The Risk of Using Inductive Risk to Challenge the Value-Free Ideal

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The argument from inductive risk has been embraced by many as a successful account of the role of values in science that challenges the value-free ideal. We argue that it is not obvious that the argument from inductive risk actually undermines the value-free ideal. This is because the inductive risk argument endorses an assumption held by proponents of the value-free ideal: that contextual values never play an appropriate role in determining evidence. We show that challenging the value-free ideal ultimately requires rejecting this assumption.

1. Introduction. The ideal of value-free science has come under increasing criticism in philosophy of science. Although not a new one (Rudner 1953), a significant challenge stems from what has come to be known as the 'argument from inductive risk' (Douglas 2009). According to this argument, because acceptance or rejection of a hypothesis is unlikely to happen with certainty, scientists must consider whether there is enough evidence to do so. This involves considering not only the likelihood of error but also how bad the consequences of error would be. When the consequences are related to public policy, this requires evaluating the ethical consequences for those potentially affected. It is thus necessary for scientists to make ethical value judgments about what sorts of errors are acceptable. Although the argument

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from inductive risk has been taken by many to show that the value-free ideal (VFI) of science is untenable (Biddle and Winsberg 2010; Steel 2010; Elliott 2011, 2013; Winsberg 2012), we contend that this is not obvious. Moreover, Douglas's positive account of the role of values in science fails to be compelling. Our intention is not to defend the VFI as plausible; rather, we argue that a successful account of the role of values in science must ultimately reject the assumption that values cannot legitimately play evidentiary roles. In the final section we show how this might be carried out.

2. Confronting the Value-Free Ideal of Science. One of the difficulties of challenging the VFI is that it is often unclear what the ideal itself involves. Both opponents and proponents of such an ideal agree that some values play a central and crucial role in scientific reasoning, namely, epistemic or cognitive values. These values are constitutive of the aims of science or are instrumentally valuable for promoting those constitutive aims (Longino 1990; Lacey 1999). Some seem to assume that such constitutive values are narrowly understood epistemic values, such as truth and empirical adequacy (Haack 1998), while others argue that scientific inquiry may have broader cognitive aims, such as increasing understanding, arriving at significant truths, unification, and so forth (Lacey 1999; Kitcher 2001; Laudan 2004). The debate over whether science ought to be "value free" thus concerns not all values but the appropriate role for contextual values, such as social, ethical, or political values.

Moreover, everyone agrees that contextual values are relevant to some scientific decisions. For example, such values may appropriately determine which research programs to pursue or whether some practice conforms to standards for the responsible conduct of research (Longino 1990; Lacey 1999; Dorato 2004; Douglas 2009; Betz 2013). Everyone also agrees that contextual values can play negative or inappropriate roles in scientific reasoning. That is, no one claims that it would always be appropriate for scientists to appeal to such values. As a result, even those who wish to argue that contextual value judgments may justifiably influence some scientific decisions also maintain that there are some instances when doing so would be inappropriate (Lacey 1999, 2005; Douglas 2000, 2009; Odenbaugh 2003; Lackey 2007). Because of all of these caveats, it is difficult to say who counts as a proponent or opponent of the VFI, as there is disagreement not only about whether contextual values should play a role in science but also about the specific roles that it would be appropriate for them to play.

Given this complexity, we take it that the VFI amounts to the claim that scientists, qua scientists, ought never to rely on contextual value judgments in decisions related to the gathering and characterization of evidence or appraisal and acceptance of hypotheses (for brevity, in what follows we refer

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to this as the core of scientific reasoning).[1] Those wishing to show that the VFI is untenable, then, must meet the following criterion:

> *The Necessity Criterion*: Contextual values are at least sometimes necessary in decisions at the core of scientific reasoning.

Two clarifications about this criterion. First, it does not require that contextual values always be present in decisions at the core of scientific reasoning. What it requires is that insofar as contextual values enter into these decisions, those values cannot be eliminated without a cost to scientific knowledge production. Second, it is a normative criterion. That is, it requires that value judgments be more than simply unavoidable. One might argue that the VFI is untenable because it ignores that certainty is impossible in science and that epistemic agents cannot avoid being affected by their preferences or desires concerning the outcome of the reasoning process and thus that it is simply impossible for scientists to avoid making value judgments (Biddle 2013; Miller 2014). Yet it is not clear that this undermines the VFI. Clearly, the fact that an ideal might be unattainable does not necessarily mean that it cannot be useful in practice, so long as there are practical ways to promote or strive for the ideal. That is, even if value judgments are unavoidable, insofar as they are thought to negatively influence science, we can strive to minimize their presence. We take it then, that challenging the VFI requires showing that even attempting to approximate the ideal would be undesirable.

Although this articulation of the VFI amounts to a strong claim, there are two powerful motivations behind it: one epistemological and the other political. The epistemological motivation arises from the desire to protect the epistemic integrity of science against the problem of wishful thinking (Haack 1998; Anderson 2004; Douglas 2009; Brown 2014). Proponents of the VFI assert that decisions about accepting or rejecting hypotheses should be solely made on the basis of empirical evidence and not in relation to particular contextual values. Typically, they argue that this is the only way to ensure that a hypothesis meets the epistemic or cognitive criteria that promote the constitutive aims of science, such as truth, empirical adequacy, consistency, or explanatory power (McMullin 1983; Haack 1998; Dorato 2004). Contextual value judgments, proponents of the VFI assert, are normative claims about the way the world ought to be and cannot provide evidence for the way the world is (Haack 1998). Thus, the argument goes, if contextual values were taken as providing reasons for accepting or rejecting a hypothesis, they might promote our social, ethical, or political aims at the expense of our epistemic ones. This would leave open the possibility that scientists could ac-

1. We use "hypothesis" broadly to include scientific theories, explanations, models, or interpretations of data.

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cept theories about "how they wished the world to be" rather than "how the world really is." On this view, appealing to contextual values in the context of justification is illegitimate, as doing so conflicts with the epistemological obligations of scientists and would pose a significant threat to the objectivity of scientific knowledge.

A second motivation for the VFI is political (McMullin 1983; Lacey 1999; Mitchell 2004). Allowing scientists to make ethical, political, or social value judgments gives them disproportionate power in shaping the science that is available to inform policy decisions (Pielke 2007; Betz 2013). Scientists have no special expertise or authority in making ethical and social value judgments, and thus, it is unclear that they alone should be the ones deciding what values ought to be endorsed. Moreover, as a group, scientists are unrepresentative of the diverse stakeholders affected by science. In addition, there can be some reasonable disagreements about social, political, and ethical values, and in pluralistic societies all stakeholders should have equal representation in determining which values ought to be endorsed or prioritized in cases of conflict. Proponents of the VFI fear that the use of contextual values in scientific reasoning allows scientists to impose their personal value judgments on others and thus that democratic principles would suffer (Pielke 2007; Betz 2013). In democratic societies, collective goals and values should be decided by legitimized institutions rather than by a handful of unelected scientists. Indeed, these concerns seem quite appropriate given cases in which scientists with commercial interests have arguably influenced the science produced so as to significantly influence or stall regulatory policies (Krimsky 2003; Michaels 2008; Oreskes and Conway 2010). Therefore, some have argued that there are important ethical and political reasons to try to avoid appealing to contextual values, regardless of whether they lead to wishful thinking. For proponents of the VFI, this provides a prima facie reason to minimize the influence of contextual values in scientific decision making.

Both the problem of wishful thinking and concerns about the potential for values to undercut democratic ideals provide powerful reasons for thinking that the use of contextual values in scientific reasoning would be illegitimate. Therefore, an appropriate account of the role of values in science must meet the additional following two criteria:

> *The Wishful Thinking Criterion*: The ways in which contextual values are claimed to operate at the core of scientific reasoning must avoid the problem of wishful thinking.
>
> *The Democracy Criterion*: The kinds of contextual value judgments scientists must make can effectively incorporate stakeholder input.

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In section 3 we consider whether the inductive risk argument establishes sufficient grounds for the necessity of contextual values when making decisions at the core of scientific reasoning. We argue that it does not. Because the inductive risks argument fails to meet the necessity criterion, it is unsuccessful in showing that the VFI is untenable. Nevertheless, section 4 shows that, even if we were to grant that contextual values are necessary for dealing with uncertainties, Douglas's positive account of the role of values in science is not persuasive. This is so because her account either fails to fully address the wishful thinking and democracy criteria or does so by vindicating the VFI.

3. Showing That the Value-Free Ideal Is Untenable. The argument from inductive risk attempts to undermine the VFI by showing that scientists must sometimes make value judgments in deciding which hypothesis to accept or reject. Specifically, the argument rejects the assumption that hypothesis acceptance is solely concerned with judgments about whether hypotheses are supported by scientific evidence or meet cognitive criteria of theory choice better than alternatives. Proponents of the inductive risk argument contend that judgments about hypothesis acceptance also rest on judgments about how much evidence is needed for such acceptance or rejection (Rudner 1953; Hempel 1965; Shrader-Frechette 1991; Douglas 2000, 2009; Biddle 2007; Biddle and Winsberg 2010; Steel 2010; Elliott 2011). How much evidence is needed depends in part on how serious the potential consequences of error could be or on decisions about what types of risks are more acceptable. In some cases, when the science is likely to inform public policy, there may be social, political, and economic consequences of error. For example, if scientists erroneously accept that a certain level of a chemical substance may cause cancer, this can lead to underregulating or overregulating such a chemical in ways that affect human health or economic interests respectively. Deciding which risks of error are acceptable requires weighing the ethical and social interests at stake. Moreover, risks of error occur not only in the final stages of deciding, for example, when a scientific debate has been "resolved" but in decisions throughout the research process. That is, there are risks of error adopting a particular model, characterizing evidence, setting p-values, and relying on background assumptions (Douglas 2000, 2009; Biddle 2013). If this is correct, then the argument from inductive risk would be able to meet the necessity criterion and, thus, would be able to prove that the VFI is untenable.

But in which ways might contextual values be said to be necessary when assessing the consequences of error? As has been noted in the literature (Elliott 2011, 2013; Steel and Whyte 2012), there is ambiguity about the sense of necessity involved in claiming that the phenomenon of inductive risk makes contextual value judgments necessary for hypothesis acceptance. First,

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contextual value judgments could be *logically necessary* to addressing uncertainty in that it would be logically impossible to derive conclusions about what hypotheses to accept or reject without relying on value judgments. Value judgments would be necessary in the same way that, say, auxiliary hypotheses are logically necessary in scientific reasoning. One cannot make evidentiary inferences without relying on some auxiliary hypotheses. But this seems implausible with respect to arriving at conclusions in the face of uncertainty, as there are other logically possible ways to arrive at conclusions, such as flipping a coin.

Value judgments might be *epistemically necessary* for deciding which hypotheses to accept or how evidence bears on a hypothesis. That is, they may be said to play a crucial role in advancing the epistemic aims of scientific knowledge (i.e., truth, empirical adequacy). But it does not seem that Douglas and others who support the argument from inductive risk can, or would want to, make this claim. They concede that contextual values are nonevidentiary or nonepistemic. For them, the more evidence in favor of a hypothesis, the less uncertainty there would be, and thus the less need for contextual value judgments (Douglas 2000, 577; 2009, 96, 107). Indeed, many supporters of the inductive risk argument contend that it is only legitimate to appeal to contextual values in dealing with uncertainties once epistemic considerations have been exhausted (Steel 2010; Steel and Whyte 2012; Winsberg 2012; Elliott 2013). Others have argued that they play a necessary role in assessing risks that may "trump" epistemological aims (Elliott and McKaughan 2014). Thus, it seems unlikely that proponents of the inductive risk argument would wish to claim that contextual values are necessary to promoting the epistemological aims of research.

Some, however, have argued that contextual values involved in risk assessment are necessary to advancing certain pragmatic aims related to the production of scientific knowledge.[2] Contextual values might thus be *pragmatically necessary* to advancing science advising and policy aims. Much of science, after all, is aimed not just at arriving at true beliefs about the world but also at addressing or informing pressing public policy needs. In such cases, scientists must draw conclusions that can be presented to policy makers and used to inform public policy, and this must be done in a timely manner despite significant uncertainties (Douglas 2009; Elliott 2013; Elliott and McKaughan 2014; Miller 2014). Thus, scientists must rely on con-

2. Some argue that there is not a sharp distinction between the epistemic and the pragmatic aims of science (e.g., Miller 2014), such that these notions of necessity ought not be viewed as distinct. While we are inclined to agree with this view, this approach has largely not been adopted by proponents of inductive risk such as Douglas. This is because (as we will see) Douglas wants to ensure that value judgments do not "trump" epistemic considerations so as to address the problem of wishful thinking.

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textual values to weigh the risks of error in deciding what hypotheses to endorse for purposes of advising policy makers.

Characterizing contextual values as necessary in this sense faces two problems, though. First, it is not obvious what would distinguish this position from the VFI. Understood thus, it no longer appears that contextual values are playing a role in decisions at the core of scientific reasoning but rather in decisions about which models, methodologies, or research strategies to pursue solely for the aim of continuing research or policy advising. Indeed, in defending the VFI against the inductive risk argument, Mitchell (2004) warns that scientists' role as policy advisers ought to be viewed as distinct from their role in producing knowledge. While it may be permissible for scientists to rely on contextual values to address uncertainties with respect to policy advising, she argues that this should be viewed as separate from their role as scientists in deciding which hypotheses to accept as likely to be true or empirically adequate. Others have argued that we can distinguish between different sorts of propositional attitudes adopted by scientists toward a hypothesis (Lacey 2005; Elliott and Willmes 2013). There is a difference between believing that a hypothesis is true on the basis of evidence versus accepting a hypothesis as if it were true for pragmatic reasons. Thus, one might argue that scientists need not make any value judgments in relation to which hypotheses are justified but rather which might be relied on for purposes of policy making. But VFI might agree with this. One might argue that pragmatic decisions about what scientific claims to present to policy makers cannot be easily distinguished from decisions about what hypotheses to accept or that attempts to distinguish propositional attitudes are problematic. Yet this would require further argumentation from inductive risk proponents. More important, this seems a distinction that at least some of those who accept the inductive risk argument have been willing to endorse (Elliott and Willmes 2013).

Second, when uncertainties exist, rather than using contextual value judgments to provide policy advising, scientists might instead use a plurality of alternative models, ranges of observational values, or parameters of statistical significance (Parker 2010; Betz 2013). For example, while there are significant uncertainties in climate modeling about cloud formation and its contribution to warming trends, this can be addressed by working with ensembles of models that make different assumptions with respect to cloud formation. Thus, policy makers can be presented with a range of likely possibilities without scientists having to make epistemically arbitrary choices in the face of uncertainty.[3] These alternative strategies, which are consistent

3. This does not mean that reasons could not be given for those choices, but the reasons would not be epistemic ones—given that in the inductive risk argument contextual values do not have an evidentiary or epistemic role. The reason involved would have to be ethical or pragmatic.

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with the VFI, could promote the pragmatic aim of furthering research and generating time-sensitive information relevant to policy development, while leaving substantive value judgments about what sorts of risks are acceptable to policy makers (Betz 2007, 2013). Granted, the decision about whether and how to hedge hypotheses, as opposed to the decision to present "hedged" hypotheses to policy makers, might itself involve inductive risk calculations (John 2015). That is, if scientists restrict themselves to only very general statements (e.g., it is more likely than not that average global temperature will increase 2 degrees over the next century) rather than accepting a more specific plain hypothesis (e.g., average global temperature will increase 2 degrees over the next century), this might have important policy consequences. However, in these cases, these risks pertain to how to present results to policy makers. There may be risks related to communicating results, but assessing such risks seems distinct from the kinds of scientific decisions that constitute the core of scientific reasoning. If contextual values are necessary only for judging how results should be communicated, then the VFI has not been undermined.

Perhaps then, contextual values can be said to be *ethically necessary* to decisions about whether to accept hypotheses as justified. That is, they are necessary in certain scientific decisions in order to fulfill scientists' ethical obligations. Douglas seems to understand them thus. For her, the necessity of contextual values comes not merely from the fact that scientists must have some way to make decisions under uncertainty so as to give guidance to policy makers but also because of a general moral obligation that all agents have to consider the consequences of their actions (Douglas 2003, 2009). The choices about which hypotheses to accept are likely to have consequences that will affect public health and well-being, and there is no reason why scientists, qua scientists, should be exempt from the obligation to give moral consideration to the impacts of their actions. Thus, there are ethical reasons to adopt certain pragmatic solutions over others in making inductive risk calculations. In this sense values play a necessary role in making pragmatic decisions in a morally responsible way.

Yet it is not obvious that, when confronted with uncertainty, scientists' ethical obligation to consider the consequences of their decisions is best met by appealing to contextual values. First, making such value judgments involves scientists appropriating the role of policy makers and, at least in principle, undermining democratic ideals. If so, then the consequences of requiring scientists to use contextual values must also be considered. Granted, one might propose mechanisms to ensure that scientists take into account the interests of relevant stakeholders (as will be considered in the next section). But insofar as such mechanisms are inadequate—as they currently surely are—the ethical need to ponder the consequences of one's actions must consider such inadequacy.

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Second, judgments about harm are rarely unambiguous, and scientists are rarely in a position to correctly assess harms. Judgments about what constitutes harm, or how to compare, balance, or judge the seriousness of different harms, are contested. This is particularly relevant when considering complex cases (e.g., climate change research) in which the values of different stakeholders may conflict and reasonable disagreement about how to weigh these competing interests exists. By making value judgments about what risks are more acceptable, scientists will effectively be disenfranchising at least some stakeholders. Public policies can affect different groups and various nations in various ways, and it is not clear that scientists in the United States, for instance, should be using value judgments to assess the consequences of error for hypotheses that have effects in, say, India. Hence, one could argue that scientists' general ethical obligation to consider the consequences of their actions would be better fulfilled by refraining from making such value judgments and using other strategies to confront uncertainties. While there might be some cases in which assessment of harms is relatively uncontroversial, this is uncommon in the realm of current policy-relevant science.

It seems then that having scientists make value judgments is neither logically nor epistemically nor pragmatically necessary. Without further argument, it is not evident either that scientists' use of contextual value judgments is ethically necessary. If so, it is not obvious that the inductive risk argument has shown the VFI to be untenable.

Nonetheless, as we have indicated, in some instances the ethical requirement to consider the consequences of error can perhaps ground the need for scientists to use contextual values in scientific reasoning. One might take this as sufficient to show that the VFI is false. Let us grant this now. However, the epistemological and political concerns that motivate the VFI are important ones, and a compelling account of values in science must address such concerns by meeting the wishful thinking and the democracy criteria. In the next section we evaluate whether Douglas's positive account of the role of values in science can do so and conclude that either it fails to do so or, insofar as it does, it vindicates the VFI.

4. Accounting for the Role of Contextual Values in Science. Douglas aims not only to undermine the VFI but also to provide a positive account of the role of contextual values in science. She proposes that we can regulate their appropriate use by distinguishing between the kinds of roles that values might play in a variety of decisions. For her, contextual values can legitimately play an indirect role in determining whether to accept a hypothesis given the risks of error, but they ought not play direct roles in determining whether a hypothesis is warranted by evidence (Douglas 2000, 2009). They may only play direct roles in certain kinds of decisions, such as deci-

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sions about what kind of research to pursue or whether some methodological choice (involving, e.g., the treatment of human subjects) would be unethical.

The distinction between direct and indirect roles is intended to address the wishful thinking criterion. It appears to do so by limiting the kinds of scientific inferences in which contextual values play a legitimate role in assessing risks or how much evidence is needed to accept a hypothesis. They play no direct role in determining what the evidence is, such that a predetermined outcome would be favored. Wishful thinking occurs only when values are allowed to directly influence what methodologies or hypotheses are adopted or how evidence is characterized. In such cases, values would supplant evidence and lead to decisions based on what scientists want to be the case in virtue of their values. The problem of wishful thinking is thus putatively avoided by employing the direct/indirect role of values distinction because judgments about what the evidence is, or whether a hypothesis is warranted, are insulated from contextual values.

As others have argued, however, the indirect/direct role distinction seems unable to appropriately regulate the use of value judgments to prevent wishful thinking (Steel and Whyte 2012; Elliott 2013). This is because decisions about how much evidence is needed to accept a particular model, for instance, or to determine appropriate levels of statistical significance can indeed influence what evidence there is, or "rig" the methodologies used toward achieving a predesired outcome. For example, scientists funded by pharmaceutical companies might—even unconsciously—allow financial interests to determine the duration of clinical trials. Consider, for example, the common use of surrogate endpoints as proxies for hard clinical outcomes such as mortality. Surrogate endpoints allow for smaller and faster trials and thus provide economic incentives to funders. The main problem with their use, however, is that favorable effects on surrogates often fail to translate into benefits to the health of patients. Decisions about whether to perform a placebo-controlled or a head-to-head trial are another example. Pharmaceutical companies, concerned with the possibility that a competitor's product might outperform their own, often fail to conduct head-to-head comparisons. These economic incentives could play an indirect role in weighing the risks and benefits associated with the choice of a particular endpoint or comparator. But although values would be playing an indirect role, appealing to such considerations may be inappropriate, as it would direct the study toward a desired conclusion. If so, then the distinction between direct and indirect roles for values cannot by itself prevent the problem of wishful thinking. Douglas might respond, however, that playing an indirect role does not establish the legitimacy of appealing to a particular contextual value in making risk assessments. Thus, what may be problematic about the use of contextual values in these sorts

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of examples is not the indirect role they play but the inappropriate use of a particular value itself. Nonetheless, this response simply calls attention to the fact that the direct/indirect role distinction alone is insufficient to address the wishful thinking criterion.

Yet even if the direct/indirect role distinction were thought to succeed in addressing the problem of wishful thinking, it would do so by vindicating the VFI. If the role of contextual values is limited to assessing the uncertainty tolerable when accepting a hypothesis with relevant policy implications, the use of such values appears merely to be the sad or unavoidable consequence of uncertainty. It is because scientists often lack definite evidence to assert or reject a hypothesis in time-sensitive policy cases that contextual value judgments are needed to manage inductive risks. But this is consistent with the view that, ideally, contextual values would not be a part of scientific decision making. Indeed, as indicated earlier, proponents of the inductive risk argument explicitly concede that the more overwhelming the evidence in favor of a hypothesis, the less uncertainty there would be, and thus the less need for the use of contextual value judgments (Douglas 2000, 577; 2009, 96, 107). As we said, that uncertainty is inevitable or that epistemic agents do not seem capable of reasoning without making value judgments when assessing risk does not show that values enhance scientific knowledge production. After all, the VFI is just that, a regulatory ideal. VFI proponents might concede that insofar as uncertainty exists value judgments involved in risk assessment are unavoidable. But if such values could be limited or reduced, then it would be better to do so. Hence, insofar as Douglas's positive account is able to address the wishful thinking concern, it does so by vindicating the VFI.

But what about the political concern? Douglas attempts to address the democracy criterion by requiring scientists to make contextual value judgments explicit (2009, 155). Making contextual value transparent allows stakeholders to assess the value judgments at stake as well as understand the sorts of decision points where uncertainty exists and where values have played a role. Moreover, making value judgments involved in risk assessment transparent arguably gives stakeholders the opportunity to provide critical feedback on the value judgments made so as to ensure that any scientific conclusion used in policy making relies on values that stakeholders (or at least the majority of relevant stakeholders) would accept.

Douglas recognizes that transparency alone is not enough to meet the democracy criterion. Risk assessment occurs throughout scientific research, and thus value judgments involved in risk assessment shape the science available for public policy. Hence, transparency alone cannot assuage the concern that in making value judgments—even explicitly—scientists will have a disproportionate power to shape the science in ways that will constrain policy decisions. Affected stakeholders must be able to have a say

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in the values that ultimately guide policy. Thus, Douglas also calls for deliberative processes that would give stakeholders a participatory role throughout the research (2009, 171–75). The public would provide scientists with feedback early in the process so as to direct the value judgments made in risk assessments.

The exact mechanisms for this deliberative processes are unclear, but Douglas offers some promising suggestions. She argues that people with diverse political interests would constitute scientific advisory boards to give value judgments a more rigorous scrutiny (Douglas 2009, 155). A diverse constituency could identify and scrutinize value-laden assumptions guiding inductive risk assessments. It is often easier to identify implicit value assumptions when the values in question are not one's own (Longino 1990). Presumably, democratic concerns can thus be addressed because, when developing public policy, policy makers and stakeholders retain the power to ultimately endorse or reject the values of scientists.

A number of challenges exist to achieving diverse advisory boards in practice. Such diversity is constrained by the availability of relevant expertise. Yet many of the stakeholders most affected by research, such as those from resource-poor countries or members of marginalized groups, face a variety of economic and political conditions that makes them less likely to be members of the scientific community. Indeed, this is in part why scientists have historically tended to be a fairly homogeneous group. Even the Intergovernmental Panel on Climage Change (IPCC), which makes robust efforts to be diverse, has been criticized for being largely constituted by white male scientists from the United States and western Europe (Agarwal 2002). This is unsurprising, as resource-rich countries can afford to support scientific research. Thus, it is difficult to imagine that efforts to increase diversity on scientific advisory boards (as desirable as that might be) will be sufficiently successful as to even approximate a representation of the competing values and interests of those affected by research.

More important, even if advisory boards were composed of those with diverse values, it is difficult to see how policy makers would be able to make use of the available science so as to promote stakeholder interests. One option would be to require transparency not only about the values guiding scientists' risk assessments but also about the pragmatic and policy aims toward which those values are directed (Elliott 2013). On this view, transparency allows for a kind of "backtracking" whereby stakeholders and policy makers can critically assess how different conclusions might have been reached with alternative values or policy aims (382; Elliott and McKaughan 2014). For example, climate scientists may decide that in the face of uncertainties, it is better to run the risk of overestimating climate change, so as to protect against the worst-case scenario. Therefore, they may endorse assumptions in climate models that risk overestimating the extent to which average global

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temperature will increase. The claim is that if scientists make these assumptions transparent—both the value judgments they are making about which risks are acceptable as well as the decisions for which there was significant uncertainty—then policy makers could evaluate how different value judgments might have produced different scientific results (Elliott 2013). In this way, democratically elected policy makers and other stakeholders can evaluate whether to accept or reject those value judgments and the scientific conclusions drawn from them.

However, the practical viability of these strategies is questionable. Requiring that scientists make value judgments transparent presupposes that scientists are aware of such judgments. This is not always the case. Values can be difficult to identify because they are widely held within the relevant sector of the scientific community. This difficulty is made more obvious by the fact that inductive risk judgments presumably occur throughout the research process not only at the time of recommending a course of action to policy makers.

Furthermore, even if value judgments are recognized and made explicit, the proposed critical scrutiny would occur at a point when the value judgments already have shaped the science available to inform public policy options. Backtracking seems to require that stakeholders be able not only to evaluate risk assessments judgments made throughout the research process but also to determine how different value judgments might have resulted in different scientific results. It is doubtful that this could occur. First, stakeholders may lack the expertise necessary to assessing how the adoption of different values could result in different conclusions. Second, even in cases in which stakeholders possess the necessary expertise, they may not be in a position to know what conclusions could follow from using different value judgments. In some cases, the kinds of decisions at stake are decisions not to collect certain data or not to employ particular methodologies. For example, imagine that climate modelers adopt assumptions that risk overestimating warming trends in order to generate data. In such cases, it will be unknown to policy makers and other stakeholders what data alternative models might have revealed. That is, they will not know, for instance, what models might have shown under the assumption that greenhouse gases would quadruple instead of double or under different cloud formations presuppositions. Adopting different value judgments would likely produce different data, but there would be no basis for guessing what those data would be without running the models.

Moreover, even if backtracking allows relevant stakeholders to ascertain what values have played a role in research, what could they do if they disagree with the particular value judgments guiding scientists' investigations? Suppose that in dioxin cancer research, some pathologists have decided to classify borderline cases of tumors in rat livers as malignant for purposes of

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calculating the cancer rate in rats exposed to these chemical. They assume that, under uncertainty, it is better to risk overestimating the cancer rate and thus incur the economic costs of overregulation than to underestimate it and thus increase harms to human health. These judgments, however, guide all the research presented to relevant stakeholders, including the cancer rates, the dose/response curve, and possible subsequent research. If policy makers believe that the particular value judgments guiding the investigation are incorrect, they will be confronted with a dilemma. They can reject the research altogether as problematic and pursue legislation uninformed by scientific evidence, which seems not only undesirable but undermines the reason for scientists to use contextual value judgments in the first place. Or, they can use the presented data to inform policy despite the fact that they disagree with the underlying value judgments. This, however, would call into question the democratic character of such decisions. Granted, as Douglas argues, stakeholders can provide feedback that could then be used to direct new future research, but insofar as decision making is time sensitive (as proponents of inductive risk assume) and policy makers need the available data to inform public policy, this will not provide a satisfying check on the power of scientists to decide which values should be given weight.

For Douglas this calls for stakeholders to be involved all throughout the research process, and she gives examples of community-based participatory research in which stakeholders have provided meaningful feedback that has directed scientists toward giving weight to particular values. Thus, we might think of scientists as merely representing the values of stakeholders in making inductive risk calculations rather than their making any personal value judgments about which risks ought to be given more weight. In this case, concerns about democracy are met, as scientists would merely be executing the preference of stakeholders in making risk assessments (regardless of what their own individual values and preferences were). This approach might indeed be successful in meeting the political concerns, but again it does so by vindicating the VFI. That is, stakeholders, rather than individual scientists, would be tasked with making value judgments, while scientists would rely on those judgments in carrying out the science. This seems perfectly consistent with the claim made by proponents of the VFI that scientists, qua scientists, ought to refrain from allowing their personal value judgments to influence their decision making, even when it comes to risk assessments.

5. Rethinking the Relationship between Values and Evidence. Examining the ways that the argument from inductive risk fails to undermine the VFI provides important insights into what is necessary for a more successful challenge. A central, and problematic, assumption that underlies the VFI is that contextual values are not relevant to whether there is evidence for or

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against a hypothesis. Indeed, it is this assumption that lends force to the problem of wishful thinking. If contextual values are irrelevant to what evidence there is, then relying on such judgments risks supplanting evidence with the desire for theories that better support one's contextual values. In trying to address the problem of wishful thinking, Douglas concedes this problematic assumption: contextual values are relevant only to judgments about how much evidence is needed in cases of uncertainty, but such values do not constitute reasons for guiding belief or theory acceptance (Douglas 2009). It is this concession that makes the inductive risk account of values unsatisfying.

An effective challenge to the VFI thus needs to deny the assumption that value judgments are always extraevidentiary such that they are likely to lead to wishful thinking. Indeed, as other opponents of the VFI have shown, there are several ways in which contextual value judgments might legitimately operate as relevant background assumptions in evidentiary assessments. For example, there may be cases in which the content of scientific theories involves contextually normative concepts (Callicott, Crowder, and Mumford 1999; Anderson 2004; Dupré 2007; Elliott 2009). Research aiming to measure harms, impacts, or risks, for example, clearly involves normative concepts that rely on assumptions about what we take to be central to well-being or about what human or nonhuman interests need protection (Shrader-Frechette 1991; Anderson 2004). For instance, in measuring climate impacts, whether the loss of a language or cultural tradition counts as an "impact" depends on judgments about what goods are worth protecting. In biomedical research, what constitutes a "side effect" or an "adverse outcome" that ought to be measured or reported in clinical trials relies on value judgments about what conditions we take to threaten human well-being (Intemann and de Melo-Martin 2010). In conservation biology, employing concepts such as "ecological restoration," "sustainability," "healthy forests," and "ecosystem integrity" presupposes values about what we take to be important to protect or what we believe is central to environmental flourishing (Callicott et al. 1999; Elliott 2009). But if, as these examples show, scientific claims are not merely descriptive claims, then normative values about what ought to be are indeed sometimes relevant to what is the case.

Even when the concepts in scientific theories appear to be descriptive, the choice of which conceptual frameworks to employ may depend on less obvious contextual value judgments. For instance, when conducting research on epidemiological studies on racial health disparities there are various ways to represent race, such as the "one drop rule," the biological race of the mother, self-identification, or geographical ancestry (de Melo-Martin and Intemann 2007). Which classification method is most appropriate will depend on what it is that we are interested in tracking, and different contextual value judgments are likely to produce different results about the extent

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to which racial health disparities exist. Thus, even when "race" might be operationalized in apparently descriptive ways, the choice of how to classify races depends on contextual value judgments about what one takes to be salient about racial health disparities. Similarly, whether, for instance, there is empirical evidence that gray wolves are in decline rests on whether we are concerned about the continued existence of gray wolves globally, the existence of "pure" gray wolves that have not interbred with coyotes, or the presence of gray wolves in a particular ecosystem. Our values and policy-related interests will be relevant to justifying decisions about what should be measured and how we measure it, and those decisions, which are grounded on contextual value judgments, will result in different evidence about the threat to gray wolves.

In addition, contextual values are relevant to determining the methodologies best suited to acquiring data. Consider research on the toxicity of Bt genetically modified maize. Persistent disagreements exist about what would constitute the right kind of empirical data to justify or challenge claims about nontoxicity. The de facto established methodological norm in such studies is to use an extraction of the purified Bt protein taken directly from the bacteria rather than using a protein from a genetically modified maize plant (Freese and Schubert 2004; Wickson and Wynne 2012). But these different methodological approaches will produce empirical evidence about either the toxicity of the Bt protein by itself or the potential toxic effects caused by the genetic modification of the maize plant (Wickson and Wynne 2012). Which methodology is better suited to produce the sort of evidence that could inform sound public policy is thus not given by nature but requires value judgments about what to measure. Similarly, methodological decisions about the duration of studies, the appropriate makeup of test subjects, and the selection of biological endpoints depend on contextual value judgments about the social aims of the research (Intemann and de Melo-Martin 2010; Wickson and Wynne 2012).

Rejecting the assumption that contextual values are irrelevant to whether there is evidence for or against a hypothesis and arguing that at least in some cases appealing to contextual values will promote the epistemic, and not just the pragmatic and ethical, obligations of scientists meets the necessity criterion. Hence, such an approach undermines the VFI. Moreover, insofar as contextual values are relevant to some decisions at the core of scientific reasoning, then the problem of wishful thinking is addressed. If contextual values provide evidence that a claim is reasonable to accept, then this does not seem to threaten the integrity of science. For example, valuing certain cultural traditions gives us good reasons to conceive of climate impacts in a certain way, to adopt certain methodologies when measuring climate impacts, and to take changes to cultural traditions as evidence for claims about the potential harms produced by climate change. But this does not mean that

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the claim that, for example, linguistic traditions will likely be lost with rising sea levels is true merely because one wishes it to be. Indeed, many of those who value linguistic traditions likely prefer that this not be true. In such cases, it is incorrect to see contextual values as "trumping" or "supplanting" epistemic considerations or promoting wishful thinking. Often, determining 'how the world really is' requires the use of contextual values.

Furthermore, to the extent that contextual values are necessary to meet the epistemic goals of science, then concerns about scientists making value judgments might be overstated. If contextual values play the type of robust roles that we have outlined, then strategies to eliminate them are problematic from an epistemic point of view and likely doomed to failure. The political motivation presents a prima facie reason for scientists to refrain from making value judgments insofar as such judgments can be avoided. But if contextual values are relevant to evidentiary considerations, then they cannot be eliminated as easily as methods for dealing with uncertainty might allow. Value judgments are required not merely because there are no other ways of making decisions under uncertainty but rather because they are relevant to the content of scientific claims or to promoting the epistemic aims of the research. If so, it would be epistemically irresponsible for scientists not to make value judgments. If they attempted to refrain from doing so, they would be ignoring factors that are relevant to whether their methodological decisions, conceptual frameworks, or judgments about which hypotheses are supported by the evidence are justified.

Nonetheless, even if one agrees that contextual values are epistemically necessary for scientific decision making, this still leaves open the question about what particular values should guide research. Thus, meeting the democracy criterion is still required in order to offer a successful account of the role of values in science. Even if scientists are justified in using value judgments in scientific decision making, such value judgments should effectively incorporate stakeholders input. It is beyond the scope of this article to propose mechanisms to achieve this goal. But if we are correct, many of the value judgments used in scientific reasoning need to be justified in relation to the aims of research. This aims approach maintains that social, ethical, and political value judgments are legitimate in scientific decisions insofar as they promote democratically endorsed epistemological and social aims of the research (Intemann 2015). On this view, value judgments about which goals constitute the aims of a particular research context must be justified by democratic mechanisms that secure the representative participation of stakeholders likely to be affected by the research. Moreover, individual scientists will have obligations to make value judgments about which types of models, methodological approaches, conceptual frameworks, or strategies for dealing with uncertainties best promote those democratically endorsed aims. Accordingly, it will be legitimate for scientists to appeal to con-

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textual values in decisions at the core of scientific reasoning in ways that will advance the epistemic and policy-related interests of stakeholders.

Thus, perhaps a more promising way to incorporate stakeholder values would be through mechanisms that increase their participation in establishing the aims of research. This is something that might happen in the early stages of developing research programs, such as in developing calls for research proposals. If research programs have clearly defined social goals that are justified by a representative range of stakeholders, scientific decision making would be justified in relation to those democratically endorsed goals, rather than the goals of particular researchers. This strategy does not call for scientists to avoid making value judgments, as scientists may be the ones with the appropriate expertise to know, for example, what test material should be used in testing Bt toxicity in order to better promote the aims of the research. But, such value judgments would be accountable to democratically endorsed aims.

Indeed, there are many examples in which stakeholder input has been successfully incorporated in establishing and refining aims of research in a way that is then used to justify particular methodological decisions (Shrader-Frechette 2007). As Douglas herself notes, community-based participatory research has been used in many social science disciplines, where researchers work with community advisory boards composed of representatives of groups affected by the research. This has been common, for example, in both national and global research on HIV/AIDS prevention and treatment. In these cases, advisory boards participate not merely in crafting policy recommendations for, for example, needle-exchange programs or HIV education programs. Rather, they play a role at various stages throughout the research process: in formulating what the policy aims and the priorities of the research should be, giving feedback on the extent to which methodological decisions sufficiently advance those aims (such as clinical trial methodology), and providing critical feedback on assumptions that scientists have made in interpreting data (Epstein 1996). Similarly, in the context of climate change research, there are increasing efforts to incorporate stakeholder input throughout the research process (Kloprogge and Van Der Sluijs 2006; Tang and Dessai 2012; Kirchhoff, Lemos, and Dessai 2013). The UK Climate Impacts Programme, for instance, has developed mechanisms for working with stakeholders to identify adaptation needs and receive critical feedback on modeling strategies to produce more "useable knowledge" (Tang and Dessai 2012).

6. Conclusion. The inductive risk argument has been hailed as a challenge to the VFI. However, if our arguments are correct this is not obvious. Because proponents of inductive risk do not see values as fulfilling an epistemic role, but simply a practical or an ethical need, it is not at all clear that they can justify the claim that values are necessary to decisions about the

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gathering of evidence or the accepting of hypotheses. If so, the inductive risk argument fails to show that the VFI is untenable. Moreover, Douglas's positive account of the role of values in science is unsatisfactory because it either does not appropriately address the wishful thinking and democracy criteria or, insofar as it does, does so by vindicating the VFI.

The inability of proponents of the inductive risk argument to effectively challenge the VFI stems at least in part from the fact that they share a problematic assumption with such an ideal: that contextual values cannot legitimately play evidentiary roles. Contesting this assumption can establish the epistemic necessity of contextual value judgments and thus address the necessity criterion that shows the VFI to be untenable. Moreover, recognizing that values are epistemically necessary calls into question the assumption that contextual values need to be eliminated in order to address wishful thinking. Similarly, recognizing that the social aims of the research are relevant to the epistemic success of science can direct attention to the types of strategies needed to meet the democracy criterion and ensure that democratic ideals are not undermined by scientists' necessary use of contextual value judgments.

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