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Introduction [to third special issue of the Journal of Mathematical Sociology on Evolution of Social Network]

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INTRODUCTION

By Patrick Doreian and Frans N. Stokman

As guest editors, we are pleased to present the third special issue of the **Journal of Mathematical Sociology** on *Evolution of Social Networks*. The first was published in 1996 (JMS Vol 21, 1–2), followed by a book version (Doreian and Stokman, Social Network Evolution, New York: Gordon and Breach 1997) containing all of the journal articles plus three new chapters. The second was published in 2001 (JMS Vol 25, 1). In all three special issues we were primarily interested in studies that concentrated on the *underlying* mechanisms that induce network change. In other words, we were interested in network *evolution*, rather than descriptions of network changes. The first volume did not bridge the gap between theory and empirical testing because most contributions focused on theory, methods, and simulation. In the second special issue, the emphasis shifted to contributions in which modeling and empirical analyses were integrated or at least combined. In this special issue we continue this line of research with four new contributions concerned with substantive developments. Yet substance and methods cannot be help apart for long. One paper in this issue presents a new method of analysis and another extends some existing methods.

The four contributions try to capture network evolution in four completely different contexts. The richest data set is undoubtedly the social interaction data in three winter-over periods at the Amundsen-Scott South Pole Station. Jeffrey Johnson, James Boster and Lawrence Palinkas investigate the interrelationship between the emergences of different forms of leadership with global network coherence. The article is rich in its description of network evolution during the three winters and its interrelationship with co-evolution of leadership patterns. We are still far away, however, from an understanding of the underlying process why evolution was so diverse over the winters and how that was intertwined with evolution of leadership. The article provides an excellent starting point for tackling that challenging task.

In two of the three remaining contributions, Snijders' stochastic actor-oriented model for network change (SIENA) is used to explain network evolution, a model introduced in the first special issue (Snijders, 1996). The method is so powerful because network changes are related to

different utility components. Individuals in a network are assumed to evaluate their present position in a network and try to obtain a "better" configuration of relationships for themselves. The evaluation takes place on the basis of a so-called objective function and a gratification function. The first relates different characteristics of the network and of the connected individuals to their overall utility. Such effects can be obtained by creation of new ties or by deleting existing ones. The gratification function differentiates these two. Marijtje van Duijn, Evelien Zeggelink, Mark Huisman, Frans Stokman, and Frans Wasseur apply SIENA to study friendship evolution among sociology freshmen. The freshmen start mainly as a group of strangers. The authors assume that physical proximity is primarily important for meeting, whereas friendships (mating) evolve in the beginning primarily on the basis of visible similarity, but subsequently on the basis of invisible similarity (in terms of attitudes and activities). Network opportunity (learning the friends of your friends) is assumed to be important throughout the whole period. These expectations are indeed corroborated, but the effects of invisible similarity for later changes are very weak. This means that the imprint of visible similarity like gender remains dominant in the structure of the networks at different time periods, but vanishes as explanatory factors for later changes. The weak effects of invisible similarity may well be due to the problem how to capture the main relevant dimensions of invisible similarity. We see the solution of this problem as one of the challenging tasks for future research.

Tom Snijders and Chris Baerveldt combine SIENA with multilevel analysis in their analysis of effects of delinquent behavior on network evolution in 19 school classes. As the analysis of network evolution in each class is already complicated, they opt for a two-step approach in which first a common model of network evolution is applied to all school classes separately. The purpose of the macro-level analysis is subsequently to estimate and test the mean and variance of the true parameter values across school classes. As expected, a similar degree of delinquent behavior has a positive effect on tie formation. The study also shows, however, that similar degrees of delinquent behavior lead to tie dissolution, which was not expected on the basis of current criminological theories. The latter needs further study.

David Dekker, Philip Hans Franses, and David Krackhardt introduce the Equilibrium-Correction (EC) model for the analysis of dynamic network data. This model is often used in time-series econometrics. The EC-model makes it possible to estimate three types of effects. One set of parameters relates to effects of changes in independent variables on network changes (short-term effects). A second set can be interpreted as indicating the long-term equilibrium relation between the independent variables and the network at equilibrium (long-term effects). The third set of parameters measures the speed of adjustment of network changes to that long-term

equilibrium. The EC-model cannot directly be applied to dynamic network data as dynamic network data have two types of autocorrelation. At each measurement moment, network data may show structural autocorrelation due to dependencies between row and/or column entries in a socio-matrix. In addition, there may be serial autocorrelation due to the fact that observations are dependent over time. The authors use a two-stage "multiple regression quadratic assignment procedure" (MRQAP) to handle both types of autocorrelations. The authors show with extensive simulations that their approach works in practice and subsequently apply it to perceived advice request relationships over two periods in a group of 13 employees of a big fast food chain. Their research question concerns the effects of network centrality of individuals on how accurate they perceive network relationships. They show, among others, that centrality indeed increases accuracy, but that the change effects are larger than the level effects.

The three special issues on *Evolution of Social Networks* have produced important new technical tools for the study of network evolution. Several articles in the first issue showed the importance of simulation for the generation of new insights in and unexpected outcomes of underlying processes that produce network change. A substantive number of articles produced improved statistical tools or completely new statistical models for the analysis of network evolution. These statistical tools are not only more sophisticated, but are better focused on substantive questions and integrated with theoretical approaches, thus reducing the gap between theory and empirical data considerably. The many empirical studies in the three volumes have generated important new insights in a variety of network contexts. We see the collection of network data over time as one of the largest bottlenecks and one of the most challenging tasks for future social network evolution research. Increasingly, network analysts are becoming aware not only of the presence of attrition and missing data, but are recognizing that these problems form the most potent threats to the analysis of social networks over time. This is clear in some of the empirical studies in the three special issues. Rich data may well be generated from modern communication flows and transaction forms. These data sets are likely to be large and to analyze such networks, new data mining techniques are required the transform registered traces of communication and transactions into network data that can be analyzed over time. We very much would like to coordinate a fourth special issue on this challenging topic and ask for relevant contributions.