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Reconstructing Granovetter's network theory

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ABSTRACT

We employ concepts from graph theory and cooperative game theory to reconstruct Granovetter's famous thesis concerning 'the strength of weak ties'. In contrast to existing formal models related to this thesis, our approach captures the mechanisms Granovetter invokes in the derivation of his thesis. Notably, our model allows for an analytical distinction between the strength of ties and the value of ties – a distinction empirical research on the labor market has shown to be of great importance. We use our model to test the theoretical validity of Granovetter's thesis and to evaluate its robustness if implicit assumptions in Granovetter's argumentation are dropped.

1. Introduction

One of the most important and most widely cited articles in sociology is Granovetter (1973). He is concerned with the ties or links between agents. According to Granovetter (1973, p. 1366) these links may have different strengths which stand for e.g. the amount of time invested in a relationship, the emotional intensity governing the relationship, or the velocity of transmission of information.

Granovetter bases his work on two postulates. First, he relates ties between two agents to common ties with other agents. Granovetter (1973, p. 1362) argues that a stronger tie between agents 1 and 2 leads to a higher proportion of third agents to whom both are tied. We call this the 'common-friends postulate'. Granovetter finds arguments from various fields in support of this claim.

Granovetter's second postulate is known as the 'forbidden triad'. In a typical network the strong ties an agent 1 has with 2 and 3 imply a tie between agents 2 and 3. For example, 2 and 3 are friends with 1 and hence friends with each other (e.g. having met at parties organized by 1). Therefore, Granovetter (1973, p. 1363) wants to rule out the situation where 2 and 3 (both being friends with 1) do not have a link between themselves. Triads that are not forbidden are called balanced and so are networks without forbidden triads.

With some cautious wording, Granovetter claims that the common-friends postulate implies the triad postulate. Since Granovetter argues in a non-formal way, he cannot substantiate this alleged implication to which we will come back later.

A typical network, in Granovetter's view, consists of cliques of friends (called 'a densely knit clump of social structure' in Granovetter, 1983, p. 202) with strong ties inside each clique (intra-clique) and weak ties (called bridges) between cliques (inter-clique). (Of course, other network structures exist also – marriages concern people of different sexes and clubs often try to attract people with different occupations.) Since the bridges open up communication or business opportunities to agents outside one's own clique, they are more important than strong ties between friends. Granovetter (1973, p. 1366) states his thesis as follows:

> The contention here is that removal of the average weak tie would do more 'damage' to transmission probabilities than would that of the average strong one.

Hence the title of Granovetter's contribution: The strength of weak ties.

1.1. Empirical tests of Granovetter's thesis

Granovetter's thesis provoked a lot of both empirical and theoretical work in the social sciences. Interestingly, most empirical studies provide a rather skeptic impression on the validity of Granovetter's thesis, while scholars have been eager to construct formal models that corroborate the thesis with little qualification. In the following, we briefly summarize the most relevant literature to motivate our own work.

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From the beginning, the thesis of the strength of weak ties was applied to the labor market. Granovetter (1974) provides empirical support for the claim that workers use contacts in addition to formal means if they search for a new job. Further, for reasons outlined above, scholars conjectured that weak ties should be more important in the search for a new job, i.e., more jobs should be found through the use of weak ties, these jobs should be paid better and should have higher occupational prestige. Empirical studies show that about 40–50% of all job matches are due to social contacts (e.g. Franzen and Hangartner, 2006; Granovetter, 1974), confirming his first claim. However, the second claim – weak ties are more important for job matches than strong ties – is highly controversial. Some studies provide clear negative evidence (e.g. Bridges and Villemez, 1986; Forse, 1997; Marsden and Hurlbert, 1988), while other studies provide rather modest support (e.g. Biang and Ang, 1997; Sprengers et al., 1988). More recently, Tassier (2006, p. 706), whose own study validates the claim, comments on the state of the art as follows: 'In summary, despite the intuitive appeal of the notion that using weak ties to find a job may increase income, for the most part, past effort to show a clear empirical link between weak ties and income have failed (Mouw, 2003).' Granovetter (2005, p. 37) himself comes to a somewhat more positive assessment: 'Whether the use of weak or other ties in finding jobs significantly affects wages, wage growth, job satisfaction and productivity has been debated but not resolved. Large aggregated data sets sometimes do not show clear effects (as in Mouw, 2003), but more focused and specialized samples often do.'

1.2. Theoretical models related to Granovetter's thesis

While these empirical studies show that Granovetter's thesis is too general and must be qualified, the formal models related to Granovetter's ideas either corroborate his thesis or use the thesis as an assumption to derive additional implications. Following are short discussions of the most relevant models with respect to Granovetter's thesis, i.e., Boorman (1975), Montgomery (1992, 1994), Fararo (1983) and Fararo and Skvoretz (1987).

Boorman (1975) constructs a game-theoretical model based on the following ideas. Each of a set of agents has to distribute a fixed time budget on weak ties and strong ties. Strong ties are more expensive to maintain than weak ties. In each time period there is a certain probability that an agent loses his job and there is a certain probability that an agent gets the information about a vacant position (this information comes from outside the model). Each agent employs a priority rule: If he gets the information about a vacancy and is unemployed, he takes the job himself. If he is not unemployed, he offers the job to some of his unemployed strong contacts. If he and all of his strong contacts already have a job, he offers the job to some of his unemployed weak contacts. Assuming that each agent wants to minimize the probability of being unemployed, Boorman (1975) shows that in a symmetric equilibrium agents invest all their time in weak contacts, provided that the probability of losing a job is not too close to 1.

While Granovetter and Boorman come to a similar conclusion – weak ties are more important than strong ties for the transmission of information in networks – the underlying mechanisms are very different. Granovetter's argument rests on the 'forbidden triad' which has the consequence that all bridges are weak ties. Boorman (1975, p. 224) explicitly rejects this idea and in fact assumes that there are no closed triads, i.e., he assumes that if a is connected with b and b is connected with c, there is no connection between a and c. Instead, Boorman's model is driven by the assumption that strong ties take more time to maintain than weak ties. While this assumption certainly is in line with Granovetter's reasoning, Boorman's model does not capture the central mechanism Granovetter invokes to establish his thesis.

Similar criticism must be directed at the two formalizations of Granovetter's thesis due to Montgomery (1992, 1994). Both models deal with the application of the thesis to the labor market. Montgomery (1992) builds on economic job-search theory (cf. Mortensen, 1986) to analyze the effects of network composition on wages. It is unnecessary to describe this model in detail, because it does not derive Granovetter's thesis from some underlying assumptions. Instead Montgomery's model rests on the thesis to derive further implications regarding life earnings. More specifically, Montgomery (1992, p. 588) comes to the conclusion that if '[. . .] a given weak tie is more likely to produce new information than a given strong tie' the proportion of contacts via weak ties has a positive influence on the reservation wage and hence expected life earnings. In a nutshell, this model is best interpreted as studying the consequences of Granovetter's thesis on the labor market, not as a derivation of Granovetter's thesis.

Montgomery (1994) constructs a Markov model of employment transitions. In this model, society is organized in dyads which are connected via strong ties. At any point in time, each dyad is in one of three states: Both individuals are employed, both individuals are unemployed, or exactly one individual is employed. At any point in time, there is a certain probability that each individual is either in contact with his dyad partner or with some other individual via a weak tie. Employed individuals lose their job at a fixed rate. Unemployed individuals get jobs via employed contacts and through formal channels, the latter at a constant rate. Montgomery assumes that unemployed contacts never know of any job, that employed dyad partners know of a job with some fixed probability, and that employed contacts via weak contacts provide a job with a certain probability. From this assumption, Montgomery derives the transitions rates between the states of the dyads. Of course, in equilibrium these rates are required to equal zero. It turns out that for a plausible range of parameter settings, the employment rate is increasing in the proportion of social interaction via weak ties.

As in Boorman's approach, in this model there is little akin to the postulate of the forbidden triad. Hence the underlying mechanism generating the beneficial consequences of weak ties are very different to Granovetter's reasoning.

Thus, the approaches by Boorman and Montgomery partly support Granovetter's conclusion, but they do not capture the underlying mechanism Granovetter describes in his original paper. The model closest to Granovetter's reasoning stems from a series of papers by Thomas J. Fararo and John Skvoretz (e.g. Fararo, 1983 and Fararo and Skvoretz, 1987). They employ the theory of biased random nets to explicate the strength of weak ties. A random net consists of a set of nodes. Consider some subset of nodes; in the first stage ($t = 1$) of the so-called tracing procedure, each node from the starting subset connects with $a > 0$ nodes, each node having the same probability of being contacted. Some of the nodes contacted in the first stage will not be from the starting set. Each of these nodes contacts $a > 0$ other nodes in the second stage ($t = 2$) of the tracing procedure, and so on ($t = 3, \ldots$). Theoretically, this set-up raises the following question: What is the expected number of connected nodes in stage t? For the case of unbiased random nets, i.e., if each node has the same probability of being contacted by some other node, Rapoport (1979, p. 6) showed that if $t \to \infty$, the expected fraction of connected nodes, γ, is implicitly defined by

$$\gamma = 1 - e^{-a \cdot \gamma}.$$

Numerical analysis shows that γ, called connectivity, is a positive function of a, called element density. Fararo's formalization of Granovetter's thesis rests on this observation and the concept of a biased random net. As already explained, in an unbiased net each node has the same probability of being contacted by some other node. In a biased random net, the probability that two nodes get in