Reciprocal Exchange: A Self-Sustaining System

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Reciprocal exchange, or gift exchange, remains a widespread means of obtaining goods and services. This paper examines the persistence of reciprocal exchange by formalizing the interaction between self-enforcing exchange agreements and monetary market exchange. When more people engage in reciprocal exchange, market search costs increase, reciprocity is easier to enforce and yields higher utility. Thus, personalized exchange can persist even when it is inefficient. Conversely, large markets can destroy reciprocity when reciprocal exchange is efficient. The results characterize the use of personal ''connections'' as a system of reciprocal exchange and explain the disappearance of reciprocity when tribes encounter markets. (*JEL* D23, D51, L14, O17)

Why have informal, personalized relationships endured as modes of exchange despite the possibility of anonymous market alternatives? *Reciprocal exchange* is informally enforced agreements to give goods, services, information, or money in exchange for future compensation in kind. Also called *gift exchange*, anthropologists originally analyzed reciprocal exchange as a phenomenon prevalent in ''primitive'' or tribal societies (see Claude Levi-Strauss, 1969; Bronislaw Malinowski, 1961; Marcel Mauss, 1967; Marshall Sahlins, 1972). More recently, anthropologists and other researchers have found that reciprocity is pervasive in ''modern'' societies as well. All over the world, people engage in reciprocal exchange: from contractors in New York City's garment industry, to entrepreneurs in Singapore, to shantytown residents in Latin America.[1]

This paper explores the incidence and persistence of reciprocal exchange. Reciprocal exchange is often explained as a response to the difficulty of obtaining goods and services through anonymous market channels. The analysis here suggests that the benefits of reciprocal-exchange agreements can actually derive from the prevalence of reciprocal exchange itself. Reciprocal exchange can be self-sustaining: The more people engage in reciprocal exchange, the harder it is to exchange commodities on a market, the greater the incentive to form and maintain reciprocal exchange relationships. Personalized exchange arrangements can persist even when a market would be more efficient.

This paper examines the interaction between personalized, long-term exchange relationships and anonymous market exchange. According to various accounts in the anthropology and sociology literature, reciprocal exchange takes place between people who know each other well. It proceeds according to unwritten, but well-understood, rules that specify the level and direction of transfers of goods and services.

* Department of Economics, University of Maryland, College Park, MD 20742. I am grateful to Eddie Dekel, Ben Hermalin, Matthew Rabin, Arijit Sen, Anand Swamy, Randy Wright, and especially, George Akerlof, Debby Minehart, and two anonymous referees for comments and discussions. I also thank seminar participants at Boston University, California Institute of Technology, Stanford University, University of California at Berkeley, and the University of Maryland for their input. Early financial support from the Alfred P. Sloan Foundation is gratefully acknowledged.

[1] For the garment industry in New York, see Sally Falk Moore (1973, 1978). For Chinese entrepreneurs in Singapore, see Yao Souchou (1987). For shantytowns in Mexico City, see Larissa Adler Lomnitz (1977) and in Lima, see Susan Lobo (1982). In developing countries, reciprocal exchange is particularly prevalent; operating a business and obtaining everyday necessities can involve establishing and maintaining extensive reciprocity relationships. In addition to the above see, for example, Hernando de Soto (1989) and Diane Singerman (1995).

Exchange occurs in response to the partners' changing circumstances.[2] The passage of time is inherent to reciprocal exchange; giving a gift obligates the receiver to render future compensation.[3] Because of this, a partner to the exchange could "cheat" by not supplying goods when expected to do so. People have an incentive to be "reliable" and "honest" because they could lose the benefits of future exchange if they are not. Agents who do not fulfill their obligations are punished, usually by termination of the relationship.[4]

An agent who reneges on a reciprocal-exchange agreement can, however, obtain goods from other sources. The utility from alternative sources determines the severity of the punishment for cheating a reciprocal exchange partner. Consequently, the availability of a spot market where agents can anonymously buy and sell goods affects the enforceability of and gains from reciprocal exchange.

This paper considers an economy in which some agents engage in reciprocal exchange and the remainder in monetary market exchange. Money facilitates transactions among a number of people, so agents who use the market have access to a variety of goods. However, they must search for trading partners. In reciprocal exchange, agents economize on search costs but obtain only the commodity produced by their exchange partner. Therefore, when it is difficult to obtain goods on the market and commodities are very substitutable, reciprocal-exchange relationships are beneficial.

Market search costs, however, are not independent of the incidence of reciprocal exchange. There is an interaction between the two modes of exchange: if many people in the economy engage in reciprocal exchange, the market is thin, and it is hard to locate trading partners in the market. Market exchange yields lower levels of utility. On the other hand, if many people engage in market exchange, the market is thick, and it is easy to buy and sell goods on the market. But, it is difficult to enforce a long-term exchange agreement. The punishment for reneging on such an agreement is not severe, and reciprocal exchange yields low levels of utility.

Since both forms of exchange have negative external effects on the other, it would be socially efficient for everyone to engage in either reciprocal or market exchange. When goods are more (less) substitutable, reciprocal (market) exchange is socially efficient. However, when the division of the population between the two modes of exchange is endogenous, the population will not necessarily converge to the efficient mode. If initially the market is "too large," reciprocal exchange cannot be enforced. All agents will engage in market exchange. If initially there are "too many" people engaged in reciprocal exchange, the market does not function well. More and more people form reciprocal exchange relationships. Gains from reciprocal exchange increase, and reciprocity persists.

These results can help explain why reciprocal exchange has disappeared in particular settings and how reciprocal exchange can endure as a mode of exchange. I mention here briefly two examples; they are discussed at length in Section IV. The !Kung tribe in

[2] Ágnes Czakó and Endre Sik's (1988) report on firm managers in Hungary discusses the advantages of such state-contingent exchange: "The function of trouble-shooting [reciprocal] transactions is to solve an unexpected problem of adverse consequences in purchases, production or sales which the manager or the firm cannot solve alone. ... Most frequently, trouble-shooting transactions are loan transactions, hiring out, leasing, surrendering gratis and selling a product originally not meant for sale" (p. 24). Studies in market economies also describe reciprocal relationships among firms' managers and owners. For Singapore, see Souchou (1987), the United States, see Moore (1973), and Italy, see Mark Lazerson (1993).

[3] Carol B. Stack who studied reciprocal exchange in a poor African-American community relates: "Since an object swapped is offered with the intent of obligating the receiver over a period of time, two individuals rarely simultaneously exchange things. Little or no premium is placed upon immediate compensation; time has to pass before a counter-gift or a series of gifts can be repaid" (Stack, 1974 p. 41).

[4] Continuing Czakó and Sik's (1988 p. 24) account, for example:

> ... the assisting partner surrenders a resource temporarily that he might need later, so he must get it back later. This is why honesty and reliability are highly valued in trouble-shooting transactions, as this ensures the observance of the basic norm of reciprocity. A breach of the norm entails severe sanctions ... a partner who fails to meet his obligations expels himself from ... the circle of those who mutually help each other.

southern Africa, according to John E. Yellen (1990), abandoned reciprocal exchange when they encountered the market economy of Botswana. This analysis points to two ways the access to markets contributed to the breakdown of traditional exchange relationships. First, the opportunity for market exchange reduced the punishment for breaching reciprocal-exchange agreements. Second, the markets made available new and different commodities that diminished the relative benefits of reciprocal exchange.

In Cairo, Egypt, according to Singerman (1995), individuals rely on reciprocal-exchange relationships to procure goods and services, find jobs and housing, and obtain other necessities. The analysis here can explain the extensive use of personal "connections" as a self-sustaining system of reciprocal exchange. As in many other settings, people in Cairo use personal connections to obtain goods and services because it is difficult to do so as an anonymous individual. Yet, it is precisely because so many people use connections that it is difficult to obtain goods and services anonymously.

Despite the pervasiveness of reciprocal exchange, it has received little attention in the economic literature.[5] George A. Akerlof (1982) analyzes the primary sector of the labor market as an exchange of gifts: workers provide above-standard work performance in return for above market-clearing wages. Miles S. Kimball (1988) and Stephen Coate and Martin Ravallion (1993) are closer to this paper. They study reciprocity as an insurance mechanism: agents whose endowments are uncertain use long-term, self-enforcing agreements to smooth consumption over time. In the present paper, reciprocal exchange is a means for individuals to exchange goods over time and economize on market search costs. Whether or not reciprocity is enforceable depends on the market size and agents' preferences. When the market is small, if agents place a sufficiently high value on future utility, they are willing to provide goods for their partner today in anticipation of receiving goods in the future. When agents require many different goods, however, a reciprocal-exchange arrangement has fewer benefits. In this case, if the market is thick enough, the market is an attractive alternative and reciprocity cannot be enforced.

This paper contributes to our understanding of the evolution of institutions that govern production and exchange. The movement from personalized exchange to impersonal markets is a central theme in the institutional approach to the study of economic development and growth. Expanding markets, it is argued, supported by legal institutions that enforce contracts and protect property rights, lead to division of labor and specialization (Douglass C. North and Robert Paul Thomas [1973] and North [1981]; for a summary of this argument see North [1989]). In the absence of well-developed legal systems, however, people must rely on self-enforcing contractual arrangements. Recently, economic historians have analyzed institutions that supported reputation mechanisms among long-distance merchants, and, thus, promoted exchange.[6] Development economists have studied various ways personalized exchange can facilitate credit, insurance, and labor transactions.[7] It is now well-understood how repeated interaction and reputation mechanisms can enforce cooperation and sustain intertemporal exchange.

The relative efficiency of self-enforcing, personalized exchange arrangements and impersonal exchange[8] and the persistence or

[5] Colin Camerer (1988) and H. Lorne Carmichael and W. Bentley MacLeod (1992) study customs that involve the one-time giving of a gift. This practice is different from on-going *exchange* of gifts that is the subject of the present paper.

[6] Avner Greif (1989, 1993), studying 11th-century trade in the Mediterranean, and Karen Clay (1993), studying trade in 19th-century Mexican California, argue that coalitions of long-distance traders, by sharing information and punishing "cheaters," ensured the honesty of agents in distant cities. Paul R. Milgrom et al. (1990) demonstrate that a Law Merchant system in the 12th and 13th centuries in Europe provided a repository of information so that the reputation mechanism was effective among a large community of merchants.

[7] For example, Timothy Besley et al. (1993) examine rotating savings and credit associations (Roscas); Coate and Ravallion (1993) study self-enforcing insurance agreements. Bhaskar Dutta et al. (1989) look at labor contracts.

[8] Besley et al. (1994) compare the efficiency of two types of Roscas with credit markets. They do not examine the interaction between credit markets and Roscas.

disappearance of alternative forms is much less well-understood. In particular, the possibility that inefficient forms of exchange can persist or displace efficient forms remains an open analytical question.[9] This paper demonstrates that the development of exchange institutions can be path-dependent. When the market size is endogenous, the economy exhibits hysteresis: whether reciprocal or market exchange survives depends on the initial division of the population between reciprocal and market exchange. Thus, inefficient outcomes are possible. The results suggest that the introduction and refinement of legal institutions to enforce contracts and support relatively more impersonal exchange, might or might not lead to the collapse of personalized exchange (as long as complete contingent contracts are not enforceable). Moreover, whether or not the displacement or persistence of a particular institution is efficient depends on preferences and technology.[10]

This analysis can be applied to the theory of the firm to understand a firm's choice between alternative supply arrangements. When complete enforceable contracts are not possible, a firm that invests in assets specific to another firm exposes itself to the "hold-up" problem (see R. H. Coase, 1937; Oliver C. Williamson, 1975, 1979; Benjamin Klein et al., 1978; Sanford J. Grossman and Oliver D. Hart, 1986). Repeated interaction, reputation mechanisms, and long-term agreements, it is argued, can mitigate the gains from ex post opportunism.[11] The results in the present paper suggest that whether firms have long-term relationships with their suppliers or firms buy inputs on a market could depend on the *interaction* between the two organizational forms. When suppliers produce inputs specific to one or two buyers, and those firms repeatedly interact, ex post opportunism in a given relationship would be checked. A buyer would be less likely to behave opportunistically because it would be difficult to find another source of inputs. However, when suppliers are not tied to a specific buyer, or communications and transportation technology expands the set of potential suppliers, a buyer could more easily locate an alternative source of inputs. A supplier would then be less willing to invest in specific assets. Which outcome is efficient would depend on the technology; that is, the value of inputs tailored specifically to firms' requirements.

The rest of the paper is organized as follows: Section I models the economy. It specifies preferences, production technology, and how transactions take place in reciprocal and market exchange. Section II examines the equilibrium gains from reciprocal and market exchange for a given market size. Section III considers a dynamic environment, where the market size is endogenous, and shows how inefficient outcomes can arise. Section IV continues the discussion of the examples of reciprocal exchange. The conclusion considers further implications of the analysis for the study of institutions and markets.

I. Model of the Economy

In this economy, two institutions for exchange are available: market and reciprocal exchange. In the tradition of Peter A. Diamond (1984) and Nobuhiro Kiyotaki and Randall Wright (1993), market exchange takes place among anonymous agents who use money as a medium of exchange. Agents have different tastes and must search for trading partners. Reciprocal

[9] In earlier work, North contends that superior institutions ultimately replace inferior institutions. In more recent work, North (1990) for example, he moves away from that position and argues that efficient institutions do not always emerge.

[10] Following North's argument, when specialization and variety become important, the persistence of personalized relationships impedes economic growth. In contrast, this paper and Kranton and Anand V. Swamy (1995), which studies personalized credit relationships, indicate that introducing the possibility of impersonal exchange can also destroy relatively more efficient personalized exchange relationships.

[11] For general discussion see Milgrom and John Roberts (1988). See Paul L. Joskow (1985, 1987) on long-term contracts in electricity generation and coal markets in the United States. Christopher Woodruff (1993) finds that repeated interaction and reputation mechanisms sustain relationships between manufacturers and retailers in the Mexican shoe industry. John McMillan (1990) and Mari Sako (1992) characterize the relationships between Japanese manufacturers and suppliers as sustained by repeated interaction and reputation mechanisms. Analytical papers on the "hold-up" problem (Grossman and Hart, 1988; William P. Rogerson, 1992, for example) examine only one-shot interactions between firms.

exchange, in contrast, is a noncooperative game between two agents who know each other well. They have information on each other's preferences and production costs that allows them to engage in a long-term self-enforcing exchange relationship.

Infinitely-lived agents are assigned either to market exchange or reciprocal exchange.[12] The parameter μ represents the proportion of the population that engage in market exchange, or, equivalently, the "thickness" of the market. An agent assigned to reciprocal exchange can always leave his reciprocal relationship and enter the market. An agent assigned to market exchange, however, has no information about any other agent and cannot enter reciprocal exchange.

Agents specialize in the production of one commodity and want to consume different commodities at different times. The market involves search but provides greater access to a variety of commodities than a reciprocal-exchange relationship.[13] Market exchange proceeds as follows: agents are either "buyers" who have a unit of currency or "sellers." Sellers go to "public production sites" (shops or offices, say) where they can produce their commodities. Buyers search for sellers at the sites where the commodities they want to purchase are produced. If a buyer and seller meet and the seller chooses to produce at his current cost, the buyer relinquishes her currency, obtains the good, consumes, and becomes a seller. The seller becomes a buyer. If the seller does not produce, the buyer continues her search. In reciprocal exchange, agents do not spend time buying and selling commodities. To consume and produce, exchange partners simply go to each others' "private production sites," which are not accessible to the general public. An agent consumes in any given period if she desires what her partner can produce and her partner is willing to produce at his current production cost.

A. *Production Technology and Preferences*

There are many nonstorable commodities (or, equivalently, services). For each commodity there are infinitely many agents who can produce that commodity but no other. Agents are infinitely lived and have a discount rate $r > 0$. Time proceeds in discrete periods.

In each period each agent can produce one indivisible unit of her commodity. Production takes place at particular locations: in order to produce, an agent must be at a "production site" for her commodity. Producing a commodity or rendering a service can be more or less difficult at any given time: for each agent, production involves an instantaneous cost in disutility $c \in [0, \infty)$ which is an independent draw from a distribution $F(c)$ at the time of production, where $F(0) = 0$ and F is differentiable with density f. Ultimately agents decide, given their current production costs, whether or not to produce their commodity for another agent.

In each period, each agent wants to consume one unit of a commodity. The parameter x captures the extent to which commodities are substitutable: each agent always desires a proportion $0 < x \leq 1$ of the commodities. Consuming a commodity from the desired set yields instantaneous utility $\bar{u} > 0$. Consuming any other commodity yields no utility. The smaller is x, then, the less substitutable are commodities, the more specialized is the economy. Agents' needs also vary over time: the composition of each agent's desired set changes randomly every period. The probability in any period that an agent desires a particular commodity is x, and x is also the proportion of agents that desire any given commodity.[14] It is assumed that agents cannot consume their own output so that there are always benefits to trade over self-sufficiency.

[12] Section III considers an overlapping-generations model where agents who enter the economy choose between reciprocal and market exchange.

[13] This would not be the case in Kiyotaki and Wright (1993) where agents of all types randomly match in the market. The chance that any two randomly matched agents desire each others' goods would be the same as the chance that any two given individuals desire each others' goods. Reciprocal exchange between two individuals would then provide the same access to variety as the market.

[14] If each agent independently selects at random a proportion x of the commodities, then, with infinitely many agents, in the limit the proportion of agents that select any particular commodity is x.

Finally, it takes time for agents to travel to and from production sites. So that agents can both produce and consume in one period, one period is defined as the time it would take for an agent to produce at one site, travel to another site to obtain a commodity, then return. Let $\tau > 0$ be the time it takes for an agent to travel between two production sites. One period is then equal to 2τ. Let $\delta \equiv e^{-r\tau}$ be the discount factor per half period.

B. *Division of the Population*

Agents are divided into two groups: the market-exchange group is a proportion μ of the agents who can produce each commodity, and the reciprocal-exchange group is the remaining $(1 - \mu)$.[15] All agents know μ but do not know which agents are in which group.

C. *Reciprocal Exchange*

Agents in the reciprocal-exchange group are born in pairs of partners who can observe each others' preferences, consumption, production costs, and decisions.[16] Only the two partners have this information, so any agreement between them must be self-enforcing.[17] Agents produce and consume at "private production sites." The locations of these sites are known only to the two exchange partners. In each period, each agent chooses whether to produce a commodity for her partner and whether to receive a commodity from her partner. These choices are based on the history of their relationship, their current preferences, and their current production costs.

D. *Market Exchange*

Agents in the market group are completely anonymous: they cannot observe any other agent's preferences, trades, production costs, or decisions. As a consequence, long-term exchange agreements are not enforceable; agents can only engage in quid pro quo transactions. Since agents must be in particular places in order to produce and it takes time to travel between production sites, direct barter is not possible: agents cannot simultaneously produce and exchange nonstorable commodities.[18] A proportion $m \in (0, 1)$ of the agents are each endowed with one unit of indivisible fiat currency, and all agents accept money as a medium of exchange.[19]

Agents in the market produce and consume at "public production sites" whose locations are common knowledge. The locations are designated by commodity, so agents know where different commodities are produced. There are the same number of public production sites for each commodity as there are potential producers of each commodity. This assumption guarantees that all agents in the population have access to the market.

Agents in the market are either "buyers" who hold currency or "sellers" who do not. In each half period, buyers and sellers meet at public production sites according to the following matching process: sellers go to public production sites where they can produce their commodities. They randomly occupy sites subject to the constraint that no two sellers occupy the

[15] Note that in what follows I am restricting attention to equilibria in which the market group is the same size for each commodity.

[16] This paper explores the nature of equilibria for a given pairing of agents. Anthropologists discuss extensively the formation of reciprocal relationships. How particular relationships arise and are sustained is the subject of current research. See Kranton (1995).

[17] I restrict attention to agreements enforced by two exchange partners. Reciprocal exchange often occurs between individuals in a network or group of people who all know each other well. In this case, the punishment for breaching one reciprocal agreement can be more severe if other members of the network or group also punish the "cheater." Networks of reciprocal exchange are discussed in the conclusion.

[18] All the results extend to a generalized model where barter is possible. A Technical Appendix available from the author upon request specifies and analyzes the economy with barter.

[19] With no possibility of barter, for all $m \in (0, 1)$, it is a Nash equilibrium for all agents to accept fiat currency in exchange for goods with probability one. The Appendix provides a formal proof. In an economy where barter is possible, agents who produce commodity k locate at sites designated for commodity-k producers. Agents who prefer commodity k sample directly from these sites to search for a producer. Barter occurs only with probability x, so there is a role for fiat money to facilitate exchange. A "pure-monetary equilibrium" (that is, all agents accept money with probability one) exists for values of m sufficiently close to $1/2$.

same site. At the same time, buyers travel to the public sites where their preferred commodities are produced. Lacking any information beyond the location of these sites, each buyer selects a site at random. It is possible that multiple buyers select the same site. A seller meets a buyer if at least one buyer selects the site he has chosen. A buyer meets a seller if she selects a site where a seller is present and she is chosen from among the other buyers that may have selected the same site.[20]

II. Analysis of Market and Reciprocal Exchange for a Given Market Size

Since market exchange is an alternative to reciprocal exchange, I analyze market exchange first. In what follows I restrict attention to symmetric, steady-state equilibria. I then consider reciprocal-exchange relationships and determine the (perfect) equilibrium gains from reciprocal exchange as a function of preferences and market size.

Market Exchange

A. *The Steady State and the "Thick-Market Externality"*

Initially, a proportion m of the market group are buyers who each hold one unit of currency; the remainder $(1 - m)$ are sellers. Since commodities are not storable, agents must be at production sites in order to produce, and agents cannot consume their own output, sellers will locate at production sites to await a buyer, and buyers will search for sellers. Since currency and commodities are indivisible and the money supply is constant, the price level is also constant: a unit of currency is simply a token valuable for a single purchase. The steady-state number of buyers and sellers, then, is completely determined by the money supply: a proportion m of the agents are buyers and $(1 - m)$ are sellers.[21]

In any given round of matching, let b be the probability that a seller meets a buyer and s the probability that a buyer meets a seller. To calculate these probabilities, let L be the number of public production sites. By assumption, L is also the size of the population, so there are total of $m\mu L$ buyers and $(1 - m)\mu L$ sellers. Of these buyers, $xm\mu L$ desire any given commodity. They select at random from xL sites where there are randomly located $x(1 - m)\mu L$ sellers.

For a seller, the probability his site is selected by at least one buyer is

$$b = 1 - \left(1 - \frac{1}{xL}\right)^{xm\mu L}. \tag{1}$$

For a buyer, the probability that she selects a site with a seller present is $(1 - m)\mu$. The number of j other buyers that select the same site has a binomial distribution with $(xm\mu L - 1)$ trials each with probability $1/xL$ of a "success." The probability that a buyer is chosen by a seller when j other buyers select the same seller is $1/(j + 1)$. Hence, the probability that a buyer meets with seller is

$$\begin{aligned} s &= (1-m)\mu \sum_{j=0}^{xm\mu L-1} \frac{1}{j+1} \binom{xm\mu L - 1}{j} \times \left(\frac{1}{xL}\right)^{j} \left(1 - \frac{1}{xL}\right)^{xm\mu L-1-j} \\ &= \frac{(1-m)\mu}{m\mu} \sum_{j=0}^{xm\mu L-1} \binom{xm\mu L}{j+1} \times \left(\frac{1}{xL}\right)^{j+1} \left(1 - \frac{1}{xL}\right)^{xm\mu L-1-j} \\ &= \frac{1-m}{m}\left[1 - \left(1 - \frac{1}{xL}\right)^{xm\mu L}\right]. \end{aligned} \tag{2}$$

[20] In equilibrium each buyer will hold one unit of currency, all buyers will search among the public sites to purchase a commodity, and all sellers will locate at these sites to produce a commodity for sale. It is optimal for a buyer to search only among the sites where his preferred commodities are produced since he receives no utility from other commodities. Given sellers randomly select a site each half period, buyers also randomly select a site, so matching probabilities are stationary.

[21] As in Kiyotaki and Wright (1993) and other models of monetary market exchange, the money supply affects the steady state and has real effects on the gains from trade.

Since,

$$\lim_{L\to\infty} 1 - \left(1 - \frac{1}{xL}\right)^{xm\mu L} = 1 - e^{-m\mu}$$

it follows from (1) and (2) that

$$(1') \qquad b = (1 - e^{-m\mu})$$

$$(2') \qquad s = \frac{1-m}{m}(1 - e^{-m\mu}).$$

Thus, we see that there is a "thick-market" externality. The probability of meeting another agent increases in the size of the market: b and s are increasing in μ. Buyers can direct their search to obtain a preferred commodity. Sellers of each commodity, however, are dispersed among the many production sites for that commodity. So when there are more buyers and sellers in the market, it is easier for them to meet; thicker markets facilitate trade.[22]

B. *Equilibrium Gains from Market Exchange*

Agents maximize the present discounted value of consumption minus production costs. Let V_b be the discounted value of lifetime utility conditional on being a buyer, and let V_s be the discounted value of lifetime utility conditional on being a seller. Sellers decide at what costs they are willing to produce their commodities. Buyers maximize utility by searching among the production sites where their desired commodities are produced.

For a buyer, the probability that a buyer meets a seller is s. If all sellers produce when their production costs are less than or equal to some cutoff cost c_M, the probability that a seller will produce is $F(c_M)$.[23] The probability that a buyer consumes in any round of matching is then $sF(c_M)$, and the optimal value equation for a buyer is

$$(3) \qquad V_b = sF(c_M)(\bar{u} + \delta V_s) + (1 - sF(c_M))\,\delta V_b.$$

For a seller, the probability that a seller receives a buyer is b. Let c_M^* be a representative seller's optimal cutoff cost, taking as given the behavior of buyers and other sellers. If a seller undertakes all production costing less than c_M^*, with probability $F(c_M^*)$ his production cost is low enough for him to produce. He produces, obtains currency, and becomes a buyer. The optimal value equation for an individual seller is then

$$(4) \qquad V_s = b\int_0^{c_M^*} (-c + \delta V_b)\, dF(c) + (1 - bF(c_M^*))\,\delta V_s.$$

The optimal cutoff rule for production is to produce at any cost less than or equal to the gain in expected utility from changing status from seller to buyer: $c_M^* = \delta[V_b - V_s]$.

We can now determine the equilibrium utility of agents in the market group as a function of the market size.[24] Let $c_M^*(\mu)$ be the highest equilibrium cutoff cost for a given μ, and let $V_s^*(\mu)$ be the corresponding

[22] The thick-market externality arises because there is a public production site to accommodate every member of the population. Sellers are dispersed among these sites, and buyers must visit a site to see if a seller is physically present. This search process captures the difficulty of using a market when personalized exchange relationships are important. See, for example, Clifford Geertz's (1979) account of markets in Morocco.

[23] If all sellers produce whenever $c \leq c_M$, a steady-state equilibrium requires $sF(c_M)m = bF(c_M)(1 - m)$. Since $b = (1 - e^{-m\mu})$ and $s = [(1 - m)/m](1 - e^{-m\mu})$, a steady-state equilibrium exists for any m.

[24] The solution for c_M^* from (3), (4) and $c_M^* = \delta[V_b - V_s]$ follows Diamond (1984) and is available upon request. A sufficient condition for the existence of an equilibrium in which $c_M^* > 0$ (at $\mu > 0$) is $\bar{u}sf(0) > [1 - \delta]/\delta$. As in Diamond, multiple equilibria are possible. In what follows, I restrict attention to the equilibrium which yields the highest gains from trade, that is, the equilibrium with the highest cutoff cost of production.

lifetime discounted expected utility starting as a seller. Solving for $V_s^*(\mu)$ from (3) and (4) yields

$$(5)\quad V_s^*(\mu) = \frac{b\phi}{1-\delta} \times \left[sF(c_M^*)\,\delta \int_0^{c_M^*} (\bar{u} - c)\, dF(c) - (1-\delta) \int_0^{c_M^*} c\, dF(c) \right]$$

where $\phi \equiv 1/[(1 - \delta) + bF(c_M^*)\,\delta + sF(c_M^*)\,\delta]$.

When there are few exchange partners in the market, agents are willing to produce only at very low costs. In the extreme, $c_M^*(0) = 0$ and $V_s^*(0) = 0$. However, when there are more people in the market group, it takes less time to buy and sell commodities. Buyers are less frustrated in their search for a seller; sellers receive more buyers. The utility from market exchange increases in the size of the market. Consequently, the incidence of reciprocal exchange adversely affects the gains from market exchange.

PROPOSITION 1: *The equilibrium gains from market exchange are higher when markets are larger: $V_s^*(\mu)$ is increasing in μ.*

PROOF:

All proofs are in the Appendix.

Reciprocal Exchange

A. *The Sequence of Interaction in a Reciprocal-Exchange Relationship*

In each period agents in reciprocal exchange choose whether to produce for their partner and consume their partner's output. I define a reciprocal-exchange relationship as the following strategies.[25] An agent produces if her partner desires her commodity and her cost is at or below a cutoff level c_R. Otherwise, an agent does not produce. An agent consumes if he desires his partner's commodity and his partner produces.[26] Agents produce and consume according to this rule as long as both agents have done so in the past. If ever either agent breaks this rule, an agent does not produce for his partner or receive any commodities from his partner in the future. Agents enter the market and produce at public production sites for costs at or below $c_M^*(\mu)$.[27]

The discounted expected lifetime utility from a reciprocal-exchange relationship is the difference between an agent's utility from consumption and disutility from production. In each period, with probability x an agent prefers her partner's commodity and with probability $F(c_R)$ her partner has a cost at or below c_R. To produce and consume in any given period, agents must travel between their private production sites. Let V_1 be the expected lifetime utility for the agent who produces first, and let V_2 be the expected lifetime utility for the agent who produces second. At the end of the period they return to the first agent's production site with probability $1/2$ and stay at the second agent's site with probability $1/2$ so that each agent has equal chance to produce first in the next period.[28] Let

[25] Of course, there are many possible ways to specify a reciprocity relationship. The specification here is the simplest representation of reciprocal-exchange relationships described in the anthropology literature.

[26] It is implicit in this strategy that agents punish their partners if they go to the market. If an agent engages in market exchange, she ties up her resources (she must wait for buyers and search for sellers) and is therefore less likely to be able to fulfill her obligations to her reciprocal-exchange partner.

[27] There is much evidence that people use this "trigger strategy." See, for example, see Moore (1978 pp. 61–62) and Czakó and Sik (1988 p. 24). It is possible that agents could renegotiate an agreement rather than enter the market. As is often the case with renegotiation, this could result in the nonexistence of cooperative equilibria. It is also plausible (though not possible in this model given the information assumptions) that if one agent cheats, agents could form new relationships with other partners. However, it is likely that the "cheater" would spend some time on the market before he finds another reciprocal-exchange partner. The utility from market exchange would remain part of his punishment payoffs.

[28] The results are robust to the alternative specifications that agents return to the first agent's site or stay at the second agent's site. With the current specification, both agents have the same expected discounted utility from the relationship.

$V_R(c_R) \equiv {}^1\!/_2 V_1 + {}^1\!/_2 V_2$ be the expected lifetime discounted utility from a reciprocal-exchange relationship. The agent who produces first, then, has expected utility

$$(6) \qquad V_1 = x \int_0^{c_R} (-c)\, dF(c) + \delta x F(c_R)\bar{u} + \delta^2 V_R.$$

The agent who produces second has expected utility

$$(7) \qquad V_2 = xF(c_R)\bar{u} + \delta x \int_0^{c_R} (-c)\, dF(c) + \delta^2 V_R.$$

Solving for $V_R(c_R)$ yields

$$(8) \quad V_R(c_R) = \frac{x}{1-\delta}\left[\frac{1}{2}\int_0^{c_R} (\bar{u} - c)\, dF(c)\right].$$

Note here that for any $c_R > 0$, the more likely it is that an agent desires her partner's good (higher x) and the more agents value future utility (higher δ), the greater the gains from a reciprocal-exchange relationship. Since $V_R(c_R)$ is increasing for $c_R < \bar{u}$ and is decreasing for $c_R > \bar{u}$, the first-best cutoff cost is $\bar{u}$. The next section examines the cutoff costs that can be sustained in a perfect equilibrium.

B. *Equilibrium Gains from Reciprocal Exchange*

B.1. *The Enforceability of Reciprocal-Exchange Agreements.*—Because reciprocal exchange occurs across time, agents have the opportunity to renege on reciprocal-exchange agreements. An agent could save production costs by not producing for her partner. An agent could also go to the market to obtain a preferred good. A reciprocal-exchange relationship is "enforceable," that is, constitutes a perfect equilibrium, if and only if each partner has the incentive to produce and receive goods according to the rule and each partner has the incentive to carry out the punishment if any partner reneges.

First, both agents are willing to carry out the punishment. If one agent never gives a commodity in the future, then the other's best response is also not to give. The only way an agent can consume is to enter the market as a seller. This is the worst possible perfect punishment an agent can receive.

Second, given this punishment, both agents in a reciprocal-exchange relationship must always be willing to produce goods for their partners. The highest cost an agent must be willing to bear is c_R. An agent has the lowest incentive to incur this cost in a period when she does not prefer her partner's commodity. Consider the agent who produces first. If she does produce for her partner and remains in the relationship, she does not consume that period but anticipates $V_R(c_R)$ in the future. If she does not produce, the relationship ends. She goes to the market as a seller for the next round of trading and earns $V_s^*(\mu)$. Therefore, in order that she has the incentive to produce at all costs $c \leq c_R$, c_R must satisfy the following "enforceability" constraint:

$$(9) \quad -c_R + \delta \cdot 0 + \delta^2 V_R(c_R) \geq \delta V_s^*(\mu).$$

Consider now the second agent. She has greater incentive to remain in the relationship. When she is called upon to produce she is closer to receiving $V_R(c_R)$, the future benefits of the relationship. Thus if the first agent is willing to produce, the second agent is as well. (The calculations that show this are available upon request.)

Finally, agents must be willing to receive the goods from their partners. If agents are willing to produce for their partners when they do not want their partner's commodity, they are certainly willing to receive commodities from their partners when they do.

Therefore, we have a single enforceability constraint on utility from reciprocal exchange. Define the "optimal enforceable" utility from reciprocal exchange as the highest utility that can be obtained in a perfect equilibrium; that is, the maximum of $V_R(c_R)$ subject to (9). Let the solution to this constrained maximization problem be $c_R^*(\mu, x, \delta)$, the "optimal enforceable" cutoff cost, and let $V_R^* \equiv V_R(c_R^*(\mu, x, \delta))$

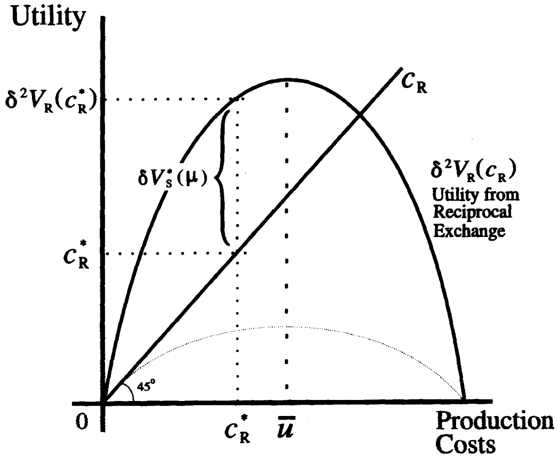

FIGURE 1. THE OPTIMAL ENFORCEABLE GAINS FROM RECIPROCAL EXCHANGE

be the corresponding level of discounted utility.[29]

Figure 1 illustrates this problem for a concave $V_R(c_R)$. Higher x and higher δ give a taller $\delta^2 V_R(c_R)$. The Figure shows a binding constraint: $\delta^2 V_R^* - c_R^* = \delta V_s^*(\mu)$ and $c_R^* < \bar{u}$.

B.2. *Market Size and the Optimal Enforceable Gains from Reciprocal Exchange.*—The enforceability constraint is harder to satisfy at larger market sizes. When more people engage in market exchange, market search costs decrease, and $V_s^*(\mu)$ increases. The punishment for breaking a reciprocal-exchange agreement is not as harsh, and agents in reciprocal exchange are less willing to incur high production costs. On the other hand, when more people engage in reciprocal exchange, it is more difficult to buy and sell goods on the market. Agents are willing to produce at higher costs to maintain reciprocal-exchange relationships, and reciprocal exchange yields higher levels of utility. It follows that when more agents engage in market (reciprocal) exchange, the equilibrium gains from reciprocal exchange are lower (higher).

PROPOSITION 2: *The optimal enforceable gains from reciprocal exchange are lower when the market is larger: c_R^* and V_R^* are (weakly) decreasing in μ.*

B.3. *Preferences and the Enforceability of Reciprocal Exchange.*—The result that larger markets make reciprocal exchange harder to enforce raises the following question: when are agents willing to produce for their partners, and when does the market become so large that agents are no longer willing to do so? The answer depends on agents' preferences. If agents put a high enough value on future utility, reciprocity is enforceable. Agents are willing to produce for their partners and remain in reciprocal-exchange relationships even when there exists a market alternative.[30] If, however, agents care enough about consuming specific commodities, it is possible for the market to be large enough so that reciprocity is not enforceable.

To see this, let $\bar{\mu}$ be the largest market size such that agents will produce for their partners: for all smaller markets, $\mu \leq \bar{\mu}$, reciprocity is enforceable and $c_R^* > 0$. For all larger markets, $\mu > \bar{\mu}$, reciprocity is not enforceable and $c_R^* = 0$. Note that a $\bar{\mu} \geq 0$ need not exist. In that case reciprocity is not enforceable for any market size, even for $\mu = 0$.

When agents care more about the future, they have a greater incentive to produce goods for their partners. As the discount factor increases (r decreases), future gains from reciprocal exchange become more valuable. When the discount factor is sufficiently high, the future utility from the relationship outweighs current production costs: $\delta^2 V_R(c_R) - c_R \geq 0$. Agents are willing to produce for their partners if they have no other trade alternative. At higher discount factors, agents are willing to produce even when they could trade on a market after they renege on an agreement. When

[29] Since $V_R(0) = 0$ and $V_R(c_R)$ is increasing for all $c_R < \bar{u}$ and decreasing for $c_R > \bar{u}$, $c_R^*(\mu, x, \delta)$ is unique.

[30] The extent to which agents discount future utility from a relationship can also represent the exogenous probability of continuing a relationship. In mobile societies (social or otherwise), this probability would be low. In less mobile societies, like developing countries, this probability would be high. Hence, this analysis can also help explain why reciprocity appears to be less widespread in mobile societies.

the market is small enough, the net benefits from reciprocal exchange would still exceed the gains from market exchange.

PROPOSITION 3: *When agents place a sufficiently high value on future utility, reciprocity is enforceable at positive market sizes: for any x, there exists a* $\underline{\delta}(x) < 1$ *such that for all discount factors* $\delta \geq \underline{\delta}(x)$, $\bar{\mu} \geq 0$.

When consuming different goods is important, however, agents have less incentive to produce for their partners. As x falls, there are fewer benefits from maintaining a reciprocal-exchange agreement: $\delta^2 V_R(c_R)$ decreases because agents are less likely to desire what their partners can produce. If x is sufficiently small, reciprocity is not enforceable at large market sizes; that is, $\bar{\mu} < 1$. When the market is large enough, agents can obtain their desired goods on the market without incurring high search costs, and the net benefits from reciprocal exchange do not exceed the utility from market exchange.

PROPOSITION 4: *When goods are less substitutable, it is possible for the market to be so large that reciprocity is not enforceable: For any* δ, *there exists an* $\bar{x}(\delta)$ *such that for all* $x < \bar{x}(\delta)$, $\bar{\mu} < 1$.

Figure 2 illustrates Propositions 3 and 4. $\underline{\delta}(x)$ is the locus of points where $\bar{\mu} = 0$. In the region below $\underline{\delta}(x)$, agents care so little for future utility that reciprocity is never enforceable. $\bar{x}(\delta)$ is the locus of points where $\bar{\mu} = 1$. On $\bar{x}(\delta)$ and above agents care so little about consuming different goods that reciprocity is always enforceable. In the region between $\underline{\delta}(x)$ and $\bar{x}(\delta)$, agents care enough about future utility but differentiate enough between commodities so that $0 < \bar{\mu} < 1$. In this region, reciprocity is enforceable when the market is small but not when the market is large.

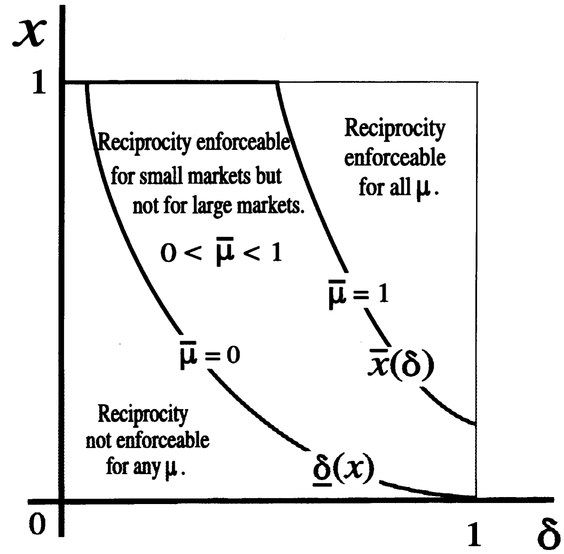

FIGURE 2. PREFERENCES AND THE ENFORCEABILITY OF RECIPROCAL EXCHANGE

III. Endogenous Market Size: Can Inefficient Arrangements Persist?

The above analysis shows that market exchange has negative external effects on reciprocal exchange, and vice versa. It would therefore be socially efficient either for everyone to engage in market exchange ($\mu = 1$) or for everyone to engage in reciprocal exchange ($\mu = 0$). When it is important for agents to consume different goods, market exchange is efficient. When it is not, reciprocal exchange is efficient.

This section constructs an environment where the market size is endogenous and asks whether inefficient exchange arrangements can persist. In an overlapping-generations model, agents who enter the economy choose whether to join the market or form a reciprocal-exchange relationship. They make their decision given the market size in the previous period. When individual agents pick the mode of exchange that yielded the highest utility, the population will converge on one mode of exchange. Which mode survives, however, depends on the initial market size. Therefore, inefficient outcomes are possible.

A. *A Dynamic Model: Overlapping Generations*

Suppose now that at the end of every half period, a proportion $(1 - \lambda)$ of buyers, sellers, and agents in the reciprocal-exchange group die. For simplicity, reciprocal-exchange agents die together with their partners. The agents or pairs who die are randomly selected from each set. At the beginning of the following half period, an equal number of agents are born, so the total population size is constant over time.[31] Agents do not inherently prefer future utility to current utility; the discount rate is now $r = 0$. However, since each agent lives with only probability λ each half period, agents discount future utility by a factor λ. To keep notation consistent with the static setting, now let $\delta \equiv \lambda$. Let μ_t be the proportion of the population in the market group in a given half period t.

When agents are born, they are matched to potential reciprocal-exchange partners. As before, agents have no information about any other agent. Thus, agents can only begin a reciprocal-exchange relationship at birth but can enter the market at any time. A proportion m of the agents who enter the market each receive a unit of currency so that the ratio of buyers to sellers is constant over time. Since an agent entering the market has a probability m of becoming a buyer, the enforceability constraint on reciprocal-exchange relationships for a given market size is now

$$(10) \quad -c_R + \delta \cdot 0 + \delta^2 V_R(c_R) \geq V_M^*(\mu)$$

where $V_M^*(\mu) \equiv mV_b^*(\mu) + (1-m)V_s^*(\mu)$.

Suppose newborn agents have the strategy to choose market exchange if the discounted utility from market exchange was weakly higher than the discounted utility from reciprocal exchange in the previous half period. Otherwise, agents choose reciprocal exchange. The Appendix shows that this strategy constitutes a Nash equilibrium. With this strategy, an agent's choice ultimately depends on the relationship between the market size in the previous half period, μ_{t-1}, and $\bar{\mu}$, the critical market size above which reciprocity is not enforceable.[32] At $\mu = \bar{\mu}$, the enforceability constraint is binding: $\delta^2 V_R(c_R^*(\bar{\mu}, x, \delta)) - c_R^*(\bar{\mu}, x, \delta) = V_M^*(\bar{\mu})$, and the discounted utility from reciprocity exceeds the discounted utility from market exchange. If $\mu_{t-1} \leq \bar{\mu}$, then reciprocity was enforceable, and the gains from reciprocal exchange were higher than the gains from market exchange: $V_R(c_R^*(\mu_{t-1}, x, \delta)) > V_M^*(\mu_{t-1})$. Agents choose reciprocal exchange. If $\mu_{t-1} > \bar{\mu}$, reciprocity was not enforceable, $c_R^*(\mu_{t-1}, x, \delta) = 0$, and the market yielded higher expected utility than reciprocal exchange: $V_M^*(\mu_{t-1}) > V_R(c_R^*(\mu_{t-1}, x, \delta)) = 0$. Agents choose market exchange.

When agents entering the economy choose in this way, eventually everyone in the population will engage in the same mode of exchange. Which mode depends on the initial market size μ_0. If reciprocal exchange starts out large, reciprocal exchange will survive: if $\mu_0 \leq \bar{\mu}$, the next agents who enter the economy will form reciprocal-exchange relationships. The market size decreases, V_R^* increases, and V_M^* decreases. The next generation will also choose reciprocal exchange, and so on. Eventually the entire population will engage in reciprocal exchange. If instead the market starts out large, the market will take over the economy, and reciprocal exchange will disappear. If $\mu_0 > \bar{\mu}$, newborn agents (and all other agents) enter the market. The market size increases, and V_M^* increases. Subsequent generations will also choose market exchange, and the entire population will engage in market exchange.

B. *Inefficient Outcomes*

The gains from market exchange are highest when $\mu = 1$, and the gains from reciprocal exchange are highest when $\mu = 0$. It is socially efficient for everyone to engage in market exchange if the weighted gains from market exchange when $\mu = 1$, $V_M^*(1)$, exceed the gains from reciprocal exchange when $\mu = 0$, $V_R(c_R^*(0, x, \delta))$, and vice versa.[33] The utility

[31] Again, I restrict attention to equilibria in which the market group is the same size across commodities. Agents in the reciprocity group are paired and die in such a way so that, in equilibrium, μ_t of the agents who produce each commodity engage in market exchange in half period t.

[32] Propositions 3 and 4 for the existence of $0 \leq \bar{\mu} < 1$ also hold for enforceability constraint (10). In the discussion that follows it is assumed that $\delta \geq \underline{\delta}(x)$ so $\bar{\mu} \geq 0$. For $\delta < \underline{\delta}(x)$, reciprocity is never enforceable. In this case, $V_M^*(\mu_{t-1}) \geq V_R(c_R^*(\mu_{t-1}, x, \delta)) = 0$ for all μ_{t-1}, and agents choose the market.

[33] Since V_R^* is weakly decreasing in μ, it is possible that an intermediate value of μ could be weakly efficient.

from reciprocal exchange increases when commodities are more substitutable. So when x is large, reciprocal exchange is efficient, and when x is small, market exchange is efficient. Let $x^*(\delta)$ be the critical preferences: for $x > x^*(\delta)$ reciprocal exchange is efficient, and for $x < x^*(\delta)$, market exchange is efficient. (The Appendix proves the existence of $x^*(\delta)$.)

There are two inefficient outcomes to consider. First, reciprocal exchange survives even though market exchange is efficient. In this case, reciprocal exchange starts large, $\mu_0 \leq \bar{\mu}$, but agents' needs are rather precise, $x < x^*(\delta)$. Reciprocity is enforceable, so $V_R(c_R^*(\mu_0, x, \delta)) > V_M^*(\mu_0)$. But market exchange is efficient: $V_M^*(1) > V_R(c_R^*(0, x, \delta))$. These inequalities are not inconsistent. Since V_R^* is decreasing in μ, we have

$$(11) \quad V_M^*(1) > V_R(c_R^*(0, x, \delta)) \geq V_R(c_R^*(\mu_0, x, \delta)) > V_M^*(\mu_0).$$

Second, market exchange survives even though reciprocal exchange is efficient. In this case, the market starts large, $\mu_0 > \bar{\mu}$, but agents' needs are not very precise, $x > x^*(\delta)$. Reciprocity is not enforceable, so $V_M^*(\mu_0) > V_R(c_R^*(\mu_0, x, \delta)) = 0$. But reciprocal exchange is efficient $V_M^*(1) < V_R(c_R^*(0, x, \delta))$. Since V_M^* is increasing in μ, we have

$$(12) \quad V_R(c_R^*(0,x,\delta)) > V_M^*(1) \geq V_M^*(\mu_0) > V_R(c_R^*(\mu_0,x,\delta)) = 0.$$

In this economy, both inefficient outcomes could arise. There is a range of preferences where reciprocal exchange is efficient, but reciprocity is not enforceable at large market sizes. So if the market starts out large, it can destroy reciprocal exchange. There is also a range of preferences where the market is efficient, but reciprocity is enforceable at small market sizes. So if market exchange starts out small, reciprocal exchange can destroy the market.

This is true because $x^*(\delta)$, the critical preferences above which reciprocal exchange is efficient, is below $\bar{x}(\delta)$, the critical preferences above which reciprocity is enforceable for all market sizes. Recall from Proposition 4 that for $x < \bar{x}(\delta)$, agents differentiate enough between commodities so that $\bar{\mu} < 1$. For $\delta > \underline{\delta}(x)$ and $x < \bar{x}(\delta)$, reciprocity is enforceable when the market is small but not when the market is large. At $\bar{x}(\delta)$ itself reciprocity is enforceable at $\mu = 1$, so the utility from reciprocal exchange exceeds the utility from market exchange. At $x^*(\delta)$ the highest possible utility from reciprocal exchange exactly equals the utility from market exchange at $\mu = 1$. Since the utility from reciprocal exchange increases in x, it follows that $x^*(\delta) < \bar{x}(\delta)$. In Figure 2, $x^*(\delta)$ is the locus of points where $V_R(c_R^*(0, x^*, \delta)) = V_M^*(1)$. It would lie between $\underline{\delta}(x)$ and $\bar{x}(\delta)$ defined for enforceability constraint (10). Thus we have the following.

PROPOSITION 5: *For preferences in the range $x^*(\delta) < x < \bar{x}(\delta)$, reciprocal exchange is efficient, but if the market starts out too large, $\mu_0 > \bar{\mu}$, reciprocal exchange will disappear. For preferences in the range $x < x^*(\delta) < \bar{x}(\delta)$, market exchange is efficient, but when reciprocal exchange starts out too large, $\mu_0 < \bar{\mu}$, the market will disappear.*

IV. Examples

A. *The Breakdown of Reciprocal Exchange when Tribes Encountered Markets*

Reciprocal exchange was prevalent among tribal communities. When tribes encountered market systems, individuals abruptly had access to other means of exchange. In this situation, in contrast to the model, people who engage in reciprocal exchange are distinguishable from those who engage in market exchange. Yet it is clear from the model how introducing market exchange could undermine reciprocal exchange: opportunities for market exchange reduce the punishment for breaching

When the discount factor is high enough so that $c_R = \bar{u}$ is enforceable at $\mu = 0$, μ can increase without decreasing V_R^* until the enforceability constraint binds. When the discount factor is so low that no reciprocity is enforceable at $\mu = 0$, μ can increase without affecting V_R^* since $V_R^* = 0$ for all μ.

a reciprocal-exchange agreement[34] and provide access to new and different goods.

According to Yellen (1990), the !Kung lived in the Kalahari desert and subsisted by foraging for plants and hunting game. They supplemented their individual activities by exchanging food and tools through reciprocal exchange (Yellen, pp. 101–2):

> Families were expected to welcome relatives who showed up at their camps. Moreover, etiquette dictated that meat from large kills be shared outside the immediate family. ... By distributing his bounty, the hunter ensured that the recipients of his largess would be obliged to return the favor some time in the future.
>
> Similarly, individuals also established formal relationships with non-relatives in which two people gave each other gifts such as knives or iron spears at irregular intervals. Reciprocity was delayed, so that one partner would always be in debt to the other.

The spacial arrangement of villages facilitated reciprocity. Huts faced the center of the village so that villagers could easily see into them, and hearths were placed outside so that they could observe each others' food consumption.

The !Kung abandoned hunting and gathering and took up farming when they came in contact with farming communities. Yellen argues that farming was not more efficient per se. Rather, a major catalyst of change was the !Kung's sudden easy access to goods when the government of Botswana encouraged trade with the tribe. The !Kung began to accumulate commodities rather than rely on others to give them gifts, and they acquired objects which had been previously unavailable (Yellen, 1990 p. 105):

> Once the !Kung had ready access to wealth, they chose to acquire objects that had never before been available to them. Soon they started hoarding instead of depending on others to give them gifts, and they retreated from their former interdependence. At the same time, perhaps in part because they were ashamed of not sharing, they sought privacy.

The spatial arrangement of the village changed. The huts no longer faced inward, and hearths moved inside the huts. Individual !Kung apparently sought privacy because they did not want anyone to observe their consumption. They no longer abided by the rules of reciprocal exchange.

B. *The Use of Personal Connections as a Self-Sustaining System of Reciprocal Exchange*

In many contexts, people have reciprocal-exchange relationships with friends, relatives and colleagues to obtain goods, services, locate housing, find employment, and so on. These relationships can limit access to goods and services to those who have the "right connections" and create incentives for others to form and maintain reciprocal-exchange relationships. In this example, the information assumptions in the model match the reality. People do not know exactly who engages in reciprocal exchange and who does not, except for their own exchange partners. When a person enters a random store or government office or applies for a job, she does not know if she will find a person to help her or if the person is busy helping her friends and relatives. The more likely it is that an individual cannot obtain goods and services without the right connections, the more valuable are an individual's own connections. The more valuable are connections, the higher the cost of losing them and the more an individual is willing to give in order to maintain them. The more people give and the more effort they exert in fulfilling obligations to their exchange partners, the higher the gains from an exchange relationship.

Consider the case of Cairo, Egypt. Singerman (1995 p. 138) observes that people rely on informal relationships to obtain goods and services: "[reciprocity] networks are used to obtain publicly subsidized goods and services through local bureaucrats and political elites. ... Because demand outstrips supply and distribution is not equitable, informal networks are an efficient vehicle to obtain scarce goods." People also use connections to find

[34] See also discussion in Matthew Rabin (1989).

jobs and obtain credit: "In Egypt, it is not only individual effort, skills and capabilities that secure a job, but intermediaries and middlemen as well. Through informal networks individuals and groups create more opportunities to find a job, obtain credit ..." (p. 139).

Yet when people use connections to obtain goods and services, they exacerbate the conditions that support the use of connections. Singerman (1995) later notes, "At the same time however, because some people obtain jobs or laundry soap through informal networks, others are denied them when bureaucrats decide that the civil service cannot absorb any more new entrants or when the supply of soap has run out at the local cooperative" (p. 139). To survive in this setting, people must develop their own exchange relationships and connections, and their attitudes towards this type of "corruption" reflect this necessity. Singerman relates: "Charges of corruption are greeted with particular ambivalence in *sha'bi* (popular) communities. Although many people complain incessantly ... It is usually expected in large families that employees who have access to scarce goods will use their influence to obtain them" (p. 214).[35]

V. Conclusion

This paper investigates the durability of personalized exchange arrangements in the face of a market alternative. The study begins with a static environment, where the size of the market is exogenous. I find, first, that the utility from reciprocal exchange depends on the division of the population between reciprocal and market exchange. When the market is larger (smaller), the enforceable level of exchange between reciprocal-exchange partners is lower (higher). Second, whether reciprocity is possible at all depends on agents' preferences. When agents often need what their partners can produce and agents place a high enough value on future utility, reciprocity can be enforced at larger market sizes. The paper then considers a dynamic environment where agents who enter the economy choose between reciprocal and market exchange. I find that outcomes depend on the initial market size. When market (reciprocal) exchange starts out large, market (reciprocal) exchange survives. As a consequence, the economy will not necessarily converge on the efficient mode of exchange.

These results are borne out in examples of reciprocal exchange. There is evidence that the level of exchange in reciprocal agreements depends on the size of the market and that inefficient outcomes occur. When the !Kung gained access to markets, the level of reciprocal exchange dropped. They acquired many different goods and services. But they settled on farms and gave up their traditional hunting and gathering activities, which Yellen (1990) believes was more efficient. In Cairo and many other settings, it can be very difficult to obtain goods and services without informal exchange relationships. The "anonymous market" is small. People therefore go to great lengths to foster and maintain reciprocal-exchange relationships. This, in turn, increases the benefits of such relationships. While such personalized exchange can facilitate transactions in the absence of a well-functioning legal system, many would argue that overall economic welfare would be enhanced if personal connections were not so important.

The results also provide predictions as to when specific transactions will take place in organized markets or in personalized exchange relationships. Personalized exchange is less likely when pertinent goods are highly heterogeneous and people do not expect to interact frequently. On the other hand, when goods and services exchanged are very similar and the same people are seeking these same services time and time again, personalized exchange arrangements are likely to dominate.

The analysis here, then, suggests a complementary explanation to the widespread phenomenon of the "unraveling" of markets studied in Alvin E. Roth and Xiaolin Xing (1994). They document that in many entry level labor markets, as well as other markets, transactions are concluded earlier and earlier in time as participants

[35] Mayfair Mei-Hui Yang (1989) gives a remarkably similar account of attitudes towards corruption in China. While people condemn the "gift economy" and use of *guanxi* (connections), they also appreciate the ingenuity of individual exploits, and they feel that if everyone else is using *guanxi*, they should as well. For other accounts of *guanxi*, see Kwang-kuo Hwang (1987) and Souchou (1987).

arrange transactions just a little before their competitors, despite efforts to set a standard date and time for transactions to take place. They suggest a likely reason for this unraveling: the pairwise instability of matches in the market. If some agents exit the market early, others may prefer to move early as well.

While this may be the motivation for circumventing the market, it appears in some accounts that participants are able to do so thanks to long-term self-enforcing relationships. For example, major college football bowls were able to conclude informal agreements with teams before the official NCAA date. These agreements were binding because "the fact that the same bowls and teams are involved with one another year after year apparently makes it quite rare for such agreements to be broken" (Roth and Xing, 1994 p. 1101). In the market for judicial clerkships students were able to apply to judges early because professors would accommodate students' requests to send recommendation letters directly to judges, rather than to the placement office. Professors would do so because "there is considerable value to professors in maintaining a reputation for being a 'feeder' to good clerkships" (Roth and Xing, p. 1004). In these examples, agents were able to use personal relationships to arrange better matches. When they move early, however, the market yields worse outcomes. This creates incentives for others to establish such relationships, and the market unravels.

The analysis also suggests that personalized exchange is more likely to persist when it takes place among many interconnected individuals. Researchers have found that reciprocal exchange often takes place in *networks* (again see Singerman, 1995; Lomnitz, 1977). A network could increase the variety of goods and services that can be obtained through reciprocal exchange. Individuals have relationships with many different people who each provide a different good or service, and goods and services can be transferred from one person to another through the network. (Consider the offer: "I'll talk to so-and-so for you; he owes me a favor.") Networks could also make individual relationships easier to enforce. When the outcomes of bilateral interactions are observable or communicated to other network members, cheating one person could have repercussions on other relationships, and increase the punishment of reneging on an implicit exchange agreement. Moreover, large networks could narrow access to goods and services for those excluded from the network.

Following Coase (1937), economists have distinguished between markets and nonmarket institutions that govern economic transactions. Nonmarket institutions emerge, it is argued, to save on market transaction costs. The analysis in this paper indicates that transaction costs are not necessarily independent of the institutions that govern exchange. While a nonmarket institution might arise to save on market transaction costs, its existence might perpetuate or increase those very costs. Beyond coordination costs examined here, it might be the case that organizations that reduce transactions costs such as those that distribute price information, set standards, or certify quality, might not emerge or might evolve more slowly when transactions do not take place in markets.

The analysis in this paper, therefore, points to the imperative of a "general equilibrium" approach to the study of institutions.[36] Research on coalitions of long-distance traders, Roscas, and informal insurance arrangements has demonstrated the ability of nonmarket institutions and personalized relationships to reduce agency costs, smooth consumption, and facilitate exchange. This paper indicates that the interaction between nonmarket institutions and their alternatives could significantly affect how exchange takes place and, ultimately, the gains from trade. Further study of these interactions is likely to lead to a better understanding of the emergence, disappearance, and efficiency of different organizational forms.

APPENDIX

Existence of a Pure-Monetary Equilibrium

Let Π denote the probability that a random seller accepts money, and let π be the best response of an individual agent. For any $m \in (0,$

[36] R. Preston McAfee (1993) and Michael Peters (1994) endogenize the trading institutions in decentralized markets with anonymous buyers and sellers. Competing sellers choose trading mechanisms to attract buyers.

1), $s > 0$ and $b > 0$. When sellers produce at all costs $c \leq c_M$, a buyer's optimal value equation is

$$\text{(A1)}\quad V_b = sF(c_M)\Pi(\bar{u} + \delta V_s) + (1 - sF(c_M)\Pi)\delta V_b.$$

A seller maximizes utility by choosing π and c_M^*, given other sellers accept currency with probability Π and produce up to cost c_M. The optimal value equation for an individual seller is

$$\text{(A2)}\quad V_s = b \max_{\pi, c_M^*} \left[\pi \int_0^{c_M^*} (-c + \delta V_b)\, dF(c) + (1 - \pi F(c_M^*))\, \delta V_s \right].$$

PROPOSITION: *When* $\Pi = 1$, $\pi = 1$ *for any* $m \in (0, 1)$.

PROOF:

Suppose $\Pi = 1$. Then, for any $m \in (0, 1)$ and $c_M > 0$, $V_b > 0$. Since sellers do not consume, $V_b > V_s$. An individual seller's best response is to accept money with probability one: $\pi = 1$. Accepting money with any lower probability reduces his utility.

PROOF OF PROPOSITION 1:

By the Envelope Theorem

$$\text{(A3)}\quad \frac{dV_s(c_M^*(\mu), \mu)}{d\mu} = \frac{\partial V_s(c_M^*(\mu), \mu)}{\partial \mu}.$$

Differentiating

$$\text{(A4)}\quad \frac{\partial V_s^*}{\partial \mu} = \frac{\partial s}{\partial \mu} \left[\frac{b\phi F(c_M^*)\delta}{1 - \delta} \int_0^{c_M^*} (\bar{u} - c)\, dF(c) \right] + \frac{\partial (b\phi)}{\partial \mu} \left[\frac{sF(c_M^*)\delta}{1 - \delta} \int_0^{c_M^*} (\bar{u} - c)\, dF(c) - \int_0^{c_M^*} c\, dF(c) \right].$$

The first term is strictly positive because $\partial s/\partial \mu > 0$ and for any $\delta < 1$ an agent would never undertake a project that is more costly than or equal to the instantaneous level of utility; that is, $c_M^* < \bar{u}$. The second term is weakly positive since $V_s^* \geq 0$ and $\partial(b\phi)/\partial \mu > 0$.

PROOF OF PROPOSITION 2:

Maximize $V_R(c_R)$ subject to (9). Let the associated Lagrangian, $L(c_R, \mu, x, \delta, \theta)$ be

$$\text{(A5)}\quad L(c_R, \mu, x, \delta, \theta) = V_R(c_R, \mu, x, \delta) + \theta[\delta^2 V_R(c_R, \mu, x, \delta,) - c_R - \delta V_s^*(\mu)]$$

where θ is the Lagrangian multiplier on the constraint. By the Envelope Theorem,

$$\text{(A6)}\quad \frac{dV_R(c_R^*(\mu, x, \delta), \mu, x, \delta)}{d\mu} = \frac{\partial L(c_R^*(\mu, x, \delta), \mu, x, \delta)}{\partial \mu} = -\theta \frac{\partial \delta V_s(\mu)}{\partial \mu}$$

which is negative for $\theta > 0$ (constraint is binding), since by Proposition 1, $\partial V_s^*/\partial \mu > 0$. It is zero for $\theta = 0$ (constraint is not binding). Since $V_R(c_R)$ is increasing in c_R for $c_R < \bar{u}$, $c_R^*(\mu, x, \delta)$ must be (weakly) decreasing in μ.

PROOF OF PROPOSITION 3:

Let $\hat{c}(x, \delta)$ be the highest cutoff cost that maximizes the difference $\delta^2 V_R(c_R) - c_R$ for a given x and δ. Since $\delta^2 V_R(0) = 0$, $\delta^2 V_R(c_R)$ is increasing for $c_R < \bar{u}$ and is maximized at $c_R = \bar{u}$, $\hat{c}(x, \delta)$ exists, is unique, and $0 \leq \hat{c}(x, \delta) < \bar{u}$.

The Proof first shows $c_R^*(\mu, x, \delta) \geq \hat{c}(x, \delta)$, then establishes the following two results: (i) for any given x and δ, $\bar{\mu}(x, \delta) \geq 0$ if and only if $\delta^2 V_R(\hat{c}(x, \delta)) - \hat{c}(x, \delta) \geq 0$ and $\hat{c}(x, \delta) > 0$; (ii) for any x, $\exists \underline{\delta}(x) < 1$ such that for all $\delta \geq \underline{\delta}(x)$, $\delta^2 V_R(\hat{c}(x, \delta)) - \hat{c}(x, \delta) \geq 0$ and $\hat{c}(x, \delta) > 0$.

Proof that $c_R^*(\mu, x, \delta) \geq \hat{c}(x, \delta)$. Suppose $c_R^*(\mu, x, \delta) < \hat{c}(x, \delta)$. By definition, $c_R^*(\mu, x, \delta)$ satisfies (9): $\delta^2 V_R(c_R^*(\mu, x, \delta)) - c_R^*(\mu, x, \delta) \geq \delta V_s^*(\mu)$. By definition $\hat{c}(x, \delta)$ maximizes the difference $\delta^2 V_R(c_R) - c_R$. Therefore $\hat{c}(x, \delta)$ must also satisfy (9). Since $V_R(c_R)$ is increasing in c_R, $V_R(\hat{c}(x, \delta)) > V_R(c_R^*(\mu, x, \delta))$ and $c_R^*(\mu, x, \delta)$ is not the "optimal enforceable" cutoff cost.

Proof of (i). If $\delta^2 V_R(\hat{c}(x, \delta)) - \hat{c}(x, \delta) = 0$ and $\hat{c}(x, \delta) > 0$, then since $V_s^*(0) = 0$, $\hat{c}(x, \delta)$ is enforceable at $\mu = 0$. Since $\hat{c}(x, \delta)$ maximizes the difference $\delta^2 V_R(c_R) - c_R$ and V_s^* is increasing in μ, (9) is satisfied at $\mu = 0$ but not for any $\mu > 0$. Hence, $\bar{\mu}(x, \delta) = 0$. If $\delta^2 V_R(\hat{c}(x, \delta)) - \hat{c}(x, \delta) > 0$, then $\hat{c}(x, \delta) > 0$. Since $V_s^*(0) = 0$ and V_s^* is increasing in μ, (9) is satisfied for some $c_R^*(\mu, x, \delta) \geq \hat{c}(x, \delta) > 0$ for some $\mu > 0$. Hence $\bar{\mu}(x, \delta) > 0$.

If $\hat{c}(x, \delta) = 0$, $\delta^2 V_R(\hat{c}(x, \delta)) - \hat{c}(x, \delta) = 0$. Since $\hat{c}(x, \delta)$ maximizes $\delta^2 V_R(c_R)) - c_R$, there is no strictly positive production cost that satisfies (9) at $\mu = 0$. Since V_s^* is increasing in μ and (9) is not satisfied at $\mu = 0$, (9) cannot be satisfied at any market size.

Proof of (ii). Notice first that $\delta^2 V_R(\hat{c}(x, \delta)) - \hat{c}(x, \delta)$ is weakly increasing in δ. From the Envelope Theorem,

$$\text{(A7)} \quad \frac{d[\delta^2 V_R(\hat{c}(x,\delta),x,\delta) - \hat{c}(x,\delta)]}{d\delta} = \frac{\partial[\delta^2 V_R(\hat{c}(x,\delta),x,\delta) - \hat{c}(x,\delta)]}{\partial\delta}$$

which is positive since $\partial V_R/\partial\delta \geq 0$. When $\hat{c}(x, \delta) = 0$, $\partial V_R/\partial\delta = 0$; when $\hat{c}(x, \delta) > 0$, $\partial V_R/\partial\delta > 0$. As $\delta \to 0$, $\delta^2 V_R(c_R) \to 0$ for all values of c_R. So as $\delta \to 0$, $\delta^2 V_R(c_R)$ falls below c_R for all $c_R > 0$, and $\hat{c}(x, \delta) = 0$. Therefore as $\delta \to 0$, $\delta^2 V_R(\hat{c}(x, \delta)) - \hat{c}(x, \delta) = 0$, and as $\delta \to 1$, $\delta^2 V_R(\hat{c}(x, \delta)) - \hat{c}(x, \delta) \to \infty$. Since $\partial V_R/\partial\delta \geq 0$, for any given x there exists a $\underline{\delta}(x) < 1$ such that $\delta^2 V_R(\hat{c}(x, \delta)) - \hat{c}(x, \delta) = 0$ and $\hat{c}(x, \delta) > 0$. And for all $\delta > \underline{\delta}(x)$, $\delta^2 V_R(\hat{c}(x, \delta)) - \hat{c}(x, \delta) > 0$. Hence, for all $\delta \geq \underline{\delta}(x)$, $\bar{\mu}(x, \delta) \geq 0$.

PROOF OF PROPOSITION 4:

The Proof has two parts. Given $\delta \geq \underline{\delta}(x)$ so that a $\bar{\mu}(x, \delta) \geq 0$ exists: (i) for any given δ and x: $\bar{\mu}(x, \delta) < 1$ if and only if $\delta^2 V_R(\hat{c}(x, \delta)) - \hat{c}(x, \delta) < V_s^*(1)$; (ii) for any δ, $\exists \bar{x}(\delta)$ such that for all $x < \bar{x}(\delta)$, $\delta^2 V_R(\hat{c}(x, \delta)) - \hat{c}(x, \delta) < V_s^*(1)$.

Proof of (i). If for a given x and δ, $\delta^2 V_R(\hat{c}(x, \delta)) - \hat{c}(x, \delta) \geq V_s^*(1)$, then the enforceability constraint (9) is satisfied at $\mu = 1$. Because V_s^* is increasing in μ, (9) will also be satisfied at all $\mu \leq 1$. Hence, $\bar{\mu}(x, \delta) = 1$. If for a given x and δ, $\delta^2 V_R(\hat{c}(x, \delta)) - \hat{c}(x, \delta) < V_s^*(1)$, then the enforceability constraint (9) cannot be satisfied at $\mu = 1$. Because V_s^* is increasing in μ, (9) can only be satisfied at smaller market sizes. Hence, $\bar{\mu}(x, \delta) < 1$.

Proof of (ii). From the Envelope Theorem,

$$\text{(A8)} \quad \frac{d[\delta^2 V_R(\hat{c}(x,\delta),x,\delta) - \hat{c}(x,\delta)]}{dx} = \frac{\partial[\delta^2 V_R(\hat{c}(x,\delta),x,\delta) - \hat{c}(x,\delta)]}{\partial x}$$

which is positive since $\partial V_R/\partial x > 0$. There are two cases to consider. (a) Suppose that for a given δ at $x = 1$ and $\mu = 1$, $\delta^2 V_R(\hat{c}(1, \delta)) - \hat{c}(1, \delta) > V_s^*(1)$. Since $\delta^2 V_R(\hat{c}(x, \delta)) - \hat{c}(x, \delta)$ is increasing in x, there exists an $\bar{x}(\delta) < 1$ such that $\delta^2 V_R(\hat{c}(\bar{x}, \delta)) - \hat{c}(\bar{x}, \delta) = V_s^*(1)$. And for all $x < \bar{x}(\delta)$, $\delta^2 V_R(\hat{c}(\bar{x}, \delta)) - \hat{c}(\bar{x}, \delta) < V_s^*(1)$. (b) Suppose that for a given δ at $x = 1$ and $\mu = 1$, $\delta^2 V_R(\hat{c}(1, \delta)) - \hat{c}(1, \delta) \leq V_s^*(1)$. Then $\bar{x}(\delta) = 1$. For all $x < 1$, $\delta^2 V_R(\hat{c}(1, \delta)) - \hat{c}(1, \delta) < V_s^*(1)$.

Existence of $x^*(\delta)$

When the discount factor is so low that reciprocity is not enforceable at $\mu = 0$ even when $x = 1$, that is, when $\delta < \underline{\delta}(1)$, $V_M^*(1) > V_R(c_R^*(0, 1, \delta)) = 0$. Market exchange is efficient for all x: $x^*(\delta) = 1$. As δ increases above $\underline{\delta}(1)$, $V_R(c_R^*(0, 1, \delta))$ increases. There exists a $\delta' < 1$ sufficiently high so that $V_R(c_R^*(0, 1, \delta')) = V_M^*(1)$. This is because there exists a $\delta < 1$ sufficiently large so that

$c_R = \bar{u}$ is enforceable at $\mu = 0$ and $x = 1$. In market exchange, in contrast, for all $\delta < 1$, $c_M^* < \bar{u}$ and the probability of finding a trading partner in the market is always less than 1 (even when $\mu = 1$). At this critical discount factor, $V_R(c_R^*(0, 1, \delta')) = V_M^*(1)$ and $x^*(\delta') = 1$. For all higher discount factors, we have $V_R(c_R^*(0, 1, \delta)) > V_M^*(1) > V_R(c_R^*(0, \underline{\delta}^{-1}(\delta), \delta))$. Since $V_R(c_R^*(0, x, \delta))$ is increasing in x, there exists an $1 > x^*(\delta) > \underline{\delta}^{-1}(\delta)$ such that $V_M^*(1) = V_R(c_R^*(0, x^*, \delta))$.

To see that $V_M^*(1) > V_R(c_R^*(0, \underline{\delta}^{-1}(\delta), \delta))$ for all $\delta \geq \underline{\delta}(1)$, notice first that since $V_R(c_R^*(0, 1, \delta)) \geq V_R(\hat{c}(1, \delta))$ and $V_R(\hat{c}(1, \delta)) > V_R(\hat{c}(\underline{\delta}^{-1}(\delta), \delta))$, $V_R(c_R^*(0, 1, \delta)) > V_R(\hat{c}(\underline{\delta}^{-1}(\delta), \delta))$. Hence, for $\underline{\delta}(1) < \delta \leq \delta'$, $V_M^*(1) > V_R(\hat{c}(\underline{\delta}^{-1}(\delta), \delta))$. Now consider discount factors $\delta > \delta'$. At δ', $V_R(c_R^*(0, 1, \delta')) = V_M^*(1) > V_R(\hat{c}(\underline{\delta}^{-1}(\delta'), \delta'))$. This implies $V_M^*(1) - \hat{c}(\underline{\delta}^{-1}(\delta'), \delta') > V_R(\hat{c}(\underline{\delta}^{-1}(\delta'), \delta')) - \hat{c}(\underline{\delta}^{-1}(\delta'), \delta') = 0$. It is not possible at some higher δ that $V_M^*(1) - \hat{c}(\underline{\delta}^{-1}(\delta), \delta) \leq 0$; that is $V_M^*(1) > V_R(c_R^*(0, \underline{\delta}^{-1}(\delta), \delta))$ always. As δ increases, the difference $V_M^*(1) - \hat{c}(\underline{\delta}^{-1}(\delta), \delta)$ increases since $\hat{c}(\underline{\delta}^{-1}(\delta), \delta) < \bar{u}$. As $\delta \to 1$, $V_M^*(1) - \hat{c}(\underline{\delta}^{-1}(\delta), \delta) \to \infty$.

Endogenous Market Size

Let Γ denote the probability that a newborn agent enters the market at the beginning of a period t, and let γ be the best response of an individual agent. Consider the following strategy for agents born at the beginning of half period t: $\Gamma = 1$ if $V_M^*(\mu_{t-1}) \geq V_R(c_R^*(\mu_{t-1}, x, \delta))$ and $\Gamma = 0$ if $V_M^*(\mu_{t-1}) < V_R(c_R^*(\mu_{t-1}, x, \delta))$.

PROPOSITION: *The above strategy constitutes a Nash equilibrium.*

PROOF:

Given $\Gamma = 0$ if $V_M^*(\mu_{t-1}) < V_R(c_R^*(\mu_{t-1}, x, \delta))$, the market size decreases: $\mu_t < \mu_{t-1}$. Since V_R^* is decreasing in μ and V_M^* is increasing in μ, $V_M^*(\mu_t) < V_R(c_R^*(\mu_t, x, \delta))$. Agents entering the economy in period $t + 1$ will also enter the market with probability $\Gamma = 0$. The market size decreases again, so in $t + 1$ $V_M^*(\mu_{t+1}) < V_R(c_R^*(\mu_{t+1}, x, \delta))$. Agents entering the economy in period $t + 2$ will also enter the market with probability $\Gamma = 0$, and so on. Reciprocal exchange yields higher utility in period t and all subsequent periods. Therefore, an individual agent's best response is $\gamma = 0$.

Given $\Gamma = 1$ if $V_M^*(\mu_{t-1}) \geq V_R(c_R^*(\mu_{t-1}, x, \delta))$, the market size increases: $\mu_t > \mu_{t-1}$. Since V_R^* is decreasing in μ and V_M^* is increasing in μ, $V_M^*(\mu_t) > V_R(c_R^*(\mu_t, x, \delta))$. Agents entering the economy in period $t + 1$ will also enter the market with probability $\Gamma = 1$, and so on. Hence, an individual agent's best response is $\gamma = 1$.

PROOF OF PROPOSITION 5:

The Proof shows that $\bar{x}(\delta) > x^*(\delta)$ when $\underline{\delta}^{-1}(\delta) < x^*(\delta) < 1$. By definition of $\bar{x}(\delta)$, $\delta^2 V_R(\hat{c}(\bar{x}, \delta)) - \hat{c}(\bar{x}, \delta) = V_M^*(1)$. By definition of $x^*(\delta)$, $V_R(c_R^*(0, x^*, \delta)) = V_M^*(1)$. Since $V_R(c_R^*(0, x^*, \delta)) > 0$, $c_R^*(0, x^*, \delta) > 0$. Recall from the proof of Proposition 3 that $c_R^*(0, x, \delta) \geq \hat{c}(x, \delta)$. Therefore, since $c_R^*(0, x^*, \delta) \geq \hat{c}(x^*, \delta)$ and V_R is increasing in c_R:

$$\text{(A9)} \quad V_R(c_R^*(0, x^*, \delta)) \geq V_R(\hat{c}(x^*, \delta)).$$

Notice next that $c_R^*(0, x^*, \delta) > 0$ implies $\hat{c}(x^*, \delta) > 0$. Clearly, if $c_R^*(0, x^*, \delta) = \hat{c}(x^*, \delta)$, then $\hat{c}(x^*, \delta) > 0$. If $c_R^*(0, x^*, \delta) > \hat{c}(x^*, \delta)$, since $\hat{c}(x^*, \delta)$ maximizes the difference $\delta^2 V_R - c_R$ and $c_R^*(0, x^*, \delta)$ is enforceable, we have $\delta^2 V_R(\hat{c}(x^*, \delta)) - \hat{c}(x^*, \delta) > \delta^2 V_R(c_R^*(0, x^*, \delta)) - c_R^*(0, x^*, \delta) \geq 0$. This implies $\hat{c}(x^*, \delta) > 0$. Because $\hat{c}(x^*, \delta) > 0$, it follows from (A9) that $V_R(c_R^*(0, x^*, \delta)) > \delta^2 V_R(\hat{c}(x^*, \delta)) - \hat{c}(x^*, \delta)$. This inequality and the definitions of $x^*(\delta)$ and $\bar{x}(\delta)$ above imply

$$\text{(A10)} \quad \delta^2 V_R(\hat{c}(\bar{x}, \delta)) - \hat{c}(\bar{x}, \delta) > \delta^2 V_R(\hat{c}(x^*, \delta)) - \hat{c}(x^*, \delta).$$

Since $\delta^2 V_R(\hat{c}(x, \delta)) - \hat{c}(x, \delta)$ is increasing in x, (A10) implies $\bar{x}(\delta) > x^*(\delta)$.

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