Empirical Equivalence & Underdetermination

Larry Laudan & Jarrett Leplin (1991)

Sameera Singh

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Outline

I. Defining Empirical Equivalence
II. An argument against Empirical Equivalence
III. An argument against Underdetermination
IV. Empirical Equivalence & The Pragmatist Turn?

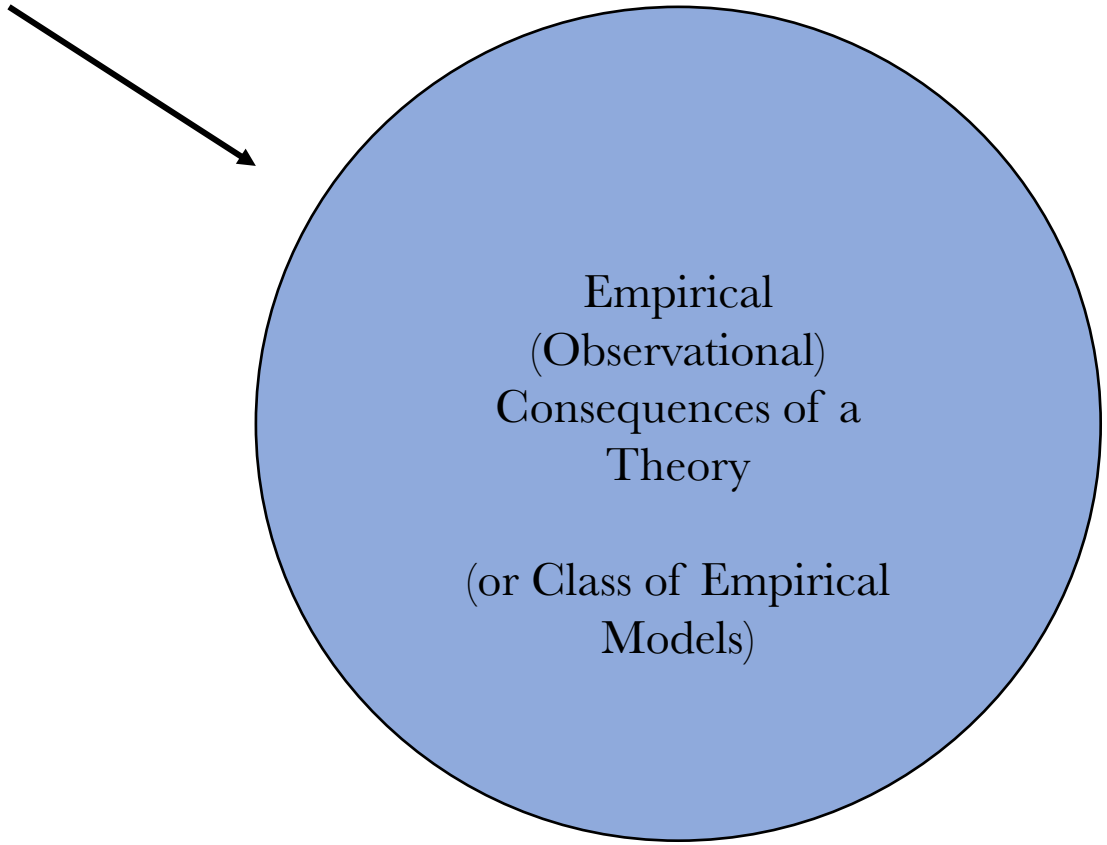
I. Defining Empirical Equivalence

Definitions

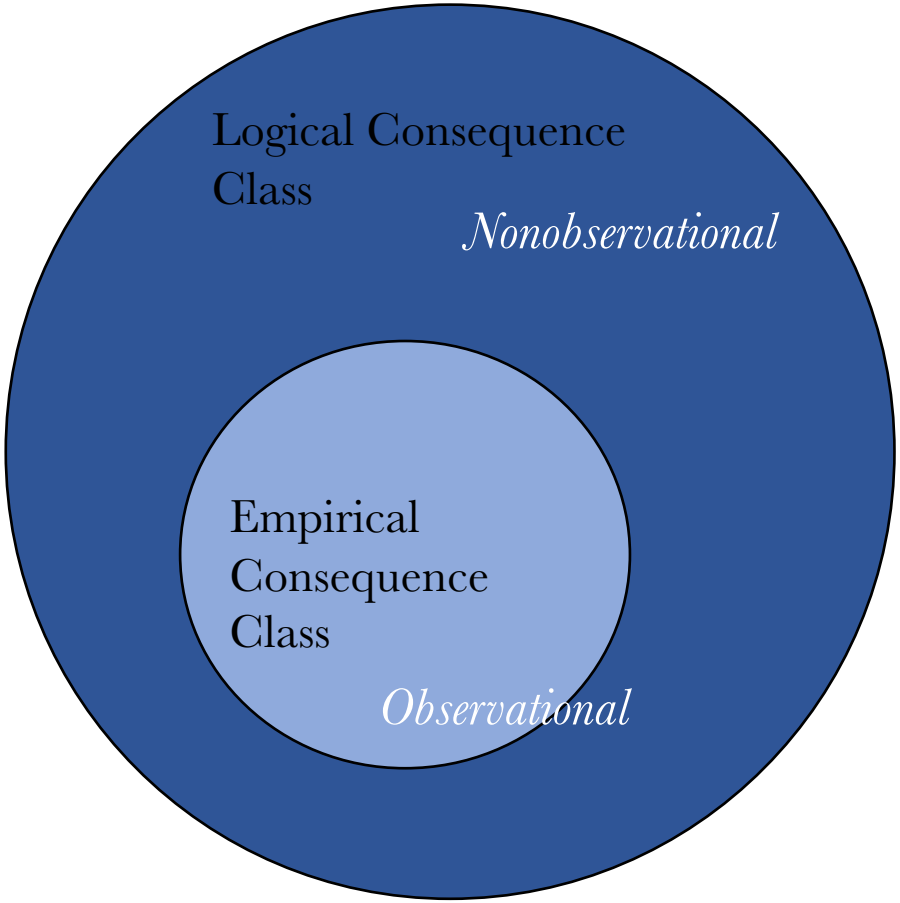
- **Empirical Equivalence**: Theories are empirically equivalent just in case they have the same class of empirical, viz., observational consequences.
- **Empirical Consequences of a Theory**: Empirical consequences of a theory are subsets of its *logical consequences* formulable in an *observation language*.
- **Logical Consequences of a Theory**: Logical consequences preserve truth in virtue of form.
- **Observational Properties**: Properties of an (observational) language which can be observed (and thus confirmed/denied through empirical data).

Empirical Equivalence

Theory 1 (A1) = Theory 2 (A2)



Consequence Class of a Theory



Example: The Theory of Continental Drift

Theory: Every region of the earth's surface has occupied both latitudes and longitudes significantly different from those that it now occupies.

Logical Consequence: Take a part of the earth P1. P1 is at latitude and longitude L1 and L2. P1 used to occupy some other latitude and longitude Lx and Ly.

Empirical Consequence: The alignment of iron-bearing rock to Earth's magnetic pole from today's time (T2) differs significantly to the alignment of rocks (to the pole) from an earlier time (T1).

...or presumably something stricter than that like "I found palm trees in Greenland".

II. Argument against Empirical Equivalence

Overarching Thesis

- Reject the assumption of empirical equivalence (EE) and inference from it to underdetermination (UDD)
  - No guarantee of genuine rivals to a given theory.
  - EE itself is a problematic notion without a safe application.
- Argument casts doubts on empirical equivalence as a *relation among scientific theories* (and between *any rival perspectives*).

i. Variability of the Range of the Observable (VRO)

Any circumscription of the range of observable phenomena is relative to the state of scientific knowledge and the technological resources available for observation and detection.

ii. Need for Auxiliaries in Prediction (NAP)

Theoretical hypotheses typically require supplementation by auxiliary or collateral information for the derivation of observable consequences.

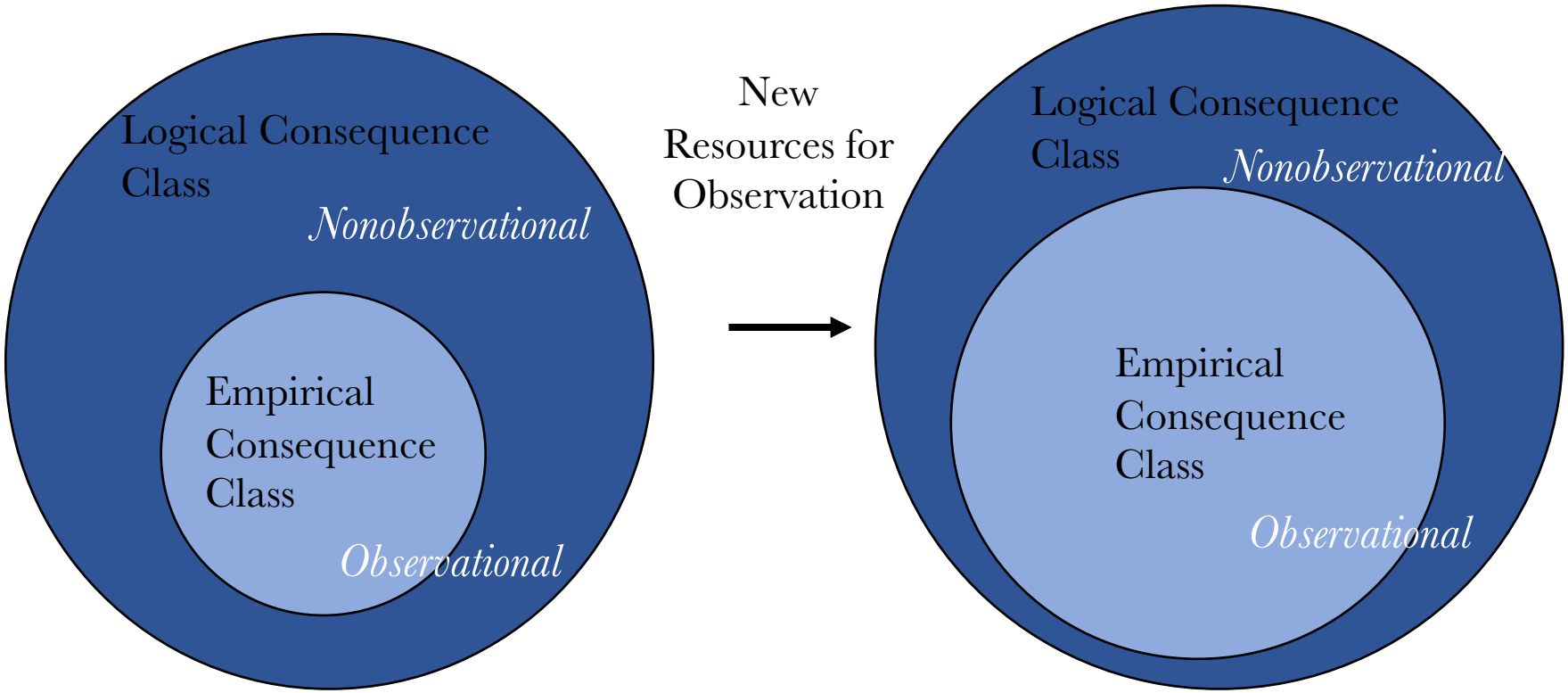
iii. Instability of Auxiliary Assumptions (IAA)

Auxiliary information providing premises for the derivation of observational consequences from a theory is unstable in two respects: it is defeasible and it is augmentable.

Argument against Empirical Equivalence

1. Inconstancy of the boundary of the observable (by VRO).

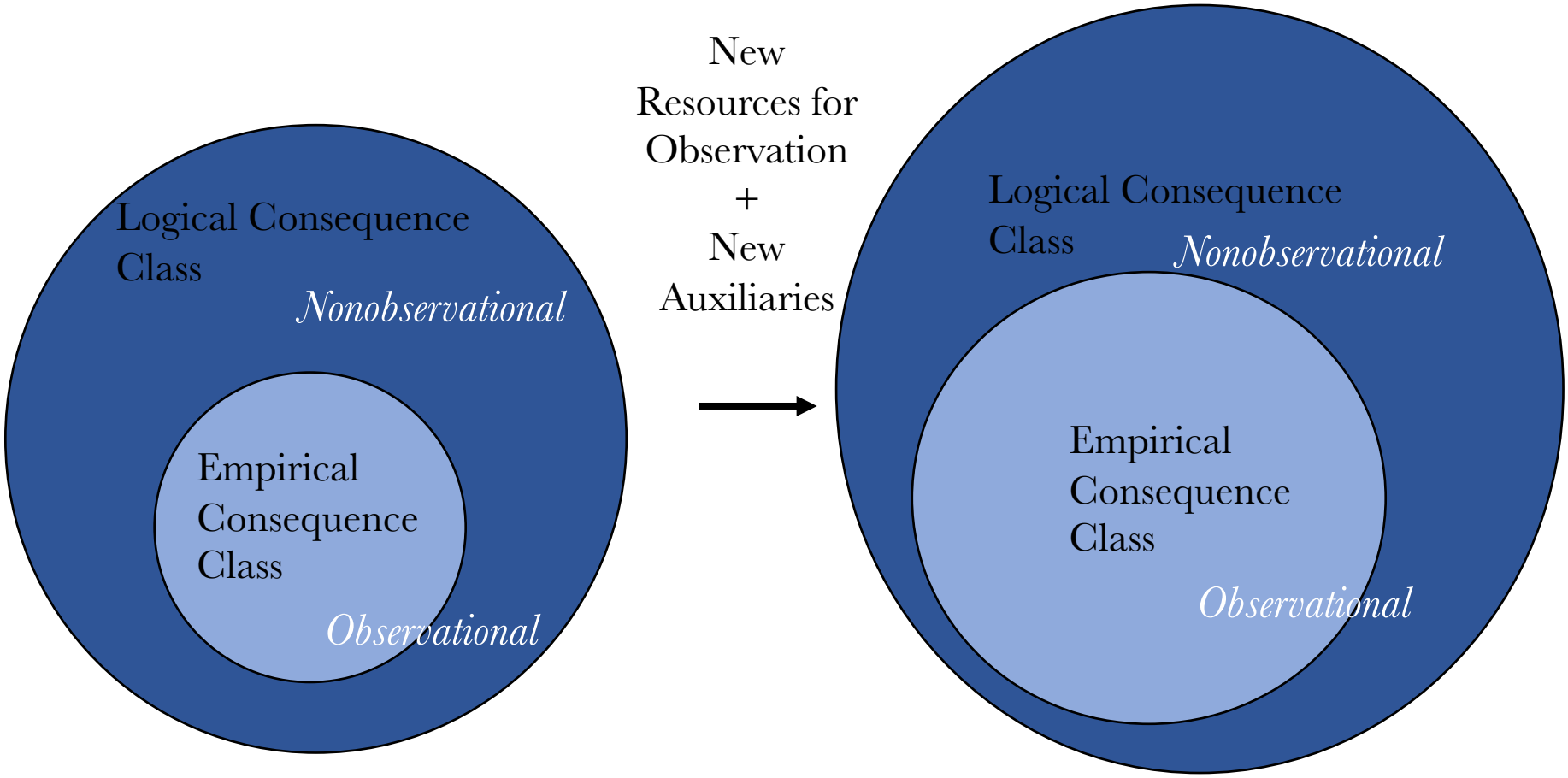
Inconstancy of the boundary of the observable



Argument against Empirical Equivalence

1. Inconstancy of the boundary of the observable (by VRO).
2. Inability to circumscribe the range of auxiliary information available for use (by NAP).
   - *A.* *Narrow* class of a theory's empirical consequences: observational statements implied by theory in isolation from other theories and hypotheses.
   - *B.* *Broad* class of a theory's empirical consequences: observational statements implied by theory only if they are cojoined with other auxiliaries.
3. A theory's empirical consequence class may increase through augmentation to the theory's total consequence class (by IAA), if we take a broad class version of a theory's consequences.

Augmentation of a theory's total consequence class through auxiliaries



From a *logico-semantic* to an *epistemic* view

- *Logico-semantic view*: The determination that a given empirical statement, *e*, is an empirical consequence of a particular theory, A, depends on whether *e* is a subset of the logical consequences of a theory A formed in an observational language. (Focus on theory's content)

- *Epistemic view*: The determination that a given empirical statement, *e*, is an empirical consequence of a particular theory, A, depends on whether there are epistemically well-grounded collateral hypotheses that establish a suitable inferential link between A and *e*. (Focus on auxiliary hypotheses).

Conclusion: EE is wrong

- There are no genuine rivals to a given theory because the class of empirical consequences of a theory may change as scientific knowledge and technology develops, making more room for the observable in ratio to the unobservable, and new auxiliaries may augment total consequence class of theories.
- The notion of EE in terms of the logico-semantic view of empirical consequences is problematic and an epistemic view in line with actual scientific practice should be adopted.

Possible objections

1. We do not need to establish empirical consequence classes in order to establish theory equivalence.
    - Logically or conceptually equivalent theories must have the same consequence class.

2. The Lowenheim-Skolem theorem shows that you can have multiple models of a theory.

- Having multiple models does not show that you can have multiple theories of common empirical content
- A physical theory, by virtue of being a physical theory, includes a semantic interpretation of its formal structure, its not simply a formal structure variously interpretable.
- Referents of a physical theory are fixed by the theory itself, its not a matter of optional interpretation.

3. A theory has instrumentalized versions, which are its empirical equivalents.

- A theory's instrumentalized version is not its empirical equivalent, they are simply its logical consequences.

Essentially, the claim isn't that there aren't empirically equivalent theories, but that they are defeasible!

III. An argument against Underdetermination

Underdetermination

UDD: The ability to supply an empirically equivalent rival to any theory is sufficient to undermine our confidence in that theory and to reduce our preference for it over another theory. In other words, theory choice is radically underdetermined by any conceivable evidence.

EE is chiefly seen as a thesis about the *semantics* of theories, UDD is a thesis about *epistemology* of theories. UDD is the epistemic implication of EE.

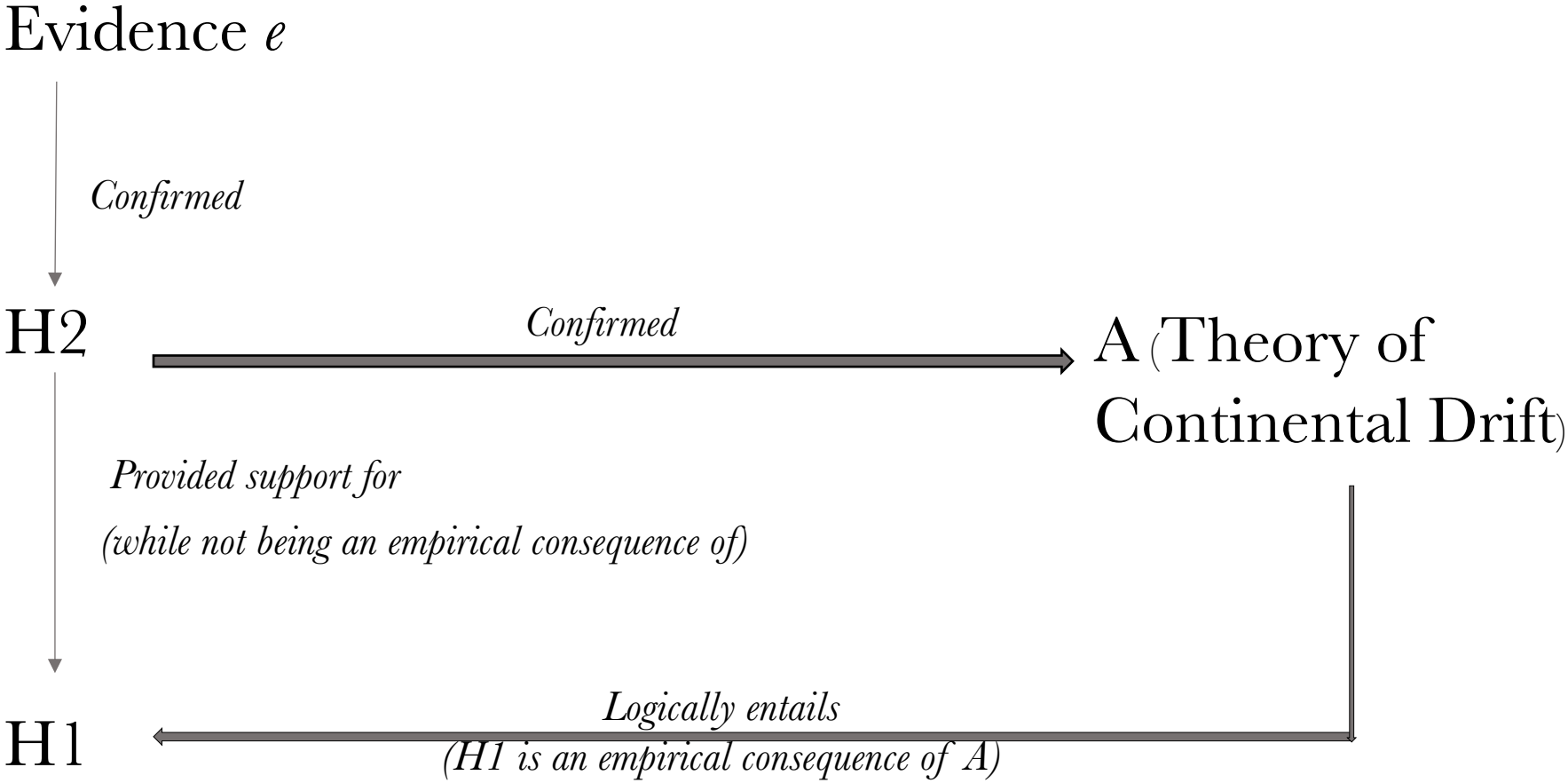
Argument against UDD

- Assumption: If theories possess the same empirical consequences, they possess the same epistemic warrant.
- However, relative degree of evidential support for theories is not fixed by their empirical equivalence, and in turn, their empirical consequences.
  - Evidential support may be provided for a theory by results which are not empirical consequences of a theory.
  - Even true empirical consequences need lend no evidential support for a theory.

Evidential results that are not consequences

- Why is evidential support only limited to logical consequences of a theory?
- Theory A: Every region of the earth's surface has occupied both latitudes and longitudes significantly different from those that it now occupies.
  - H1: There has been significant climactic variation throughout the Earth, the current climate of all regions differing from their climates in former times.
  - H2: The current alignment with the Earth's magnetic pole of the magnetism of iron-bearing rock in any given region of the Earth differs significantly from the alignment of the region's magnetic rocks from earlier period.

Evidential results that are not consequences

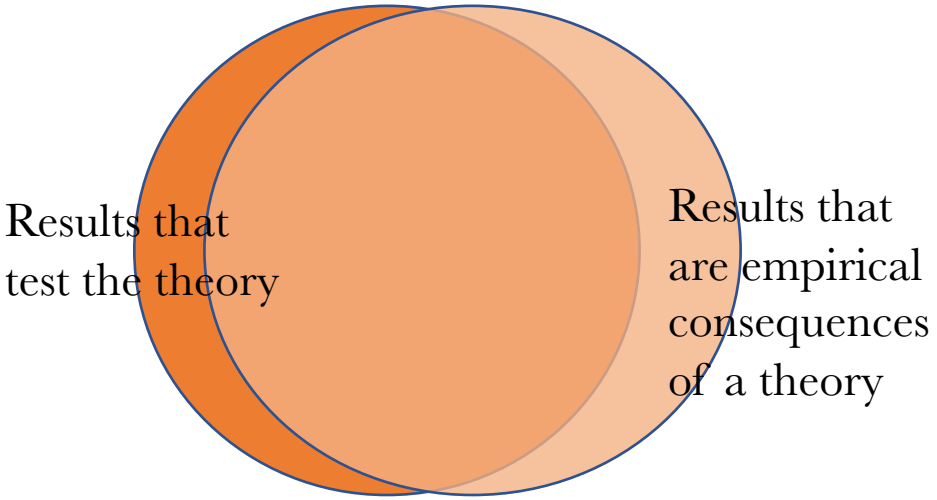


Empirical results that are not evidential

- Theory B: Regular reading of scripture induces puberty in young males.
  - H: Such readings are efficacious
    - Evidence *e*: 1000 males from the age of 7 were forced to read the scripture for 9 years. Medical exam after 9 years established that all subjects reached puberty by age 16.
- We do not grant evidential status to a result *e* with respect to a hypothesis H just because *e* is a consequence of H.

Conclusion: EE does not imply UDD

- Even if EE were to obtain, it would not by itself establish UDD. One of several empirically equivalent theories may be uniquely preferable.



- Being an empirical consequence of a theory is neither necessary nor sufficient to qualify a statement as providing evidential support for a theory.

I. Empirical Equivalence & the Pragmatist Turn?

Empirical Equivalence & the Pragmatist Turn?

- Gripe with positivism
  - Verifiability (Carnap/Logical Positivism)
  - Falsifiability (Popper)
- Gripe with pragmatism
  - Constructive Empiricism (Van Frassen)
  - Naturalized epistemology (Quine)
  - Conventionalism (Reichenbach)
  - Instrumentalism
  - Relativism

Summary

- There are no genuine rivals to a given theory because the class of empirical consequences of a theory may change over time.
- The notion of EE in terms of the logico-semantic view of empirical consequences is problematic and an epistemic view in line with actual scientific practice should be adopted.
- Even if we accept EE, that does not imply UDD. Even if theories have the same epistemic consequences, they do not have the same epistemic warrant. This is because even true empirical consequences need lend no evidential support for a theory, and evidential results may not be consequences of a theory.
- Theories equivalent in their empirical consequences may be differentially supported, such that one is epistemically preferable to another.

Questions

- Tension between there being not being empirically equivalent theories, and there being empirically equivalent theories but them being defeasible.
- The claim that the semantic approach to EE has led to various forms of pragmatism which ignores that in actual scientific practice, there aren't actually equal rivals to a theory (although, pragmatism is a claim about language, not equivalence per se).
- Would increasing the total consequence class of a theory (through technological developments and auxiliaries) be a bad thing? Is it making the theory too complicated?
- Does specifying EE in terms of empirical consequences and empirical models make a difference? Are empirical models epistemic in nature, thus complementing L:audan & Leplin's empirical view of the theory-evidence relation?

Gems and Coals

- Gems 
  - Clear writing
  - Good organization of contents
  - Relevance of scientific practice to philosophy of science
  - Rejection of purely formal a priori thesis of scientific theories

- Coals 
  - Some terms are left unspecified (eg., "logical consequence of a theory"/"logical consequence class of a theory", "theory")
  - Too many (sometimes inconsistent) claims!

End.