Conceptualizing Space: Reply

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We read with interest the sundry points raised by King in his comment (2002) on our article (Anselin and Cho 2002). Given the space and time constraints in this forum, it is impossible for us to address adequately all of the issues here. It is sufficient to say that we strongly disagree with King's claims that we are "missing the point." We will pursue a more thorough and formal rebuttal elsewhere, but would like to set the record straight on a few issues in the limited space provided here.

First, King's primary focus on our empirical example is misplaced. The example is tangential to our main argument, and its sole purpose was to illustrate that spatial autocorrelation does indeed occur in actual data sets (a point disputed by some), and can be observed in both the outcomes as well as the so-called conditioning variables and beta coefficients. Although spatial autocorrelation is an empirical fact, what causes a particular spatial pattern is more ambiguous. Because many different underlying processes may yield the same outcome, the observed spatial autocorrelation may be the result of a pure spatial process, aggregation bias, or some other form of misspecification. In the analysis of our example, we do not advocate one underlying process over another, but simply outline various possibilities. King alleges that we are confused about spatial effects and aggregation bias, stating that one of our themes is that the two assumptions are related. We state clearly, however, that "[i]t is important to note that while we artificially separate these two conditions in our simulated data, aggregation bias and spatial effects usually co-exist in real data," not that one causes the other. Note that King (1997, p. 159) himself states, "But it pays to remember that most real applications that deviate from the basic ecological inference model do not violate one assumption while neatly meeting the requirements of the others." In other words, he too has maintained that problems from violations of multiple assumptions "occurring simultaneously" is the usual case. King's current position, "[i]f a violation of one assumption is detected, we have no more information about whether the other is violated," is confusing in light of these earlier statements. Also, we do not advocate OLS over EI,

as King suggests, but include the example as an illustration of what may happen to both estimators in the presence of observable and significant spatial autocorrelation.[1]

Second, and more importantly, we would like to emphasize that in a discussion of "spatial" effects, King's continued reference to his earlier results is not productive. It has been noted by many (e.g., Fotheringham, O'Loughlin, Anselin) that King's original design (1997, Chapter 9) is a-spatial, and reduces the complexity of two dimensions and multi-directional interaction to a one-directional line. King's characterization of this time series dependence as "a special case of spatial autocorrelation" is misleading because it assumes away all of the distinguishing features of the "spatial" case (see Cressie 1993, and Anselin and Bera 1998, for an extensive technical discussion of the differences between dependence in time and space). The other discussion of spatial models in King (2000, p. 604, Table 1) is ambiguous as well. There, King describes the data generating process as a "Monte Carlo experiment according to the specifications in Anselin (1988)." Readers familiar with Anselin (1988) know that it contains no specification that applies to the EI model. The complexities imposed by the ecological inference context are spelled out in detail in our paper. It should be obvious that the range of spatial autoregressive models discussed in Anselin (1988) does not transfer to this context. In any case, it is not clear from King's description in the paper which model he might have used. The "spatial" data generating process outlined in the appendix to his comment is not a standard form (and *not* contained in Anselin 1988), but is remotely similar to what is referred to as *spatial error components* in the spatial econometric literature (Kelejian and Robinson 1995). The specific nature of induced spatial autocorrelation in this model is peculiar (see Anselin and Bera 1998, p. 250). More importantly, it is not clear how draws of β_i^b, β_i^w from "independent truncated bivariate normal densities" can yield spatially correlated outcomes.

In addition, a simulation experiment cannot be interpreted without express descriptions of both the DGP and the parameter values. King's (2000) results in Table 1 contain only two rows, one labeled "Independent" and the other labeled "Spatial." Nowhere does the paper discuss parameter values. The appendix to King (2002) states that the "simulation was repeated over a wide range of [parameter] values," but the article does not specify what this range may be for the spatial parameter. This is also puzzling because King claims that our simulations set autocorrelation levels considerably higher than any published ecological inference application. Moreover, exactly what "applications" the article refers to is unclear, and, in any case, the statement is ambiguous because spatial autocorrelation, like aggregation bias, is unknown in a real ecological inference application.

Finally, we note that we purposely followed King's own simulation designs (1997) to maximize consistency and comparability. Although he contends that our autocorrelation levels are unreasonably high, we chose these levels to mimic the levels he purports to test in his book (1997, p. 168). Similarly, he protests that our bounds are "highly uninformative," but our bounds and our variance parameters are identical to those chosen by King (1997). We strongly disagree with the implication of King's comment that somehow our simulation experiments were tainted by an incorrect design and inappropriate models for spatial processes. We maintain that we have provided the only simulations of true spatial effects in the ecological inference context thus far, and that descriptions of "spatial" simulation designs and previous results by King do not allow a proper assessment of the effect of spatial

[1] As an aside, we would like to clarify that we did provide King with a very detailed listing of our empirical results from the original run as well as from more recent replications, providing insight into the procedures used, assumptions made, and results selected for inclusion in the paper. However, we could not provide King with the raw data because they were covered under restrictions related to previous research.

autocorrelation in the ecological inference context. This is a central point in our paper and we stand by it. We will pursue a more technical elaboration elsewhere.

References

Anselin, Luc, and Anil Bera. 1998. "Spatial Dependence in Linear Regression Models with an Introduction to Spatial Econometrics." In *Handbook of Applied Economic Statistics*, eds. Amman Ullah and David E. A. Giles. New York: Marcel Dekker, pp. 237–289.

Anselin, Luc, and Wendy K. Tam Cho. 2002. "Spatial Effects and Ecological Inference." *Political Analysis* 10:276–297.

Cressie, Noel. 1993. *Statistics for Spatial Data*. New York: Wiley.

Kelejian, Harry H., and Dennis P. Robinson. 1995. "Spatial Correlation: A Suggested Alternative to the Autoregressive Model." In *New Directions in Spatial Econometrics*, eds. Luc Anselin and Raymond J. G. M. Florax. Berlin: Springer-Verlag, pp. 75–95.

King, Gary. 1997. *A Solution to the Ecological Inference Problem: Reconstructing Individual Behavior from Aggregate Data*. Princeton: Princeton University Press.

King, Gary. 2000. "Geography, Statistics, and Ecological Inference." *Annals of the Association of American Geographers* 90:601–606.

King, Gary. 2002. "Isolating Spatial Autocorrelation, Aggregation Bias, and Distributional Violations in Ecological Inference: Comment on Anselin and Cho." *Political Analysis* 10:298–300.