Social Networks 40 (2015) 25–33

Contents lists available at ScienceDirect

Social Networks

journal homepage: www.elsevier.com/locate/socnet

Analysis of contested reports in exchange networks based on actors' credibility

Weihua An [a,*], Sam Schramski [b]

[a] Indiana University, Departments of Sociology and Statistics, 752 Ballantine Hall, 1020 E. Kirkwood Avenue, Bloomington, IN 47405, USA
[b] Post-Graduate Program in Amazonian Society and Culture, Federal University of Amazonas, Brazil

ARTICLE INFO

Keywords:
Exchange networks
Contested reports
Measurement error
Credibility

ABSTRACT

Exchanges of information, goods, and services are an essential part of human relations. However, a significant number of reported exchange ties tend to be contested: the reports of the sender and the receiver in an exchange do not concur with each other. To accurately understand the exchange ties between actors and the properties of the associated exchange networks, it is important to address such disagreement. Common practices either eliminate the contested reports or symmetrize them. Neither of them is ideal, as both underuse valuable information in the reports. In this paper, we propose new methods for handling contested exchange ties. The key idea is to measure actors' credibility based on their asymmetric connections. For example, an actor is less credible the more contested ties she or he has. Using the credibility scores thus calculated, we develop two methods for handling contested ties. The first method is deterministic: it takes the report of the more credible actor as a reflection of the true exchange status between two actors. The second method is stochastic: it assumes the true exchange status between two actors is a random draw from their reports with probabilities proportional to their credibility. We illustrate the above methods by analyzing contested reports in cigarette exchange networks among middle school students in China and social and economic exchange networks among rural households in South Africa. The results show that our methods provide more reasonable corrections to contested reports than previous methods.

1. Introduction

People exchange information, goods, or services with one another so frequently that social exchange has been viewed as one basic form of social behavior (Homans, 1961). An objective account of any social exchange would render concordance: both actors involved in the exchange would agree about the nature of their relationship. As shown below, however, many reported exchanges between actors can be discordant: either they do not agree about the existence of an exchange relationship or they disagree about the amount of information, goods, or services they exchange. Consider two examples from our data (see Section 3 for more details). Panel 1 of Fig. 1 shows the cigarette exchanges among five adolescents. Among them, A and B, and D and E agree with one another that they have exchanged cigarettes before while B and C, B and D, and C and D disagree with each other. Panel 1 of Fig. 2 shows the monthly food exchange among four households in a South African village. Now the reported ties are not binary anymore, but rather they have four levels: ego exchanges nothing with the partner (0), ego and the partner exchange equally (1), ego gives more to the partner than the partner gives to ego (2), and the partner gives more to ego than vice versa (−2). In this example, Households B and C agree they exchange food equally on a monthly basis while other pairs of households disagree on the relative amount of food they exchange. For example, Household A claims to exchange food equally with Household B, but B reports being a net recipient. At the same time, Household A reports being a net recipient of food from Household C while Household C reports no exchange.

Addressing these asymmetric or contested exchange ties is essential to having an accurate understanding of the exchanges taking place, as well as the global properties of the associated exchange networks. A simple method for that is to eliminate all the contested exchange ties, also known as symmetrizing on the minimum (Hanneman and Riddle, 2005). The risk with this method is that it may remove some of the actual exchanges in the process and so produce false negative reports. A second commonly used method is to symmetrize on the maximum, namely, using positive reports

* Corresponding author. Tel.: +1 812 856 1370.
E-mail addresses: weihuaan@indiana.edu (W. An), schramski@gmail.com (S. Schramski).

http://dx.doi.org/10.1016/j.socnet.2014.07.002
0378-8733/

as surrogates for the "true" exchange ties while ignoring negative reports. A drawback of this approach is it can record exchange ties that do not exist and so produce false positive reports (Costenbader and Valente, 2003).

Given the limitations of previous methods, in this paper we propose new methods to handle contested reports in exchange networks. What is novel about our methods is that they measure actors' credibility based on their asymmetric ties possessed. For example, an actor is less credible the more contested ties she or he has. By using the credibility scores thus calculated, we develop two methods to handle the contested exchange ties. The first method is deterministic: it takes the report of the more credible actor as the one that reflects the true exchange status between two actors. The second method is stochastic: the true exchange status between two actors is considered to be a random draw from their reports with probabilities proportional to their credibility. The first method is simple and intuitive to understand while the second takes into account uncertainties in correcting contested exchange reports. Both methods can be used in binary and categorical exchange networks. We illustrate them by applying them to addressing contested reports in (binary) cigarette exchange networks among middle school students in China and (categorical) exchange networks involving food, wood and water, and money among rural households in South Africa.

There are two key assumptions behind our methods. One is that we assume that uncontested ties are by and large accurate. However, note that if positive and negative reports are randomly provided with an equal probability, an uncontested tie between any two actors in a binary exchange network can arise half of the time from chance alone. Since there is no disagreement in the concordant reports, in this paper we assume it may not have behavioral consequences. Thus, although our methods help to deal with apparent disagreements, there may still be errors hidden in concurrent reports. The second assumption we make is that either of the contested reports by any two actors is accurate. But there exists the possibility that neither of them is accurate. Unless more assumptions or additional information are introduced, there is no obvious way to account for the effects of either assumption. With these two assumptions, our methods are shown to work effectively in many realistic situations.

The paper proceeds as follows. First, we review previous research about reporting disagreements in social networks. Then we describe in detail our methods and illustrate them by two simulated examples. After that, we apply the methods to analyzing contested reports in the four different types of exchange networks mentioned above. Last, we conclude and discuss the possible limitations of our methods. In particular, we highlight that concordant or discordant reports can arise from situational, cultural, and stochastic causes. Having a good understanding of the possible causes is crucial for using our methods effectively.

2. Background

Research in exchange networks is rooted in anthropology and economics (Emerson, 1972; Stolte and Emerson, 1977; Cook and Emerson, 1978) as well as sociology (Cook et al., 1983; Skvoretz and Willer, 1993; Yamaguchi, 1996). Many prior studies took for granted actors' reports and focused on the analysis of the properties of the resulting exchange networks, such as reciprocity, power, and the distribution of resources. For example, Yamaguchi (1996) found that often no clear broker emerges in a contradictory exchange network.

However, when respondents are asked to report their ties with others, there are various ways that the reports can be inaccurate (Marsden, 2005). Some studies (e.g., Brewer and Webster, 1999) have shown that recall error can, on average, lead to underreporting 20 percent of known friendships. Others have shown social pressure or stigma may be another reason for actors to misreport their ties (LaPiere, 1934; Deutscher, 1973; Hing, 1993). More recent work (e.g., Hildum, 1986; Freeman and Romney, 1987; Freeman, 1992; Carley and Krackhardt, 1996; Krackhardt and Kilduff, 1999; Handcock and Gile, 2010) and a series of papers written by Killworth and Bernard (1976) and Bernard et al. (1980, 1982, 1984) have found that respondent accuracy is conditioned by a number of factors, including "cognitive mechanisms, instrument design, informant experience, and even the informant's position in the social structure itself" (Butts, 2003: 109). For example, Freeman and Romney (1987) show that social expectation can bias actors' cognition and lead to reports that deviate from factual social interactions.

Contested reports for certain kinds of relationships like friendship, assistance, or advice-seeking relationships may be meaningful and valid. But contested reports of exchange relationships are problematic, as these relationships are inherently symmetric. Prior research has proposed several solutions to addressing contested reports in exchange networks. One simple approach is to eliminate all the contested reports and retain only uncontested reports. For simplicity, we refer to this method as the elimination method (i.e., symmetrizing on the minimum by Hanneman and Riddle (2005)). The problem with this method is it tends to remove true social ties along with incorrectly reported ties and therefore produces unnecessary false negatives.

The second approach is to symmetrize on the maximum. It recovers an exchange status according to the positive report while ignoring the negative report. For example, if actor A reports having an exchange tie with actor B, the assumption is that such a tie exists even if actor B reports there is no tie between them. In general, this method may result in extra false positives and tend to over-count the prevalence of ties in a given relationship. For simplicity, we refer to this method as the symmetrization method.

Another approach is to use multiple peer reports to correct contested reports (Krackhardt, 1987; Butts, 2003). For example, in cognitive social structure (CSS) data, each actor is asked to report ties between all dyads in his or her social unit, which usually results in multiple reports for any one tie in the network (Krackhardt, 1987). Besides the fact that multiple informants may continue to disagree with one another (adams and Moody, 2007), the limited availability of CSS data is a significant constraint on the generalizability of this approach. In this paper, we consider how to handle contested reports when CSS data is not available.

One last approach for dealing with discordant reports is through a cultural consensus model (CCM). Actors are asked to provide answers to a series of questions and the agreement between their answers are used to calculate the competence score for each actor (Romney et al., 1986, 1987; Weller, 2007; Borgatti and Halgin, 2011). Our methods proposed below share with CCM the notion that both view actors as possessing different levels of competence in providing correct reports. But they also differ in notable ways. First, CCM is most interested in inferring shared group beliefs about cultural objects (like multiple choice questions) rather than network relationships. Second, in CCM there are multiple questions to answer and so the degree to which two actors agree with one another can be easily measured. In contrast, in our case there is only one question for each pair of actors to answer (i.e., the exchange status between them). Thus the information that can be used to measure their level of agreement is very sparse. Third, the methods for calculating competence are different. CCM factorizes the agreement matrix between actors and uses the principal eigenvector to measure competence (Weller, 2007; Borgatti and Halgin, 2011). In contrast, to solve the information paucity problem in our case, we