Braumoeller, Bear, "Casual Complexity and the Study of World Politics."

The Problem

"*Complex causation*" describes the situation – common in a variety of international relations questions – wherein a change in the level of one independent variable changes the effect of another independent variable upon the dependent variable. (This is partly an analytically powerful explication of multiple, interacting necessary and sufficient conditions.) Braumoeller identifies two types of complex causation:

1. *Redundant causation*, where one independent variable counteracts the effects of another; and
2. *Conjunctural causation*, where one independent variable helps activate the effects of another.

Either type of complexity invalidates additive statistical procedures, as the effects of complex antecedents varying individually by definition do not sum to the effect of such antecedents varying jointly – with redundant causation, such a sum would be too large; with conjunctural causation, the converse would be true. Unfortunately (given the preponderance of phenomena exhibiting causal complexity), the simplicity of purely additive econometric procedures, especially GLS regression, has allowed such procedures to dominate statistical study of world politics. Thus causal complexity comprises a *theory problem*, and is only indirectly related to the more commonly examined class of problems dealing with data improvement.

Various unsatisfactory solutions to the theory problem exist: *multiplication of variables*, for example, straightforwardly models some types of complex causation, but for meaningful analysis makes very strict demands upon the data. The introduction of *variables incorporating alternative explanations* into models is a superficially appealing method of modeling redundant causation, but it, too, encounters model misspecification difficulties in most situations. Representations of causal complexity ranging from *variable-parameter models* (involving modeling of change of independent variables) to *Cobb-Douglas functions* (multiplied exponentiated variables) founder for most applications by incorporating too much or too little flexibility. Even Ragin's *Boolean algebra*, for all its insight, proves incapable of smoothly handling large-N or probabilistic models.

Braumoeller's Solution

Braumoeller develops a statistical technique he terms *multiple path probit*, which requires (first) modeling the probability of incidence of a causal factor and then describing the interaction of these probabilities. In the case of conjunctural causation, this entails multiplying the probabilities of incidence of the various conjuntural causes; for redundant causation, multiplying the probabilities of nonoccurrence of the various redundant causes and subtracting the result from 1.[1] For added econometric élan, the probabilities of occurrence of each of the independent variables need not be predetermined; Braumoeller's model allows for likelihood functions, so that the probabilities of occurrence become modeled variables. This produces relatively straightforward (but still insightful) functional forms for every possible combination of redundant and conjunctural causes.

[1] For example, consider two independent events: event A with probability $\frac{1}{7}$, and event B with probability $\frac{1}{5}$. If events A and B were conjunctural causes of outcome C, outcome C would be expected with probability p(A) $\times$ p(B) = $\frac{1}{7} \times \frac{1}{5} = \frac{1}{35}$; this is because both A and B are necessary for C. If A and B were, however, redundant causes of C, the probability of C would be $1 - [(1 - p(A)) \times (1 - p(B))] = 1 - [\frac{6}{7} \times \frac{4}{5}] = \frac{11}{35}$: since either cause individually is sufficient to induce C, the probability of C is equal to the sum of p(A) and p(B) minus the probability of true redundant causation when both of the sufficient events occur, which in this two-event case is simply p(A) $\times$ p(B).

Such a method produces a number of advantages: it demonstrates greater predictive accuracy in Monte Carlo simulations; it produces a model more attuned to the vagaries of theory, and thus can be more coherent than alternate models; it allows for the investigation of how variables matter, which can be indeterminate in other statistical methods; it immediately reveals uncommon combinations of independent variables, and thus emphasize the need for circumspection in one's inferences based upon such combinations; and it sometimes provides a distinct set of conclusions, providing new insight and fodder for social-scientific debate.