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Prosocial norms and degree heterogeneity in social networks

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Abstract

We provide empirical evidence to support the claims that social diversity promotes prosocial behavior. We elicit a real-life social network and its members' adherence to a social norm, namely inequity aversion. The data reveal a positive relationship between subjects' prosociality and several measures of centrality. This result is in line with the theoretical literature that relates the evolution of social norms to the structure of social interactions and argues that central individuals are crucial for the emergence of prosocial behavior.

1 Introduction

The emergence and maintenance of prosocial behavior has been widely analyzed. Recently, the literature has pointed out the important role of heterogeneity in some of its forms [1, 2, 3, 4, 5, 6].

Following Nowak and May's [7] seminal contribution, there is a growing body of literature that advocates *network interaction* as a key element for the evolution of social norms [1, 8, 9, 10]. Some papers have explored the role of specific network architectures in promoting the stability of prosocial traits. Santos and Pacheco [3] were the first to stress the role of scale-free networks, specifically those in which degree follows a power-law distribution [11]. More recently, it has been shown that degree heterogeneity, which is characteristic of the power-law distribution, is the key element for social norms to thrive

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in such networks [4, 12, 13, 14, 15, 16, 17]. The underlying intuition is that norms promoted by central individuals are easier to spread than norms promoted by peripheral members of the population. Hence, cooperation can stabilize if central positions are occupied by individuals adhering to the norm. If evolution has indeed evolved this way we should find a relation between network position of humans and their prosocial behavior.

In this paper, we analyze the relationship between network centrality and a specific prosocial norm, *inequity aversion*, defined as subjects' willingness to promote a fair outcome at their own cost [18, 19]. There is a large body of interdisciplinary and cross-cultural evidence that people have social preferences to reduce inequity [20, 21, 22, 23, 24], and recent neural evidence has confirmed the existence of egalitarian motives in humans [25].

To this aim, we elicit the social network within a group of undergraduate students and collect information about their inequity aversion by way of simple experimental protocols. Our data set consists of a network of almost 300 individuals. For a subset of these 300 individuals inequity aversion is measured by their willingness to even off an unequal prize allocation.

In this respect, the evidence reported here is consistent with previous research on the relationship between connectivity and social norms. Brañas et al. [26] find a positive association between network centrality and unconditional altruism. Along similar lines, Cassar [27] reports the results of a laboratory analysis in which more connected subjects cooperate more in the Prisoner's Dilemma (even though network architecture is artificially created in the lab).

2 Methodology

The participants in our study were first-year undergraduate students at the University of Granada, Spain. The experiment consisted of several sessions. In this analysis, we use data from two of these sessions: (i) network elicitation and (ii) inequity aversion elicitation.

1. Network elicitation. We elicit the (directed) social network of a class of first-year undergraduate students in economics. A total of 291 students (out of the 360 registered) either participated in the elicitation or were named as friends by participants. Subjects were asked to write down the names of friends in the class whom they may have the chance to benefit in later phases of the experiment (without any specific information on how this would be implemented). With the objective of eliciting mostly strong links, the instructions clearly stated that subjects might be given the chance to benefit only one of their friends. Given that the beneficiaries were randomly selected from each subject's list, the more friends they listed, the lower the chance of benefiting any specific friend. Despite the relative simplicity of the protocol, we obtained an average of 42.2% bidirectional links. This procedure resulted in a very accurate mapping of social correspondences when compared to more sophisticated protocols used for analogous purposes [26, 28, 29].

Insert Figure 1 around here

As shown in Figure 1, the elicited network shares features of typical social network architectures [30]. More precisely, there is a giant component encompassing 201 (69%) network vertices, the second largest component only contains 11 nodes and there are 24 (8%) unconnected nodes. The average (undirected) degree is 2.74 neighbors (Std. Dev. 1.85). The clustering coefficient (i.e. the average fraction of links of a node that are linked themselves) is 0.34. Notice that the expected clustering in a randomly generated network of the same size and connectivity would be roughly 2.74/291=0.0094, two orders of magnitude lower than the observed level. We also observe a tendency of highly connected nodes to be interconnected (the correlation between the degrees on both sides of a link is 0.36) and relatively small distances (the average and maximum distance and diameter in the giant component are 7.77, SD 3.64, and 24, respectively).

2. *Inequity aversion elicitation.* Since network and inequity aversion elicitations were performed in different sessions, not all subjects attended both phases of the experiment. Overall, we were able to collect both network and inequity aversion measures for 169 subjects of our sample. The social norm elicitation comprises two stages.

Stage 2.1. In this stage, subjects have to fix the allocation of 10 experimental points between two subjects [25, 31]. The purpose of this stage is to artificially generate inequity since only one of the two subjects receives the entire endowment, while the other gets nothing. We ran Stage 2.1 under two treatment conditions. In the first treatment, the individual who decides the allocation, the Dictator, is one of the two recipients. This yields a variant of the classic *Dictator Game*, where a player decides the payoff distribution between herself and the recipient [32]. The only difference with regard to the standard Dictator Game is that the decision-maker in our experiment can either give all or nothing [24]. In the second treatment, the Dictator who decides over the all-or-nothing allocation is a third party who receives no benefit from the allocation she picks. In each of the two conditions there were two frames: $Stranger$ and $Friend$. In the latter frame, the Dictator is matched with subjects from her list of friends, while in the first frame the match is not on the list. Dictators are only aware that the recipient is one of her friends in the Friends frame, while they have no information about the recipients in the Stranger frame. Recipients do not know anything about the Dictators. All the individual decisions were private.

This design generates four different treatments. The number of observations for each treatment is shown in Table 1.

Insert Table 1 around here

Stage 2.2. This stage is designed to elicit subjects' inequity concerns. In this stage, the decision-makers have to state how much they are willing to pay so that the subjects who have *not* been given anything also receive 10 points. The possibility of inequity reduction had not been announced before this stage

to minimize the risk that the first-stage decision would be nuanced by the possibility of ex-post redistribution. This elicitation is performed using a payment card. Subjects face ten different situations with the following structure:

"I am willing to pay 1 point in order to give the other player the opportunity to obtain 10 points" Yes ☐ No ☐
"I am willing to pay 2 points in order to give the other player the opportunity to obtain 10 points" Yes ☐ No ☐
...
"I am willing to pay 10 points in order to give the other player the opportunity to obtain 10 points" Yes ☐ No ☐

The subjects' task is to mark all the options they are willing to accept. We use the maximum amount subjects are willing to pay as the measure of inequity aversion since it represents how much they value equity.

To provide a common frame for our statistical exercise, we first normalize the data from stage 2.2 by subtracting the corresponding treatment median from each observation. Table 2 provides summary statistics and Figure 2 shows the distribution of inequity aversion.

Insert Figure 2 around here

Insert Table 2 around here

3 Results

Figure 1 illustrates the relationship between network position and inequity aversion. The color of each node represents subjects' level of inequity aversion. The white nodes correspond to subjects whose willingness to pay is below the treatment median, the red nodes correspond to subjects above the median, and the yellow nodes correspond to subjects in the median. Finally, the grey nodes denote individuals who did not participate in the social norm elicitation.

We then apply standard measures in network theory to test our research hypothesis that subjects' inequity concerns are (positively) correlated with their centrality in the network. We analyze five measures of centrality:

1. in-degree, the number of subjects who name i as a friend;
2. out-degree, the number of individuals i names as friends;
3. degree, the number of links of a node i;
4. reciprocal degree, the amount of i's reciprocated ties;

5. betweenness centrality, the number of shortest paths between all pairs of individuals (different from i) passing through i.

While the first four measures define *i's* network position *locally* (since they are determined by i's neighborhood mapping), betweenness accounts for i's *global* centrality since the determination of betweenness involves the entire network. Table 2 provides summary statistics of these measures in the sample.

Table 3 explores the effect of these social integration measures on revealed inequity aversion. We estimate standard ordered Logit regressions in which the probability of any possible level of inequity aversion is regressed against one of the above-mentioned social integration measures. We also control for gender, which has been shown to have a significant impact on social norm adherence [33].

Insert Table 3 around here

The significance of network measures suggests that social integration is related to inequity concerns. In the regressions, all measures but in-degree have a significant and positive impact on inequity concerns. The positive signs of the coefficients support our research hypothesis that more connected individuals "adhere more" to the prosocial norm. As for the magnitude of the effect, for instance, one unit increase in degree increases the odds of giving one more point by exp (0.18)=1.1972. The effect is even larger for out-degree and reciprocal degree. The importance of these findings is strengthened by the fact that the global measure of centrality, betweenness, also significantly affects subjects' inequity concerns.

4 Summary and Discussion

Our results are related to the hypothesis that heterogeneity in network positions may have played an important role in the evolution of human prosocial norms such as altruism, cooperation or inequity aversion. Norms followed by central individuals spread more easily in the population and our data suggest that central positions are occupied by more prosocial individuals.

Ideally, further empirical evidence should explore the dynamic interplay between social norms and social structures over time, that is, how network architecture and behavioral traits coevolve. These studies should shed some light on the crucial issue of *causality* (i.e. which causal direction we should give to our detected correlation between network integration and inequity aversion). Work along these lines is already in progress.

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[31] The experimental currency were classpoints that served to increase the final grade in the Microeconomics course. This experiment was the first out of four different experiments and the payoff system was as follows: The best performing subject in the four experiments earned 3 points in grade out of 10. In other words, the winner earned 30% of the final grade of the course. The remaining subjects' earnings depend on how close their performance is to the winner. Each of the four experiments had equal weight in the final count. Thus, the winner could have earned 7.5% of the final grade of the course by the performance in the reported sessions.

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	stranger	friend	Total
player involved	28	27	55
player not involved	64	50	114
Total	92	77	169

Table 1. Number of observations per treatment

Variable	Obs.	Mean	*SD*	Min	Max
inequity aversion	169	-0.12	1.52	-4	3
in-degree	169	2.01	1.69	0	8
out-degree	169	2.17	1.47	0	6
reciprocal degree	169	1.66	1.90	0	7
degree	169	2.92	1.46	0	8
betweenness	169	574.9	1015.71	0	6244.5

Table 2. Summary statistics

Figure 1. The elicited network of participants. Nodes represent participants, edges represent friendsh relationships. Colors reflect the level of inequity aversion (IA). Red, Above- median IA. Yellow, Medi White, Bellow- median IA. Grey, IA not elicited.

Figure 2. The distribution of inequity concerns (normalized by treatment medians).

inequity aversion	(1)	(2)	(3)	(4)	(5)
in-degree	.12 (.08)	-	-		
out-degree	-	.29** (.10)	-	-	-
degree	-	-	.18* (.07)	-	-
reciprocal degree	-	-	-	.23* (.12)	-
betweenness	-	-	-	-	3.37×10^{-4}** (1.31×10^{-4})
female	−.33 (.28)	−.40 (.28)	−.38 (.28)	−.34 (.28)	−.37 (.28)
N	169	169	169	169	169
LR χ^2_2	3.07	10.00	6.60	4.86	7.33
P $> \chi^2_2$	.22	.01	.04	.09	.03
Pseudo R^2	0	.02	.01	.01	.01

Significance level: ** 1%, * 5%. Standard errors in parentheses.

Table 3. Social norms and Centrality: Estimation Results