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Time is Not A Theoretical Variable

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Carter and Signorino (2010) (hereinafter ''CS'') add another arrow, a simple cubic polynomial in time, to the quiver of the binary time series–cross-section data analyst; it is always good to have more arrows in one's quiver. Since comments are meant to be brief, I will discuss here only two important issues where I disagree: are cubic duration polynomials the best way to model duration dependence and whether we can substantively interpret duration dependence.

But first, I should make it clear that I agree with CS, amongst other issues, that adding duration dummies to the logit specification is inferior to adding a smooth function of duration to that specification. In Beck, Katz, and Tucker (1998) (hereinafter ''BKT''), we noted that the duration dummies (which are simply the grouped duration analogue of the Cox [1972] proportional hazards model ''baseline hazards'') are estimated very imprecisely (especially for loner durations). We then suggested that we expected the baseline hazard function to be reasonably smooth and hence could be better modeled by as a smooth function of time. CS's discussion of separation provides another reason to prefer smooth functions of time to the duration dummies.

CS argue that a simple cubic polynomial in time is about as good, and more easily interpretable, than a cubic spline. BKT suggested a natural cubic spline because at the time, it was the best smoother available in the widely used package Stata and we wanted to appeal to the applied researcher.[1] In the ensuing decade, R has become popular and today I would recommend researchers use *mgcv* in R or, if the prefer to stay with Stata, *fracpoly*. I agree with CS that choice of knots can be difficult. These newer and now easily available programs allow the user to specify a more intuitive ''degree of smoothing'' (or ''bandwidth'') parameter and so avoid the knot selection problem.[2] Today, there is no need to choose between only the somewhat awkward natural cubic spline and the somewhat procrustean cubic polynomial. Moreover, there is no reason to choose the latter because it is easier to get intuitive graphs; both routines mentioned make it easy to get plots of the baseline hazard against time.

Before leaving splines, it should be noted that CS's position on knots in splines reflects our discipline's general uneasiness with allowing researchers to make decisions about issues such as smoothness that require some art. CS's position here is logically

Authors' note: This comment was written while I enjoyed the kind hospitality of El Centro de Estudios Avanzados en Ciencias Sociales of the Fundación Juan March in Madrid.

[1] In work with Jackman (Beck and Jackman 1998, 1999), we used smoothers that we considered superior but were, at the time, only available in the proprietary S-Plus.

[2] See Keele (2008) for a recent discussion of modern smoothing methods that simplify life for the applied social scientist.

inconsistent. Note that the cubic polynomial is just the smoothest cubic spline, one with no knots. Thus, CS avoid any issues of placing knots (which is a work of art) by simply assuming a priori there are no knots. This preference for arbitrary and strong assumption, which require no art, over more flexible methods, which do require art, seems to be widely shared in our discipline. This preference is pernicious. So long as we guard against overfitting the data and carefully test whether additional flexibility is needed, is it not better to allow researchers to use some judgment in how much smoothness to impose? In this particular case, since we can easily test whether the knots imposed are needed, how can a model that simply assumes away knots be superior? But the recommended method today, as already mentioned, is not the natural spline, but rather, the various smoothing splines that allow the analyst to work in a more intuitive manner.

My second issue is how seriously to take time, that is, should we substantively interpret the plot of the baseline hazard (whether it be a cubic polynomial in time, a smoothing spline or whatever)? The baseline hazard is akin to the error term in a regression model; it picks up everything that is left out of the model. To ignore duration dependence (a baseline hazard that changes over time) leads to statistical inefficiency and incorrect standard errors. All event history models should allow for, and then test for, duration dependence. About this, there is no disagreement.

But what does it mean to say that the baseline hazard is rising or falling or neither? This is just a statement about omitted variables. As with correlated errors or time trends in time series, the baseline hazard is a moving target. Thus, our goal should not be to interpret this term, but rather to find the variables that lead to duration independence. Although estimation that does not allow for duration dependence when it remains is inferior (this was the point of BKT), duration dependence is both atheoretical and changes with the model. Thus, we should look at the shape of duration dependence to see how our model could be improved (and of course we should do this by looking at the graph of the baseline hazard). To think of duration dependence (or the baseline hazard) as a substantive part of our model leads in the wrong direction. The right direction is a substantive model with no duration dependence; alas, until we get to that point, we need to take duration dependence into account for statistical reasons. But issues of the shape of the baseline hazard graph cannot be used to discriminate between alternative theories or to otherwise provide substantive knowledge of the political universe. Just as we should not substantively interpret time trends or correlated errors, we should not theoretically interpret duration dependence. Time is not a theoretical variable.

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