Lange 7
The Problem of Provisos

(pp. 162–168)

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Many laws are false as usually formulated

Example: Law of thermal expansion (p. 162)

A usual formulation of the law:

> *Whenever the temperature of a metal bar of length L_0 changes by ΔT, the bar's length changes by $k\, L_0\, \Delta T$, where k is a constant characteristic of that metal.*

This may be violated if, e.g.:

- The bar is being hammered inward on one end.
- The bar is encased on four sides by a rigid material that fails to yield as the bar is heated.
- The bar melts.

Example: Snell's law of refraction (p. 162)

A usual formulation of the law:

> *When a beam of light passes from one medium to another,* $\sin i / \sin r$ *is a constant, where* i *is the angle of incidence,* r *is the angle of refraction, and the constant is characteristic of the two media.*

This may be violated if, e.g.:

- The temperature or pressure is outside a certain range.
- There is an electric or magnetic potential difference across the boundary between the media.
- One or both media has non-uniform optical density.
- The second medium is double refracting (e.g., calcite).
- The beam isn't monochromatic.

Provisos: The problem

- If the law of thermal expansion, Snell's law, etc., really are laws, and if laws are true, then these laws must contain some (usually unstated) restriction to exclude situations in which they are false.
- Such an restriction is called a *proviso*.
- Problem: What exactly does the proviso say?

Answer 1: Proviso lists all excluded factors

Examples

- *Whenever the temperature of a metal bar of length* L_0 *changes by* ΔT*, the bar's length changes by* $k\, L_0\, \Delta T$*, where* k *is a constant characteristic of that metal, provided the bar isn't being hammered inward on one end, and doesn't melt, and . . .*
- *When a beam of light passes from one medium to another,* $\sin i / \sin r$ *is a constant, where* i *is the angle of incidence,* r *is the angle of refraction, and the constant is characteristic of the two media, provided there is no electric or magnetic potential difference across the boundary between the media, and the second medium isn't double refracting, and . . .*

Criticism of answer 1

Suppose the law has the form: *All F are G provided . . .*

- To make this law true, ". . ." must exclude every factor that could cause an F not to be G.
- *The trouble now is that, surely, we can know the law of, say, thermal expansion without having already identified each of the other factors besides temperature that can affect a metal bar's length.* (p. 163)
- Proof: When scientists discover a law, they don't in general know all these factors.
  - *For instance, the law of thermal expansion was discovered long before the relativistic effects of velocity on length were known.* (p. 164)
  - Galileo discovered a law of freely falling bodies, but he did not know all the factors that interfere with the rate of fall of a body, e.g., electromagnetic forces.

Answer 2: Proviso says no other factors at work

Carl Hempel . . . says that a given theory covers a particular kind of influence, and a proviso is a kind of completeness assumption: that in the given case, only the influence covered by the theory is present. (p. 165)

Example (p. 166)

Whenever the temperature of a metal bar of length L_0 changes by ΔT, the bar's length changes by $k\, L_0\, \Delta T$, where k is a constant characteristic of that metal, provided temperature change is the only factor at work.

Lange's criticism of answer 2

1. To make a prediction using the law, we need to know that no factor other than the one the law deals with is operating to influence the result.
2. To know this we must know all the other factors that can influence the result.
3. The law does not tell us what these factors are and we usually don't know them all.
4. Hence, "we cannot generate any testable predictions from the" law. (p. 167)

I say:

- If the argument was sound, scientists couldn't make predictions using these laws; but they do.
- Premise (2) is false; scientists can know by experience that the law works in this sort of context, without knowing all the factors that might influence the result.

My criticisms of answer 2

1. Many laws are not about any "kind of influence," they just describe what happens. E.g.:
   - Bodies freely falling from rest cover a distance proportional to the square of the time taken. (Galileo)
   - When a beam of light passes from one medium to another, $\sin i / \sin r$ is a constant, where i is the angle of incidence, r is the angle of refraction, and the constant is characteristic of the two media. (Snell)

   Answer 2 doesn't apply to laws like this.
2. The law of thermal expansion, with the suggested proviso, is false; the bar can still melt when temperature change is the only factor at work.

Answer 3: Real laws don't use provisos

We may be tempted to reject the problem of provisos by insisting that genuine law-statements simply lack provisos. On this view, the fact that many familiar "law-statements" are actually not law-statements at all only goes to show that we have discovered very few genuine laws. (p. 168)

Some things that would count as laws on this view (p. 162)

- Maxwell's equations of electromagnetism.
- "All material bodies, accelerated from rest, travel slower than the speed of light."

[Actually, Maxwell's equations "break down at scales at which quantum mechanical effects become important" (Woodward p. 271), so even they wouldn't count.]

Criticism of answer 3 (p. 168)

- Scientists call many proviso-laden claims "laws."
- Scientists use proviso-laden claims in connection with explanation and counterfactuals in the manner characteristic of laws.
- An account of the nature of laws needs to fit with scientific practice; otherwise we are not talking about the same thing.
- Therefore, denying that proviso-laden claims can be laws isn't an option.

Review

- If what are usually called "laws" really are laws, and laws are true, then many laws must contain implicit provisos in order to rule out cases where the "law" is false.
- If laws do contain provisos, it is not obvious what they say.
  - Provisos can't list all the factors that need to be excluded to make the law true, because scientists discover and know laws before they know all these factors.
  - Provisos can't say that no factor other than the one mentioned in law is at work, because (a) many laws do not say what factor is at work, and (b) even when they do, this does not avoid all counterexamples.
- If we say that the only genuine laws are the ones that don't need provisos to be true, we would not be talking about what scientists mean when they talk about laws.
- The problem of provisos is to find an adequate solution to these difficulties.
- Next time: Lange's solution.

Questions

1. Why has it been thought that many scientific laws must contain a (usually unstated) proviso?
2. What is wrong with saying that laws contain a proviso that lists all the factors that need to be excluded in order for the law to be true? Illustrate your answer with at least one example.
3. What is wrong with saying that laws contain a proviso that says the only factor at work is the one whose influence is covered by the law? Illustrate your answer with at least one example.
4. What is wrong with saying that real laws don't need provisos to be true? Illustrate your answer with at least one example.