Social Capital, Inclusive Networks, and Economic Performance

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Abstract

Empirical studies show that the relationship between social capital and economic performance is ambiguous. The paper points to the potential trade-off between the sustainability of self-enforcement and the magnitude of gains from trade in social networks as an explanation. Based on an infinitely repeated multi-player prisoners' dilemma it is shown how self-enforcement of cooperation within a network is influenced by its inclusiveness, its communication capacity, and the complexity of the exchange setting. The paper shows that inclusive social capital can combine both low enforcement costs and high gains from trade even in a complex exchange setting.

Keywords: Social Capital, Networks, Self-enforcing Contracts, Development.

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1 Introduction

Social capital has become an intensively discussed topic since the publication of Putnam's (1993) *Making Democracy Work*, although the concept is older.[1] While the

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[1] For an overview see Woolcock (1998).

basic tone in the current debate is to emphasize the benefits of social capital and its importance for economic performance, there are some persistent voices which claim that social capital has also a downside that may hinder economic performance (Portes and Landolt 1996; Stolle and Rochon 1998; Annen 2001a). Unfortunately, empirical studies that try to measure this relationship remain ambiguous (Knack and Keefer 1997; Temple 1998). This raises theoretical questions about the economic value of social capital and about the factors that influence its value. This paper addresses these questions in a framework of infinitely repeated games.

Roughly, the argument of the paper is as follows: Networks of personalized exchange relationships are characterized by low enforcement costs because reputation is a valuable asset that conditions individuals included in the network towards cooperative behavior. Nevertheless, payoffs may be low because of the inability to realize economies of scale and scope due to restricted exchange possibilities. There is a trade-off between self-enforcement and the magnitude of gains from trade that depends on the inclusiveness of the network, the complexity of the exchange setting in which the network operates (complexity constraint), and the network's capacity to communicate information about the members' identity (communication constraint). In a developing economy with increasing complexity, social capital is valuable if networks are able to soften the communication constraint without reducing inclusiveness.

In the literature, the emergence of cooperation in personalized exchange settings is well understood. Kandori (1992) shows that cooperation is sustainable even in a setting in which players change their partner in each period. This is possible if a cheating player is punished by others than the cheated one (community enforcement

based on indirect punishment). Similarly, evolutionary models of *indirect* reciprocity determine the conditions under which cooperative strategies supported by indirect punishment are evolutionary stable (Nowak and Sigmund 1998; Boyd and Richerson 1989). This literature, however, considers the sustainability of cooperation only, and does not account for the fact that in *some* circumstances the capacity to cooperate within communities may come at the cost of reduced gains from trade. The model presented here captures this aspect explicitly. Moreover, the paper determines the optimal inclusiveness of a network and shows how it changes in a context of increasing complexity (development). The papers by Landa (1981), Carr and Landa (1983), and Cooter and Landa (1984) are most closely related to the argument presented here. They develop a model of optimal clubs where enforcement costs in a club are positively affected by its size. However, the surplus created in exchange relationships is determined exogenously. In the model presented here, the surplus generated in exchange relationships depends on the inclusiveness of the network (where size might be one proxy for inclusiveness) and the complexity of an exchange setting. The reason is that in a rather simple exchange setting where the degree of division of labor is low, goods are more substitutable so that inclusiveness does not affect the exchange surplus in the same way as in a more complex exchange setting. Network exchange has been analyzed in more recent papers by Kranton (1996) and Kali (1999). These papers are mostly concerned with the relative efficiency between network exchange and impersonal market exchange. Ultimately, these papers assume that impersonal contract enforcement by the state and enforcement based on personalized relationships are substitutes. Barzel (forthcoming) points out that in contrast to formal contract

enforcement, enforcement based on reputation does not require the explicit articulation of all exchange attributes. In analogy to incomplete contract theory (Hart 1988), reputation enforces "residuals" while formal enforcement can only enforce exchange attributes that had been explicitly articulated in advance. Thus, these two forms of enforcement are not necessarily substitutes. The paper here, treats personalized exchange settings only. Finally, economic historians emphasize the superiority of impersonal contract enforcement by the state over systems of community enforcement (North 1991, p. 100). The former institutional setting has an advantage over the latter one because of its higher inclusiveness. That is, under the former institutional arrangement more individuals and individuals with different social and cultural backgrounds are able to maintain cooperative relationships. This paper shows that gains from trade can be high also in personalized exchange relationships as long as the communication capacity in a social network is high.

The paper is organized as follows: Section 2 defines social capital and shows how this definition relates to concepts discussed in the literature. Section 3 specifies the subgame perfect equilibrium of the infinitely repeated multi-player game with communication constraint and complexity constraint. It discusses two practical implications of this equilibrium. Section 4 determines the optimal inclusiveness of a network in a given exchange setting and discusses how it changes in a context of development. It shows that only social networks which are able to increase inclusiveness can combine both low enforcement costs and high gains from trade when an exchange setting's complexity increases. Finally, the paper concludes by discussing briefly some suggestions for further research.

2 A Conception of Social Capital

In the literature, there is no generally accepted definition of social capital. As any form of capital (i.e. physical and human capital), social capital refers to a specific asset that yields a stream of benefits over time. An individual's reputation for being cooperative within a social network is such an asset. The mere fact of having a "good name" and to be known by others as trustworthy may generate job opportunities, lower transaction costs, attract clients, etc. The definition of social capital used in this paper is based on this insight.

Definition 2.1 (Social Capital) *Social capital is defined as a player's reputation for being cooperative within a social network. A social network is a set of players and a pattern of exchange of information and/or goods among these players. A player may be a person or an organization (e.g. firm, family, kinship, nation, etc.).*

This definition indicates, first, that a player not only has to behave cooperatively, but that others have to know that this is the case. It is not a player's trustworthiness per se that determines the social character of this form of capital but the fact that others know about this player's trustworthiness. The point is that an individual's qualities have to be known by others and this knowledge constitutes an asset that influences this individual's stream of benefits over time. Thus, to identify social capital with a player's reputation qualifies it as inherently "social". Important to note, however, is that the beneficiary of social capital is a single player which is an individual category. A measure for the value of social capital – say for a given country – will then consist of an aggregation of all the individual benefits.

Second, the definition focuses on one specific kind of reputation, namely the one related to a player's trustworthiness. The functional quality of social capital is to sustain cooperation among players who are included in a social network. In this sense, social capital has to be seen as a factor that facilitates the governance of economic relations. It should be emphasized that a more general definition of social capital may include other qualities than a player's trustworthiness. An example is the fact of being known by others as having the capacity to carry out a specific task because a player has the necessary skills and the adequate equipment. The reputation for having a specific stock of human and physical capital is certainly an important part of a player's stock of social capital. In the following, the paper's focus, however, is limited to a player's reputation for being cooperative within a social network.

Third, social capital is associated with network membership. By definition, the knowability of a player's reputation is delimited by the social network. Network membership is part of many definitions of social capital used in the literature and, in particular, the one used by Putnam (1993).[2] An understanding of differences in network characteristics is crucial in order to determine the economic value of social capital created in these networks.

Forth, the definition does not say why players behave cooperatively. For example, cultural perceptions of social capital emphasize the importance of inherited values and habits of cooperation (e.g. Fukuyama 1995). A player may feel guilt or shame if he deviates from these values and this induces this player to behave cooperatively

[2]I, however, do not go as far as Putnam (pp. 89–90) who asserts that "associations instill in their members habit of cooperation, solidarity, and public-spiritedness." It is not assumed that network membership will change the individual's preferences.

(first-party enforcement). In this paper, individuals are assumed to behave opportunistically. Thus, the model does not refer to guilt as an enforcement mechanism. Here, an individual behaves cooperatively only because the punishment enforced by others outweighs the benefit of a defection. The assumption of opportunistically behaving individuals is not introduced because it is claimed that inherited values of cooperation are unimportant. There is no doubt that first-party enforcement is an important determinant of individual behavior in many real world contexts. In other situations, however, such values are not strong enough or do not exist altogether so that one can gain valuable insights by asking the question under what conditions a cooperative equilibrium is possible even if individuals have no taste for cooperation.

Finally, one further clarification is important: Related to physical capital, Hirshleifer (1970, pp. 153–155) explains that the word "capital" is a source of confusion because of its different meanings. Among others, he points to the difference between *real capital* and *capital value*. Real capital refers to a collection of capital goods as physical objects existing in the present but constituting the source of benefits in the future. The discussion about human capital, however, has made clear that a capital good is not necessarily physical or material. Education, for instance, is an immaterial capital good. Social capital as defined above is another example for an immaterial capital good. Capital value, in contrast, is the *present* valuation of any sequence of *future* incomes or payments. Thus, the existence of a capital good (material or immaterial) and its evaluation are two different matters that should not be confused. The mere fact of having a tool (physical capital), an education (human capital), and a "good name" (social capital) has to be distinguished from the question of how valu-

able these objects are. The literature on social capital is mostly concerned with the first aspect. There is a proliferation of definitions which try to describe what social capital is and what it does.[3] To assess the value of social capital, in contrast, seems to be more difficult. One reason is the lack of a straightforward measure for the value of social capital. The value of physical and human capital is, at least theoretically, closely related to the investment of money and time in these capital goods because an investment decision is based on expected returns. Thus, the time spent for education may be an adequate measure for the value of human capital.[4] Although spending time in clubs, having business lunches, going to conferences, or any other means of building relationships and to get known by others can be interpreted as an investment in social capital, to a large extent social capital is built as a by-product when doing business or because of the human need "to belong" (Baumeister 1995). Thus, there is only an imprecise relationship between investment in social capital and its expected return or its value. The social capital value of an highly embedded individual is not necessarily high. Empirical evidence reported by Knack and Keefer (1997), at least, indicates so. In their cross-country study they find no correlation between associational activity – i.e. social network membership – and economic growth. The question then is whether the value of social capital simply depends on the specific context in which it is created or whether there are more general factors that influence its value. The paper argues that inclusiveness (e.g. size and heterogeneity of a social network)

[3]For an overview and a discussion of the many definitions used in the literature see Adler and Kwon (1999).

[4]Note that the relationship between investment and human capital value is already less clear than the one between investment and physical capital value as pointed out by Schulz (1961, p. 8). Education often is not a pure investment good and has in addition the quality of a consumption good. Then, the value of human capital has to be measured by is yield rather than by its cost.

is one such factor and shows how inclusiveness may affect the value of social capital. To have a reputation for being cooperative in a large and diversified network might generate a higher social capital value than to be known as trustworthy in a rather small and homogenous network because of higher gains from trade.[5] The fact that there is no straightforward measure for the value of social capital indicates that more theoretical work is needed in order to determine how different network characteristics affect the value of social capital created in these networks. The model presented in the next two sections is one such contribution.

3 Social Networks and the Value of Social Capital

Consider an exchange setting with N individuals, where $N \in \{2, 4, 6, \ldots\}$. The exchange setting may refer to a whole economy, a specific industry, a firm, an organization or any other entity. Furthermore, assume that this exchange setting is characterized by a degree of division of labor $\gamma \geq 1$, where a higher degree of differentiation is indicated by a higher γ. γ denotes the complexity of this setting. Depending on γ, individuals differ in the function they fulfill and this implies that the specificity of the exchange needs varies with γ. Differentiation implies that there is the possibility that an individual does not meet his needed exchange party in one period. The model captures this fact by qualifying an exchange relationship either as a "high-match" or as a "low-match" yielding a cooperative payoff of c_h and c_l respectively, where $c_h > c_l$. As long as all N individuals can exchange among each other, the probability of having a low-match is zero. It is assumed that there is no

[5]For a similar point see Granovetter's (1973) explanations on the "strength of weak ties".

unemployment in this setting. In each period, an individual is matched with another individual. Before each stage of the game, individuals seek for the individual who fits their needs with transaction costs of zero.[6]

The following strategic form describes the 2-player stage game of the infinitely repeated multi-player matching game, where each player can either cooperate (c) or defect (d):

		player j	
		(c)	(d)
player i	(c)	c_k, c_k	b, a
	(d)	a, b	0, 0

where $k \in \{h, l\}$. The payoffs satisfy $a > c_h > c_l > 0 > b$ and $a + b \leq 2c_l$. Furthermore, individuals have a discount factor $\delta \in (0, 1)$ which is assumed to be the same for all players. As a starting point assume a *state of nature* in which exchange relationships have no social dimension. Exchange parties have no identity. In this situation individuals are not able to maintain long-term economic relationships in order to exhaust gains from exchange. Because individuals are not able to recognize themselves in different stages of the game, defection in each stage of the game is the dominant strategy. In this situation, no long-term trade occurs – i.e. there are no "gains from trade".

[6]The matching market can be described as follows: There is an urn with N balls with γ different colors, where $2z\gamma = N$. $2z$ is the number of individuals with matching exchange needs indicated by the same color of the ball. Complexity can be measured by the number of different colors, γ, in the urn. A match with a ball of the same color is a high-match while a match with a ball of a different color is a low match. As long as all N individuals are matched together, there are no low-matches. The probability of a low-match arises if n balls from the N balls are randomly taken into another urn where $n < N$ and then matched together (network formation creates market segmentation). This probability increases as γ increases and as n decreases.

Now, consider a social network with n players, where $n \in \{2, 4, 6, \ldots\}$ and $n < N$. n refers to the size of the network. Without loss of generality, inclusiveness of a network is identified with its size n.[7] As defined earlier, individuals are able to build a reputation within the network (social capital). This implies, first, that each individual has an identity, and, second, that information about the history of this individual can be obtained within the network. Furthermore, assume that these individuals are matched only with other members in all subsequent periods. These conditions change the strategic environment of the included individuals substantially. As Kandori (1992) shows, the Folk theorem does also apply in a situation where players change their partners in each period as long as the history of the players is accessible knowledge for all players in any exchange relationship.[8] If a network is able to provide information about an individual's history, individuals care for their reputation which may induce them to behave cooperatively (communication constraint).[9] Then, a defecting individual can be identified in all subsequent periods and be punished by excluding him from the social network – "We don't know you anymore". The communication mechanism in the game is defined as follows:

Definition 3.1 (Communication Constraint) *Communication in the social net-*

[7]Inclusiveness may also include a measure for social heterogeneity. Heterogeneity can be defined by $h \in (0, 1)$ and $H \in (0, 1)$ as the probability that two randomly chosen individuals from the n and N individuals respectively belong to a different social category. Inclusiveness, say ϕ, is then defined as a combination of n and h, as for example by $\phi = n(1 + h)$. A network is fully inclusive if $\Phi = N(1 + H)$. Then, a segmentation of the exchange setting (i.e. $\Phi > \phi$) may occur because of size ($N > n$) and because of social segregation ($H > h$).

[8]In two-player games, this condition is trivially satisfied as long the assumption of perfect recall is maintained.

[9]Kandori (1992) and Ellison (1994) establish a "contagious" punishment equilibrium where cooperation is sustainable even when there is *no* information available. This strategy, however, is sustainable only if the population size in relation to the discount factor is not too large.

work is reliable with probability $q(n,\lambda)$*, where* $q(n,\lambda)$ *depends on the inclusiveness of the network* n *and the communication technology* λ*.* $q(n,\lambda)$ *is a twice differentiable function* $q : \mathcal{A} \times \mathcal{I} \to [0,1]$ *where* $\mathcal{A} = \{\lambda \in \Re, \lambda \geq 1\}$*.* $\frac{\partial q(n,\lambda)}{\partial n} < 0$*,* $\frac{\partial q(n,\lambda)}{\partial n \partial n} > 0$*,* $\frac{\partial q(n,\lambda)}{\partial \lambda} > 0$*, and* $q(0,\lambda) = 1$*.* $q(n,\lambda)$ *defines the probability of being discovered in the next period after defection. The probability of not being discovered after defection is* $1 - q(n,\lambda)$*. When a defecting individual is not discovered in the next period after defection, this defection will be forgotten in all subsequent periods.*

Definition (3.1) states that communication becomes less reliable as inclusiveness of the network increases. Carr and Landa (1983, p. 141) consider this aspect by introducing an enforcement cost function which increases as the size of a club increases. Here, communication, however, depends also on the communication technology, λ, in a social network. It makes a difference whether communication is based on face-to-face interactions only, or whether a social network has other means in order to distribute information, such as writing letters, electronic data bases, mass medias, etc. The better the communication technology, λ, of a network, the higher q. Notice that the inaccuracy of communication within the network is due to technological limitations and not because members of the social network have an incentive to communicate deceptive informations. It is assumed that individuals communicate truthfully.[10]

The second aspect is that network formation leads to a *segmentation* of the exchange setting because $n < N$. This introduces the possibility that a network member will not find his optimal match within the network.[11] To illustrate this point, an in-

[10]For an explicit treatment of the role of communication in a context of community enforcement with private monitoring and the related incentive problems see Annen (2001b).

[11]It was assumed that the presence of the network influences the matching mechanism such that

dividual may need a specialist in car repair but unfortunately in the network there is only somebody who knows about motorcycle repair who is able to repair cars but less efficiently, hence the lower payoff c_l.

Definition 3.2 (Complexity Constraint) *A low-match in the network is given with probability $p(n, \gamma)$, where $p(n, \gamma)$ depends on the inclusiveness of the network n and the complexity of the exchange setting γ. The probability of a high-match is given with probability $1 - p(n, \gamma)$. The probability of a low-match $p(n, \gamma)$ is a twice differentiable function $p : \mathcal{A} \times \mathcal{I} \rightarrow [0, 1]$ where $\mathcal{A} = \{\gamma \in \Re, \gamma \geq 1\}$. $\frac{\partial p(n,\gamma)}{\partial n} < 0$, $\frac{\partial p(n,\gamma)}{\partial n \partial n} > 0$, $\frac{\partial p(n,\gamma)}{\partial \gamma} > 0$, and $p(0, \gamma) = 1$.*

Definition (3.2) states that the probability of a low-match becomes smaller as inclusiveness increases. Agglomeration theories, for instance, emphasize that the size of a city influences the efficiency of knowledge exchange (Berliant et al. forthcoming). Accordingly, Pred (1966, pp. 128–29) asserts that "[i]t is logical that the larger the city, the larger the number of intentionally and unintentionally overlapping information fields of laborers and other industrial personnel, the larger the volume of influential short-distance information flows ..." Definition (3.2) states also that the probability of a low-match increases as complexity of the exchange setting increases. That is, in a rather simple exchange setting the produced goods are more likely to be substitutable. This means that more individuals fulfill the same tasks which decreases the probability of a low match for a given network size. In a very specialized context, in contrast, produced goods are less substitutable which implies that less individuals fulfill the same tasks which increases the probability of a low match. Note that com-

members of the network are matched only among each other.

plexity is determined externally to the network. It is a feature of the whole exchange setting in which the network operates.

The strategy to cooperate in each period t is a subgame perfect equilibrium if and only if

$$\pi_i(\mathrm{c}_i^t, \mathrm{c}_{-i}^t) \geq \pi_i(\mathrm{d}_i^t, \mathrm{c}_{-i}^t) \qquad \forall i \in \{2, \ldots, n\},\ \forall t \tag{1}$$

where π_i is the discounted payoff of agent i of the infinitely repeated game and c_i^t and d_i^t denote the actions cooperate and defect respectively in period t, and $-i$ denotes all other agents $j \in \{2, \ldots, n\}, \forall j \neq i$. Considering the communication constraint and the complexity constraint, the self-enforcing condition (1) holds, if

$$\frac{\big(1 - p(n,\gamma)\big)c_h + p(n,\gamma)c_l}{1-\delta} \geq a + \frac{\delta\big(1 - q(n,\lambda)\big)\Big(\big(1 - p(n,\gamma)\big)c_h + p(n,\gamma)c_l\Big)}{1-\delta} \tag{2}$$

whereby the left-hand side of the inequality (2) denotes the expected discounted payoff when cooperating and the right-hand side denotes the expected discounted payoff when defecting. The subtraction of the right-hand side from the left-hand side of (2) leads to the following definition which will be useful for the remainder of the paper:

Definition 3.3 (Positive Enforcing Power) *The network has positive enforcing power $S(n, \gamma, \lambda)$, if*

$$S(n,\gamma,\lambda) = \frac{a(\delta - 1) + \Big(c_h\big(1 - p(n,\gamma)\big) + c_l p(n,\gamma)\Big)\Big(1 - \delta\big(1 - q(n,\lambda)\big)\Big)}{1-\delta} \geq 0.$$

As in any repeated game framework, the discount factor δ needs to be high enough in order to sustain the cooperative equilibrium given the incentive structure of the game. Here, the incentive structure changes with n, λ, and γ. It is easy to see that positive

enforcing power S is an increasing function of $q(n, \lambda)$ and a decreasing function of $p(n, \gamma)$. All other parameters and variables constant, S increases if γ decreases and if λ increases. The effect of the network size n is ambivalent and is discussed in Section 4.

3.1 Social Capital in Simple Exchange Settings

Ceteris paribus, cooperation is more likely to be sustainable in exchange settings with limited complexity. In such a setting, the value of social capital is high because of the combination of high gains from trade and low enforcement costs even if inclusiveness is low. Because γ is low, the probability of a low match $p(n, \gamma)$ is low. This feature of the model may account for the fact that social capital played an important role in earlier and less complex economies. For instance, economic historians describe its importance in medieval trade in Europe (Greif 1994; Milgrom et al. 1990; Greif et al. 1994) and in the early 19th century in Southern California (Clay 1997). This may also account for the fact that social capital receives considerable attention in the context of developing economies (Jagannathan 1987; de Soto 1989; Berry 1989; Annen 2001a). For instance, Jagannathan (1987, p. 11) notes that in urban markets in developing countries "wealth often exists in form of behavioral relations that acquire the characteristic of intangible property rights." The value of social ties remains high due to the limited complexity of this setting which means that relationships do not become obsolete as fast as in a more dynamic and changing environment. The result also suggests that social capital may play a more important role in less dynamic industries. A convincing illustration for this point is the diamond industry which has been traditionally dominated by a

rather limited number of Orthodox Jews. This is true till today, although to a lesser extent as pointed out by Bernstein (1992). In conclusion, whether the exchange setting refers to past economies, developing economies or less dynamic industries, in these settings social capital even if created in rather exclusive networks is valuable because gains from trade are high and enforcement costs are low.

3.2 Social Capital and Communication

A second implication is that, ceteris paribus, cooperation is more likely to be sustainable in social networks where the capacity to communicate is high. This means that in complex exchange settings the value of social capital is high only if information about members flows easily and extensively which allows the network to be inclusive. There may be agents in a social network with the explicit role to provide members with information about other members. This was, for instance, the role of the private judges under the Law Merchant in the Champagne fairs in medieval France. As pointed out by Milgrom et al. (1990, p. 3), the task was "to transmit *just enough* information to the right person in the right circumstances to enable the reputation mechanism to function effectively for enforcement." Efficient communication channels may be given because of spontaneously grown norms and customs. For example, in the report about the social structure in the successful small firm cluster of surgical instruments in Sialkot, Pakistan, Nadvi (1999) shows that information flows easily and extensively due to the many levels of social ties which relate most of the participants among each other. Similarly, the presence of social norms and customs can hinder communication between economic actors as for instance pointed out by

Knorringa (1996) in the case of the footwear cluster in India where caste rules prevent cooperation between the producers and the marketer of footwear.

When considering the tremendous progress in communication technology, an implication of the model is that social capital becomes more important as the means of communication are improving. E-commerce is a contemporary example where social capital facilitates governance in very extensive networks. For instance, on the world's largest online auction web-site eBay.com, founded in 1995, each participant has an identity and a record on the experiences made by others with this identity (Aoki forthcoming). Because of mass medias and the internet it is much easier that individuals around the whole globe become knowable with each other.

4 Endogenous Inclusiveness and Development

In this section, inclusiveness n is defined as an endogenous variable. Members are assumed to choose n such that their expected payoff is maximized. Moreover, it is assumed that inclusiveness can be adapted without any costs – i.e. inclusion of new members and exclusion of supernumerary members is possible with cost of zero. When members have to choose the network's inclusiveness, they face the following trade-off: On the one hand they would gain by increasing inclusiveness because this decreases the probability of a low-match p. But on the other hand communication in the network will become worse because higher inclusiveness of the network leads to a decreasing q which jeopardizes the sustainability of the cooperative outcome. In this situation, network members will choose n such that the expected payoff is maximized subject to the constraint that $S \geq 0$ – i.e. cooperation remains self-

enforcing. Formally,

$$\max_{n} \left(\frac{\big(1 - p(n,\gamma)\big)c_h + p(n,\gamma)c_l}{1-\delta} \right) \quad \text{s. t.} \quad S \geq 0. \tag{3}$$

Thus, the extent of the market is limited by the inclusiveness of the social network for which cooperation remains self-enforcing.

Consider the positive enforcing power S as presented in definition (3.3). $S(n,\gamma,\lambda)$ is either convex $\forall n > 0$ or is concave for $0 < n < n^0$ and then convex for $n > n^0$.[12] Convexity in the higher range of n guarantees that (3) has one solution as long as S becomes negative if a network grows too large. For this reason, let's assume that the parameters of the game are chosen such that $S(n,\gamma,\lambda) \geq 0$ for $0 < n < \bar{n}$ and $S(n,\gamma,\lambda) < 0$ for $n > \bar{n}$. Given this assumption, (3) holds if n^* is chosen such that $S = 0$, thus $n^* = \bar{n}$.

4.1 Exclusive Social Capital

The question is now what happens to the optimal inclusiveness n^* assuming that the exchange setting in which the network operates becomes more complex over time (development). Assume that the network is exposed to a sequence of unanticipated shocks of increasing complexity. The higher complexity produces a negative externality on the network because the probability of a low match p does increase. This reduces expected payoffs in the network. How does the network respond to this externality? Or in other words, what happens to n^* when γ increases assuming all other variables constant? A change in γ changes S by

$$\frac{\partial S(n,\gamma,\lambda)}{\partial \gamma} = -\left(\frac{\partial p(n,\gamma)}{\partial \gamma} (1 - \delta + q(n,\lambda)\delta) \right) (c_h - c_l) \equiv \Delta_Q$$

[12] See Appendix for details.

Given that $\frac{\partial p(n,\gamma)}{\partial \gamma} > 0$, an increase in complexity will decrease S. The network members will have to adapt to this change by changing the network's inclusiveness. A change in n changes S by

$$\frac{\partial S(n,\gamma,\lambda)}{\partial n} = \Delta_R + \Delta_T$$

where

$$\Delta_R \equiv -\left(\frac{\partial p(n,\gamma)}{\partial n}\big(1-\delta+q(n,\lambda)\delta\big) + \frac{\partial q(n,\lambda)}{\partial n}p(n,\gamma)\delta\right)(c_h - c_l),$$

and

$$\Delta_T \equiv \frac{\partial q(n,\lambda)}{\partial n}\delta c_h.$$

Note that Δ_T and Δ_R change in opposite directions. After a change in γ, optimal inclusiveness n^* is reached if

$$\Delta_Q = \Delta_R + \Delta_T. \tag{4}$$

The question is whether the network has to increase inclusiveness or to decrease inclusiveness in order for (4) to hold. They will increase n if $|\Delta_Q| + |\Delta_T| = |\Delta_R|$, and they will decrease n if $|\Delta_Q| + |\Delta_R| = |\Delta_T|$. The question is whether $|\Delta_T|$ changes more quickly than $|\Delta_R|$ with a changing n or vice versa. Although the network's response cannot be unambiguously determined for lower values of γ, if γ increases high enough, the only response a network will have is to decrease inclusiveness. Because $p(0,\gamma) = 1$ and $p_n < 0$ and $p_y > 0$, $\frac{\partial p}{\partial n} \to 0$ as $\gamma \to \infty$. This implies that $|\Delta_T| > |\Delta_R|$, which means that a network can only respond by becoming exclusive.

Thus, the model predicts that sooner or longer the social network's only response in a developing economy is to decrease inclusiveness. They trade-off the higher probability of a low-match by a higher reliability of the information circulating in the

network. The result is an *exclusive* social network in which enforcement is still effective, however, the payoffs generated in this networks are low because of the high probability of a low match in each period. There is a small and exclusive group of cooperative individuals, but this cooperation ends mostly in low matches.

Definition 4.1 (Exclusive Social Capital) *Exclusive social capital is created in social networks which are responding to an increasing complexity constraint by reducing inclusiveness.*

It is obvious that this reaction is possible only for a limited period of time because a sequence of unanticipated shocks which increases γ has the consequence that there will be a point where the network no longer can shrink and it will completely disappear or the discounted payoff in the network decreases such that $S < 0$, $\forall n > 0$. Exclusive social capital reduces economic performance because gains from trade decrease as a social network becomes more exclusive. Thus, exclusive social capital in a complex exchange setting is associated with a low social capital value.

Clay' s (1997, p. 225) report about the merchant coalition in Mexican California is an illustration of such a break down due to increasing complexity in this region. One reason was that the 1848 gold rush in this area changed the exchange needs in this setting which reduced the profitability of the membership to the coalition. According to Clay, the reduction in cooperative payoffs was one reason for the collapse of the coalition. An instructive illustration is also Greif's (1994, p. 943) comparative institutional analysis in long-distance trade in late medieval Mediterranean between the Genoese traders who built on formal legal and political enforcement and the Maghribis traders who built on self-enforcement given by reputation in a closed social network.

At the end of his paper, Greif (1994, p. 943) speculates that Maghribis traders were possibly driven out by Genoese traders because formal institutions allowed a greater inclusiveness which is important for capturing gains from trade, especially when the division of labor is becoming more important.

4.2 Inclusive Social Capital

The dynamic of the model changes if the network is allowed not only to adapt its inclusiveness but to improve its capacity to communicate λ in the network. Because $q(0, \lambda) = 1$, $\frac{\partial q(n,\lambda)}{\partial n} < 0$ and $\frac{\partial q(n,\lambda)}{\partial \lambda} > 0$, $\frac{\partial q(n,\lambda)}{\partial n}$ decreases as λ increases which decreases $|\Delta_T|$ and increases $|\Delta_R|$. That is, if a network is able to increase λ high enough, it will respond by including more network members. Cooperation in the network remains sustainable despite the higher complexity and the higher inclusiveness.

Definition 4.2 (Inclusive Social Capital) *Inclusive social capital is created in social networks which are able to respond to an increasing complexity constraint by increasing its inclusiveness.*

Thus, the model suggests that in a complex exchange setting inclusive social capital is more valuable because it can combine both, low enforcement costs and high gains from trade. Moreover, it is only this form of social capital which is sustainable in the long-run assuming that a network is facing a sequence of unanticipated complexity shocks. This point can be illustrated by Nadvi's (1999) account about the "shifting ties" in the surgical instrument cluster in Sialkot, Pakistan. Nadvi points out that the importance of social ties given by kinship and family membership has declined while social ties given by "localness" have become more important. The latter form

of social ties are more open so that this cluster was able to increase its inclusiveness in the process of development. Another example is Rabellotti's (1997, p. 20) account about the footwear cluster in Mexico after trade liberalization in this country which changed the complexity of the setting considerably for these producers. In these clusters various programs have been introduced with the explicit goal of establishing social ties among firms which go beyond family ties. In short, the goal was to convert exclusive social capital into inclusive social capital. Another example of increasing inclusiveness is the conversion to Islam in Africa as described by Ensminger (1997). By converting to the Islam, an individual is able to expand the range of potential trade partners beyond kinship membership. In this context, it is important to remember that religious organizations often value a large and growing membership in its own right such that world conversion is a stated goal of many religious communities. Also Platteau (1994, p. 551) identifies religion and the possibility of conversion as a means to enlarge the community space and therefore to increase gains from trade.

The creation of inclusive social capital facilitated by the tremendous progress of the communication technology has been mentioned earlier. Important to note is that given these communication capacities, inclusiveness of social networks may surpass the one of formal institutions where inclusiveness of institutions often ends at the border from one nation to another.

5 Conclusions

Social capital is defined as a player's reputation for being cooperative in a social network. The mere fact of having social capital, however, should not be confused with

the value of a specific stock of social capital. The model points to the importance of inclusiveness of social networks in which social capital is created. The model is driven by two constraints: The communication constraint and the complexity constraint. It shows that the sustainability of cooperation in a social network may be jeopardized if inclusiveness of a network is too high because communication becomes inaccurate. Gains from trade, however, may be small if inclusiveness of a network is too low. It is shown, first, that the latter effect is less important in a less complex exchange setting. I referred to examples in economic history and economic development. Second, cooperation is sustainable in inclusive and large networks if these networks have a high capacity for communication. I referred to the progress in communication technology (e.g. internet) which allows for the attractive combination of high gains from trade and low enforcement costs even in a complex exchange setting. Moreover, it was shown that if a network is not able to improve its communication technology, its optimal inclusiveness will shrink as complexity of the exchange setting increases (development). Under these circumstances, the value of social capital declines.

The model suggests that empirical research trying to assess the amount of social capital not only has to focus on associational activity as for instance the average number of group memberships cited per respondent in each country (e.g. Knack and Keefer 1997). In order to assess the amount of social capital such a measure should be complemented with a measure of inclusiveness of these groups (i.e. size of a association and the heterogeneity of its membership structure). Then, empirical research has to show whether inclusive social capital, ceteris paribus, is associated with better economic performance as predicted by the model.

The value of a given stock of social capital might depend also on other qualities of a social network than its inclusiveness. Networks differ in their organizational structure. Some are vertical others are horizontal. For example, Putnam (1993, p. 175) argues that "vertical networks are less helpful than horizontal networks in solving dilemmas of collective action." Some networks have an organizational structure based on the M-form (multi-divisional form) and others based on the U-form (unitary form). In a recent paper, Maskin et al. (2000) show under what conditions these two organizational forms induce better economic performance. The general framework for studying network structures developed by Kranton and Minehart (forthcoming) might be a useful tool to gain insights of how network structures affect economic performance and therefore the value of social capital created in these networks.

A Appendix

This appendix analyzes the functional form of $S(n, \gamma, \lambda)$ with respect to n. The second derivative of S with respect to n is as follows:

$$\frac{\partial S}{\partial n \partial n} = \frac{(c_l - c_h)\big(\frac{\partial p}{\partial n \partial n}(1 - \delta + \delta q) + \frac{\partial q}{\partial n \partial n}\delta p + 2\delta \frac{\partial q}{\partial n}\frac{\partial p}{\partial n}\big) + \frac{\partial q}{\partial n \partial n}\delta c_h}{1 - \delta} \tag{5}$$

It can be seen that the second derivative changes with n. Given the properties of $q(n, \lambda)$ and $p(n, \gamma)$ as specified in definition (3.1) and definition (3.2)

$$\lim_{n \to \infty} q(n, \lambda), p(n, \gamma), \frac{\partial p(n, \gamma)}{\partial n}, \frac{\partial p(n, \gamma)}{\partial n \partial n}, \frac{\partial q(n, \lambda)}{\partial n}, \frac{\partial q(n, \lambda)}{\partial n \partial n} = 0 \tag{6}$$

This implies that there is $n \geq n^0$ for which $\frac{\partial S}{\partial n \partial n} > 0$ because $|c_l - c_h| < c_h$. Because of (6) and because $|c_l - c_h| < c_h$,

- either $\frac{\partial S}{\partial n \partial n} > 0 \quad \forall n > 0$ which establishes the convex property of S. This holds more easily the smaller the difference between c_h and c_l.

- or $\frac{\partial S}{\partial n \partial n} < 0$ for $0 < n < n^0$ and $\frac{\partial S}{\partial n \partial n} > 0 \quad \forall n > n^0$ which establishes the concave property of S for $0 < n < n^0$ and the convex property of S for $n > n^0$. This holds more easily the larger the difference between c_h and c_l.

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