ISSN 1045-6333

HARVARD

JOHN M. OLIN CENTER FOR LAW, ECONOMICS, AND BUSINESS

LEGAL INSTITUTIONS AND THE STRUCTURE OF INFORMAL NETWORKS

Ethan Bueno de Mesquita
Matthew Stephenson

Discussion Paper No. 419

04/2003

Harvard Law School
Cambridge, MA 02138

Legal Institutions and the Structure of Informal Networks*

Ethan Bueno de Mesquita and Matthew Stephenson†

*We are indebted to Scott Ashworth, Chris Avery, Bob Bates, Bruce Bueno de Mesquita, Charles Cohen, Eric Dickson, Amanda Friedenberg, Mary Jackman, John Ohnesorge, Matt Price, Jas Sekhon, Ken Shepsle, David Singer, Anne-Marie Slaughter, Alastair Smith, Jim Snyder, Christine Taylor, Leeat Yariv, and participants in the Harvard Rational Choice Lunch Group and the Harvard Political Economy Workshop for valuable comments.

†Ethan Bueno de Mesquita is Assistant Professor of Political Science, Washington University in St. Louis. Matthew Stephenson is John M. Olin Fellow and Instructor in Public Policy, Kennedy School of Government, Harvard University. Stephenson thanks the John M. Olin Center for financial support. Send correspondence to: Matthew Stephenson, Department of Government, Littauer Center-North Yard, Harvard University, Cambridge, MA 02138. Email: mstephen@fas.harvard.edu.

JEL Classifications: K12, C72, Z13

Legal Institutions and the Structure of Informal Networks

Ethan Bueno de Mesquita and Matthew Stephenson*

Abstract

The relationship between government-provided contract enforcement and informal trade networks raises important sociological, political, and economic questions. When economic activity is embedded in complex social structures, what are the implications of governmental contract enforcement for the scope and nature of economic relations? What determines whether individuals rely on formal legal institutions or informal networks to sustain trade relationships? Do effective legal institutions erode informal networks? To address these questions, we develop a model in which a trade-off exists between size and sustainability of networks. By adding the possibility of enforceable contracts, we provide a theoretical explanation for the coexistence of legal contract enforcement and an informal economy. We find that legal enforcement has little effect on networks unless the cost of law drops below a certain threshold, at which point small decreases in the cost of law have dramatic effects on network size and the frequency of use of the legal system.

---

*Ethan Bueno de Mesquita is Assistant Professor of Political Science, Washington University in St. Louis. Matthew Stephenson is John M. Olin Fellow and Instructor in Public Policy, Kennedy School of Government, Harvard University. Stephenson thanks the John M. Olin Center for financial support.

Legal Institutions and the Structure of Informal Networks

Third-party contract enforcement is thought to be one of the essential public goods provided by government. Nonetheless, in societies without well-developed governmental institutions for the enforcement of contracts, cooperative economic interactions still take place; informal networks make such cooperation possible (Granovetter 1973; Moore 1978; Landa 1981; Weiss 1987; Benson 1990; Ellickson 1991; Bernstein 1992; Greif 1993; Winn 1994). Examples of such networks include the club-like relationship among Chinese rubber merchants in Malaysia (Landa 1981), the informal economy of Peruvian street vendors (De Soto 1989), and the reputation-based management of agency relationships established by medieval Jewish merchants in the Mediterranean (Greif 1993). Moreover, there is evidence that such networks persist even with the development of sophisticated legal enforcement (Macaulay 1963; Landa 1981; De Soto 1989; Ellickson 1991; Fafchamps 1996; DiMaggio and Louch 1998) and within highly industrialized societies (Portes and Sassen-Koob 1987). Indeed, it has been argued that such networks, rather than formal institutions, are the chief building block of sustainable economic relationships, even in modern economies (Granovetter 1973). Wisconsin businessmen, California ranchers, and entrepreneurs in Taiwan have all been observed to rely more on personal relationships and informal agreements than on formal legal enforcement mechanisms (Macaulay 1963; Ellickson 1991; Winn 1994).

The relationship between formal, legal contract enforcement and informal networks raises a number of important question. First, if the government fails to provide adequate third-party contract enforcement, what are the implications for the scope and nature of economic interactions? Second, what determines whether individuals will choose to rely on formal legal institutions or their informal social networks, when both are available? This question is particularly important for governments attempting to build an effective legal infrastructure. Third, to what extent does the introduction of governmental contract enforcement erode the social networks that sustain the informal economy? This is a matter of concern inasmuch as governments value both the positive effects of social ties maintained through informal networks and the greater societal cohesion achieved by replacing narrow social networks with a more formalized, integrated economy.

These issues lie at the nexus of several disciplines within the social sciences. Sociologists have a long tradition of examining how social structures other than the market – such as informal trade networks – affect economic interactions (Polanyi 1957, Granovetter 1985, Powell and Smith-Doerr 1994). Further, the question of how government policies and legal institutions impact economic outcomes and social structures are of interest to sociologists, political scientists, and economists alike (Skocpol 1985, Shapiro 1987, North 1990, Platteau 1994, Edelman and Suchman 1997).

In order to address these issues, we develop a model of informal networks in the absence of legal contract enforcement. We then introduce the possibility of legal contracts and analyze its equilibrium effects on these networks. In our model, cooperation in informal networks is sustained through repeated play and reputation. The need for reputation-based enforcement limits the number of trading partners with whom cooperation can be sustained. As the number of potential trading partners grows, the probability of interacting repeatedly with an individual decreases. However, as long as the network does not grow so large that cooperation is unsustainable, utility-maximizing individuals want to be in as large a network as possible. Expected gains from trade in such networks increase as the network size grows because individuals are likely to find more profitable trading partners among a larger group of potential partners.

By modelling the trade-off between size and sustainability of cooperation, we identify the optimal size of informal trading networks as a function of other parameters. We find further implications of this theory by exploring the endogenous evolution of informal networks within our model. When informal networks begin with a size that is larger than optimal, individuals defect until their networks have shrunk sufficiently to sustain cooperation. When networks are smaller than the optimal size, larger networks are more attractive to potential new members. This provides an endogenous explanation for the emergence of networks.

We extend our model by introducing the possibility of costly legal contract enforcement. Players choose between a costly, formal contract that allows them to cooperate with their most-preferred trading partner in the entire population and an informal contract with a member of their network. Our model predicts that informal trade networks often persist when formal legal enforcement becomes possible. Further, in many cases where the possibility of legal enforcement exists, it will neither be used nor have a significant effect on the size of informal trade networks unless it is sufficiently inexpensive. Thus, we provide a theoretical explanation for the continuation of informal networks even when legal enforcement is possible and demonstrate the relationship between the cost of legal enforcement, the size of informal networks, and the relative importance of the formal and informal economies.

LITERATURE REVIEW AND PUZZLES

Sociologists have paid particular attention to the use of informal networks to alleviate the uncertainty inherent in trading with strangers (DiMaggio and Louch 1998; Mizruchi and Brewster Stearns 2001). The more risky a particular interaction is, the more likely individuals are to trade in a network where trust has developed. Our analysis hinges on this insight, in the sense that people in our model trade within their networks precisely because members of the larger economic world cannot be trusted to deliver on promises. We then examine how the existence of formal legal institutions for the enforcement of contracts attenuates the riskiness of out-of-network interactions and, thereby, affects the structure of informal network.

In order to focus our discussion on the primary questions of interest – the effect of law on networks – we necessarily abstract away from some of the richness and nuance that has been developed in the literature on informal networks. Cultural and ethnic theorists have argued that one of the keys to sustainability of informal networks is that members of a particular group share similarities that foster trust by making internal monitoring easier (Colson 1974; Landa 1981; Bernstein 1992; Greif 1993; Fearon and Laitin 1996). Cultural cues allow members of a group to determine whether an individual is a cooperator or a shirker and kinship ties encourage cooperation. Another common line of argument is that cooperative networks are sustained through social norms. Such norms change people's preferences through an evolutionary or socialization process. The result is that individuals actually prefer to cooperate, even in situations where they could shirk without being caught (Ellickson 1991; Cooter 1996).

The explanation of cooperative networks that is most familiar to economists, and which is closely related to the idea of networks as a response to uncertainty, is reputation and repeated play. If self-interested players expect to interact many times, they can maintain cooperation through punishment strategies, assuming they care enough about the future (Axelrod 1984). It has been noticed, however, that although punishing past defections can sustain cooperation, it limits the size of informal groups. As groups become larger, the likelihood of interacting with any particular person in a given turn decreases, making cooperation more difficult to sustain. However, individuals benefit from being in larger groups where they are more likely to find profitable trading partners. Thus, there is a trade-off between sustaining cooperation and increasing diversity of trading partners.

Information sharing institutions are one possible solution to the problem of limited group size. If reputations can be credibly transmitted, then cooperation can be sustained in larger groups because players can punish not just players who have cheated them, but players who have cheated anyone (Milgrom, North, and Weingast 1990; Bernstein 1992; Greif 1993). However, efficient information sharing becomes more difficult to sustain effectively as groups grow. Hence, it is often argued that reputational enforcement mechanisms are inadequate to sustain cooperation in large, complex societies and thus become obsolete when formal legal enforcement of contracts becomes possible (North 1990; Platteau 1994).

Moreover, it has been theorized that legal enforcement eliminates the need for informal trading networks. Legally binding contracts ensure that individuals can enter into mutually cooperative relationships with their most profitable trading partner, even if they never expect to interact again. Therefore, according to this theory, legal institutions will replace informal trade networks (Lee 1993; Kranton and Swamy 1999). However, empirical evidence indicates that economic activity continues to be embedded in such networks even in societies with highly developed legal institutions (Macaulay 1963; Ellickson 1991; DiMaggio and Louch 1998). And, such informal mechanisms are in many cases the norm, persisting long after legal enforcement becomes available (Granovetter 1973; Landa 1981; De Soto 1989; Fafchamps 1996). Indeed, in many such cases, the formal legal institutions are rarely used at all. This has led other scholars to conclude that the law is of little relevance in these societies (Ellickson 1991; Winn 1994).

Both characterizations miss fundamental aspects of the choice between legal and reputational enforcement mechanisms. The former relies on the assumption that legal enforcement is costless, and the latter overlooks the complex interaction between the legal system and informal networks. Our model, in which individuals can trade in both the informal and formal economies provides a more nuanced perspective on this issue.

Because our main focus is on how legal institutions affect informal networks, we do not directly address the issues of ethnic or cultural subgroups, norm-based preferences for selfless cooperation, or information sharing. This work seeks to demonstrate how and why informal networks remain important even in the presence of formal legal institutions. Clearly, ethnic and cultural ties, social norms that favor cooperation, and information sharing all strengthen the linkages that sustain informal networks. By abstracting away from precisely those elements of networks that make cooperation most likely, we are considering the most difficult case. If informal trade networks persist in our model, without the sustaining effects of ethnic and cultural ties, social norms, or information sharing, they will be all the more robust in a richer model that includes these reinforcing elements. Thus, we do not claim that our model constitutes a complete description of the economic or social structure underlying informal networks. Rather, it is a simple and tractable stylization that allows us to explore the particular question of interest in this work, and is amenable to extension to include other important elements of networks. And, indeed, in our model, in which agents are homogenous, narrowly self-interested, and not privy to information about interactions that they do not personally observe, cooperative reputation-based trade networks still emerge in equilibrium. Further, our model provides a theoretical explanation for why economic interactions continue to be embedded in informal networks despite the existence of legal enforcement. We demonstrate that formal legal enforcement will rarely be used in societies with informal networks when such enforcement is expensive. This, however, does not imply that legal enforcement of contracts will always remain irrelevant in such societies. A sufficient decrease in the cost of law could lead to a dramatic increase in use of formal legal institutions.

THE MODEL

Consider an individual, i, who is a member of a society, $\mathbf{W}$, of size W and of an informal trading group which is a subset of that society and of size $n+1$, $n \in \mathbb{N}$. The number of partners in i's network is denoted by n.

In each round one player is selected from $\mathbf{W}$ by nature and labeled the selector, which means that she has the opportunity to choose a trading partner and engage in trade. The player she chooses to trade with is the selectee. A player, i, has probability $\frac{1}{W} \equiv \alpha$ of being the selector. The selector, i, has n_i potential trading partners. Let $N_i = \{1, ..., n+1\}$ be the set of all members of player i's trading group and N_{-i} be the same set, excluding player i herself. If $j \in N_i$ we assume $i \in N_j$. But we do not assume that if $j \in N_i$ and $k \in N_i$ then $j \in N_k$.

At the beginning of a round, trades between each dyad of players are assigned a value. A player observes the total value of a trade between herself and each other individual. The value of the trade between players i and j, in period t, is given by the random variable $V_t(i,j) : W \times W \rightarrow \mathbb{R}$. We assume that $V_t(i,j)$ is distributed uniformly on the interval $[0,2]$. Each trader receives half the value of a trade. Thus the value of a deal with player j to player i in round t, $V_i^t(j) = V_j^t(i) = \frac{V_t(i,j)}{2} \sim Uniform[0,1]$. Each $V_t(i,j)$ is iid. That is, the value of the deal between players i and j is uncorrelated with either of their individual values to any other player k, and is uncorrelated with the value of a deal between them in previous rounds.

The intuition behind this set-up might be something like the following. Imagine that player i is a carpenter and player j a baker. If in round t, player k needs an addition built to her house, a deal between i and k is more valuable than a deal between i and j. On the other hand, if in round $t+1$, k needs a wedding cake, the deal between k and j is more valuable.

We assume that in each round, the value of a deal between each dyad of players is drawn from a uniform distribution between 0 and 2. Thus, a priori, each player has an expected value of $\frac{1}{2}$ from engaging in trade.

In each round, the selector chooses her best trading partner in her network and they play a prisoner's dilemma.[1] If they both cooperate, they split the full valuation

[1] Much of the existing literature employs a social matching game in which palyers are randomly

FIG. 1. The Stage Game

		Player j	
		Cooperate	Defect
Player i	Cooperate	$V^t_j(i)$ / $V^t_i(j)$	$V^t_j(i) + b$ / $-rb$
	Defect	$-rb$ / $V^t_i(j) + b$	0 / 0

of the trade. If one defects, the defector gets her half of the deal plus a benefit $b > 0$. The player who is defected against receives a negative payoff of $-rb$, with $r > \frac{1-b}{b}$.[2] If both defect, both players receive a payoff of 0. The stage game is represented in Figure 1.

In each round, a player's expected valuation of her best trade is the nth order statistic of n-draws from a uniform distribution between 0 and 1.[3] In a uniform distribution, the n^{th} order statistic is given by the formula $\frac{n}{n+1}$.

The game is played in infinite repetition. Players discount the future with a common, constant discount rate $\delta \in (0, 1)$.[4] We assume that players costlessly remember

paired (Milgrom, North, and Weingast (1990); Laitin and Fearon (1996)); here we allow players to choose their best partner. Another interesting approach, that uses the prisoner's dilemma to explore the immergence of cooperation, without assuming a social matching game is Macy and Skvoretz (1998). For a discussion of the use of the Prisoner's Dilemma as a model of social interactions see Lomborg (1996).

[2]This assumption rules out equilibria in which players alternate between (C,D) and (D,C), a set of equilibria that are not interesting for the subject at hand.

[3]The n^{th} order statistic of n-draws is the single highest draw.

[4]Note that δ is actually a function of W. As W increases the probability of playing in any given

all of their own previous interactions but do not observe others' interactions. Each player plays a grim trigger strategy; if player j defects against player i once, player i defects against player j forever, but continues to cooperate with others who have not defected against her. [5]

To summarize, the sequence of events in a single round of play is as follows. First, a selector is chosen at random and she observes the value of each potential match. Second, she considers, as potential partners, those players who are in her informal network, who have never defected against her, and against whom she has never defected. Third, from this set, she chooses the partner with whom the value of cooperating is maximal. Finally, this selector and her chosen partner play a prisoner's dilemma.

ANALYSIS AND RESULTS

In this section, we solve the model and develop an extension in which we add the possibility of legally enforceable contracts. We begin by analyzing the optimal size of an informal trade network. We then address the endogenous formation and evolution of such networks. Finally, we include the possibility of costly, third-party contract enforcement, and explore how informal and formal enforcement mechanisms interact.

Optimal Network Size

The first question we consider is the maximum sustainable size of an informal network in which all players cooperate with one another. Players prefer to be in as large

round decreases. Thus, we think of an individual as having a true $\delta = \delta^*$. Then, the δ used in utility calculations is δ^{*-W} so that the amount that a player discounts between expected trades is unchanging in W. Because we offer no comparative statics on W we simply label δ^{*-W} as δ.

[5]This strategy is subject to criticism as it is neither renegotiation proof nor evolutionarily stable. However, it is sub-game perfect and we adopt it because it is the simplest version of the type of reputation-based punishment scheme that we are interested in.

a network as possible, as long as cooperation is sustained. Given cooperation, the expected value of each interaction in an informal network is $\frac{n}{n+1}$, which is strictly increasing in n. As an informal trading network grows, cooperation becomes more difficult to sustain through reputational mechanisms because as n increases the probability that a player will interact with any particular member of her network in a given round, $\frac{2\alpha}{n}$, decreases. Players maximize their utility by being in a network that is as large as possible while sustaining cooperation. We label this optimal number of informal partners as n^*.

In order to determine n^* we find the conditions under which a player, i, will cooperate. Denote the lifetime payoff to player i of a strategy X given that all other players adopt strategy Y as $EU_i(X, Y_{-i})$. Further, if player i follows strategy X once and then Z forever after that, we write the lifetime payoff as $EU_i(XZ, Y_{-i})$. Thus, the expected utility to i of always cooperating, given that all others cooperate is

$$EU_i(C, C_{-i}) = \left(\frac{2\alpha}{1-\delta}\right)\frac{n}{n+1} \tag{1}$$

If player i were to defect in one round, assuming that everyone else cooperates, she would get an expected payoff of $\frac{n}{n+1} + b$. As a result of this defection, in each subsequent round where she is the selector, she can only choose from $n-1$ rather than n possible partners. Further, the probability that someone else in her network will be selected and then choose to trade with her decreases from α to $\frac{\alpha(n-1)}{n}$. Thus, we can write i's expected utility from defecting once and cooperating forever, if all others are cooperating, as

$$EU_i(DC, C_{-i}) = \frac{n}{n+1} + b + \left(\frac{\alpha\delta}{1-\delta}\right)\left(\frac{n-1}{n} + \frac{n-1}{n+1}\right) \tag{2}$$

If $EU_i(C, C_{-i}) \geq EU_i(DC, C_{-i})$ then all $i \in N$ have an incentive to cooperate. If, however $EU_i(C, C_{-i}) < EU_i(DC, C_{-i})$, then player i prefers to defect if her partner is expected to cooperate. If her partner is expected to defect, i will always defect as well. In any trading pair (i, j) if i and/or j defect, they will never cooperate with one another again. Player i suffers this same loss of a trading partner for all future rounds whether she defects or not. But in the current round, if she defects she receives a payoff of 0 and if she cooperates she receives a payoff of $-rb < 0$. Hence, $EU_i(C, D_{-i}) < EU_i(DC, D_{-i})$ for all i. This implies that all players will cooperate if and only if

$$EU_i(DC, C_{-i}) - EU_i(C, C_{-i}) = \frac{n(1-2\alpha)}{n+1} + b - \frac{\alpha\delta}{n(1-\delta)} \leq 0 \qquad (3)$$

If the above inequality does not hold player i defects. Therefore, n^* (given δ, b, and α) is the maximum value of n for which equation (3) holds. Because all players have identical utility functions, all players will have the same n^*.

Proposition 1 *Given values of δ, b, and α a unique optimal network size, $n^* + 1$, exists.*

Proof. First observe from equation (1) that utility is strictly increasing in n given that one is in a network where cooperation is sustained. Thus, one always prefers to be in the largest cooperative network possible. Next, observe that equation (3) is increasing in n. Further, as n gets very large, equation (3) approaches to $1 - 2\alpha + b$, which is strictly positive, since $\alpha = \frac{1}{W} < \frac{1}{2}$. There are now two cases to consider.

Case 1: If when $n = 1$ equation (3) is positive, then equation (3) is always positive and no cooperative networks are possible and $n^* = 0$.

Case 2: If when $n = 1$ equation (3) is negative, then a cooperative network can be sustained. Further, because equation (3) is increasing in n and converges to a positive number as n become very large, equation (3) will eventually become positive and remain positive as n increases. Thus, once equation (3) becomes positive, cooperation is no longer sustainable. Thus n^* exists, and is the largest integer for which equation (3) is negative. ■

This confirms that an optimal network size exists. It follows directly from equation (3) that optimal network size is increasing in δ and decreasing in b.

Cooperative interaction is possible through informal networks, in the absence of third-party enforcement, generalized norms of reciprocity, information-sharing institutions, or differentiation between agents (such as ethnic or cultural subgroups). The size of an informal trade network is bounded above by n^*. As n increases, the expected payoff from cooperation, $\frac{n}{n+1}$, increases but the probability that two players will meet in any given round, $\frac{2\alpha}{n}$, decreases. This creates a trade-off: as n increases, cooperation is more profitable but harder to sustain. Further, as δ increases, so that players care more about the future, the size of the maximum sustainable cooperative network increases. Players who care more about the future can more easily commit to cooperating to avoid long-term punishment. As the benefit from defection, b, increases, cooperation becomes more difficult to sustain and group size decreases.

Endogenous Group Formation

Our model predicts a unique optimal network size, $n^* + 1$, given parameter values δ and b. We now consider how such optimally sized networks might emerge from a state of disequilibrium. We consider two initial conditions: when $n_0 + 1$, the original size of a group, is greater than $n^* + 1$, and when $n_0 < n^*$.

When networks begin larger than the optimal size, breakdown will occur through defection. No player has an incentive to cooperate, so all players will defect until they have decreased their number of trading partners to a size where cooperation is sustainable. This breakdown provides an endogenous explanation for the existence of informal networks. One can imagine that "at the beginning of time" everyone was in the same network of size W. Players, of course, could not sustain cooperation because $W > n^*$. This led to a series of defections, until as discussed above, players had defected against enough other people to be in a sustainable network.

Consider, now, the case where $n_0 < n^*$. There are two types of networks to investigate. We define an open network as one in which, if players j and k are both trading partners of player i, they are not necessarily each others' partners. That is $j \in N_i$ and $k \in N_i$ does not imply $j \in N_k$. For example a businessperson may have a network of trading contacts who do not know each other.

Conversely, a closed network is one in which all members of a given network share each other, and no one else, as trading partners. That is $j \in N_i$ and $k \in N_i \Rightarrow j \in N_k$. Examples of closed networks include small communities of farmers who do not trade in a larger market, or members of an ethnic group who only engage in commerce with one another.

When groups are smaller than optimal size, no individual has an incentive to defect and, thus, every individual has an incentive to add partners. In an open network system each player will add new partners, if possible, on her own until her network has reached optimal size.

A system of closed networks in which new members are scarce yields more complicated dynamics. Suppose that two informal trading networks exist, each of sub-optimal size. We label these G_1 and G_2, where the sizes of the groups are $n_1 + 1$ and $n_2 + 1$, respectively. Let $n^* > n_1 > n_2 \geq 1$ and $n_1 + n_2 > n^*$ so that the two groups cannot combine and maintain cooperation. An individual, labeled k, is a potential new member. We assume that once a person joins a network, it is sufficiently costly for her to leave that network that she will never do so. Each of the existing groups would like to attract this new partner. Indeed, groups may be willing to make side payments to player k in order to attract her. However, side payments require the groups to solve a collective action problem and a commitment problem. The collective action problem is that each member of a group may have an individual incentive to free-ride on her partners by not paying her share of the side payment. The commitment problem is that the group must be able to commit to making the side payment once the new member has joined the network and is unable to leave. We do not explicitly model these problems. Instead we consider two cases: when a mechanism does not exist to solve these problems, so that side payments are not possible, and when such a mechanism does exist.

If side payments are not possible, k will join G_1. Cooperation is sustained in both groups because both are smaller than the optimal size. It is clear from equation (1) that expected utility in cooperative groups is increasing in n. Thus, the new member will join the larger group.

Because members of groups that are smaller than optimal size also increase their utility by increasing the size of their group, they have an incentive to make side payments to potential new members to try to attract them. The question becomes, if credible side payments are possible, can small groups out-compete larger (but still smaller than optimal size) groups for new members?

Denote the maximum side payment that G_1 and G_2 are willing to make as S_1 and S_2, respectively. An individual, k, decides which group to join by comparing the expected lifetime utility of joining a group of size n_1 or n_2 plus the side payment that each group is willing to make. The expected utility to new member k of joining a group G_i of size n_i and receiving the side payment is given by: $EU_k(joinG_i) = EU_k(n_i + 1) + S(n_i)$, where $EU_k(n_i + 1)$ is the expected lifetime utility to player k of being in a group of size $n_i + 1$.

Both G_1 and G_2 would like the new partner to join them, provided that the side payment required to attract her is smaller than the benefit the group will receive from adding a new member. The groups are willing to pay up to the total surplus that they realize from adding a new member in order to attract her. The new member receives this total surplus. Thus, we can write the side payment that G_1 is willing to make as:

$$S_1 = (n_1+1)\left[EU_{i\in G_1}(n_1+1) - EU_{i\in G_1}(n_1)\right] = \left(\frac{(n_1+1)\,2\alpha}{1-\delta}\right)\left(\frac{n_1+1}{n_1+2} - \frac{n_1}{n_1+1}\right)$$

Thus player k's expected utilities from joining G_1 is:

$$\begin{aligned} EU_k\,(joinG_1) &= EU_k(n_1+1) + S(n_1) \\ &= \frac{2\alpha}{1-\delta}\left(\frac{n_1+1}{n_1+2}\right) + \left(\frac{(n_1+1)\,2\alpha}{1-\delta}\right)\left(\frac{n_1+1}{n_1+2} - \frac{n_1}{n_1+1}\right) = \frac{2\alpha}{1-\delta} \end{aligned}$$

Note that the expected utility to a potential new member is independent of the size of the group that she joins. This is because there are two competing forces in the competition for new members. Large groups are more attractive to new members due to the greater number of potential trading partners and have a larger number of people who can make side payments. However, new members are more valuable to smaller groups because the marginal utility of new trading partners is decreasing. Members of small groups can make up for their smaller size because they are willing to make larger side payments.

The perfect indifference of new members to which group they join (assuming credible side payments) only holds when potential new members do not anticipate the availability of future new members. Imagine that one potential new member becomes available every round. A player who would be indifferent between two groups of different size due to side payments will choose the group whose size is closest to n^*+1. Players recognize that they will have to contribute to the side payments used to attract future new members, and so choose to join the larger group because it will require the smallest number of future side payments. Thus, in a society with multiple informal networks all below equilibrium size, and a scarcity of new members, our model predicts that the largest sub-optimal group will grow fastest, regardless of whether credible side-payments can be made.

The Possibility of Legal Enforcement

In the original formulation of the model, players could only engage in exchange with members of their informal trade network. In this section we analyze the impact of the possibility of third-party enforceable contracts on the equilibrium we found in our earlier analysis.

In each round, the selector has a choice between informal trade within her network or going outside her network to make a formal contract. This is a departure from earlier approaches to modeling interactions between legal and informal enforcement, which have tended to assume that players are either part of the informal, reputation-based economy or the formal, contract-based economy (Landa 1981; Cooter and Landa 1984; Kali 1999). In our model, this choice is endogenous, and made each round.

A player, i, makes the decision either to write a formal contract or trade within her network after observing $V^t_{-i}(j)$ for all $j \in \mathbf{W}$. If player i chooses to write a formal contract, she finds a trading partner outside of her network, whose expected value to her is $\frac{W-n-1}{W-n}$.[6] However, contract enforcement carries a fixed cost $c \in [0, 1)$. Once a contract is written, we assume perfect enforcement. Because in equilibrium cooperation is always sustained in informal trade networks, players never write formal contracts with members of their own network. However, they can write formal contracts with ex-members of their network against whom they have defected in the past.

Note that this is not a change to the information structure of the game. As in the model of networks in the absence of a legal option, players can observe the value of trade with every other player. However, in that earlier version, information about players outside of one's informal network was not useful, because cooperation with

[6]Note that when W is large this term is very close to 1.

them was not sustainable.

Play proceeds as before, with the addition of the decision over whether or not to write a formal contract. Assume that $n \leq n^*$, so that cooperation is sustained in the informal networks. In round t, where player i has been selected to trade, she chooses to write a formal contract if and only if

$$\max_{j \in \mathbf{W}} V_i^t(j) - c > \max_{j \in N_{-i}} V_i^t(j) \tag{4}$$

otherwise i trades with her best trading partner in her network, and they play the same stage game as in the basic model.

As before, we must identify the maximum value of n for which cooperation is sustainable in informal trade networks. By the same logic developed earlier, cooperation will be the equilibrium strategy if and only if $EU_i\left(C, C_{-i}\right) \geq EU_i\left(DC, C_{-i}\right)$. We begin our analysis of the expected utility functions in a round in which the selector, i, will choose to interact within her network.[7] This first round payoff for defecting versus cooperating will only differ by b, the benefit from defecting. We refer to this first-round payoff (excluding the payoff from defecting) as R.

The expected utility from always cooperating, given that others will cooperate, is equal to the first period payoff of R plus the expected value of mutual cooperation for all subsequent rounds, given that in some of those rounds in which she is the selector, player i may choose to use the law rather than engage in trade in her informal network, and that in some of those rounds she will be the selectee. We can write the expected utility to player i of cooperating, given that others will cooperate, and given that legal enforcement is possible, as the summation of four terms.

(1) The probability the player i is the selector, times the probability that her

[7] If we began the analysis in a round in which player i writes a formal contract, then defection is not an option. As we are comparing the expected utility from defecting versus cooperating, the only case that is of interest is one in which player i has the option to do either.

network contains some members who are more valuable to her than writing a formal contract and trading outside of her network, times the expected utility to player i.

$$\alpha \sum_{m=1}^{n} \binom{n}{m} \left(c + \frac{1}{W-n}\right)^{m} \left(1 - c - \frac{1}{W-n}\right)^{n-m} \left(\frac{m+1-c-\frac{1}{W-n}}{m+1}\right)$$

(2) The probability that i is selected to play, times the probability that she writes a formal contract, times the expected utility.

$$\alpha \left(1 - c - \frac{1}{W-n}\right)^{n+1}$$

(3) The probability that someone else in player i's network is chosen, times the probability that person does not write a formal contract, times the probability that i is that player's most valuable informal partner, times the expected utility.

$$\alpha \sum_{m=1}^{n} \binom{n}{m} \left(c + \frac{1}{W-n}\right)^{m} \left(1 - c - \frac{1}{W-n}\right)^{n-m} \left(\frac{m+1-c-\frac{1}{W-n}}{m+1}\right)$$

(4) The probability that someone not in player i's group is selected, times the probability that player writes a formal contract, times the probability that i is that player's best partner in $\mathbf{W}$, times the expected utility.[8]

$$\alpha \left(1 - c - \frac{1}{W-n}\right)^{n+1}$$

Thus, we can write the entire expected utility function as,

$$EU_i^{Law}\left(C, C_{-i}\right) = R + \frac{2\alpha\delta}{1-\delta} \left[\begin{array}{c} \left(1-c-\frac{1}{W-n}\right)^{n+1} + \\ \sum_{m=1}^{n} \binom{n}{m} \left(c+\frac{1}{W-n}\right)^{m} \left(1-c-\frac{1}{W-n}\right)^{n-m} \left(\frac{m+1-c-\frac{1}{W-n}}{m+1}\right) \end{array} \right] \quad (5)$$

[8]We assume that players treat all networks as if they were the same size as their own when calculating probabilities.

A similar procedure yields the expected utility from defecting, except that after defecting player i now has a group of size n rather than $n+1$. However, she assumes that others still have a group of size n because of the assumption that all others cooperate. Player i defects in round one, securing an expected payoff of $R+b$ in that round. Then her expected utility is the summation of five terms.

(1) The probability that player i is selected, times the probability that some members of her group are more valuable than writing a formal contract, times the expected utility.

$$\alpha \sum_{m=1}^{n-1} \binom{n-1}{m} c + \frac{1}{W-n+1} \left(1 - c - \frac{1}{W-n+1}\right)^{n-1-m} \left(\frac{m+1-c-\frac{1}{W-n+1}}{m+1}\right)$$

(2)The probability that she is selected, times the probability that no one in her group exceeds the value of writing a formal contract, times the expected utility of using the law.

$$\alpha \left(1 - c - \frac{1}{W-n+1}\right)^{n}$$

(3) The probability that someone in her group is selected, times the probability that person does not write a formal contract, times the probability that i is that player's best informal trading partner, times the expected utility.

$$\frac{\alpha(n-1)}{n} \sum_{m=1}^{n} \binom{n}{m} \left(c + \frac{1}{W-n}\right)^{m} \left(1 - c - \frac{1}{W-n}\right)^{n-m} \left(\frac{m+1-c-\frac{1}{W-n}}{m+1}\right)$$

(4) The probability that someone (other than the player against whom i has already defected) not in i's group is selected, times the probability that player uses the law, times the probability that i is that person's best trading partner in $\mathbf{W}$, times the expected utility.

$$\alpha \left(1 - c - \frac{1}{W-n}\right)^{n+1}$$

(5) The probability that the player against whom i defected is selected, times the probability that player writes a formal contract, times that probability that i is her best trading partner in $\mathbf{W}$, times the expected utility.

$$\frac{\alpha}{W-n}\left(1-c-\frac{1}{W-n+1}\right)^{n}$$

Thus, player i's expected utility from defecting once, given that all others cooperate, is

$$\begin{aligned} EU_i^{Law}\left(DC, C_{-i}\right) &= R+b+\frac{\alpha\delta}{1-d} \\ & \left[\begin{array}{c} \left(\begin{array}{c} \sum_{m=1}^{n-1}\binom{n-1}{m}\left(c+\frac{1}{W-n+1}\right)^{m} \\ \left(1-c-\frac{1}{W-n+1}\right)^{n-1-m}\left(\frac{m+1-c-\frac{1}{W-n+1}}{m+1}\right) \end{array}\right)+ \\ \sum_{m=1}^{n}\binom{n}{m}\left(c+\frac{1}{W-n}\right)^{m}\left(1-c-\frac{1}{W-n}\right)^{n-m}\left(\frac{m+1-c-\frac{1}{W-n}}{m+1}\right)+ \\ \frac{W-n+1}{W-n}\left(1-c-\frac{1}{W-n+1}\right)^{n}+\left(1-c-\frac{1}{W-n}\right)^{n+1} \end{array}\right] \end{aligned} \tag{6}$$

As in the analysis of networks in the absence of law, we can determine whether cooperation is an equilibrium strategy by comparing equation (6) to equation (5). Player i defects if and only if

$$\begin{aligned} & EU_i^{Law}\left(DC, C_{-i}\right)-EU_i^{Law}\left(C, C_{-i}\right)= \\ & \quad b+\tfrac{\alpha\delta}{1-\delta}\sum_{m=1}^{n-1}\left(\binom{n-1}{m}\left(c+\frac{1}{W-n+1}\right)^{m}\left(1-c-\frac{1}{W-n+1}\right)^{n-1-m}\left(\frac{m+1-c-\frac{1}{W-n+1}}{m+1}\right)\right)- \\ & \quad \tfrac{n+1}{n}\sum_{m=1}^{n}\left(\binom{n}{m}\left(c+\frac{1}{W-n}\right)^{m}\left(1-c-\frac{1}{W-n}\right)^{n-m}\left(\frac{m+1-c-\frac{1}{W-n}}{m+1}\right)\right)+ \\ & \quad \tfrac{W-n+1}{W-n}\left(1-c-\frac{1}{W-n+1}\right)^{n}-\left(1-c-\frac{1}{W-n}\right)^{n+1} \end{aligned}$$

We do not present an analytic solution. However, we report computational results to demonstrate the workings of the model. Figure 2 reports n^{*}, the maximum sized network that sustains cooperation, given values for δ^{*}, b, and c. We report the results allowing δ^* to equal 0.75, 0.85, and 0.95 and b to equal 0.1, 0.2, and 0.3. The parameter c is evaluated in intervals of 0.02 on the unit interval (but in all cases it ceases to have an effect once law becomes sufficiently expensive, after which we stop evaluating it). We set $W = 1000$.

The comparative static results for the parameters b and δ from the case with no law continue to hold when legal enforcement becomes possible. All else equal, the optimum network size increases (or remains constant) as δ increases and decreases (or remains constant) as b increases. These relationships are shown in Graphs 1-6 in the appendix.

The most important results concern the relationship between the cost of law and the sustainability of informal networks. The cost of law - parameter c - affects the optimum network size. As c decreases - that is, as legal contracts become less expensive to use - the optimum number of partners decreases. However, for most values of c, n^* is positive. Thus, we have demonstrated that informal networks and legal contract enforcement can coexist even when every player has the option to use either method.

Although the option of legal contract enforcement can reduce the size of informal networks, law only begins to have an effect on optimal group size when it is sufficiently inexpensive. Furthermore, when c is sufficiently low, n^* can change very quickly. For example, consider the case where $b = 0.1$ and $\delta^* = 0.85$. For all values of $c \geq 0.08$, each player prefers to have $n^* = 62$ partners. In other words, players have as many partners when the law guarantees them a minimum per-turn payoff of approximately 0.92 as they do when law is not an option at all. When c drops to 0.06 – so that a payoff of 0.94 is guaranteed – n^* shrinks to 60, still not much of a change. But as soon as c drops to 0.02 – guaranteeing a payoff of 0.98 – n^* drops to 24. The large decrease in c from 1 to 0.08 does not change n^*at all. But the much smaller decrease

FIG. 2. Values of n^*, given δ^*, b, c ($W = 1000$)

δ^*	b	c	n^*	δ^*	b	c	n^*	δ^*	b	c	n^*
0.75	0.1	0.02	**0**	0.85	0.1	0.02	**24**	0.95	0.1	0.02	**195**
0.75	0.1	0.04	**17**	0.85	0.1	0.04	**56**	0.95	0.1	0.04	**200**
0.75	0.1	0.06	**28**	0.85	0.1	0.06	**60**	0.95	0.1	0.06	**200**
0.75	0.1	0.08	**32**	0.85	0.1	0.08	**62**	0.95	0.1	0.08	**200**
0.75	0.1	0.10	**33**	0.85	0.1	0.10	**62**	0.95	0.1	0.10	**200**
0.75	0.1	0.12	**33**	0.85	0.1	0.12	**62**	0.95	0.1	0.12	**200**
0.75	0.1	0.14	**34**	0.85	0.1	0.14	**62**	0.95	0.1	0.14	**200**
0.75	0.1	0.16	**34**	0.85	0.1	0.16	**62**	0.95	0.1	0.16	**200**
0.75	0.1	0.99	**34**	0.85	0.1	0.99	**62**	0.95	0.1	0.99	**200**
0.75	0.2	0.02	**0**	0.85	0.2	0.02	**0**	0.95	0.2	0.02	**80**
0.75	0.2	0.04	**0**	0.85	0.2	0.04	**12**	0.95	0.2	0.04	**98**
0.75	0.2	0.06	**2**	0.85	0.2	0.06	**24**	0.95	0.2	0.06	**99**
0.75	0.2	0.08	**9**	0.85	0.2	0.08	**28**	0.95	0.2	0.08	**100**
0.75	0.2	0.10	**12**	0.85	0.2	0.10	**30**	0.95	0.2	0.10	**100**
0.75	0.2	0.12	**14**	0.85	0.2	0.12	**30**	0.95	0.2	0.12	**100**
0.75	0.2	0.14	**15**	0.85	0.2	0.14	**31**	0.95	0.2	0.14	**100**
0.75	0.2	0.16	**16**	0.85	0.2	0.16	**31**	0.95	0.2	0.16	**100**
0.75	0.2	0.18	**16**	0.85	0.2	0.18	**31**	0.95	0.2	0.18	**100**
0.75	0.2	0.99	**16**	0.85	0.2	0.99	**31**	0.95	0.2	0.99	**100**
0.75	0.3	0.02	**0**	0.85	0.3	0.02	**0**	0.95	0.3	0.02	**31**
0.75	0.3	0.04	**0**	0.85	0.3	0.04	**0**	0.95	0.3	0.04	**61**
0.75	0.3	0.06	**0**	0.85	0.3	0.06	**8**	0.95	0.3	0.06	**65**
0.75	0.3	0.08	**0**	0.85	0.3	0.08	**14**	0.95	0.3	0.08	**66**
0.75	0.3	0.10	**3**	0.85	0.3	0.10	**17**	0.95	0.3	0.10	**66**
0.75	0.3	0.12	**6**	0.85	0.3	0.12	**19**	0.95	0.3	0.12	**66**
0.75	0.3	0.14	**8**	0.85	0.3	0.14	**19**	0.95	0.3	0.14	**66**
0.75	0.3	0.16	**9**	0.85	0.3	0.16	**20**	0.95	0.3	0.16	**66**
0.75	0.3	0.18	**9**	0.85	0.3	0.18	**20**	0.95	0.3	0.18	**66**
0.75	0.3	0.20	**10**	0.85	0.3	0.20	**20**	0.95	0.3	0.20	**66**
0.75	0.3	0.22	**10**	0.85	0.3	0.22	**20**	0.95	0.3	0.22	**66**
0.75	0.3	0.24	**10**	0.85	0.3	0.24	**20**	0.95	0.3	0.24	**66**
0.75	0.3	0.26	**11**	0.85	0.3	0.26	**20**	0.95	0.3	0.26	**66**
0.75	0.3	0.28	**11**	0.85	0.3	0.28	**20**	0.95	0.3	0.28	**66**
0.75	0.3	0.99	**11**	0.85	0.3	0.99	**20**	0.95	0.3	0.99	**66**

in c from 0.08 to 0.02 reduces n^* by more than sixty percent.

This suggests that the observation made by some researchers that in many societies law has little or no effect on informal trade networks does not imply that law is inherently irrelevant in those societies for cultural or ideological reasons. Until law becomes sufficiently inexpensive, it is expected to be used only infrequently and to have little effect on the size of informal networks. However, once the cost of law drops below a certain threshold, then small changes in the cost of law can have a dramatic impact on informal networks.

The point at which lowering c begins to have an effect on n^* depends on the values of the other parameters. n^* begins to decrease at higher values of c when δ is lower and/or when b is higher. That is, when the benefits of defection increase - whether because the immediate payoff from defection has gone up or the relative value of future trades has gone down - law will have an effect on optimal group size at higher values of c. This suggests several potentially observable implications. In a society with multiple sectors in which informal networks exist, if discount rates or benefits from defection differ across those sectors, we expect to see their informal networks beginning to erode at different times as law becomes less expensive. Similarly, societies with differing levels of b and δ will experience the effects of legal institutions at different levels of c.

In addition to the size of the informal networks, it is important to know the extent to which governmental contract enforcement will be used. This is easily determined in the model. An individual will rely on the formal legal system if and only if no partner in her informal network has a trading value that exceeds $\left(\frac{W}{W+1} - c\right)$. Thus, the probability of making a legally enforceable contract rather than trading within an informal network is $(\frac{W}{W+1} - c)^{n^*}$. This probability is strictly decreasing in c and in n^*. Since n^* is itself a non-decreasing function of c, both c's direct effect on the probability of using the formal economy and its indirect effect through n^* cut in the same direction. As we would expect, when law becomes less expensive the formal economy is used more frequently. Perhaps less intuitively, the probability of relying on formal contracts increases at an accelerating rate as c decreases. This is due primarily to c's effect on n^*. Individuals become much more likely to use the law as it becomes less costly, not so much because of the increasing affordability of legal contracts per se, but rather because inexpensive law drastically reduces the size of informal networks, making trade within the informal economy relatively less desirable.

Consider the example above. Although the probability of an individual using a legal contract is decreasing in c, this probability remains below 0.01 until c falls somewhere below 0.08. When $c = 0.08$ the probability is $\left(\frac{1000}{1001} - 0.08\right)^{62} \approx 0.0057$, when $c = 0.06$ the probability drops to $\left(\frac{1000}{1001} - 0.06\right)^{60} \approx 0.02\,4$, and when $c = 0.02$ the probability is $\left(\frac{1000}{1001} - 0.02\right)^{24} \approx 0.62$. This example highlights the possibility of coexistence of formal and informal economies. In this latter case, 62 percent of economic interactions make use of governmental contract enforcement. Nonetheless, individuals remain members of relatively large informal networks. The relationship between c and the probability of using the formal economy in this example is shown in graph 7.

The size of c's direct effect on the probability of using the formal economy (as opposed to its indirect effect through n^*) is dependent on the values of the other parameters. In the preceding example, c's primary effect on the probability of trading in the formal economy was through its effect on n^*, because n^* was relatively large when c was close to 1. Thus, the exponential impact of n^* swamped the effect of a change in c (that is, any value between 0 and 0.92 raised to the 62^{nd} power translates to a probability very close to 0). However, the direct effect of c is more pronounced in cases where n^* is relatively small even when c is close to 1. For instance, consider the case where $\delta^* = 0.75$, $b = 0.3$, and $W = 1000$. A striking illustration of c's direct effect in this example is the change in probability when c moves from 0.18 to 0.16. In both of these cases, $n^* = 9$, thus there is no indirect effect of a change in c through

n^*. Nonetheless, when $c = 0.18$ the probability of trading in the formal economy is $\left(\frac{1000}{1001} - 0.18\right)^9 \approx 0.17$ and when $c = 0.16$ the probability is $\left(\frac{1000}{1001} - 0.16\right)^9 \approx 0.21$, a difference of 5 percent. To see the overall relationship between c and the probability of trading in the formal economy in this example, refer to graph 8.

These results have important implications for understanding the politics of developing legal systems. Government provision of legal contract enforcement does not necessarily eliminate informal networks. However, unless law becomes inexpensive enough to erode informal networks significantly, the legal system will be used very infrequently. Governments concerned with providing widely-used legal enforcement services must recognize this trade-off. Furthermore, marginal changes in the efficiency of the legal system have a larger effect in economies with relatively small informal networks. In these situations, increases in the efficiency of the legal system may have a significant effect on the frequency with which formal contracts are used, even when the size of informal networks is unaffected.

CONCLUSION

Economic life is embedded in complex social structures. Among the most important of these are informal trade networks, where economic activity is sustained not through formal legal channels but through relationships of trust. An important question for students of the relationship between government policy, social structure, and economic activity is how the introduction of government provided contract enforcement interacts with and affects self-sustaining informal networks.

To address this question, we developed a model of informal trade networks and the effects of formal legal institutions on such networks. Building on the logic of reputational enforcement, we established that a trade-off exists between the profitability of trade in an informal network, which increases as the size of the network increases, and the sustainability of cooperation, which becomes more difficult as network size increases. Because of this trade-off, the size of an informal trade network in which cooperation can be sustained is bounded above. We further demonstrated the effects of changing discount rates and benefits from defection on the equilibrium size of informal networks. The size of cooperative networks increases when members value the future more and decreases when the benefit from defection increases.

We characterized the evolution of informal trade networks. When networks begin larger than optimal size, players defect until cooperation becomes sustainable. In open groups of smaller than optimal size, players add new partners until the optimal size is reached. In closed groups of smaller than optimal size, groups compete with one another for scarce new members. Despite the greater benefit to small groups of adding new members, and regardless of whether side-payments are possible, large groups will out-compete small groups for new members until they reach optimal size.

Extending the model to include the possibility of legally enforceable contracts, we found five important results. First, in most cases, our model, consistent with empirical observations, predicts that informal and formal economies will co-exist. Moreover, individuals are not segregated into either the informal or formal economy, but operate in both. Second, the existence of a legal option decreases the optimal size of informal trade networks, sometimes by a large amount. Third, the existence of legally enforceable contracts has little effect on the size of informal networks until such contracts become sufficiently inexpensive. Once they reach this threshold small changes in the price of using law can have dramatic effects on informal networks. This result is consistent with the empirical observation that, in many cases, legal enforcement is infrequently used, but it contradicts the assertion that this lack of use implies the social or cultural irrelevance of law. Instead, it suggests that little-used legal institutions may not be sufficiently inexpensive. Fourth, the threshold below which less expensive law begins to have an effect on informal networks increases as the benefits of defection increase and/or the weight given to the future decreases. Fifth, increases in the efficiency of law increase the frequency with which legal contracts are used, in part because of the greater affordability of such contracts, but primarily because inexpensive law erodes informal networks, making contractual exchange relatively more attractive. Our model thus provides a more nuanced perspective on the relationship between government-provided contract enforcement and informal social/economic organization.

REFERENCES

[1] Axelrod, Robert. 1984. *The Evolution of Cooperation.* (New York: BasicBooks).

[2] Bates, Robert. 1983. "Modernization, Ethnic Competition, and the Rationality of Politics in Contemporary Africa." In State Versus Ethnic Claims: African Policy Dilemmas, ed. Donald Rothchild and Victor Olornsola. (Boulder: Westview Press).

[3] Benson, Bruce L.1990. *The Enterprise of Law: Justice Without the State.* (San Francisco: Pacific Research Institute for Public Policy).

[4] Bernstein, Lisa. 1992. "Opting Out of the Legal System: Extralegal Contractual Relations in the Diamond Industry." *Journal of Legal Studies* 12(1):115-157.

[5] Colson, Elizabeth. 1974. *Tradition and Contract.* (Chicago: Aldine).

[6] Cooter, Robert D. 1996. "Decentralized Law for a Complex Economy: The Structural Approach to Adjudicating the New Law Merchant." *University of Pennsylvania Law Review* 144(5): 1643-1696.

[7] Cooter, Robert D. and Janet T. Landa. 1984. "Personal Versus Impersonal Trade: The Size of Trading Groups and Contract Law." *International Review of Law and Economics* 4(1):15-22.

[8] De Soto, Hernando. 1989. *The Other Path: The Invisible Revolution in the Third World*. (New York: Harper and Row).

[9] DiMaggio, Paul and Hugh Louch. 1998. "Socially Embedded Consumer Transactions: For What Kinds of Purchases Do People Most Often Use Networks?" *American Sociological Review* 63(5).

[10] Edelman, Lauren B. and Mark C. Suchman. 1997. "The Legal Environments of Organizations." *Annual Review of Sociology* 23.

[11] Ellickson, Robert C. 1991. *Order Without Law: How Neighbors Settle Disputes*. (Cambridge: Harvard University Press).

[12] Fafchamps, Marcel. 1996. "The Enforcement of Commercial Contracts in Ghana." *World Development* 24(3): 427-448.

[13] Fearon, James D. and David D. Laitin. 1996. "Explaining Interethnic Cooperation." *American Political Science Review* 90(4): 715-735.

[14] Granovetter, Mark 1973. "The Strength of Weak Ties." *American Journal of Sociology* 78.

[15] Granovetter, Mark. 1985. "Economic Action and Social Structure: The Problem of Embeddedness." *American Journal of Sociology* 91.

[16] Greif, Avner. 1993. "Contract Enforceability and Economic Institutions in Early Trade: The Maghribi Traders' Coalition." *American Economic Review* 83(3): 525-548.

[17] Horowitz, Donald L. 1985. *Ethnic Groups in Conflict*. (Berkeley: University of California Press).

[18] Kali, Raja. 1999. "Endogenous Business Networks." *Journal of Law, Economics and Organization* 15(3).

[19] Kranton, Rachel E. and Anand V. Swamy. 1999. "The Hazards of Piecemeal Reform: British Civil Courts and the Credit Market in Colonial India." *Journal of Development Economics* 58:1-24.

[20] Landa, Janet T. 1981. "A Theory of the Ethnically Homogenous Middleman Group: An Institutional Alternative to Contract Law." *Journal of Legal Studies* 10(2): 349-362.

[21] Lee, Tahirih V. 1993. "Risky Business: Courts, Culture, and the Marketplace." *University of Miami Law Review* 47:1335-1414.

[22] Lomborg, Bjorn. 1996. "Nucleus and Shield: The Evolution of Social Structure in the Iterated Prisoner's Dilemma." *American Sociological Review* 61(April).

[23] Macaulay, Stewart. 1963. "Non-Contractual Relations in Business: A Preliminary Study." *American Sociological Review* 28:55-67.

[24] Macy, Micahel W. and John Skvoretz. 1998. "The Evolution of Trust and Cooperation Between Strangers: A Computational Model." *American Sociological Review* 63(5).

[25] Milgrom, Paul R., Douglass C. North, and Barry R. Weingast. 1990. "The Role of Institutions in the Revival of Trade: The Law Merchants, Private Judges, and The Champagne Fairs." *Economics and Politics* 2(1):1-23.

[26] Mizruchi, Mark S. and Linda Brewster Stearns. 2001. "Getting Deals Done: The Use of Social Networks in Bank Decision-Making." *American Sociological Review* 66(5).

[27] Moore, Sally Falk. 1978. "Law and Social Change: The Semi-Autonomous Social Field as an Appropriate Subject of Study" In *Law as Process: An Anthropological Approach*, ed., Sally Falk Moore. (London: Routledge & Kegan Paul). Pp. 54-81.

[28] North, Douglass C. 1990. *Institutions, Institutional Change, and Economic Performance*. (Cambridge: Cambridge University Press).

[29] Platteau, Jean-Philippe. 1994. "Behind the Market Stage Where Real Societies Exist - Part I: The Role of Public and Private Order Institutions." *Journal of Development Studies* 30(3): 533-577.

[30] Polanyi, Karl. 1957. *The Great Transformation*. (Boston: Beacon Press).

[31] Portes, Alejandro and Saskia Sassen-Koob. 1987. "Making It Underground: Comparative Material on the Informal Sector in Western Market Economies." *American Journal of Sociology* 93(1).

[32] Posner, Eric A. 1996. "Law, Economics, and Inefficient Norms." *University of Pennsylvania Law Review* 144(5): 1697-1744.

[33] Powell, Walter W. and Laurel Smith-Doerr. 1994. "Networks and Economic Life." In *Handbook of Economic Sociology*, eds., Neil J. Smelser and Richard Swedberg. (Princeton: Princeton University Press and Russell Sage Foundation).

[34] Shapiro, Susan P. 1987. "The Social Control of Impersonal Trust." *American Journal of Sociology* 93(3).

[35] Skocpol, Theda. 1985. "Bringing the State Back In: Strategies of Analysis in Current Research" In *Bringing the State Back In,* eds., Peter B. Evans, Dietrich Rueschemeyer, and Theda Skocpol. (Cambridge: Cambridge University Press).

[36] Weiss, Linda. 1987. "Explaining the Underground Economy: State and Social Structure." *The British Journal of Sociology* 38(2).

[37] Winn, Jane Kaufman. 1994. "Relational Practices and the Marginalization of Law: Informal Financial Practices of Small Businesses in Taiwan." *Law and Society Review* 28(2):193-232.

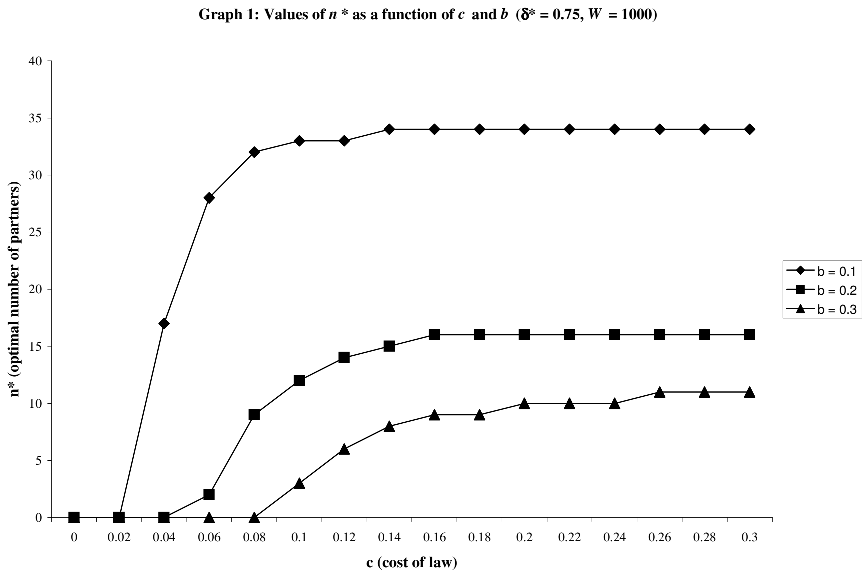
Graph 1: Values of n * as a function of c and b (δ* = 0.75, W = 1000)
n* (optimal number of partners)
c (cost of law)
b = 0.1
b = 0.2
b = 0.3
0
5
10
15
20
25
30
35
40
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
0.26
0.28
0.3

FIG. 3.

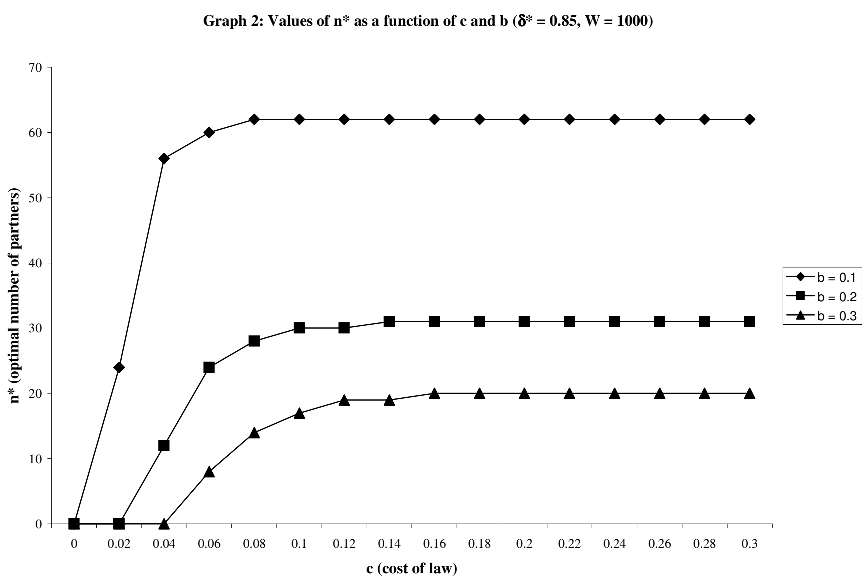
Graph 2: Values of n* as a function of c and b (δ* = 0.85, W = 1000)
n* (optimal number of partners)
c (cost of law)
b = 0.1
b = 0.2
b = 0.3
0
10
20
30
40
50
60
70
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
0.26
0.28
0.3

FIG. 4.

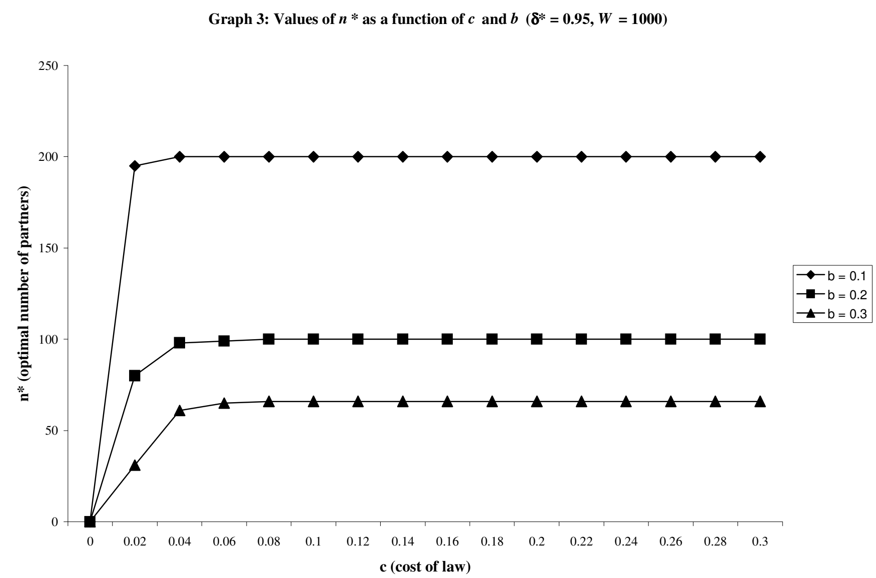
Graph 3: Values of n * as a function of c and b (δ* = 0.95, W = 1000)
n* (optimal number of partners)
c (cost of law)
b = 0.1
b = 0.2
b = 0.3

FIG. 5.

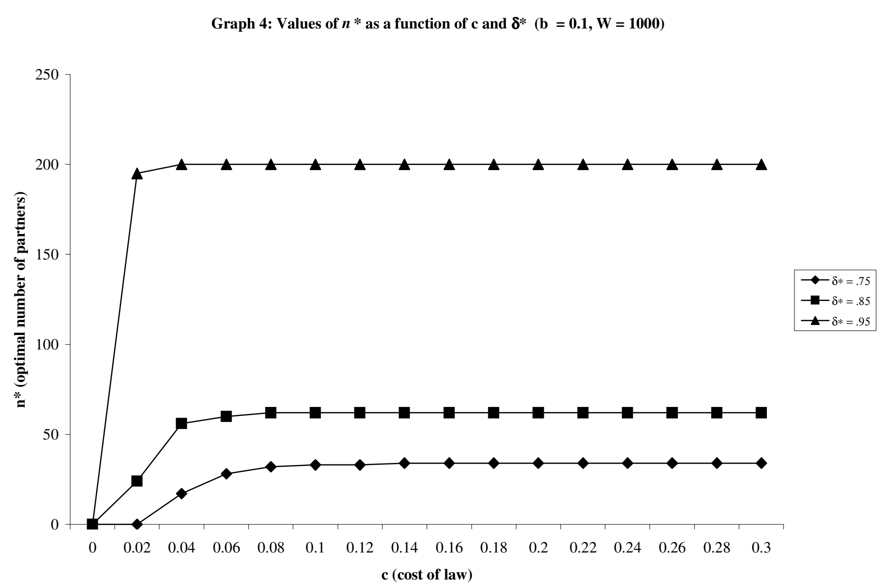
Graph 4: Values of n * as a function of c and δ* (b = 0.1, W = 1000)
n* (optimal number of partners)
c (cost of law)
δ* = .75
δ* = .85
δ* = .95

FIG. 6.

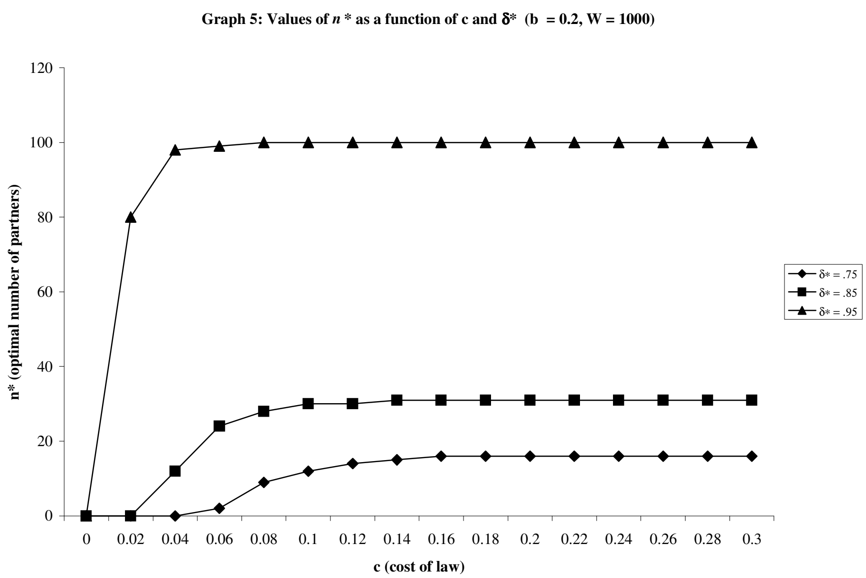
Graph 5: Values of *n* * as a function of c and δ* (b = 0.2, W = 1000)
n* (optimal number of partners)
c (cost of law)
0
20
40
60
80
100
120
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
0.26
0.28
0.3
δ* = .75
δ* = .85
δ* = .95

Fig. 7.

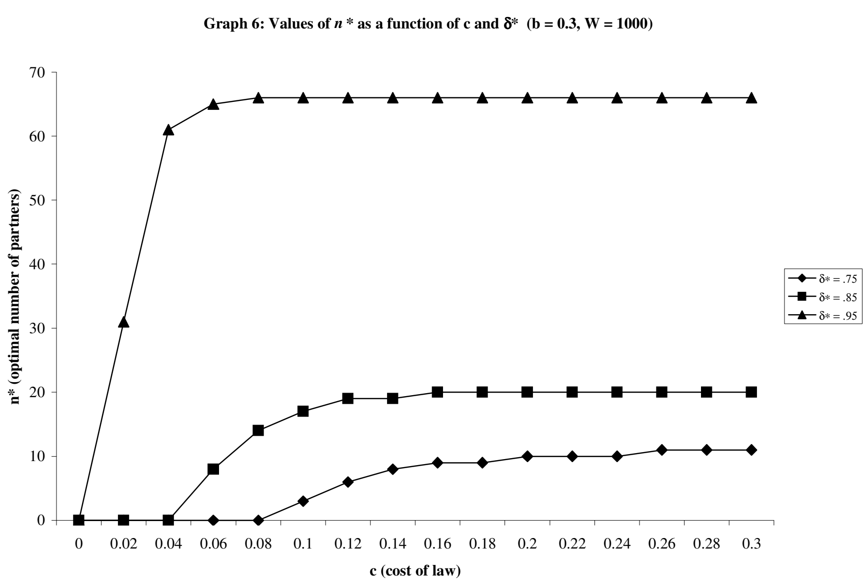
Graph 6: Values of *n* * as a function of c and δ* (b = 0.3, W = 1000)
n* (optimal number of partners)
c (cost of law)
0
10
20
30
40
50
60
70
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
0.26
0.28
0.3
δ* = .75
δ* = .85
δ* = .95

Fig. 8.

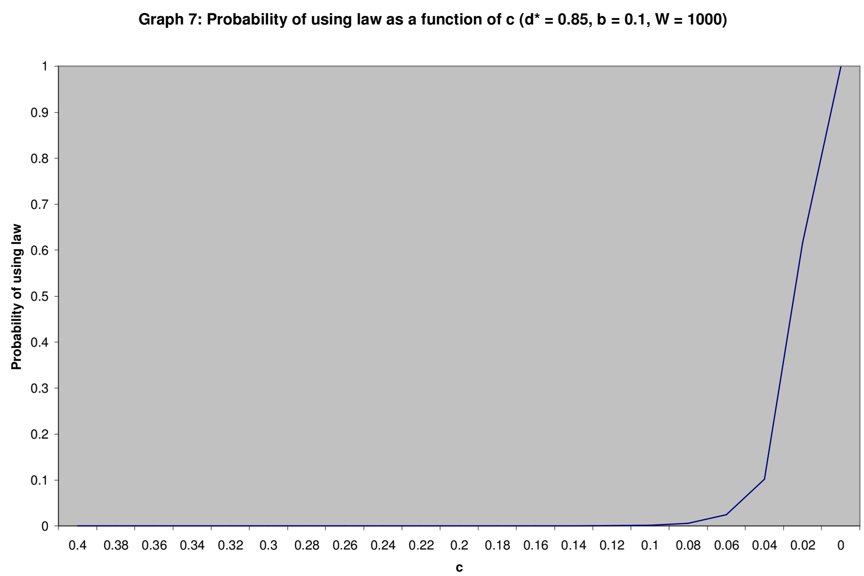
Graph 7: Probability of using law as a function of c (d* = 0.85, b = 0.1, W = 1000)
Probability of using law
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.4 0.38 0.36 0.34 0.32 0.3 0.28 0.26 0.24 0.22 0.2 0.18 0.16 0.14 0.12 0.1 0.08 0.06 0.04 0.02 0
c

FIG. 9.

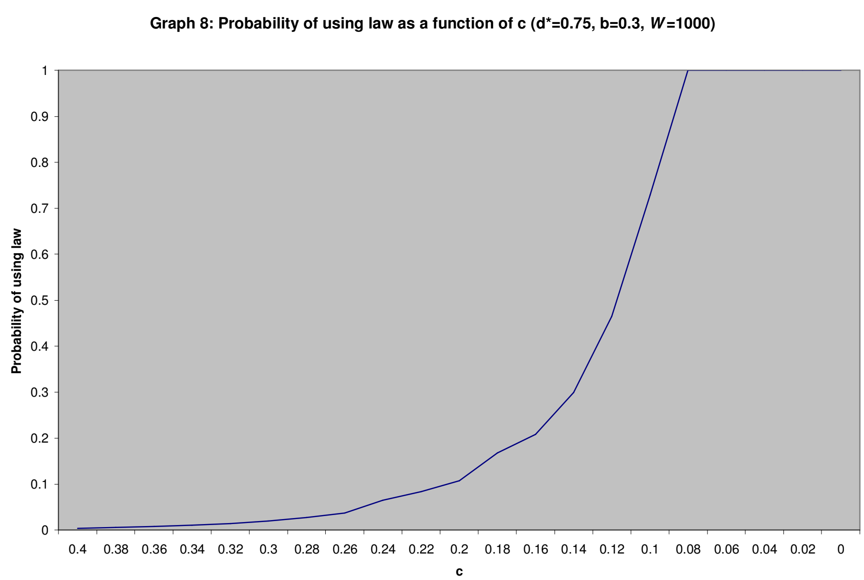
Graph 8: Probability of using law as a function of c (d*=0.75, b=0.3, W=1000)
Probability of using law
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.4 0.38 0.36 0.34 0.32 0.3 0.28 0.26 0.24 0.22 0.2 0.18 0.16 0.14 0.12 0.1 0.08 0.06 0.04 0.02 0
c

FIG. 10.