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Peer effects in adolescents' delinquent behaviors: Evidence from a binary choice network model ☆

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ABSTRACT

This paper studies peer influences in adolescents' deviant behaviors, including drinking alcohol, doing dangerous things, skipping school and physical fighting, by a binary choice network model with heterogenous rational expectations proposed in Lee et al. (in press). For a wide range of parameter values for social interactions, this model has a unique equilibrium and is not subject to multiple equilibria and other model coherency related issues for discrete choice models. I specify peer reference group based on actual friendship networks. The data are from the National Longitudinal Study of Adolescent Health (Add Health). A school fixed effect strategy is employed to control for the confounding effects. Two ways of calculating marginal effects are evaluated. Robustness analysis is performed with regard to several alternative spatial weights matrices. I find that both endogenous and contextual effects exist in all the activities considered, even after controlling for school fixed effects. Similar to the case of continuous variables, the results are robust to several alternative specifications of the weighting matrix based on friend heterogeneity, providing justification for the common practice of assigning equal weight among friends. The changes in the results under the friendship reciprocity assumption indicate the relevance of the real friendship nomination network.

1. Introduction

Participation in deviant behaviors such as drinking alcohol, skipping school, physical fighting and the like is widespread among adolescents. Several studies, e.g. Dee (1999) and DeSimone (2008), demonstrate that involvement with risky behaviors could imply a significant human capital loss for adolescents, which in turn impair their future labor market performance and earning capacities. Furthermore, many risky behaviors, such as alcohol drinking, are addictive, thus could pose a long term negative impact on health and other related outcomes. Therefore, understanding the determinants for these deviant behaviors among adolescents is of great importance to the youth human capital accumulation and the labor market in the long run.

Among the factors that determine youth behavioral outcomes, peer influence has been argued to be a crucial one. As pointed out by many researchers, peer group is an important context of providing information flow, shaping social norms and expectations for young adults, playing a prominent role in adolescents' development. Many studies, such as Duncan et al. (2001), Haynie (2002), and Lin (2010), to name a few, demonstrate that adolescents are significantly influenced by their friends in a variety of outcomes. Meanwhile, many economists are skeptical of the empirical importance of peer effects due to a number of methodological and identification problems.

As noted by Manski (1993), the first difficulty in peer effect estimation is the "reflection problem", which refers to the impossibility to disentangle different types of social effects. An individual's outcome (e.g. alcohol drinking) may be affected by his or her peers' outcomes (e.g. alcohol drinking), the so-called endogenous effect, and/or by peers' characteristics (e.g. family background), the so-called contextual effect. The feedback mechanism induced by endogenous effect gives rise to the

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possibility of social multipliers, which serve to amplify the impacts of any exogenous shock such as policy intervention, while contextual effect does not generate such mechanism. Therefore, these two types of social effects have different policy implications. Unfortunately, separately identifying these two effects is not possible in the conventional linear-in-means model for social interactions. Another difficulty in peer effect estimation is the separation of social effect from non-social effect, the so-called correlated effect. Correlated effect arises through endogenous group formation, common institutional or environmental factors, causing group members to behave similarly even in the absence of social effect. Failing to control for confounding effect will lead to spurious estimate of peer effect.

In addition to the difficulties raised above for the linear social interaction model for continuous variables, estimation of social interaction effect in a discrete choice framework faces further challenges. In particular, the reduced form model, which is necessary for estimation and can be easily obtained for continuous variables, is more complicated to derive in a discrete variable setting. And as in the case of simultaneous probit model (Heckman, 1978; Maddala, 1983), the possible multiplicity or non-existence of the equilibrium also complicates the estimation to a large extent. Furthermore, the proper calculation marginal effect calls for more sophisticated procedure which takes into account the equilibrium feature of the network system.

To address these identification issues, I employ the binary choice model with social interactions under heterogenous rational expectations in Lee et al. (in press) to identify the influences of peers on an adolescent's decision to participate in four delinquent behaviors: drinking alcohol, doing dangerous things, skipping school and physical fighting. Data are from the National Longitudinal Study of Adolescent Health (Add Health). Both endogenous and contextual effects are identifiable in the model. And the correlated effects caused by commonly observed or unobserved characteristics shared by students within the same school, such as school or state institutional regulations, school locations, local prices and so on, are controlled for by school fixed effects. Two ways of calculating marginal effects are considered. One is the conventional way which ignores the social interaction feature and assumes the changes of contextual variables and friends' expected average choices are exogenous. The other is the proper (sophisticated) approach which takes into account the equilibrium nature of the system and incorporates the multiple impacts of the change of a particular individual's characteristics. And the changes in endogenous and contextual variables are induced by the changes in own characteristics through social interactions and are regarded as endogenous. In addition, this paper builds on Lin (2010, 2013), which study issues related to social interaction estimation for continuous variables, to explore the proper specification of the spatial weights matrix that summarizes the social network structure, in a discrete choice framework. To my knowledge, this is the first paper that empirically documents the robustness of the estimation results to different specifications of the weighting matrix in a discrete choice setting. Specifically, to account for the heterogeneity among peers, I allow elements of the weighting matrix to depend on friend nomination order, on the amount of activities associated together, etc. I also explore the sensitivity of the results to the friendship reciprocity assumption.

The results show that both endogenous and contextual social effects exist in all the four deviant behaviors considered, even after controlling for school fixed effects, implying that peer effect can be utilized as a potential policy tool to reduce delinquent behaviors among adolescents. The significant reductions in the estimated social effect parameters in the models with school fixed effects from the model without indicate the serious bias caused by the confounding factors, for all four outcomes under study. Consonant with Lin (2013), friend heterogeneity does not appear to be an issue. In fact, the models based on the weighting matrix with equal weight for all friends, on the weighting matrix assigning different weights according to friend nomination orders, and on the weighting matrix that assigns weights according to the activities involved together all generate very similar results.[2] And similar to the case of continuous variables studied in Lin (2013), the imposition of the friendship reciprocity assumption slightly changes the estimation results, which indicates the relevance of the real friendship nominations.

The remainder of this paper is organized as follows. Section 2 reviews the related literature, and Section 3 discusses the binary choice network model along with the proper way of calculating marginal effect. The description of the data and empirical specification are provided in Section 4. Section 5 presents the estimation results and the robustness analysis is given in Section 6. Section 7 concludes.

2. Literature review

Numerous papers study peer effects in academic performance, criminal behaviors and so on, in a continuous variable setting, including Calvó-Armengol et al. (2009), Hanushek et al. (2003), Lin (2010, 2013), Patacchini and Zenou (2012), Sacerdote (2001), and Zimmerman (2003), among others. In contrast, research on discrete choice variables with social interactions is rather limited. This is largely due to the methodological difficulties involved: one needs to address not only the well known identification problems in peer effect estimation, but also the complicated issues such as model coherency related to the limited dependent variable literature. This section surveys some recent papers that analyze social interactions in a discrete choice framework.

For the sake of convenience, several studies of discrete choice variables with social interactions do not pay special attention to the discrete feature of the model. Instead, they focus on addressing the identification issues in peer effect estimation. For example, Gaviria and Raphael (2001) estimate peer influences on the propensity to engage in five activities, including drug use, alcohol drinking etc. among teenagers. They specify a linear model with social interactions, by treating the dichotomous indicator as a continuous dependent variable and estimate the endogenous social effect by a simple two stage least squares method. Powell et al. (2005) specify a probit model for the dichotomous dependent variable, i.e. smoking, and estimate the model by a two-stage generalized least squares. In particular, the endogenous regressor, i.e. peer smoking measure, is treated as a linear function of the instruments and the other exogenous variables. Other studies such as Clark and Lohéac (2007), also rely on a simple probit model to identify the influences of lagged values of reference group behavior in the consumption of tobacco, alcohol and marijuana among adolescents. Bifulco et al. (2011) specify a logit model to study the contextual effects of classmate socioeconomic status and racial composition on several post-secondary outcomes including college attendance, the consumption of marijuana or drinking, using school fixed effects as well as cohort fixed effects. Fletcher (2012) relies on a linear-in-means model to estimate peer effects on alcohol consumption by employing a combined instrumental variable/school fixed effect methodology.

Meanwhile, several studies adopt an equilibrium-based structural approach by taking into account the feedback feature generated by the discrete choice decision made by an individual on the whole network system under social interactions. Brock and Durlauf (2001) propose a random-fields approach to study social interactions in a binary choice setting. They follow Manski (1993) to impose a rational expectation condition on the subjective choice probabilities of the individuals in a large group interaction setting. In their model, an individual is equally affected by all the other members in the same group, and he or she forms (endogenous) homogenous rational expectations regarding the choice probabilities of all the other group members. They analyze the existence, uniqueness and multiplicity of the rational expectation equilibrium in the logistic binary choice specification. On the other hand, other papers study small group interactions where choices of peers

[2] As pointed out in Lin (2013), this finding is assuring as many datasets do not have information about the detailed structure of social networks to distinguish among peers and consequently, peers are usually treated homogenously and given equal weight.