logically derivative from impartiality. And *neutrality* means that "in principle, [scientific findings] can be put at the service of any values, explaining valued phenomena, illuminating the realm of the possible, informing means to ends and the attainability of ends" (Lacey 1999, pp. 74-75)— that is, whatever interests one might have, scientific findings can be used to promote those interests. MacGillivray argues for "value-neutral risk assessment" by criticizing the argument from inductive risk, which is an argument against the value-free ideal (that is, an argument for impartiality in Lacey's sense). We therefore take his use of *value-neutral* to be equivalent to *value-free* as it is often used by philosophers of science today. Following the latter standard, in this response we'll use the term *value-free*.

1. THE ARGUMENT FROM INDUCTIVE RISK

MacGillivray argues that risk assessment should aim to be value-free in its "core scientific inference"— viz. "the analysis, synthesis, and interpretation of evidence." This core, he writes, is "making and communicating informative, good predictions." By *informative* he means that reports should be "relevant to some real world decision problem." By *good*, he means "reliable" and aimed to "correspond" to the world. (MacGillivray 2019, p. 1521) He does not remark that these two imperatives, relevance and reliability, are inevitably in tension. A greater demand for reliability leads to more cautious, more qualified, less determinate— ultimately less informative— claims. To put it in plainer terms: The aim of saying true things pushes analysts to say more and hedge less. The aim of avoiding error pushes them to say less and hedge more. Making predictions, even tentative and qualified predictions, requires striking a balance. This tension is the core of the Argument from Inductive Risk (AIR).

Although the AIR is among the most common arguments against the value-free ideal of science, there are different construals of the argument available in the literature.

Following the way that the early debate was posed by Rudner (1953), the AIR is sometimes presumed to apply only to the unqualified confirmation and acceptance of hypotheses. So critics such as Jeffrey (1956), Mitchell (2004), Betz (2013), and MacGillivray (2019) argue that the problem can be evaded by not fully accepting any conclusion but instead just reporting probabilities, degrees of uncertainty, or other qualified claims. The AIR is broader than this, however— a point we return to below.

The name Argument from Inductive Risk itself is unfortunate, because it naturally suggests an overly narrow construal of the argument's upshot.

In a narrow sense, the term *induction* is commonly used to mean projective inference, inferring from the particular to the general. In a closely related usage, induction is used to mean statistical inference and hypothesis testing, i.e., from some particular observed data to a more general, population-level hypothesis. Some authors writing about the AIR take it to be about induction in one of these narrower senses. The title of MacGillivray 2019 ("Null Hypothesis Testing ≠ Scientific Inference") suggests that the scope of the paper's argument takes AIR to be essentially concerned with null hypothesis testing (NHST).

However, the term *induction* is also commonly used as a contrast with deduction, to apply to any inference in which it is at least logically possible for the premises to be true and the conclusion false.[1] All

[1] Although MacGillivray is aware of the distinction, the ambiguity nevertheless obscures his argument. The broader sense of the term is not explicit in MacGillivray (2019), but cf. MacGillivray (2014; 2017).

or almost all scientific inference is inductive in this sense. The concept of *inductive risk* then refers to the general, logically unavoidable possibility of error in non-deductive inference.

The narrow understanding of the AIR, in terms of inferring from particular to general and with close connections to NHST, is understandable. The argument is often introduced using hypothesis testing-scenarios (for example, Rudner 1953, p. 3). However, the considerations that motivate the AIR are broader. Namely, forming any belief or making any report in a non-deductive way exposes the analyst to different kinds of error. Reckoning with those possible errors requires considering the possible consequences, including what the benefit of believing/reporting would be (if the claim were true), what the cost of believing/reporting would be (if it were false), what the cost of not believing/reporting would be (if it were true), and what the benefit of not believing/reporting would be (if it were false).

It is easy to think of this as just a decision-theoretic problem, with the values filled into a two by two matrix and a recommendation to be made by calculating expected utility. This is misleading for at least two reasons. First, it requires that one fill in the relevant probability. However, the claim that the probability is such-and-so is itself a further claim and hence carries with it inductive risks. One may be more or less cautious, consider more or fewer of the indefinitely many possible sources of error, and specify a more or less precise probability. There is always a tradeoff, and making that tradeoff in particular ways imposes costs and yields benefits.[2] Second, a decision-theoretic representation of this scenario necessarily involves simplifying assumptions. For example, as Steel (2015) points out, degrees of belief are often not determinate and do not necessarily satisfy the formal probability axioms. Thus the "personal probabilities" of Jeffrey and de Finetti are fictions. Although they are mathematically convenient, using them to calculate expected utility involves making a non-deductive inference. Representing qualitatively different kinds of outcomes (such as human health, economic productivity, and ecosystem integrity) as though they were quantitatively comparable likewise requires the use of simplifying assumptions and non-deductive inference.

The possibility of error arises at every moment where there are unforced methodological choices: definitions, models, parameters, methods of data analysis, decisions about when to stop, and so on (Steel 2015, Andreasen and Doty 2017, Biddle and Kukla 2017). MacGillivray admits that that the AIR "putatively applies" to these decisions, but objects that it is better to explicitly use formal approaches to uncertainty analysis than to rely on implicit judgments of value. MacGillivray writes: "The general point is that there are formal methods for uncertainty analysis, which to a large extent remove the obligation of the analyst to estimate, through untutored introspection, the probabilities, and consequences of methodological error" (MacGillivray 2019, p. 1526). This point applies to the AIR understood narrowly, but it misses the mark against the broader argument.

The application of formal approaches still involves presuppositions and unforced choices. This is true even if the formal methods guide practitioners "to a large extent." As MacGillivray immediately recognizes, "we are rarely in a situation where all sources of uncertainty can be fully, formally characterized" (MacGillivray 2019, p. 1526). MacGillivray observes rightly that "scientists can use a plurality of models, perform sensitivity analysis to reflect parameter uncertainty, and feed this into a formal decision analysis that would explicitly account for values (e.g., utilities)" (MacGillivray 2019, p. 1523). Even when using a multi-model approach, there are still unforced choices that analysts must make— which models? how large a plurality? (Andreasen and Doty 2017) The tradeoff between the pressure to get an answer and the pressure not to leave something out still plays a role, even when formal approaches are used to explicitly model uncertainty (Steel 2016; Hicks 2018). There is no single, formally-

[2] This point was anticipated by Rudner (1953, p. 4).

correct way to make this tradeoff. It is value-laden, and the values at issue are precisely those at issue in the AIR.[3]

Moreover, the analysis of evidence requires deciding what possible inputs are going to be counted as evidence. The analyst wants to consider all the accurate sources of data but exclude the inaccurate ones. This is the same tension between pursuing truth and avoiding error that underlies the AIR (John 2015, Magnus 2018).

Although it may be formulated in more narrow ways, the spirit of AIR accommodates a wider range of causes of inferential error than those captured formally in statistical and decision-theoretical models. If it is possible for a judgement to be in error or a methodological decision to alter the error characteristics of an inferential process, then investigators ought to consider what the consequences of such an error would be. Although thinking about these decisions formally can be valuable, there are no methods which explicitly and formally decide all the tradeoffs involved in every decision made during the synthesis, analysis, and interpretation of evidence. Any time an analyst makes a choice which involves a tradeoff, they are implicitly appealing to (or at least aligning themselves with) a set of values. The absence of a formal method does not absolve researchers of the demand to consider foreseeable consequences of their methodological decisions. If analysts only allow themselves to consider these issues formally, they overlook important features of practice and allow unexamined values to implicitly shape their results.

2. THE DEMOCRACY DEFENSE

Even though it is unavoidable, one might worry that the role of values in science identified by the AIR is pernicious. MacGillivray asks: "On what moral or political authority are scientists warranted to make judgments about the relative desirability of certain social consequences?" (p. 1523) The worry is that scientists generally have no special training or knowledge of the values of members of the general public, either individually or collectively. They are not elected by citizens, at least in their role as scientists. Even scientists who are appointed to scientific positions by elected officials (e.g., as science advisors) are not directly accountable to the public. So if we reject the value-free ideal, we seem to be allowing scientists to impose their own personal, perhaps idiosyncratic values without any accountability. Such imposition would to be undemocratic. This is what we might call the *democracy defense* of the value-free ideal.[4]

As MacGillivray recognizes, some philosophers have addressed this argument at least indirectly. Intemann (2015) argues that "value judgments [in science, specifically climate modeling] are legitimate when they promote democratically endorsed epistemological and social aims of research" (p. 217). On this sort of view, the values that scientists should incorporate into their research are not necessarily their own, but rather those of the polity. In this respect, scientists might be expected to act rather like political representatives (Fernández Pinto and Hicks 2019). Indeed, Schroeder (forthcoming) argues that scientists should appeal explicitly to the values endorsed by representatives of the public, such as elected officials or the statutory authority of relevant institutions (e.g., an environmental regulatory agency's mandate to protect human health and the environment). These approaches align with conceptions of objectivity as intersubjectivity (intersubjective agreement) rather than as value-freedom or disinterestedness (Longino 1990). According to intersubjective conceptions of objectivity, science can be both value-laden and objective so long as the values at play have survived a process of open and inclusive scrutiny. This alone is sufficient to rebut the democracy defense: Giving up the value-free ideal does not have to mean letting

[3] Regarding values in resolving model uncertainty, see Biddle and Winsberg (2010).
[4] There is not yet a standard term for this argument in the science and values literature, although it is not original with MacGillivray. He cites Betz (2013), but similar arguments are discussed by Mitchell (2004) and Bright (2018).

scientists' personal, subjective values determine how the science turns out— the values implied by inductive risk can be collective or shared values.

Other philosophers have examined particular forms of democratic policymaking in more detail. Douglas (2009, pp. 159-167) discusses the "analytic-deliberative" model of risk assessment developed in the National Research Council report *Understanding Risk* (NRC 1996).[5] These kinds of participatory procedures are a way of reckoning with public values, integrating them into technical policymaking, without abandoning democracy. MacGillivray objects that "in practice these kind of processes tend to be geared more toward questions of framing .... They have not focused on engaging publics within the core inferential tasks of risk assessment" (2019, pp. 1523-1524).

Philosophers working on inductive risk would agree with MacGillivray that more work needs to be done to extend and develop analytic deliberative frameworks to these core inferential tasks. Douglas herself notes that "The assessment of the sufficiency of evidence, or the acceptability of uncertainty, is not discussed in" *Understanding Risk* (Douglas 2009, p. 162). That is, as presented in the report, the analytic-deliberative model does not incorporate inductive risk.

But the fact that the NRC model *did not* address inductive risk does not mean that it *could not* be extended to do so. Indeed, Douglas goes on to analyze a case in which inductive risks were successfully incorporated into a risk assessment following the analytic-deliberative model (Douglas 2009, p. 164-5).[6]

Other philosophers have written on even more radically participatory models, often including discussions of particular instances of participatory research (Jordan, et al. 2011; McHugh 2011; Harding 2015; Fernández Pinto and Hicks 2019). In all of these cases, scientists and other technical experts come to understand and respect the concerns and interests — the values — of affected publics. They do not undemocratically impose their idiosyncratic values on the public, but instead incorporate public values into their science in ways that promote democratic accountability and political legitimacy (Richardson 2002; Whyte and Crease 2010; Schroeder forthcoming).

3. VALUES IN AN INSTITUTIONAL CONTEXT

MacGillivray argues that proponents of inductive risk frequently use an oversimplified model of (environmental) policy decision making, according to which overregulation leads to health benefits while underregulation leads to economic benefits in a straightforward way (p. 1528). As MacGillivray correctly points out, more typically a potential policy will have complex distributive effects on a variety of different benefits and burdens, with causal relationships between different benefits and burdens. For example, a policy might improve property values for some people, while decreasing the income of others. These changes in wealth might have further consequences on the health of each group, which in turn might loop back to influence their susceptibility to environmental hazards. Further, these causal relationships will often be contextually specific, nonlinear or even non-monotonic, and poorly understood.

We agree that philosophers of science have discussed inductive risk too often using this oversimplified model of policy decisions. However, we suggest that this model has been used for expository purposes. It efficiently illustrates the basic logic of inductive risk in an accessible way, bracketing the added complications of uncertain, nonlinear, distributive effects.

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[5] In addition, Kristin Shrader-Frechette, a philosopher of science, was a member of the committee that wrote *Understanding Risk*. Other philosophical discussion of this and related models include Gutmann and Thompson (1996), ch. 4; Norton (2005); and Elliott (2011), ch. 5.

[6] Ulibarri (2018) gives a similar example.

But the fact that this model is oversimplified does not mean that inductive risk does not exist in more complex cases. Indeed, the added layers of complexity — and thus uncertainty — in these cases mean that inductive risks loom even larger over scientists and policymakers. The collection *Exploring Inductive Risk* (Elliott and Richards 2017) includes several examples of philosophers applying the inductive risk framework to more complex decisionmaking cases.

MacGillivray argues that, because of the complexity of effects and the way that "risk assessment outputs can take on a life of their own" (p. 1528), it may be impossible to reasonably foresee the full consequences of a particular methodological decision. This is no objection to the AIR, however. First, the AIR is fully compatible with the suggestion that analysts are responsible for only the *foreseeable* consequences of their methodological decisions. Douglas explicitly restricts scientists' responsibilities under the rubric of inductive risk to the reasonably foreseeable consequences of error, tying these to the legal concepts of recklessness and negligence (Douglas 2009, p. 69 ff). Second, even if we reject the restriction to only the foreseeable consequences, other work in philosophy provides useful resources. Drawing from ethics, a "retrospective" model that separates causal and moral responsibility can be applied even when the consequences of action are not foreseeable (Young 2008). And adaptive management has been discussed by policymakers, scientists, and philosophers as a framework for thinking about the relationship between scientists and policymakers in handling unforeseeable consequences (Norton 2005; Mitchell 2007; Steel 2015; Fernández Pinto and Hicks 2019). Third, decision-theoretic models are also vulnerable to the problem of unforeseeable consequences. MacGillivray acknowledges this last point, but responds that decision theory has developed a variety of methods, which have various strengths and limitations across various kinds of cases (MacGillivray 2019, p. 1529). However, in line with our arguments in section 1, evaluating the seriousness of these strengths and (especially) limitations is an exercise in evaluating inductive risks: In a given situation, which limitations are morally and politically acceptable?

More broadly, we agree that taking inductive risks into account will often be complex and challenging. The challenge may even render some lines of research practically impossible. Yet we deny that this is any argument for the value-free ideal.

Consider the parallel requirements implied by the ethics of human subjects research. We do not conclude that the principle of informed consent is false because in some cases it is difficult to understand the full implications of and requirements for informed consent. Instead we have developed institutional supports — including research ethics training, simplified but generally applicable sets of guidelines, the federal Common Rule, and Institutional Review Boards — that (albeit very imperfectly) help scientists recognize and account for the appropriate treatment of human subjects in every stage of their research.

MacGillivray notes that "[m]any regulatory domains are characterized by legal rules or conventions setting out methodological choices to be adopted under conditions of uncertainty" and that "[t]hese heuristics serve to constrain interpretive possibilities" (p. 1524). These constraints mean that scientists need not consider inductive risk in practice, but such regulation is rarely conceived of in these terms. And this means that it risks imposing inappropriate methodological choices. As Douglas argues, "rigid guidelines can run roughshod over the scientific complexities of specific cases" (Douglas 2009, p. 44). General policies can take considerations of inductive risk out of the hands of individuals, but that is only effective if the policies themselves are sensitive to problems of inductive risk.[7] There is certainly more work to be done on developing institutional supports for dealing with inductive risk.

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[7] The danger of applying decision rules in cases where they are inapplicable is a central issue in MacGillivray 2014 and 2017. In discussing several methods for closing "the inferential gaps in a heuristic argument", MacGillivray

At the very least, the concerns underlying the AIR cannot be deflected by retreating behind formal methods and the value-free ideal. Analysts should consider the possible consequences of particular methodological tradeoffs and endeavor to identify the values implicitly informing their judgements and inferences, because values are in play throughout the process. MacGillivray's aims of improving the legitimacy, credibility, and quality of risk assessment might be rhetorically served in the short term by a pretense of value-freedom, but they are ultimately better served by recognizing respects in which values are ineliminable.

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