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A New Tool for Old Questions: The Sequence-Analysis Multistate Model to Study Relationships Between Time-Varying Covariates and Trajectories.

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Abstract The relationship between processes and time-varying covariates is of central theoretical interest in many social sciences research questions. On the one hand, event history analysis has been the method of choice to study these relationships. However, it is limited to outcomes that can meaningfully be specified as simple instantaneous events or transitions. On the other hand, sequence analysis (SA) has made increasing inroads into the social sciences to analyze trajectories as holistic “process outcomes”. However, it does not allow for studying their relationship with time-varying covariates.

We propose the sequence-analysis multistate model (SAMM) that combine the advantages of both approaches. SAMM models the relationship between time-varying covariates and trajectories specified as processes outcomes that unfold over time. It proceeds in two steps. First, we use an adapted sequence analysis to identify typical sequencing and spacing between main transitions in trajectories. Second, we adapt multistate models to estimate the chances to follow each kind of the identified typical sequence. The usefulness of SAMM is illustrated with an example from life course sociology on how 1) time-varying family status is associated with women’s employment trajectories in East and West Germany, and 2) how the German reunification affected these trajectories in the two sub-societies.

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1 Introduction

Many theoretical questions in the social sciences address the relationship between time-varying covariates and processes. Life course and career researchers are interested how changes in one life domain affect trajectories in another life domain, e.g. family and employment (Aisenbrey et al., 2009). How changing economic condition or family policies shape the transition to adulthood is also a central question in life-course researches (Shanahan, 2000). Social policy analysis is concerned with processes of policy development that can be altered by specific events, such as wars or a change of government (Abbott, 1995; Frank et al., 2000). Related research questions are at the center of historical comparative sociology and institutional analysis. Similarly, social movement scholars study how social movements unfold over time in response to trigger events (Minkoff, 1995; Olzak, 1989). Organizational ecology researchers examine how industries and organization develop over time. The relationship between these developmental processes and time-varying factors, for instance the introduction of new technologies, is of core theoretical interest in this field as well (Carroll et al., 1993). This list of selected examples could easily be extended to other sub-fields of sociology and related disciplines. They have in common that they are not only interested in processes of metric outcomes, such as income or IQ, but more often than not, in processes that consist of categorical states, including family trajectories, specific policy programs, or stages of group behavior until the outbreak of violent protest.

Two broad families of methodological strategies have been used to study the relationship between time-varying covariates and outcomes on the one hand, and trajectories of categorical states, on the other hand. The first strategy focuses on the occurrence of events or transitions (Allison, 1984; Yamaguchi, 1991; Therneau and Grambsch, 2000) and relies on event history analysis (EHA) for estimating the effect of time-varying covariates on the risk to observe an event. However, event history analysis is limited to modeling instantaneous changes and loses sight of the trajectory as a whole (Billari, 2005). The second strategy emphasizes the holistic nature of trajectories or processes of categorical states by relying on sequence analysis (SA) (Abbott, 1995; Studer and Ritschard, 2015). SA considers change and multiple transitions as lasting over longer time spans rather than being instantaneous. However, within the traditional sequence analysis framework it is not possible to study the relationship between time-varying covariates and trajectories.

We propose an original combination of these two approaches called Sequence Analysis Multistate Model (SAMM). Combining sequence analysis and multistate models, SAMM offers several advantages for studying processes. First, it allows for modeling the relationship between time-varying covariates and patterns of change within processes that unfold over longer periods of time. This methodological approach closely corresponds to the theoretical concepts of trajectories as “process outcomes” (Abbott, 2005). Second, studying trajectories holistically allows us to uncover potential interdependencies

between states and transitions within trajectories. The social meaning of a given situation often depends on previous but also later events, which may be known in advance by the actors involved. For instance, a woman may start a new job even (or because) she knows that it will be only temporary. Finally, SAMM can handle censored observations. This allows for the inclusion of trajectories that are only partially observed, which is not possible within the traditional sequence analysis framework.

The contribution of SAMM is demonstrated with an original example application in life course sociology. Two central theoretical principles in the life course paradigm include that individual life courses are multidimensional, e.g. family and employment, and that macro-structural, historical change strongly shapes individual life courses trajectories (Elder et al., 2003). We employ the historically unique social experiment of the German reunification to exemplify how SAMM can contribute to a better understanding of these two core life course principles. Specifically, we assess how 1) time-varying status in the family domain are associated with women's employment trajectories in East and West Germany (multidimensionality of lives), and 2) how the German reunification affected women's employment trajectories in the two sub-societies (impact of macro-structural change). In 1990, the former communist East Germany with a centrally planned economy (German Democratic Republic, GDR) was abruptly absorbed into the democracy and social market economy of the West (Federal Republic of Germany, FRG). The German reunification thereby provides an ideal case for studying how abrupt and profound macro-structural change was associated with change in individual life course trajectories that unfold over time. Beyond previous research on the impact of the German reunification (Bonin and Euwals, 2002; Hauschild, 2002; Trischler and Kistler, 2010; Klammer and Tillmann, 2001), our example application uses data for more recent cohorts that allows us to track difference and similarity in women's employment trajectories in East and West Germany not only in the immediate transition period, but until 20 years after the reunification.

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