Social Embeddedness and Economic Governance: A Small World Approach

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Abstract

We develop a framework that may be helpful for understanding the coevolution of social embeddedness and economic governance as an economy modernizes. We associate the transition from a traditional to a modern economy with an increase in the probability of interacting with individuals outside of a narrow relational neighbourhood. The small world framework, based on random graph theory, enables us to use this probability to interpolate the economy between a situation of close-knit group interaction and arms-length anonymous market interaction. This transition is accompanied by a decline in social embeddedness and can cause cooperation to collapse if the economy crosses a threshold before third party institutions emerge. Consequently, external institutions are crucial for market development to proceed beyond a threshold of complexity. The relative effectiveness of different institutions depends on the stage of modernization of the economy. Enforcement is relatively more valuable at low levels of modernization while information is relatively more valuable at high levels.

1 Introduction

The difficulties experienced over the last decade by many emerging and transition countries in trying to move toward market-oriented systems of economic organization have emphasized the need for a better understanding of the foundations of a smoothly functioning market (see Stiglitz, 1999). The issue of economic governance has consequently moved to the forefront of both theory and policy in economics (see Dixit 2001). We now realize that many regions of the world are deeply fragmented into groups, often along ethnolinguistic lines, with little or no cooperation outside their boundaries. Others regions are characterized by patterns of broad cooperation across society backed by formal legal and financial institutions. This cleavage, referred to variously as the distinction between relational and rule-based or arms-length governance, becomes much more than a curiosity when we find that it correlates with economic performance (Li, 1999; Barro, 1997; La Porta et al., 1998, 1999). The puzzle is further deepened by the surprising degree of resistance that efforts at establishing rule-based governance have encountered in different parts of the world[1]. Despite this dichotomy in economic governance and economic performance, why do relation-based economies sometimes appear to be so resistant to the transition toward a more rule-based arms-length system? What role do external institutions play in this? If they do play a role, can we say anything about the relative importance of different institutions? Does this depend on the stage of development[2]?

In this paper we attempt to provide some answers to these questions by means of a framework that is motivated by recent research in the fields of sociology and statistical mechanics. But in order to adopt this framework, two assumptions are crucial. The first comes directly from sociology and is the notion that economic interactions are often *embedded* in social relations (Granovetter, 1985). The second is adapted from statistical mechanics and is the notion that a key difference between a *traditional* economy and an economy in the process of *modernizing* is the higher probability of interacting with individuals outside a relational

[1] The persistent civil strife between different ethnic groups (Pashtuns, Hazaras, Uzbeks and Tajiks) in Afghanistan is an example that has recently attracted attention.

[2] One of the central themes of the World Development Report 2002: *Institutions for Markets,* is that institutions need to be tailored according to the stage of (under)development of an economy.

neighborhood[3]. We refer to this interaction probability as the *complexity* of the economy[4].

The core of the argument that we develop in more detail in the paper is as follows. Start by considering self-governance, where there are no external institutions and intermediaries to govern transactions. In such an environment, if the economy has very low complexity (a *traditional* economy), interactions are mostly with neighbors, social embeddedness is strong and thus plays a vital role in governing transactions. This is consistent with numerous studies that find relation-based governance prevalent in developing countries (see for example McMillan and Woodruff, 1999; Johnson, McMillan and Woodruff, 2002). However, as the economy increases in complexity (*modernizes*), social embeddedness begins to weaken and consequently has less influence on economic behavior. If the economy progresses beyond a certain threshold of complexity (determined by parameters of the economy), pure relationship-based governance begins to disintegrate and can eventually lead to a complete breakdown of economic interaction.

This collapse of cooperation once a threshold of complexity is crossed suggests a gainful role for external institutions. We therefore go on to consider two types of simple intermediation: information and enforcement. We find that while both types are beneficial for the economy, at low levels of complexity the marginal impact of enforcement intermediaries is relatively higher, while the reverse is true at high levels of complexity.

In her pioneering study of market development among the Orma tribe of Kenya, Ensminger (1992) describes a trajectory that matches this process quite closely. She describes how cooperation collapsed as social embeddedness disintegrated in the wake of increasing interaction across groups, only to be restored gradually by the development of formal political

[3]The term *modernization* seems appropriate for this process because modernization is associated with development of infrastructure and adoption of technologies, such as roads and telecommunications, that are likely to increase random interactions in the economy. It is important to note that prior usage has been different, though not entirely inconsistent with ours. Banerjee and Newman (1998) use this terminology to distinguish between a low-productivity *traditional* economy and high productivity *modern* economy. Kevin M. Murphy, Andrei Shleifer, and Robert Vishny (1989) also use the term in this way.

[4]This terminology is adopted from what has been referred to as the *complexity* prespective or the *Santa Fe* perspective, or occasionally the *process and emergence* perspective (see Arthur, Durlauf and Lane, 1997). Similar notions have been also referred to as the entropy (Georgescu-Roegen, 1971) or temperature (Krugman, 1997) of the economy.

and economic institutions[5]. This could also be considered consistent with the "disorganization" interpretation of the output collapse that has been observed in Russia and several other transition economies following the collapse of socialist methods of economic organization (see Blanchard and Kremer, 1997)[6].

The framework suggests one answer to the question of why many traditional economies are so riven by ethnolinguistic divisions and resistant to change[7]. In the absence of reliable external intermediaries, social embeddedness is critical for even a modicum of economic interaction. A realization that increasing modernization may chip away at this embeddedness and lead to economic anarchy could explain fragmentation and the associated resistance to expand economic activity beyond ethnolinguistic boundaries. This in turn emphasizes the importance of a reliable institutional framework as a prerequisite for the establishment of a broad based market economy[8]. To go one step further, in terms of the sequencing of institutional reform, the framework also suggests that marginal benefits from different types of institutional infrastructure are sensitive to the stage of modernization. Enforcement infrastructure comes first, followed by informational. This is again, consistent with evidence from research in anthropology on the problems of market development (Ensminger, 1992).

As we discuss in greater detail in the next section, the increase in complexity of the economy and the attendant decline in social embeddedness is akin to the replacement of *strong tie* social capital with *weak tie* social capital (Granovetter, 1973). Following this

[5] We describe Ensminger's findings in more detail in section 6.

[6] A recent paper by Recanatini and Ryterman (2000) continues this inquiry by noting that in the aftermath of the initial sharp output collapse, organizations which they term business associations have emerged in many parts of Russia and that these organizations arrested the output decline in regions where they emerged. They also find evidence that the formation of such an association is affected by regional characteristics. Membership in an association is more likely for firms that were formerly under the umbrella of the same Soviet planning ministry, because of prior relationships and contacts that existed, and for firms that are closer in terms of geographic distance. In terms of our framework these factors seem proxies for the limits of relationships.

[7] Witness the well publicized difficulties of getting the different ethnolinguistic factions to cooperate in Afghanistan for the *loya jirga.* Associated Press report "Afghans Pin Hopes on Loya Jirga" *New York Times*, June 9 2002.

[8] The realization that markets do not function in a vacuum and that their efficient functioning depends on a (minimal) basic institutional infrastructure is arguably one of the important lessons from the recent experience of the transition economies. See Stiglitz (1999) for a more detailed discussion along these lines.

interpretation, our finding that in the absence of external institutions, economic activity may collapse as strong ties are replaced by weak ties during the process of modernization runs counter to the school of thought on social capital that suggests that bonds of civic community are sufficient to surmount problems of opportunism in the development of "market order" as Putnam (1993, 2000) has suggested. Instead, our analysis supports Platteau's (Platteau 1994 a,b) critique of the social embeddedness thesis originated by Granovetter and subsequently elaborated into the theory of social capital by Putnam. Platteau suggests "While embeddedness theory does play an important role it is unable to provide a complete answer to the puzzle of market order, especially if the division of labor is highly developed and exchange is complex. ... Market order needs to be supported by institutions of both public and private order kinds, understood as organizations deliberately created which can use coercion to enforce agreements."

The remainder of the paper is structured as follows. In the next section we provide an introduction to the "Small World" approach and suggest it as a framework for understanding the coevolution of social embeddedness and economic governance as an economy modernizes. Section 3 develops the model in greater detail. Section 4 applies the model to self-governance, a world without formal institutions. Section 5 introduces two simple institutions to the framework: an informational intermediary and an enforcement intermediary. Section 6 discusses Ensminger's anthropological study of market development in Kenya in more detail. Much of our analysis finds support in her research. Section 7 concludes.

2 The Small World Approach

A. Social Capital

While social networks have been of interest to sociologists for some time (Granovetter, 1973; Coleman, 1988; Wasserman and Faust, 1994), economists have only quite recently begun to apply them to problems in various areas. However, they have already been found especially useful in understanding problems relating to contractual governance, market development and international trade (Greif, 1993; Ghatak, 2001; Kali 1999; Kranton 1996; Rauch 1999; Rauch and Casella 2001).

Most recently there has been a surge of interest in the related notion of social capital (see Sobel 2002 for a recent survey), in large part due to the interest generated by the work of Putnam (1993, 2000). According to Putnam, social capital refers to features of social organization, such as trust, norms, and networks, that can improve the efficiency of society by facilitating coordinated actions. Granovetter (1973), among the first to examine these kinds of issues, argued for a distinction between bonding (strong tie) social capital and bridging (weak tie) social capital. Strong ties connect people within a network. Weak ties connect across networks. In subsequent work, Granovetter (1974) demonstrated that these different types of social capital are useful for different purposes. Weak links are better for collecting information (increasing connectivity) while strong links are important for fostering cooperation (overcoming the prisoners dilemma) and coordination (Chwe, 2000). Two agents are connected through a weak link if they have few common neighbors and they are connected through a strong link if their neighbors overlap to a large extent. The presence of strong ties does not necessarily imply the presence of weak ties. Societies with high levels of embeddedness are likely to have strong ties. But strong ties without weak ones may lead to a clustered but fragmented society. A recent paper by Alesina and La Ferrara (2000) that examines issues relating to social capital using survey data on the U.S. finds that local heterogeneity on the bases of ethnicity, race and income is indeed inimical to intra-community interaction. Related research by Kingston (2002 a,b) examines how social structure affects parochial behavior, finding that segmented societies are able to sustain higher levels of parochialism than more integrated societies.

A number of recent papers have adopted the view that social capital is embedded in social networks. An increasingly persuasive body of recent research (such as Mailath and Postlewaite, 2002; Okuno-Fujiwara, 2002) argues that humans are embedded in social structures and that they choose actions taking account of the social contexts in which they live. We adopt this viewpoint and attempt to examine how social embeddedness may evolve as an economy modernizes and the implications this will have for economic governance. A path-breaking recent paper by Watts and Strogatz (1998) has suggested a framework for thinking about this evolution, which we adopt in this paper.

B. The Small World Approach

The cornerstone of this approach is the idea that the process of market development can be represented in terms of a gradually increasing likelihood of interacting with individuals outside a person's close relational neighborhood. A situation of extreme underdevelopment is associated with a very low ($p \sim 0$) probability of interacting with others outside the neighborhood. As market development proceeds this probability increases until finally we arrive at what could be called anonymous market interaction ($p \sim 1$). Varying the probability of random interaction (p) in the economy allows us to 'tune' the economy through intermediate stages of market development. By grafting a Prisoners' Dilemma game onto this structure we are able examine cooperation (and it's collapse) in the transition from highly clustered, group-based economic interaction at the one extreme, to anonymous, market interaction at the other.

This approach is motivated by a paper by Watts and Strogatz (1998) that uses techniques from graph theory. Starting from a regular graph where individuals correspond to the nodes and the links joining nodes are fixed, they start "rewiring" links randomly with probability p. This rewiring procedure effectively converts the regular graph into a random graph. They define two statistical properties for the random graph thus formed. The *clustering coefficient*, which is a measure of the cliquishness of a neighborhood and the *characteristic path length*, which is a measure of the average number of links connecting any two people. Normally one would expect that as the probability of random rewiring increases, the clustering coefficient should fall. But their most striking discovery is that as the random rewiring probability increases, the characteristic path length does indeed fall sharply but the clustering coefficient remains at high levels over a fairly large range. In other words, there is a large interval of randomness over which the cliquishness of the graph remains high even though connectivity is high too. This phenomenon has been referred to as the "Small World" effect and graphs which display low characteristic path length and high clustering are referred to as small world graphs[9].

[9] A social network exhibits the small-world phenomenon if, roughly speaking, any two individuals in the network are likely to be connected through a short sequence of intermediate acquaintances. This has long been the subject of anecdotal observation and folklore; often we meet a stranger and discover that we have an acquaintance in common. It has since grown into a significant area of study in the social sciences, in large part through a series of striking experiments conducted by Stanley Milgram and his co-workers in the 1960's (Milgram 1967, Corte and Milgram,1978). Recent work has suggested that the phenomenon is pervasive in

The clustering coefficient and characteristic path length are particularly useful statistics for our analysis. We use the clustering coefficient as a measure of the informational capabilities of the economy and the characteristic path length as a measure of the search costs.

The Prisoners' Dilemma presents an agent with the temptation to cheat, but the clustering coefficient acts as a brake on such behavior by determining the extent to which others will know the agent's record and punish his transgression in the future. In addition, each period an agent can search for his 'ideal' trading partner with whom gains from trade are higher than with others. But there is a trade-off between the clustering coefficient and characteristic path length as complexity increases, which could be thought of as accompanying the modernization process. When complexity is low, clustering is high, and the likelihood of cheating is low. But since search costs are high in this situation, the likelihood of finding the ideal trading partner will also be low.

In the absence of any external institutions this trade-off leads to an optimal level of complexity for the economy. This, in turn, leads to an optimal level of market (under)development. An interpretation of this is that an economy is likely to stay close to the degree of market development that maximizes its relative gains from honest exchange. Deviating from this level may actually lead to the breakdown of exchange altogether. In other words, depending on the parameters, a highly clustered group based economy may be the most desirable organization of the economy.

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networks arising in nature and technology, and a fundamental ingredient in the structural evolution of the World Wide Web (Watts and Strogatz 1998).

Milgram's basic small-world experiment remains one of the most compelling ways to think about the problem. The goal of the experiment was to find short chains of acquaintances linking pairs of people in the United States who did not know one another. In a typical instance of the experiment, a source person in Nebraska would be given a letter to deliver to a target person in Massachusetts. The source would initially be told basic information about the target, including his address and occupation; the source would then be instructed to send the letter to someone she knew on a first-name basis in an effort to transmit the letter to the target as efficaciously as possible. Anyone subsequently receiving the letter would be given the same instructions, and the chain of communication would continue until the target was reached. Over many trials, the average number of intermediate steps in a successful chain was found to lie between five and six, a quantity that has since entered popular culture as the "six degrees of separation" principle (Guare, 1990).

However, if the degree of complexity in the economy is affected by exogenous factors (such as the drive for modernization) and continues to increase beyond this level (say p^*), then incentives for honest behavior begin to crumble. If this process continues, the economy could even reach a situation where it tips into a regime of dishonesty — an anarchic situation where there is no incentive to behave honestly. This suggests a gainful role for institutions, as individuals should be willing to pay for the improvement in their payoffs. We consider two types of simple institutions: informational intermediaries who gather and transmit information regarding cheating to their clients, and enforcement intermediaries, who increase the penalties for dishonest behavior. Informational intermediaries could be considered similar to credit reporting bureaus, trade associations and auditing firms. Enforcement intermediaries could be considered along the lines of the police force and judicial system.

Our analysis suggests that when complexity is low, the marginal gains from enforcement intermediaries are relatively higher than the marginal gains from informational intermediaries. This is because at lower values of complexity, clustering and thus information are already high and the temptation to cheat does not come from the likelihood of being found out, but from the possibility of lenient punishment if found out. However, at higher levels of complexity, it is the low likelihood of being found out that is the driving force. In other words, the stage of market development can play a role in the relative marginal benefits of the two types of intermediaries.

3 The Model

A. The Economy as a Relational Graph

We consider the economy to be representable as a relational graph. Relational graphs have the defining property that the rules governing their construction do not depend upon any external metric of distance between vertices[10]. The distance between vertices is measured solely in terms of the graph itself, and not in terms of any externally defined space.

Specifically, our economy consists of n individuals constituting the vertices of a one-

[10] This is something of a fine point because the vertices of relational graphs are labelled and ordered according to some kind of geometry (such as a ring).

dimensional ring lattice. Distance is measured in the economy solely in terms of connections or links between the vertices. Whatever combination of factors makes people more or less likely to associate is accounted for by the distribution of those links that actually form. Hence we are not concerned with questions of spaces and metrics: only connections. Furthermore we assume that all such connections are symmetric and of equal significance: that is, given some definition of what is required in order to "know" someone (whatever it may be), either two individuals know each other or they do not.

Each individual i is directly connected to k others on the ring by undirected edges. In order to capture the idea of a group where individuals interact only with people who are socially close to them, we assume that the connections are initially with the k closest neighbors[11]. Each vertex is thus of *degree* k[12]. This kind of structure represents a completely ordered lattice or a regular graph.

Our graph-economy is assumed to have many vertices with sparse connections, but not so sparse that the graph is in danger of becoming *disconnected*[13]. This is ensured by assuming $n \gg k \gg \ln(n)$. The first inequality ensures that the graph is sparse while the second prevents it from becoming disconnected (Bollobas, 1985).

There are two statistics of the relational graph economy that will be of particular interest to us. The first is the *characteristic path length* $L(n,k)$, that is the typical distance $d(i,j)$ between every vertex and every other vertex. Distance here refers not to any separately defined metric in which the graph has been embedded, but to a distinct graph metric–simply the minimum number of edges (in the edge set) that must be traversed in order to reach vertex j from vertex i, or in other words the shortest path length between i and j. Operationally, L is defined as the shortest path $d(i,j)$ between two vertices, averaged over all $\binom{n}{2}$ pair of vertices and is best computed numerically for a known graph. The idea of a *neighborhood*[14]

[11] This will be relaxed later.

[12] The *degree* of a vertex is the number of edges connected to that vertex.

[13] A graph is *connected* if there is a path joining every pair of distinct vertices in the graph. Consider any sequence $x_1, ..., x_{n+1}$ of vertices. A *path* P is a sequence of edges $e_1, ..., e_n$ such that the endpoints of edge e_i are x_i and x_{i+1} for $i = 1, 2...n$.

[14] Two edges are *adjacent* if they are both incident to the same vertex. A vertex and an edge are *incident* to one another if the vertex is the endpoint of an edge.

The set of vertices adjacent to the vertex x is the *neighbourhood* of x.

is useful in quantifying another statistic that will be useful, the *clustering coefficient* $C(n,k)$. The clustering coefficient characterizes the extent to which vertices adjacent to any vertex v are adjacent to one another, and is defined as follows. Suppose that a vertex v has k_v neighbors; then at most $\frac{k_v(k_v-1)}{2}$ edges can exist between them (this occurs when every neighbor of v is connected to every other neighbor of v). Let C_v denote the fraction of these allowable edges that actually exist. C is defined as the average of C_v over all v. For our relational graph economy these statistics have intuitive meanings. L is the average number of acquaintances in the shortest chain connecting two people. C_v reflects the extent to which friends of v are also friends of each other, and thus C measures the cliquishness of a typical acquaintance circle. Note that L is a global property whereas C is a local property.

B. Random Graphs

We introduce the notion of a *random graph*[15] as a tool for thinking about the transition of the economy from a situation of underdevelopment where individuals interact only with their close neighbors, to a situation where a market is well developed and individuals encounter and interact randomly with others spread throughout the economy. By varying the extent of randomness (which we refer to in the paper as *complexity)* in interactions within the framework of a random graph we are able to interpolate the economy from a situation of close-knit interaction (groups or tribes) to a situation of arms-length random interaction (the anonymous market).

A random graph is simple to define. A random graph is a collection of points, or vertices, with links or edges, connecting pairs of the vertices at random. In a random graph the presence or absence of an edge between two vertices is assumed to be independent of the presence or absence of any other edge, so that each edge may be considered to be present with independent probability p. Within our relational graph economy, we can construct a random graph by taking the n nodes or "vertices" and placing connections or "edges" between them, such that each pair of vertices i, j has a connecting edge with independent probability p.

[15] The study of random graphs has a long history. Starting with the influential work of Paul Erdos and Alfred Renyi in the 1950s and 1960s (Erdos and Renyi 1959, 1960) random graph theory has developed into one of the mainstays of modern discrete mathematics, and has produced a prodigious number of results, many of them highly ingenious, describing statistical properties of graphs, such as distributions of component sizes, existence and size of a giant component, and typical vertex-vertex distances. See Bollobas (1985).

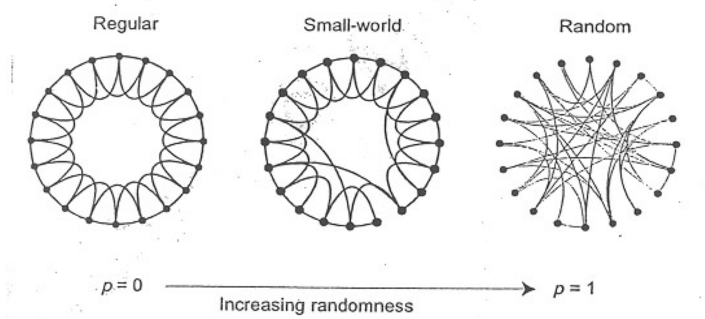

Figure 1: Random rewiring procedure, Watts and Strogatz (1998).

We use Watts and Strogatz's (1998) procedure for interpolating between a regular ring lattice and a random graph without altering the number of vertices or edges in the graph. Their procedure works as follows. Take the one-dimensional ordered ring lattice in which each vertex has precisely k neighbors ($\frac{k}{2}$ on either side) and then randomly rewire the edges with probability p using the following algorithm. Choose a vertex (i) and the edge that connects to its nearest neighbor ($i+1$) in a clockwise sense. With probability p,we reconnect this edge such that i is connected to another vertex j, which is chosen uniformly at random over the entire ring, with duplicate edges forbidden; otherwise we leave the edge in place. We repeat this procedure by moving clockwise around the ring, considering each vertex in turn until one lap is completed. When all the vertices have been considered once, we consider the edges that connect each vertex to its second-nearest neighbors clockwise (that is $i + 2$). As before, we randomly rewire each of these edges with probability p,and continue this process, circulating around the ring and proceeding outward to more distant neighbors after each lap, until each edge in the original lattice has been considered once. As there are $\frac{nk}{2}$ edges in the entire graph, the rewiring process stops after $\frac{k}{2}$ laps.

Figure 1 depicts this process for different values of p. For $p = 0$, the original lattice is unchanged. As p increases the graph becomes increasingly disordered until for $p = 1$ all edges are rewired randomly, resulting in a close approximation to a random graph. The algorithm thus allows the "tuning" of the graph between regularity ($p = 0$) and disorder ($p = 1$).

C. The "Small World" phenomenon

Watts and Strogatz numerically explore the properties of the characteristic path length $L(p; n, k)$ and the clustering coefficient $C(p; n, k)$ over the range of p. The regular lattice at $p = 0$ is a highly clustered world where L grows linearly with n. But as p grows, $L(p)$ drops almost immediately and falls very quickly to a value close to L_{random}, (when $p = 1$). $C(p)$ however, remains practically unchanged for small p even though $L(p)$ drops rapidly. This existence of high clustering like a regular graph, yet small characteristic path length like a random graph is referred to as the "small-world" property of the network by analogy with the small-world phenomenon. One of Watts and Strogatz's main contributions is the discovery of the small-world phenomenon for intermediate values of p ($0 < p < 1$).

The onset of the small-world results from the immediate drop in $L(p)$ caused by the introduction of a few long-range edges. Such "short cuts" connect vertices that would otherwise be much further apart than L_{random}. For small p, each short cut has a highly nonlinear effect on L, contracting not just the distance between the pair of vertices that it connects, but between their immediate neighborhoods, neighborhoods of neighborhoods and so on. By contrast, an edge removed from a clustered neighborhood to make a short cut has, at most, a linear effect on C. Consequently, at the local level the transition from the large to the small world is almost undetectable. Figure 2 depicts the behavior of $L(p)$ and $C(p)$ as obtained by Watts and Strogatz.

We use these properties to motivate the idea of the transition of an economy from close-knit groups to networks and finally to the anonymous market. The idea is that when p is small the economy is like a regular lattice, with individuals interacting only within their circle of immediate neighbors. Market development could be modeled by the increase in p and the associated interaction with individuals located further away in terms of social distance. Another way to think about it is to say that initially, economic interaction is embedded in a social network of strong ties. The introduction of short cuts is akin to the introduction of long-range weak ties.

For our purposes, all we require are the qualitative properties of the statistics produced

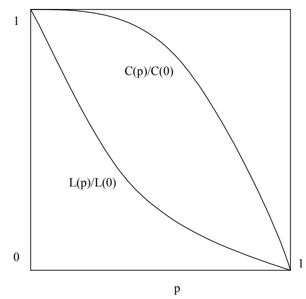

Figure 2: Characteristic path length and clustering coefficient for the family of randomly rewired graphs.

by the procedure[16]. As in Watts and Strogatz, we consider values normalized by $C(0)$ and $L(0)$, so that the normalized clustering coefficient $c(p)$ and characteristic path length $l(p)$ lie between zero and one. We assume the following properties of $c(p)$ and $l(p)$, as motivated by the work of Watts and Strogatz[17].

A1 $c(p)$ and $l(p)$ are continuous and differentiable.

A2 Over the whole range, $p \in [0,1], c^{/}(p) < 0, c^{//}(p) < 0$ and $l^{/}(p) < 0, l^{//}(p) > 0$.

A3 Over a certain range, say $p \in [0,\overline{p}]$, $\left|c^{/}(p)\right| \leq \left|l^{/}(p)\right|$ and over $(\overline{p},1]$, $\left|c^{/}(p)\right| > \left|l^{/}(p)\right|$.

A4 Over a certain range, say $p \in [0,\widetilde{p}]$, $\widetilde{p} < \overline{p}, \left|c^{//}(p)\right| \leq \left|l^{//}(p)\right|$ and over $(\widetilde{p},1]$, $\left|c^{//}(p)\right| > \left|l^{//}(p)\right|$.

[16] Exact analytical results have not yet been obtained for this procedure (See Newman, Watts and Strogatz, 2002 for a recent review of the literature). Consequently, our approach is essentially a "reduced form" use of the small world procedure.

[17] As in Watts and Strogatz, we assume values normalized by $C(0)$ and $L(0)$, so that $C(p)$ and $L(p)$ lie between zero and one.

		Side 2	
		Honest	Cheat
Side 1	Honest	H,H	E,W
	Cheat	W,E	D,D

Figure 3: The Prisoners' Dilemma

A5 Over the whole range, $p \in [0, 1]$, $l(p) \leq c(p)$.

D. The Stage Game

The agents in our relational graph economy are infinitely lived and are confronted with a symmetric two-sided prisoners' dilemma game each period. We consider a two-sided prisoners' dilemma in order to capture the idea that each side of the transaction can cheat on the other: the seller could cheat by providing poor quality and the buyer could cheat by defaulting on payment. The payoffs are shown in Figure 3. As usual, we assume $W > H > D > E$ and $W + E < 2H$.

In addition, an agent's needs change period by period. Every period two agents are uniformly randomly selected to be a "best match" to each other in terms of their needs. If the two players whose needs and capabilities fit best engage in trade, the payoff from honest behavior on the part of both players is $H + \theta$, instead of H as it is with any other partner. θ is thus the premium obtained from trading honestly with the "ideal" partner, given an agent's specific needs that period.

The fundamentals of the game are stationary and we consider stationary equilibria with the following "grim" trigger strategy[18].

(i) When faced with an opponent whose record you do not know, play Honest.

(ii) If you know your opponent's record,

(a) Play Honest if the opponent has an Honest record.

(b) Play Cheat if the opponent has a Cheat record.

A Cheat record means that the player's action history contains at least one "Cheat" and an Honest record means that the player's action history contains no "Cheat." The premium θ is not delivered when the Cheat record is found out.

E. Search and Information

Since there are n agents, the probability that any player j is player i's ideal trading partner is $\frac{1}{n}$. In each period player i does not know in advance who his ideal partner is, but can engage in search. The average cost of each search is proportional to the characteristic path length $l(p)$. Total search costs are assumed to be a quadratic function of the number of searches q of the form $\frac{1}{2}q^2 l(p)$[19]. The search process works as follows. Agent i gathers information from q other individuals simultaneously. Let Q be the sample of q agents that i gathers information from. After analyzing this information, if he finds his "ideal" partner he trades with him. If the ideal partner is not within the sample, he trades with a partner selected at random from the set Q. The probability that the ideal partner is within set Q is thus $\frac{q}{n}$. The discount factor is δ.

The clustering coefficient is a measure of how likely it is that information regarding an individual's behavior is known to other agents in the economy. We thus assume that $c(p)$ is the probability that a randomly chosen individual will know your record.

[18] More sophisticated equilibrium strategies are of course possible, such as two-phase carrot and stick punishments (see Fudenberg and Tirole 1991, Ch 5). But for our purpose grim trigger strategies are simpler and convey adequate intuition.

[19] The quadratic form of search costs is adopted only for simplicity and the arguments are valid for a general convex cost function.

4 Self-Governance

In this section we analyze the sustainability of cooperative behavior in the absence of any external enforcement institutions.

Let V_H and V_C denote the expected present value payoff of an agent with Honest record and Cheat record, respectively. Also, let $V_{H,\theta}$ and $V_{H,0}$ stand for the present value payoffs when an agent with Honest record finds his ideal match and does not find his ideal match, respectively. $V_{C,\theta}$ and $V_{C,0}$ are similarly defined for an agent with Cheat record. Then we can write the following system of equations to characterize behavior in the model.

$$V_{H,\theta} = \max\{H + \theta + \delta V_H, W + \theta + \delta V_C\} \tag{1}$$

$$V_{H,0} = \max\{H + \delta V_H, W + \delta V_C\} \tag{2}$$

$$V_H = \max_q (\frac{q}{n}) V_{H,\theta} + (1 - \frac{q}{n}) V_{H,0} - \frac{1}{2} q^2 l(p) \tag{3}$$

$$V_{C,\theta} = (1 - c(p)) \max\{H + \theta + \delta V_C, W + \theta + \delta V_C\} + c(p) \max\{E + \delta V_C, D + \delta V_C\} \tag{4}$$

$$V_{C,0} = (1 - c(p)) \max\{H + \delta V_C, W + \delta V_C\} + c(p) \max\{E + \delta V_C, D + \delta V_C\} \tag{5}$$

$$V_C = \max_q (\frac{q}{n}) V_{C,\theta} + (1 - \frac{q}{n}) V_{C,0} - \frac{1}{2} q^2 l(p) \tag{6}$$

where in the curly brackets the first (second) term represents the payoff when the player chooses to play Honest (Cheat). Note that the player with Cheat record always chooses Cheat.

If a player with Honest record chooses to be honest in the current period his payoff is obtained to be

$$V_H = \frac{1}{1 - \delta} \left[H + \frac{q\theta}{n} - \frac{1}{2} q^2 l(p) \right] \tag{7}$$

whereas if he chooses to cheat in the current period his payoff is obtained to be

$$V_H = W + \frac{q\theta}{n} - \frac{1}{2} q^2 l(p) + \delta V_C \tag{8}$$

Since a player with Cheat record always chooses to cheat, we can obtain his payoff to be

$$V_C = \frac{1}{1 - \delta} \left[\frac{q\theta}{n} (1 - c(p)) + (1 - c(p)) W + c(p) D - \frac{1}{2} q^2 l(p) \right] \tag{9}$$

From (7) we can find the optimal level of search (q) when Honest to be

$$q^* = \frac{\theta/n}{l(p)} \tag{10}$$

and from (9) we find the optimal level of search when cheating to be $(1 - c(p))q^*$.

We state this intuitive result on search in the form of the following lemma.

Lemma 1: *Search is increasing in the expected premium from the "ideal" match and decreasing in the characteristic path length of the economy.*

Subtracting (8) from (7) and using (9) yields an expression for the premium from honest behavior,

$$G = \delta c(p)\left[W - D + \frac{\theta^2(3 - 2c(p))}{2n^2 l(p)}\right] - (W - H) \tag{11}$$

$G = 0$ on the boundary where an agent is indifferent between honesty and dishonesty. $G > 0$ implies we will be in the honest regime, when agents chose to cooperate, and $G < 0$ implies we will be in the dishonest regime, when agents chose to cheat. In order to examine issues relating to regime switching as the economy increases in complexity from regularity to randomness, we differentiate G with respect to p. This yields,

$$\frac{\partial G}{\partial p} = \delta\left[c^{/}(p)\left(W - D + \frac{\theta^2(3 - 2c(p))}{2n^2 l(p)}\right) + \frac{c(p)\theta^2}{2n^2 l(p)}\left(-2c^{/}(p) - \frac{(3 - 2c(p))l^{/}(p)}{l(p)}\right)\right] \tag{12}$$

The first part of this expression is negative while the second part is positive. Consequently whether $\frac{\partial G}{\partial p} \gtrless 0$ depends on the relative magnitudes of the first and second parts.

In order to understand the behavior of the G function over the range of p, we use A1-A4 to analyze the behavior of expressions (11) and (12).

First consider the value of G at the two extremes, $p = 0$ and $p = 1$.

At $p = 1$, $l(p), c(p) = 0$. So it is easily observed that $G\mid_{p=1} < 0$.

At $p = 0$, $l(p), c(p) = 1$. So, $G\mid_{p=0} = \delta\left[W - D + \frac{\theta^2}{2n^2}\right] - (W - H)$. We can see that this can be positive under a variety of parameter configurations. For example, this would be the case if the "ideal match" premium θ/n were large ($>> W - H$), the discount factor δ were high, and the punishment payoff D were small.

Since we have assumed $l(p), c(p)$ are continuous, $G(p)$ will also be continuous. Then by the Intermediate Value Theorem we can argue that G can go from positive to negative values as p increases.

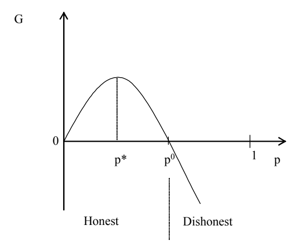

Figure 4:

Next, consider $\frac{\partial G}{\partial p}$ from (12). At low values of p the magnitude of $c^{/}(p)$ is low while $c(p)$ and $l^{/}(p)$ are high. Also, because of the small world effect, $l(p)$ is low. This implies that the first term will be small while the second term will be large. Consequently (12) can be positive at low values of p. However, as p increases, it can turn negative.

We could summarize this as suggesting a shape for the G curve as depicted in Figure 4. Call the value p where $G = 0$, p^0.

Note that this implies a value of p, say p^*, with $p^* < p^0$ where the gains from the honest regime G are highest. This value could be backed into an optimal level of clustering and characteristic path length. In other words, in the absence of external enforcement mechanisms, there is an optimal level of randomness in the economy that determines the optimal size of the network. We summarize the preceding analysis in the following proposition.

Proposition 1: *In the self-governance economy, parameter values determine an optimal level of complexity p^*. This level of complexity in turn determines the optimal level of social embeddedness in the economy: The optimal level of complexity p^* determines the optimal degree of clustering $c(p^*)$ and the optimal characteristic path length $l(p^*)$, of the economy.*

We could interpret this result as follows. Without external institutional mechanisms to intermediate reliable exchange, the economy is apt to confine itself to an intermediate level of interaction in order to sustain cooperation. Given the constraints the economy faces, the economy will choose the level of networking that ensures the maximal gains from exchange. This may provide an explanation for why many underdeveloped economies (Afghanistan for example) are split into small ethnolinguistic clusters or groups, and they resist expansion and opening up. In the absence of external institutions, an expansion in interaction with other individuals outside the relational neighborhood could prove disastrous by leading to the collapse of cooperation altogether.

5 Institutions

As we have seen in the preceding analysis, at large values of p, when $G < 0$, the existing structure of links in no longer adequate to sustain honest economic activity. The suggests that beyond this level of *complexity* there is a gainful role for external institutions. There are two kinds of institutions that we consider, information intermediaries and enforcement intermediaries.

A. Information Intermediaries

Consider an intermediary who gathers and transmits information regarding cheating through the economy. We could think of such an intermediary being similar to a credit rating agency. For a given value of p, such an intermediary increases the likelihood of being found out. We could say then that the probability of being found out it is not $c(p)$ but $c(p) + \gamma$, bearing in mind the restriction $c(p) + \gamma \leq 1$. γ is thus a parameter that stands for the function of the information intermediary. We call such an intermediary Info following Dixit (2003)[20]. The introduction of Info has the effect of shifting up the G curve as depicted in Figure 5.

The G function now takes the form

$$G = \delta(c(p) + \gamma) \left[W - D + \frac{\theta^2(3 - 2(c(p) + \gamma))}{2n^2 l(p)} \right] - (W - H) \qquad (13)$$

[20] The terms Info and Enfo were coined by Dixit (2003) to refer to Information and Enforcement intermediaries.

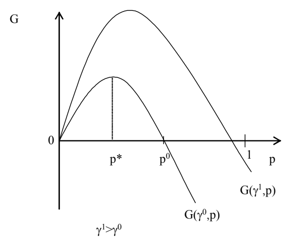

Figure 5:

This also has the effect of changing p^* and the maximal value G^*. Agents in the economy should be willing to pay Info the difference $S = G(\gamma^1, p) - G(\gamma^0, p)$, where $\gamma^1 > \gamma^0$. Note that intermediation is essential for normal economic activity beyond p^0, but is valuable even before. Consequently, whether Info enters or not depends whether the sunk cost of setting up intermediation is less than S.

B. Enforcement Intermediaries

These kind of intermediaries inflict punishment on cheaters. We refer to such an intermediary as Enfo. If found out, the cheating payoff goes down because of Enfo. We could think of this as a decrease in the mutual cheating payoff D. This also has the effect of shifting up the G curve as with Info.

We can compare between Info and Enfo.

$$\frac{\partial G}{\partial \gamma} = \delta \left[W - D + \frac{\theta^2 (3 - 2(c(p) + \gamma))}{2n^2 l(p)} \right] - \delta (c(p) + \gamma) \left[\frac{\theta^2}{n^2 l(p)} \right] \tag{14}$$

$$\frac{\partial G}{\partial D} = -\delta (c(p) + \gamma) \tag{15}$$

$$\frac{\partial^2 G}{\partial\gamma\partial D} = -\delta < 0 \quad (16)$$

Note that since an improvement in Enfo is indicated by a decrease in D, the sign of (16) implies that Info and Enfo are complements.

We can see that if p is high, the magnitude of the expression in (14) will be high while the magnitude of the expression in (15) will be low. Conversely, when p is low, the magnitude of the expression in (15) will be high while that of (14) will be low. In other words, a marginal improvement in Info has a greater impact than a marginal improvement in Enfo when *complexity* in the economy is at a high level. We could state this as follows.

Proposition 2: *At low levels of complexity, a marginal improvement in enforcement is more valuable than a marginal improvement in information. At high levels of complexity, the reverse is true.*

This is intuitive. When p is low, $c(p)$ remains relatively high and information is not at stake. What deters cheating at this level is not the probability of being found out, but the potential punishment. On the other hand, at high values of p, $c(p)$ is likely to have fallen, implying serious information difficulties. We could interpret this as saying that, at low levels of modernization (low p), enforcement intermediaries are more likely to be more effective. At higher levels of modernization (high p), informational intermediaries are more effective.

In terms of the transition to modernization, choices often need to be made about institutional priorities. This analysis implies that the effectiveness of each type of institution depends on the stage of modernization. It is important to remember however, that we have not considered the cost structure associated with each type of intermediation and have just considered the benefits. The ultimate cost-effectiveness will of course depend on a consideration of the costs associated with each type of institution as well.

Also,

$$\frac{\partial^2 G}{\partial\gamma\partial p} = \delta\left[-\frac{\theta^2(3-2(c(p)+\gamma))l^{/}(p)}{2n^2 l(p)^2} - \frac{2\theta^2 c^{/}(p)}{n^2 l(p)} - \delta(c(p)+\gamma)\left(\frac{\theta^2 l^{/}(p)}{n^2 l(p)^2}\right)\right] > 0 \quad (17)$$

$$\frac{\partial^2 G}{\partial D\partial p} = -\delta c^{/}(p) > 0 \quad (18)$$

Expressions (17) and (18) imply that marginal gain from improvement of intermediaries is greater at higher values of p. We could state this as follows.

Proposition 3: *Both kinds of intermediation are more valuable at higher levels of complexity in the economy: the marginal effects of both types of intermediation are higher at higher values of* p.

One could interpret this result as representing the idea that formal institutions are in general more valuable at higher levels of complexity than at lower levels.

6 Market Development: The Orma Tribe of Kenya

As far as in-depth studies of the process of market development, Ensminger's fascinating study of the Orma tribe of Kenya is perhaps the most detailed resource. The source of her data is extensive field work in Kenya, including two extended periods of residence among the Orma in the village of Wayu in Eastern Kenya between 1978-81 and in 1987. Much of her research supports the preceding analysis.

Her study documents the process of market development that took place among the pastoral Galole Orma and transformed Orma society in the process. Ensminger traces Orma origins in Kenya to migrations from Ethiopia that took place in the early seventeenth century. Since then and until the early part of the twentieth century, the Orma were mainly pastoralists, subsisting on cattle grazing and limited agriculture. Social organization within the tribe was very cohesive with close-knit cooperation smoothing consumption among tribe members, backed by the authority of tribal elders. Ensminger refers to this as the "moral economy."

During this period, long distance trade outside the tribe was almost nonexistent. The Orma had a reputation for being hostile to individuals outside their tribe. Caravans and Arab traders avoided Orma territory and considered them "fierce" and "aloof." Ensminger notes that the "closure" of Orma territory almost certainly retarded the development of trade but probably aided in preserving cooperation within the tribe and the authority of the chief.

In the early twentieth century the Orma gradually started trading relationships with other groups and tribes. Emsminger attributes this opening up to a number of causes. On the one hand, devastating wars with the Masai and Somali in the late 1800's nearly resulted in the annihilation of the Orma and created a period of insecurity that stressed their social, political and economic organization. On the other hand, a number of developments in the early 1900's created a decline in the transactions costs of trade and interaction. In terms of our framework we could interpret these as representing the process of modernization. Ensminger lists these as (a) conversion to Islam, which allowed the sharing of the institutions of Islam for governing trade, in particular the Islamic honor code and the *comenda* Islamic credit system; (b) the standardization of weights and measures by the British colonial government; (c) improvement in transportation and communication in the form of roads, motorized lorries and telegrams; (d) government services in the form of the establishment of an administrative bureaucracy to organize trade.

Ensminger also describes how increasing economic interactions with outsiders and the resultant increase in diversity led to a breakdown of community and a failure of cooperation and collective action among the Orma. This precipitated a major change in authority from rule by a collective council of elders to the modern nation state of Kenya. Ensminger states that one of the proximate crises that led to this change was the need for new property rights that the elders were incapable of enforcing without third-party institutions such as the state.

7 Conclusion

The goal of this paper has been to introduce a framework to understand the coevolution of social embeddedness and organizations for the governance of economic transactions. The small world framework of Watts and Strogatz (1998) provides us with a mechanism for interpolating an economy between a low-complexity strongly tied world of groups with a high degree of social embeddedness to a high-complexity weakly tied world of anonymous markets with a negligible degree of social embeddedness.

Strong ties facilitate cooperation but weak ties facilitate information gathering. Increasing complexity in the economy, that may come about on account of attempts to modernize, causes strong ties to unravel at the expense of weak ties. In the absence of third party institutions, we find an optimal level of complexity for the economy that in turn implies an optimal level of social embeddedness for economic governance. Further increases in the complexity of the economy leads to a weakening of social embeddedness and a corresponding weakening in its ability to govern transactions. Cooperation may collapse altogether.

This suggests a crucial role for external intermediation once the level of complexity in the economy has crossed a certain threshold. While the marginal benefits to enforcement intermediaries are higher at low levels of complexity, the marginal benefits of informational intermediaries are higher at high levels of complexity. But both types of intermediation become more valuable as the economy becomes increasingly complex.

The analysis in this paper may help us understand a number of features about underdeveloped and developing countries that seem so baffling to economists and policy makers. First, the reason why severely underdeveloped countries are often fragmented into deep divisions on the basis of ethnolinguistic criteria could be because this is a necessary arrangement to ensure a modicum of honest economic exchange within the group. Second, if the country modernizes too rapidly and interactions between individuals across groups increases faster than the emergence of reliable third party intermediation, economic anarchy may be the result. Third, after a threshold in the process of modernization is crossed, third party intermediation becomes essential to further development of markets and exchange. Fourth, the marginal benefits to the economy from different types of third party intermediation depends on the level of modernization. At low levels, enforcement dominates information, though at high levels the opposite appears to be true.

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