HOW PROBABILISTIC CAUSATION CAN ACCOUNT FOR THE USE OF MECHANISTIC EVIDENCE.

Erik Weber

Centre for Logic and Philosophy of Science
Ghent University (UGent)
Blandijnberg 2
B-9000 Gent
Belgium
Erik.Weber@UGent.be

Introduction

- 'Interpreting Causality in the Health Sciences' (*International Studies in the Philosophy of Science* **21** (2007), pp. 157-170): analysis of causality in terms of probabilistic relationships does not do justice to the use of mechanistic evidence to support causal claims.

- Section 2: common ground.

- Section 3: Ronald Giere's theory of probabilistic causation.

- Section 4 and 5: Giere's theory can account for the use of mechanistic evidence (both in the health sciences and elsewhere).

- [Section 6: Suppes, Eells and Humphreys]

Evidential pluralism and output monism

Evidential pluralism:
“Evidence is constituted by two complementary elements: probabilities and mechanisms.” (p. 159)
“To establish causal claims, scientists need the mutual support of mechanisms and dependencies.” (p. 159)

Output monism:
“On the contrary, we will argue, only a single notion of cause is used in the health sciences. More specifically, health scientists use two types of evidence *for a single causal claim*, ‘*C* causes *E*’, not for two different types of causal claim, *C*-causes$_1$-*E* and *C*-causes$_2$-*E*. Because only *one* notion of cause is used in the health sciences, pluralism is false. (p. 165)”

Giere's theory of probabilistic causation (1)

- Definitions:

C is a *positive causal factor* for E in the population U whenever $\mathbf{P}_X(E)$ *is greater than* $\mathbf{P}_K(E)$.
C is a *negative causal factor* for E in the population U whenever $\mathbf{P}_X(E)$ *is less than* $\mathbf{P}_K(E)$.
C is *causally irrelevant* for **E** in the population U whenever $\mathbf{P}_X(E)$ *is equal to* $\mathbf{P}_K(E)$.

- "Average effect" theory (as opposed to context unanimity theory).

Giere's theory of probabilistic causation (2)

- Defines causation in terms of what would happen in two *hypothetical* populations.

(1) Epistemological consequence of this: analogy with the use of observation instruments.

(2) We have primary data for which we show, by means of a theoretical argument, that they constitute good evidence for our claim. Furthermore, there is no way to bypass this procedure: the species is too small, so it is unobservable without the aid of instruments.

(3) All the evidence we obtain (whether it is of a probabilistic nature or of a different type) comes from the *real* world. As a consequence, we need an explicit argument to show the relevance of any kind of evidence for the *hypothetical* worlds which figure in Giere's definitions.

Giere's theory of probabilistic causation (3)

- Causal relevance versus the effectiveness of a causal factor:

(1) Measure: **Ef**(C,E) = $\mathbf{P}_X$(E) – $\mathbf{P}_K$(E)

(2) In order to have an idea of the effectiveness of a causal factor, one needs to have rather precise estimates of the value of the $\mathbf{P}_X$(E) and $\mathbf{P}_K$(E).

(3) Establishing a causal claim does not require such a precise estimate: given Giere's definitions, all we need is an argument supporting the claim that $\mathbf{P}_X$(E) is larger than $\mathbf{P}_K$(E) (in case of a positive cause) or smaller (in case of a negative cause).

How probabilistic theories can account for the use of mechanistic evidence, part 1 (1)

- Claim:

The reliable water supply in Taiwan (due to Japanese irrigation projects in the 1930s) caused a breakdown of the joint-family system in rural areas of the island.

- Evidence:

Thought experiment along the following lines:
Premisses
(1) In both parts (irrigated and non-irrigated) an equally great substantial part of the population makes rational decisions about family structure.
(2) In both parts, normal frictions in social life (e.g., between sisters-in-law) occur often and with equal frequency.
(3) In the irrigated part, farmers are convinced that the irrigation system protects them against crop failure due to draught.

How probabilistic theories can account for the use of mechanistic evidence, part 1 (2)

(4) In the non-irrigated part, farmers know that, in a nuclear family system, their rice crop will fail (due to insufficient labour supply) if there is less than *15* days of consecutive rainfall.
(5) In the non-irrigated part, farmers know, in a joint family system, their rice crop will fail (due to insufficient labour supply) if there is less than *10* days of consecutive rainfall.
(6) Periods with more than 10 but less than 15 days of consecutive rainfall occur often.
Conclusion
(I) The irrigated part evolves towards nuclear families more rapidly than the non-irrigated part.

How probabilistic theories can account for the use of mechanistic evidence, part 1 (3)

- The way the thought experiment works is this:

(1) We know what would happen in the experimental group, because its characteristic property has been present in the real world: the result in the experimental group would be the same as in the real world (e.g. evolution towards nuclear family)..
(2) We do not know *why* this result occurred in the real world, only *that* it occurred.
(3) We try to find out which mechanism produced the result in the real world (and thus would produce the result in the experimental group).
(4) We use this mechanism to argue that the result would be different in the control group.

How probabilistic theories can account for the use of mechanistic evidence, part 1 (4)

- Three conclusions from this example:

(1) In history and more broadly in the social sciences, it happens that we want to make causal claims about populations while no probabilistic evidence is available.

(2) In such cases, mechanistic evidence can help: a bottom-up argument as specified above can lead to conclusions about the hypothetical populations X and K.

(3) For a historian or social scientist that wants to make a Gierean causal claim about a population, it is perfectly rational to gather mechanistic evidence, since that evidence can help him to establish the claim.

- Case not closed: “[T]he proponent of the probabilistic theory can’t account for the fact that mechanisms are required even when appropriate probabilistic associations are well established.” (p. 164)

How probabilistic theories can account for the use of mechanistic evidence, part 2 (1)

- Mechanisms and confounders:

I agree that there are cases in which one can draw reasonable conclusions about what causes what without the aid of experiment or substantial knowledge of underlying mechanisms. However, the usefulness of conditioning on potential causes does not undermine the proposal that mechanisms significantly aid causal inferences in the social science, since social scientists are rarely able to measure all potential common causes. Indeed, the inability to exhaustively consider all potential common causes is a basic element of the problem of confounders, to which mechanisms are being considered as a partial solution. (Steel 2004, p. 63)

- Giere's definitions are certainly compatible with the use of results of prospective and retrospective studies as evidence.

How probabilistic theories can account for the use of mechanistic evidence, part 2 (2)

- This means that Giere's theory can account for the use of mechanisms, even in cases where appropriate probabilistic associations are known from prospective or retrospective studies: mechanistic evidence plays a role in the process by which data from such studies are used to build an argument for causal claims.

- So for a scientist who wants to make Gierean causal claims about populations, it is perfectly rational to look for mechanistic evidence: it will be useful for processing the results of prospective and retrospective studies.

- Experiments from animal experiments is a context in which mechanistic and probabilistic evidence are combined in practice (cfr. the IARC procedures).

- There is a sound justification for this practice (conflicting information from different animal species).

How probabilistic theories can account for the use of mechanistic evidence, part 2 (3)

- Giere's theory of probabilistic causation has no problem to account for this practice. Data about animals do not automatically give us reliable estimates of the value of the $\mathbf{P}_X(E)$ and $\mathbf{P}_K(E)$ (where X and K are hypothetical populations of humans). So a scientist who wants to make a Gierean causal claim, needs a warrant to link the animal data to the hypothetical human populations. Mechanistic evidence can provide this link. So it is rational for such a scientist to look for mechanistic evidence.

Conclusion & further claims

(1) Giere's theory of probabilistic causation can account for the use of mechanistic evidence in various contexts in which scientists use such evidence.

(2) Other probabilistic theories of causation (Suppes, Eells and Humphreys) cannot account for the use of mechanistic evidence.

(3) Giere's theory has other advantages, especially with respect to the policy relevance of causal claims.