**Reading**: “Empirical Equivalence and Underdetermination”

**Authors**: Larry Laudan & Jarrett Leplin

**Presenting**: Elmo

**Big Picture:**

They are attacking:

1. For any theory, there is an empirically equivalent rival theory
2. This means that all scientific theories are underdetermined
3. This results in skepticism about scientific knowledge and possibly knowledge in general.

Against this, the authors argue that:

1. “empirical equivalence itself is a problematic notion without safe application” (450)
2. “the empirical equivalence of a group of rival theories, should it obtain, would not by itself establish that they are underdetermined by the evidence” (450)
3. The belief that empirical equivalence leads to underdetermination has had pernicious effects not just in philosophy of science but also lead to general skepticism / relativism in epistemology

**Key Points:**

* Empirical equivalence is problematic:
	+ in practice, observational consequences of theories are derived using auxiliary assumptions. Because these auxiliary assumptions can change over time, empirical equivalence is unstable.
	+ What exactly does ‘problematic’ mean?
		- They don’t claim “that there are no cases of empirical equivalence, but that the claim that there are is defeasible” (459)
		- “deny the omnibus a priori claim that every theory has empirically equivalent rivals” (459)
* Underdetermination does not follow:
	+ There can be empirical support for a theory that is not a logical consequence of the theory.
	+ There can be empirical data that matches the observational consequences of a theory without providing epistemic support for it.

**Detailed Outline:**

1. The Problem:

link “between empirical equivalence and epistemic skepticism” (450)

“The idea that theories can be empirically equivalent, that in fact there are indefinitely many equivalent

alternatives to any theory, has wreaked havoc throughout twentieth century philosophy. It motivates many forms or relativism, both ontological and epistemological, by supplying apparently irremediable

pluralisms of belief and practice.” (450)

Lots of things are blamed on this:

* “contemporary versions of empiricism, including those of Quine, Bas van Fraassen, and J. D. Sneed, which belie the promise of science to deliver theoretical knowledge.”
* “conventionalism in geometry through Hans Reichenbach's invocation of universal forces”
* “questions the possibility of ordinary knowledge of other minds through the contrivance

of the inverted spectrum.”

* “blocks inductive generalization through the stratagem of fashioning artificial universals to vie with natural kinds, as in Nelson Goodman's "grue" paradox, reducing the status of apparent laws to mere entrenchment” (450).

Goes back to “classical skepticism” in Hume, Descartes, and Berkeley.

“no experience epistemically grounds a belief if that experience is strictly compatible with an alternative

belief” (451)

B. The Argument against EE

“On the traditional view, theories are empirically equivalent just in case they have the same class of empirical, viz., observational, consequences”, which are the subset “of its logical consequences formulable in an observation language” (451).

Three ‘familiar theses’:

1. The range of observable phenomena is “relative to the state of scientific knowledge and the technological resources available for observation and detection.” (VRO) (451)
2. In order to derive “observable consequences” from “theoretical hypotheses” we need “auxiliary information” (NAP) (452)
3. This “auxiliary information” is “defeasible” and “augmentable”, i.e. it changes over time (452).

“any finding of empirical equivalence is both contextual and defeasible.” (454)

“It has been widely supposed that one can, utilizing the resources of logic and semantics alone, ‘read off’ the observable consequences of a theory” (454).

“the availability of auxiliaries-auxiliaries crucial for determining what a theory's empirical consequences are-is neither a matter of logic nor semantics; it is inescapably epistemic.” (454).

“How well supported an auxiliary is by evidence available now may depend on findings made later” (455) 🡪??

“C. Responses to anticipated objections” (455)

*Objection A:*

Worry: given any scientific theory, a rival theory can be constructed from it that is different but matches the same set of empirical data.

* The Löwenheim-Skolem Theorem could be used to construct rival theories

Response:

* A physical theory includes “a semantic interpretation of its formal structure” (456)
* “But what its referents are if it has them is fixed by the theory itself” (456)
* “The reference-fixing devices of physical theory are rich and various” (456)
* “If, given the Lowenheim-Skolem Theorem, formal statements in first-order logic are referentially indeterminate, then a physical theory is not simply a set of formal statements in first-order logic.” (456)

🡪 seems to point towards a different account of physical theories I am not familiar with?

*Objection B:*

* Imagine the Newtonian theory (TN) with the center of mass of the universe constant, or moving at a steady velocity.
* Can we distinguish between these two options empirically?

Answer:

* If two theories are empirically equivalent for mechanics, they are also ee for any extension of mechanics in which the new (non-mechanical) phenomena depend on the old ones (as “basons” depend on absolute velocity).

Subtle/weird clarification:

“We may have good or sufficient reason to regard theories as empirically equivalent, but there is no guarantee. That concession is all our argument requires. We do not deny the possibility that the world is such that equally viable, incompatible theories of it are possible. We do not deny the possibility of the world's being unamenable to epistemic investigation and adjudication, beyond a certain level. But whether or not the world is like that is itself an empirical question open to investigation.” (459)

Seems to mean:

* Empirically equivalent theories about the world may be possible or not.
* The theory that posits EE (TEE) and the theory that posits not EE (NEE) are not empirically equivalent. (this seems to be required, otherwise how could we investigate which one is true?)

 🡪 kicking the can to the meta-level?

Historical point:

* Most alleged examples of EE hinge on the relativity of motion (Newton v Copernicus, Einstein v Lorentz)
* Relativity of motion can either be an empirical finding or “guaranteed conceptually” (459)
* They don’t claim “that there are no cases of empirical equivalence, but that the claim that there are is defeasible” (459)
* “deny the omnibus a priori claim that every theory has empirically equivalent rivals” (459)

Question: What exactly does “defeasibility” mean and what does it do for us?

Section II: Underdetermination

Various conclusions have been drawn from the spectre of EE:

* Empiricist: no amount of evidence can “single out” (460) a theory for acceptance, because a rival EE theory might be possible.
* Instrumentalist: possibility of EE theories is bad news for “deep structure theorizing” (460) and scientific realism.
* Pragmatist: since it is not determined epistemically which theory we should subscribe to, we can “pick and choose freely” (460).

🡪 underdetermination (UD) is the epistemic counterpart to the semantic problem of EE.

Claim: UD does not “in general obtain” “even under conditions of” EE (460).

Supposition: “if theories possess the same empirical consequences, then they will inevitably be equally well (or ill) supported by those instances” (460)

 🡪 authors contest this!

“the relative degree of evidential support for theories is not fixed by their empirical equivalence.” (460)

How this works:

1. “significant evidential support may be provided a theory by results that are not empirical consequences of the theory” (460)
2. “(even) true empirical consequences need lend no evidential support to a theory” (460)

“an empirical consequence of a hypothesis is neither necessary nor sufficient for being evidentially relevant to a hypothesis” (460-461) 🡪 “theories identical as to empirical consequences may be differentially supported, such that one is epistemically preferable to the other” (461)

A) *Support without consequence*

“instances of a generalization may evidentially support one another, although they are not consequences of one another” (461).

“Previous sightings of black crows support the hypothesis that the next crow to be sighted will be black, although that hypothesis implies nothing about other crows.” (461)

🡪 is this actually correct? Do the sightings directly support each other, or do they support the generalization, which in turn generates the prediction?

Even that would be a problem for UD, because “allowing a statement to accrue indirect empirical support in this fashion already undermines the claim that statements are confirmable only by their empirical consequences. This result alone suffices to establish that the class of empirical consequences of a statement and the class of its prospective confirming instances are distinct.” (461)

Better example: plate tectonics, with two hypotheses:

H1: the climate in any given region has changed over the course of earth’s history

H2: the magnetic orientation of rocks containing iron has changed over the course of earth’s history

Evidence for H2 is claimed to support H1.

Brownian motion supported atomic theory even though it’s not a consequence of atomic theory (and many other examples).

And now, “the connection that we claim our examples to establish between nonconsequential evidence and differential support of empirically equivalent theories” (464):

1. “Theoretical hypotheses H1 and H2 are empirically equivalent but conceptually distinct.
2. H1, but not H2, is derivable from a more general theory T, which also entails another hypothesis H.
3. An empirical consequence e of H is obtained.
4. e supports H and thereby T.
5. Thus, e provides indirect evidential warrant for H1, of which it is not a consequence, without affecting the credentials of H2” (464).

Question: why do we care about support for individual statements now, rather than support for theories? If we had a theory T2 that entails H2 and H3, where H3 is EE to H, wouldn’t we just have UD again?

Could someone say “T is underdetermined by e, so we shouldn’t take H being supported by e to be sufficient for believing T nor for passing on the warrant to H1?” Steps 4 and 5 seem plausible if you think e is sufficient reason for us to believe T, but if you think T might be UD by e, wouldn’t you just reject the 4+5 combination?

Other examples of “nonconsequential empirical support in science” (464) include analogies, e.g. “Maxwell analogized a closed system of elastic particles to a contained gas” (464).

Against Popper: Evidence for a hypothesis does not have to come from its “empirical consequence class” (465).

Against Quine: EE does not guarantee that there is “epistemic parity” between two theories (465).

B) *“Empirical consequences that are not evidential”* (465)

Inverse of A): Just like there are instances of empirical support that are not consequences of a theory, there are also observations that support consequences of a theory without thereby supporting the theory itself:

“a person hypothesizes that coffee is effective as a remedy for the common cold, having been convinced by finding that colds dissipate after several days of drinking coffee.” (466)

🡪 “Being an empirical consequence of a theory is neither necessary nor sufficient to qualify a statement as providing evidential support for the theory.” (466)

Section III: Why did this ruin epistemology?

People misunderstand the relationship between semantics and epistemology which results in them “bringing the largely technical and formal machinery of semantics improperly to bear on epistemic issues.” (466)

“It is commonly supposed either that truth and meaning conditions just *are* justification conditions, or, at least, that they can be made to double as justification conditions.” (467)

The problem goes back to “Descartes's image of a mathematically rigorous, deductive structure for knowledge” (467).

The modern relative of this is the use of semantic notions to demarcate science, such as “verifiability” and “falsifiability” (467). These semantic means alone are not suitable for the epistemic task “of judging the reasonableness of belief” (467).

Logical positivists wanted to separate “cognitive significance from emotive uses of language”, but the problem is that epistemic claims share the “evaluative force of, e.g., ethical pronouncements” (468).

In the 40s and 50s, accounts of scientific explanation gained currency which all but ignored “epistemic and pragmatic dimensions of confirmation and explanation, in favor of their syntax, logical structure, and semantics” (468).

This only seemed plausible because of “linguistic view of conceptual analysis”, where to understand how a concept is used is to analyze the truth conditions of sentences in which it is (468).

🡪 truth condition of knowledge emphasized over its justification condition (469)

“the assimilation of support to consequences exceeded the confines of logical empiricism to capture the format of textbook characterizations of scientific method itself.” (469).

🡪 consequentialism: “hypotheses are to be tested exclusively by an exploration of the truth status of those empirically decidable statements which they entail.” (470)

“This ubiquitous assimilation of a theory's test cases to its logical consequences in an observation language, as we have argued above, wrongly ignores some of the more salient ways of testing theories.” (471)

Then something bad happened to “saving the phenomena”:

“For a Newton, a Ptolemy, or a Mach, ‘saving the phenomena’ meant being able to explain all the salient facts in the relevant domain” (471) (and not just those phenomena it happens to make statements about)

“With the rise of neopositivism, the epistemic responsibilities of theories were radically reinterpreted. Theories became liable only for what they entailed” (471-472).

“Where empirical adequacy formerly meant the ability to explain and predict all the salient phenomena, it now requires only possession of none but true empirical consequences.” (472)

Questions:

1. On paper: do we think the proponents of underdetermination would be convinced by this? And were they, historically?
2. Is there a tension between treating theories as sets of logical sentences when we want to investigate their empirical claims, but insisting that physical theories are importantly more than that when we talk about reference?
3. What Laudan and Leplin are arguing against is a specific logical argument from EE to UD. Assuming that they succeed in showing that this argument isn’t sound, does that mean that UD is not a severe problem? (i.e., are they correctly characterizing the sources of the problem as a logical argument, rather than a historical observation, as in Stanford?)
4. Do all the ‘bad relativisms’ described in the beginning really rely on the EE 🡪 UD relationship, considered as a logical argument?

Gems / Lumps of Coal:

#1: This is difficult writing. Many of these sentences make it actively harder for me to understand what is going on. They say very little with way too many words, and too many of the words are nouns.

#2: The link between epistemology and philosophy of science. I don’t quite get what’s going on there in general but I think it’s important, and problematic. What does this link look like when we consider the historical development of the two philosophical subfields? And if there is a link between skepticism in epistemology and anti-realism in philsci, is there a corresponding link between Realism and realism in philsci?

#3: What exactly is the status of the project in which we reconstruct scientific theories as sets of logical sentences? (🡪 in Imitation of Rigor Wilson seems to tell a story of how this started during debates about the nature of force in Newtonian physics amongst e.g. Hertz and Mach) Do we still think that scientific theories are or should be set of logical sentences from which we can derive other statements?