Families, Markets, and Self-Enforcing Reciprocity Norms

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This paper develops and simulates a model of the co-evolution of self-enforcing reciprocity norms and the demand for children in a developing economy. Children are viewed by agents in this economy as "investment goods," which yield an income stream when offspring are children and adults. In order to induce children to return the parental investment in their human capital, parents try to instill preferences for reciprocity in their children. These investments in "ethical education" by parents create a nucleus of reciprocator types in the community, which in turn induces the remaining opportunistic types to behave as if they were reciprocators, in order to find partners in their market transactions. The model predicts the emergence of self-enforcing norms of reciprocity with economic development, as well as the decay of these norms with increasing geographical mobility of the population, and a resulting decline in the demand for children.

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1 Introduction

There is a growing recognition among economists of the importance of institutions and social norms in the process of economic development. The present paper is concerned with explaining a transition observed in the course of economic development, from an extended-family form of economic organization to a market-based form of economic organization, and with the consequences of this transition for the stability of self-enforcing reciprocity norms among opportunistic agents.

A frequently cited example of the contrast between market- and family-based economic organization is the striking difference in the paths of development (or lack of it) of Northern and Southern Italy. Banfield (1958) provided an early, detailed study of a Southern Italian village, describing the ethos prevailing there as "amoral familism." Putnam (1993) has demonstrated that Northern Italy is characterized both by a more developed economy and a more civic-oriented (as opposed to family-oriented) society. Democratic government works better in Northern Italy, and norms of cooperation among individuals who have no family relation are stronger. The model developed in the present paper accounts for both of these stylized facts, as well as predicting a decline in cooperative social norms with economic development, once well-developed markets are already in place.

The theory can be outlined as follows. In a primitive economy, the commodities individuals produce, such as agricultural products and shelter, are standardized and undifferentiated. Nevertheless, successful production requires teamwork, and this in turn entails that team members follow through on their commitments. For example, if the member of a production team promises to show up at a hunting expedition at a certain time, reneging on this promise is costly for the rest of the team. In order to minimize these costs, production is organized within a family, clan or tribe.[1] Family members, sharing a common genetic inheritence, are relatively altruistic toward each other (cf. Trivers, 1971) and therefore less likely to renege; additionally, intrafamilial sanctions for reneging are relatively easy to organize.

Technological change, however, opens up the possibility of producing more differentiated products. Since individuals do not possess the same skills, some will have a comparative advantage in producing one type of product,

[1] See Platteau and Hayami (1998) who contrast the tribal (blood-relation) form of social organization typical of the nomadic and geographically mobile populations of sub-Saharan Africa, to the reciprocity-based village form of social organization typical in Asia, where populations are less geographically mobile. The correlation of these two forms of organization with geographical mobility nicely corroborates the model developed in this paper.

and others will have a comparative advantage in producing another product. Thus there is an increase in the gains of buying products from outside the family, whose relatively small number of members have a small set of specialized skills. At this stage of development, however, third-party (legal) enforcement of contractual commitments is unreliable, and therefore market transactions must be based on trust.

I assume that altruism to non-family members is too low to provide a basis for the necessary level of trust. Trust is therefore based on reputations for fair dealing. The game-theoretic literature on reputation, beginning with the seminal work of Kreps, et al. (1982); emphasizes that reputations in …nitely repeated games can develop only if agents have some (perhaps small) degree of uncertainty about the type of their counterparts. In the theory presented here, I assume that individuals are either opportunists or reciprocators. Opportunists maximize their material payo¤s, although they have some small degree of altruistic feeling for their parents, which induces them to transfer some proportion of their income, ®$_O$, to their parents. Reciprocators prefer to deal fairly, providing goods of the agreed-upon quality and paying their debts, and also are more altruistic and therefore make a larger transfer, ®$_R$; to their parents. Unlike standard models of asymmetric information, the prior beliefs of agents regarding their counterpart's type are not introduced ad hoc, but rather are assumed to be derived from the distribution of these two types in the population. In particular, I assume that if the proportion of reciprocators in the population is r, then the prior probability each individual assigns to the proposition that a randomly drawn agent is a reciprocator is simply r:

The proportion of reciprocators in the population r is determined endogenously by a social evolutionary process, in which player types are de…ned not by "wired-in" strategies, but rather by their preferences, as in standard economic theory.[2] Agents, regardless of their type, are expected utility-maximizers. As children, their preferences are molded by their parents, who have the opportunity of increasing the probability that their children will be reciprocators, at a cost.[3] To the extent that reciprocators are successful, in

[2] This follows what Werner Güth has called the "indirect" evolutionary literature, as distinct from the literature stemming from Axelrod (1981, 1984), in which automaton-like player types are de…ned by their strategies. The idea of using an evolutionary process to explain the distribution of preferences in society seems to be have been suggested …rst by Michael and Becker (1973). For further seminal contributions, see Güth (1995), Güth and Yaari (1992), and Güth and Kliemt (1994). Guttman (1999) provides a review of this literature as well as a model similar to the present model, but without the explicit modeling of parental investment in ethical education.

[3] This assumption follows an emerging literature in which parents incur costs to instill preferences in their children. See Akerlof (1983), Becker (1991, 1993), Guttman, Nitzan

material terms, relative to opportunists, parents will attempt to instill such preferences for reciprocity. The parents' motive in making this educational investment is to increase their material return from their children. In the present model, children are treated as "investment goods," as is usually the case in less-developed countries.[4]

An agent's decision regarding whether to transact in the market or within the family will be determined by two key variables. The first variable is the probability that a randomly chosen partner, who is not a family member, will uphold his or her commitments. The second variable is the gain of transacting in the market, relative to transacting within the family. This variable will be positively related to the size of the population of agents transacting in the market. The larger is the market, the closer will be the best match between the product that can be acquired in the market to the preferred product type of the buyer. The closer is this match, the greater the gain of transacting in the market, relative to obtaining an undifferentiated product from a family member.

Thus we would expect to observe two equilibria. In one equilibrium, the market is small or non-existent, and family members continue to obtain their required commodities from each other. Parents do not attempt to instill preferences for reciprocity,[5] since such preferences are counterproductive in a hostile environment. The lack of reciprocators reinforces the net gain of transacting only within the family, since market transactions will be relatively unreliable.

In the second equilibrium, the market is large enough to induce agents to transact within the market, despite the greater risk of reneging by their partners. Parents now have an incentive to instill preferences for reciprocity, since (given a critical "density" of market transactions) reciprocators do well, relative to opportunists.[6] Given a core of reciprocators, it is optimal for opportunists to maintain reputations for being reciprocators, reputations which they destroy (by defecting) only at the end of their careers. The resulting

and Spiegel (1992), Stark (1995), Bisin and Verdier (1998), and Guttman (forthcoming).

[4] For evidence of the empirical importance of this "pension motive" in raising children in developing countries, see Nugent and Gillaspy (1983), Lee, Parish and Willis (1994), and Lillard and Willis (1997).

[5] In describing the Southern Italian village studied in his book, Banfield (1958) writes, "In general, the parents are extremely permissive" (p. 146), and notes "indulgence of parents toward children and their willingness to allow children to be selfish and irresponsible—'carefree'—until all at once at the time of marriage the grown child must assume the burden of looking after a family of its own" (p. 151).

[6] It will be shown that this gain to being a reciprocator requires that reciprocators exhibit some "sign" that has a positive correlation, however small, with the reciprocator type, and which is difficult for opportunists to mimic.

reliability of market transactions reinforces the gain of transacting within the market.

The reciprocator type can be assumed to prefer to reciprocate not only in bilateral market transactions, but also in group endeavors like the provision of public goods. Provided that a certain proportion of other members of the community contribute to the provision of public goods, the reciprocator prefers to contribute as well. The opportunistic type, in contrast, prefers to free-ride, since the private return of contributing is less than the cost. Thus contributions to the provision of a public good serve as signals of the agent's type. For the same reason that opportunists optimally uphold their commitments in market transactions—i.e., the private incentive to maintain a reputation for being a reciprocator—they also optimally contribute to the provision of public goods, again up to, but not including, the end of their careers. Thus, provided that the "density" of market transactions is su¢ciently high, public goods are provided as well.[7]

These two equilibria, I suggest, roughly correspond to the cases of Southern and Northern Italy, respectively. There is, however, a second stage of economic development, beyond the market stage sketched above. The voluntary provision of public goods, viewed in the previous paragraph as a by-product of the development of the market, permits the establishment of democratically elected government. Once governments and legal systems, which are themselves public goods, develop, the importance of one's partner being a reciprocator type declines. Third-party enforcement is a substitute for trust.

Moreover, in this second stage of economic development, the local market community begins to transact with neighboring villages. Improving information of the characteristics of other villages, induced by a rising frequency of transactions with these villages, leads to increasing population mobility between communities. The market thus becomes larger and market transactions become less personalized. This in turn reduces the perfection of information that agents have of each other's past behavior, e¤ectively reducing the transactional "density" (modeled as the number of stages of a repeated game) in the community, which, as I show, reduces the evolutionary stability of the reciprocator type. Thus, in the second stage of development,

[7] For a rigorous development of the statements made in this paragraph, as well as empirical evidence, see Guttman and Götte (1999). In the model developed here, I do not formalize the voluntary provision of public goods. It should be noted that government can also be provided by "roving bandits" or "stationary bandits" (see Olson, 1993) who autocratically provide public goods in return for a percentage of the tax revenues. Generally, however, democratic government provides a public good-tax package more closely approximating the preferences of the median voter (McGuire and Olson, 1996).

increasing development is negatively correlated with the stability of norms of reciprocity.

Section 2 of this paper sets out the model. Section 3 analyzes the finitely repeated game played by members of the community when they trade in the market, without third-party enforcement of their transactional commitments. Section 4 endogenizes the proportion of reciprocators in the population, and describes a "bootstrap" mechanism by which a community can move from the "low-level" equilibrium of zero market transactions to the "high-level" equilibrium of nearly complete market transactions. This mechanism is used to explain the sharply differing paths of development of Northern and Southern Italy. Section 5 presents some simulation results showing how increased geographical mobility leads to a breakdown of reciprocity norms. Section 6 concludes the paper.

2 The Model

2.1 Basic Assumptions

Consider a community consisting of a proportion r of reciprocators and $1 - r$ of opportunists. Each agent's lifetime is divided into three periods: (a) childhood, in which the agent is economically dependent on his or her parents, but nevertheless contributes to household production, (b) maturity, in which the agent is economically independent, and (c) old age. The agent's maturity period consists of a "career" of T stages, where T is exogenously determined. For simplicity, I assume that all agents begin (and therefore end) their careers at the same time.

In each of the T stages ($t = 1, \dots, T$), agents perform one barter transaction. The agent performs these transactions either in the market or within the family. For simplicity, the payoff of performing a transaction within the family is normalized to equal zero. Since legal enforcement of transactions is assumed to be weak and/or prohibitively costly, market transactions are modeled as Prisoner's Dilemma (PD) games, as shown in Figure 1.

	C	D
C	v, v	$-c, v + c$
D	$v + c, -c$	$0, 0$

Figure 1. Payoff Matrix of Individual Transaction

Suppose each agent has a commodity which he or she values at c. If both agents uphold their commitments and follow through on a proposed exchange (i.e., play the C move), each receives a payoff of v. This payoff can be interpreted as the buyer's or seller's surplus from the transaction. If, say, player 1 fails to uphold his or her commitment (plays D), he or she receives a payoff of $v + c$; since he or she receives the other agent's good and does not have to relinquish his or her own good. Meanwhile, the cheated player loses the value of the good he gave, c, without receiving anything in return. The dominant strategy of each player, if his or her utility is given by the payoffs in Figure 1, is to defect. The $(0; 0)$ payoffs at the DD outcome assume that, in the joint-defect outcome, both players can exercise the "outside option" of household transactions.

Moreover, I assume that v is an increasing function of the proportion of community members who transact in the market, p: This specification captures the idea, introduced in the Introduction, that the "match" between the commodity that can be purchased and the preferred product type of the buyer is greater when the good is purchased in the market than if it is acquired within the family, due to the smaller number of specializations of family members, relative to the corresponding number for agents in the market. The greater is p; the larger is the relative gain of transacting in the market.[8]

2.2 The Probabilistic Determination of the Type of Offspring

For simplicity, I assume that each agent-pair (treated here as a single agent) produces one child. In this model, children are viewed purely as productive assets to be employed in production or from whom material transfers will be received, as distinct from the conventional view of children, going back to Becker (1960), as "consumer durables."[9]

While parents in this model raise a child solely as an investment, they attempt to influence the type of their children.[10] The parents' motivation in doing this is purely selfish: they want to maximize their expected payoff from raising children, who will transfer part of their earnings to the parents after they become economically independent and leave the household. (Parents also receive a payoff from the children when they are still dependents within the household, but this payoff is invariant to the children's type, since

[8] See Rapoport and Weiss (2000) for a model developing this idea.

[9] See Guttman (forthcoming) and the references therein for models in which children are similarly viewed as means for ensuring a stream of income in old age.

[10] See Akerlof (1983) for an early analysis of parental investment in influencing the preferences in their children, as well as a discussion of the empirical work of Coles (1967) on the process of instilling preferences in children.

I assume that children within the family have no choice but to help in family production.) I assume that the proportion of his or her income that a reciprocator-type child transfers to his or her parents when the child becomes economically independent is

$$\alpha_R = (1 + \gamma)\alpha_O,$$

where α_O is the proportion of income transfered by an opportunistic child. If the child transacts only within the family, I assume that $\gamma = 0$, since intrafamilial altruism, possibly reinforced by social sanctions, will equalize the transfers made by opportunistic types and reciprocator types to their parents. If, on the other hand, the child transacts in the market, thus increasing the "social distance" between the child and his or her parents, I assume that $\gamma > 0$.

Denote the (ethical) educational investment of the parents of household j to influence their children's type as e_j. For simplicity, I assume that this investment takes the form of (costly) "effort", which is measured by a variable that varies between zero and unity.[11] Thus $e_j \in [0, 1]$. The probability that a child in household j of generation $g + 1$ will be a reciprocator, $Pr(R)_{j,g+1}$, is an increasing function of e_j and of the proportion of reciprocators in the parents' generation g.

$$Pr(R)_{j,g+1} = \theta f(e_j) + (1 - \theta) r_g$$

where $\theta \in (0, 1)$; $f(e_j) \in [0, 1]$; $f(0) = 0$; $f'(e_j) > 0$, and $f''(e_j) < 0$. The "inertial" effect of the proportion of reciprocators in the parents' generation r_g is due to emulation of the previous generation, as discussed and modeled by Boyd and Richerson (1985).

In order to be able to simulate the working of the model, I make the specific assumption that $f(e) = e^{\sigma}$, where $\sigma \in (0, 1)$. Thus the previous equation becomes

$$Pr(R)_{j,g+1} = \theta e_j^{\sigma} + (1 - \theta) r_g. \qquad (1)$$

Thus the parents' expected profit from raising their child is

$$EY \equiv [\alpha_O E\pi_O (1 - Pr(R)_j) + \alpha_O (1 + \gamma) E\pi_R \, Pr(R)_j + \phi] - e_j w$$

where ϕ is the child's expected contribution to household production when he or she is still resident in the household, w is the cost of educational effort (e.g., the opportunity cost of time or a measure of psychic cost), and

[11] Thus I abstract from differences in the ability to invest in child quality arising from varying levels of wealth.

$E\pi_k$, $k = O, R$, is the expected market income, over his or her career, of type k when he or she is an independent economic agent (O denotes the opportunist type and R denotes the reciprocator type). The first two terms in the brackets give the expected return from each child when the child becomes economically independent. (In stages in which the child transacts within the family, $E\pi_{kt} = 0$.) The payoffs $E\pi_k$ and ϕ are undiscounted sums of the payoffs received from the child over the lifetime of the parents. For simplicity, the only cost of raising the child is assumed to be the cost of ethical education.

The parents must estimate this expected profit EY as a function of e_j, in order to determine the optimal level of ethical education. In order to simplify the simulations of the model, I assume that the market payoffs $E\pi_k$ that the parents use in this calculation are those prevailing in the parents' own generation. Thus the probability that a given agent in generation g will be either a reciprocator or opportunist will depend on the relative payoffs of the two types in the previous generation $g - 1$. The difference in payoffs over generations derives from the changes in r and p from one generation to the next.

The first-order condition for max EY is

$$\alpha_O \theta \sigma e_j^{\sigma - 1}[(1+\gamma)E\pi_{Rt} - E\pi_{Ot}] - w \leq 0, \qquad (2)$$

yielding, for optimal e_j,

$$e_j^* = \begin{cases} 0 & \text{if } E\pi_R \leq \dfrac{E\pi_O}{(1+\gamma)} \\ \left[\dfrac{\alpha_O \theta \sigma [(1+\gamma)E\pi_R - E\pi_O]}{w}\right]^{\frac{1}{1-\sigma}} & \text{if } E\pi_R > \dfrac{E\pi_O}{(1+\gamma)} \end{cases} \qquad (3)$$

Note that, as $E\pi_R$ rises relative to $E\pi_O$, $[(1+\gamma)E\pi_R - E\pi_O]$ will increase, leading the parents to spend more on ethical education. We thus obtain

Proposition 1 If $E\pi_R \leq E\pi_O/(1+\gamma)$, parents will not invest in ethical education of their children. If, on the other hand, $E\pi_R > E\pi_O(1+\gamma)$, as the reciprocator type becomes more materially successful relative to the opportunistic type, parents will optimally spend more resources in educating their children to be reciprocators.

2.3 Reciprocator Types and Opportunistic Types

As stated in the Introduction, reciprocators differ from opportunists in two respects: (a) reciprocators prefer to transfer a larger part of their incomes to their parents when they become economically independent, i.e., ° > 0; and (b) reciprocators prefer to play C in their barter transactions. In both respects, these preferences re‡ect a desire to reciprocate—either the parents' investment in the child, or cooperative behavior by the agent's counterpart(s).

The strategy chosen by reciprocators in their barter transactions, however, depends on their expectations of the behavior of the partners. The subjective payo¤s of the reciprocator in these barter transactions di¤er from the material payo¤s depicted above in Figure 1. In Figure 2, the parameter a is less than v; indicating that the reciprocator type dislikes cheating his or her partner, and his or her disutility of cheating is greater than the material payo¤ of cheating, c: Thus, in a matching of two reciprocators, as shown in Figure 2, there are two Nash equilibria: CC and DD.[12] I assume that a social norm, which is simply a device for coordinating expectations on a particular Nash equilibrium, leads the players in this case to select the Pareto-optimal CC Nash equilibrium.

	C	D
C	v; v	¡ c; a
D	a; ¡ c	0; 0

Figure 2. Subjective Payo¤ Matrix for Matching of Two Reciprocators

Now suppose that a reciprocator is matched with an opportunist. The opportunist's payo¤s are identical to the material payo¤s shown in Figure 1. Thus, if the column player is an opportunist and the row player is a reciprocator, we obtain Figure 3. Since the opportunist has a dominant strategy to play D, and the reciprocator's best reply to a D move by his or her opponent is also to play D, the unique Nash equilibrium in this game is the joint-defect outcome, DD.

	C	D
C	v; v	¡ c; v + c
D	a; ¡ c	0; 0

Figure 3. Payo¤ Matrix for Matching of Reciprocator (Row Player) and Opportunist (Column Player)

Finally, if two opportunists are matched, the game becomes the PD depicted in Figure 1, in which the unique equilibrium is again the DD outcome.

In intrafamilial "transactions", I assume that agents—even if they are opportunistic types—always cooperate, due to their mutual altruism (Trivers,

[12] This is the Assurance Game, due to Sen (1967).

1971), combined with sanctions for defecting within the family. Thus agents will transact in the market if and only if their expected payoff in market transactions is greater than zero, the (normalized) payoff of intrafamilial transactions.

2.4 Information Available to Agents

The treatment of the games in Section 2.3 implicitly assumed complete information—i.e., players know each other's type. I do not, in fact, make this overly strong assumption.[13] Rather, I assume that players can only observe a signal, denoted S, which has some positive, but arbitrarily small, correlation with the reciprocator type. S can be interpreted as an "honest face", or some other sign that cannot be perfectly mimicked by the typical opportunist. [Frank (1988) has provided convincing evidence that such signs exist.] Denote the probability of observing S, given that the opponent is a reciprocator, as $\Pr(S|R)$; and let the probability of observing S, given that the opponent is an opportunist, be $\Pr(S|O)$. Given that S is positively correlated with the reciprocator type, we have $\Pr(S|R) > \Pr(S|O)$. Let

$$\chi \equiv \frac{\Pr(S|R)}{\Pr(S|O)} > 1 \tag{4}$$

be the signal-to-noise ratio associated with the sign S. Let $\Pr(S)$ be the probability of observing S in a randomly chosen agent from the whole population of agents. Finally, recall from the Introduction that agents observe the population proportion of reciprocators, r, and use this as their prior belief that a randomly chosen opponent is a reciprocator. Then, by Bayes' Theorem,

$$\Pr(R|S) = \frac{\Pr(S|R)\, r}{\Pr(S)}. \tag{5}$$

Given that $\Pr(S) = \Pr(S|R)r + \Pr(S|O)(1 - r)$, we have

$$\frac{\Pr(S)}{\Pr(S|R)} = r + \frac{1 - r}{\chi},$$

so that (5) becomes

$$\Pr(R|S) = \frac{r}{r + \frac{1-r}{\chi}} = \frac{1}{1 + \frac{1-r}{\chi r}}. \tag{6}$$

[13] In particular, I assume for simplicity that agents have no information of the investment in ethical education of an opponent's parents—information which would help them infer the opponent's type. For an analysis that compares the results of agents' knowing and not knowing their opponent's type, see Guttman (2000).

In addition to observing the presence or absence of the sign S, I assume that agents observe their counterparts' past actions in market transactions.[14] Thus, if an agent ever defects, this information becomes common knowledge to the whole community in all future stages. The time period of one stage is defined as the time required for this information to spread to all members of the community. The transfers agents make to their parents, however, are not observed by other agents in the community.

2.5 Matching Mechanism in Market Transactions

In market transactions, I assume that agents initially are randomly matched. However, an agent, upon learning the identity of his or her partner, is assumed to be able to refuse to transact with that partner and be costlessly rematched with another partner offering the same good. The opportunity to be rematched may be utilized if the partner is known to have defected in the past, or if the partner does not exhibit the signal S. As will be shown, however, while it is always optimal to refuse to transact with an agent who is known to have defected in the past, it is sometimes optimal for an agent who does not exhibit S to transact with another agent who does not exhibit S.

3 Analysis of the Game

In this section, we solve for the equilibrium behavior of the reciprocator types and the opportunists, in their maturity period, if they decide to transact in the market. The solution concept to be employed in the analysis of the repeated game outlined in Section 2 is Perfect Bayesian Equilibrium (PBE). Accordingly, we begin the analysis in the last stage T. In this stage, it is clear that the opportunistic agents will defect in their market transactions. The reciprocator types, knowing this, will calculate their expected payoff of cooperating, given their prior probability that the partner is an opportunist, i.e., $1 - r$; and the additional information provided by the presence or absence of the signal S in the partner.

Let us consider a candidate for an equilibrium in which all reciprocators cooperate at stage T. We wish to determine whether it is optimal for each reciprocator i to cooperate, i.e., whether it is suboptimal to deviate from this proposed equilibrium.

[14] This assumption could easily be weakened to make the observation of the agent's defection occur with some probability less than unity.

If S is observed, the expected payoff of cooperating at stage T will be, using (6),

$$E\pi(C)_T = \frac{v}{1+\frac{1-r}{\psi r}} - c\left(1 - \frac{1}{1+\frac{1-r}{\psi r}}\right) \quad (7)$$

If, on the other hand, the reciprocator defects, his or her expected payoff will be

$$E\pi(D)_T = \frac{a}{1+\frac{1-r}{\psi r}}; \quad (8)$$

since, in the event that the partner is an opportunist, the payoff of defecting will be zero. Subtracting (8) from (7), we find that $E\pi(C)_T \geq E\pi(D)_T$ if and only if

$$E\pi(C)_T - E\pi(D)_T = -c + \frac{v+c-a}{1+\frac{1-r}{\psi r}} \geq 0. \quad (9)$$

Thus it will not be optimal to deviate from the proposed equilibrium if and only if

$$r \geq \frac{1}{1+\frac{\psi(v-a)}{c}}. \quad (10)$$

Denote the r.h.s. of (10) as r_{min}.

In parallel to r_{min}, we can derive the minimum r, to be denoted r^*, that will induce a reciprocator to cooperate (given that all other reciprocators cooperate), when the partner does not exhibit S. Denote the absence of the sign in the partner as S'. Then we have

$$1 - \Pr(S) = \Pr(S'|R)\,r + \Pr(S'|O)(1-r). \quad (11)$$

Let $\varphi \equiv \Pr(S'|R)/\Pr(S'|O) < 1$. Then, dividing (11) by $\Pr(S'|R)$,

$$\frac{1-\Pr(S)}{\Pr(S'|R)} = r + \frac{(1-r)}{\varphi};$$

and, by Bayes' Theorem,

$$\Pr(R|S') = \frac{\Pr(S'|R)\,r}{1-\Pr(S)} = \frac{r}{r+\frac{(1-r)}{\varphi}} = \frac{1}{1+\frac{(1-r)}{\varphi r}}.$$

Thus we have

$$r^* \equiv \frac{1}{1+\frac{\varphi(v-a)}{c}}. \tag{12}$$

We can now observe that, if $r < r_{min}$, all reciprocators will defect at stage T, in equilibrium, even if the partner exhibits S, since the condition expressed by (10) would not be met. Therefore all agents will defect at stage T, in equilibrium, and, by backwards induction, all agents will defect throughout their careers. This point is summarized by the following proposition:

Proposition 2 *If $r < r_{min}$, all agents will not cooperate in market transactions, throughout their careers.*

If, on the other hand, $r \in [r_{min}, r^*)$, there is an equilibrium in which reciprocators cooperate with a partner who does exhibit S, even at stage T, since (10) will hold.[15] In this case, as we will see below, there will be cooperation in equilibrium only among agents exhibiting S, while agents not exhibiting S will not have trading partners. Finally, if $r \geq r^*$, reciprocators will cooperate, in equilibrium, even with partners who do not exhibit S. In this case, there will be two "trading groups", one consisting of agents exhibiting S, and one consisting of agents not exhibiting S. Thus, setting aside the case in which $r < r_{min}$, we consider two cases: (a) $r \in [r_{min}, r^*)$; and (b) $r \geq r^*$.

3.1 $r \in [r_{min}, r^*)$

Suppose opportunist i, who exhibits S, were to defect at some stage $\tau \leq T$. It can easily be shown that in all future stages, opportunist i will not find trading partners. The reasoning is as follows. The defection by opportunist i at stage τ reveals the fact that he or she is an opportunist, since reciprocators exhibiting S would not defect given that $r \geq r_{min}$, even at stage T when an opportunistic partner would defect with certainty. It therefore becomes common knowledge that i will defect at stage T, so that no other agent will transact with i at that stage. Knowing that no agent will transact with him or her at stage T, opportunist i will have no incentive to cooperate at stage $T-1$. This fact is known to all other agents, so that no agent will transact with agent i at stage $T-1$ as well. Thus, by backwards induction, the

[15] There is also an equilibrium in which all agents defect, but I again assume that the social norm of cooperation coordinates agents' expectations on the Pareto-preferred equilibrium.

consequence of a defection at stage τ by opportunist i is that i will have no trading partners for the rest of his or her career.

Suppose all other opportunists exhibiting S, in a proposed equilibrium, defect at stage t. Opportunist i has three strategy choices:

- To preempt at stage $t - 1$.
- To simultaneously switch at stage t.
- To wait and defect at a later stage $t + k$.

If i preempts, his or her (undiscounted) payoff over the whole market game of T stages will be

$$E\pi_{preempt} = (t - 2)v + (v + c), \tag{13}$$

since i will cooperate with any other partner (exhibiting S) for $t - 2$ stages, and then defect against a cooperating partner, with certainty, at stage $t - 1$. In subsequent stages, the opportunist will transact only within the family, since he or she will not be able to find trading partners in market transactions.

If, on the other hand, i switches simultaneously, his or her expected payoff will be

$$E\pi_{SS} = (t - 1)v + \Pr(R|S)\,(v + c), \tag{14}$$

since i will now benefit from $t - 1$ stages of cooperation, and, at stage t, will defect only against a reciprocator (recall that the other opportunists defect at the same stage).

Finally, if i waits and only defects at stage $t + k$, his or her expected payoff will be

$$E\pi_{wait} = (t - 1)v + \Pr(R|S)\,v - \Pr(O|S)\,c + (k - 1)v + (v + c). \tag{15}$$

Here the reasoning is that, for $t - 1$ stages, i again benefits from joint cooperation; at stage t, he or she is cheated with probability $\Pr(O|S)$ and continues to cooperate with probability $\Pr(R|S)$; for $k - 1$ stages, agent i then cooperates with certainty (the other opportunists having defected and thus having revealed their type); finally, at stage $t + k$, agent i defects against a cooperating reciprocator with certainty. Equation (15) can be rewritten as

$$E\pi_{wait} = (t - 1 + k)v + \Pr(R|S)(v + c).$$

Note that $E\pi_{wait}$ increases as k increases. Thus the maximum $E\pi_{wait}$, for a given t, will be where $t + k = T$. Consequently, we can write

$$E\pi_{wait} = (T - 1)v + \Pr(R|S)(v + c). \tag{16}$$

We can now prove the following result:

Proposition 3 If $r \geq r_{min}$, in the unique, symmetric Perfect Bayesian Equilibrium, all opportunists [if $r < r^*$, all opportunists exhibiting S] defect only at stage T.

Proof. Subtracting (14) from (15), we obtain

$$E\pi_{SS} - E\pi_{preempt} = v - \{[1 - \Pr(R|S)](v + c)\}.$$

Thus we have

$$E\pi_{SS} \geq E\pi_{preempt} \iff 1 - \Pr(R|S) \leq \frac{v}{v + c}. \tag{17}$$

From (10), which defines the case $r \geq r_{min}$, together with (6), we have

$$1 - \Pr(R|S) \leq \frac{v - a}{v + c - a} < \frac{v}{v + c}.$$

It follows that condition (17) holds, and it is never optimal to preempt. We then must compare $E\pi_{wait}$ to $E\pi_{SS}$:

$$E\pi_{wait} - E\pi_{SS} = (T - t)v \tag{18}$$

which is positive for all $t < T$. Therefore it is optimal to deviate from any symmetric, proposed PBE in which all opportunists defect at some stage before stage T. The only symmetric PBE is therefore where all opportunists defect at stage, T, in which case the r.h.s. of (18) is zero. □

3.2 $r \geq r^*$

In this case, Proposition 3 continues to hold. The only difference is that when r reaches r^*, it will be optimal for a reciprocator to cooperate even with an agent who does not exhibit S, in the last stage T of the game (and, a fortiori, in earlier stages). Agents exhibiting S, however, will prefer to transact only with other agents exhibiting S, thus maximizing their expected payoff (since reciprocators are relatively likely to exhibit S). Agents not exhibiting S will be forced to transact with other agents not exhibiting S.

4 Endogenous Determination of r

In the previous section, r was treated as an exogenous datum. In this section, I endogenize r by calculating the relative expected payoffs $E\pi_k$ of the two types, on the assumption that the outcome of the interaction of the two types is the symmetric PBE of the game analyzed in the previous section.

4.1 Conditions for the Low- and High-Level Equilibrium

By Proposition 2, $r < r_{min}$, all agents' market payoffs are equal at zero, regardless of their type. Thus, by Proposition 1, parents will not find it optimal to invest in ethical education, and, by (1), r_g will be $(1 - \theta)r_{g-1}$. Thus, over time, r will decrease and eventually reach zero. This case is the low-level equilibrium discussed in the Introduction, in which agents do not transact in the market because market transactions offer no gain over intrafamilial transactions.

If, on the other hand, $r \in [r_{min}, r^*)$, we obtain the following result. Let

$$T_{min} \equiv 1 + \left[\frac{\left(\dfrac{c\left(\dfrac{1}{r} - \dfrac{\gamma}{1+\gamma}\right)}{\left(\psi - \dfrac{1}{1+\gamma}\right)v} \right) - 1}{1 + \dfrac{1-r}{\psi r}} \right].$$

Proposition 4 If $r \in [r_{min}, r^*)$, and $T > T_{min}$, $E\pi_R > E\pi_O$ and parents will optimally invest in ethical education (i.e., $e^* > 0$). Thus, for a range of parameter values (specified in the Appendix), all agents exhibiting S will transact in the market and play the C move in their market transactions up to and including stage $T - 1$. At stage T, the opportunistic types will defect and the reciprocators will continue to cooperate.

Proof. See Appendix.

The intuition underlying Proposition 4 is that, given $r \in [r_{min}, r^*)$, the only agents transacting in the market are those exhibiting S. When T is sufficiently large, the payoff advantage of the opportunists arising from their defecting against the reciprocators at stage T is outweighed by the fact that a larger proportion of opportunists will find themselves without trading partners over the previous $T - 1$ stages, since only agents exhibiting S will transact in the market, among whom the opportunists are "under-represented". The large T can be interpreted as a sufficiently large "potential intensivity" of market transactions and/or sufficiently perfect information flow regarding agents' past C or D moves.

While Proposition 4 is driven, to a large extent, by the fact that when $r \in [r_{min}, r^*)$, only agents exhibiting S transact in the market, it is nevertheless the case that even when $r \geq r^*$; and all agents transact in the market, parents will still optimally invest in ethical education, provided that T is sufficiently large. This is due to the fact that reciprocators transfer a larger part of their incomes to their parents than that transfered by opportunists, i.e., $\gamma > 0$. Thus parents have an incentive to invest in ethical education even if the lifetime incomes of the opportunists are somewhat higher, provided that the reciprocators' lifetime expected income is not too much lower than that of the opportunists. Since the opportunists' payoff advantage arises only in the last stage T, the larger the number of preceding stages (in which expected payoff of the reciprocators is slightly higher, as noted above), the greater will be the incentive to invest in ethical education.

The condition for ethical education to be sufficiently large to support the high-level equilibrium when $r \geq r^*$ is specified in the Appendix, though expression for the minimum T in this case is too complex to be of interest, and therefore is not shown.

4.2 Transition to the High-Level Equilibrium

The question naturally arises, is there some "bootstrap" mechanism by which a community which is located at the low-level equilibrium can move to the high-level equilibrium? By introducing two new elements into the model, we can show that such a mechanism does exist. The two elements are: (a) a distribution of transaction values v for agents with differing relative valuations of the market-produced (as opposed to family-produced) commodity, and (b) an increase in v for some subset of the population, induced by ties with neighboring communities.

Suppose that there is a finite number of market transaction values v of the agents in the community which lie on the line segment $[\underline{v}; \overline{v}]$; and that the density of the distribution of v for a given v is $\xi(v)$: To fix ideas, let there be three groups of agents in the community, with market transaction values $\{v_1; v_2; v_3\}$; where $v_1 < v_2 < v_3$: Suppose further that the community is located at the low-level equilibrium, so that $r < r_{min}$; but has not yet reached the long-run evolutionary equilibrium in which $r = 0$:

Now let group 3, say, benefit from an exogenous increase in demand (e.g., by a neighboring community) for a good which group 3 has a comparative advantage in producing, or an exogenous improvement of the transportation link to the neighboring community, so that its market transaction value v_3 rises to a higher value v_3^0 which is sufficiently large that $r_{min}(v_3^0) \leq r$: [Note, from (10), that r_{min} decreases as v increases.] This will induce the members of group 3 to engage in market transactions and, under the condition specified in the Appendix, to invest in ethical education. The entry of group 3 into the market will increase the proportion of community members transacting in the market p from zero to $\xi(v_3)$. This, in turn, will increase v for all three groups. If v_2 increases sufficiently, it may be the case that at its new value, v_2', $r_{min}(v_2') \leq r$, and group 2 would enter the market as well. The entry of group 2 will further increase p, and this may in turn induce the entry of group 1.

Thus ties to a neighboring community may trigger a shift from the low-level to the high-level equilibrium, even if these ties directly affect only a subset of the local community. It is quite plausible that the greater proximity of Northern Italy to the rest of Europe was what led to its present high-level equilibrium, while the relative remoteness of Southern Italy prevented the shift to this equilibrium. The following observations by an historian of modern Italy support this conjecture:

> The economic handicaps of the South in 1871 were overwhelming. The South ... was remote from European markets... The South lacked capital, entrepreneurial skills, foreign contacts, and skilled labour. The South also lacked regular water supplies for energy — it is no accident that so many of Italy's first factories were situated in Alpine valleys. [T]he North had commercial contacts with other countries, and was thus in touch with new ideas and values. Indeed, the Northern regions developed almost as 'sub-regions' of other European states: Piedmont had close links with French commerce and finance, as did Lombardy with those of Switzerland and Germany.[16]

5 Effect of a Decline in T on the High-Level Equilibrium

To illustrate how the high-level equilibrium can be destroyed by a gradual decline in T induced by increased impersonality of transactions and increased population mobility, let us consider the following simulation of the model. Let $\Pr(S|R) = 0.7$ and $\Pr(S|O) = 0.5$, so that $\psi = 1.4$ and $\varphi = 0.6$. Let $v = 2$, $a = 0.5$ and $c = 0.6$. Thus $r_{min} = 0.222$ and $r^* = 0.4$. Let $\alpha_O = 0.2$, $\gamma = 0.3$, and $w = 1$. Finally, let σ, the "production elasticity" of investment in ethical education, be 0.3, and $\theta = 0.2$ (these parameterizations imply a relatively small relative effect of parental educational investment on the expected type of their offspring). Let T initially be 50, which easily supports the high-level equilibrium, and let the initial value of r be r_{min}.

[16] Clark (1984), p. 24, my italics.

Figure 4 shows what will occur if T remains equal to 50 up to and including the 26th generation of the community, and then declines at the rate of 2 time periods per generation, until the 50th generation. The figure shows the resulting time paths of e^* and r.

The level of ethical educational investment drops at $g = 5$, when r exceeds r^* and thus the payoff advantage of the reciprocators disappears. However, the high initial T is sufficient to make it optimal to invest in ethical education, since reciprocators transfer 30 percent more of their income to their parents ($\gamma = 0.3$), until $g = 27$. In that generation, T begins its gradual decline, and e^* drops sharply to zero. This sharp drop in e^*, which contrasts with the gradual decline of T, results from the fact that, prior to $g = 27$, r reached an equilibrium value of approximately 0.5 which could only be supported by the initial value of $T = 50$. When T begins to decline, the $[(1+\gamma)\pi_{Rt} - \pi_{Ot}]$ term in (2) becomes negative, making $e^* = 0$. Further declines in T occur quickly enough that, even for the rapidly declining r, $[(1+\gamma)\pi_{Rt} - \pi_{Ot}]$ still is negative. At about $g = 31$, r has already dropped below r_{min}, which implies (by Proposition 2) that all agents stop interacting in the market. From this point on, $[(1+\gamma)\pi_{Rt} - \pi_{Ot}] = 0$, and e^* remains equal to zero.

[Figure 4 about here]

6 Concluding Remarks

We have found that a relatively simple model of the evolution of preferences for reciprocity leads to the following predictions:

- In the first stage of development, an emerging market economy will induce the rise of self-enforcing reciprocity norms.

- In the second stage, the increasing impersonality of market transactions and population mobility, which accompany economic development, will lead to a decline of these norms.[17]

- In this second stage, as well, children tend to be replaced as "investment goods" by publicly provided social security as well as saving and private-market pensions. Thus the process described above will contribute to the demographic transition.

[17] For a review of empirical evidence supporting this prediction, see Guttman (forthcoming).

The second stage of development, in which reciprocity norms decline, does not imply, however, that the market ceases to function. It simply implies that the norms-based self-enforcement of transactional commitments is replaced by a market whose transactions are increasingly enforced by the legal system. The legal system emerges in the first stage of development, since, as argued by Guttman and Götte (1999), the same evolutionary mechanism which explains self-enforcing reciprocity norms in bilateral transactions also explains the voluntary provision of public goods—perhaps the most important of which being democratic government, the courts, and the police. But even in highly developed economies, transactions are still enforced, to a large extent, by informal reciprocity norms.[18] The secular decline in these norms, however, would suggest that increasing transactions costs and social difficulties (such as crime) will characterize the more advanced market economies.

[18] For the classic reference on this point, see Macaulay (1963).

Appendix

Proof of Proposition 4

By Proposition 3, the opportunists exhibiting S will defect, in equilibrium, only at stage T. Their expected payoff, divided by $(1+\gamma)$, will be

$$\frac{E\pi_O}{1+\gamma} = \frac{\Pr(S|O)}{1+\gamma}\left[(T-1)v + \frac{v+c}{1+\frac{1-r}{\psi r}}\right], \qquad \text{(A1)}$$

since only opportunists exhibiting S have trading partners, and at stage T they cheat their partners with probability $1/\{1+[(1-r)/\psi]\}$, while in the case that they are matched with another opportunist, their payoff at stage T would be zero. The expected payoff of the reciprocators will be

$$E\pi_R = \psi \Pr(S|O)\left[(T-1)v + \frac{v}{1+\frac{1-r}{\psi r}} - \frac{c\left(\frac{1-r}{\psi r}\right)}{1+\frac{1-r}{\psi r}}\right], \qquad \text{(A2)}$$

by similar reasoning. Subtracting (A1) from (A2) and dividing through by $\Pr(S|O)$, we obtain

$$\frac{E\pi_R - \frac{E\pi_O}{1+\gamma}}{\Pr(S|O)} = \left(\psi - \frac{1}{1+\gamma}\right)(T-1)v + \frac{v\left(\psi - \frac{1}{1+\gamma}\right) - c\left(\frac{1}{r} - \frac{\gamma}{1+\gamma}\right)}{1+\frac{1-r}{\psi r}}. \qquad \text{(A3)}$$

The r.h.s. of (A3) is positive if and only if

$$T > 1 + \left[\frac{\dfrac{c\left(\frac{1}{r} - \frac{\gamma}{1+\gamma}\right)}{\left(\psi - \frac{1}{1+\gamma}\right)v} - 1}{1+\frac{1-r}{\psi r}}\right]. \qquad \text{(A4)}$$

Denote the r.h.s. of (A4) as T_{min}. It follows that

$$E\pi_R \gtrless \frac{E\pi_O}{1+\gamma} \text{ as } T \gtrless T_{min}. \qquad \blacksquare$$

Thus the condition that $e_j^* > 0$ in (5) of the text is satisfied if $T > T_{min}$. However, in order for the condition $r \geq r_{min}$ to hold, we further require that e_j^* be sufficiently large that $f(e_j^*) = (e_j^*)^{\sigma}$ is at least r_{min}. Using (5), this amounts to requiring

$$\left[\frac{\alpha_O \theta \sigma[(1+\gamma)E\pi_{Rt} - E\pi_{Ot}]}{w}\right]^{\frac{\sigma}{1-\sigma}} \geq r_{min} \equiv \frac{1}{1+\psi(v-a)}. \qquad \text{(A5)}$$

Using (A1) and (A2), (A5) can be rewritten as

$$r_{min} \leq \left[[(1+\gamma)\psi - 1](T-1)v + \frac{v[(1+\gamma)\psi - 1] - c\left(\frac{1+\gamma}{r} - \gamma\right)}{1 + \frac{1-r}{\psi r}}\right]^{\frac{\sigma}{1-\sigma}} \times \left(\frac{\alpha_O \theta \sigma \Pr(S|O)}{w}\right)^{\frac{\sigma}{1-\sigma}} : A6 \qquad (19)$$

Condition (A6) must hold in order for the "high-level equilibrium" to obtain.

The condition for the high-level equilibrium to obtain when $r \geq r^*$ is analogous to (A6), but takes account that agents not exhibiting S transact as well. Let

$$\Delta E\pi \equiv \Pr(S|O)\left[[(1+\gamma)\psi - 1](T-1)v + \frac{v[(1+\gamma)\psi - 1] - c\left(\frac{1+\gamma}{r} - \gamma\right)}{1 + \frac{1-r}{\psi r}}\right] + [1 - \Pr(S|O)]\left[[(1+\gamma)\varphi - 1](T-1)v + \frac{v[(1+\gamma)\varphi - 1] - c\left(\frac{1+\gamma}{r} - \gamma\right)}{1 + \frac{1-r}{\varphi r}}\right]$$

Then the condition that, for a given $r \geq r^*$, e_j^* is sufficiently large to make $f(e_j^*) \geq r$ is

$$\left(\Delta E\pi \frac{\alpha_O \theta \sigma}{w}\right)^{\frac{\sigma}{1-\sigma}} \geq r.$$

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