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Eliciting real-life social networks: a guided tour

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Abstract
This paper surveys some of the mechanisms that have been proposed by the experimental literature to elicit social networks. These mechanisms differ in their incentive structures, as well as the means of reward they employ. We compare these elicitation devices on the basis of the estimated differences in the characteristics of the induced networks, such as the number of (mutual) links, correspondence and accuracy. Our main conclusion is that the elicited network architecture is itself dependent on the structure (and the nature) of the incentives. This, in turn, provides the social scientist with guidelines on the most appropriate device to use, depending on her research objectives.

JEL Classification: C9; C72; D85

Keywords
social networks — economic experiments — coordination games

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Introduction

There is a growing literature that highlights the importance of networks in our social and economic life. These works experimentally explore how social networks influence behavior in a wide variety of environments, from job search to information transmission within firms, when it becomes crucial to understand how networks' architecture influences individual behavior and, vice versa, what is the impact of individuals' decisions on the network's structure and performance[1].

The aim of this paper is to survey the –rather scarce– literature that looks at various mechanisms to elicit *real* (rather than *fictitious*, or artificially created in the lab) social networks. The latter are, mainly, friendship networks. These mechanisms vary from simple surveys (in which subjects are just requested to name their friends without incentives) to more sophisticated devices in which network elicitation takes place under simple incentive schemes, designed to induce subjects to truthfully reveal the network of their social relationships. These mechanisms employ heterogeneous means of reward (from financial incentives, to exam grades) and rely on different coordination devices.

Clearly, any empirical analysis on social networks crucially depends on the elicitation device being used. This consideration notwithstanding, in all the cited papers the mechanism design problem associated with real-life network elicitation is kept in the background: once the network topology has been mapped explicitly, this is when the action starts. Nonetheless, the basic message of this paper is that *friendship is a subjective domain*, in that individuals may perceive their social ties asymmetrically, as well as of a different intensity. This, in turn, makes the exercise of network elicitation subject to significant measurement errors. When economic incentives are employed –not surprisingly– *the elicited network architecture is itself dependent on the nature (and the structure) of these incentives*[2]. In this respect, this paper provides the social scientist with guidelines on the most appropriate elicitation device to use, depending on the research main objectives.

The remainder of the paper is arranged as follows. Section surveys the various devices employed for network elicitation, while in Section we look at their differences from the viewpoint of mechanism design, by comparing the incentive structures of the induced game-forms. Section reports our empirical findings, confirming our main conjecture: *network architecture strongly depends upon the characteristics of the elicitation device*. Finally, Section concludes. The Supplementary Materials online contains further design details, experimental instructions and graphs of representative networks.

Network elicitation mechanisms

This section describes the most popular devices for real-life network elicitation, ordered by their complexity. Starting from non incentivized surveys, we move toward simple strategic schemes in which network elicitation is rewarded with different means and relies on different coordination patterns.

[1] See the surveys of Vega-Redondo (2007), Goyal (2007) and Jackson (2010).

[2] Along these lines, see also Comola and Fafchamps (2014)

Non-incentivized devices

What we know about social networks in Sociology comes from non-incentivized surveys in which subjects are asked to list their friends (see, among others, Barabasi and Albert (1999). We will refer to them as HYPS devices (the acronym refers to the "hypothetical" nature of rewards, which is the term being used in Experimental Economics to indicate the absence of incentives).

The combination of behavioral and survey data has been extremely useful in studying, for instance, the interplay between social ties and behavioral traits among teenagers: educational aspiration levels, political orientation, consumption of marijuana, crime and so forth. These studies have been useful in understanding people's tendency to link with those who display similar behavioral traits, namely, *homophily* (Jackson and Rogers 2007) and the strong preference for *cliques*: individuals prefer to link with those who are already linked to each other (Goeree *et al.* 2010).

Banerjee *et al.* (2013) use a non-inventivized mechanism to elicit *central* individuals in a social network[3]. Their goal is to develop a micro-finance program in some villages in India through central individuals in the network. In an extensive survey they include a section that collects social network data along 12 dimensions: names of those who visit the respondent's home, those whose homes the respondent visits, non-relatives with whom the respondent socializes, etc. Individuals are allowed to name as many as five to eight network neighbors, depending on the category. The data exhibit almost no "top-coding": less than 10% of the respondents names the maximum number of individuals in any single category.

However, HYPS networks are not exempt from problems. For instance, it is unclear whether individuals' responses are more likely to represent the desire to establish a link with others ("aspirational" friendships) rather than to flag a "real" relationship. It is also unclear whether misreported links are due to a desire for privacy.

Benefit-Your-Friend

The Benefit-Your-Friend (hereafter BYF) protocol has been first proposed by Brañas-Garza *et al.* (2010). In essence, BYF is *a survey with social incentives*, in the sense that subjects do not receive any direct reward for naming a friend, but give the latter some chance to be rewarded by having been named. The protocol is extremely simple: subjects are asked to write down the name of their friends from the same undergraduate class on a piece of paper. As it is stated in the instructions, "*there is a chance that one of them will be benefited later in the experiment*". No further information is provided at that stage on the type of decisions subjects would make afterwards, or what these future benefits might be: participants are not aware of the nature of the rewards and, therefore, cannot condition their "eliciting strategy" to this information. As a result, it is very unlikely that this mechanism yields a social network of subjects with specific needs (money, grades, etc...).

On the other hand, BYF aims at revealing the identity of "close friends". The instructions clearly state that subjects might be given the chance to benefit "*only one of their friends*", randomly selected from the list. Therefore, the higher the number of friends they list, the lower the chance of benefiting any one of them.

Coordination Game I

The first example of an incentivized mechanism comes from Leider *et al.* (2009). Its challenging results motivated this literature, whose aim is to design incentive-compatible mechanisms to induce subjects to truthfully reveal the complex network underlying their social relations.

Leider *et al.* (2009) develop an elicitation protocol based on a simple coordination game, we call it COORD-I, with the following rules: *i*) participation is voluntary, with recruitment conducted via the Internet; *ii*) COORD-I is a coordination game by which each subject has to pick the name of her ten best friends from a list of students of two university dorms, together with an estimate of the time spent together with each of them; *iii*) the outcome function of the mechanism is as follows: all links are checked, yielding a lottery by which subjects are rewarded with a prize of 50 cents with a 50% chance if the link is reciprocated, and nothing otherwise. If the difference in the reported time spent together (per week) is lower than one hour, the winning probability is raised to 75%. Leider *et al.* (2009) also use a variation of this elicitation device: *iv*) subjects have to name their best ten friends about whom they would answer some questions in the following weeks. For each correct question both friends answer, they both receive a prize. In this way, participants have incentives to name those friends they know sufficiently well.

Cobo-Reyes and Jiménez (2012) employ a mechanism, COORD-II, that can be thought as an intermediate device between BYF and COORD-I. Like in BYF, only one link is checked at random for payment; like in COORD-I, a link is rewarded only if it is reciprocated. Extensive information about this device is provided in the Appendix.

There are some important innovations in COORD-II with respect to COORD-I: *i*) recruitment is not voluntary but participation is; *ii*) to be rewarded, links have to be reciprocated with sufficiently close *precision* (mutual perception of "strength" of the friendship: a subjective assessment on a scale from 0="no friendship" to 4="close friendship"); *iii*) subjects are also allowed not to name anyone and still receive the full prize.

In addition, COORD-II varies between subjects the means of reward: *no reward* (TN), *monetary reward* (TM, 5 €) and *class points* (TP). Clearly, different reward means may elicit different networks with different characteristics, as they trigger different domains of friendship relationships.

Table 1 summarizes the different design features of the

[3] Betweenness centrality is an index which measures how "central" each subject is in the network by counting the number of shortest paths connecting any pair of nodes in the network which pass through that particular subject. To obtain this index, we need to look at the entire network architecture, instead of simply considering the local properties of a given node.

elicitation devices surveyed in this paper.

Table 1. Features of the elicitation mechanisms

Mech.	Inc.	SymmL	IRL	Exit Option
HYPS	No	No	-	-
BYF	No	No	-	-
COORD-I	Yes	Yes	Yes	No
COORD-II	Yes	Yes	No	Yes

Note: *Mech.* refers to Mechanism and Inc. to Incentives, *SymmL* to Symmetric links, *IRL* to Increasing reward with links

Theoretical conjectures

There is a variety of reasons why subjects would prefer (or not) to coordinate in each of these friendship elicitation games. We do not only consider problems related to coordination failure, but also those related to the means of reward and social preferences, like envy or altruism.

Coordination and symmetry

We have already noticed that both COORD-I and COORD-II –as opposed to HYPS and BYF– reward reciprocal elicitation. Even more, using two different devices (one more "objective", as time spent together, one more "subjective", as the subjective assessment of the "strength" of the relationship), both mechanisms provide incentives to elicit *symmetric* relationships (i.e., relationships that are perceived as similar by both parties involved). This is natural for any elicitation device based on coordination, where we expect subjects to disregard links that may be lived of a different intensity by either party. Whether asymmetric relationships may play a role in the topics object of study by the cited papers is open to discussion. Nevertheless, *we may expect asymmetric relationships to be underestimated* by any elicitation device that relies on coordination. The reason is that only when the two subjects who are part of the link name each other, the link is considered in the network (this is, by definition, a *symmetric* –or *undirected*– network).

Rewards

In BYF participants do not know the nature of the rewards (monetary, grades, etc.) their named friends could enjoy in the future. As a result, it is very unlikely that this mechanism elicits a network of those friends who need anything specific, whether money or grades.

In addition, in COORD-II there are two different means of reward: money or grades. Before providing any conjecture about differences in behavior due to a difference in rewards, we should focus our attention on the effect of the "exit option" of naming no friends in this mechanism. If a subject believes that a friend may name her, she should reciprocate in order to avoid her friend to lose the reward. Therefore, if participants think that their friends are in need of money or class points they should not name them, since those friends can assure themselves the maximum payoff for not naming anybody. In this sense, it is likely that the means of reward affect the "type" of friends participants decide not to name.

All links *vs.* 1

As we already discussed, one important difference between COORD-I and both BYF and COORD-II is that, in the former, all elicited links are payoff relevant, instead of just one, picked at random. This, in turn, implies that, in COORD-I, *expected monetary payoffs are increasing in the number of elicited links.* In other words, COORD-I is meant to map a social network "as dense as possible". Given this design feature, we can expect subjects to name as many friends as possible, not just very close ones. By contrast, both BYF and COORD-II limit to one the number of checked links, forcing subjects to disregard their "marginal" social relationships (i.e., "acquaintances").

Social preferences I: unconditional altruism

As we mentioned in Section , in BYF subjects do not receive a reward by naming a friend. Instead, they grant the latter with the possibility of a future reward. Therefore, the extent to which BYF may outperform HYPS lies in the degree of *unconditional altruism* (see, e.g., Cox *et al.* 2007) subjects hold with respect to their friends, that may be exploited by the eliciting device.

Social preferences II: guilt aversion

As we discussed earlier, COORD-II allows for the possibility of ensuring the full prize by simply not naming anyone. This is labelled as "Case 1" in the experimental instructions (see the Appendix). Cobo-Reyes and Jiménez (2012) introduce this rule for ethical reasons, since they collect this very sensitive information during the standard activities of an undergraduate class (even more in the case of TP, which was administered during the final exam). Remember that, in the experiment, although participation was voluntary, recruitment was not. In this sense, the authors acknowledge that the "exit option" embodied in Case 1 may induce subjects to underreport their friendship network. In game-theoretic terms, under "selfish preferences" (i.e., assuming that subjects are only concerned in maximizing the probability of winning the prize), Case 1 corresponds to a weakly dominant strategy, since it guarantees the highest monetary prize, independently of the others' behavior. On the other hand, the working conjecture of Cobo-Reyes and Jiménez (2012) is that the impact of Case 1 would be limited if subjects hold *social preferences* (i.e., if they are also concerned about the monetary payoffs of their friends). The argument is straightforward: if subjects hold sufficiently strong beliefs that they would be named by their friends, not reciprocating them will turn them down. To the extent to which subjects exhibit *social preferences* (in the special form of guilt aversion, see Charness and Dufwenberg 2006) this breaks weak dominance of Case 1[4]. In fact, it can be shown that the above argument is not restricted to guilt aversion, but is applicable to a wider class of social preferences functions, such those, for example, of Fehr and Schmidt (1999), Bolton and Ockenfels (2000), Martí (2007) or Sobel (2005).

Loss aversion

A different explanation of the features of the network elicited by COORD-II that also relies on the exit option of not naming any friend, is loss aversion. Participants who are loss averse will name a lower number of friends (than those who are loss neutral) and they should mainly name their close friends who will be more likely to risk a safe payoff for them.

Different means of reward

As we discussed, COORD-II is played under three increasing levels of incentives: *no reward* (TN), *monetary reward* (TM, 5 €) and *class points* (TP)[5]. We conjecture (and find) that, increasing the value of the prize may amplify the effects of the strategic properties of COORD-II. We provide in the Appendix a sample of network maps for each treatment, together with some classical measures extracted from these graphs.

Results

This section reports the main estimated differences in the network characteristics. We first look at out-degree, that is, the number of links (i.e., elicited friends) starting from any given node, moving then to link correspondence and strength.

Out-degree

Figure 1 compares the out-degree distribution in Kovarik *et al.* (2012) using BYF in a network of 291 students with that in Kovarik *et al.* (forthcoming), elicited by way of HYPS in a network of 208 individuals.

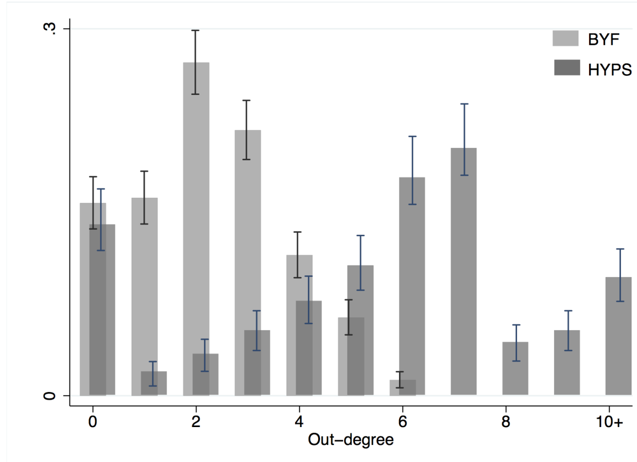
As Figure 1 shows, BYF yields a network with a lower number of links per capita. Interestingly, this does not translate into differences in terms of corresponded links, where relative frequencies sum up to 42.5% and 39% for HYPS and BYF, respectively[6].

[4] Although a strategy profile in which everybody conforms to Case 1 still remains a strict Nash equilibrium of the induced game, it is not necessarily the most efficient one.

[5] A rough calculation shows that an extra point in the final exam may be much more valuable than 5 €. In Spain, students pay tuition fees per credit. The fee for a 6-credit course (1 credit = 10 hour), such as Micro II at the University of Granada, is approx. 60 €. Given past exam history, we can estimate at approximately 15% the ex-ante probability of a student obtaining a grade of 4 to 5 (that is, a grade for which the extra point would be crucial for passing the exam) and another 5% the ex-ante probability of receiving a grade of 8 to 9 (that is, a grade for which 1 grade higher would imply Distinction, which in the Spanish university system implies 6 free credits in the following academic year). As rough as this calculation could be, this adds up to a 20% probability of the extra-point being worth 60 euros, with an expected benefit of $0.2 \times 60 = 12$ €. This in only a *lower-bound*, in fact, the value of 1 extra-credit is definitely larger for many students

[6] Note that the goal of this network mechanism is to elicit the central individuals of the network and not close friends or acquaintances (like in the other devices). In this sense, this networks is not really comparable with the others.

Figure 1. Average distribution of out-degree with 95% confidence intervals: BYF vs HYPS.



Result 1: BYF, compared with HYPS, yields subjects to name fewer subjects.

Figure 2 reports the out-degree distributions in COORD-II conditional upon the means of rewards: no rewards (TN), monetary rewards (TM) and exam points (TP). As Figure 2 shows, the link distribution of TP is "more uniform" and with a wider support than that of TM. Another interesting feature is that about 10% of the participants do not name anybody in both TM and TN. This is the same percentage we found for BYF and HYPS (see Figure 1). Surprisingly, we find that *nobody in TP opt for the "safe" option of naming no friends*. We also see that TN and TM are not that different in terms of links per capita ($z = 0.399$; $prob = 0.6897$ two-tailed test) whether TP is distinct, as it provides a larger out-degree average [TP vs. TM $z = 6.502$ ($prob = 0.000$, one-tailed) and TP vs. TN $z = 6.930$ ($prob = 0.000$, one-tailed test)]. We conjecture that this is a direct consequence of the incentives scheme: *guilt aversion is larger in TP*, where the most valuable reward being is being used.

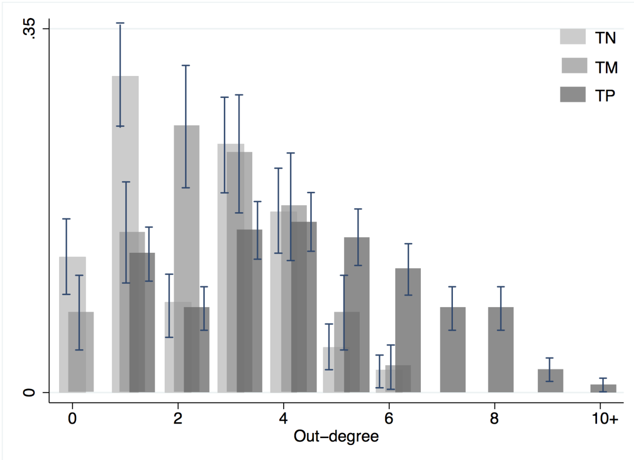
A simple summary of average results (pooling data from different treatments) indicates that COORD-II does not induce naming, compared with the other elicitation devices. Less than 10% of subjects name 6 or more friends while in COORD-I average and modal out-degree is 10[7]. Although TP is the incentive scheme in COORD-II that induces highest link elicitation, still it stays far from the figures of COORD-I.

Result 2: COORD-II elicits fewer links per capita compared with COORD-I.

Result 2 holds independently on the mean of rewards being employed. As Figure 2 shows, nobody in TP (and a very small percentage in TM, 7%) opts for the weakly dominant

[7] Note that this is due to the rules of the mechanism which allow to name a maximum number of ten friends.

Figure 2. COORD-II: distributions of out–degree with 95% confidence intervals by incentive scheme.



strategy of Case 1. In addition, 174 participants in TP and TM who name at least one link are reciprocated at least once. This confirms our "social preference" conjecture.

Link correspondence and strength

We now compare the various mechanisms with respect of their likelihood in obtaining *mutual* (that is, reciprocated) links as a proxy of their performance. Since the probability of two subjects naming each other at random with sufficiently close strength is basically null, if the rate of mutual links captured by a mechanism is sufficiently high, we can then claim that, for that mechanism, most of the links correspond to "true friendships".

We are also interested in looking at the extent to which the differences in the design of COORD-II, compared with COORD-I and BYF, translate into differences in the estimated link correspondence. Recall that the main differences between COORD-II and COORD-I is that the former provides an exit option (Case 1) and, in general, lower incentives to name many friends (given the fact that only one link is paid off). Therefore, we expect COORD-II to capture "strong" relationships, with average elicited links lower than in COORD-I. Regarding the comparison between COORD-II and BYF, in the latter subjects do not lose any money if the link they send is not reciprocated, so we also expect a lower average out-degree –and higher frequency of mutual links– in COORD-II.

Table SM-1 (see Supplementary Materials) looks at the likelihood of COORD-II in obtaining mutual links in the seven networks under consideration. The first three columns of Table SM-1 correspond to data from TP (TP1 to TP3), while column μTP reports treatment averages. Columns 5 to 8 correspond to the TM sessions (plus treatment average, μTM), while the last column summarizes TN statistics. Corresponded links in each network are partitioned into three categories according with the difference in strength (D = 0, D = 1 and D>1). As Table SM-1 shows, almost 74% and 72% of the links are reciprocated in TP and TM, respectively, while only 5% of the links are reciprocated in TN[8]. Recall that COORD-I shows 37% of mutual links, while this frequency is a bit larger in case of BYF: 50% in Brañas-Garza *et al.* (2010) and 42.5% in Kovarik *et al.* (2012). Goeere *et al.* (2010) find a coordination rate of around 50% within a subject pool of children using a survey. All in all, we can say that COORD-II with incentives (TP and TM) provides higher correspondence than COORD-I and BYF. So, we can conclude that the COORD-II is more likely to identify mutual links.

Result 3: Incentivized COORD-II mechanisms elicit reciprocated relations "of close friends".

Kovarik *et al.* (forthcoming) find an average degree of correspondence of 39.5% in four (HYPS) networks containing 208 students who sent 1158 links (5.56 links per capita, see Figure 1). This percentage is much larger than the 5% of correspondence found in TN.

Figure 3 reports the relative frequency of each positive strength across TP, TM and TN[9]. As Figure 3 shows, the number of links associated with "acquaintance" relationships –that is, relationships with a strength not higher than 2– in TP is very small (4% and 11% of the total, respectively). Moreover, the frequencies of links associated to "friendships" ($strength = 3$) and "close friendships" ($strength = 4$) are very similar (45% and 40%, respectively)[10]. Recall that setting a strength equal to 4 is weakly dominated by setting it equal to 3 (see the Appendix).

Regarding TM, Figure 3 shows that the links associated to "acquaintance" relations are also low (similar to the figures in TP, 4% and 11%, respectively). Instead, frequencies of links with strength equal to 3 and 4 are different (50% and 35%, respectively) and this difference is statistically significant (see footnote 10), showing the weak dominance of strategy of setting the strength equal to 3.

Result 4: COORD-II mostly captures reciprocated relations of "close friends" (especially in TP).

Discussion

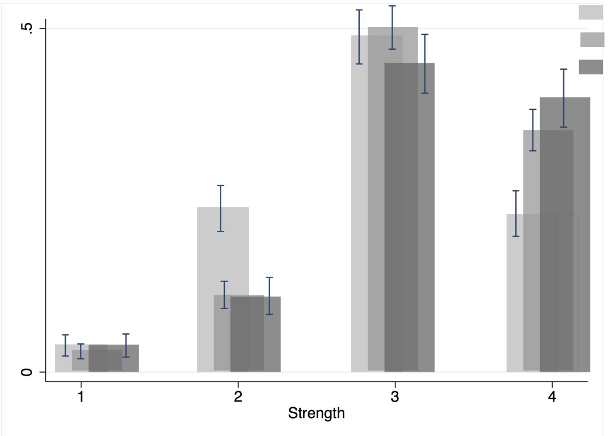
Elicitation is the preliminary step of any empirical analysis of social networks, whatever is the specific object of research. This consideration notwithstanding –with very few exceptions– the growing empirical literature on social networks seems to disregard the most obvious insights from mechanism design and consider the elicited networks as exogenously determined,

[8] We do not find differences between treatments TP and TM ($z = 0.160$, $prob = 0.873$, two-tailed test) while strong differences emerge between TP vs. TN ($z = 9.956$, $prob = 0.000$, two-tailed test) and TM vs TN ($z = 9.834$, $prob = 0.000$, two-tailed test).

[9] The displayed frequency of TP and TM is an average of the three sessions conducted for each treatment.

[10] In fact we do not find any significant difference between number of links with strength 3 and 4 in TP $z = 0.601$ ($prob = 0.548$, two-tailed test) but strong differences in TM $z = 2.473$ ($prob = 0.013$, two-tailed test).

Figure 3. Fraction of links corresponding to acquaintances or friends with 95% confidence intervals: TP, TM & TN.



independently on the objectives of the researcher and the methodologies being employed. This paper fills a gap in the current debate by reporting on four different devices to elicit real-life social networks and accounting for their differences in the methodology being employed, and the observed differences in the network characteristics. Table 2 summarizes our main findings.

1. HYPS is fairly good in terms of links per capita (outdegree), although link correspondence is relatively small.
2. BYF is not very efficient in term of links per capita and mutual links. However, it is extremely simple to implement.
3. COORD-I can be useful to obtain a *directed network*, that is, a graph with a high number of asymmetric links. In other words, COORD-I is optimal if the researcher wants to elicit large networks (taking into account that COORD-I provides higher incentives for naming as many links as possible).
4. COORD-II seems to work better to obtain a *higher percentage of corresponded links*, that is, a non directed network. The limitation of using COORD-II is that we must have a closed environment in order to have the whole network participating at the same time (take, for example a classroom, or a company).

In sum, depending on the researchers' objectives, one mechanism turns out to be better than the others, with no "clear winner" on all dimensions. COORD-I is better when a large network with a high number of nodes is needed and the fact that the induced network is directed (i.e., with a relatively small number of corresponded links) is not important (take, for example, the analysis of individual behavior in non-strategic environments).

Table 2. A comparison among elicitation devices

	Incent.	Links	Strength	Mutual	*N*
BYF	€	220	0/1	45%	79
HYPS	no	1753	0/1	39%	398
COORD-I	€	5690	0/1	37%	569
COORD-II	€	133	0 to 4	74%	58
COORD-II	Points	202	0 to 4	74%	45
COORD-II	no	103	0 to 4	5%	40

By contrast, COORD-II seems more appropriate when analyzing strategic environments and games played in pairs (i.e., when there is interaction between players), since, if we want to analyze how pairs of friends play a specific game, we need bidirectional links to ensure that both members of the pair are friends and there is no deception. Finally, the non-incentivized mechanisms, such as BYF and HYPS, seem to work worse than COORD-I and COORD-II in terms of the number of elicited links, although they are easier to implement.

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Abstract
SUPPLEMENTARY MATERIALS

Keywords
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Appendix: COORD-II

COORD-II: design details

The game-form of COORD-II is as follows. Students are asked to reveal the full names of their friends in their undergraduate class, jointly with a subjective evaluation ("strength") of each relationship. Let s_{ij} define the strength reported by i to the $i-j$ relationship, framed in the experimental instructions as follows: $s_{ij}=1$: j is a person i "hardly knows"; $s_{ij}=2$: j is "an acquaintant"; $s_{ij}=3$: j is "a friend"; $s_{ij}=4$: j is "a close friend". Finally, if subject i does not name subject j, let $s_{ij}=0$. As for the outcome function, subjects receive a prize if one of the following two cases holds:

Case 1 they *do not name* anybody, or

Case 2 they *name at least one* subject. In this case, one of the elicited links is checked at random (each link being selected with equal probability). Let $\jmath$ denote the subject associated with the randomly selected link. Subject i receives the prize if both rules are satisfied:

R1: also $\jmath$ has also named i as a friend (i.e. only if $s_{\jmath i}\neq 0$);

R2: friendship strength assessment should also be sufficiently *accurate*, since, to ensure payment, the difference in the reported strengths should not be higher than 1: $D_{i\jmath}=|s_{i\jmath}-s_{\jmath i}|\leq 1$.

Case 1 corresponds to an "exit-option",while Case 2 recalls the coordination device employed in COORD-I.

To sum up, COORD-II modifies COORD-I in the following dimensions.

a) First, subjects play the elicitation protocol *simultaneously*, that is, they have basically no possibility to coordinate their actions (something that can easily done in COORD-I, where elicitation takes place via Internet, with absolutely no control on the experimenter's behalf).

b) Recruitment in COORD-II is not voluntary, as network elicitation takes place during regular teaching sessions (or even during final exams (treatment TP, see the Appendix). This allows (almost) full participation of the social group under scrutiny, as voluntary recruitment may imply self-selection issues affecting the network mapping through channels outside the experimenter's control.[1]

c) In addition to the standard written consent, to further preserve our subjects' rights of privacy that may be infringed by the non-voluntary recruitment protocol (*a fortiori*, when elicitation takes place during a regular exam), an "exit option" is introduced (CASE 1) *built in the same system of incentives*.

d) COORD-II allows to assess the effect of changes in the means of reward, as it comes under three alternative treatments, depending on the nature of the prize. The baseline treatment, TP, involves the use of 1 extra-credit point (out of 10) in the final exam grading; in treatment TM the prize corresponds to 5 €; while in treatment TN there is no prize at all.

Treatments and subjects

As we just mentioned, Cobo-Reyes and Jiménez (2000) conduct three treatments which differed only in terms of the nature of rewards: extra-credit points (TP), a monetary reward (TM) and no incentives (TN).

In the three TP sessions (TP1, 2 and 3), subjects could gain an additional point (out of 10) for a final "bonus question" on the exam. To check the robustness of our their results to the change in rewards, they also run 4 additional sessions. Sessions TM1, 2 and 3 use a monetary prize (5 €), while the last –treatment TN - uses no reward at all. Instructions for all the treatments were identical, except for the description of the outcome (reward) function.

All the sessions were non-computerized classroom experiments conducted with subjects with no (or minimal) prior

[1] Voluntary participation was still ensured by the fact that all subjects were asked to give their written consent (and, therefore, they could still refuse to participate in the experiment).

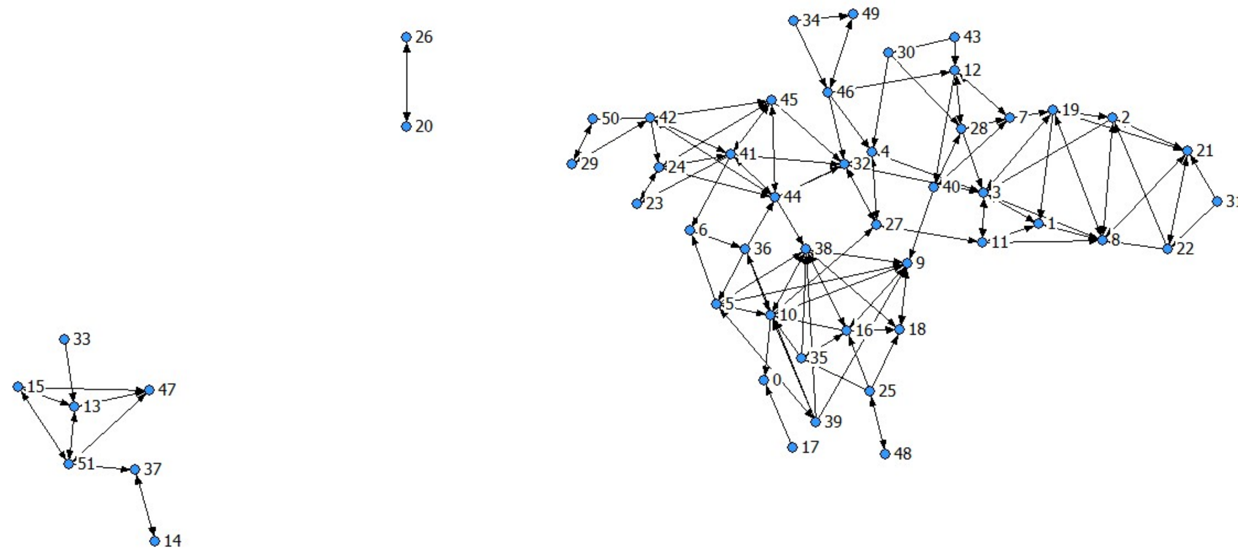

Figure 1. Resulting network using point rewards (TP2): 51 subjects and 165 links

exposure to game theory. The three TP sessions were conducted in June 2004 during the Microeconomics II exam; a first-year undergraduate course in economics at the University of Jaen, Spain. We included a "special question" as an additional item on the final exam. The experiment was in three different classes: TP1 and TP2 with students in the Business Degree program and TP3 3 with students in the Law and Business Degree program. These three groups consisted of 51, 53 and 31 students, respectively.

The TM1 session was conducted in February 2006 at the University of Granada. The group was comprised of 39 students from Microeconomics I; a first-year course in economics. Identical first-year students are used for TM2 (February 2009) and TM3 (February 2012) with 65 and 70 students respectively.

Finally, the TN session was also conducted at the University of Granada in February 2006. The sample was composed of 40 students from Microeconomics I; a first-year course in the Business Administration program.

The format of the classroom experiment was chosen to ensure the maximum participation of the social networks under scrutiny. If subjects named friends or acquaintances who were not present at the sessions, the corresponding links were removed from the network since correspondence could not be checked.[2] This problem is due to simultaneous play in our experimental design. This feature has the advantage that subjects could not agree to name each other during the experiment. The main disadvantage is that we could only consider subjects who were present as network nodes.

COORD-II: experimental instructions[3]

Hello, you are now going to take part in an economic experiment. We thank you in advance for your collaboration. This is part of a project coordinated by a teacher from the University of Alicante who has requested your collaboration to carry it out. The aim of this experiment is to study how individuals make decisions in certain environments. The instructions are simple.

If you follow them carefully, you will receive an additional POINT TOWARDS YOUR FINAL GRADE IN MICROECONOMICS II [AMOUNT OF MONEY] confidentially at the end of the experiment.

You may ask questions at any time. To do so, just raise your hand, but do not speak. Except for these questions, any kind of communication between you is forbidden and will be cause for expulsion from the experiment.

Please write a list with the name and surname of all your friends in the class. Next to their names, you have to write a number:

1 if you hardly know him/her;

[2] As for the TP sessions, in Net 1 (2) [3] we removed 10 (8) [12] links out of a total number of 175 (160) [289], that is, a percentage of 5.7% (5%) [4%], respectively. The rate of link removal for the TM and TN sessions, Net 4 and Net 5, were much higher (both around 19%). This is because they were conducted during a regular lesson. Given that they were not run during an exam, maximum group attendance could not be guaranteed.

[3] The differences between TP and TM (TM in brackets) are highlighted in CAPITAL letters.

		TP1	TP2	TP3	μTP	TM1	TM2	TM3	μTM	μTN
Mutual	$D = 0$	180	82	98	120	37	85	74	65	3
	$D = 1$	34	31	16	27	33	16	40	24	2
	$D > 1$	6	2	0	3	0	2	6	2	0
	Total	220 (76%)	115 (70%)	114 (75%)	150 (74%)	70 (69%)	103 (74%)	120 (75%)	97 (73%)	5 (5%)
	Not Mut.	69	50	38	52	32	35	40	36	98
	links	289	165	152	202	102	138	160	133	103
	subjects	53	51	31	135	39	65	70	174	40

Table 1. COORD-II: link correspondence across treatments.

2 if he/she is an acquaintance;

3 if he/she is your friend;

4 if he/she is a very close friend.

How do I GET THE POINT [RECEIVE THE MONEY]? We will take your list and randomly choose the name of one (only one) of your friends (the ones you have mentioned). We will then look at your friend's list and see whether:

i) he/she has mentioned you and

ii) he/she has given you a similar score to the score you have given him/her (by "similar" we mean a maximum difference of one point between the two scores).

If i) and ii) are affirmative, you will win THE POINT [5 €]. If i) or ii) fails, then you will win nothing (0 POINT [0 €]).

Let me give you an example. My list is:

- Jose Pérez with a 3.
- Juan Martínez with a 4.
- Emilio López with a 1.
- Jose Antonio Rodríguez with a 2.

José Pérez is then randomly chosen from my list. The experimenter then looks at José Pérez' list and sees that he has given me a score of 4. Given that the difference in scores was just one point, I win THE POINT FOR MICROECONOMICS II [5 €]. If I had given José Pérez a score of 2 points, I would win nothing.

NOTICE 1. If you mention no-one, you also receive THE POINT FOR MICROECONOMICS II [5 €].

NOTICE 2. (about the above notice). Be aware that if you mention no-one, but someone mentions you, this may be prejudicial to him or her. In other words, a friend who mentions you would not receive THE POINT FOR MICROECONOMICS II [5 €] because you didn't include him/her on your list of friends

For the TNI treatment, instructions were as follows:

"Hello, you are now going to take part in an economic experiment. We thank you in advance for your collaboration. This is part of a project coordinated by a teacher from the University of Alicante who has requested your collaboration to carry it out. The aim of this experiment is to study how individuals make decisions in certain environments. The instructions are simple.

You can ask questions at any time. To do so, just raise your hand, but do not speak. Except for these questions, any kind of communication between you is forbidden and will be cause for expulsion from the experiment.

Please write a list with the name and surname of all your friends in the class. Next to their names, you have to write a number:

1 if you hardly know him/her;

2 if he/she is an acquaintance;

3 if he/she is your friend;

4 if he/she is a very close friend.

Thank you very much."

Map of networks across different means of rewards

Cobo-Reyes and Jiménez (2012) elicit classroom social networks under three means of reward: 3 networks under TP -TP1 to TP3 - with 53 (289 links), 51 (165 links) and 31 (152 links) subjects, respectively; three networks under TM -TM1 to TM3- with 39 (102 links), 65 (138 links) and 71 (160 links) subjects, respectively, and one TN network, with 40 subjects (103 links). Figures 4 to 6 display the network maps for TP2, TM3 and TN, repsectively.

The elicited networks, displayed in Figure 4 and 5, share most features of typical social network architecture (see Newman 2010). More precisely, there is a giant component encompassing 42 (61%) and 43 (82%) of network vertices for TP2 and TM3, respectively; the second largest component only contains 7 and 5 nodes and there are 0 (0%) and 9 (13%) unconnected nodes, for TP2 and TM3, respectively. The average (undirected) degree is 4.36 neighbors (Std. Dev. 1.87) and 3.46 (Std. Dev. 2.44), respectively. The clustering coefficient, i.e., the average fraction of links of a node that are linked

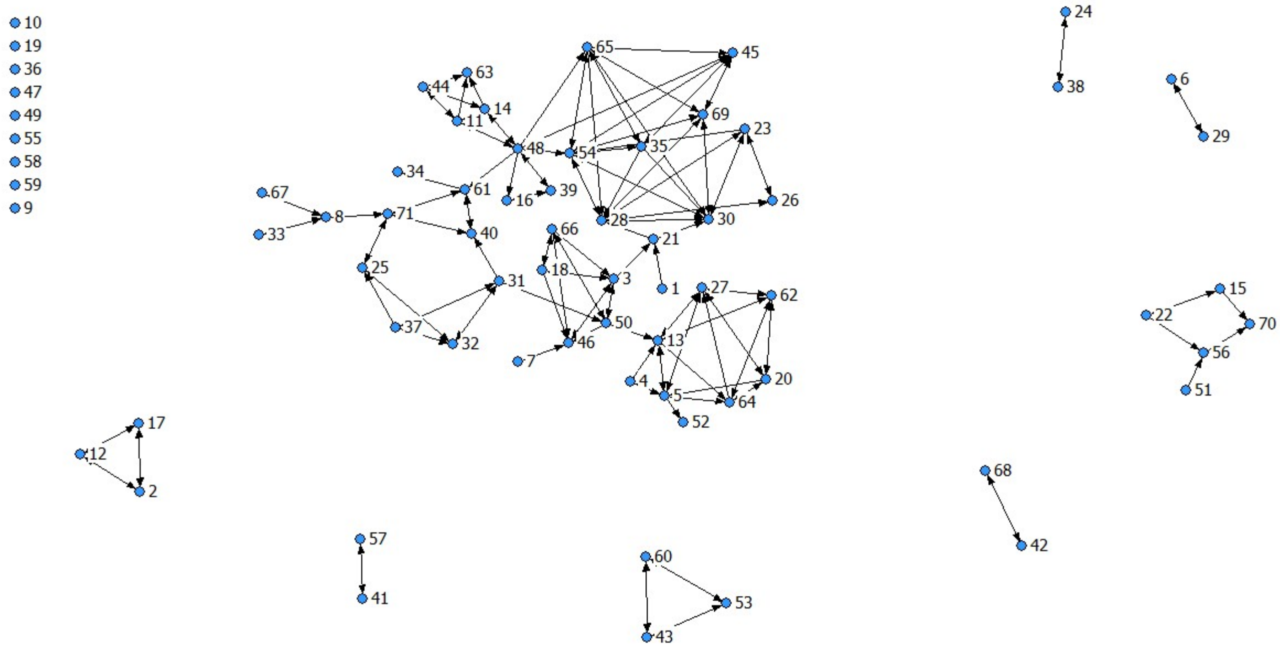

Figure 2. Resulting network using monetary rewards (TM3): 71 subjects and 160 links

themselves, is 0.45 and 0.53, respectively. Notice that, in a randomly generated network of the same size and connectivity, the expected clustering would be roughly 4.36/165=0.026 and 3.46/160=0.022, one order of magnitude lower that the observed level. We also observe small distances (the average and maximum distance, diameter, in the giant component are 3.73 and 11, 4.32 and 11, for TP2 and TM3, respectively).

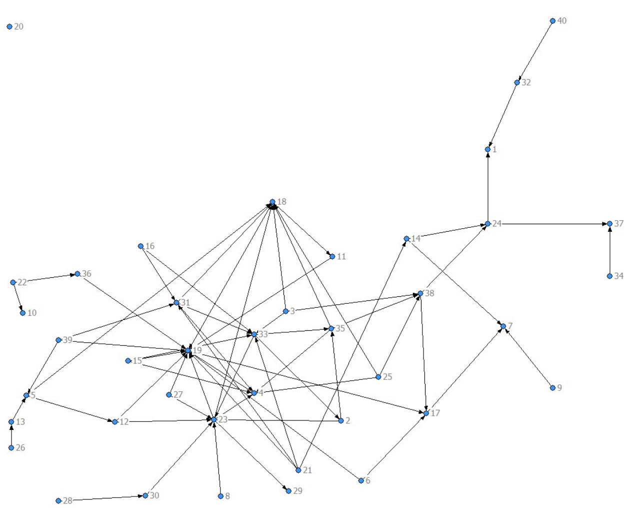

Figure 3. Resulting network using no rewards (TN): 40 subjects and 103 links