Evidential Equivalence

It has been argued that a theory can be supported by evidence that does not form part of its observational consequences. One alleged source of extra-observational evidence is the so-called 'theoretical virtues' of unity, simplicity, explanatory power, and comprehensiveness. Mainstream scientific realists view these as the only way to overcome anti-realist claims that observational evidence underdetermines theory choice. Anti-realists reply that these are merely conventional and/or pragmatic features of theory choice. There is thus a standoff over the epistemic significance of theoretical virtues.

Suppose the realist is right, i.e. theoretical virtues are evidentially relevant. Is the issue of underdetermination settled? The answer is 'No'. Even if two empirically equivalent theories are evidentially inequivalent, there may still be theories that are evidentially equivalent (i.e. are confirmed equally by all available evidence) to each! What needs to be established is whether or not there are evidentially equivalent rivals for any theory, i.e. whether the following sentence is true:

(EVE) $\forall T \exists T' [(T' \vdash \neg T) \ \& \ T'$ is evidentially equivalent to T].

If EVE is false, there are at least some theories that the evidence can uniquely identify. If, however, EVE is true, then underdetermination remains rife, albeit in a restricted form that, for example, no longer supports constructive empiricism. The difference consists in the extent to which underdetermination can be mollified.

Realism does not need to defeat underdetermination altogether to be able to defeat constructive empiricism. To achieve the latter, it suffices to provide non-observational constraints to underdetermination. To achieve the former, the following sentence must be shown to be true:

(EVE2) $\neg \exists T \exists T' [(T' \vdash \neg T) \ \& \ T'$ is evidentially equivalent to T].

That is, if we want to defeat underdetermination entirely, we need to show that *no* theory has evidentially equivalent rivals, i.e. all theories are uniquely identified by some set of (observational and non-observational) evidence.

EVE2 seems too strong a claim, since it requires all theories to lack evidentially equivalent rivals. Realists, it might be argued, can achieve their aim of vanquishing underdetermination with the weaker claim that all *true* theories lack evidentially equivalent rivals. That is, they can achieve their aim if they can show the following sentence to be true:

(EVE3) $\neg \exists T \exists T' [(T' \vdash \neg T) \ \& \ T'$ is evidentially equivalent to T], where *T* is any true theory.[1]

[1] In a sense, EVE3 says something trivial. If *T* is true, then surely *T'* must be false since it contradicts *T*. Why then do we *need* to show that EVE3 is true? Presumably because it is *possible* for two or more theories to be evidentially equivalent and true with respect to all possible observations, yet still have inconsistent theoretical components.

Suppose EVE3 is true. What follows? Once scientific inquiry arrives at a true theory, this theory will have no evidentially equivalent rivals. Since EVE3 refers only to true theories, theories that do not possess this trait may well have evidentially equivalent rivals. To the extent that all of our current theories are at best approximately true, i.e. not true simpliciter, establishing EVE3 is of no immediate help. A realist must also require that approximately true theories lack evidentially equivalent rivals:

(EVE4) $\neg\ \exists T\ \exists T'\ [(T' \vdash \neg T)\ \&\ T'$ is evidentially equivalent to T], where *T* is any approximately true theory.

Theory choice may well remain ominously indeterminate, even after a potential defeat of the constructive empiricist brand of underdetermination.