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ARTICLE

The Problem of Deep Competitors and the Pursuit of Epistemically Utopian Truths

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Abstract According to standard scientific realism, science seeks truth and we can justifiably believe that our successful theories achieve, or at least approximate, that goal. In this paper, I discuss the implications of the following competitor thesis: Any theory we may favor has competitors such that we cannot justifiably deny that they are approximately true. After defending that thesis, I articulate three specific threats it poses for standard scientific realism; one is epistemic, the other two are axiological (that is, pertaining to the claim that science seeks truth). I also flag an additional axiological "challenge," that of how one might justify the pursuit of a primary aim, such as truth. Bracketing epistemic realism, I argue that the axiological threats can be addressed by embracing a refined realist axiological hypothesis, one that specifies a specific subclass of true claims sought in science. And after identifying three potential responses to the axiological "challenge," I contend that, while standard axiological realism appears to lack the resources required to utilize any of the responses, the refined realist axiology I embrace is well suited to each.

Keywords Aims of science · Axiological realism · Scientific realism · Underdetermination of theories by data

1 Introduction

The *contemporary* scientific realism debate pivots around two key questions: (1) What is the primary aim of science? (2) What can one justifiably believe about successful scientific theories? Scientific realism is a contemporary position that endeavors to answer these questions. In response to the first question, the realist asserts that science aims primarily at truth (which crucially includes for the realist truth about unobservable entities). In answer to the second, the realist claims that we can justifiably believe that our empirically successful scientific theories achieve, or at least approximate, this aim. Most realists claim that this purported relation between empirical success and approximate truth is ultimately to be

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treated as "an overarching empirical hypothesis"; and, to justify belief in that hypothesis, realists generally appeal to what has been dubbed the "no-miracles argument": it would be a miracle were our theories as successful as they are, were they not at least approximately true. Putting these pieces together, standard scientific realism is a contemporary position that embraces the following two tenets:

> *Axiological* (*Scientific*) *Realism*: science aims, primarily, to express true statements about the world.
> *Epistemic* (*Scientific*) *Realism*: given the no-miracles argument, we can be justified in believing the empirical hypothesis that successful scientific theories are (approximately) true.

At issue in the contemporary scientific realism debate is the acceptability of these claims. The non-realists (or antirealists) deny both tenets: they challenge the realist hypothesis that successful theories are approximately true along with the legitimacy of the no-miracles argument; and they posit that science seeks goals that are less contentiously within our epistemic reach, such as problem solving effectiveness (Larry Laudan) or empirical adequacy, i.e., truth about only observable entities (Bas van Fraassen).

There are two key arguments against scientific realism. The first is a historical argument (emphasized by Laudan); the other is based on the underdetermination of theories by data (emphasized, for instance, by van Fraassen). Although in what follows I will say a few words on the historical argument, I've explored that argument in detail elsewhere (Lyons 2002, 2006, 2009). In this paper I will focus on concerns pertaining to underdetermination. Central to such concerns is the following thesis:

> *The competitor thesis*: Any theory we may favor has competitors such that we cannot justifiably deny that they are approximately true.

While I will discuss this thesis in the next section, here we can discern three threats to standard scientific realism that appear to arise from this competitor thesis; the first is epistemic, the second two are axiological.

> *The epistemic threat*: the realist hypothesis "successful theories are approximately true" lacks justification; hence, contrary to the realist's epistemic tenet we cannot be justified in believing that realist hypothesis. In fact, as I've shown in my 2009 (68–69) the claim that we can justifiably believe that realist hypothesis requires justification for believing, not only (a) that the competitor thesis is false, but also (b), that the theories included in that realist hypothesis have no competitors whose approximate truth we cannot justifiably deny.[1] And if the competitor thesis holds, (b) does not; and epistemic realism is refuted.
> *The first axiological threat*: the standard realist's axiological tenet, "science aims at truth," is unable to account for, let alone justify, a *crucial component of theory choice* in science, namely the practice of rejecting competitors that are such that we cannot justifiably deny that they are approximately true. Hence, insofar as competing (namely, non-realist) axiological hypotheses can account for this practice, the realist's axiological tenet should not be accepted.

[1] Notice that (b) is far more demanding than (a): the competitor thesis would be rendered false by—in other words, (a) obtains upon our—specifying just *one* theory that is without competitors; however, that one instance will not be sufficient for (b); (b) requires that *the realist hypothesis includes no theories* that have competitors whose approximate truth we cannot justifiably deny. Yet, as I show in my 2009, epistemic realism requires justification for believing not only (a), but the far more demanding (b).

The second axiological threat: the standard realist's axiological tenet, "science aims at truth," renders the aim of science such that one cannot justifiably identify when that aim has been achieved or even approximated, in which case, one cannot say that science is progressive; hence the realist's axiological tenet renders science irrational; and, insofar as competing axiological hypotheses allow for the rationality of science, the standard realist's axiological tenet should not be accepted. (As will be noted below, Laudan emphasizes this problem, given for instance his historical argument against realism. My emphasis here will be on the competitor thesis, specifically, as that which motivates this second axiological threat.)

To the extent that realists have addressed the issue of competition between theories, they have tended to do so in the context of the epistemic threat. And the most common approach to answering that threat is to deem the competitor thesis (or something like it) false—or, at least, to claim that non-realists have yet to show that any such threatening competitor thesis holds. If successful, such a realist response might well alleviate the threats noted. However, in the next section, I will argue on behalf of the non-realist that we *cannot* deem the competitor thesis false and that, in fact, it holds. In Sect. 3, I will contend further that *standard* scientific realism is genuinely threatened in each of the three ways identified. Recognizing this will prompt us to look for an alternative variant of realism. And, embracing what I consider to be the most crucial component of realism, namely the core element of the realist's axiological tenet, I will specify and articulate such an alternative. That is, I will offer a refined version of axiological scientific realism that is faced with none of the threats above—*even if the competitor thesis (and its epistemic threat) can be secured.*

2 The Competitor Thesis

Realists will tend to deny that the competitor thesis holds, or at least that it has been shown to hold. Here I endeavor to remedy this shortcoming on behalf of the non-realist. I will attempt to ground the claim that indefinitely many competitor theories—whose (potential) truth our favored theory, T, cannot even approximate—cannot be dismissed in the quest for truth. And I will contend that this is so even granting the additional realist demands for explanatory depth and accordance with a principle of uniformity of nature. (While, as indicated above, I will offer an axiological realist solution to the problem (in Sects. 5, 6), my aim in this section is to make apparent the problem for standard realism.) Note first that our contemporary theoretical system

- asserts itself to have been devised in light of data obtained from a speck in the immense cosmos and during a period that constitutes an exceptionally tiny fraction of the time-scale of the universe;
- is itself rife with specifications of situations in which experimental results are determined by the presence of a specific condition in whose absence arise very different results—the latter of which are taken to be, not direct consequences of any deep truth about nature, but mere effects of the presence of the particular condition.

The type of competitor I aim to introduce in this paper embraces these foundational posits of science, which the realist must grant, deeming the successful empirical claims of our favored theories such that they describe nothing more than mere effects that result from the presence of particular conditions. The general structure of such competitors can be

understood as follows, where DeeperT is a description of nature that is dramatically distinct from, does not even approximate, our own T, and whose dramatically different consequences are non-apparent only because they are blocked by a particular condition, C:

- The world is as DeeperT describes—which allows for the presence and absence of condition C and, in itself, patently contradicts (our favored theory) T.
- Condition C obtains (according to the theory complex within which DeeperT is embedded) in spatiotemporal location, *l*, and causes observable entities E to behave in *l* (approximately) as (our favored theory) T claims.

C can be among any number of specific and perhaps cosmically rare conditions whose particular effect is to bring about a set of phenomena that are in approximate accord with our favored theory. Candidate conditions include dimensions intersecting, relations between our universe and others in a multi-verse, stages in our universe's expansion, perhaps even relations between our galaxy and the Great Attractor, or our solar system and a galactic center, etc. Alternatively, and at nearly any level of nature, C can simply be a threshold for emergence—met by any variable regarding populations, masses, charges, relations between entities, processes, etc.—where the descriptions we favor describe no more than rare emergent properties: the properties we attribute to entity, E, have come about only because a particular threshold was reached; and upon either a surpassing of the narrow limits of, or a drop below, that threshold, those properties will no longer persist. From the standpoint of all such competitors, the theory we hold to describe nature, T, predicts phenomena resulting only from the otherwise rare effects of the specified condition C. Once that particular condition is absent, phenomena will be governed not by C but by the fundamental states of nature asserted by DeeperT, for which nearly any randomly chosen self-consistent set of descriptions qualifies.[2]

Since according to such competitors our favored T's success is no more than a byproduct of condition C and since the deep-level competitors can diverge dramatically from T, on the assumption that one such competitor is true, our favored T need not describe, to any stretch of "approximation," the actual underlying truths of nature. Our favored T need share no more with a true competitor than a relatively small subset of (approximating) empirical claims. And inferring that T achieves this is perfectly non-realist. Put another way, stretching so as to embrace the idea that such relations qualify as approximations, the notion of "approximate truth" would be left with little if any relation to the rich notion of truth embraced by realists—and doing so would pose a significant threat to the epistemic realist's desire to explain success (see Laudan 1981, 1984; Lyons 2002, 2003, 2006). Moreover, it looks as though such alternatives stand at nearly any level and against nearly any theories we might be tempted to deem expressions of genuine truths. Finally, these competitors explain the observable changes unexpected by our favored theory: in the absence of condition C, a condition deeply embedded in our profoundly limited experience of the universe, descriptions we attribute to the universe will break down. And in that case, it is only our attribution of uniformity that is defied; the principle of the uniformity of nature is not. In fact, while DeeperT posits significant exceptions to what our favored T asserts, DeeperT itself can take either a non-exceptioned

[2] This characterization is meant only to *reveal* that there are such competitors (and the example in the appendix is meant only to illustrate how bizarre such competitors can be). However, even if this characterization were employed to *generate* competitors, the realist cannot exclude those competitors solely for embracing and building upon a restricted range of our favored T's empirical generalizations, while ultimately contradicting T. Newton, for instance, did precisely this, wholly discarding, as he did, Kepler's full-bodied theory.

or an exceptioned form. Granted, we may wish to deem DeeperT incomplete, in either form. But such incompleteness is likewise attributable to our best theories, including general relativity and quantum mechanics. Notably, contemporary science asserts that general relativity itself is exceptioned—some of its exceptions being articulated within quantum mechanics, for instance, in the context of black holes—and hence, at best, incomplete. Allowing for such incompleteness, as we must, even the competitors whose DeeperT posits exceptions do nothing to require a non-uniformity of nature. More generally, these kinds of competitors can be rejected neither for failing to posit explanatory mechanisms nor for violating a principle of the uniformity of nature.[3]

Realists will be tempted to require that our theories cohere with our accepted system of background theories, with the hope of excluding the competitors. However, notice that my characterization of competitors *began with* two crucial components of our favored background system, and hence cannot be said to be wholly out of accord with our favored background system.[4] In any case, contrary to realist desires and to assertions that realists often explicitly make, the demand that our theories cohere with the *accepted* system of background theories has not been a requirement in science. Three decades of steps toward quantum mechanics, e.g., Planck's, Rutherford's, Einstein's, Bohr's, and De Broglie's steps, blatantly contradicted and defied classical background posits. Regarding historical shifts to broad and deep theories, the shifts to the Newtonian system, to relativity, and to quantum mechanics, wholly failed to cohere with the Aristotelian background system, ether theories/Euclidean geometry, and Newtonian determinism/classical electromagnetism, respectively. Such deep and broad ranging competitors generally come with their own set of background theories.[5] In fact, we see that, if the quest for truth were to require coherence with the background system *already in place*, realism would be left unable to account for these instances of theory change. Moreover, our favored background theories are faced with competitors of the sort noted above no less than are our favored theories themselves. Since the quest for truth can require no more than that a theory cohere with *a* set of statements that accounts for a broad range of data, the quest for truth affords no warrant to disallow, for each competitor, its own system of background theories. Even if the competitors were to *wholly* fail to cohere with our background theories,[6] coherence with the background system *in place* is not a property that is, ought,[7] or can be required in theory selection. Such a demand cannot then be invoked to eliminate the competitors.[8]

[3] While the explanatory foundations offered by the competitors will be limited, since any theory, including the theories that make up the standard model, leaves the behavior of some entities or conditions unexplained (consider for instance the need for renormalization), we cannot simply reject the competitors for doing so. And, as should be clear here, such explanatory limitations provide no justification for denying that a theory—be it a favored theory or a competitor—is true.

[4] Notice also that, in my fictional illustration in the "Appendix", specifically, the "packet cosmology" embraces at its core the principle of natural selection; it also includes posits that are analogous to quantum fluctuations, the multi-verse hypothesis, and Democritean natural motion/Newton's first law.

[5] Regarding large scale theories, see Swinburne (1997).

[6] And, as noted in footnote 4, it is not obvious that even the bizarre examples in the "Appendix" *wholly* fail to cohere with the contemporary background system.

[7] The general prescriptive point here is classically emphasized by Feyerabend (1963). Of course, favorably embracing this particular empirical point does nothing to commit one to embracing Feyerabend's more radical claims.

[8] While realists may claim that such competitors fail to meet a requirement of simplicity, they are faced with the well-known burden of establishing that simplicity has anything to do with truth. There is widespread if not universal agreement among realists and non-realists alike that requiring simple theories in the quest for truth takes for granted the thesis that the world is simple. (See for instance, Van Fraassen (1980,

3 Threats to Scientific Realism

The point of all this is not of course to claim that such competitors are true. (The non-realist makes no such commitment: non-realists are patently not epistemic realists about competitors.) Nor is the point that we have empirical data that recommend choosing them over the theories we favor. The point is rather that the empirical data alone provide no grounds for *denying* that such competitors are (approximately) true. And with this we arrive at the competitor thesis: any theory we may favor has competitors such that we cannot justifiably deny that they are approximately true. Upon introducing this competitor thesis in Sect. 1, I identified three threats to realism that appear to arise from it. As noted, nearly all attention to the competitor thesis (and theses like it) has been directed toward solving the epistemic threat; and unfortunately, in that context, any degree of realist attention to the axiological threats has been wholly incidental and ultimately peripheral. Pre-reflectively, one might assume that, if the epistemic threat is answered, the other threats—the two axiological threats—are likewise nullified. Perhaps that assumption could be sustained if one could show that the competitor thesis is false. However, I have now argued that the competitor thesis holds. With the competitor thesis in hand, I will now employ it to reveal the seriousness of each of the threats mentioned, the epistemic threat and the two axiological threats.

3.1 The Epistemic Threat

While I have not yet argued that the epistemic threat follows from the competitor thesis, I will now contend that it does, and that the epistemic threat is a genuine threat. The following, for instance, is an underdetermination argument against realism. At the core of its structure (2–4) lies a *modus ponens*:

1. T qualifies as a candidate for the realist hypothesis, i.e., the type of theory that realists claim we can justifiably believe to be approximately true (e.g. T has enjoyed novel success).
2. If, however, we have reason to accept the competitor thesis, that T has (indefinitely many) competitors such that we cannot justifiably deny that they are approximately true, then (in contrast to what the epistemic realist claims) we are not justified in believing that T is approximately true.
3. We do have reason to accept the competitor thesis. (Given my argument in Sect. 2.)
4. Therefore, we are not justified in believing that T is approximately true.

Having now argued for its key contentious premise in the last section (see also the "Appendix"), I suggest that this *modus ponens* underdetermination argument poses a serious problem for standard epistemic realism, the claim that we are justified in believing

Footnote 8 continued
90), Lipton (2004, 143), Worrall (2000, 356).) The challenge, of course, is to ground that thesis. (A virtue of the axiological hypothesis I will articulate below is that it justifies a demand for various forms of simplicity without appeal to the metaphysical thesis that the world is simple.) Further, since nothing precludes ad hoc theories from being true, demand for non-adhocness (or criteria involving the motivations of scientists) cannot be employed to eliminate the competitors. I've addressed this latter point in detail in Lyons (2009).

that T is approximately true.[9] Furthermore, as noted earlier, there remains a second argument against realism, the historical argument. I've argued elsewhere that, for the last quarter of a century, this well known argument has been consistently misunderstood, and that, as a consequence, realists have been addressing "a straw man." Most if not all realists will claim that the historical threat against realism (emphasized by the non-realist) is merely a pessimistic induction, an inference from the success of past false theories to the conclusion that our present successful theories are likewise false. I contend, however, that this misconstrues the (legitimate) non-realist's inference. To put it briefly here, I argue that the real historical threat does not take this weak and logically invalid form, but instead takes the logically valid form of a *modus tollens*, rendering false the hypothesis the epistemic realist claims we can justifiably believe. The historical threat is, I contend, far more serious than tends to be recognized (Lyons 2002, 2006). More generally, I suggest here that epistemic realism is seriously threatened by these two arguments, the *modus ponens* underdetermination argument and the historical *modus tollens*. And while the primary aim of the present paper is not to refute epistemic realism, I contend that these considerations do suffice to motivate a solution to the axiological threats—in particular, to motivate a solution that does not rely on epistemic realism.

As a final motivation for seeking an axiological realism that does not depend on epistemic realism, allow me to add a crucial point: even if the *modus ponens* and *modus tollens* arguments against epistemic realism could be answered—or, taking this to extremes, even if epistemic realism could be *established*—the conclusion that would be drawn from any contemporary solutions to the epistemic threat would not be sufficient to solve the two axiological threats, noted above. Given the historical argument, contemporary realists have (found themselves forced to) become very selective; they very deliberately seek to exclude many accepted scientific theories from being included in the class of theories to which they will attribute approximate truth. While the realist may want to deny that those theories qualify, by the realist's restrictive criteria, for an attribution of approximate truth, the realist cannot deny that such theories are the products of theory-choice in science. That given, the quantity of theories that fall into the following class is substantial: theories that are, on one hand, chosen/accepted by scientists, and hence the products of theory choice, but that are, on the other hand, such to which (even realists admit) we cannot justifiably attribute approximate truth. That class includes not only past theories/constituents now taken to be patently false; it also includes theories that are accepted by contemporary science but which have yet to meet the strict realist demands. Realists, then, in seeking to account for what occurs in science, must account for those choices, deeming them progressive in some sense, independent of any claim that we can justifiably believe that those theories achieve or even approximate the primary aim of science. Hence, even if epistemic realism could be established, somehow, for a (very) restricted subset of the set of theories that have been chosen/accepted by scientists, that would not suffice to solve the two axiological threats. What we see here is that, no matter

[9] The general structure of this argument is drawn from an exploration I've engaged in elsewhere (forthcoming). In the course of that inquiry, I analyze an argument, a "new induction," recently embraced by Stanford (2006), which draws on insights of Lawrence Sklar and Pierre Duhem. Stanford claims that, because past scientists failed to think of alternatives, contemporary scientists fail as well. However, I show that Stanford's argument poses no threat to contemporary realism: it neglects concern with the type of theories to which scientific realists appeal (e.g. those that make successful novel predictions), thereby failing to provide evidence for step 1; it rests on a problematic thesis regarding the failure of scientists; and it relies, not on one induction but two, and they are two dubious inductions at that. The argument I've articulated here faces none of these problems.

how confident contemporary realists may be in thinking they've solved the epistemic problems of scientific realism, they can claim confidence in having done so for only a subset of accepted theories; but in order to provide a general account of scientific practice, which the realist endeavors to provide in the axiological thesis, confident epistemic realists must concern themselves no less with, and address separately, the axiological threats. And finally, as I've just argued, given the underdetermination *modus ponens* and the historical *modus tollens*, epistemic realism is far from being secured. Realists, epistemic or not, are pressed if not compelled, therefore, to explore how the axiological thesis of scientific realism fares independently of its generally presumed connection to the epistemic component of realism.

3.2 The Axiological Threats

While I will defend a refined variant of the realist's axiological hypothesis in light of the concerns above (and below), I contend that the standard realist axiological hypothesis, "science seeks truth," is in serious trouble. We have now seen grounds for the competitor thesis, the thesis that any theory we may favor has indefinitely many competitors whose approximate truth we cannot justifiably deny. That thesis given, it is wholly unclear just how the posit that science seeks truth can explain, let alone justify, any single instance of theory choice; *for each instance of theory choice* requires the exclusion (i.e., non-acceptance, if not wholesale disregard) of the indefinitely many competitors. By contrast, it is not at all clear that the competitor thesis threatens our non-realist; for she can account for the rejection of such competitors on pragmatic grounds: because, according to the non-realist, science does not seek truth, science need not concern itself with the competitors, irrespective of whether we can justifiably deny that they are approximately true. The theories that we favor are applicable to the world in that they are empirically successful, solve problems, etc.; and science, according to our non-realist, need seek nothing more.[10] It appears then that such versions of non-realism can explain the scientific practice of rejecting the competing theories whose approximate truth we cannot justifiably deny. By contrast, realism, despite its touted explanatory ability, is wholly unable to account for this practice—again, a practice at play in each instance of theory choice. This is the first axiological threat to scientific realism, noted in Sect. 1.

It will be recalled that the second axiological threat derives from the realist's desire to claim that science is progressive in a sense that is relevant to the goal the realist posits. If any theory we may favor has indefinitely many competitors whose approximate truth we have no grounds to deny (which entails the competitor thesis), then it is not clear how we can say that past and present theory choices in science constitute progress in terms of truth. Laudan contends that, upon the proposal that science aims at the truth, "science emerges as non-progressive since we evidently have no way of ascertaining whether our theories are more truth-like… than they formerly were" (1981, 145). And if our postulate regarding the aim of science is such that we cannot say science makes progress in respect to it, then our axiology at least threatens to render science irrational. Laudan claims that construing science as aiming at the truth "leads to the view that science represents a utopian, and therefore irrational activity" (qtd. in Rescher 1982, 227). By contrast, again, there are non-

[10] According to van Fraassen, science does seek something more, namely empirical adequacy (i.e. empirical perfection). Hence, I do not mean to include his particular non-realist position among those against which I am now contrasting standard realism. In fact, I've argued in my (2005) that his constructive empiricism faces problems similar to those I'm flagging for standard realism.

realist axiologies that face no such threat: setting aside truth, we can say that science does make progress in respect to other aims that are discernible, such as empirical success, applicability, problem solving, etc. Because these alternatives do not prohibit the identification of progress, and do not thereby render science irrational, the non-realist contends that the realist's axiology is unacceptable. In short, given the first axiological threat, the realist's axiological hypothesis is *unable to account for and justify the practice of* excluding the many competitors whose approximate truth we cannot justifiably deny; and given the second axiological threat, the realist's axiological hypothesis *fails to afford any discernible measure for progress*, and so threatens to render science irrational.

4 An (Additional) Axiological Challenge, and Potential Responses

Eschewing epistemic realism, as I am, I will make no effort to answer the epistemic threat. However, I will attempt to address both axiological threats below. Specifically, in Sect. 5, I will turn to discuss a refined realist axiological hypothesis that, I will argue, is not faced with those two axiological threats. In advance of doing that, however, we are called to acknowledge what might be seen as a third *challenge* (if not a threat) to axiological realism. To get at this worry, assume for the moment that, despite the potential epistemically utopian character of the realist's aim, the realist has the means for answering the second axiological threat—the demand for a way to evaluate progress in light of the realist's posited aim of science. (Below, I will defend the view that what we are only assuming here does hold for my refined axiology.) In this case, a failure to provide a measure for progress can no longer be cited as grounds for claiming that realism renders science irrational. Nonetheless, the non-realist might assert the following: it is one thing to say the realist can diffuse the charge of irrationality when that charge is based on a premise that can be answered, i.e., a premise that can be shown to be false. However, it is quite another task for the realist to show a *positive* rationale for pursuing the primary aim she has posited for science. And the non-realist might challenge the realist to provide such a positive rationale.

On the way toward addressing this axiological *challenge*, we need to consider the extent to which this is a special challenge for an axiological realism that eschews commitment to epistemic realism. That is, is this challenge one that holds for epistemically utopian goals specifically? Above I noted that, even if epistemic realism could be established for certain theories, it would not suffice to answer the two axiological threats. A similar point holds here: Even if the epistemic realist were to justify the belief that we've achieved or approximated the truth, doing so would not, in itself, suffice to provide a rationale for pursing truth. One could posit as a goal any number of plausibly identifiable theory characteristics—e.g. theories that fit with numerology or the I-Ching, theories that are tested in England, that entail empirical consequences that are wholly out of accord with our experiences, etc. The mere fact that we might justifiably believe that such characteristics have been achieved does nothing, in itself, to imply that it is rational to seek theories that possess those characteristics. What this obvious point makes clear is that the challenge of rendering rational the pursuit of a primary goal is not a challenge restricted to the pursuit of epistemically transcendent ideals, or in this context, to an axiological realism that eschews the epistemic counterpart.

I think the two other axiological concerns do pose genuine threats to the realist axiological hypothesis; however, for the reason just noted (and others below), I am not convinced that the demand for a rationale for pursuing truth poses a genuine threat to realism,

even when we assume that the primary aim that is posited by the realist is epistemically utopian. Nonetheless, it is a question that calls for exploration. It is for this reason that I am calling this an axiological *challenge* rather than a threat, and I will now explore the general possibilities for answering this challenge. In Sect. 5, I will identify an axiological hypothesis that, I will contend, not only nullifies the two axiological threats discussed above but also offers the greatest promise for answering this axiological challenge.

4.1 Potential (General) Responses to the Axiological Challenge

Recognizing that achievability is not sufficient to render a goal rational, and accepting that we are addressing the demand only insofar as it *arises* from within the context of the broader debate on scientific realism (e.g. from Laudan), we are compelled only to *justify* the pursuit of an epistemically transcendent aim from within the *context* of that debate. I suggest that the framework in which the scientific realism debate takes place allows for at least three possible responses. After introducing these responses, I will argue that there is little promise for invoking these responses while embracing the standard axiological realist hypothesis, "science seeks truth."

The first response to the demand for justifying the pursuit of a posited primary goal we can call *the lesser among evils* response. The idea here is that any axiology will be faced with this problem, whether it rests on one primary goal or a collection of goals. We *cannot* demand a justification for *every* goal in any axiology. Our quest for a justification of goals has to end at some point, and the best stopping point is with a set of goals all subsumed, related, and justified under one. The second response is related to the first. We can call it the *fundamental premise response*. The idea behind this response is that all parties in the contemporary scientific realism *debate*—at least as that debate occurs with regard to van Fraassen and Laudan—accept the following fundamental premise: science is rational. This claim requires, thus entails, that science is justified in pursuing its (most predominant) aims. In our attempt to characterize the aims of science, we should accept the axiology that is most compatible with the fundamental premise. In other words, according to this second response, the fundamental premise response, we should accept the axiology which, when conjoined to that premise, demands from that premise the least amount of justificatory "work." Spelling out the third possible response will take a bit more care. We can call it *the utility response*.

Nicholas Rescher argues that the pursuit of transcendent goals can be justified by their utility. Citing Kant, Rescher points out that, while we may never be able to recognize the attainment of moral perfection, we are justified in striving for moral perfection if, in our doing so, we elevate our morality (1984, 151, 1992, 93). While a craftsperson may never know when she has perfected her craft, if, in striving for perfection, her technique and product improve, the pursuit of such an ideal is rendered rational (1987, 29). While the goal of perfect health (1987, 29) may be unrecognizable, if, in striving for that state one feels better, is more active, is happier, lives longer, etc., the pursuit of that ideal may be rational. In this way, an ideal, though utopian, can be legitimated: if it is effective in bringing about other accessible and valuable goals, we are rationally justified in pursuing it, even if we can never know when we've attained or approximated it. Thus on this third response, the utility response, to the axiological challenge, a transcendent goal is seen as a methodological device: its pursuit can be justified by showing its efficacy in bringing about another set of desired ends.

So we have identified three possible responses to the axiological challenge, the demand that positive grounds be offered for pursuing transcendent ideals in general. The first

response requires that a set of goals are subsumed under one; the second requires that our axiology be the one that demands the least justificatory 'work'; the third response requires that our primary goal is efficacious toward a set of subsidiary but independently desirable goals. Each of these responses, then, appears to require that the goal we posit as primary is closely related to a set of subsidiary aims. However, given considerations in Sects. 2 and 3, it is at best unclear whether the hypothesis "science seeks truth" will suffice in this regard. More specifically, while there may be other subsidiary goals to which the quest for truth might be related, the prospect for invoking these responses to justify the standard axiological realist hypothesis is at least dimmed given what we've dubbed the first axiological threat: it is not clear how the endeavor flagged above, that of rejecting the competitors whose truth we have no grounds to deny, could be related to, hence subsumed under, the quest for truth.

Here we are prompted to look again to Rescher, who endeavors to employ his utility model of goal justification to address the very challenge with which we are concerned, to provide a positive justification for the pursuit of truth. Although I think Rescher's *utility model of goal justification* (the third potential response to the axiological challenge) holds considerable promise, I will now argue that Rescher's attempt to *employ it* in justifying the pursuit of truth does not succeed.

4.2 Against Rescher's Attempt to Apply the Utility Response

Rescher takes truth, as we are treating it here, to be transcendentally ideal. For Rescher truth is an ideal that is justifiably pursued on the basis of its utility. He claims, "the ultimate truth' about the workings of nature seems to be a *telos* of just this sort" (1987, 32). For Rescher, truth serves as a *precondition for* progress. It is "a useful contrast-case" (1982, 226) "between what we have and what we would ideally like to obtain" (1995, 83). It is something against which we can contrast our current scientific claims. Without "our (regulative) commitment to the view that there is indeed such a thing as the real truth" (1992, 59), we would be unable to recognize that our purported truths do not themselves constitute the truth. For Rescher, then, the conception of truth allows discontent with our present science. And a state of discontent is required for us to retain our epistemic humility. Such humility keeps us from complacency in respect to our science, which would, presumably, prohibit us from taking action, thus from making progress. According to Rescher, because the conception of truth leads us toward progress, our appeal to truth is justified: "The validation of this idealization lies … in its ongoing *utility* as a regulative ideal that affords a contrast to what we do actually attain" (1984, 151). Truth "marks a fundamental contrast that *regulates* how we do and must view our claims to have got at the truth of things" (1982, 225). For Rescher, the sort of *regulation* imposed on us by the concept of ultimate truth is epistemic.

In fact, it is only epistemic, insofar as it is even that. While there are a number of problems with Rescher's attempt to apply his utility criterion as a justification of the pursuit of truth, I will direct four interrelated critical points against it. First, we note, at least for clarification, that the mere conception of truth is not intrinsically such that it suggests that we may not have it: it does not, in itself, reveal itself as a contrast to what we possess. To become contrastive, the conception of truth must be conjoined to further information that we may not have it (for instance, information obtained via the *modus ponens* and *modus tollens* discussed earlier). Second, even ensuring that truth is a contrast conception by conjoining such information, the mere fact that a conception qualifies as a contrast conception does nothing to imply that it is a goal (let alone justify it as such). A

retiree can very well develop a contrast conception of what his or her career could or should have been like. One can attempt to conceive of moral evil in its absolutely epitomized state (for whatever reason, e.g., to make salient that our moral world is not in that state). One can contrast our civilization against a projected dystopia or a civilization of the past. The mere fact that these are contrast conceptions does not render them goals, and justifying their employment as contrast conceptions does not justify their pursuit. Likewise with Rescher's use of the conception of truth. The role of *truth as a concept* has been conflated with that of *truth as a goal;* in short, "goal," "aim," "*telos*," are simply the wrong words for the role in which Rescher has here cast truth.[11] Third, Rescher seeks to justify the pursuit of truth by its utility. However, a goal is arguably useful only to the degree that it is informative with respect to which actions/choices are appropriate. Contrary to Rescher's claims, however, truth as he has employed it does not "guide," (1987, 29, 31) "canalize," or "structure" (1984, 152) our actions or our course of inquiry. It is not informatively regulative. It does not *lead* us in "in constructive and productive *directions*" (1982, 227). Rescher's truth is, at best, a *prompting* for action, but it is not a *guide*; it is not "a compass for orienting our thought and action amid the shoals an snares of a difficult world" (1992, 303). While possibly affording us reason to act, Rescher's truth does not inform us of *how* to act, how to direct our theory choices, etc. A final, related point is that truth, even as a goal, provides no reason to reject the competitors discussed above, which, as I've argued, are such that (without simply assuming that epistemic realism holds) we have no grounds to deny their (approximate) truth. In other words, even if we do posit Rescher's truth as a goal, it does nothing, in itself, to solve the axiological threats 1 and 2; it serves as no guide in light of those threats. He has justified neither the *pursuit* of truth by its utility, nor even the descriptive claim that, "ideal science represents the ultimate objective (goal) of inquiry" (1992, 216). Rescher advocates a (scientific) *realism of intent*, what we are calling axiological realism: he holds that science aims at the truth. However, he has shown, at best, that we need to acknowledge that *there is truth*, not that we can justifiably seek it or even that such a posit can account for what goes on in science. If Rescher is a *scientific* realist (beyond being a "metaphysical realist"), even limiting this to *intent* as he suggests, no such realism has found warrant here.

In addition to mistakenly identifying *truth as a concept* with *truth as a goal*, the primary problem (made salient in my fourth critical point) is that, although Rescher purports to set aside epistemic realism, the axiological hypothesis he embraces is that of the *standard* realist. While I have identified three responses to the demand for justifying the pursuit of a transcendent ideal (or more generally a primary goal), it remains unclear whether that standard axiological realist hypothesis, "science seeks truth," is a candidate for any of the responses. The posit that science seeks truth appears to hold little promise for meeting the axiological challenge, the demand (insofar as we accept it) that the primary aim of science be justified. Moreover, given the competitor thesis, realism remains threatened by, not only an epistemic threat, but the two axiological threats: it looks as though the posit that "science aims at truth" leaves us unable to account for, let alone justify, a crucial component of theory choice in science, namely the practice of rejecting the many competitors

[11] The intuitive appeal of the utility of Rescher's examples of ideals mentioned earlier (e.g. perfected craftsmanship, moral perfection, perfect health) comes from seeing them as goals, rather than mere contrast conceptions. After mentioning perfected craftsmanship as an ideal Rescher writes, "And the situation of inquiry is exactly parallel with what we encounter in other domains—ethics included" (1987, 29). But we now see that, as he actually employs truth, it is not parallel with the *pursuit* of these other ideals.

whose approximate truth we have no grounds to deny; and an inability to say that science is progressive threatens the idea that realists can claim that science is rational.

5 A Refined Axiological Postulate: Science Seeks an Increase in Experientially Concretized Truth

I suggest that what the many concerns articulated above reveal, especially the first axiological threat, is that our standard realist has misconstrued the goal the science. Nonetheless, I propose that the heart of realism, the axiological postulate, does contain the resources for refinement.[12] After articulating a new realist postulate (introduced in my 2001 and 2005, relabeled for clarification here), I will address both the axiological threats and the axiological challenge. Central to that axiological postulate is the specification of a certain subclass of true statements, which, in need of an abbreviation, I will call *XT statements*:

> *XT statements*: those whose truth is experientially concretized—that is, true statements whose truth is made to deductively impact, is deductively pushed to and enters into, documented reports of specific experiences (hereafter, 'DRSEs').[13]

We can understand the notion that a statement's truth can be made to *deductively impact* another statement in terms of *truth preservation*—provided that we supplement the notion of truth preservation with (the above) two restrictions. The first restriction is that the truth of S is deductively *pushed to* a DRSE, where the 'push' is the activity of theorizing, e.g. adding, modifying, or replacing auxiliary hypotheses (or even core theoretical components), so that the truth of S is channeled through an entire deduction to, and so preserved in, the conclusion—where the conclusion matches a DRSE (e.g., via bridges specifying a margin of error, etc.). The second restriction, that the truth of S *deductively enters into* a DRSE, requires that the terms of S be logically connected, by mediating terms, to at least one term in the conclusion, and that the conclusion matches a DRSE (as above). Restricting the familiar notion of truth preservation in these two ways, the truth of S is *made to deductively impact* a DRSE. XT statements, then, are those true statements whose truth is experientially concretized, that is, true statements whose truth is made to deductively impact DRSEs.

Since XT statements are a subclass of true statements, a false statement cannot be an XT statement. Yet XT statements are distinguished from other true statements in that they cannot be *vacuous* or altogether *detached* from a theory complex; nor, crucially, can they be such that their truth fails to deductively reach any DRSEs *due to obstruction by false statements* in the theory complex. Crucially, the experiential concretization of XT statements is non-epistemic: While XT statements are such that their truth is deductively pushed down to and enters into DRSEs, no claim is being made here that the fact of this relation to DRSEs *informs us* of the truth of XT statements. Nonetheless, we can sometimes discern when and roughly where we have a *deficiency* of XT statements. Two forms

[12] In discussing the axiological thesis of scientific realism, Howard Sankey makes progress in this direction by characterizing the realist as claiming that science seeks, not merely truth, but "revealing," "interesting" and "explanatory" truths (2000, 106). While I think this is on the right track, I contend that our attempt to provide a robust account of what goes on in science requires a far greater degree of refinement.

[13] Attempting to articulate the intuition that drives science, as I am, the notion of an XT statement is not meant to be particularly complicated, surprising, or unfamiliar.

evident XT-deficiencies can take are type (a), where it is evident that non-XT statements are present in the complex; and, type (b), where it is evident that we possess DRSEs that have no matching prediction statements. Turning now to my alternative realist postulate, it is that, in the modification of its theory complexes, science endeavors to

1. remedy evident XT-deficiencies by increasing the number—and/or the extent, degree, or exactitude of the experiential concretization—of XT statements;
   - for type (a) evident XT-deficiencies this means: (i) add XT statements that turn obstructed statements into (or clear the particular obstruction from) XT statements and/or (ii) replace false statements with XT statements whose truth deductively impacts at least as many DRSEs as were predicted by the replaced statements;
   - for type (b) evident XT-deficiencies this means: (i) add XT statements, and/or (ii) replace XT statements with other (more universal or more exact) XT statements whose truth deductively impacts a set of those DRSEs;
2. retain or increase the extent and degree of the experiential concretization of each individual XT statement;
3. retain non-vacuous and non-detached statements that are not replaced; and
4. avoid increasing the non-XT (and the non-concretization of XT) statements.

Any occasion of complex modification that exactly meets conditions 1–4, I will call an 'increase in experientially concretized truth' or an 'IncXT'. My postulate is that complex modifications in science constitute the *endeavor* to achieve such a state.

Now the achievement of an IncXT is inextricably related to other subsidiary goals. That this is so for two such subordinate ends, empirical accuracy and breadth of scope, can be indicated here. We can take the degree of a theory complex's empirical accuracy to be a reference to the number, breadth, and precision of prediction statements that match accepted data statements. At the outset, we can recognize that, at least roughly, where predictions and data statements do not match, the truth of a statement leading to those predictions cannot be experientially concretized. We can understand breadth of scope as a reference to the range of phenomena to which available prediction and data statements pertain (but need not match). The achievement of an IncXT via (b(i)) and/or (b(ii)) will increase breadth of scope: the range of DRSEs in regard to which the prediction and data statements pertain will broaden. However, remedying a type (a) evident XT-deficiency with XT statements need not extend the prediction and data statements over a greater range. Nor however will it reduce them to a narrower range. So the breadth of scope will be at least retained, if not increased, when an IncXT is secured.

Elsewhere (2005) I've detailed explicitly that and how the *actual* achievement of an IncXT *requires* the achievement of an increase in, not only empirical accuracy, but also consistency, and an increase in, or at least the retention of, not only breadth of scope, but also testability, and three distinct forms of simplicity. There I've also shown that the quest for an IncXT promotes, though does not entail, the achievement of at least three other desiderata, including a fourth form of simplicity, as well as the derivation and testing of novel predictions and explanatory depth. Given these relations between an IncXT and these identifiable desiderata, I contend that the postulate that science seeks an IncXT uniformly explains the quest in science for these otherwise potentially disparate ends. On these grounds, and insofar as the other ends are sought in science, I suggest that this postulate offers significant empirical promise as a description of the aim of science. In fact, letting go of experientially concretized truth, it is not at all clear how the ten or so desiderata just noted might be related. Moreover, without such a unifying goal, we appear to be left

wondering why we should pursue theories with these properties rather than some other set of properties—e.g., accordance with the I-Ching, being written on white paper, etc. By contrast, our axiological postulate makes salient relationships between a full complex of goals. Each individual virtue noted is related to an IncXT. And those goals as a group are related to an IncXT. In fact, given their mutual relation to this primary goal, each virtue is also related to *each* of the other virtues: empirical accuracy is related to consistency; testability is related to simplicity; explanatory depth is related to breadth of scope, etc. Each goal among our large set of goals is integrated into, and interrelated within, the axiological webbing by a single unifying goal, an IncXT.

6 Addressing the Axiological Threats

With this, let us reconsider the first axiological threat. We have seen that, in the absence of distinguishing data-statements, we cannot deny the approximate truth of the deep-level competitors discussed above, those that render the confirmed empirical consequences of our favored theories mere effects of a postulated condition. However, in the quest for an IncXT, we do have reason for refraining from accepting those competitors, as, in the absence of distinguishing data-statements, their acceptance cannot meet the required conditions of our primary goal. Unpacking an implicit point in our discussion of those competitors, we must admit to the possibility of statements whose truth is not deductively pushed down through any theory complex we may be considering. This possibility is acknowledged in contemporary science itself, from whose standpoint atomistic, non-geocentric, evolutionary, and natural selection hypotheses qualify as contenders for truth. However, when first proposed by Democritus, Pythagorus/Aristarchus, Anaximander, and Empedocles, respectively, these hypotheses were unrelated to—they were not deductively pushed through—any available theory complex. Even if true, the appeal to such hypotheses could not, against their competitors at the time, bring about an increase in *experientially concretized* truth. The quest for an IncXT offers grounds for not accepting such theories prior to their meeting the discernible necessary conditions of our primary goal. Hence, in contrast with standard realist hypothesis, "science seeks truth," by embracing our axiological hypothesis, "science seeks an IncXT," the realist can explain and in fact justify this fundamental feature of theory choice in science, the practice of excluding the kind of deep level competitors identified in Sect. 2.

Regarding the second axiological threat, we've seen that, without relying on epistemic realism (and its required denial of the competitor thesis), the standard realist's axiological hypothesis fails to allow the evaluation of progress as related to the very aim it posits. However, against Laudan, Rescher (1982, 220, 229) points out that the need for discerning progress does not prohibit a transcendent ideal from being employed as *an* aim of science. It only precludes that ideal from being employed *as the specific means by which we measure our progress*. On this view, we need not commit ourselves to the thesis that progress in science is determined by the extent to which its primary goal is achieved (or the degree to which that goal is approximated). (In Sect. 4 I argued that Rescher's standard realist hypothesis ("science seeks truth") fails. However, I contend that this present point of Rescher's, that one could measure progress by subsidiary goals holds, nonetheless.) Drawing on this point, and applying it to the quest for an IncXT: with the subsidiary desiderata, we see not only that we have measures for progress, but that, because those measures and our posited primary goal are directly related, progress can be evaluated in terms to which our primary goal is inextricably connected, and, hence, can be evaluated in

terms that are wholly relevant to that primary goal. If a proposed theory change *fails* to meet the specified necessary conditions for achieving an IncXT—an increase in empirical accuracy and consistency, the retention of, or increase in breadth of scope, simplicity, testability, etc.—we know that the primary goal aspired to in theory change has not been achieved (such a failure being the case in accepting one of the deep-level competitors discussed earlier). That given, we could not be making progress toward our goal. By contrast, when those identifiable necessary conditions are met, we can positively affirm that subordinate ends, ends to which our primary goal is inextricably bound, have been achieved. While progress on this model is measured in terms of the identifiable necessary conditions of our primary goal, particular instances of theory change can be evaluated for progress in terms directly relevant to the quest for that goal, an IncXT. That given, even if the endeavor to achieve an IncXT is epistemically utopian, we are not barred from evaluating progress. It is not the case, then, that we have rendered science non-progressive and, for that reason, irrational.

7 Addressing the Axiological *Challenge*

In Sect. 4.1 I identified three possible responses to the axiological challenge that a *positive rationale* must be provided for the pursuit of the primary goal of science. There I suggested that it is at best unclear how *standard* axiological realism could embrace any of those responses. I will now illustrate how I think my axiological posit can be invoked in each response. The first I dubbed *the lesser among evils* response, the idea being that, in order to avoid an infinite regress, the demand for the justification of goals must end at some point, and the best point to halt that demand is with a set of goals all subsumed, related, and justified under one. While alternative axiologies might simply posit a full collection of distinct goals as unjustified and largely unrelated, the quest for IncXT provides a rationale for seeking the subsidiary-goal-set (noted above), provides a coherent understanding of the relationships between the goals in that set, etc. Insofar as an axiology by its nature must leave at least one goal such that it is not independently justified, the axiology here proposed has the virtue of leaving only a single yet subsuming primary goal, an IncXT.

The second possible response to the axiological challenge was dubbed above the *fundamental premise response*, the idea being that all parties in the relevant *debate* accept as a premise that science is rational. Requiring compatibility with that fundamental premise, we seek an axiology which, when conjoined to that premise, demands from it the least amount of justificatory "work." Given the intimate relation between an IncXT and the many subsidiary goals, our axiological hypothesis provides an explanatory, justificatory, coherent, and unifying account of what would appear to be otherwise disparate aims of science, etc. When conjoined to axiological realism, less "work" is required of the fundamental premise: it need only license justification for one unifying goal rather than independently licensing justification for each member of the full set of what are otherwise potentially disparate goals.

The third response to the demand that a positive rationale be provided for the primary goal of science is Rescher's *utility response*. In Sect. 4.2 I argued that Rescher has not successfully followed through on applying that utility model of goal justification to the aim he posits, truth. Nonetheless, he has offered a framework for justifying a primary goal, even if that goal is epistemically utopian. The pursuit of a goal, even a transcendentally ideal one, can be justified by showing its efficacy in bringing about another set of desired ends. Before showing that this intriguing proposal is suited to the quest to justify the pursuit of an IncXT, the utility model of goal justification calls for greater articulation.

To make clear how an ideal might bring about other ends, we can adopt, for heuristic purposes, a causal model of the relationship between actions and goals. Goals can be said to precede our actions. We might see a goal as something that, by way of our rational deliberation of appropriate measures, can cause an action. And that action will lead to various consequences. Now on the traditional picture, Laudan's picture, the attainment of the goal itself must be one of these consequences. By contrast, on Rescher's utility model of goal justification, we need only demand of a goal that the consequences of its pursuit be valuable. A goal need not be a consequence of the actions it produces—it can be distinct from those consequences. Nonetheless, the goal can be seen as a *cause* of these consequences by way of the action it promotes. If the consequences are desired ends, not only do we attribute utility to the action in bringing those ends about, we may also credit the goal that prompted that action. On this model, if the pursuit of a given ideal brings about desired ends, then that pursuit is justified.

I suggest that this utility model can be fruitfully applied toward a justification of the pursuit of an IncXT. The endeavor to bring about an increase in the experientially concretized truth of our complexes *prompts us* to do what is required to bring about that goal. Specifically, given that an IncXT requires certain subsidiary goals, we are prompted to invoke a meta-methodology, i.e., to test for methods that will be efficacious toward those subsidiary goals. (See Laudan 1987 on meta-methodologies in general.) If our actions or methods do not serve us toward bringing about the required elements of the subsidiary-goal-set, we know they cannot be serving our attempt to bring about an IncXT; and we are prompted by our primary/leading goal, to revise those actions. Upon identifying methods that are efficacious toward achieving the subsidiary-goal-set, the endeavor to achieve an IncXT prompts us to *employ* those methods. Given our possession of a suitable meta-methodology and given the fact that the subsidiary-goal-set is identifiably achievable, pursuing an IncXT guides us toward or is effective in bringing about the subsidiary-goal-set, thus the individual elements included in that set.

Now the utility model above requires our transcendent goal to be effective in bringing about, not merely other ends, but other *valuable* ends. At least some of the elements of the subsidiary-goal-set must then posses *value in themselves*; that is, they must be valuable beyond the value they receive via their inclusion in the set of necessary conditions for an IncXT. I take it as non-contentious that at least two of the elements of the subsidiary-goal-set do possess such value, those I've already flagged above: the achievement of an increase in empirical accuracy constitutes the attainment of predictive success in the range of phenomena to which it applies; and the retention of breadth of scope preserves our ability to make predictions about a broad range of phenomena. (While other elements of the subsidiary-goal-set may also have their own intrinsic value, I will focus on these two.) Empirical accuracy and breadth of scope are therefore desired ends. And since the endeavor to achieve an IncXT requires empirical accuracy and breadth of scope, pursuing the former prompts us toward action, toward employing those methods that serve to bring about empirical accuracy and breadth of scope. The pursuit of an IncXT is in this way efficacious toward the achievement of these desired theory characteristics. Just as we may be justified in pursuing the goal of perfect health—were that pursuit to lead us toward feeling better, living longer, etc.—I am proposing that the endeavor to bring about an IncXT receives justification by its utility toward these subordinate but nonetheless desired virtues. And this justification stands, regardless of whether or not we can discern when an IncXT has been achieved.

One concern, when conjoining this argument to earlier points, is that there may be a certain circularity involved. Above I've implied that

> The pursuit of the subsidiary-goal-set (which includes empirical accuracy and breadth of scope) is justified by the fact that its elements are required for, and/or encouraged by, an IncXT. And (I've postulated that) science seeks an IncXT.

I've now proposed the possibility that

> The pursuit of an IncXT is justified by the fact that it brings about (pushes us toward a methodology that leads to) empirical accuracy and breadth of scope (which are included in the subsidiary-goal-set). And empirical accuracy and breadth of scope are valuable.

Note however that, in the first claim, the justification comes about because the elements of the subsidiary-goal-set (including empirical accuracy and breadth of scope) are *required for*, and/or encouraged by, an IncXT. In the second claim, the justification comes because pursuing an IncXT *brings about* elements of subsidiary-goal-set. Further, in the first claim it is clear that the *elements as a set* receive their justification from the pursuit of an IncXT: in the second claim, it is clear the pursuit of an IncXT receives its justification from only *some* of the elements of the subsidiary-goal-set. If there is a circularity here it is "asymmetrical," to use an awkward metaphor. I'd also suggest it is minimal, if not innocuous. In any case, I will now suggest that a minimal circularity of this sort is an unavoidable consequence for any axiology, given the assumptions that have pushed us toward an attempt to justify the pursuit of an IncXT. (And, in part, because it is an unavoidable consequence for any axiology, coupled with the fact that an axiology is unavoidable in any account of rational action, I have, as above, opted to express it as a challenge rather than a threat to axiological realism).

The demand that we justify the pursuit of our primary goal stems from the claim that the pursuit of all goals must be justified. We can articulate the reasoning that would lead to such a demand.

> An action must be justified (in order to be rational);
> The *pursuit* of a goal is an action;
> Therefore, the pursuit of our goals must be justified.

Now Laudan, and many others insist that, "Good reasons are instrumental reasons; there is no other sort" (1996, 178). So we add the following premise:

> an action must always be justified by way of its goals.

Since the *pursuit* of a goal is an action, the pursuit of our goals must always be justified by the pursuit of some other goal(s). Because we cannot justify an infinite number of goals, we cannot allow an infinite regress of goals. The only other option, it seems, is to rest the justification for some of our goals on goals whose justification ultimately rests—in some way and at some point in the justificatory webbing—on those very goals. The minimal circularity involved in the justification we've run into above, then, appears to be a necessary consequence of conjoining the demand that *all goals be justified* with the instrumentalist principle that *all actions be justified by their goals*. And accepting such minimal circularity licenses the utility response as a means for justifying the pursuit of an IncXT—even if that goal is epistemically utopian. Notably, if one were to challenge whether the minimal circularity, the justificatory interrelations, between IncXT and empirical accuracy and breadth of scope is rational, we could make new appeal to, and conjoin, *the fundamental premise response* here: all in the debate, at least with the likes of

van Fraassen and Laudan, espouse the premise that science is rational in its primary goals; if minimal circularity is required by our principles of rational goal selection, as it appears to be, then such minimal circularity is rational.

If, on the other hand, we insist that such minimal, "asymmetric" circularity cannot be rational, we must (barring an infinite regress of justifications) reject the instrumentalist principle. Were this course preferred, we can then set aside the utility response and invoke for our axiological realism the *lesser among evils response* or the (original version of the) *fundamental premise response* we saw earlier. More broadly, while we'd like to maintain that science is justified in pursuing the full set of its central goals, we appear to be limited to the following options:

1. we accept an infinite regress or
2. we opt for some sort of "asymmetrical" and minimal circularity or
3. we stop at some goal and assert that its pursuit needs no justification or
4. we stop at some goal and deem it justified given that we all grant that the set as a whole is justified.

Since we could never justify (or even specify) an infinite number of goals, option 1 is precluded. It looks as though the scenario we've just depicted, involving *the utility response*, would fit with option 2. The *lesser among evils* response would fit under option 3. And our original *fundamental premise response* would fit under option 4. It appears, then, that we've covered every available base. If we reject all options, then it would seem we've precluded the possibility of providing an account of science (or *any other enterprise*) that renders it rational. That noted, it is important to emphasize a point made at the beginning of Sect. 4, that, since achievement is not sufficient for justifying a goal, the present concern is not one that is limited in any way to *our* realist axiology or even to axiologies that invoke transcendent ideals. Realists and non-realists alike, be they in favor of or against epistemically utopian goals, will have to address this issue and opt for one of the responses. And, given earlier considerations, it looks as though the axiological realism here proposed would provide a particularly robust account, nullifying the two axiological threats and holding significant promise for answering—*insofar as any axiology can*—what I've dubbed the axiological challenge.

8 Conclusion

I began by offering grounds for what I've called the competitor thesis: any theory we may favor has competitors such that we cannot justifiably deny that they are approximately true. I then noted that this thesis threatens both the epistemological and axiological tenets of scientific realism. Putting to question the claim that we can be justified in believing that our successful scientific theories are true, the *modus ponens* underdetermination argument (along with the historical *modus tollens*) articulated above seriously threatens epistemic scientific realism. As I've indicated, I think it remains quite questionable whether epistemic realism as it is commonly construed can be salvaged from such criticism. But in addition to the epistemic threat, I noted two axiological threats to standard realism that arise given the competitor thesis. The first is that the standard realist axiological hypothesis, "science aims at truth," is wholly unable to account for, let alone justify, a crucial and ubiquitous component of theory choice in science, namely the practice of rejecting the many deep level competitors (discussed in Sect. 2) whose approximate truth we have no grounds to deny. The second axiological threat: because, given the competitor thesis, it is

not clear how progress is to be evaluated in light of the standard realist's axiological hypothesis, "science seeks truth," that axiological hypothesis threatens to render science irrational. I've argued however that a refined realist axiological hypothesis, one positing an *increase in experientially concretized truth* as the aim of science, is not faced with either of these threats. Going beyond and adding to these points, I identified three responses to what I've called the *axiological challenge*, the question of how we can *justify* the pursuit of our primary aim. While standard axiological realism appears to lack the resources required to utilize any of the responses, and while Rescher's approach does not live up to the task, I've argued that, by contrast, the realist axiology I've introduced is well suited for each response. Though I find the *utility response* the most interesting, I remain undecided as to just which is best suited to the axiology I've proposed. Nonetheless, I suggest that, since my refined axiological postulate nullifies the axiological threats and offers promise for answering the axiological challenge, that postulate offers considerable improvement over the standard realist axiological hypothesis, "science seeks truth." Elsewhere (2005), I've argued that, because the quest for an IncXT explains and justifies the set of desiderata flagged above (empirical accuracy, breadth of scope, various kinds of simplicity, etc.), this refined realist axiology provides a better account of the scientific enterprise than competing non-realists accounts proposed by Laudan and van Fraassen. Given its virtues, I offer my postulate as one to be empirically tested against the history of science and (setting aside concern with justified belief) as *a candidate for acceptance* as the axiological account of the scientific enterprise. My postulate, in sum, is that science pursues an increase in experientially concretized truth, and that science is justified in doing so (via, for instance, the utility response) irrespective of whether or not we can justifiably believe we've achieved truth, approximate truth, or, for that matter, an increase in experientially concretized truth.

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Appendix

In this appendix, I endeavor to merely hint at how bizarre such competitors can be. Although such competitors are *designed* to strike us—psychologically and by present theory—as not even approximately true, as patently false, and so, *absurd* (by present lights), it is noteworthy that any principles invoked to exclude such competitors in the quest for truth must accord with their own relevant data at least as well as the competitors themselves accord with theirs. Moreover, we can ask just how much more intuitively radical such possibilities are than the sort we find expressed in quantum mechanics and cosmology—with particle/wave duality of "entities," wormholes, Kaluza-Klein theories, branes, holographic universes, and the like. In light of that disclaimer (and taking license for a bit of shameless fun), consider the following set of cosmological competitors to whose development a large and *fictional* group of theorists is strongly dedicated. According to this family of theories subsumed under the general rubric of "cosmological packet theories," the universe is eternal and, while bounded, exponentially greater in size than standard science takes it to be. It consists of an ontologically primary multi-dimensional continuum and innumerably many large-scale (from our vantage point) cosmological packets that travel through it. Packet theorists divide the whole of the continuum into conventionally defined domains. Packets are continuously generated in a random process

(the generation of which is deemed by packet theorists as *analogous to* quantum fluctuations); each packet possesses its own set of properties, entities, and/or causal relations, likewise randomly generated (analogous to the multi-verse hypothesis); and each will travel through a variety of domains until it is annihilated (the "traveling" is deemed analogous to Democritean natural motion, Newton's first law, etc.). In general, a packet will enter a given domain, bringing its properties/entities into realization; and, in general, a variety of different packets will occupy various levels of a domain during any given period.

When a packet first enters a domain and intersects with the set of packets already present in the domain, varying degrees of change in the domain can result. This change is a function of the compatibility between the new packet (and its properties/entities) and the "resident" packet-set (deemed analogous to the response of a biological adaptation to an environment). Upon intersection, many new packets will pass with no effect at all; many others will disintegrate; some will bring utter destruction; and others will introduce dynamic development to the domain. Those packets that are not initially destroyed and which are able to survive as later packets intersect the relevant packet-set will eventually pass beyond the given domain, taking at least their fundamental properties/entities to another domain. Just where one packet is bounded and another begins is indiscernible, as packets have a projection effect that renders whatever lies beyond a packet-set's domain such that it appears to consist of entities that behave in general accord with those produced by the packet-effects as observed from a given domain. While these postulates make up the dominant theoretical framework for packet theories, in which our fictional group of theorists work, a set of particular and otherwise competing packet theories are put forward within that framework.

Although most of the competing packet theories agree that phenomena have been observed to behave (roughly or within the range of experimental error) as standard science describes, they deny that phenomena have behaved as they have for the reasons posited by standard science. Packet theories diverge from one another in their descriptions of the source(s) of the packets, of just how these packets are brought about, and of the kinds of properties that are most conducive to sustainability. They also differ in their descriptions of how the packet-layers are divided, the quantity of packets, how packets relate to and interact with one another, which effects can be attributed to specific packets and which are mere byproducts of, and/or emergent properties attributable to, the intersection of the packets in a set, etc. They disagree further on just when (from our vantage point) various packets entered our own domain, when they will pass, when the next packet will intersect, the level at which that packet will dominate, the kinds of properties, entities, and/or causal relations it will possess, and how new packets will affect the resident packet-set in general. In short, there are multitudes of theory sub-complexes set within the dominant general framework of packet-cosmology.

But for each sub-complex, in the end, it is the presence of the particular packet-set that explains what we observe, and more generally, explains the set of observable properties/entities/relations of our domain; it is the passing of packets in that set that explains why and when we will no longer observe what we have observed. It is the compatibility of a given packet with the packet-set of our domain that addresses the question of why a given packet exists in our domain; and it is the sustainability of the packet-set as a whole that addresses why the particular packet-set in our domain exists. In short, given the random generation of packets and the fiercely competitive nature of packet intersection, the properties/entities that constitute the packet-set in a given domain during a given period are what they are because they allow for the packet-set's general sustainability. (While I

suggest that standard realism fails to ground the rejection of such competitors, the refined realist axiology I propose in Sect. 5 does (thankfully) ground such a rejection.)

Now these packet theories are introduced only to illustrate by a single set of examples the kinds of competitors that would be included in the general kind I've articulated in Sect. 2, those in light of which our favored theory T's empirical claims stand as descriptions of no deep truths of nature but of mere effects, brought about by a particular condition.

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