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Spontaneous Market Emergence[1]

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Abstract

Drawing insights from the literature on credit and labor markets and from the author's own survey work on contractual practices among manufacturers and traders in Africa, this paper investigates the spontaneous emergence of markets in the presence of heterogeneous agents. Using a dynamic game setting, we derive precise conditions under which relational contracting spontaneously emerges and deters opportunistic breach of contract even in the absence of formal market institutions. Exclusion of cheaters from future trade is not required for exchange to begin. Markets at early stages of development are characterized by trade based on mutual trust and on the sharing of information among acquaintances. As markets develop, newcomers may be excluded from trade when screening costs are high and agents long lived. Reputational equilibria in which cheaters are permanently excluded from trade are not decentralizable unless markets are already developed and breach of contract is interpreted as a sign of impending bankruptcy. Market emergence is a path dependent process.

JEL classification: O1; K0; P5

Keywords: market institutions; information sharing; networks; social capital; path dependence

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[1] An earlier version of this paper circulated under the title of 'Market Emergence, Trust, and Reputation'. I benefitted from discussions with and comments from Avner Greif, Masa Aoki, Robert Cooter, Jonathan Conning, Lin Zhou, and seminar participants at Stanford University, Duke University, the University of Montreal, Namur University, and the American Law and Economics Association conference.

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The inspiration for this paper comes from ten years of research on market institutions in Africa.[2] Micro evidence from surveys of manufacturing firms and traders in various parts of the world shows that markets do not operate in the manner predicted by standard economic textbooks. Legal institutions are not important and courts are seldom used to enforce commercial contracts -- partly because the amounts involved are small, partly because debtors have no assets to foreclose upon (e.g., Fafchamps (1996), Bigsten et al. (2000), Fafchamps and Minten (2001), McMillan and Woodruff (1999)). Prevention is the dominant solution to contract enforcement problem; this generates efficiency losses (e.g., Fafchamps, Gunning and Oostendorp (2000), Johnson, McMillan and Woodruff (2001)). Ex post renegotiation is the main dispute resolution mechanism. If renegotiation fails, breach of contract occurs and the relationship is severed. Similar findings are reported by McMillan and Woodruff (1999), Johnson, McMillan and Woodruff (2000), Woodruff (1998), Johnson, McMillan and Woodruff (2002) for various parts of the world.

To simplify a bit, markets operate as a two-tier system, with a core of sophisticated firms and traders and a fringe of small enterprises operating on a purely cash-and-carry basis. Core firms are in long-term relationships with each other and contract with each other -- supplier credit, warranty, orders (e.g., Fafchamps (1997)). Fringe firms operate largely in an anonymous fashion, and leave as little room as possible to breach of contract. Core firms often are networked to each other in the sense that they interact outside business -- in religious and family events as well as at sports events (e.g., Marris (1971), Himbara (1994), Fafchamps (2000)). Firms with better networks receive more supplier credit and make more money (e.g., Fafchamps and Minten (2001), Fafchamps and Minten (2001)). These findings echo earlier work by other social scientists (e.g., Amselle (1977), Meillassoux (1971), Geertz, Geertz and Rosen (1979)).[3]

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[2] This work is brought together in an upcoming book entitled 'Market Institutions in Sub-Saharan Africa', MIT Press (forthcoming).

[3] Historical descriptions of markets follow a similar vein. Historians have long noticed that business and trade often are in the hands of specific ethnic groups (e.g., Lombards and Genoese merchants in Western Europe, Jews in the Mediterranean, Armenians in the Middle East; see, for instance, Braudel (1986), Greif (1993), Greif (1994).

What is remarkable is that these features are virtually universal and have been observed in many different economies, irrespective of culture or legal history. Bernstein (1992), Bernstein (1996) has described similar features among New York diamond traders and Mid-Western grain traders. Her findings mirror the work Granovetter (1995) the U.S. job market. It is only in organized markets such as stock exchanges, commodity exchanges, or the U.S. real estate market that rules of operation differ. It therefore appears that, left to their own device, markets naturally develop along or into networks of relational contracting.

Building on these findings, this paper shows how the simultaneous presence of core and fringe agents is essential to the spontaneous emergence of market exchange. This is because the two intereact to create a unique self-disciplining market structure. The main characteristic of this structure is that, as in Ghosh and Ray (1996), the fact that agents are heterogeneous and search is costly makes the equilibrium entirely decentralizable. Unlike in Kandori (1992), there is no need for coordinated punishment strategy; meta-punishments are not required. Unlike in court-based exchange where anonymous transactions are, in principle, feasible, personalized exchange is the rule and commercial relationships are long lasting. Excluding cheaters from future trade is not required for trade to arise. As market emerge, so do networks of relational contracting, in a way similar to Kali (1999).

Within this structure, pre-existing social networks enable certain individuals or groups to prosper. This is because of the sharing of information among agents in the network. We also demonstrate that, when the screening of potential commercial partners is sufficiently costly, newcomers may find themselves excluded from trade. Business then becomes monopolized by a social network, possibly sharing the same ethnic or religious affiliation.

First best is not achieved because of breach is not fully deterred and switching costs reduce market flexibility. A more efficient equilibrium is possible, but it does not arise at the outset. Under certain conditions, decentralized market interaction can spontaneously evolve into a higher level where breach of contract by core firms is eliminated. In particular, we show that the fear of dealing with bankrupt firms can trigger this evolution without a need for coordinated sanctions against contractual breach, The resulting equilibrium ressembles a standard reputational equilibrium as in Kandori (1992) and Greif (1993), albeit without coordination. Taken together, these results provide a theory of spontaneous market emergence without state intervention or coordinate action of any kind.

This paper formalizes some of the insights in Platteau (1994), Platteau (1994) and extends previous work by Greif (1993), Greif (1994), and Milgrom, North and Weingast (1991) on medieval merchants and by Shapiro and Stiglitz (1984) and Montgomery (1991) on labor markets. It complements previous work by Kranton (1996) who also considers the interaction between a reciprocal exchange market and a monetary market exchange but focuses on the minimization of search costs instead of commitment failure. Unlike these papers which rely on static or steady state models, we offer a thorough treatment of equilibrium dynamics and examines how relational contracting may foster the spontaneous emergence of markets. We also expand on these previous work by allowing for the circulation of information among agents.

Section 1. A Model of Relational Contracting

Research by anthropologists, sociologists, historians, political scientists, and economists has brought to light the nearly universal reliance on interpersonal relations at early stages of market development (e.g., Hopkins (1973), Greif (1993), North (1990), Meillassoux (1971), Amselle (1977), Jones (1959), Bauer (1954), Sahlins (1972)). Recent work has similarly noted the widespread existence of long term relationships between manufacturers and their suppliers and clients in developed (e.g., Lorenz (1988), Aoki (1988), Dore (1987), Fukuyama (1995)) and developing economies alike (e.g., Stone, Levy and Paredes (1992)). The prevalence of long term personalized relationships is also the norm in employment contracts.

Detailed case studies conducted in several African countries suggest that the main reason why firms enter in long term trading relationship with their suppliers and clients is to save on screening costs and minimize breaches of contract. Firms indeed realize that suppliers and clients differ in competence and honesty; consequently, finding reliable commercial partners is difficult and costly. Empirical results further indicate that firms that are able to share information about clients and suppliers save on screening costs, identify reliable partners more easily, and can more readily switch among potential suppliers and clients Fafchamps and Minten (1999), Gabre-Madhin (1997). To further our understanding of these phenomena, we contruct a model that reproduces many of the stylized features of markets in developing countries.

We begin with a model of relational contracting and we examine how relational equilibria unfold over time. We first give a description of the economy, the action set of each player, and their payoffs. We then demonstrate the existence of a relational equilibrium and derive laws of motion for the economy. In this section, we reproduce Ghosh and Ray's (1996) result that, in the presence of heterogeneous agents, the stigmatization of cheaters is not required for exchange to take place. We also show that agents benefit from sharing information even if cheaters are not excluded from future trade. Perfect deterrence of opportunistic breaches of contract is nevertheless not achieved. We conclude this section with two special cases: a relational equilibrium with no information sharing; and a closed-shop equilibrium.

The Economy

Consider an infinitely lived economy with a continuum of agents, indexed from 0 to 1, who trade over time and discount the future with a common discount factor δ.[4] The economy combines random matching with relational contracting. There are two types of agents, competent and

[4] The assumption of an infinite number of agents not only enables us to abstract from strategic interactions that may arise among a small number of agents. It also implies that the aggregate laws of motion of the economy are deterministic along the equilibrium paths we consider.

incompetent.[5] Their proportions G and $B = 1 - G$ in the economy are constant and known to all agents, but an agent's type is not directly observable. Competent agents require one unit of a homogeneous good per period. Incompetent agents can only earn a positive payoff by breaching contracts with competent agents. Agents payoffs are private, non-verifiable information.

The economy consists of an infinitely repeated sequence of trading rounds during which agents either trade, screen, or do nothing -- in which case their instantaneous payoff is normalized to zero.[6] External contract enforcement is assumed inexistent.[7] Each trading round is divided into three stages: the matching stage, the contracting stage, and the compliance stage. These stages are shown in Figure 1. All agents are initially unmatched. At the beginning of the matching stage, agents decide either to continue trading together or to find a new partner, in which case they join the pool of unmatched agents. Trade is voluntary; if one agent decides to stop a relationship, his partner becomes unmatched. Unmatched agents are randomly paired; they observe each other's identity but not each other's type.[8] Informal information sharing is represented by the assumption that, with probability κ_i, an agent i obtains a costless and accurate report summarizing the past actions of the agent it has been matched with.[9] We assume that κ_i is

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[5] Incompetence encompasses insufficient or antiquated equipment; lack of technical or marketing skills; fragile financial base; and natural predisposition toward dishonesty.

[6] An alternative interpretation of the model is to regard 'trade' as short for 'business-like transaction' involving the placement of an order, monthly invoicing, payment terms, use of checks, quality warranty, etc, and to regard 'no trade' as short for 'road-side transaction' involving visual inspection of the goods and instantaneous payment in cash. In this case, gains from trade represent the convenience and cost saving of business-like transactions.

[7] This is obviously a simplifying assumption destined to focus the attention on relational equilibria. In developing countries, the circumstances under which a pure court-based system could effectively deter opportunistic breach of contract -- low legal costs, predictable courts, large transactions, verifiability of contract terms, and wealthy defendants -- are likely to be particularly problematic. There, courts are typically underfunded and subject to political pressures, markets are thin and transactions small, illiteracy and lack of education preclude the widespread use of written contractual instruments, and many economic agents are poor. Consequently, the threat of court action is unlikely to perfectly deter opportunistic breach, either because too many debtors are 'judgement-proof' in the sense that they have insufficient assets to repay their debts; or because court action is too costly and unpredictable for a plaintiff to sue.

[8] We postulate that economic agents can be unambiguously identified through group recognition, business registration, or identity card, and that the falsification of one's identity is prohibitively costly.

[9] Behind this assumption is the idea that agents form informal and partially connected information sharing networks (e.g., Raub and Weesie (1990)). Lang and Nakamura (1990) argue that agents may not find it in their immediate interest to share information with others for fear of losing reliable partners to them. In the model presented here, this issue does not arise since, by assumption, unmatched agents do not choose their partners but are matched at random.

exogenous and time invariant. Information circulates in both directions, so that κ_i is also the proportion of agents who get a report on *i*. Agents who are new and have never traded are called untested.

The contracting stage begins with agents making one of three possible contracting offers: trade; screen; or do nothing.[10] If players choose to do nothing, they collect an instantaneous payoff of 0 and move to the next trading round. If they choose to screen each other, they incur a screening cost *c*, obtain information about the other player's type, and move to the next round.[11] If both choose to trade, they move to the compliance stage. Nature then first draws a proportion $1-\theta$ ($0 < \theta \leq 1$) of competent agents who are replaced by new, identical agents at the end of the round. The outcome of this random draw is privately revealed to agents at the beginning of the compliance stage; it is not verifiable and is purported to represent bankruptcy shocks. All incompetent agents are replaced at the end of the round.[12] Next, nature picks a proportion $1-\hat{\tau}$ of agents who, for reasons outside the scope of the model, have to break up a relationship.[13] In both cases, gains from trade for the concerned agent fall to zero -- permanently for disappearing agents, until they find a new partner for breaking-up agents.[14] Agents discover that they must disappear or break up *after* having incurred contractual obligations but *before* complying with them; they are able to complete the transaction but no longer makes any profit from it.[15]

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[10] If offers differ, players continue to make offers until they are the same.

[11] The screening cost is the minimum transaction that would induce an incompetent agent to reveal its type and is regarded as exogenous. We assume that agents cannot observe whether the other party has actually incurred the screening cost. Without this assumption, cheaters may be induced to reveal themselves by asking them to incur a screening cost, as is implicitly done in Milgrom, North and Weingast (1991). Here, incompetent agents always agree to screen but never do.

[12] Alternatively, *B* agents may be too numerous to be remembered or may easily conceal their identity.

[13] E.g., changes in economic conditions and trade patterns. See Greif (1993) and Ghosh and Ray (1996), section 4.2.1 for similar assumptions.

[14] Since the number of agents is infinite, the probability that two agents are ever matched again is zero.

[15] This situation is distinct from one in which agents become unable to fulfill a contract due to temporary circumstances beyond their control (e.g., fire, riot, flood). Such extraordinary circumstances may be ground for excusable default; they are ignored here. In other words, we abstract from efficient breaches (e.g., Craswell (1995), Cooter and Ulen (1988)). If gains from trade fall to zero after the transaction is completed, agents may initiate an additional transaction with the intent of breaching the contract. In our model, premeditated and non-premeditated breaches turn out to be formally equivalent and the distinction is ignored.

There are three states *s* in which a player can be at the end of the compliance stage: *n*, normal state, *d*, disappearing state, and *b*, breaking-up state.[16] The probabilities of being in the normal, breaking-up, and disappearing states are $\hat{\tau}\,\theta$, $(1-\hat{\tau})\theta$, and $1-\theta$, respectively. Knowing the state they are in -- but not the state in which their partner is -- agents take one of two actions: comply or breach. An agent's action may only depend on its own type and current state as well as on the known history of play. If both agents are competent and in the normal state, their payoffs take the familiar Prisoner Dilemma's form:

Payoff Matrix A

	Comply	Breach
Comply	$\hat{\alpha}, \hat{\alpha}$	-1, 1
Breach	1, -1	0, 0

with $\hat{\alpha}$ representing agents' profit margin if both comply.[17] If a competent agent is in either the disappearing or breaking-up state, its payoff from compliance is 0 instead of $\hat{\alpha}$. Incompetent agents derive a negative payoff from compliance; for them, cheating is the only way to get a positive payoff.

Relational Strategies

Having characterized the economy, we now examine the conditions under which relational contracting enables agents to trade. We proceed as follows. We first define a set of relational strategies. Based on these strategies, we compute expected payoffs conditional upon the state agents are in. Next, we derive the laws of motion of the economy, given these strategies, and we derive the properties of the long term steady state. We then study the parameter configurations for which relational strategies are subgame perfect.

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[16] Consequently, there are $2^3 = 8$ possible configurations in which pairs of players can be.

[17] Gains from trade are divided equally among them so that payoffs are symmetrical. This assumption is not essential; similar results can be derived in a one-sided Prisoner's Dilemma game. But it simplifies the analysis considerably by eliminating certain forms of strategic interaction, such as breaching a profitable contract to renegotiate its terms.

Let us define simple relational strategies as strategies in which two agents trade with each other until a breach of contract occurs, at which point they look for another partner. Within this broad class of strategies, we first consider one specific set of strategies which we denote SRS_a and we show that, for some parameter values, it constitutes a subgame perfect equilibrium and satisfies the bilateral rationality condition. Strategies SRS_a are as follows. *Matching stage:* At time t, agents offer to continue trading with the agent with whom they were matched in the previous round unless, at $t-1$, (1) screening has revealed that the agent is incompetent; (2) a breach of contract occurred; or (3) they discovered that they must break up the relationship. In all these cases, the agent seeks a new partner. New agents always seek a new partner. *Contractual stage:* Competent agent offers to trade if they have chosen to continue trading with the same partner. In the case of a new match, they offer to trade if the credit report shows that the agent has complied at least once in the past; otherwise they offer to screen. *Compliance stage:* Competent agents comply with their contractual obligations unless their payoff falls to 0 (i.e., they disappear or must break the relationship), in which case they breach the contract. Incompetent agents always breach. No stigma is attached to breach of contract since, with probability 1, all competent eventually breach. Stigma is revised in Section 3.

We now investigate the conditions under which these strategies form a sustainable, subgame perfect equilibrium, which we denote RE_a. Expected payoffs of incompetent agents are constant and are ignored from now on. Expected long term payoffs for competent agents are derived as follows. At the beginning of each period, competent agents are in one of three possible states: matched (M); tested and unmatched (U); or untested and unmatched (K). Matched agents are those who are in a long-term relationship. Tested agent are those that have been screened as competent; untested agents are those who have never been screened. Dropping i subscripts for simplicity, let V_t^M, V_t^K, and V_t^U denote the expected continuation payoff of a matched, unmatched but tested, and untested agent at the beginning of period t, respectively. We get:

$$V_t^M = \hat{\alpha}\hat{\tau}^2\theta^2 + (1-\hat{\tau}^2\theta)\theta\hat{\delta}V_{t+1}^K + \hat{\tau}^2\theta^2\hat{\delta}V_{t+1}^M \tag{1}$$

The first part is the agent's instantaneous payoff times the probability that both agents comply. The second term is the expected continuation payoff if either of the two agents breaks up the relationship and they must find a new partner. The third term is the continuation payoff if the relationship continues. Equation (1) incorporates the fact that disappearing agents have a continuation payoff of 0. To simplify the notation, let $\tau^2 \equiv \hat{\tau}^2\theta$, $\delta \equiv \hat{\delta}\theta$, and $\alpha \equiv \hat{\alpha}\theta$. Equation (1) can then be rewritten more succinctly as:

$$V_t^M = \alpha\tau^2 + (1-\tau^2)\delta V_{t+1}^K + \tau^2\delta V_{t+1}^M \tag{2}$$

To derive the expected payoff of unmatched agents, let I_t be the proportion of tested agents at time t, a fraction K_t of which are unmatched at the beginning of the period. Next, let U_t stand for the fraction of untested, and thus unmatched, agents. By construction, $G = I_t + U_t$ at all t. Let μ_t be the proportion of untested agents among the unmatched, and let p_t be the proportion of incompetent agents among the untested. By definition, we have:

$$\mu_t \equiv \frac{B + U_t}{B + U_t + K_t} \tag{3}$$

$$p_t \equiv \frac{B}{B + U_t} \tag{4}$$

The expected payoff of a tested unmatched agent V_t^K can then be written:

$$V_t^K = (1-\mu_t)\kappa(\alpha\tau^2 + (1-\tau^2)\delta V_{t+1}^K + \tau^2\delta V_{t+1}^M) + \tag{5}$$
$$((1-\mu_t)(1-\kappa)+\mu_t(1-p_t))((1-\tau^2)\delta V_{t+1}^K + \tau^2\delta V_{t+1}^M) + \mu_t p_t\delta V_{t+1}^K - (\mu_t + (1-\mu_t)(1-\kappa))c$$

The first term represents the expected payoff from being matched with a known tested agent and trading from the start. This option is not open to untested agents because they are undistinguishable from incompetent agents and therefore never trade at their first encounter. The second and third terms are the expected payoff from being matched with an unknown but competent agent, and with an incompetent agent, respectively. The last term is the screening cost. A similar equation can be derived for untested agents:

$$V_t^U = (1-\mu_t p_t)((1-\tau^2)\delta V_{t+1}^U + \tau^2 \delta V_{t+1}^M) + \mu_t p_t \delta V_{t+1}^U - c \qquad (6)$$

If $\kappa = 0$, it is easy to verify that $V_t^K = V_t^U$ for all t.

Together, equations (2), (5) and (6) constitute a set of recursive equations that can be used to compute agents' payoffs provided we know μ_t and p_t. Since the number of agents is infinite, the laws of motion of K_t and U_t are given by:

$$K_{t+1} = \theta(1-\tau^2)I_t + \theta\tau^2\mu_t p_t K_t \qquad (7)$$

$$U_{t+1} = (1-\theta)G + \theta[1-\tau^2(1-\mu_t p_t)]U_t \qquad (8)$$

The economy's laws of motion do not depend on κ_i. This is because, unlike in Kranton (1996a), social networks are not used to speed up the search for reliable commercial partners. The economy starts with all agents in the untested, unmatched category, i.e., with $U_0 = G$, $I_0 = 0$, and $K_0 = 0$. The initial proportion μ_0 of untested agents in the population is equal to 1. Equations (7) and (8) constitute a self-contained system of difference equations that describes the law of motion of μ_t and p_t over time. Let p^* and μ^* denote the steady state of this system. Linearizing these equations around p^* and μ^*, it can be verified that the system is locally stable and that it is approached monotonically from below. Numerical simulations further suggest that the system is globally stable and that K_t increases monotonically over time.[18]

The properties of steady state expected payoffs are summarized in the following proposition. All proofs are given in appendix.

Proposition 1: Steady state payoffs V^M, V^K and V^U are increasing in α, κ, δ, and τ and decreasing in c, μ^* and p^*.

Proposition 1 states that agents' payoffs are higher when gains from trade α are larger, when they have a dense network of relations κ, and when relationships last longer (τ large). They

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[18] If $\theta = 1$ -- competent agents are never renewed -- the number of untested agents eventually tends to 0 and $p_* = 1$: in the long run, untested agents are all incompetent. If $\theta < 1$, the presence of newcomers among the unmatched ensures that p_* remains below 1: a certain proportion of unmatched agents remains competent even in the long run. It can also be verified that p^* and μ^* increase with θ. Moreover, the proportion of competent agents among the unmatched falls with time and the product $\mu_t p_t \equiv \frac{B}{B + U_t + K_t}$ rises monotonically as initially untested agents progressively become known.

are lower when screening costs c are high, the proportion of untested agents μ^* is high, and the proportion of incompetent among the untested p^* is high. The reason is that, the more incompetent agents there are in the economy, the more time competent agents waste (on average) trying to find a reliable trading partner. These results are comparable to Propositions 4 and 5 in Ghosh and Ray (1996). Since the laws of motion of K_t and U_t do not depend on α, δ, c or κ, if follows that:

Proposition 2: For all t, V_t^M, V_t^K and V_t^U increase with α, δ, and κ and decrease with c.

Proposition 2 generalizes the results of Ghosh and Ray (1996) by showing that important characteristics of the equilibrium around the steady state also hold during transitional dynamics. The Proposition implies that returns to social network capital are unambiguously positive: agents with a high κ_i enjoy higher payoffs than those with low κ_i during all trading rounds.[19] They do so because they can save on screening costs and trade immediately. The sharing of information thus improves market efficiency even though reputation is not used to stigmatize cheaters. This kind of reputation effect has been ignored in much of the theoretical literature because agent heterogeneity is typically not considered (e.g., Kandori (1992), Greif (1993), Milgrom, North and Weingast (1991), Raub and Weesie (1990), Ellison (1994)).

An immediate policy implication is that the welfare of market participants can be raised by favoring the circulation of market information among them. This can be accomplished in various ways, such as by creating a credit reference bureau, circulating information on potential workers, or fostering business associations and meetings. Identification of firms and agents, an essential ingredient of an information sharing system, can itself be facilitated by setting up a business registration system. The circulation of inaccurate or ill-intended information can itself be punished as defamation or fraud. However, as we shall demonstrate in the following pages, the circu-

[19] Remember that i subscripts have been dropped from the notation to improve readability, but are implicit in Propositions 1 and 2 and all that follows.

lation of information is not always beneficial.

Equilibrium conditions

We now examine the conditions for which relational strategies RE_a form a self-enforcing, subgame perfect equilibrium. Although many individual rationality conditions need to be satisfied, only three types of conditions deserve to be investigated in detail:[20] continuation of relationship (CR) conditions that ensure that matched agents continue to trade with each other; breach deterrence (BD) conditions that ensure that contractual obligations are respected; and willingness to screen (WS) conditions that ensure that agents willingly screen each other.

For CR conditions to be satisfied, agents' payoffs must be higher when matched than unmatched, i.e.:

$$V_t^M \geq V_t^K \qquad \text{(CR)}$$

This is always true since unmatched agents incur the cost of identifying a reliable agent while matched agents do not.[21] Next, consider breach deterrence. In a relational equilibrium, opportunistic breach is deterred by the prospect of having to incur the cost and risk of screening new potential partners. For agents in the 'normal' state, the breach deterrence condition is:

$$\tau(\alpha + \delta V_{t+1}^M) + (1-\tau)(-1 + \delta V_{t+1}^K) \geq \tau + \delta V_{t+1}^K$$

which can be rewritten more simply as:

$$V_{t+1}^M - V_{t+1}^K \geq \frac{1-\alpha\tau}{\tau\delta} \qquad \text{(BD)}$$

This condition cannot be satisfied unless V_{t+1}^M is strictly larger than V_{t+1}^K. For agents who have discovered that they will disappear or that they must find a new partner, however, deterrence is ineffective. To deter willful breach by breaking-up agents, it would have to be true that:

$$\tau(1 + \delta V_{t+1}^K) + (1-\tau)\delta V_{t+1}^K \leq \tau\delta V_{t+1}^K + (1-\tau)(-1 + \delta V_{t+1}^K)$$

which boils down to $1 \leq 0$, an impossibility. A similar impossibility is found for disappearing

20 The others are satisfied trivially and are left as an exercise for the reader.

21 This can easily be seen by comparing equation (3) to equation (6).

agents since their have a zero continuation payoff. Breach by breaking-up agents cannot be fully deterred for two reasons. First, the economy does not stigmatize cheaters and cannot, therefore, penalize breaking-up agents above and beyond the loss that they already suffer from having to end a commercial relationship. This is true even though agents share information about each others through an informal reputation mechanism. Second, the economy is large enough that the chance that agents would be paired with the same agent again in the future is vanishingly small. If the number of agents was finite and sufficiently small, agents would worry that cheating some agents may seriously reduce their chances of finding a new commercial partner, a process that could, by itself, support cooperation (e.g., Kandori (1992), Ellison (1994)). This possibility is ignored here.

Let us now turn to willingness to screen conditions. First, it must be better for unmatched agents to screen unknown agents rather than withdraw from trade altogether, i.e.:

$$V_t^K \geq 0 \qquad \text{(WS1K)}$$

$$V_t^U \geq 0 \qquad \text{(WS1U)}$$

Second, untested agents must prefer to screen now instead of waiting for the next trading round:

$$V_t^U \geq \delta V_{t+1}^U \qquad \text{(WS2U)}$$

Finally, tested agents must prefer to screen now rather than wait until next period in the hope that they will be matched with a known agent and will not have to incur the screening cost:

$$((1-\mu_t)(1-\kappa)+\mu_t(1-p_t))((1-\tau^2)\delta V_{t+1}^K + \tau^2 \delta V_{t+1}^M) +$$
$$\mu_t p_t \delta V_{t+1}^K - (\mu_t + (1-\mu_t)(1-\kappa))c \geq (\mu_t + (1-\mu_t)(1-\kappa))\delta V_{t+1}^K$$

which can be rewritten as:

$$V_{t+1}^M - V_{t+1}^K \geq \frac{c(\mu_t + (1-\mu_t)(1-\kappa))}{\delta\tau^2(\mu_t(1-p_t) + (1-\mu_t)(1-\kappa))} \qquad \text{(WS2K)}$$

If either of these conditions is violated, agents refuse to screen unknown agents. If the breach deterrence condition (BD) and the four willingness to screen conditions are satisfied, it can be verified that other individual rationality constraints are satisfied as well. Together, these conditions therefore define the set of model parameters for which the relational equilibrium RE_a is self-enforcing. They can be used to derive the following propositions.

Proposition 3: In a relational equilibrium RE_a,

(3.1) Breach cannot be fully deterred and economic efficiency is not achieved.

(3.2) Breach deterrence is harder when κ is large.

(3.3) Gains from trade α must be strictly positive.

(3.4) If $c = 0$ and $\alpha > 0$, willingness to screen conditions are always satisfied.

Proposition 3.1 is a consequence of the fact that breach by breaking-up agents cannot be deterred. Proposition 3.2 follows from the fact that the breach deterrence condition is harder to satisfy when information is shared widely. The reason is again due to the absence of stigma: tested agents trade more easily when unmatched and are thus less penalized if they breach. The large κ is, the easier it is to trade, and the harder it is to prevent opportunistic breach. Proposition 3.3 is an immediate consequence of the breach deterrence condition: for a relational equilibrium to exist, agents must derive strictly positive expected gains from trade, otherwise they have no incentive to preserve commercial relationships. In these circumstances, agents may naturally interpret gains from trade as returns to their social capital in the form of commercial relationships and reputation Fafchamps and Minten (2001), Fafchamps and Minten (2001). Proposition 3.4 implies that, if screening is costless, it is always in an agent's interest to sample unknown firms in the hope of finding a suitable commercial partner. In this case, the only equilibrium condition that is possibly binding is equation (BD). A contrario, if screening is costly, it may be better for agents to stop screening altogether or to wait until they are matched with a known firm. To illustrate what patterns of trade may emerge in relational equilibria, two special cases are examined more in detail.

Pure Relational Equilibria

We now investigate the conditions under which a pure relational equilibria may be self-emerging. Let $\kappa_i = 0$ for all i and modify SRS_a accordingly by instructing agents to screen all unknown agents. Call the result pure relational strategies or PRS_a, and denote the corresponding equilibrium a pure relational equilibrium PRE_a. In the steady state, this equilibrium is very similar to that discussed in Ghosh and Ray (1996) and to what Greif (1993) call bilateral punishment strategies.

In PRS_a, equilibrium conditions boil down to $V_t^M - V_t^U \geq \frac{1-\alpha\tau}{\tau\delta}$ (BD) and $V_t^U \geq 0$ (WS1U).[22] The set of α and c values for which equilibrium conditions in PRS_a are satisfied evolves over time in the manner illustrated in Figure 2 (see proof of Proposition 4). II_0 and JJ_0 depict the locus of α and c values such that equilibrium conditions are exactly satisfied at time t_0; II^* and JJ^* represent steady state equilibrium conditions.[23] Values of α and c above the II and JJ lines ensure that a PRE_a exists. It is easy to show that equilibrium conditions are more easily satisfied when relationships are stable (high τ) and agents are patient (high δ) (e.g., Ghosh and Ray (1996)).

Two shaded areas, A and B are of particular importance. For values of α and c in the B shaded area, equilibrium conditions are satisfied in the steady state but not at t_0. The reason is that, at $p_0 = B/(B+G)$, unmatched agents find each other easily and the penalty for breach of contract is not strong enough to induce compliance. The pure reputational equilibrium is sustainable and locally stable, but it cannot be reached from a no trade situation. A relation-based market fails to emerge even though, if it were there, it would be sustainable. Under these cir-

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[22] Since $V_t^K = V_t^U$ for all t, conditions (WS1K) and (WS2K) drop out. It is easy to verify that V_t^U and V_t^M unambiguously fall over time. The reason is that the proportion of incompetent agents among the unmatched, $\mu_t p_t$, increases with t: $\mu_t = 1$ for all t and $p_t = B/(B+U_t)$ rises as agents, who initially are all unmatched, progressively identify commercial partners. Condition (WS2U) is thus always satisfied along the equilibrium path.

[23] These can be derived algebraically by solving recursive equations (2), (5) and (6) for a fixed V^M and V^U, and replacing μ_t by its steady state value μ^*.

cumstances, an unanticipated shock to the economy that would break existing relationships between agents could permanently eliminate trade.[24]

Shaded area A correspond to another scenario, one in which the development of commercial relationships initially satisfies equilibrium conditions, but eventually fails to satisfy $V_t^U \geq 0$: as the number of competent agents among the unmatched falls, unmatched agents eventually find it too costly to sample each other and withdraw from the market. The reason is that, as p_t rises, the cost of sampling c is no longer compensated by the hope of finding a reliable long-term partner. This means that PRS_a are not sustainable in the long run; a pure relational equilibrium does not exist. It is possible, however, to find other relational strategies that support trade in the long run (see proof of Proposition 4). These results are summarized in the following proposition:

Proposition 4: When $\kappa_i = 0$ for all i,

(4.1) A PRE_a is not sustainable if gains from trade α are small and screening costs c are high.

(4.2) A PRE_a is more likely to be sustainable when relationships are stable (high τ) and agents are patient (high δ).

(4.3) For α sufficiently high and c sufficiently low, there exists a sustainable, reachable pure relational equilibrium of the first kind PRE_a; market emergence is spontaneous.

(4.4) For certain values of α and a low enough c, PRE_a may be sustainable but not reachable from $U_0 = G$. Spontaneous market emergence does not occur; shocks may destroy markets.

(4.5) For certain values of α and a high enough screening cost c, PRS_a are satisfied at $t=0$ but not at the steady state. Alternative equilibrium relational strategies nevertheless exist but, at the steady state, a fraction of competent agents are shut out from trade.

History abounds with examples of trading relationships that resemble pure relational strategies, such as the spice and silk trade of the pre-industrial world (e.g., Braudel (1986)); long

[24] E.g., warfare, the expulsion of a merchant group from the country, or a brutal change in economic conditions that call for a change in trade patterns.

distance cattle and kola trade in West Africa (e.g., Hopkins (1973)); cattle trade in Kenya (e.g., Ensminger (1992)); or gold trade along the Zambezi river (e.g., Shillington (1989)). These ancient patterns of trade have in common to be highly profitable (high α) and, if undisturbed, extremely stable over time (high τ). Yet history suggests that they often are vulnerable to temporary trade disruptions in the sense that, once trading routes are disturbed by warfare or political turmoil, these routes are difficult to reestablish.

It is still possible to find examples of similar trade patterns in contemporary Africa (e.g., Staatz (1979), Meillassoux (1971), Amselle (1977), Jones (1959)). One of the reasons is that the semi-legal nature of much cross-border African trade precludes recourse to courts. In addition, the small size of the transactions implies that suing is seldom an attractive option. The embryonic manufacturing sector of Ghana operates largely in the same manner Fafchamps (1996). The reason appears to be that the Levantine businessmen who run much the country's manufacturing sector are prohibited by law to run trading businesses. As a result, they find themselves sandwiched between suppliers and clients from other ethnic groups with whom socialization and thus the exchange of information is problematic. Trade in illegal drugs is another contemporary example of a pattern of exchange essentially based on relational contracting: the illegal nature of the trade prevents the use of courts to enforce contracts while the fear of informants complicates the exchange of business information. Efforts by drug enforcement agencies to disrupt trade channels (e.g., by arresting dealers) in the hope of permanently stopping trade can be seen as an application of Proposition 4.4. As part 4.1 suggests, however, these efforts are bound to fail if gains from trade are sufficiently large.

Closed-Shop Equilibria

Things are somewhat different if agents exchange information. To focus on an interesting special case, we assume that competent agents are renewed slowly or are not renewed at all. To keep the notation simple, we assume that $\kappa = 1$. In this case, equilibrium conditions simplify to the following:

$$V_{t+1}^{M} - V_{t+1}^{K} \geq \frac{1-\alpha\tau}{\tau\delta} \qquad \text{(BD')}$$

$$V_{t+1}^{M} - V_{t+1}^{K} \geq \frac{c}{\delta\tau^{2}(1-p_{t})} \qquad \text{(WS2K')}$$

plus (WS1K), (WS2U) and (WS1U).

From Proposition 3.4, we know that willingness to screen conditions are automatically satisfied when $c = 0$. It is then easy to verify that parameter values exist such that breach of contract can be deterred by SRS_a strategies. When $c > 0$, however, condition (WS2K') is impossible to satisfy for values of p_t close enough to 1. In this case, SRS_a are unsustainable in the long run. The reason is that tested agents cannot be convinced to incur screening cost $c > 0$ in order to sample untested agents when the latter are, in their great majority, incompetent. Tested agents prefer to limit their dealings to tested agents whom they can immediately trust. Since $p_t \to 1$ as $t \to \infty$ when agents are not renewed, i.e., when $\theta = 1$, we get the following proposition:

Proposition 5: If $\kappa = 1$, $\delta < 1$, $c > 0$ and $\theta = 1$, the RE_a is unsustainable in the long run.

By extension, RE_a is unsustainable for θ or κ close enough to 1. This, however, does not imply that no transaction can ever occur between tested and untested agents. In early periods, the number of tested agents K_t is small and competent agents U_t constitute a large proportion of all untested agents. In this case, waiting to be matched with another tested agent would take too long; screening untested agents, even though it means incurring screening cost c, is likely to constitute a more profitable alternative. This leads to the following proposition:

Proposition 6: If $\kappa = 1$, $\theta = 1$, and $c > 0$:

(6.1) There exist parameter values for which a relational equilibrium is sustainable. This equilibrium involves changes of strategies over time.

(6.2) There is a time $t^* \geq 0$ such that, for all $t < t^*$, SRS_a satisfy equilibrium conditions, and for all $t \geq t^*$, tested agents refuse to transact with untested agents. After t^*, absorption of agents into the group of tested agents is slower than before t^*.

(6.3) There is a time $t^{**} \geq t^*$ such that, for all $t \geq t^{**}$, untested agents refuse to screen each other. After t^{**}, untested agent are permanently excluded from trade.

The evolution of equilibrium payoffs implied by Proposition 6 is illustrated in Figure 3.[25] The Proposition implies that, if screening is costly, firms are long lasting, and information circulates freely among them, then trade is likely to take a 'closed-shop' form: established firms deal only with other established firms and refuse to even consider unknown agents as potential partners.[26] The reason is that there are too few competent agents among the unknown, untested agents and it would be too costly to identify them. In such a world, agents with no payment history find it difficult if not impossible to be given a chance to prove themselves: the deck is stacked against newcomers. Possible real-life examples of such equilibria include, for instance, the difficulties that young inexperienced workers often encounter getting their first job, and the problems that start-up companies face in qualifying for credit from banks and suppliers. Similar examples can be found in developing countries where a closely knit business community has a hold on a particular economic activity: e.g., the Chinese in Indonesia, the Asians in Kenya, or the whites in Zimbabwe. Proposition 6 suggests that this hold is strongest in societies where economic opportunities are unchanging over time (high τ) and firms are long lasting (high θ).

A corollary of Proposition 6 is that setting up a mechanism to improve the circulation of business information among agents -- such as a credit reference bureau -- may result in excluding from the market those firms that have not yet established a name for themselves. Allowing established firms to better exchange information among themselves indeed makes it easier for them to identify each other -- and thus to economize on screening costs by waiting to be matched with each other. Empirical work on Ghana, Kenya, and Zimbabwe manufacturing suggests that

[25] Figure 3 is the result of a computer simulation using the following parameter values: $\theta = 1$, $\kappa = 1$, $\delta = 0.95$, $\tau = 0.95$, $\alpha = 0.3$, $c = 0.05$, $B = 2/3$, $G = 1/3$.

[26] A similar result is derived by Taylor (1997) using different assumptions and a static setup.

widespread circulation of information may indeed be detrimental to newcomers. The three countries differ greatly in the extent with which manufacturing firms exchange information. For reasons discussed earlier, Ghanaian manufacturers share little information. In contrast, Kenyan manufacturers, who are predominantly of Asian origin, informally exchange information among themselves. In addition to informal information sharing, Zimbabwe also has a credit reference bureau. Of these three countries, it is also the one which manufacturing appears the most closed to newcomers, especially blacks, while Kenya occupies an intermediate position and Ghana is the most open. This evidence is only suggestive, given that it is based on a small number of case studies in three countries, but it is consistent with the idea that information sharing may hurt newcomers. This issue deserves further investigation.

Section 2. Stigmatization and Collective Punishment

So far we have shown that exchange can take place in the absence of formal institutions for the enforcement of contracts. Unlike much of the theoretical literature on informal contract enforcement, we have done so without resorting to any coordinated punishment strategy. Instead, we showed that the value that agents attach to commercial relationships can be sufficient to deter breach of contract whenever agents are heterogeneous. Better deterrence could, however, be achieved if breach of contract resulted in permanent exclusion from trade. Indeed, we saw in section 1 that in an equilibrium where breach is not sanctioned by permanent exclusion from trade, a commercial relationship always ends with a breach of contract. In this section, we examine the conditions under which the threat of exclusion may be credible even without coordination between agents, that is, without meta-punishment.

The basic intuition of our argument is as follows.[27] Agents who know they are leaving the

[27] An ingenious example of self-enforcing exclusion can be found in Greif (1993). Using a stylized model of merchant-agent relations, Greif shows that, when other merchants punish deviant agents, it is not in any merchant's interest to trade with a cheater. The reason is that a cheater must receive a higher wage to be deterred from cheating again. Although formally appealing, Greif's approach requires that merchants extract all gains from trade, subject to agents' participation constraint. If, in contrast, gains from trade are shared between both parties, as is implicitly assumed here, cheaters could presumably propose to take a lower share of the gains in order to resume trade. In this

business have no incentive to comply with their contractual obligations. Consequently, they are willing to take on contractual obligations they cannot fulfill and go bankrupt.[28] We begin by showing that permanent exclusion of known cheaters serves as an additional deterrent to opportunistic breach. We then examine the conditions under which permanent exclusion is self-enforcing. We show that breach of contract may trigger permanent exclusion from trade if it is interpreted as a signal of impending bankruptcy. Self-enforcement then comes from what breachers reveal about themselves.[29]

Exclusion From Trade

We now investigate strategies in which agents who breach contracts are stigmatized and permanently excluded from trade. We continue to assume that agents do not observe the other party's gains from trade, even *ex post.* Since agents cannot verify the conditions of a breach, all breaches must be equally punished. Let us define stigma-augmented relational strategies (*SARS*) as strategies in which only agents who are incompetent or going out of business cheat. Other agents never cheat, even at the end of a relationship. Cheaters are stigmatized: if they are matched with a competent agent who knows them, the agent refuses to trade with them. When matched with unknown agents, cheaters follow simple relational strategies. For the surplus, strategies are identical to simple relational strategies.

Since there is less cheating, the following proposition obtains:

Proposition 7: Expected payoffs, and thus market efficiency, are higher when agents follow stigma-augmented relational strategies instead of simple relational strategies.

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case, the threat of exclusion would no longer be credible.

[28] We abstract from legal penalties attached to fraudulent bankruptcy.

[29] When agents receive credit from multiple sources, breach of contract can lead all sources of credit to withdraw their support simultaneously, thereby precipitating the firm's demise. This may serve as additional deterrent to breach of contract. A formalization of some of these arguments can be found in the literature on bank runs (e.g., Diamond and Dybvig (1983)).

Conditions for $SARS_a$ to form a subgame perfect equilibrium are largely unchanged, except for a new breach deterrence condition along the equilibrium path:

$$\delta V_{t+1}^K \geq \theta + \delta V_{t+1}^C \qquad \text{(BD'')}$$

where V_{t+1}^C is the expected payoff to a one-time cheater. Manipulating equation (8) and combining it with payoff functions implied by the *SARS* yields the following proposition:

Proposition 8:

(8.1) Stigma-augmented relational strategies become more easily sustainable over time.

(8.2) Stigma-augmented relational strategies are more likely to be sustainable if κ is large for all agents.

The reason for Proposition 8.1 is simply that the gap between the expected payoff of a cheater V_t^C and that of an established non-cheater V_t^K increases over time, hence making equation (8) easier to satisfy. The gap increases because the proportion of tested agents among the competent ones rises over time, making it difficult for cheaters to establish relationships with untested competent firms. Proposition 8.2 follows from the fact that deterrence is more effective when the probability of punishment is higher.

An immediate corollary of proposition 8 is that stigmatization is ineffective with totally unknown agents, that is, agents whose $\kappa_i = 0$. Trade with such agents is only feasible via simple relational strategies. If agents differ with respect to their κ_i, stigmatization may be feasible only within a closely-knit group. This opens the door to more complicated strategies whereby agents play stigma-augmented strategies with certain agents and relational strategies with others. For lack of space, we do not explore this possibility here but it fits rather well the way Kenyan manufacturing firms interact: while Asian entrepreneurs share information with each other and refuse to deal with Asian cheaters, African entrepreneurs do not (e.g., Fafchamps et al. (1994)). A similar contrast among various business groups could be observed in Zimbabwe (e.g., Fafchamps, Pender and Robinson (1995), Fafchamps (1997)).

Proposition 8 implies that changing one's identity must be sufficiently costly for a *SARS* to constitute a subgame perfect equilibrium. A *SARS* cannot exist if agents who opportunistically breach a contract can subsequently hide among unknown agents. Stigmatization requires a precise way of identifying agents. In the absence of a formal identification system -- e.g., business registration or an identity card system -- stigmatization must remain confined to face-to-face interaction. This may explain why the threat of stigmatization is largely ineffective against so-called informal sector firms which, as a rule, are not registered -- and hence why transactions among informal sector firms remain quite unsophisticated *(ibidem).* Interviews with entrepreneurs in Africa further suggest that running away to one's village -- and resurfacing later with a different identity -- is a widely used strategy to escape contractual obligations. Such strategies are typically not available to expatriate communities, a feature that may explain why stigmatization is easier among them and hence why breach is more easily deterred. This feature, by itself, could explain why expatriate communities dominate business in many agrarian societies of the Third World.

Finally, we note that a *SARS* shares essentially the same willingness to screen conditions as the simple relational equilibria discussed in Section 1. Consequently, Propositions 5 and 6 also apply. For instance, if $c > 0$, $\kappa = 1$, and $\theta = 1$, established agents eventually refuse to trade with untested agents. Stigmatization does not preclude closed-shop equilibria.

Self-Enforcing Stigmatization

We now investigate the circumstances under which the stigmatization of cheaters is self-enforcing, that is, does not require that agents who trade with cheaters be themselves punished.[30] We begin by noting that cheaters lucky enough to find someone willing to trade with them cannot be deterred from breaching the contract at the end of the relationship: in their case BD'' cannot

[30] In which case stigmatization satisfies the bilateral rationality condition of Ghosh and Ray (1996) and is also renegotiation-proof.

be satisfied since δV_t^C cannot be greater than $\theta + \delta V_t^C$.[31] During the relationship, however, breach deterrence is easier, i.e., $V_t^N - V_t^C \geq V_t^M - V_t^K$. This is because a cheater has a harder time finding a new partner, making a commercial relationship more valuable to him or her than to a non-cheater. Cheaters can therefore credibly promise that they will not cheat again[32] while at the same time proposing to split gains from trade differently, e.g., by offering a bribe b such that the cheater gets a cooperation payoff of $\alpha - b$ and the stigmatization buster gets $\alpha + b$. Cheaters may, therefore, escape exclusion by credibly promising to amend their ways while at the same time anticipatively compensating the other agent for the fact that they will cheat at the end of the relationship. The threat of permanent exclusion from trade is thus not credible and a stigma-augmented relational strategy is unsustainable without meta-punishment.

There is, however, one possible mechanism by which stigmatization can be self-enforcing. So far, we have postulated that, with probability $1-\theta$, competent agents leave business and are immediately replaced by new, untested competent agents. We now assume instead that these agents remain in the economy. Since these agents do not derive any gain from trade, they have no incentive to honor contracts. Like incompetent agents, they take advantage of every opportunity to cheat but, unlike them, they have been 'tested' by the market and enjoy a long history of honored contracts. In a simple relational equilibrium, they could offer to trade with the tested agent they are matched with -- and profit by cheating them. All they would have to do is to claim that they cheated their previous commercial partner because they had discovered they needed to find a new partner, an event that affects all agents with probability $1-\tau$. In a simple relational equilibrium, therefore, agents going out of business would find it in their interest to remain in the economy only to cheat others.

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[31] The expected loss from breach of contract at the end of a relationship may, at least theoretically, discourage agents to deal with cheaters, but this is unlikely since the loss will happen only in some (possibly distant) time in the future. We do not pursue this possibility further.

[32] Except at the end of the relationship.

Things are different with *SARS* because agents are instructed not to trade with known cheaters. The threat of exclusion deters cheating by all agents except those who have nothing to gain from any future trade. In equilibrium, therefore, all cheaters are either incompetent or going out of business and no competent agent should deal with them. Refusing to deal with cheaters is then self-enforcing and the threat of exclusion credible.[33]

That *SARS* are self-enforcing does not guarantee that a stigma-augmented relational equilibrium or *SARE* is the only possible equilibrium configuration. Consider an agent who is matched with a known cheater. If all cheaters are incompetent or going out of business, refusing to trade is optimal. If, however, most cheaters are competent agents who follow simple relational strategies, trading is optimal. There will, therefore, be parameter configurations in which two rational expectations equilibria are possible, one in which agents believe cheaters to be incompetent or bankrupt, in which case competent agents never cheat; and one in which agents believe most cheaters are competent agents who reached the end of a relationship, in which case cheating at the end of a relationship is not deterred. The first equilibrium is a *SRE*, the second a *SARE*.[34] These results can be summarized in the following proposition:

Proposition 9:

(9.1) A *SARE* can be self-enforcing if agents going out of business remain in the economy.

(9.2) There exist parameter vectors for which both a *SRE* and a *SARE* exist and are self-enforcing; the *SARE* is Pareto superior to the *SRE*.

Section 3. Spontaneous Market Emergence

We are now in a position to speculate as to how markets may spontaneously emerge in the absence of any formal institutions for the enforcement of private contracts.[35] We first discuss the

[33] Agents may even be willing to pay a credit reference bureau for the names of cheaters.

[34] For another example of multiple signaling equilibria, see Rasmusen (1996) model of criminal deterrence.

[35] Formal institutions may nevertheless be required to define and protect property rights (e.g., North (1990)).

conditions required for exchange to be initiated. We then examine how the sharing of information among agents leads to an increase in the role of information and generates returns to social connectedness. Finally, we demonstrate that, given the right conditions such as a major economic downturn, agents may spontaneously switch to a higher level of breach deterrence in which all cheaters are permanently excluded from trade.

The Initiation of Exchange

What makes relational contracting a convincing working hypothesis about the way markets emerge is that, unlike other equilibrium concepts discussed in the literature (e.g., Kandori (1992)), it does not require any coordination. One could possibly argue that, if all agents are cheating on all transactions, then it is not in anyone's interest to contract, so that markets may never emerge. No trade is thus always a possible equilibrium. If the conditions for a simple relational equilibrium are satisfied, however, no trade violates the bilateral rationality condition of Ghosh and Ray (1996). It is also not renegotiation-proof. All that is required to initiate market exchange is for two deviant players to take the risk of what Axelrod (1984) calls 'brave reciprocity' with each other. Once trade is initiated between these two agents, breaches are even easier to deter than when all agents follow a simple relational strategies because the penalty for cheating in a no trade equilibrium is a zero payoff forever. When *SRE* conditions are satisfied, a no-trade equilibrium is thus also not evolutionary stable.

The mere presence of gains from trade is not, however, sufficient for trade to take place if external breach deterrence is absent. Unless opportunistic breach of contract is deterred by market discipline, agents will optimally choose not to initiate exchange. It is thus quite possible to observe situations in which trade appears beneficial but fails to occur. For trade to be initiated, gains from trade must rise above a certain threshold sufficient to compensate agents for the cost of screening potential partners and incur some opportunistic breaches. As Proposition 4 demonstrated, this threshold is higher before a market has emerged than after it is in place. Spontaneous market emergence thus requires that gains from trade be sufficiently high. Once trade has started, however, market exchange may continue even if gains from trade α subsequently falls. Market emergence is thus a path dependent process: abnormally high arbitrage opportunities can induce agents to take the risk of trading. Once established, trade patterns become somewhat resilient to variations in returns to arbitrage and other gains from trade.

From Pure Relational Contracting to Reputation-Based Contracting

In the absence of any information about other agents, agents are likely to proceed with caution. Their first goal is to identify a reliable commercial partner. This may take some time, given the presence of incompetent agents in the economy. Having found one, they continue to trade with each other until one of them finds the relationship no longer profitable. At that point, breach of contract occurs and both agents look for another partner. Markets at the early stage of their development is thus characterized by pure relational contracting.

At times goes on, however, the population of tested agents grows. Circulating the names of tested agents reduces screening costs. Reputation becomes important. Agents may begin spending resources to expand their information network and raise κ_i, a form of social capital on which they can capitalize (Proposition 2). If the rate at which economic agents are renewed is low (θ high) and if information circulates widely among agents, the economy eventually reaches a stage at which tested agents refuse to deal with untested agents. The reason is that over time most competent agents have been uncovered and remaining unmatched agents are mostly incompetent. For a while, untested competent agents may continue to trade with each other but, eventually, they also find that the expected gain from identifying a reliable agent among the unmatched is more than outweighed by the cost of finding one. The economy then reaches a steady state in which established firms trade exclusively with each other and net new entry is zero. Prospective entrants must wait until one of the ’in’ agents retires and makes room for them.

In contrast, if agents are renewed fairly rapidly, as would be the case if new firms are regularly created and new entrepreneurs enter the market, screening of untested agents continues indefinitely. Established firms conserve sufficient hope of finding competent agents among the unmatched to induce them to incur the screening cost. In this case, markets are somewhat less inimical to start-ups and newcomers, although the latter still have to be screened before joining the mainstream. This nevertheless supposes that a sufficiently large proportion of newcomers are competent. If many of them are not, a self-disciplining market may be quite inimical to newcomers, closing its doors to numerous promising agents because it would be too costly to screen them all.

The Emergence of Stigmatization

As is clear from the contrast between sections 1 and 2, information sharing is not a sufficient condition for exclusion from trade as a collective punishment to be implementable in a decentralized manner -- i.e., without meta-punishment. For exclusion to be self-enforcing, agents must interpret breach as a signal of impending bankruptcy -- i.e., of a change in type from competent to incompetent. We now investigate the conditions under which the economy may switch spontaneously from simple reputation-based contracting to stigma-augmented relational contracting or *SARE*.

We know from Proposition 8 that a *SARE* is hard to get started: the presence of lots of untested firms in the economy makes it easy for cheaters to avoid immediate punishment. An emerging market is therefore unlikely to take the form of a *SARE* right from the start. The question then arises: could an economy naturally evolve from a *SRE* into a *SARE*? We know that a *SARE* gets more easily sustainable as the proportion of established agents among the unmatched rises over time (Proposition 8). Therefore, even if the conditions for a *SARE* are not initially be satisfied, they eventually may. This can be illustrated as follows. Suppose that *SARE* conditions are not satisfied at t_0 and that the economy follows simple reputation-based contracting -- the

SRE_a path. Assume further that, as p_t rises, *SARE* conditions -- and in particular the breach deterrence condition BD'' -- become satisfied at t_1. It follows from Proposition 8 that they are also satisfied for all $t \geq t_1$. By Proposition 9.2, however, we know that the economy may not automatically switch to the superior *SARE* because multiple equilibria are possible.

How can the switch to the superior equilibrium take place then? One possibility is for agents to coordinate their actions. Once agents have agreed to refuse to trade with cheaters, breach of contract is prevented and, from Proposition 9.2, the *SARE* is self-enforcing. How such a coordinated change of strategy can be achieved is unclear, however. In their detailed study of a Moroccan market in the 1950's, Geertz, Geertz and Rosen (1979) reports that religious authorities and business leaders play an important role in defining norms of acceptable commercial conduct and in sanctioning deviations. Such institutions could possibly use their moral authority to promote the switch to higher standards of business ethics and favor the stigmatization of opportunistic breach of contract. Another possibility is that agents might get so aggravated at being cheated that they threaten all their business acquaintances with commercial and social retaliation if they deal with cheaters. Although such an action is not rational, it may be sufficient to trigger the switch to a *SARE*. The belief that opportunistic breach of contract results in ostracism is easier to generate if members of the group feel a sense of moral outrage towards breach of commercial contracts. This feature may help explain why social norms in general -- and religion in particular -- play an important role in market emergence (e.g., Platteau (1994a, 1994b), Greif (1993, 1994), Geertz, Geertz and Rosen (1979), Ensminger (1992)).

There exists another decentralized avenue through which an economy could spontaneously switch from a *SRE* to a *SARE*. In a *SRE* there are three types of cheaters among unmatched agents: incompetent agents, agents going out of business, and competent agents in search of a new partner. The latter should be contracted with, the first two should be avoided. It is intuitively clear that if the first two categories represent a high enough proportion of cheaters, agents will refuse to deal with all cheaters. To show this formally, let D_t be number of agents going out of business but still present in the economy, and let d_t denote their proportion among the unmatched, i.e.:

$$d_t = \frac{D_t}{B + U_t + K_t + D_t} \tag{9}$$

Define d_t^* as the value of d_t that would make agents indifferent between trading and not trading with cheaters. If, somewhere along the *SRE* equilibrium path, the actual proportion of agents going out of business, d_t, rises above d_t^*, agents refuse to deal with known cheaters. If this moment arises at $t \geq t_1$, the economy switches from the *SRE* to the superior *SARE*. The change occurs suddenly but in a decentralized manner.

To demonstrate this possibility, suppose that bankrupt agents never leave the economy:

$$D_{t+1} = D_t + (1-\theta)I_t \tag{10}$$

This assumption is unrealistic but it is made for the sake of illustration. It is then possible to show that the economy eventually switches from a *SRE* to a *SARE* equilibrium:

Proposition 10:

(10.1) $0 < d_t^* < 1$

(10.2) There exist a time t_2 after which agents refuse to trade with known cheaters.

(10.3) If $t_2 \geq t_1$, at t_2 the economy spontaneously switches from a *SRE* to a *SARE*.

An economy may also spontaneously switch from a *SRE* to a *SARE* if it is hit by an unexpected shock that suddenly drives a large proportion of competent agents out of business -- e.g, a major recession, or structural adjustment. By abruptly raising d_t, such a shock may induce agents to revise their interpretation of breach of contract and now see is as a sign of impending bankruptcy, hence refusing to deal with known breachers. Once this change of inference is internalized by all agents, it yields a shift in what Greif (1994) calls cultural beliefs and Platteau (1994) moral norms. Expectations about the market behavior of other agents can thus be interpreted as the result of an endogenous market formation process, not as the product of extra-economic social factors. This is another example of path dependence in market institutions.

Conclusion

Approaching market exchange from the angle of commitment failure, we have examined the conditions under which markets emerge. We show that, when economic agents are differentiated, a fully decentralized market equilibrium can spontaneously emerge and discipline itself in the absence of formal market institutions, provided gains from trade are large enough. Incompetent agents are screened away through a trial period, which also serves as sanction for breach of contract, as in Shapiro and Stiglitz (1984) and Ghosh and Ray (1996). Agents who have identified reliable partners continue to transact with each other until economic gains from the relationship vanish. Exchange is not anonymous but personalized and based on mutual trust. Agents collect rents from their business relationships; these rents cannot be competed away lest trade stops.

We investigated whether the circulation of information along networks improves the efficiency of relational contracting. We show that, when agents are heterogenous, two types of information must be distinguished: information about revealed types, and information about cheating. Sharing information about types resembles name recognition. In the presence of screening costs, sharing information about types may lead agents to refuse screening unknown agents, thereby resulting in a closed-shop equilibrium in which newcomers are excluded from trade. We showed that such an outcome is more likely if agents are long-lived and opportunities to trade are stationary -- as is often the case for agricultural and other primary products. We interpreted this result as throwing light on the well documented existence of closely knit business communities or networks the world over. Contrary to what one might expect, wider circulation of information about types -- e.g., via a credit bureau -- does not eliminate the problem; it only makes it worse. This might account for the virtual exclusion of black firms from the business mainstream in

Zimbabwe in spite of the existence of an active credit reference agency (e.g., Fafchamps (1997)).

We also investigated the conditions under which an economy might shun all cheaters. Strategies that condition on cheating behavior are not as easily enforceable as previously assumed in the literature (e.g., Kandori (1990)). We also show that exclusion of all cheaters from trade is unlikely to arise at early stages of market development. This finding may explain why Western firms dealing with developing countries for the first time are often surprised by different norms of contractual behavior and react very negatively to breach of contract (e.g., Biggs et al. (1994)). For exclusion of cheaters to be self-enforcing and decentralizable without meta-punishment, breach of contract must be interpreted as a sign of impending bankruptcy. This leads to possible multiple equilibria. The switch from simple name recognition to exclusion of all cheaters is a path dependent process sensitive to shocks.

Taken together, results demonstrate that market exchange can emerge with minimal state intervention but is unlikely to be fully efficient, at least initially. This is broadly consistent with observed characteristics of markets in Africa, for instance. Less advanced economies such as Ghana are indeed characterized by less advanced market development while in more industrialized ones such as Zimbabwe and, to a lesser extent, Kenya one observes a stricter respect of contracts and wider circulation of information. Other features such as relational contracting and information sharing along business networks are also consistent with the evidence. The model presented here thus provides a realistic framework for studying emerging markets.

Appendix 1: Proofs of Propositions

Proof of Proposition 1:

First, solve equations (2), (5) and (6) for constant V^M, V^K and V^U. Convoluted algebraic expressions result, one of which is shown below.

$$V^M = \frac{\alpha\tau^2(1-\delta-\delta\kappa\mu+\delta\tau^2+\delta\kappa\mu\tau^2-\delta\mu p\tau^2) - c\delta(1-\kappa+\kappa\mu)(1-\tau^2)}{1-\delta-\delta\kappa+\delta\kappa\tau^2-\delta\mu p\tau^2-\delta^2\mu p\tau^2}$$

Differentiate V^M, V^K and V^U with respect to various parameters yields complicated expressions like the one shown below.

$$\frac{\partial V^M}{\partial\alpha} = \frac{\tau^2(1-\delta(1-\mu p\tau^2(1-\delta))-\delta\kappa\mu(1-\tau^2))}{1-\delta(1-\mu p\tau^2(1-\delta))-\delta\kappa(1-\tau^2))} > 0$$

Careful analysis such as the one illustrated above makes it possible to sign the various derivatives.□

Proof of Proposition 2:

Using equations (2), (5) and (6), apply backward induction to Proposition 1, noting that μ_t and p_t are unaffected by changes in α, δ, κ or c.□

Proof of Proposition 3:

The first part follows from the text and the fact that $\alpha + 0 > -1 + 1$: cheating at the end of a relationship is inefficient. To show the second part, we solve for steady state values V^M and V^K and compute the difference between the two. We get:

$$V^M - V^K = \frac{(c + \alpha\tau^2)(1 - \kappa(1 - \mu))}{1 - \delta\mu p\tau^2}$$

It clear that $V^M - V^K$ is a decreasing function of κ. This result can be extended to all periods using a recursive argument.

For the third part, combining all the willingness to screen conditions, we get that $V_t^K \geq 0$: since trade is voluntary, agents cannot be forced below their autarkic payoff. Consequently, V_t^M must be strictly positive for BD to be satisfied. For this to be true, α must itself be strictly positive.

For the fourth part, if $c = 0$, V_t^U must be ≥ 0: the worst thing that could happen to an untested firm would be to be matched repeatedly with incompetent firms, in which case its expected discounted payoff would be 0. This takes care of condition (WS1U). Since $\alpha > 0$, V_t^K and V_t^M are also ≥ 0. From this it follows that the other willingness to screen conditions are satisfied as well.□

Proof of Proposition 4:

Equilibrium conditions BD and WS1U define a locus of values of α and c below which a TBE is not sustainable. To investigate the long-term sustainability of a TBE, we evaluate these two conditions at the long run steady state. Solving for the steady state values of V_t^M and V_t^U, we get:

$$V^M = \frac{\alpha\tau^2(1-\delta+\delta\tau^2-\delta p\tau^2) - c\delta(1-\tau^2)}{(1-\delta)(1-\delta p\tau^2)}$$

$$V^U = \frac{\alpha\delta\tau^4(1-p) - c(1-\delta\tau^2)}{(1-\delta)(1-\delta p\tau^2)}$$

Plugging the above into the two equilibrium conditions and solving for α and c, we get:

$$\alpha = \frac{1-\delta p\tau^2 - c\delta\tau}{\tau(1 + \delta\tau^2 - \delta p\tau^2)}$$

$$\alpha = \frac{c(1 - \delta\tau^2)}{\delta\tau^4(1 - p)}$$

The two lines intersect at $\alpha^* = \dfrac{1 - \delta\tau^2}{\tau}$ and $c^* = \delta(1 - p)\tau^3$. It is easy to verify that the shape of the sustainable set is as depicted in Figure 1 where the *JJ´* and *II´* lines represent the two above equations. This proves part (1).

To show part (2), note that $\partial \alpha/\partial \tau \leq 0$ and $\partial \alpha/\partial \delta \leq 0$ in both equations. Higher values of τ and δ thus shift both *II´* and *JJ´* downward, making it easier for a TBE to be sustainable.

To show part (3), it suffices to show that *II* and *JJ* shift over time as shown in Figure 1. This can be demonstrated with the following recursive argument. Let T be the time at which V_t^M and V_t^U reach their steady state values. Then:

$$V_{T-1}^U = (1-p_{T-1})((1-\tau^2)\delta V_T^U + \tau^2 \delta V_{T-1}^M) + p_{T-1}\delta V_T^U - c$$

which is above V_T^U since $p_{T-1} < p_T$. Since V_{T-1}^U is larger than V_T^U, the willingness to screen constraint $V_t^0 \geq 0$ is easier to satisfy and JJ shifts clockwise as one goes back in time (see Figure 1). Using the fact that $V_T^M - V_T^U = \dfrac{c + \alpha\tau^2}{1-\delta p_T \tau^2}$, we also get:

$$V_{T-1}^M - V_{T-1}^U = \frac{c + \alpha\tau^2}{1-\delta p_T \tau^2}(1 - \delta\tau^2(p_T - p_{T-1})) > \frac{c + \alpha\tau^2}{1-\delta p_T \tau^2}$$

The breach deterrence constraint is thus harder to satisfy as one goes back in time and the II locus shifts down as shown in Figure 1.

Part 4 follows from the text. To show part 5, we simply need to find other relational strategies that support trade in the long run. One such set of strategies, which we denote PRS_b, has two parts: the first part is exactly like PRS_a, and is played until the proportion p_t of incompetent agents among the unknown rises so much that V_t^U approaches zero. At that point, agents are requested to switch to randomized screening whereby only a fraction of unknown agents are screened in any period. By choosing the proportion of screened agents just right, p_t can be maintained at a level such that V_t^U remains exactly zero forever. At that point, unmatched agents are indifferent between screening and not screening and the willingness to screen condition is satisfied exactly. For those who find this kind of coordinated randomization unlikely, we propose a set of pure strategies, denoted $PRS_{b'}$, that closely approximates PRS_b. In $PRS_{b'}$, agents are instructed to screen all unknown agents until V_t^U falls below zero, at which point all screening stops. When this happens, the law of motion of the system is temporarily replaced with:

$$U_{t+1} = (1-\tau^2)(G - U_t) + U_t \qquad (3')$$

As a result of the breaking-up of relationships and replacement of agents, the number of unmatched competent agents begins to rise, hence driving p_t down. After a while, V_t^U becomes positive again. At this point, agents are again instructed to screen all unknown agents, until V_t^U again falls below zero, at which point they again stop screening. The cycle is then repeated ad infinitum and the economy oscillates around a value of p that satisfies $V^U = 0$. With either PRS_b or $PRS_{b'}$, relational markets emerge spontaneously, but in the long run, not all unknown agents get instantly screened. Market participation is interrupted for some agents who are denied screening and cannot prove their worth. This completes the proof.□

Proof of Proposition 5:

All we need to show is that the left hand side of WS1K is bounded below ∞. It is easy to see that V_t^M is bounded from above by $\alpha/(1-\delta)$: agents cannot receive more than the equivalent of full gains from trade every period. From WS1K, $V_t^K \geq 0$. The difference $V_t^M - V_t^K$ is thus bounded by $\alpha/(1-\delta)$. Thus, as long as $\delta < 1$, there exists a p_t close enough to 1 such that WS1K is violated.□

Proof of Proposition 6:

From the text we see that there exist a t^* such that, if agents follow SRS_a:

$$V_{t+1}^M - V_{t+1}^K \geq \frac{c}{\delta\tau^2(1-p_t)} \tag{11}$$

for $t \leq t^*$ and

$$V_{t+1}^M - V_{t+1}^K < \frac{c}{\delta\tau^2(1-p_t)} \tag{12}$$

for $t > t^*$. Tested agents K_t initially find it profitable to sample untested agents U_t but they stop doing so beyond t^* when K_t gets too large and U_t too small. At this point, the economy must switch to another set of strategies in which tested agents no longer trade with untested agents. Call this set of strategies SRS_c. In SRS_c, tested agents are instructed not to screen untested agents but to wait for a match with another tested agent instead. As long as $V_t^U \geq 0$, untested agents continue to sample other untested agents. By screening each other, untested agents may still join the ranks of tested agents K_t. In a SRS_c, agents' payoff are defined as follows:

$$V_t^M = \alpha\tau + (1-\tau^2)\delta V_{t+1}^K + \tau^2\delta V_{t+1}^M \tag{13}$$

$$V_t^K = (1-\mu_t)(\alpha\tau + (1-\tau^2)\delta V_{t+1}^K + \tau^2\delta V_{t+1}^M) + \mu_t\delta V_{t+1}^K \tag{14}$$

$$V_t^U = (1-\mu_t+\mu_t p_t)\delta V_{t+1}^U + \mu_t(1-p_t)((1-\tau^2)\delta V_{t+1}^U + \tau^2\delta V_{t+1}^M) - \mu_t c \tag{15}$$

The corresponding law of motion for U_t is now:

$$U_{t+1} = (1-\mu_t\tau^2(1-p_t))U_t \tag{16}$$

which implies slower absorption into the ranks of tested agents. If the WS2K' condition is violated at time 0, but $V_t^U \geq 0$, then $t^* = 0$ and the economy begins with SRS_c from the start. Otherwise, SRS_a are followed until t^*, at which point agents spontaneously switch to SRS_b.

This is not the end of the story, however. If SRS_c strategies are followed indefinitely until all competent agents have been tested and $p = 1$, the steady state value of V^U will be:

$$V_R^U = -\frac{c\mu}{(1-\delta)} \tag{17}$$

which, for $c > 0$, violates the $V_t^U \geq 0$ equilibrium condition. This implies that there is yet another time, say t^{**}, beyond which V_t^U falls below 0. Beyond that point, untested agents find it too risky to screen each other and the population of untested agents remains constant. The economy then operates in a closed-shop relational equilibrium: only tested agents trade with each other; untested agents remain excluded permanently. If $V_0^U < 0$, competent agents, who by assumption are all untested in period 0, never transact, never acquire reputation, and a relational equilibrium does not exist. This completes the proof.□

Proof of Proposition 7:

When all agents follow a *SARS*, payoffs are as follows:

$$V_t^M = \alpha\tau\theta^{-1/2} + (1-\tau^2)\delta V_{t+1}^K + \tau^2\delta V_{t+1}^M \tag{18}$$

$$V_t^K = (1-\mu_t)\kappa(\alpha\tau\theta^{-1/2} + (1-\tau^2)\delta V_{t+1}^K + \tau^2\delta V_{t+1}^M) + \tag{19}$$

$$((1-\mu_t)(1-\kappa)+\mu_t(1-p_t))((1-\tau^2)\delta V_{t+1}^K + \tau^2\delta V_{t+1}^M) + \mu_t p_t\delta V_{t+1}^K - (\mu_t + (1-\mu_t)(1-\kappa))c$$

$$V_t^U = (1-\mu_t p_t)((1-\tau^2)\delta V_{t+1}^U + \tau^2\delta V_{t+1}^M) + \mu_t p_t\delta V_{t+1}^U - c \tag{20}$$

The laws of motion of U_t, K_t, μ_t and p_t are unchanged. It is immediately apparent that less cheating leads to higher payoffs: $\tau\theta^{-1/2} \geq \tau^2$, with strict inequality if τ or $\theta < 1$.□

Proof of Proposition 8:

We begin by noting that cheaters can continue to trade with agents who did not find out about their dishonest behavior. Their expected payoffs when unmatched V_t^C and matched V_t^N are thus:

$$V_t^C = ((1-\mu_t)(1-\kappa) + \mu_t(1-p_t))((1-\tau^2)\delta V_{t+1}^C + \tau^2\delta V_{t+1}^N) + ((1-\mu_t)\kappa + \mu_t p_t)\delta V_{t+1}^C - (\mu_t + (1-\mu_t)(1-\kappa))c \quad (21)$$

$$V_t^N = \alpha\tau\theta^{-1/2} + (1-\tau^2)\delta V_{t+1}^C + \tau^2\delta V_{t+1}^N \quad (22)$$

The above equations take into account the fact that one-time cheaters subsequently follow simple relational strategies. Because cheaters cannot trade with agents who know about their cheating, their expected payoff is lower than that of untested agents, i.e. $V_t^C \leq V_t^U$. The inequality is strict as long as tested agents accept to trade with untested agents.

Part (1) follows from the fact that the instantaneous difference between V_t^K and V_t^C -- $(1-\mu_t)\kappa\alpha\tau\theta^{-1/2}$ -- is increasing over time given that μ_t declines with t. As the instantaneous gap widens, so does the difference between the two expected payoffs. Part (2) follows from the fact that V_t^C and thus V_t^N is decreasing in κ, while V_t^K is increasing in κ. It is easy to verify that if κ = 0, cheating goes unnoticed and $V_{t+1}^C = V_{t+1}^K = V_{t+1}^U$, in which case condition BD'' cannot be satisfied.□

Proof of Proposition 9: See text.□

Proof of Proposition 10:

Note first that the laws of motion of K_t and U_t -- and thus μ_t and p_t -- are the same along *SRE*'s and *SARE*'s. Consider the choice of an *SRE* agent faced with a known agent. Since in a *SRE* cheating is not deterred at the end of a relationship, known agents tend to all have cheated at some moment in the past. (Strictly speaking, not all K_t agents have breached contracts. They may be in the pool of unmatched agents because they themselves were cheated by another agent. We skip this detail for the sake of clarity. This omission has no influence on the proof.) It is rational for the agent to trade with the known cheater iff:

$$(1-\mu_t)(1-d_t)(\alpha\tau^2 + (1-\tau)\delta V^K_{t+1} + \tau^2\delta V^M_{t+1}) + d_t(-\tau^2 + \delta V^K_{t+1}) \geq ((1-\mu_t)(1-d_t) + d_t)\delta V^K_{t+1}$$

which can be rewritten:

$$(1-\mu_t)(1-d_t)\tau^2\delta(V^M_{t+1} - V^K_{t+1}) \geq d_t - (1-d_t)(1-\mu_t) \qquad (23)$$

Clearly, in a *SRE*, if $d_t = 0$, equation (23) is always satisfied. On the other hand, if $d_t = 1$, equation (23) boils down to $0 \geq 1$, an impossibility. As d_t rises, the right hand side of equation (23) rises and the left hand side falls: $1-d_t$ decreases and it can be shown that, other things being equal, V^K_{t+1} falls more rapidly with d_t than V^M_{t+1}. Finally both sides of the equation are continuous in d_t. There exist therefore a level of d^*_t such that equation (23) is satisfied. This completes part (1).

To show part (2), note that $D_0 = 0$ implies that $d_0 = 0$. Since D_t increases without bounds, $\lim_{t \to \infty} d_t = 1$. Over time, d_t thus increases monotonically from 0 to 1. Part (2) then follows from part (1). To show part (3), simply note that if $t_1 > t_2$, the *SRE* will collapse before conditions are satisfied for a *SARE* to take over. If, in contrast, $t_1 \leq t_2$, agents will stop dealing with known cheaters at a time when this refusal deters cheating without endangering trade.□

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Figure 1. Sequence of Events During a Trading Round

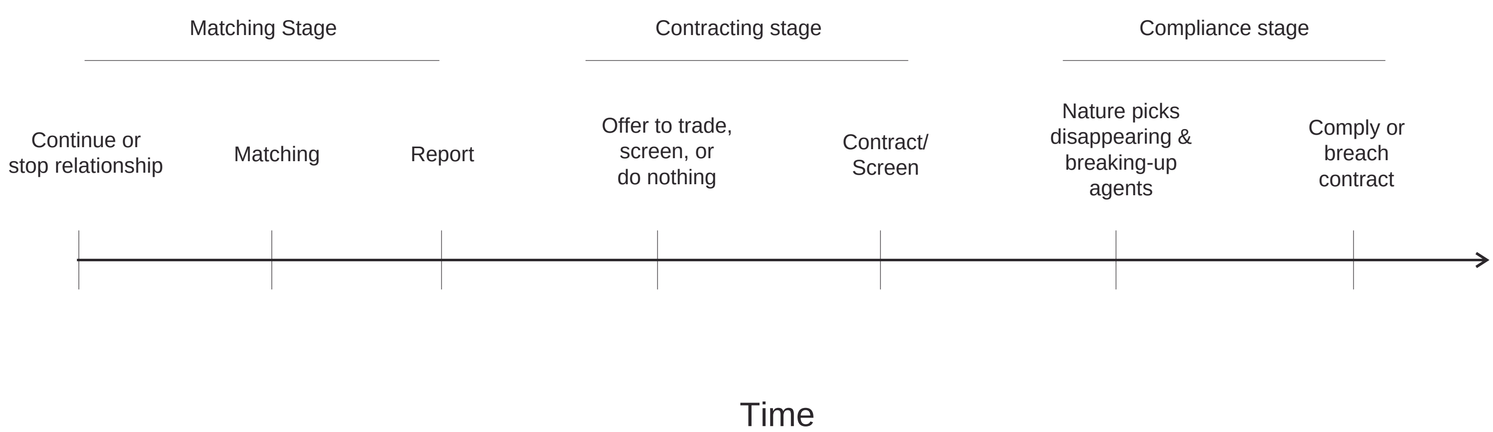

Figure 2. Existence of Pure Relational Equilibria

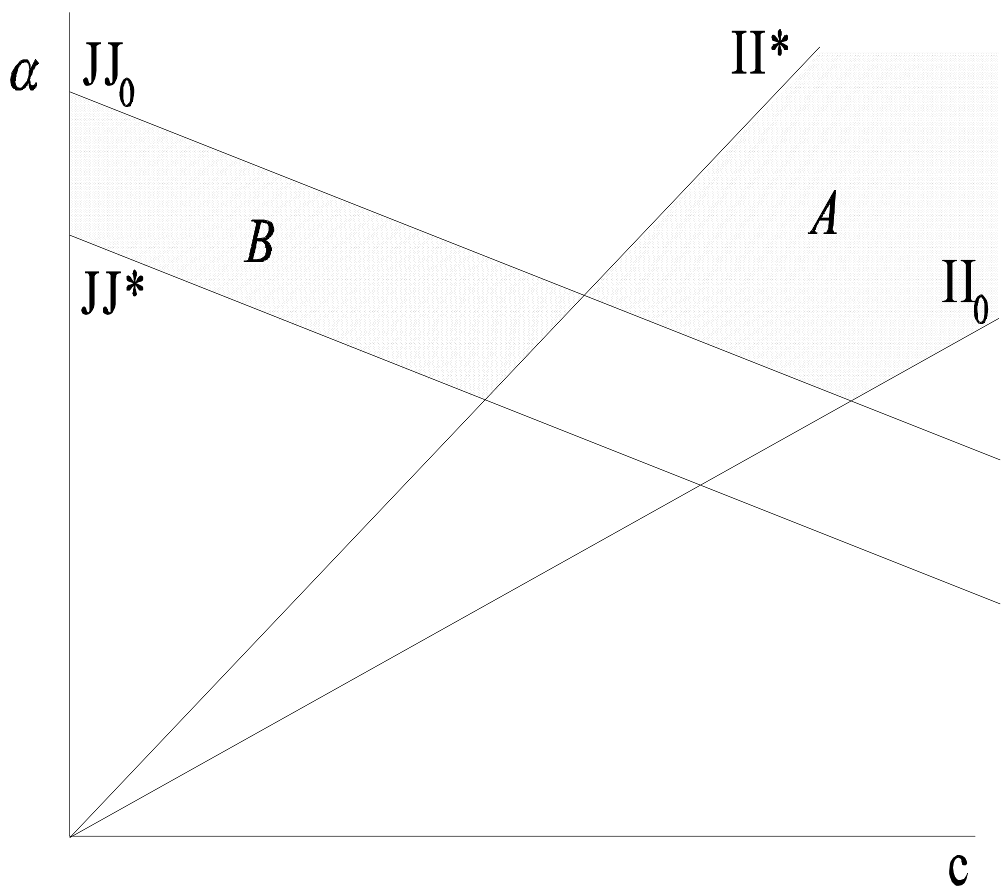

Figure 3. Closed-Shop Equilibrium