Journal of Public Economics 136 (2016) 30–44

Contents lists available at ScienceDirect

Journal of Public Economics

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

Conformism and self-selection in social networks

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ARTICLE INFO

Article history:
Received 4 November 2014
Received in revised form 28 December 2015
Accepted 27 February 2016
Available online 7 March 2016

JEL Codes:
D85
C31
C57

Keywords:
Conformism
Social networks
Peer effects
Social interactions
Network formation

ABSTRACT

I present a model of conformism in social networks that incorporates both peer effects and self-selection. I show that conformism has positive social value and that social welfare can be bounded by network polarization and connectivity measures. I apply the model to empirical data on high school students' participation in extracurricular activities. I find that the local effect of conformism (i.e. the endogenous peer effect for a fixed network structure) ranges from 7.5% to 45%, depending on the number of peers that an individual has. Simulations show that the optimal policies of an inequality-averse policymaker change depending on a school's enrollment. Small schools should encourage shy students to interact more with other students, while large schools should focus on promoting role models within the school.

1. Introduction

Do teenagers smoke because their friends smoke, or do they smoke in hopes of making new friends? Does peer pressure come from *influence* or *self-selection*? The literature on peer effects in social networks has mainly focused on influence, while the literature on network formation has focused on self-selection. To date, these two sources of social interactions have mainly been studied separately.

In this paper, I present a model of conformism in social networks, where *both* influence and self-selection affect behavior. The magnitude of each effect can be clearly identified because changes to an individual's peer group induce discontinuous changes in the individual's behavior, while changes in how individual's peers behave (holding constant who an individual chooses as his peers) induces continuous changes in an individual's behavior. I characterize the set of all (Nash) equilibria and present an equilibrium refinement (perfect and robust) based on the potential function of the game. I estimate the model using student-level data on participation in high school extracurricular activities, as well as on students' friendship networks.

I show that, for a social planer with quadratic preferences, equilibria can be ranked according to the variance of equilibrium behavior and that conformism has a positive social value. I also show that the optimal policy results from a trade-off between *connectivity* and *polarization*. A social planer who wants to prevent the emergence of bad (i.e. high-variance) equilibria should promote integration and ensure that no group of individuals is isolated from the rest of the network. A social planer who wants to support the emergence of good (i.e. low-variance) equilibria should focus on promoting role models. A comprehensive public policy should thus consider both polarization and connectivity.

I characterize the relationship between individual behavior and the network structure for all equilibria of the game. For any equilibrium, peer effects depend on the number of peers an individual has, and cannot be derived solely from the average behavior of an individual's peers. As a result, the overall impact of conformism on the outcome variable increases with the number of peers an individual has, with each marginal peer having less impact than the previous one. A specific feature of the model is the high degree of unobserved heterogeneity allowed. Accordingly, and due to self-selection, the model cannot be represented as a random exponential graph, which contrasts with the recent literature on empirical network formation.[1]

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[1] E.g. Badev (2013), Chandrasekhar and Jackson (2014) and Mele (2015). See Appendix C for a formal discussion.

http://dx.doi.org/10.1016/j.jpubeco.2016.02.005
0047-2727/

The focus on self-selection is new to the empirical literature on peer effects in social network.[2] In most of the literature, the endogeneity of the social network results from the presence of a fixed variable, observed by the individuals in the model, but unobserved by the econometrician. This variable is assumed to affect the individuals' behavior as well as the network formation process, thus creating endogeneity.[3] Since the unobserved variable is unaffected by the individuals' choices, this has no equilibrium implication. Self-selection however has important equilibrium implications coming from the interplay between (1) the choice of the behaviors given the network, and (2) the choice of the network given the behaviors.

I apply the model empirically using data on high school students' extracurricular activities.[4] Although it is not feasible to estimate the true model, I provide bounds for the density of the equilibrium network; each bound can be interpreted as a latent space model (see, for example, Goldsmith-Pinkham and Imbens, 2013). In practice, the bounds lead to roughly the same estimated parameters. Depending on the number of peers that a student has, the local impact of conformism (that is, the endogenous peer effect for a given network structure) ranges from 7.5% to 45%. Using simulations, I show that the cost of increasing connectivity increases with the size of a school, while the potential benefit decreases. This suggests that small schools should focus on connectivity, whereas large schools should focus on polarization.

The remainder of the paper is organized as follows. In Section 2, I review the related literature. In Section 3, I present a microeconomic model where individuals simultaneously choose their behavior and their peer groups. In Section 4, I present an empirical application using data on student participation in extracurricular activities. I conclude in Section 5.

2. Related literature

This paper contributes to various aspects of the literature on social networks, which I will discuss individually.

I contribute to the literature on conformism in social networks. I focus on quadratic preferences, as in Bisin et al. (2006), Bisin and Özgür (2012) and Patacchini and Zenou (2012). I follow Bisin et al. (2006) and Bisin and Özgür (2012) by assuming that the value of a link between two individuals is decreasing in the distance between their behavior. While Bisin et al. (2006) and Bisin and Özgür (2012) present dynamic theoretical models for fixed network structures, I present a static model of conformism, allowing for self-selection.

Patacchini and Zenou (2012) also focus on quadratic preferences and present an empirical application, which assumes that the network is exogenous. They assume that individuals conform with the average behavior of their peers. This implies that the influence of conformism is the same, regardless of the number of peers they have. I present a model of conformism allowing for self-selection where the influence of conformism grows with the number of peers an individual has.

This paper also contributes to the theoretical literature featuring games in endogenous networks. Hojman and Szeidl (2006) present a model where individuals simultaneously choose their behavior and the agents that they link with within a network. They find, for large enough populations with mostly homogeneous agents, that the equilibrium network is minimally connected.[5] Herman (2013) and Kinateder and Merlino (2014) focus on the provision of local public goods. Baetz (2015) presents a model of strategic complementarities and finds that any (strict) equilibrium is a multipartite network. An extreme version of the model presented in this paper has a similar intuition (see Proposition 7). König et al. (2014) also present a model of complementarities based on an homogeous version of Ballester et al. (2006), where the optimal behavior for a fixed network is given by the individuals' Bonacich centrality. Coherently, they present a model of network formation based on the Bonacich centrality and find that the implied networks are nested split graphs. Bolletta (2015) presents a model based on Bisin and Özgür (2012), where individuals are located on the line, and finds that individuals connect to the closest individuals first. I contribute to this literature by focusing on conformism games, and by presenting a model featuring a wide variety of observed and unobserved heterogeneity, which allows for the estimation of the preference parameters.

This paper also contributes to the empirical literature on network formation (e.g. Boucher and Mourifié, 2015; Chandrasekhar, 2015; Chandrasekhar and Jackson,2014; Currarini et al.,2009,2010; Leung,2013; Mele,2015). As in most of those papers, the model in this paper suffers from the "curse of dimensionality," since the strategy space grows exponentially with the number of individuals.[6] Mele (2015) develops a two-step Metropolis–Hastings algorithm in order to compute the posterior distribution for his model. Chandrasekhar and Jackson (2014) use the set of sufficient statistics for random exponential graphs in order to reduce the computing time. Boucher and Mourifié (2015) and Leung (2013) use mixing random fields to achieve consistent estimation. Most of the literature focusses on random exponential graphs. Since the model developed in this paper is not a random exponential graph (see Appendix C for a formal discussion), the techniques found in the literature cannot be directly applied. I circumvent the computational problem by providing easily computable bounds for the equilibrium network, while allowing for a wide variety of unobserved heterogeneity. In practice, these bounds are tight enough to infer the model's parameters.

This paper also contributes to the large literature on peer effects (e.g. Blume et al.,2015; Bramoullé et al.,2009; Gaviria and Raphael,2001; Sacerdote,2001). [7] Most of the literature focuses on the model usually referred to as "linear-in-mean," where an individual's behavior is affected by his peer group's *average*. The measured impacts of peer effects vary substantially across studies, from nonexistent to more than 90% (see for example the discussion in Sacerdote, 2011, Table 4.2, for peer effects on academic achievement). I present a model where the magnitude of peer effects changes as a function of the number of peers an individual has. I find a peer effect coefficient for teenagers' involvement in extracurricular activities ranging from 7.5% to 45% which represents, on average, an impact of the peer-group average of 15.5%.

Finally, this paper also contributes to the recent empirical literature on peer effects in endogenous networks. As mentioned in the introduction, most papers (e.g. Goldsmith-Pinkham and Imbens, 2013; Hsieh and Lee, 2014; Patacchini and Rainone, 2014; Qu and Lee, 2015) present models where endogeneity is due to the presence of a *fixed*, unobserved variable. That is, there exists a variable, unaffected by individuals' decisions, which is observed by individuals in the model but not by an econometrician. This unobserved variable is assumed to affect the choice of behavior as well as the choice of the network, which creates endogeneity. As in Badev (2013), this paper looks at a different source of endogeneity: individuals' abilities to self-select into the social network. This difference is important since it implies that the choice of behaviors and the network are intrinsically linked, which has important equilibrium implications.

[2] A notable exception is Badev (2013), see Section 2 for a discussion.

[3] E.g. Goldsmith-Pinkham and Imbens (2013), Hsieh and Lee (2014) and Patacchini and Rainone (2014). See Section 2 for more details.

[4] Such activities include chess clubs and sport teams, for example.

[5] For some specifications, they also find that the equilibrium network is a wheel.

[6] The number of possible network structures for a population of n individuals is $2^{n(n-1)/2}$.

[7] See Boucher and Fortin (2015) for a recent review.