Connectivity and Cooperation

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1. Introduction

Connectivity –particularly as networks expand to be large and even global in scale - greatly increases prospects of cooperation. In this chapter we first discuss the concept of connectivity and its relationship to cooperation as it has been explored across disciplines. The discussion focuses on the two main questions pursued in connectivity research; how do cooperative connections emerge, and which connections are most efficient when promoting cooperation? Much of the initial research to be discussed is laboratory based, allowing for strict controlled conditions to test the effect of network density and structure on performance. The final set of connectivity research reviewed is a set of field experiments that allow for greater external validity, yet also allowing for replication of the key results linking connectivity among target populations and cooperation.

In the second half of this chapter we present results from a six country study of the global connections of 1195 participants and their propensities to cooperate with one another. In this research we push the limits of the scale of connectivity, but also alter elements of network density and structure typically found in prior research. Nonetheless, the results demonstrate that as global connectivity increases, cooperation increases as well.

2. A critical review of the notion of connectivity

Networks have been studied from very different perspectives. Physics and computer science focuses on large-scale sets of interconnected nodes, and model these networks as complex systems governed by exogenous, sometimes stochastic rules (Schweiterz *et al.*, 2009, survey the new challenges of this approach). Networks evolve by adding or deleting links between nodes, following different network dynamics, bound in space and time (Barrat *et al.*, 2008).

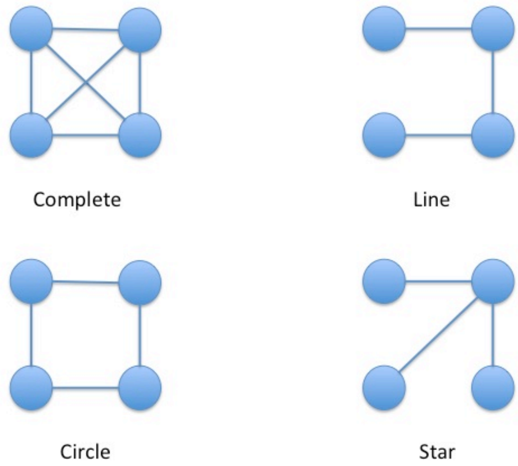
In the social sciences, too, networks are defined as a set of interconnected nodes. Nodes may represent countries or individuals, and the nature of their mutual relationship may be trade or friendship. In addition to the analysis of network dynamics, social scientists study how the strategic behavior of agents is influenced by network architectures, sometimes arbitrarily simple.

Both approaches have advantages and disadvantages. The socioeconomic approach is typically grounded on simplifying assumptions about networks' institutions and individuals' behavior. Individual incentives explain relatively well the emergence of formal and informal links between rational agents (See Jackson and Wolinsky (1996) or Bala and Goyal (2000), see below); however, it typically fails to predict volatile dynamic outcomes, better interpreted by models from physics based on large-scale systems (Albert and Barabasi, 2002).

Within the social sciences, the first to develop an approach to networks were sociologists. Simmel (1922) stressed the importance of considering the position of an individual in a group, even before Moreno (1934) formally introduced the analysis of social networks as sociograms (Smith-Doerr and Powell (2003) survey this literature). In the last twenty years, networks have been intensely analyzed by economists, given the relevance of networks in many economics situations, from labor opportunities, to trade, cooperation between firms, corporations' governance or non-centralized markets (See Jackson, 2003, for an extensive survey of this literature, including many empirical studies).

The very idea of networks refers to the existence of connectedness between nodes or agents. A critical concept in the analysis of networks is connectivity, and its density. A network's density measures its structural properties. A complete network is one extreme case: as it is maximally connected, it is denser than any incomplete network. Figure 1 below shows some complete and incomplete networks for a group size of 4 agents or nodes:

Figure 1: Complete and incomplete networks



Connectivity has been positively associated with performance, even when the relationship is far from monotonic[1]. Being connected makes cooperation within the group easier. As Fowler and Christakis (2010) put it, *"interacting with others in large populations without structure greatly reduces the likelihood of cooperation"*. From a theoretical point of view, the more connected with others agents are, that is, the denser the network, the higher the cooperation rate. Information about the decisions of others may act as a dynamic coordination device (Skyrms and Pemantle, 2000), and heterogeneity may even improve cooperation prospects (Santos et al 2008). Eshel et al. (1998) show that cooperation survives as an equilibrium strategy in repeated prisoner's dilemma type interactions when individuals are able to imitate their neighbors. As local interaction between interconnected agents allows cooperative players to cluster together, connectivity make partner selection easier (Lieberman et al 2005).

However, it is difficult to learn about causality in theoretical and field studies. In the field, it is difficult to control some basic endogeneity problems. The cooperative association between connected individuals could be the outcome of some common environmental factors that generate cooperation in both agents. A theoretical prediction about equilibrium outcomes does not answer the two main questions in network analysis: how do cooperative networks emerge? Which network is more effective in promoting cooperation? Running experiments in a controlled environment may help to disentangle the dynamics of network formation and the effectiveness of different network structures promoting cooperation.

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[1] Granovetter (1973) was probably the first to point out that not all links are equally important. Job searches are typically more effective through informal (personal) links than through formal channels (Granovetter, 1995). The finding that some weak ties are more effective has been replicated in several field studies; Lin (1999) reviews this extensive literature.

Some recent works try to answer these questions. A first branch tries to understand the formation of networks as the *outcome* of the experiment. Subjects are able to generate networks in the laboratory, in a controlled environment with monetary incentives. These experiments typically test some pre-existent model. Jackson and Wolinsky (1996) is the seminal theoretical reference.[2] In their connections model, they present a typical conflict between efficiency and stability. Individuals directly received benefits from being connected to others, and support the cost of their connections. When the cost of being connected is arbitrarily low, the unique efficient and stable network is the complete one, while the empty network (in which no links are established) is the only efficient stable network when the cost is high. For some intermediate cost, the star network is efficient but unstable. Bala and Goyal (2000) show a similar result for unilateral and bilateral networks. A network is stable when all (or no) players are connected, and there are no redundant links[3].

Deck and Johnson (2004) experimentally test an extended version of the connection model by Jackson and Wolinsky (1996) under different institutions and environments. Participants' performance critically depends on the parameters chosen. In some cases, the performance is particularly poor (no group achieves a positive surplus, and subjects never coordinate on the efficient network). Callander and Plott (2005) try to understand this coordination failure. They analyze the emergence of networks under different conditions reducing the cost of mis-coordination. Their participants are often able to converge to equilibrium outcomes.

Falk and Kosfeld (2003) test Bala and Goyal's (2002) model and get mixed results. Subjects are able to coordinate well in unilateral networks (information flows one-way, to the participant supporting the link), but they fail when networks are bilateral (information flows two-ways). Authors provide a simple explanation based on fairness considerations. Equilibrium payoffs are unequal in equilibrium, so the equilibrium outcome may no longer be a stable solution for socially motivated subjects (e.g. inequity averse players). In other words, networks need to be fairness compatible to be stable.

Riedl and Ulle (2002) test an alternative model by Vega-Redondo (2002)[4], with infinite repetitions and uncertain payoffs. Participants in the experiment endogenously generate the network structure. Cooperation rates critically depend on the amount of information transmitted through the links, and cooperators propose links to *like-minded* participants (other cooperators).

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[2] Myerson (1977) first analyzed the emergence of networks in cooperative games in which there is no explicit consideration of the network structure value.
[3] The theoretical literature on networks has grown exponentially. Both Kosfeld (2004) and Jackson (2003) survey these papers.
[4] Vega-Redondo (2002) studies the formation of networks in infinitely repeated prisoners' dilemma games with changing payoffs. Dense social networks can only be sustained when payoff volatility is not very high.

More interestingly, the possibility of endogenously selecting the network (relative to a control experiment in which the network is exogenously imposed) greatly improves efficiency.

A second branch of the literature tries to study networks as an *experimental input*. The typical approach consists of fixing the network structure in advance to study their properties. Given that subjects typically need to learn about the environment in a relatively short time, this seems to be a natural method to minimize complexity; and assess the efficiency of different network structures. Following a between subjects design, in these experiments subjects usually participate in a single treatment condition in which the network structure cannot be modified. Kirchlamp and Nagel (2007) test the model by Eshel et al. (1998). In sharp contrast with the theoretical prediction, they find that cooperation rates are higher when imitation is more difficult and social interaction stronger (subjects interact in isolated groups rather than interacting locally with other groups). Cassar (2007) finds a similar result, as subjects seem to show persistent difficulties learning from their observation of others.[5]

Connectivity has been analyzed in recent public goods experiments. Carpenter (2007) was the first to introduce a network effect in a public goods experiment. Subjects observe the contributions made by all group members and are able to monitor (punish) a subset of the group. He restricts the analysis to symmetric (monitoring) networks. Fatas et al. (2010) extend this analysis with a public goods game in which a network determines which members of the group each subject observes. They consider both symmetric (complete network and circle) and asymmetric (star and line) structures and find that the star network outperforms any other incomplete network considered. Fatas et al. (2008) analyze sanctioning behavior under different network structures defining both the observational and the monitoring structure, with very similar results. The Star network promotes an efficient use of punishment: peripheral subjects strongly react to small amounts of punishment sent by the central player, who is the only commonly observed player in the group. Eckel et al. (2010) explains this preeminence of the star network considering the role of status in this setting. Fatas et al. (2011) provides a simple theoretical explanation based on the existence of conditional cooperation and some information decay across the network. Conditional cooperators are better able to interpret the individual decisions by others when they are connected to the commonly observed agent (the central player in the star network). As there is no central player in the line or the circle, conditional cooperation becomes weaker and cooperation declines faster.

[5] Choi et al. (2005) implement three different directed network structures (star, circle, and complete network) to study observational learning in the lab. Kosfeld (2004) surveys this literature and discuss different explanations for these results.

Fowler and Christakis (2010) test the role of social networks in human cooperation in one-shot games with and without punishment. Subjects are randomly assigned to a sequence of different groups to play one-shot public goods games. Both with and without punishment, subjects are influenced by the contributions of their partners in the first game.[6] The positive effect of social connectivity survives even when no future interaction is possible.

Social networks critically determine cooperation in the lab. Socially oriented subjects are typically able to coordinate in some efficient and fairness compatible network, exploit the benefits of some norm enforcing institutions (like punishment) to stop free riders and select those subjects who show more cooperative past actions.

Can these results be replicated in the field? A number of field studies show that this is indeed the case. Field studies are natural settings for testing the external validity of experiments. In the field, participants carry with them their own experience with pre-existing social networks. So, their social networks can be elicited in the experiment to understand their properties and how they shape social behavior. Leider et al. (2009) exploit this possibility. They conduct an online field experiment in which a real social network is first elicited to distinguish between different components of pro-social behavior. Their results suggest that real social networks also group together socially oriented individuals, and that the possibility of interacting in the future with the same individuals positively strongly affect cooperation. Goeree et al. (2009) combine survey and experimental data on real social networks to detect homophilous behavior. Subjects connect to other participants similar to them. Brañas-Garza et al. (2009) extend Leider et al. (2009) to show that social integration goes hand in hand with pro-social behavior in simple distributional games, using a sample of students. Feigenberg et al. (2009) run a field study in India with microfinance groups to find that the intensity of social interaction explains current cooperation levels within each group.

Connectivity in social networks seems to play a critical role in explaining cooperation when diversity is present. Miguel and Gugerty (2005) find that the provision of certain types of local public goods (as education) is strongly determined by subjects' heterogeneity. The results of their field experiments run in Kenya suggest that norm enforcement is more difficult when groups are ethnically diverse because social connections are weaker. Habyarimana et al. (2007, 2009) get similar results in Uganda. Different ethnic groups exhibit similar provision preferences. But, co-ethnics perform better because their social networks are denser, social sanctions are successfully implemented and homogeneous groups are better able to coordinate.

3. Large-scale connectivity and cooperation with strangers

[6] D'Exelle and Rield (2008) show that networks, and the relative position hold by subjects, also matter in giving behavior.

3.1 Description

The literature reviewed supports the basic theoretical conclusion that the more connected agents are with one another – that is, the more dense the network - the higher the cooperation rate. Furthermore, much of the research discussed focuses on the effect of network density and structure on interactions and performance; e.g. agents who are more similar to one another or who know they will be interacting again are more likely to be cooperative. However in contemporary global societies many interactions take place among individuals who are complete strangers to each other and interact only once. In a piece of research conducted by our group (Buchan *et al.*, 2009), we studied experimentally the relationship between real-life individual connectivity and cooperation with strangers. Connectivity was estimated through a questionnaire, while cooperation was measured in experimental decisions. This makes it possible to test whether the seemingly positive effects of connectivity on cooperation stressed by the literature remain limited to the network or can spread to interactions with complete strangers. Our results point to a resounding yes. The higher individuals' real-life connectivity, the higher their propensity to cooperate at various levels of interaction. The following sections offer a brief account of the results.

In our research we were interested in studying a specific notion of connectivity, that is, large-scale connectivity. The theoretical background was offered by globalization studies that depict contemporary human relationships as being characterized by *"the spread of transplanetary and [...] supraterritorial connections between people.*" (Scholte, 2009). More specifically, the process known as globalization *"[...] involves reduction in barriers to transworld contacts. People become more able – physically, legally, culturally, and psychologically – to engage with each other in 'one world'."* (Scholte, 2009). The main thrust of this conceptualization lies in the possibility to access a *deterritorialized* space of connections, that is, a space that enables people to create connections regardless of their specific geographical location in the world. The objective was to study the relationship between an individual's level of large-scale interconnectedness and their propensity to cooperate.

The deterritorialized space *par excellence* is the internet, given its power to become connected with other people worldwide regardless of the territorial distance of the nodes. Other media sharing similar characteristics are for instance cell phones, standard mail, fax, *etc*. Increased migratory flows make it possible to establish social contacts with people from different nationalities and different ethnic groups than one's own. Many other deterritorialized "spaces" are created under several other domains. In the economic domain, credit cards allow consumers to access their bank accounts worldwide, and financial investment make economic returns globally inter-dependent. Multi-national retail shops and fast food chains make it possible to consume standardized commodities in a growing number of cities around the world. In the cultural domain, global media of communication – such as satellite TVs, international magazines, newspapers, music, *etc.* - enable users around the world to access the same sources of information.

In spite of the growing diffusion of this network, the world is still far from being a "global village." There are many areas and many individuals around the world that are cut off from this network. To tap into the full measure of an individual's interconnectivity in the global network, our analysis draws on two different indexes. The first index measures the extent to which an individual has material *access* to the global network; that is, to several media or channels of *potentially* global connection. We call this index the *exposure to global network* (EGN) index. A complete list of the media/channels we have used is included in the Appendix. For the full text of the questionnaire, please consult Buchan *et al.* (2009: SOM, Section 4).

A second index measures an individual's *usage* of the network, provided s/he has access to it. "Usage" is relevant to global interconnectivity in two ways. Some questions ask the frequency with which the individual accesses the media of global connection identified. The second aspect refers to the *scope* of the connection. Although such media have a potentially global reach, the actual scope is down to individual choice. In principle an individual could access the network only to gather information about local issues. Therefore, a set of questions asks the territorial reach of a subject's activity on the global network, distinguishing between activities carried out at the local, national, or global scale. This second index measures the overall *participation* of the individual in the global network, taking into account both the frequency and the scope of the activities. It assigns higher scores to individuals who participate in the global network more frequently and on a larger scope than others. We call it the *individual globalization index*, (IGI). A complete list of the items included in the IGI is given in the Appendix[7]. Buchan *et al.* (2009: SOM, section 1 and Figure S1) show and comment the distribution of EGN and IGI across countries.

3.2 Factors related with large-scale connectivity

In this section we analyze the correlation between EGN and IGI and some individual demographic, behavioral and attitudinal factors. Our data come from six countries where we conducted research to investigate the relationship between globalization and cooperation. These were the US, Italy, Russia, Argentina, South Africa and Iran. These countries cover a broad range in terms of country-level globalization, as measured by the Centre for the Study of Globalization

[7] For more technical details about how the index was constructed, see the supplementary information of Buchan *et al.* (2009).

and Regionalization index (Lockwood and Redoano, 2005). Within each country the research focused on a large metropolitan area and on surrounding areas that were likely to be less globalized in nature[8]. For example, in Russia the research was carried out in Kazan, a relatively globalized city in Tatarstan, and in more rural surrounding outposts. In the United States the metropolitan area was Columbus, Ohio; in South Africa it was Johannesburg; in Italy it was Milan; in Argentina it was Buenos Aires; and in Iran it was Tehran. Research participants were drawn from the general population according to a quota sampling method. This ensured that different age classes and socio-economic status groups had equivalent representation in the sample within each country. Descriptive statistics of the samples are reported in Buchan *et al.* (2009, SOM: Table S3).

Table 1 reports regression analyses illustrating the effects of demographic and possible explanatory factors on EGN and IGI. It is notable that both income and education have positive and statistically significant effects (at the 1% level) for both variables. This is not surprising. Access to the global network requires, in many cases, owning media of connection, and these are generally not available for free. Moreover, when access does not depend on one's actions, global channels of connections (e.g. foreign restaurants) are likely to be placed in wealthier areas. Consequently, wealthier people have greater exposure and participation in global networks. Likewise, accessing the network, e.g. accessing the internet, requires some basic level of skills. Thus, more educated people are in a better position to access the global network. Women are significantly less globally connected than men. This effect is significant at the 5% level. Arguably this is the result of social factors constraining women's connectivity. Younger cohorts are significantly more connected than older cohorts. Furthermore, the larger the population of the urban area where people live, the higher EGN and IGI. This is consistent with globalization theories emphasizing the role of large cities as "hubs" of global networks (Sassen, 2001). People belonging to ethnic minorities have a significantly lower connectivity level than others. This is significant at the 1% level for EGN and at the 5% level for IGI.

Finally, we want to investigate the relationship between the large-scale connectivity indexes and other factors widely used in connectivity studies. In particular, the social capital literature stresses the role of participating in voluntary associations to create a social network of potential economic value to an individual. For this purpose we use the dummy variable, association membership (AM), which identifies whether an individual is member of a voluntary association [9].

[8] In South Africa the research was only conducted in Johannesburg, but the different districts that were sampled varied considerably in terms of exposure to globalization.

[9] The question lists a number of 13 types of association asking the participant to indicate which types s/he belongs to. The dummy assigns value of 1 if the individual belongs to at least one type of association. 68% of the sample belongs to at least one type of association. Clearly this is a rather coarse measure of one's

This shows a positive and strong correlation with IGI, but no correlation with the EGN. The correlation between IGI and AM is not surprising, given that both are forms of individual connectivity. The lack of correlation between EGN and AM can be explained by considering that, unlike AM, EGN does not (always) reflect a choice by the individual. For instance, whether a multi-national fast food restaurant is located in the individual's residential area is clearly not an individual's choice. Hence, a correlation between the two indexes is not necessary. Finally, both EGN and IGI show a positive correlation with individual trust in others (TRUST henceforth)[10]. Here the causality issue is open. It may be conjectured that having a broader exposure and participation in large-scale networks increase inter-personal trust in strangers (Grimalda and Mittone, 2010). Likewise, people more disposed to trust others may be more inclined to set up connections with distal others (although it is not obvious why this should apply to EGN).

"social capital", as it does not measure the actual involvement of the individual with the association, e.g. the hours spent within the association.

[10] Inter-personal trust is measured by the answer to the question normally used for this purpose in surveys. The question asks "Would you say that most people can be trusted or that you couldn't be too careful in dealing with people?"

Table 1: Regression Analysis of Connectivity Indexes

DEP. VAR.	EGN	IGI
	(1)	(2)
Income	0.0998***	0.137***
	(0.0111)	(0.0137)
Education	0.127***	0.150***
	(0.0159)	(0.0176)
Gender	-0.0158**	-0.0127**
	(0.00703)	(0.00619)
Age	-0.000920***	-0.00183***
	(0.000237)	(0.000261)
Urban Population	0.0179***	0.0128***
	(0.00241)	(0.00218)
Ethnic Minority	-0.0297**	-0.0235**
	(0.0114)	(0.0113)
Trust	0.0131**	0.0203***
	(0.00651)	(0.00688)
Association Membership Index	0.00983	0.0333***
	(0.00742)	(0.00753)
Constant	0.627***	0.152***
	(0.0264)	(0.0259)
Observations	998	998
Adj. R-squared	0.416	0.411
F	51.78	49.24

Notes: An OLS estimator has been used. The model includes country dummies. Standard errors robust to heteroschedasticity clustered per experimental sessions are reported in parenthesis. Stars denote significance levels as follows: * = P-value<0.1; ** = P-value<0.05; *** = P-value<0.01.

Section 4. Large-Scale Connectivity and Cooperation

Our project aimed at studying the relationship between large-scale connectivity and cooperation. Experiments comprised three experimental decisions measuring cooperation at the local, national, and world levels. Here we report results from the last decision, but qualitatively similar results obtain for the first two decisions. Decisions were anonymous, and the groups to which subjects were assigned were randomly selected at the beginning of each decision. The last decision examined how much individuals were willing to cooperate in their locality and beyond it, with people from other countries. We used a Multi-level Sequential Contribution experiment at the global level for this purpose (see Buchan *et al.*, 2009). The monetary incentives are the same as those in standard linear Voluntary Contribution Mechanism (VCM) games. An individual willing to maximize her monetary returns should have allocated all her tokens to the personal account. Any token allocated to the collective accounts implied a cost for the individual, but benefited other people. Hence, the returns for the group were maximized when tokens were given to collective accounts. The World account offered a lower marginal per capita return but a higher social return than the Local account. For purposes of this chapter, the dependent variable is the sum of the tokens allotted to the Local and World accounts (COOP henceforth). This represents the overall propensity of an individual to cooperate with others in this decision. The nature of the sequential interaction and the parameters for each decision are summarized in Buchan *et al.* (2009: SOM, Table S5). Decisions were made privately using 10 tokens that could be allocated into envelopes representing the personal, local, and world accounts.

In general, cooperation was high and varied significantly across countries. COOP ranged from a minimum of 5.62 tokens in Iran to a maximum of 7.97 in the US. Table 2 shows the regression analysis based on an ordered logit model. It shows a strong and statistically significant effect (at the 1% level) of both the EGN and IGI (columns 1 and 3). Buchan *et al.* (2009) expand on the theoretical linkages between large-scale connectivity and propensities to cooperate. They argue that being interconnected reduces social distance among an individual and others even in anonymous interactions with strangers. Given the positive relationship between reduced social distance and propensity to cooperate (Hoffman *et al.*, 1996; Whitt and Wilson, 2007), higher levels of interconnection may be conducive to higher levels of cooperation. Buchan *et al.* (2010) deepen the analysis of the possible mechanisms behind the relationship, finding evidence in its support. The effect we find for EGN and IGI is robust to the introduction of AM and TRUST (columns 2 and 4). The sizes of the coefficient are marginally lower, but the level of significance remains unaltered at the 1% level. It is also interesting to note that AM exerts a significant effect when used in conjunction with both EGN and IGI. This is consistent with the result from other studies that have found a positive relationship between experimental cooperation and being a member of voluntary associations (Glaeser *et al.*, 2000; Anderson *et al.,* 2004). This may be interpreted as evidence supporting – or at least not contradicting - the argument put forward in the organization theory literature (Zucker, 1986; Coleman, 1990; Lahno, 1995**)** later popularized by Robert Putnam (2000) that voluntary associations instill in their members norms of cooperation that may also be applied to interactions with strangers. However, since this argument is subject to a reverse causality criticism, more work needs to be done to address this point[11].

The analysis also shows a positive effect of TRUST on cooperation. It has been long debated what the variable TRUST actually measures, and its power in predicting behavior has been questioned (Glaeser, 2000). Our analysis confirms the predictive value of trust, in line with other studies (Yamagishi, 1998; Fehr *et al.*, 2002). At the same time, our results help deepen understanding of the causal mechanisms of the relationship between connectivity and cooperation. It may be conjectured that connectivity helps increase trust in generalized others, thus boosting the propensity to cooperate (Grimalda and Mittone, 2010). The present analysis suggests that this effect may be limited, as the inclusion in the analysis of inter-personal trust exhausts neither the impact of IGI nor EGN. Even in this case, more analysis should be done.

As a next step in the analysis we created a dummy variable called HIGH EXPOSURE to identify the individuals ranking at the top of the EGN. This is done to prevent the risk of multi-collinearity between EGN and IGI[12]. Such individuals are those who have full access to *all* media and channels of connections that we have considered. They represent about 17% of the sample. This term is interacted with IGI.[13] The last two columns of Table 2 show a significant interaction effect between HIGH EXPOSURE and IGI (participation in global networks). The regression shows a positive but only weakly significant effect of IGI in the group of the lowly-exposed (Table 2: Column 5). On the contrary, the effect of IGI is significantly higher (at the 1% level) for those fully exposed. As a result IGI is strongly significant in this group (β=4.547, s.e. = 1.606, z=2.83, p-value=0.005). Hence, increased *participation* in global networks has a much higher effect on cooperation for people who are already fully exposed than for others.

This somehow surprising result still needs further investigation by our group to be fully spelled out. One conjecture is that it may be due to a "reactance" effect against globalization by the

[11] It may well be the case that people who are already characterized by a stronger attitude to cooperate with others are more likely to join voluntary associations because of the social benefits produced by such associations.

[12] The linear correlation between EGN and IGI is in fact equal to 61%.

[13] Cooperation at the local level in the first decision of the experiment has also been included as a control. In this way the dependent variable should be interpreted as propensity to cooperate at the world level *net* of the propensity to cooperate at the local level.

urban poor, who are the same time particularly exposed to globalization – as demonstrated in Table 1 – but have low levels of participation, particularly because of their low levels of income and education. These people may be – or they may perceive themselves as being – "losing" from globalization – particularly from immigration from other countries. This may thus trigger aversion to cooperate at the world level, in comparison with people who have similar levels of participation but are *not* fully exposed. This conjecture is supported by the fact that the sign of HIGH EXPOSURE is negative and significant at the 5% level. Column 6 of Table 2 confirms that such interaction effect also holds when AM and TRUST are introduced in the regression, although the effect of IGI in the lowly-exposed group drops outside the significance region.

Figure 1a offers a graphical representation of this result considering the predicted probability of cooperating with respect to a specific outcome. People belonging to the fully exposed group but who have very low levels of IGI have a lower predicted probability of cooperating than people in a similar position in the not-fully-exposed group. The effect in the graph may appear small, but analysis of the partial effects of HIGH EXPOSURE shows that the effect is strongly significant for this particular outcome, as well as for several others (see Table 3). The analysis of partial effects also shows that the effect of the interaction term is particularly strong for the highest level of contribution. Figure 1a plots this case. It shows that the predicted probability of contributing all tokens to the collective accounts goes from around 0.1 for people at the lowest levels of IGI in the fully-exposed group to nearly 6 times as much for those topping IGI. On the contrary, predicted probability only rises by a factor of 2 for people in the not-fully-exposed group. This suggests that participation in large networks has clearly different effects in the two groups.

Table 2: Ordered Logit Analysis of Contributions to Collective Accounts

DEP. VAR.	Contributions to collective accounts					
	(1)	(2)	(3)	(4)	(5)	(6)
EGN	1.697***	1.491**				
	(0.574)	(0.585)				
IGI			2.001***	1.725***	1.204*	0.847
			(0.620)	(0.629)	(0.673)	(0.669)
HIGH EXPOSURE					-1.740**	-1.912**
					(0.845)	(0.804)
HIGH EXPOSURE X IGI					3.343**	3.628**
					(1.665)	(1.603)
TRUST		0.292***		0.283**		0.0755
		(0.112)		(0.111)		(0.115)
AM		0.407***		0.362**		0.415***
		(0.147)		(0.147)		(0.147)
Income	0.0195	-0.0248	-0.107	-0.130	0.0868	0.101
	(0.249)	(0.248)	(0.254)	(0.252)	(0.264)	(0.266)
Education	0.270	0.0615	0.176	-0.00407	-0.0426	-0.139
	(0.331)	(0.328)	(0.333)	(0.333)	(0.299)	(0.301)
Gender	0.00633	0.0171	0.00764	0.0198	0.116	0.113
	(0.122)	(0.122)	(0.119)	(0.119)	(0.107)	(0.107)
Age	0.00270	0.00237	0.00494	0.00432	0.00467	0.00418
	(0.00441)	(0.00442)	(0.00442)	(0.00445)	(0.00407)	(0.00407)
Ethnic Minority	0.0752	0.115	0.0782	0.109	0.212	0.271*
	(0.172)	(0.171)	(0.172)	(0.170)	(0.145)	(0.144)
local1					0.582***	0.587***
					(0.0391)	(0.0388)
	1.697***	1.491**				
Observations	995	990	995	990	993	988
chi2	8892	8429	7261	7248	6200	5992
Pseudo R2	0.0294	0.0328	0.0305	0.0334	0.144	0.147

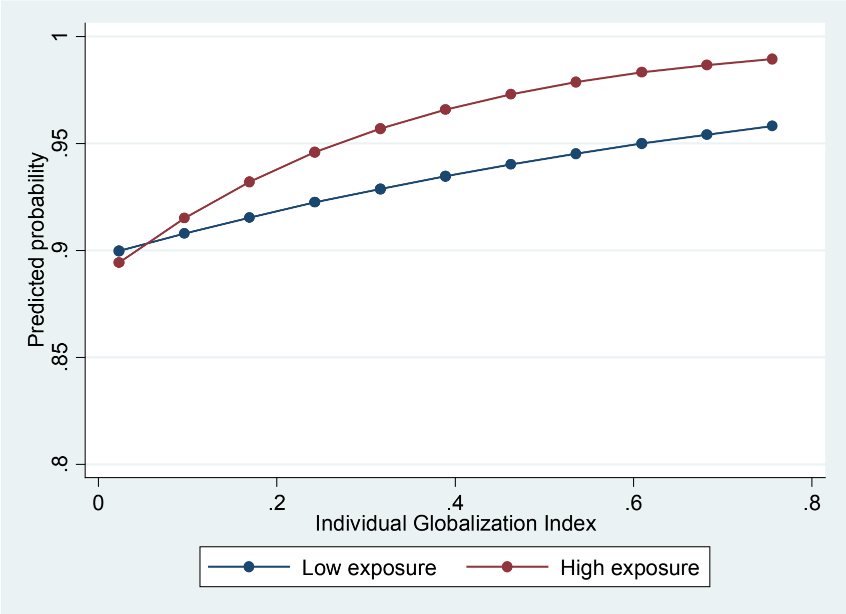
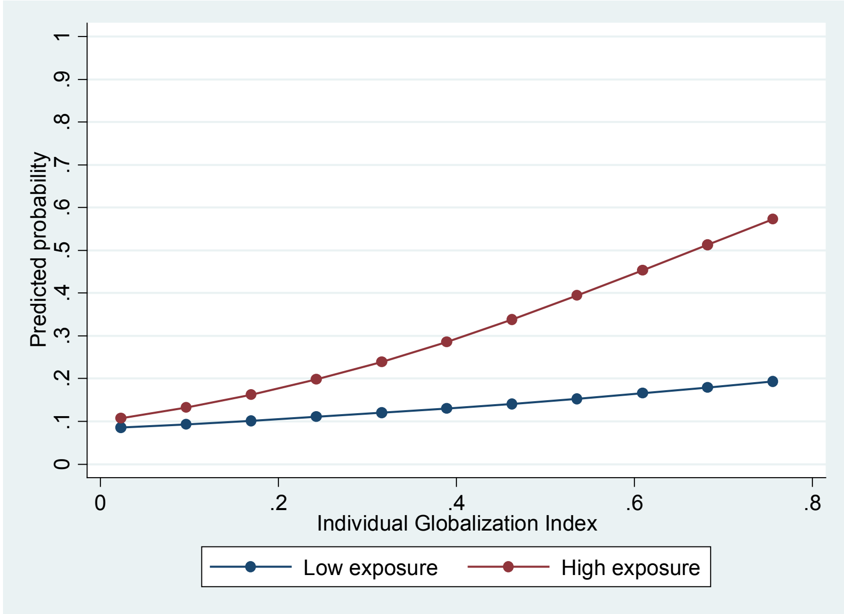
Notes: The dependent variable is the number of tokens contributed to the World and Local accounts. 24 dummy variables identifying the locations where the research has been conducted have been included in the model. Standard errors robust to heteroschedasticity clustered per sessions are reported in parenthesis. Stars denote significance levels as follows: * = P-value<0.1; ** = P-value<0.05; *** = P-value<0.01.

Table 3: Partial effects of selected variables on probability to contribute N tokens to collective accounts, for N={0,10}

	Outcome										
	0	1	2	3	4	5	6	7	8	9	10
IGI	-0.049	-0.004	-0.01	-0.019	-0.022	-0.053	-0.027	-0.008	0.022	0.019	0.151
	*(0.023)***	*(0.0024)*	*(0.0058)**	*(0.0105)**	*(0.0108)***	*(0.0264)***	*(0.0141)**	*(0.0045)**	*(0.0109)***	*(0.0096)***	*(0.0738)***
HIGH EGN	0.115	0.008	0.019	0.034	0.033	0.052	0.009	-0.014	-0.058	-0.036	-0.162
	(0.0722)	*(0.0052)*	*(0.0121)*	*(0.0156)***	*(0.012)****	*(0.0082)****	*(0.008)*	*(0.0146)*	*(0.0346)**	*(0.0175)***	*(0.0445)****
HIGH EGN X IGI	-0.135	-0.011	-0.027	-0.054	-0.061	-0.146	-0.074	-0.022	0.06	0.053	0.418
	*(0.0598)***	*(0.0049)**	*(0.0159)**	*(0.0245)***	*(0.0288)***	*(0.0648)***	*(0.0325)***	*(0.0118)**	*(0.0266)***	*(0.0245)***	*(0.1836)***

Notes: Partial effects are the average effect for the estimated sample. Partial effects are discrete partial changes in the probabilities of all possible outcomes defined by the dependent variable as the independent variable increases by the unit of measurement. For HIGH EGN, unit of measurement is 1. For other variables, units of measurement are automatically detected by an algorithm. Standard errors of partial effects are estimated using the delta method. Stars denote significance levels as above. Partial effects were computed using the STATA margeff .command (Bartus, 2005)..

Figure 1: Predicted probability of contributions to collective accounts as a function of IGI

Figure 1a: Predicted probability of contributing more than 4 tokens to collective accounts	**Figure 1b: Predicted probability of contributing 10 tokens to collective accounts**
	

Note: Predicted probability computed according to estimates derived from model of Table 2, column 5 above.

Section 5. Open Issues and Conclusions

Connectivity is clearly a powerful resource for cooperation. An open question of our research is the causal relationship between large-scale connectivity and cooperation. Are connectivity and cooperation expression of fundamentally similar pro-social attitudes, so that they are intrinsically related? Or does connectivity *spur* cooperation, for instance because developing connections within groups instills cooperation norms that are transferred to the population at large? Or is it the case that "global" connectivity is particularly good in fostering cooperation with strangers, for instance because the "cosmopolitan" character of such large scale connections helps inculcate a sense of shared identity with *any* fellow human being? We still do not know the answer to these questions. Research by Fowler and Christakis (2010) showing the existence of cooperation cascades in experimental randomly formed groups would seem to suggest that a causal link going from connectivity to cooperation is possible. Future work of our group aims at investigating the extent to which it is the "large-scale" property of connectivity, rather than mere social connectivity, which is conducive to higher propensity to cooperate with others.

A second issue probed by this research is the effect on cooperation when connective ties interact. When analyzed individually, participation in a network clearly is more likely to enhance cooperation than is mere exposure to the network. Yet the marginal gain in cooperation from an increased level of exposure differs greatly by individual when the two ties interact. More work is needed to give us a contextual understanding of why this interaction in connectivity occurs.

Section 6 Appendix

Table 4: List of Questionnaire Items

Questionnaire Item	Exposure to Global Network Index	Individual Globalization Index
	Own/has access to internet	Frequency of internet access
	Own/has access to landline phone	Territorial scope of phone use
	Own/has access to cellphone	Territorial scope of mobile phone use
	Own/has access to email	Territorial scope of email use
	Own/has access to postal service	Territorial scope of mail use
	Own/has access to fax	Territorial scope of fax use
	Community of foreign migrants lives in participant's residential area	
	Community from different ethnic background lives in participant's residential area	
		Speaking foreign languages
		Born abroad
		Parent born abroad
	Own/has access to TV program from a different country	Watch TV program from a different country
	Own/has access to international news source	Read an international news source
	Has access to international magazine	Read international magazine
	Own/has access to book by foreign author	Read a book by foreign author
	Own/has access to music made by foreign artists	Listen to music made by foreign artists
	Own/has access to international news source	Follow international news source
	Own/has access to satellite TV	
	Own/has access to radio	
		Travel abroad within continent
		Travel abroad outside continent
		Followed international sports events
		Followed international cultural events or international trade fairs
	Foreign restaurants available in participant's residential area	Frequency of going to foreign restaurants
	Foreign food/drinks available in participant's residential area	Frequency of using foreign food/drinks
	Foreign clothes available in participant's residential area	Frequency of using foreign clothes
	Restaurants owned by multi-nationals (e.g.	Frequency of going to restaurants owned multi-nationals

	large fast food chains) available in participant's residential area	(e.g. large fast food chains)
	Food/drinks produced by multi-nationals available in participant's residential area	Frequency of using food/drinks produced by multi-nationals
	Clothes produced by multinationals available in participant's residential area	Frequency of using using clothes made by multi-nationals
	Own/has access to credit card	
		Work for multi-national company
		Car from other country
		Owns foreign currency
		Owns bank deposit in other country
		Owns investments in another country
	Informed about global warming	
	Informed about global diseases	
	Informed about Intl. Criminal Court of Justice	
	Informed about income gap between rich and poor around the world	

Table 4 (contd.)

Questionnaire Item	Exposure to Global Network Index	Individual Globalization Index
	Informed about United Nations	
	Informed about multi-national or foreign companies	
	Informed about International Organizations like World Bank, IMF and WTO	
	Informed about intl. NGOs, e.g. Red Cross	
	Informed about UN Security Council missions	
	Informed about of international agreements, e.g. Kyoto Protocol	

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