One version of the pessimistic meta-induction is self-undermining

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1 Introduction

One version of the pessimistic meta-induction (PMI) relies heavily on evidence provided by historians of science. This version of the PMI runs as follows: the historian of science provides a long list of examples of past scientific theories to the philosopher of science (hereafter 'LIST'). LIST solely enumerates a number of scientific theories that are (ontologically, referentially, predictively) incompatible with our best-available scientific theories. Furthermore, these theories were mature and empirically successful. The philosopher concludes the maturity and empirical success of a scientific theory are not indicative of a theory being (probably approximately) true. Therefore, the no-miracles argument (NMA) is refuted.

However, the disciplines of history of science and philosophy of science has a long history of differing theories that were mature and successful, but incompatible with presently-accepted theories. These theories include reports from historians and philosophers over whether certain scientific theories should be included or excluded from LIST. That is to say, there is a long history of incompatible *historical and philosophical theories*. These theories include whether to include or exclude scientific theories on LIST.

For our purposes, we can consider longstanding, intergenerational disagreements amongst historians and philosophers of science over whether particular scientific theories currently on LIST were (a) *genuinely* accepted as probably approximately true (and not merely instrumentally useful), (b) *genuinely* mature, (c) *genuinely* empirically successful, and (d) *genuinely* incompatible with a currently-accepted scientific theory.

Furthermore, these proposals from historians and philosophers of science about inclusion and exclusion from LIST were also, for a time, considered well-entrenched within the communities of historians and philosophers, mature, based

on plausible standards and fully in line with the available historical evidence. However, these past historical theories were eventually abandoned and replaced. Furthermore, these past historical theories are *themselves* incompatible with current consensus in history and philosophy of science.

This reasoning targets a key premise in the PMI: if there exists a long history of mature historical theories about inclusion and exclusion from LIST, we lack grounds to accept the current members of LIST. However, this reasoning relies on a core premise of PMI: a long history of mature and successful theories that are incompatible with presently-accepted mature and successful theories prohibits acceptance of presently-accepted theories on the basis of their present maturity and success. Therefore, the anti-realist that accepts this key premise of the PMI cannot accept LIST, since the veracity of LIST is undermined by accepting the core premise of PMI.

This result is, however, manifestly absurd: the anti-realist *must* accept the testimony of historians and philosophers of science in order to accept LIST. Consequently, there is an instability for the anti-realist: on the one hand, anti-realists that accept the PMI must accept LIST in order for the PMI to be sound; on the other hand, we have a conditional:

> (CONDITIONAL): If there is a long history of mature historical theories that entailed including or excluding scientific theories on LIST and these theories are incompatible with present historical theories that entail including or excluding differing theories on LIST, then philosophers of science that accept the PMI cannot also accept LIST.

I argue the antecedent in the conditional is true: there is a history of mature historical theories that fit the available historical evidence. These theories are incompatible with current mature historical theories that fit the available historical evidence. My focus here will be limited to whether past scientific theories were genuinely mature and successful. Furthermore, the conditional in conjunction with the PMI entails the consequent. Therefore, this version of the PMI is unsound.

Furthermore, assume the consequent is *false*: anti-realists that accept the PMI *should* accept LIST. After all, the anti-realist must accept LIST to infer the conclusion of the PMI. If LIST is accepted, the PMI in its present form relies on fallacious reasoning, for the PMI does not undermine our confidence in LIST.

In sum, if the anti-realist accepts LIST (and subsequently rejects the soundness of PMI) or the accepts the PMI (and subsequently rejects LIST), the anti-realist should not accept this version of the PMI. Thus this version of the PMI is self-undermining.

1.1 The no-miracles argument

There are many different versions of *pessimistic meta-inductive arguments* (PMI). These arguments are often attributed to Larry Laudan (1981). Since Laudan philosophers have developed two distinct *types* of PMI arguments. Some PMI arguments have stronger conclusions than others, targeting a number of key theses accepted by scientific realists; others are more limited, and target a specific argument for scientific realism, known as the *no-miracles argument* (NMA). My focus will be on the version of the PMI argument that targets the NMA.

The NMA usually runs as something approximating the following:

(R1) Presently-accepted (mature) scientific theories are (predictively, experimentally, etc.) successful.

(R2) The best explanation of the success of (mature) scientific theories is that these scientific theories are (approximately) true.

(R3) Therefore, presently-accepted (mature) scientific theories are (probably approximately) true if they are (predictively, experimentally, etc.) successful.

According to the NMA, the (probable approximate) truth of scientific theories is the best explanation for (predictive, experimental) success, or as Putnam put it, this explanation is the only available explanation 'that does not make the success of science a miracle' (Putnam 1975, 73). In what follows, I address a strictly weaker version of the PMI that targets the NMA.

1.2 The pessimistic meta-induction

This PMI takes the form of a following *reductio*. It is partly based on the formulation popularised by Lewis 2001, p. 373, Psillos 1996 and Saatsi 2005.

(P1) (Mature) scientific theories are (predictively) successful.

(P2) If there is a long history of (mature) scientific theories that are each successful but are (ontologically, referentially, predictively) incompatible with present (mature) scientific theories, then scientists cannot reasonably infer (mature) scientific theories are (probably approximately) true based on predictive success alone.

(P3) Many past (mature) scientific theories were for a time successful and are (ontologically, referentially, predictively) incompatible with present (mature) scientific theories. (LIST)

(P4) Scientists cannot reasonably infer (mature) scientific theories are (probably approximately) true based on predictive success alone.

In sum, the anti-realist concludes the following: past scientists accepted a set of scientific theories as being (probably approximately) true rather than being merely instrumentally reliable or merely the best available explanation at the time, and as making certain ontological claims about the underlying structure of the physical world; these theories, terms and predicates were interpreted in ways that modern-day scholars can determine what they were referring to; and more importantly, these theories were genuinely 'mature' and predictively or experimentally 'successful' according to certain reasonably-held standards of maturity and success. *Only* these theories are on LIST, and LIST is available to the anti-realist. The anti-realist accepts LIST, and therefore has reason to accept (P3).

This version of the PMI is designed to be as weak as necessary to defeat the NMA. The anti-realist need not overstate their claim. For example, the conclusion drawn from the PMI is not that we can reasonably infer that (mature) scientific theories are false; rather, the conclusion is directed at the scientific realist that appeals to success as a reason to believe the theory is (probably approximately) true.

One realist tactic has been to show how the apparent historical evidence fails to support (P3): the realist argues the LIST contains rejected scientific theories that were not mature or successful (or, perhaps, were not as mature or successful as presently-accepted scientific theories). The realist's response to the PMI then follows the usual path of determining whether these examples satisfy whatever conditions of maturity and success they adopt as licensing the inference from maturity and success to (probable approximate) truth. This debate has gone on for some decades.

This debate need not go on any longer in order to undermine this version of the PMI: history of history of science, in conjunction with a PMI that targets historical theories about which scientific theories are on LIST, entails the anti-realist cannot accept (P3) without abandoning (P2), and therefore the anti-realist cannot accept the PMI.

1.3 Motivations for accepting PMI

What motivates accepting the PMI? The anti-realist rightly focuses on the disconnect between (at least in retrospect) momentary and fleeting success and (probable approximate) truth. Employing this form of inference from success to probable approximate truth outside the most mundane cases of engagement in everyday circumstances is—at least to the anti-realist-*overly epistemically optimistic*.

This optimism lets in a large number of incompatible beliefs, for many false theories will appear (for a time) both mature and successful. This is not in dispute. Even with restrictions to mature scientific theories and to probable approximate truth, the realist must deal with this uncomfortable fact: 'at least some past theories that pass all realist tests of maturity and success are still considered false' (Psillos 1996, S307).

Implicit in the motivation to adopt the PMI is that the NMA does not or should not cover beliefs that extend beyond the empiricist's 'safe home' of *commonsensical beliefs*. Some commonsensical beliefs, like proverbs and folk remedies, may be in error, or (ontologically, referentially, predictively) contradict our current folk theories. Furthermore, it is possible that perceptual and phenomenological beliefs may also err. However, on the whole, the empiricist's 'safe home', while fallible and subject to revision, does not exhibit (so the anti-realist claims) the same degree of constant ontological, structural and referential revision present in disciplines such as the natural sciences.

So long as there is a long history of incompatible mature and successful theories in some discipline (e.g. LIST) and we attempt to infer from the present maturity and success of best-available theories to their probable approximate truth, we enter dangerous territory: we can no longer make the inference from the maturity and success of best-available theories to their probable approximate truth. Epistemic caution saves the anti-realist from being overly epistemically optimistic, and saves the anti-realist from making a fallacious inference like the NMA.

1.4 The pessimistic meta-induction is self-undermining

In articulating the motivations for adopting the PMI, it's clear these motivations are not restricted to the natural sciences. There exist a number of disciplines beyond wherever the boundaries of the epistemic 'safe home' are drawn that have a history of incompatible mature and successful theories.

If there has been a long history of incompatible theories in any discipline–specifically, a long, disreputable history of apparent success marred by eventual failure–the anti-realist should be equally concerned with inferring from the maturity and success of currently-accepted mature and successful theories in that discipline to probable approximate truth. This is, naturally, only applying the PMI fairly.

The natural sciences are, presumably, one of our best modes of empirical inquiry outside of everyday or commonsensical belief-formation. In fact–and here the underlying problem of the incompatibility of accepting both (P3) and (P2) rears its head–the methods and evidence available in the natural sciences may be far better in its methods and track record than in the discipline of history.

Most versions of the PMI are almost exclusively directed at the natural sciences, rather than other modes of inquiry outside the 'safe haven' of commonsensical beliefs. But other modes of inquiry suffer from a long history of theories on the scrapheap. The motivations for adopting the PMI transfer over to other disciplines of disrepute, such as the discipline of history.

Does the discipline of history suffer from a long history of historical theories that were (for a time) accepted, mature and successful and are incompatible with our best historical theories? The answer is 'Yes.' Thus LIST cannot be accepted by the anti-realist that accepts this version of the PMI.

1.4.1 An overview

In what follows, I demonstrate how the PMI spreads like a highly contagious virus, beginning with highly abstract disciplines such as historiography, down to concrete examples from the discipline of history of science:

In §2 the PMI leads us to conclude based on a long history of incompatible well-entrenched theories in historiography that we lack theoretical grounds to conclude that historical theories are probably approximately true. In §3 I show we have empirical reasons to conclude that there exists a long history of incompatible mature theories in the discipline of history. Thus on both abstract, theoretical grounds and empirically-minded historical grounds, the anti-realist cannot accept the testimony of historians. But this is absurd: the anti-realist must accept its negation in order to accept LIST; therefore the anti-realist must accept either the falsity of (P3) or that (P2) hinges on a fallacious form of reasoning. Either way, the PMI is self-undermining.

In §§4-4.1 I present a fork for the anti-realist that seeks to escape this *reductio*: either the PMI applies only to particular research programmes incompatible with current members of LIST, not the totality of the natural sciences, or the arguments set out for rejecting LIST in §§2-3 are entailed by the PMI.

The second path leads to the PMI being self-undermining; however, the first path leads to neutering the PMI (§3.1). Furthermore, attempts at neutering the PMI to avoid the conclusion that the PMI is self-undermining leads to §§4.2-4.2.2, in which I introduce PMI arguments for the inability to accept LIST as well as the inability to accept present standards of maturity and success. But we have reason to accept LIST and present standards of maturity and success. Therefore the PMI, even in this neutered form, is self-undermining.

§5 addresses any last anti-realist objections, showing that attempts to escape these PMI arguments lead to accepting an *optimistic meta-induction* (OMI) that undercuts the reasoning behind (P2). Therefore, while the PMI appears at first glance to be an unstoppable global contagion that will wipe out all disciplines with a history of incompatible mature theories, it turns out the PMI is less lethal than the

common cold.

2 The theory-based anti-realist

Imagine you are a *theory-based anti-realist*: you have theoretical grounds to accept both the PMI and the testimony of historians. Consequently, you accept LIST. However, the PMI targets domains outside the 'safe home' of commonsensical beliefs with a long history of incompatible theories that were both mature and successful. I now show the disciplines of history and science share a number of plausible similarities that entail the PMI applies to both.

The PMI applies equally to all modes of empirical inquiry that extend beyond the 'safe home' of commonsensical belief so long as these modes of empirical inquiry have such a long history of temporary success and have a history of failure. In this way, the PMI targets all forms of *Wissenschaft* with long histories of failure.

A theory-based anti-realist may object that the discipline of history of science is dissimilar from the natural sciences: to many non-historians the reports of historians are taken as part of an immutable archive or repository of the past. Based on this archive, the historian conveys a narrative, a series of events, and reconstructs the social, economic, religious and material conditions that motivate the actions of historical figures and communities.

However, behind the curtain is a long history of dispute between historians. Many historiographers, for example, conclude that historical scholarship is fundamentally untrustworthy (White 1973; Ankersmit 1994; LaCapra 1985; Kleinberg 2017): these historiographers argue historians fail to provide anything over and above a historical narrative reflecting the beliefs of the author, no different in standing than works of fiction.

Some historians (e.g. Evans 1999), have attempted to respond to these criticism, while other historians (e.g. Jenkins 1991), have incorporated these criticisms and attempted to provide a synthesis between the two positions. Whichever position is adopted, however, there remain a long history of mature and successful theories from historians, but are incompatible with current theories from historians.

The discipline of history may be understood as part of the empirical sciences–as a well-honed form of *Wissenschaft*–that tackles problems so complex they require inter-generational attempts at positing explanations, re-examination of the data, and re-examination of the standards accepted by the community. In sum, the theory-based anti-realist has the same grounds for accepting there is a long history of failure in the discipline of history (that is, rejecting LIST) as they do for accepting there exists a long history of failure in the natural sciences (accepting LIST).

But this result is absurd. The anti-realist has grounds for both accepting and rejecting LIST. Something has gone wrong, and one plausible explanation is that the PMI is simply a form of fallacious reasoning when applied to the discipline of history. Where could the faulty premise lie? It is not (P1), nor is it (P3). The likely culprit is (P2), which carries all the argumentative weight to entail (P4). In order to accept (P3) we must reject the reasoning behind (P2), therefore the PMI is self-undermining.

3 The evidence-based anti-realist

Imagine that you are an *evidence-based anti-realist*: you do not care so much for idle speculation or theory birthed from the armchair. Unlike the theory-based anti-realist, you are a *better* empiricist: talk about demarcation does not interest you, since you can pre-theoretically point to paradigmatic cases of historical theories and scientific theories. The two disciplines are fundamentally separate, and the PMI only targets the natural sciences, for history of science is, so you think, a horse of a different colour. You are not interested in past standards of maturity and success, but what you can see with your own eyes. The available historical evidence and standards for maturity and success indicates some scientific theories belong on LIST and others do not; historians are fundamentally data-driven, and the data is not in dispute.

The evidence-based anti-realist is (in part) correct: we have good reason for accepting that some theories belong on LIST, and our standards of maturity and success are preferable to past standards. That is not in dispute. But what is alleged here is merely the following: there exists a long history of data-driven historical theories that were, for a time, mature and successful; these historical theories are incompatible with currently-accepted historical theories; if the anti-realist accepts the reasoning behind (R2), this reasoning applies equally well to the discipline of history. We are then faced with the following question: are there *evidence-based objections* from historiographers about the reliability of historical scholarship?

There are: for one such example, we can turn to a simple question about the extent of economic growth in England during the industrial revolution in the later eighteenth and early nineteenth centuries. This question should be easily answerable. In the 1950s and 1960s, Phelps-Brown and Hopkins collected data examining the wages of craftsmen during the industrial revolution and collected it in a wage index. However, historians disagreed over interpretations of the data (Hudson 2014, p. 30), which data should be analysed (ibid., p. 31), what could be inferred from the data (ibid., p. 1) and which theories best explained the data (ibid., p. 137).

Based on the data available in the wage index, historians inferred a period of dramatic economic growth (Hudson 2014, p. 37). However, Deane and Cole's work, based on alternate data, lead Hoffman to develop his own index and revise the estimate of economic growth downwards, concluding 'that more rapid growth began as far back as the 1740s and that change was a gradual and cumulative process' (ibid., 38, cf. 25). Harley pushed for an even more radical lowering of the estimate of economic growth, leading to calls to revise the very idea of an 'industrial revolution' (ibid., p. 38). Later historians like Berg and Hudson did not merely question the data collected by Harley but contested the interpretation of the data that looked at national aggregate statistics, rather than regional development (ibid., p. 123).

Within a few short decades, the consensus amongst historians fluctuated between several different interpretations of the historical data, which of the indices should be adopted, and numerous incompatible historical theories. While the underlying ontology and referential structure remained relatively fixed in comparison to theories in the natural sciences, the apparent success of each mature theory was not indicative of probable approximate truth of any one theory.

3.1 A pessimistic meta-induction for the discipline of history

If the discipline of history is on par with the natural sciences, we encounter the following PMI:

(Q1) Our current (mature) historical theories are presently (empirically) successful.

(Q2) If there is a long history of mature historical theories that are each successful but are incompatible with present mature historical theories, then historians of science cannot reasonably infer mature historical theories are probably approximately true based on success alone.

(Q3) Many past (mature) historical theories were for a time successful and are incompatible with present (mature) historical theories.

(Q4) Historians cannot reasonably infer (mature) historical theories are (probably approximately) true based on success alone.

(Q5) One historical theory is that current members of LIST were, for a time, genuinely mature and successful.

(Q6) From (Q1)-(Q5), anti-realists that accept the PMI cannot accept LIST.

If the evidence-based anti-realist is swayed to accept the evidence-based objection, the evidence-based anti-realist accepts (Q1)-(Q4). But historians of science are, by supposition, no different than other historians, and history of science has a similar history of revision and replacement of historical theories. If (Q1)-(Q5) is accepted, then (Q6): the evidence-based anti-realist that accepts this version of the PMI cannot also accept LIST, for the reasoning behind the PMI leads to rejecting LIST. Since acceptance of LIST is required, in conjunction with (P1) and (P2), in order to accept (P4), the evidence-based anti-realist that accepts the evidence-based objection cannot accept LIST.

This result is, again, absurd: the evidence-based anti-realist that accepts the PMI must accept both (Q3) and LIST. The most likely explanation is conditional set out in (Q2) does not entail the consequent: the reasoning behind (Q2) is fallacious. Therefore the evidence-based anti-realist must accept that (P2) is a fallacious form of inference. Therefore the PMI is self-undermining.

4 The hard-nosed anti-realist

Imagine that you are a *hard-nosed anti-realist*: you aren't convinced by the sort of arguments that would convince an evidence-based anti-realist. The theory-based and evidence-based anti-realists have made several fundamental errors: theoretical objections to the discipline of history are wastes of time. Questions about demarcation between history and science bore you. You are not interested in history of economics, geology, radiocarbon dating, astronomy, war, and so on. These historical disciplines may all be open to debate; *you* are interested in *history of science*, and the realist has yet to show that there exists a long history of disagreement amongst historians about whether members of LIST are genuinely mature and successful. Where is the evidence historians of science have a long history of disagreement about which scientific theories belong on LIST?

There are two problems with the hard-nosed realist's response. First, this restriction to historians of science disagreeing about LIST is enough to salvage a modest form of realism even if the PMI were valid. Second, historians of science have historically disagreed over whether past scientific theories on LIST were mature and successful. In the next section, I address this first problem. In later sections, I address the hard-nosed anti-realist's second response.

4.1 A fork for the hard-nosed anti-realist

One objection to this line of reasoning may be that appealing to disciplines other than history of science is the lack of specificity in the framing of the PMI: It is more or less an accident of academic administration that 'history' is applied as an

umbrella term to a number of unrelated problems addressed by 'historians': for example, historians working on translating ancient Babylonian cuneiform tablets often have a different history of success or failure, access to historical data, methodology and standards when compared to historians working on history of early twentieth century theoretical physics in the Austro-Hungarian empire. In sum, it would be improper to make the inference from a history of failures in one part of the discipline of history to another, unrelated part.

An analogy serves to support the anti-realist's response: it would be just as unreasonable to blame the son for the sins of the father or my neighbour for my failure to turn off my lights when I leave for work. Furthermore, it would be especially unreasonable to engage in a fallacy of composition and conclude that because both the son and father belong to the same family, that since the father is blameworthy the son is also blameworthy. Just as we restrict the relevant class to mature scientific theories that were successful in our PMI, we must similarly restrict the relevant class to mature theories in *history of science*, otherwise we engage in a fallacy of composition.

The hard-nosed anti-realist is correct; however, a modest form of realism survives the PMI intact. Here is the rub: the realist adopts the same plausible form of reasoning as the anti-realist, and notices by this form of reasoning, we should not conclude, for example, that (by supposition) because there existed numerous (mature) scientific theories in biology that were predictively successful and were (ontologically, structurally, predictively) incompatible with one another, that we therefore lack the grounds to infer that present (mature) scientific theories in the climate sciences that are (predictively) successful are probably approximately true. The history of the biological sciences may simply be (by supposition) on shakier ground than history of the climate sciences.

In sum, domain-carving into 'science' and 'humanities' is an administrative concern, as is grouping different disciplines together under the heading of 'science'; we should be interested in whether there exists a history of repeated failures of mature and successful theories within a *particular research programme*, not the entirety of what is lumped together as 'science' or 'history'.

The hard-nosed anti-realist points to a key issue with the formulation of the PMI: we do not wish to engage in a fallacy of composition, and blame the son for the sins of the father, or my neighbour for my inability to turn off my lights. Ascriptions of blame to past failures in one research programme do not license ascriptions of blame to other research programmes that lack a history of failure. Consequently, the realist is permitted to believe that whatever research programmes are not not incompatible with members of LIST are probably approximately true based on a NMA.

The hard-nosed anti-realist may object as follows: failures of mature and successful theories in biology indicate that we cannot infer that mature and success-

ful theories in astronomy are probably approximately true. They are both part of the 'sciences', after all. Failures in one domain in the 'sciences' undermine inferring from past successful mature theories in all domains in the 'sciences'. If so, the hard-nosed anti-realist must also accept the evidence-based objection: failures of mature and successful theories in other sub-disciplines of history indicate that mature and successful theories in the discipline of history of science are not (probably approximately) true. Thus the anti-realist should not accept LIST, and if the anti-realist should not accept LIST, the anti-realist cannot conclude this version of the PMI is sound.

Where is the likely failure in the PMI? It is surely not (P1), nor is it (P3). After all, the anti-realist must accept both (P1) and (P3). Therefore, it is likely (P2), the conditional that carries the PMI to its conclusion. Thus (P2) is a fallacious form of reasoning, and the PMI is self-undermining.

In summation, the hard-nosed anti-realist reaches a fork: either the hard-nosed anti-realist concludes the PMI is far weaker than it appears to be, (P2) is a fallacious form of reasoning, and the scientific realist may infer from the NMA that research programmes not on LIST and are not incompatible with members of LIST are probably approximately true; or the hard-nosed anti-realist concludes the PMI is incapable of accepting LIST, and the PMI is self-undermining.

4.2 One problem for the hard-nosed anti-realist

Assume the hard-nosed anti-realist takes the first road in the fork and weakens the PMI. In what follows, I present two evidence-based objection to whether the hard-nosed anti-realist should accept both LIST and the PMI:

The first objection notes there exists a long history of incompatible accounts over whether the historical evidence indicates that member theories of LIST were *genuinely* mature and successful (according to our current standards). The second objection notes that there has been a long history of differing accounts of what standards for maturity and success should be accepted. In both cases, these long histories of incompatible explanations for the historical evidence and the standards for maturity and success lead to accepting a PMI. But this is absurd: philosophers of science have good reason to believe that some past scientific theories were, for a time, genuinely mature and successful; anti-realists have good reasons to accept current standards of maturity and success. Therefore the PMI is a fallacious form of reasoning, and is self-undermining.

4.2.1 Current historians agree: some of these theories were never mature or successful

Consider the question of whether a number of theories on LIST were *genuinely* mature and successful. I argue that there exists historical disagreement over whether these theories were in fact successful and mature. Many different theories were proposed in history of science; some of these theories were well-entrenched within the scientific community. However, since there was historical disagreement, the PMI entails we cannot accept (if it were to exist) current consensus amongst historians over whether these theories were genuinely mature and successful. But this is absurd: the anti-realist must accept that these theories are genuinely mature and successful. Therefore the PMI is self-undermining.

It is illustrative to examine Laudan's theories that he considered 'both successful and (so far as we can judge) non-referential with respect to many of their central explanatory concepts' (Laudan 1981, p. 33):

> – the crystalline spheres of ancient and medieval astronomy;
> – the humoral theory of medicine;
> – the effluvial theory of static electricity;
> – 'catastrophist' geology, with its commitment to a universal (Noachian) deluge;
> – the phlogiston theory of chemistry;
> – the vibratory theory of heat;
> – the vital force theories of physiology;
> – the electromagnetic aether;
> – the optical aether;
> – the theory of circular inertia;
> – theories of spontaneous generation.
>
> This list, which could be extended *ad nauseam*, involves in every case a theory which was once successful and well confirmed.

In each of these cases, while the theories may have (more or less) fit the available empirical evidence for some time, we must ask whether these theories were *genuinely* mature and successful. However, if anti-realists are to take what current historians of science have to say seriously, historians of science object to Laudan's list:

For example, the theory of crystalline spheres–that planets were embedded in impenetrable, three-dimensional objects–may never have been *genuinely* successful, even according to the standards accepted at the time. One obvious example

was the inability of the theory of crystalline spheres to adhere to any of the available astronomical data, thus failing to have been a successful scientific theory:

> …the maximum distance of a lower planet was assumed to be equal to the minimum distance of the next highest planet. Unacceptable gaps occurred, however …[by] measuring solar and lunar parallax, …the space so obtained failed to correspond exactly to the spheres nestled therein.' (Westman 2011, 58, cf. 291).

Historians and philosophers of science have presented a number of compelling arguments for why the other theories on Laudan's list should be removed from LIST. This is the usual realist 'historical gambit' that has been played for the past few decades: the humoral theory of medicine and effluvial theory of static electricity do not appear to have ever been mature (Psillos 1999, p. 108); 'catastrophist' geology under 'a universal (Noachian) deluge' was generated 'retroductively' to fit the available evidence and was never successful by the time it was abandoned (Baker 1998); the vibratory theory of heat; the vital force theories of physiology; the theory of circular inertia (Worrall 1994, p. 335); theories of spontaneous generation. A literature review on the realist's 'historical gambit' can be extended *ad nauseam* Park 2011. The only remaining theories on LIST post-Laudan are phlogiston, caloric and optical aether, although even then there remains debate over caloric theory (cf. Chang 2003; Psillos 1994).

The anti-realist may object to the realist's 'historical gambit' as follows: *other* theories may belong on LIST, like Rankine's vortex theory (Hutchison 2002), Kirchoff's theory of diffraction (Saatsi and Vickers 2011), Kekulé's theory of the Benzene molecule (Lyons 2002), Dirac's relativistic wave equation (ibid.), pre-inflationary big bang theory (ibid.) and Bohr's and Sommerfeld's models of the atom (Vickers 2012). All are plausible candidate theories. Perhaps other theories may be included, such as theories by Copernicus, Galileo, Kepler and Newton.

While the realist's 'historical gambit' is not particularly effective in undermining inductive versions of the PMI, the 'historical gambit' serves a different role: the history of revision to members of LIST indicates there exists a long history of differing historical theories amongst historians and philosophers of science over the most elementary issues that must be answered in order to correctly determine whether these theories belong on LIST.

As an illustration of the difficulties faced by historians of science, there has been a historical disagreement between historians over, for example, related astronomical theories about the solar system were primarily adopted for theological, astronomical, astrological, instrumentally pragmatic, or personal reasons (Westman 2011); if the experiments and observations were accurate (Graney and Grayson 2011); if the available forms of technology were reliable or unreliable (and

to what extent) (van Helden 1985); what these astronomical theories entailed (Westman 2011); if a 'Copernican revolution' occurred (cf. Kuhn 1957; Grant 1984); and if there were any clear crucial experiments in astronomy until long into the nineteenth century (Gingerich 2011, p. 136).

While a well-informed philosopher of science may look at the available evidence and arguments and come to a well-reasoned and justifiable position, the anti-realist cannot, for there exists a history of incompatible well-entrenched and mature theories: if anti-realists are to take what current historians of science have to say seriously, there has been a long history of differing theories presented by historians of science over whether these scientific theories were genuinely mature and successful. A PMI is once more introduced, which leads the anti-realist to undermining the testimony of historians of science. But this is absurd: the anti-realist must accept the testimony of historians in order to accept LIST. Therefore the PMI is self-undermining.

4.2.2 A long history of disagreement amongst philosophers of science

Which standards of maturity and success should be adopted? Notice that members of list are theories that were accepted according to the standards of long-ago scientific communities. But these theories fall short of our current standards. Many of the theories Laudan considers to be mature and successful lack basic quantitative data to support them.

In history of science there existed differing standards of maturity and success. These standards were, at the time, considered mature and successful. However, these past standards are incompatible with our current standards of maturity and success. Since these standards are incompatible with our current standards, a PMI applies. If we accept the reasoning behind (P2), we conclude that our current standards are not accepted on principled grounds, even though they are well-entrenched and presumably accepted on reasonably-held grounds. After all, past standards were *also* well-entrenched and accepted on reasonably-held grounds at the time. Therefore, we lack the grounds to infer that these standards of maturity and success are not the best available standards for inclusion or exclusion of theories from and on LIST.

For example, the question of whether the theory of crystalline spheres was 'successful' remains open. Irrespective of the available evidence, were a paper advocating a theory of crystalline spheres published today, it would be considered a disreputable theory long before any testing had been done. According to our current standards it could never have been a mature and successful theory, for the theory of crystalline spheres posited that certain spheres had certain qualities that influenced astrological signs:

> …the Earth was the locus where the primary physical qualities–heat, cold, moisture, and dryness–where in a constant state of mingling and recombination. Saturn, the planetary sphere most distant from the Earth, was cold and dry …it was associated with the least mixing of qualities. At the other end of the heavens, the Moon was closest to the sphere of mixing …Jupiter …was hot and moist, but Brudzewo differentiated its moisture from that of the Earth by calling it a spiritual quality, the "carrier of life virtue." Jupiter's sphere could not initiate the mixing of matter, but it could influence matter that was already moved and mixed …(Westman 2011, p. 54)

Today, these claims belong more in a book on astrology, divination or New Age spirituality than in a reputable scientific journal (cf. ibid., p. 200. The theory of the crystalline spheres may have been (by supposition) 'successful' *according to the standards of sixteenth century prognostic practitioners* (ibid., p. 144)–up to refusing to accept an apparent falsification of the perfection of the crystalline spheres after the collective observation of the 1572 supernova (ibid., p. 225)–but not according to any standards that developed in the following centuries.

If one were living in Classical Antiquity, your standards of maturity and success will differ from the standards in Medieval islamic and European work in natural science; these standards of maturity and success differ from Renaissance natural philosophers; these standards differ from early twentieth century physicists, which differ from the standards of twenty-first century physics. Notice that over time the standards become *more* strict, *more* rigorous, *more* exact, more quantitative and less qualitative. This concern alone should cast doubt on whether the standards used in determining members of LIST should be accepted[1].

The PMI arrives once more: since there have been well-entrenched standards for maturity and success in the past that are incompatible with our currently well-entrenched standards for maturity and success, we cannot infer that currently well-entrenched standards should be accepted based on their maturity and success.

However, this conclusion is absurd: we may have good reason to accept our current standards of maturity and success even if there is a long history of revision and replacement of these standards. These standards are simply *better* than past standards. They are closer to what standards of maturity and success *should be*. They may not be perfect, but scientists and philosophers of science should accept them over their now-defunct rivals. But in order to accept current standards of maturity and success, we must conclude the PMI is a fallacious form of reasoning.

[1]Note: this argument coincidentally bears some similarities to an argument applying P. Kyle Stanford's 'problem of unconceived alternatives' to history of philosophy (Mizrahi 2016)

Where could the mistake be in the PMI? It is not likely (P1), nor is it (P3), which must be accepted for the anti-realist that accepts the PMI in order to conclude that we lack the grounds to infer that currently mature and successful *scientific* theories are probably approximately true. Therefore, it is likely that (P2) is fallacious. But if (P2) is fallacious, the PMI is itself a fallacious form of reasoning, and the hard-nosed anti-realist should not accept the PMI, for the PMI is self-undermining.

5 The intransigent anti-realist replies

The *intransigent anti-realist* may retort that this evidence-based objection is not enough. Arguments that attempt to apply the PMI to the discipline of history of science are merely sophistry. Some members from LIST may no longer be accepted, but it does not lead to concluding that all current members of LIST are in disrepute. What would be some the plausible reasons provided by the intransigent anti-realist were they to defend this decision? Perhaps the intransigent anti-realist responds with a number of reasons:

(a) historians of science today are often believed to be usually better at doing historical scholarship than past historians, therefore current members of LIST can be accepted.

(b) the explanations from present historians of science are often usually better explanations than past historians, therefore current members of LIST can be accepted.

(c) modern historians of science have access to better evidence than past historians, and their theories incorporate more historical data than past historical theories, therefore current members of LIST can be accepted.

After all, if the intransigent anti-realist were to deny (a)-(c), they have good reason to reject current members of LIST: this version of the PMI leads us to conclude that we lack the requisite grounds to infer that simply because a number of members of the LIST were once accepted by historians of science that they will continue to be accepted by historians of science in the future.

This reply from the intransigent anti-realist sets a trap. Any stated reason for accepting (a)-(c) can be provided in support of realist objections to the PMI.

Consider a variation of (c): the intransigent anti-realist believes our current LIST should be accepted because current members of the LIST are based on (mature) historical theories that are more successful, better supported and more stable than past historical theories. This recent shift in the quality of historical scholarship and historiography makes success fundamentally different today than in the

past. On these grounds, we accept the current members of LIST. Thus, present historical scholarship lets us infer that there did in fact exist a number of scientific theories that were genuinely mature and were genuinely successful, and are in fact incompatible with our present (mature) scientific theories that are successful. (P3) is accepted and the PMI runs as usual, at the expense of weakening (Q2).

We could think that the hard-nosed anti-realist has discovered an important insight: it is not controversial to accept the current members of LIST. After all, history of science is a relatively new discipline. Historical scholarship has simply reached this level of analysis that permits making correct determinations that some past scientific theories were genuinely mature and successful. Our current theories about LIST are more mature and successful than past theories.

However, this response from the hard-nosed anti-realist destroys the grounds for accepting the conditional in (P2). A structurally similar argument with perhaps even greater empirical evidence for a dissimilarity between past and present success can be drawn in the natural sciences, thereby leading to an optimistic meta-induction (OMI): 'our current best theories enjoy far higher degrees of success than any of the refuted theories in the past, which enjoyed only fairly low degrees of success' (Farbach 2011b, p. 1285).

As Farbach claims, we may assume the examples provided by Laudan may show a long history of incompatible scientific theories that were *modestly* successful, but our current theories have a very high degree of success (Farbach 2011a). What is good for the goose is good for the gander: by accepting this form of reasoning to salvage acceptance of other members of LIST, the intransigent anti-realist opens the door for the realist to accept a scientific OMI. This version of the PMI has been superseded by the OMI, for the OMI undermines (P2), and on grounds that are eminently plausible to the intransigent anti-realist: there exists a salient difference between presently-accepted and past scientific theories, *viz.* their differing degrees of maturity and success. Thus the intransigent anti-realist must begrudgingly accept the OMI.

6 Conclusion

I have argued that when (P2) is applied to disciplines other than natural science lead to rejecting the grounds for accepting that the current members of LIST are genuinely mature and successful. But that is absurd: we have grounds for accepting the current members of LIST are genuinely mature and successful.

The discipline of history of science must be relied on by the anti-realist for the anti-realist to accept that current members of LIST are genuinely mature and successful, according to our standards of maturity and success. Anti-realists should accept the reports of historians of science over which scientific theories were genu-

inely mature and successful according to our best-available standards, but the anti-realist is incapable of accepting the testimony of historians of science. The long history of differing candidates for LIST–that is, past disagreement amongst historians of science over whether these theories were genuinely mature and successful, according to our accepted standards–entails the PMI undermines accepting the testimony of historians. Consequently, the PMI entails the anti-realist cannot rely on the testimony of historians of science.

But that result is absurd: the anti-realist can rely on the testimony of historians of science. In fact, reliance on this testimony is necessary to accept (P3). But this means accepting that the PMI does not apply to history of science, a discipline that is on equal or weaker ground than the natural sciences. Since (Q1) and (Q3) are uncontroversial, the problem must rest with (Q2): the bridge preventing inferring from past success to probable approximate truth. Therefore, (P2) relies on a form of fallacious reasoning.

Furthermore, the discipline of philosophy of science must be relied on by anti-realists to provide reasonable standards of maturity and success. Since the acceptance of LIST is required to accept (P3) and (P1) is not disputed by anti-realists, the conditional in (P2) is a fallacious form of reasoning when applied to the discipline of history of science. But if (P2) is a fallacious form of reasoning, then the PMI is not an acceptable form of inference. Therefore the PMI is self-undermining. Anti-realists should retire this version of the PMI. If they wish to remain anti-realists and presently rely on this version of the PMI, they should turn to different arguments.

In fact, the anti-realist must treat the testimony and arguments from these communities as trustworthy in order to accept that current members of LIST are genuinely mature and successful. Nevertheless, the PMI forbids accepting these testimonies and arguments, no matter how compelling they may seem, for there exists a long history mature and successful theories in these disciplines, and these theories are also incompatible with currently-accepted theories.

Other objections have not been set out in detail here, such as the current disagreement over whether particular members of LIST are in actuality incompatible with presently-accepted theories, or whether particular members of LIST were genuinely believed by past scientists on the purported grounds of maturity and success, and not based on sociological, political or personal grounds. However, these objections run much the same as in every previous case: there exists or existed a long history of incompatible theories that were mature and successful, therefore by the PMI, we cannot infer that current consensus amongst experts (if it exists) about a mature theory should be accepted. But this is absurd: we can, and we should (if consensus exist). In fact, the anti-realist *must* accept the consensus of experts in order to accept LIST. Therefore, the PMI is self-undermining.

Since the acceptance of LIST is required to accept (P3) and (P1) is not disputed

by anti-realists, the conditional in (P2) is a fallacious form of reasoning when applied to the discipline of historiography, the discipline of history, and the disciplines of history of science and philosophy of science. But all these disciplines are on equal or weaker epistemic footing than the natural sciences, for they each have a long history of mature theories incompatible with presently-accepted theories. Therefore, if (P2) is a fallacious form of reasoning in these disciplines, then the PMI is not an acceptable form of inference. Therefore this version of the PMI is self-undermining.

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