Necessary, Sufficient, and Probabilistic Causal Claims

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Political scientists posit causal conjectures on a regular basis, yet it is difficult to find a useful discussion of the different types of causal conjectures one might make. There is increasing interest in how one can properly test different kinds of conjectures, though even this is limited.[1] This brief essay sketches the differences between the different types of conjectures (or, if you prefer, hypotheses). The purpose is not to provide a detailed discussion. Rather, I hope to help you become conscious of theoretical choices that tend to be made implicitly in our field.

1 Probabilistic v. Deterministic Conjectures

A probabilistic hypothesis states that a causal relationship between x and y holds in many instances. We might say, more formally, that x has a causal impact on y with some probability, p, such that $0 < p < 1$, though I have never seen a political scientist make such a formal claim. The idea here is that if we collected the universe of x and y pairs, we would observe a causal relation between x and y in some, but not all and not none, of those pairs. One might rephrase it as x sometimes has a causal impact on y.

The primary (but not the sole) alternative to a probabilistic conjecture is the statement of a law:[2] a relationship that always holds. Stated formally, a deterministic conjecture that claims that x has a causal impact on y with probability, $p = 1$. Few, if any, political scientists believe that there are laws of politics, and thus deterministic conjectures are rare indeed. That said, deterministic conjectures are strong because they are easily rejected–a single case

[1] See, for example, Ragin (1987, 2000),Dion (1998), Braumoeller & Goertz (2000), Seawright (2002) and the replies to his article, Sekhon (2004), and Clark, Gilligan & Golder (2006).

[2] I have always found the 'law' label irritating in that I treat laws as hypothetical statements: future evidence might cast them in doubt. So when I use the term law I do not mean a hypothesis that has been proven to be true, but instead a hypothesis that x has an impact on y in all circumstances.

that is inconsistent with the hypothesis demonstrates that it is false.[3] If we restate a law as a probabilistic conjecture, then note that a single case no longer rejects it. In fact, because it is probabilistic, we fully expect outlier cases.

Probabilistic conjectures are generally weak relative to deterministic conjectures. Why are probabilistic conjectures weak? Because they are considerably more difficult to reject. A deterministic conjecture can be rejected with a single disconfirming case (Rogowski 1995). Probabilistic conjectures, on the other hand, anticipate outlying cases. I discuss this issue in more detail below.

1.1 Necessary and/or Sufficient Conjectures

Necessary conditions are also weak conjectures, but sufficient conditions are strong conjectures. Both are law statements: neither is a probabilistic conjecture.[4] I stated above that very few, if any, political scientists put forth conjectures as laws. The 'if any' clause is a hedge against the ambiguity in some work that appears to make necessary and/or sufficient condition conjectures. I cannot think of any work that does so explicitly, but there have been scholars interested in methods who suggest that other scholars have done so and then test their propositions as if they were stated as necessary and/or sufficient conditions.[5]

A necessary condition conjecture states that y cannot occur in the absence of x. The standard way to think about both y and x in such conjectures is as a dichotomous variable, often a state that is either present or absent. For example, one might conceptualize 'revolution,' 'war,' or an 'executive veto' variable as a 'state' variable, such that the state is either absent or present. Any hypothesis that stated that the 'present state' of y was not possible in the absence of the 'present state' of some x would be a necessary condition conjecture.

Necessary condition conjectures are strong in the sense that it takes only one case to reject them: if one finds a case where y is present, but x is not, then one would reject the necessary condition conjecture. As Ragin (1987) explains, correlational analysis is inappropriate as a test for such conjectures.[6]

The main point I wish to emphasize is that a necessary condition conjecture is very different from a probabilistic conjecture. Note especially that this type of conjecture is limited to dichotomous 'state variables.' Probabilistic conjectures, on the other hand, can be made

[3]The Duhem-Quine thesis rejects this claim, observing that one cannot be certain whether the conjecture failed due to measurement error (or some other innocuous auxiliary assumption) or because the theory is poor. I am, for simplicity, ignoring that problem here.

[4]This is not to say that one could not make probabilistic statements about necessary and/or sufficient conditions. However, doing so would weaken them considerably, and I am unfamiliar with attempts to do so in political science.

[5]Skocpol (1979) is a classic work that is treated as such, though I am hard pressed to find those claims in her work. See the pieces cited in footnote 1.

[6]Though see Clark, Gilligan & Golder (2006) for an alternative view.

with respect to any discrete, or continuous, concept. Ragin (1987) contends that the focus on 'state variables' is a virtue as any discrete or continuous conceptualization can be collapsed to a dichotomous conceptualization by identifying some threshold that distinguishes the two states. Ragin is, of course, correct, and I do not wish to suggest that probabilistic conjectures are inherently superior to necessary condition conjectures–any such a priori judgment is foolish (indeed, it is anti-scientific). Rather, the point is that it is important to understand the differences in these types of conjectures, both when evaluating the work of others and when producing one's own theories and conjectures.

A sufficient condition conjecture posits that when x is present (or absent) then y will be present. Note that y can be present in the absence of x, but y cannot be absent in the presence of x. Like necessary condition conjectures, sufficient condition conjectures apply to 'state variables' that can be conceptualized as present or absent. You might find it useful to review the Wikipedia entry for Necessary and Sufficient Conditions: `http://en.wikipedia.org/wiki/Necessary_and_sufficient_conditions`.

Finally, it is possible to make conjectures that combine the two such that x is hypothesized to be both a necessary and sufficient condition for y. Ragin (1987) is an excellent introductory text for both theory and testing with respect to necessary and sufficient conditions.

2 Causal Conjunctions (aka Conditional Relationships)

It is almost a platitude to observe that political outcomes are produced by a conjunction of different variables. Yet theory development in political science tends to focus on the development of conjectures concerning x and y, *all other things held constant.* The italicized clause admits that other things have an impact, but if we could hold them constant, then x would exhibit an impact on y (in many/most cases). But it might be that x only has an impact on y, all other things held constant, when z has values in some range (most simply, when z is present or absent). Such a conjecture posits a causal conjunction or conditional relationship (x's impact on y is conditioned by z). These sorts of conjectures are becoming increasingly common.

3 Fuzzy Sets

A (relatively) new area in mathematics, fuzzy sets, has given rise to a probabilistic form of necessary and sufficient condition conjectures. Ragin (2000) is an excellent introduction, and I will not go into it here simply because this type of theorizing has yet to take root in political science. Those of you interested in this will find Ragin's book rewarding.

4 References

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