Social Capital and Growth*

Bryan R. Routledge †
Joachim von Amsberg ‡

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Abstract

We define and characterize social capital in a simple growth model. Like the physical, human and technological forms of capital, social capital can significantly impact welfare. We capture social capital in a model where individuals in a community maximize their lifetime gains to trade. Each trade between two members of a community has the structure of the prisoners’ dilemma. Trades are repeated indefinitely, but not necessarily each period. Social capital is defined as the social structure which yields cooperative trade as an equilibrium. We describe how social capital is a public good. Private investment in social structures need not lead to an efficient outcome. The trading model is then incorporated into a growth model to explore the connections between growth, labor mobility, and social capital. The key assumption is that technological innovation, which drives growth, involves a reallocation of resources. In particular, technological change is accompanied labor relocation. This change in the social structure effects the social capital. Modifying the responsiveness of labor to a technological shock, has implications for both labor efficiency and social capital. Since both impact welfare, it is not the case that frictionless labor mobility is optimal.

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†GSIA, Carnegie Mellon University
‡The World Bank
1 Introduction

Capital is an important determinant of prosperity. The improvement in the quality and quantity of tools and machines enhances the productivity of labor and, therefore, well being. However, capital need not be just physical. Human Capital, in the form of skills, education and training, is also an important component of productivity (see Becker (1964)). Organizational Capital, the system of organizations to process information (Prescott and Visscher (1980)), or more generally, a business’s technological know-how (Ronen (1990)) are further examples of non-physical capital. Similarly, Coleman (1990), Putnam, Leonardi, and Nanetti (1993), and Putnam (2000) all recognize that the social structure is an important determinant of the feasibility and productivity of economic activity. Relationships between individuals, norms and trust all help facilitate the coordination and cooperation which enhances productivity.

Putnam (2000) notes that the first usage of “social capital” was L.J Hanifan, a social reformer, who in 1916 chose the word “capital” specifically to highlight the importance of the social structure to people with a business and economics perspective.\(^1\). Despite its importance, there are few models which capture the economic productivity of social capital. In fact, there is no single accepted definition of social capital. Coleman chooses to define social capital loosely in terms of its function. Social capital, he argues, is some aspect of the social structure “making possible the achievement of certain ends that would not be attainable in its absence” (page 302). A more useful starting definition is provided by Putnam, Leonardi, and Nanetti (1993). They define social capital as the social structure which facilitates coordination and cooperation.

Despite the difficulty in formulating a definition suitable for a tractable economic model, a great deal of research has been done to measure social capital and its effects. Putnam, Leonardi, and Nanetti (1993) argue that the success and failure of the regional governments established in Italy can be explained by social capital. They find that traditions of civic engagement, voter

\(^1\)Putnam (2000) page 443
turnout, active community groups and other such measurable manifestations of social capital are necessary for good government. There is some interesting evidence of the empirical connection between social capital and economic and financial development in Italy. Guiso, Sapienza, and Zingales (2001) measure social capital, as is standard in much of the sociology research, using a variety of indicators like participation levels in associations, election turn out, and other measures of civic involvement. They find that the level of social capital is positively related to financial development. People with more social capital have higher investments in the stock market and have more access to formal financial institutions. However, the connection between economic prosperity and social capital is not always clear. Putnam (2000) documents, in great detail, the large decline in social capital in the United States in the twentieth century. While, this fact is linked to some economic measures, it is hard to argue that the U.S. economy did not flourish over this same period.

An important step to understanding of social capital it is to develop tractable economic models that can both define and measure social capital, understand how it influences welfare, and how social capital is modified by policy. With this goal in mind, we develop a simple, hopefully tractable, model of social capital that captures some of the important characteristics of social capital and economic activity. For concreteness, we focus on social capital as influencing cooperative behavior. The necessity of cooperation stems from the expense or difficulty in writing complete and enforceable contracts. In these situations, trust or cooperation reduces contracting costs. Often, without cooperative behavior, the transaction may not even be feasible. The social structure that facilitates trust is a form of social capital. Since externalities are pervasive in modern economic life, the social capital which mitigates externalities is productive and potentially extremely important.2

While not directly addressing social capital, some economic research does

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2 Using a prisoner's dilemma to model gains to trade is related to the large body of research on institutions and transactions costs. The work of Williamson (1985), North ((1987), (1991) focusses on measuring the size, nature, and determinants of transaction costs.
focus on the economic consequences of the social structure. Congleton (1991), for example, determines when a work ethic will be productive. A “work culture” which motivates work for its own sake has obvious advantages in economies where joint production is important. Similarly, Akerlof (1980) and Romer (1984) raise similar issues: Preferences over social norms affect production. Chirinko (1990) provides a different avenue for social capital to directly affect preferences. The model uses dual utility where an agent’s decision is the result of a “bargaining” between altruistic and egotistical sub-agents. Social capital influences the relative bargaining strengths of the sub-agents. Roughly stated, since one feels more charitable in a monastery than in a shopping center, building monasteries increase social capital.

In contrast to preference-based models of social capital, we consider social capital in a model with standard self-interested preferences. Here, individuals receive no additional utility from the act of cooperating nor from following external norms. Instead, we define social capital as facilitating the Pareto optimal equilibrium. At the core of the model is bilateral trade where the gains from the trade are a prisoner’s dilemma. Friendly trade is Pareto optimal but unfriendly trade is the dominant strategy in a one-shot game. This payoff structure captures externalities that are pervasive due to the expense and/or inability to write complete, enforceable contracts. In our model individuals living in a community, maximize their lifetime gains to trade. In each period, any two agents from a community will meet at most once. However, trading opportunities are stochastic and an agent pair may go several periods without meeting. Since, the trading game is repeated indefinitely, cooperative or friendly trade is a potential equilibrium. However, for friendly trade to be an equilibrium, trade must be frequent enough to induce agents not to act opportunistically. We use this framework to define social capital as influencing the frequent trade.

The interpretation of social capital we use in this paper as facilitating cooperation in repeated play is specific. Researchers that measure the “quantity”
social capital tend to take a more broad view. Putnam (2000) draws the analogy to many different types and uses of physical capital. He measures social capital primarily by observing participation in political, civic, and religious activities. In contrast, Burt (1992) focuses more on characterizing the network topology between individuals. A person’s location in a network determines their social capital. In our model we treat the communities created by participation or the network connections between individuals as the given social structure. Using our model, we can then determine the “quantity” of social capital, by looking at the equilibrium outcome of the trading game given the social structure. This allows us to focus more directly on the economic consequences of social capital.

In this simple context, we explore several aspects of social capital. First, in Section 2, we develop the simple trading model that defines social capital. Through some examples, we demonstrate that social capital is a public good. Private investment in social structures need not lead to an efficient outcome. However, we demonstrate that social capital destruction can make everyone worse off, better off, or be Pareto non-comparable. The model highlights an important trade-off. In larger communities, which have more opportunity for trade or are more efficient, cooperative trade is harder to sustain. We develop this tension in more detail in Section 3. This section incorporates the trading model into a growth context to explore the connections between growth, labor mobility, and social capital. The key assumption is that technological innovation, which drives growth, involves a reallocation of resources. In particular, technological change is accompanied with higher labor turnover. This change in the social structure effects the social capital. Modifying the responsiveness of labor to a technological shock, has implications for both labor efficiency and social capital. Since both impact welfare, it is not the case that frictionless labor mobility is optimal.

3In the repeated game, equilibrium cooperation is supported by the threat of future unfriendly trade in the bilateral game. This abstracts from the more general adherence to social norms. There is more to social capital than the reciprocity we focus on here. As Yogi Bera said: “You should always go to other people’s funerals; otherwise, they won’t come to yours.”
2 Simple Model of Social Capital

In this section, we consider a model of $M$ communities each with $N_m$ individuals. Initially, we focus on the activities in one community. Consider a community of $N$ individuals. In each period, $t \in \{0, 1, \ldots\}$, they may trade with some of the members in their community. Trader seek to maximize their expected lifetime total discounted gains from trade. Each transaction involves two agents who choose whether to trade in a friendly (cooperate or $c$) or unfriendly (exploit or $d$) manner. Gains from trade, arising from the choices of the agents, are modeled as having the structure of the familiar prisoners’ dilemma whose payoffs, for concreteness, are shown in Table 1. This structure to the trades can reflect contracting cost. Friendly trade is more efficient since fewer resources are wasted on contracting, measuring, and enforcing. However, since trade without formal contracts involves trust, a friendly trade may be exploited by the other party. Unfriendly trade can be viewed as both parties attempting to exploit the other. The result is a less efficient trade where resources are consumed by formal contracting and measurement. However, the structure of payoffs is consistent with many types of externalities.

In any one period, any two agents will meet at most once. However, since each meeting is probabilistic, two agents may go several periods without trad-

\begin{table}[h]
\centering
\begin{tabular}{ccc}
\hline
 & \textit{Trader 0} & \textit{Trader j} \\
\hline
\textit{c} & (2, 2) & (0, 3) \\
\textit{d} & (3, 0) & (1, 1) \\
\hline
\end{tabular}
\caption{Gains to trade per meeting. Payoffs to the trade are shown as (Trader 0, Trader j). For concreteness, specific payoffs are used. This is without loss of generality.}
\end{table}

\footnote{This section is adapted from Routledge and von Amsberg (1996).}
ing with one another. Preferences are time-additive and risk neutral. The preferences for trader 0 are:

\[ U_0 = (1 - \beta) \sum_{t=0}^{N-1} \beta^t \left\{ \sum_{j=1}^{N-1} \pi_{0j}(x_t) u(s_{0j}(x_t), s_{j0}(x_t)) \right\} \]  

(1)

\( \beta \in (0, 1) \) is a discount factor, which for simplicity, is the same for everyone. \( x_t \) represents the trading history or past actions of the traders in periods 0 to \( t - 1 \). What is included in the history, \( x_t \), has important implications for our model and is discussed further below. \( \pi_{0j}(x_t) \) is the probability that trader 0 and \( j \) meet at period \( t \). The probability of meeting may, in general, depend on the history of trade. Traders 0 and \( j \) can meet as often as once in a period and, of course, \( \pi_{0j}(x_t) = \pi_{j0}(x_t) \). The payoff, \( u \), from the trade between 0 and \( j \) depends on the actions of the two traders and is given in Table 1. The actions of the traders, \( c \) or \( d \), are determined by the strategies of the players. The strategy of individual 0 is \( s_0 = \{ s_{0j} \}_{j=1}^{N-1} \), where \( s_{0j}(x_t) \) determines the action, \( c \) or \( d \), when trading with individual \( j \) having observed the history \( x_t \).

To help us define and consider social capital, we make some specific assumptions. Each of these assumptions is discussed further in Section 2.3.

**Assumption (i): Trade is pair-wise.** Our model assumes that opportunities for gains from trade arise between two agents. There is no collective action or team production. Our model differs, therefore, from models which treat social dilemmas as N-person prisoners’ dilemmas such as Olson (1965), Bendor and Mookherjee (1987), and Hirshleifer and Rasmusen (1989).

**Assumption (ii): Games are Private.** No agent can observe or obtain information on the actions between other agents. Therefore, we restrict a strategy for trader 0 for playing \( j \) to depend only on the past trades between these two agents 0 and \( j \). Even if information about past play is completely private, agent 0 could base his move with \( j \) on the past behavior of anyone in the population. However, we rule these strategies out.

**Assumption (iii): All gains from trade are non-negative.** In particular, it is
important that the payoff when both agents play $d$ is strictly positive. When agents do not meet, they earn zero since there is no trade. Individuals strictly prefer an unfriendly trade to no trade at all.

**Assumption (iv):** *Meeting for Trade probability is history independent.* In the examples we will assume that this probability is the same for all agent pairs. It will depend on community size. In particular, we assume $\pi_{ij}(x_i)$ is a constant that we will denote $\pi_{ij}$.

**Assumption (v):** *Agents will trade cooperatively if it is an equilibrium.* The agents are playing a repeated prisoners’ dilemmas (in fact $N$ of them simultaneously). By the folk theorem, there are possibly many sub-game perfect equilibria. To highlight the role of social capital, we will concentrate on strategies which support only repeated cooperation or repeated defection along their equilibrium path. We abstract from the complex question of how agents choose and arrive at an equilibrium. Unfriendly trade, where only $(d, d)$ trades are observed, is always a sub-game perfect equilibrium since it is a Nash equilibrium of the stage game. The strategy profile where all agents choose $d$ for all trades regardless of history will be called $s^d$. Friendly trade is where only $(c, c)$ trades are observed in equilibrium. A strategy profile which will potentially support friendly trade is for all agents to use the a trigger strategy for play in all $N$ games: When playing agent $j$, play $c$ initially and play $c$ as long as the history of trades with $j$ with contains only $(c, c)$ trades, otherwise play $d$. This strategy profile is denoted $s^c$. Whether or not all traders following $s^c$ is an equilibrium will define the existence of social capital.

### 2.1 Social Capital Definition

Social capital is not easily defined. Coleman (1990), who pioneered consideration of the economic importance of the social structure, defines social capital in terms of its function. Social capital, he argues, is some aspect of the social structure “making possible the achievement of certain ends that would not
be attainable in its absence” (page 302). However, we will use the more concrete definition of Putnam, Leonardi, and Nanetti (1993) that social capital is the social structure which facilitates coordination and cooperation. In the trading environment we have described, social capital exists in a community when friendly trade, \( s^f \), is an equilibrium and does not exist when the only equilibrium is the unfriendly, \( s^d \), trade. In our model, social capital will exist between two players 0 and \( j \) in a community if the probability that the two traders meet, \( \pi_{0j} \), is high enough.

**Proposition 1:** For the trade of player 0 and player \( j \), the strategies \( s^0 \) and \( s^j \) are a sub-game perfect equilibrium if and only if \( \pi_{0j} > \pi^e \) where \( \pi^e = \frac{1-\beta}{\beta} \).

Cooperative trade is not supportable if \( \beta < 0.5 \).

The proof, which is standard, is in the appendix. Cooperative trade, supported by \( s^e \), is an equilibrium as long as each individual trader values the future cooperative trade more than the one-time gain of an exploitive trade (playing \( d \) when the other plays \( e \)) followed by unfriendly trade at subsequent meetings. For friendly trade to be an equilibrium, it must be the case that individuals meet frequently (\( \pi_{0j} \) is high) and are sufficiently patient (large \( \beta \)). The social structure determines the frequency of trade, \( \pi_{0j} \).

Finally, we can calculate the total value of future trades for individual 0 in a community since in equilibrium, the individual will earn 2 (see Table 1 if the trade are friendly (\( \pi_{0j} \geq \pi^e \)) or 1 if the trade is unfriendly.

\[
U_0 = \sum_{\{j|\pi_{0j} \geq \pi^e\}} 2\pi_{0j} + \sum_{\{j|\pi_{0j} < \pi^e\}} 1\pi_{0j}
\]  

(2)

### 2.2 Examples of Social Capital

We have defined social capital as facilitating friendly trade. In our model, friendly trade is determined by the probability two individuals meet in a period, \( \pi_{ij} \). To make the definition of social capital useful, we need an assumption
that links this probability of trade to a more primitive feature of the economy. Here, we will focus on community size. Larger communities provide more opportunity for trade, but trade is more anonymous. These features are captured in the following assumption:

Assumption (vi): The probability of trade for all individuals $i$ and $j$ in a community of size $N$ is given by $\pi_{ij} = \pi(N) = \min \left(1, \frac{N}{N-1}\right)$ This assumption reflects that there is a limited amount of time in a day (period) for trade. Individuals have a maximum capacity for trade of $\bar{N}$ trades per period. If they live in a community of size $N < \bar{N}$ they will trade at most $N$ times per period.

The following examples demonstrate that social capital is a public good that may be subject to both “under-investment” and “over-investment.” We will consider several simple examples using the model developed thus far. In each of the examples, a financially viable project may destroy social capital. The examples are similar in that increasing the number of opportunities to trade can affect the equilibrium at which those trades occur and thus affect social capital.

Consider two communities, $L$ and $R$. At present, the two communities are separate and the $N_L$ individuals in $L$ do not trade with the $N_R$ people in community $R$. We will consider an innovation that allows the agents in $L$ to emigrate to $R$. For concreteness, imagine a bridge constructed between the two communities. The bridge changes the social structure of the economy and we will consider the impact of the bridge on social capital.\footnote{The model assumes the social structure to be fixed. In particular, $\pi_{ij}$ are assumed to be constant. Formally, the construction of a bridge is not an anticipated change and is analogous to a comparative static exercise. This is just for expositional purposes. In Section 3 we formally consider changes in the social structure that arise from a technological shock that all agents correctly anticipate.}
2.2.1 Social Capital Under-Investment

The first example demonstrates how the construction of a bridge destroys social capital and leaves all the agents worse off. This example is parameterized by $\beta = 0.55$, each community initially has $N = 3$ individuals, and $\bar{N} = 3$ trading opportunities per period. That is, in each community, each person trades twice.

The critical probability required to support friendly trade is $\pi^c = 0.818$. In each community, the probability of meeting each other is sufficiently high to support friendly trade; that is $\pi(3) = 1 > \pi^c$. All individuals have utility of 4 ($2 \text{ trades per period} \times 2 \text{ per trade}$). If the bridge simply serves to unite the two communities, the new larger community has $N_{LR} = 6$. In this case, the probability of any agent pair meeting is now $\pi(6) = 3/5 < \pi^c$ and friendly trade is no longer an equilibrium. In the larger community each agents' utility has decreased to 3 ($3 \text{ trades per period} \times 1 \text{ per trade}$). Despite the increased opportunities for trade, each agent is worse off since each gain from trade now occurs on unfriendly terms.

Despite the fact that the bridge is Pareto decreasing, it is in each agents' individual interest to use the bridge. Instead of assuming the bridge simply unites the communities, we can consider an individual's choice to use the bridge to emigrate. Consider for simplicity, the situation where the bridge is temporary. Individuals in community $L$ have a one-time opportunity to emigrate to $R$. It is a dominate strategy for individual 0 in $L$ to use the bridge to emigrate. If others choose not to move, by moving to $R$, she would increase her utility (and the utility of current residence of $R$) from 4 to 6 ($3 \text{ trades} \times 2 \text{ per trade}$). If at least one other person in $L$ chooses to move, individual 0 must also move. Remaining in the now smaller community $L$ yields a utility of 2 (one friendly trader per period) or 0 (no trade if both other agents move). Even though agent 0 realizes her decision to emigrate to $R$ will result in unfriendly trade ($\pi(5) = 3/4$ and $\pi(6) = 3/5$ are both less than less than $\pi^c$), the greater number of opportunities for trade makes
moving optimal, yielding a utility of 3 (3 trades per period \( \times 1 \) per trade). Since moving is a dominant strategy, everyone from \( L \) will move to \( R \) despite the loss of social capital.\(^6\)

If the bridge is a permanent structure which people can choose to use at any period as part of a repeated game, the resulting game is more complicated. Assume that people cannot discriminate based on the origin of the player and emigration depends only on community size.\(^7\) First note that if \( N_L \leq 2 \), individuals will emigrate from \( L \) to \( R \) since the one friendly trade is inferior to three unfriendly trades. Given this, consider agent 0’s choice to emigrate to \( R \) when \( N_L = N_R = 3 \). In this case, not emigrating and maintaining the status quo results in a utility of 4. Emigrating gives a one period utility based on three friendly trades in the first period. However, in the next period, when the other two \( L \)-individuals emigrate to \( R \), trade is unfriendly. Therefore, agent 0 will emigrate if: \( 4 < (1 - \beta)6 + \beta 3 \), or equivalently, if \( \beta < \frac{1}{3} \). Therefore, in this example with \( \beta = 0.55 \), the status quo with two communities with social capital (friendly trade) is not an equilibrium. The construction of the bridge destroys social capital.

The introduction of a bridge leads to a sub-optimal community size since individuals ignore their externality on the social capital. The externality has two parts. Emigrating from community \( R \), can affect the set of possible equilibria making friendly trade no longer viable for all individuals in \( R \). In addition, the emigrating trader leaves behind a community with reduced opportunities for trade. The desire not to live in too small a community that makes emigration the dominant strategy. This example captures the important under-investment problem with social capital: “...[A] family’s decision to move away from a community ... may be entirely correct from the point of view of the

\(^6\) Of course, the assumption that individuals move from \( L \) to \( R \) can trivially be replaced with the assumption that people move from \( R \) to \( L \). If however, we do not specify the direction of movement, there are multiple equilibria. Both everyone moving to \( L \) or moving to \( R \) are equilibria. In addition there is at least one mixed strategy equilibrium. For example, a symmetric mixed strategy equilibrium is each agent choosing to move with probability 0.5.

\(^7\) If agents can discriminate based on community of origin, then the bridge need not affect social capital. We revisit this point in Section 2.3.
family. But because social capital consists of relations among persons, others may experience extensive loss” (Coleman (1990) page 316).

We can view the forgoing of trade opportunities as an investment in social capital. The example demonstrates that agents under-invest in social capital. Interestingly, the externality which causes the under-investment is a “second-order externality” in that it does not directly affect utility. It is not, for example, increased pollution. Social capital destruction affects the community’s ability to mitigate the first-order externality contained in the trade. The bridge causes each trades to be less frequent and therefore less efficient since it eliminates the viability of the friendly trade solution to the prisoners’ dilemma.

The example captures the migration from rural communities to large cities that occurs in developing countries. For example, many development projects are designed to provide infrastructure. These investments usually facilitate market integration by providing mobility. Decreasing transportation costs or improving telecommunication can act as the bridge between communities. In addition, highly skilled and able-bodied agents have the most to gain from migration. Our model does not capture this aspect as all gains from trade are identical. However, it seems apparent that this will aggravate the social capital decay in rural communities since rural communities not only become smaller but also less skilled.

Finally, note that constructing a bridge between the two communities is not an unreasonable project. An entrepreneur could construct the bridge and charge a toll for its use and make a profit. People would pay a price to use the bridge even though everyone in the two communities are made worse off by the bridge. The bridge is a financially viable project because the entrepreneur does not bear the cost of the destroyed social capital. For example, measuring the bridge’s value by a willingness-to-pay measure overstates the bridge’s value since individuals do not consider the externality their move has on social capital.
Increasing specialization is important for increases in productivity and growth. However, failing to consider the social implications of increased mobility, which in practice may be much harder to measure, can lead to Pareto decreasing investments. The possible connection between growth and social capital is considered further in Section 3.

2.2.2 Social Capital Under-Investment

Assume there are three communities each with two agents and the other parameters identical to the previous example. Bridges connecting these communities would create a single large community with six agents \((N = 6)\). Each agent’s utility would increase from one friendly trade, yielding \(U = 2\) to three unfriendly trades giving a utility of \(U = 3\). The increased opportunities for trade outweigh the costs of destroying social capital.

2.2.3 Social Capital Investment is Pareto Non-Comparative

In the first example, a change in social capital led to a reduction in each individual’s welfare. In the second example, all agents were made better off by eliminating social capital. Changes in social capital, however, need not be Pareto comparable. Consider the situation with one small community with \(N_L = 2\) people and a larger community with and \(N_R = 4\) people. The other parameters are the same as the previous examples. The construction of a bridge to link the two communities will improve the utility of the individuals in \(L\) (from 2 to 3) and reduce the utility of agents in community \(R\) (from 6 to 3). Social capital is destroyed since the bridge facilitates emigration to community \(R\) which eliminates friendly trade. In addition, the average of all agents’ utility is decreased because of the bridge. However, the situation with and without the bridge are Pareto non-comparable.

The example highlights a difficult policy issue surrounding social capital. Putnam, Leonardi, and Nanetti (1993) points out that “Social inequities may
be embedded in social capital. Norms and networks that serve some groups may obstruct others” (page 42). In this example, the social structure (the isolation of community $I$) benefits one community at the expense of the other. Public policy goals of equity or equal opportunity may make social capital destruction (bridge construction) desirable. Equity considerations may be particularly predominant when the separation of communities is based on ethnic or racial discrimination. School desegregation in the United States is perhaps one such example where equity considerations were of primary importance.\footnote{\cite{Putnam2000}}

### 2.3 Key assumptions Revisited

To complete this section on examples of social capital, it is helpful to look at the how each of the key assumptions effects the results.

**Assumption (i): Trade is pair-wise.**

The analysis was constructed assuming that the agents play $N$ separate (and simultaneous) iterated, two-person prisoner dilemma games. A large number of models where group size plays a role in the group’s ability to achieve a Pareto efficient outcome are $N$-person games. These contrast with our model in that payoff for an agent (per period) depends on the choices of the other $N$ agents. Olson (1965) pioneered the work on problems of collective action and group size. One of his primary conclusions is that the larger the group, the more difficult (cooperative) collective action becomes. Public goods are more easily provided when the community is small. Community size in his model plays a much different role than in our model. First, Olson’s analysis focuses

\cite{Putnam2000} distinguishes between bridging and bonding social capital. The bonding social capital is present in a small cooperative community. The bridging form of social capital links groups. He discusses on page 362 that it is likely not feasible to simultaneously build bridges and bonds. This is consistent with our model, here. One can expand the trading opportunities by joining communities, but it is hard to do so without affecting the nature of trade in the new, larger, community. As in the case school bussing, the choice between small communities with (bonding) social capital and a larger community where people have more opportunities for trade is difficult.
on single interaction (non-iterated) games. Secondly, in Olson’s public good problems it can so happen, depending on group size, that it is in the interest of one or more agents to be cooperative, regardless of the actions of the choice of the other agents. For example, I may be willing to bear the entire cost of a park even though I must share its benefits with the other two members of my community. Group size plays a role since I am less willing to bear the cost if I must share the (more crowded) park with five members of the community. An N-person game where the dominant choice for all agents not to contribute to public goods provision is analogous to the model we present here.

Bendor and Mookherjee (1987) model an infinitely repeated N-person collective good game. They show, using the Folk Theorem, the efficient (cooperative) outcome can be supported as an equilibrium regardless of community size. However, if agents cannot perfectly monitor the behavior of the N other agents, then group size matters. Larger group size increases the chance that an action is misinterpreted. Since a cooperative equilibrium must involve punishment for perceived violations of cooperation (to induce agents not to try to “hide” uncooperative behavior as an error), larger group size leads to more frequent punishment and less cooperation on average. In our model, community size is important because it affects the expected frequency of pairwise transactions.

In our model, pair-wise interaction is not crucial. A model where the N individuals in a community play n-person prisoner dilemma games (n < N) will share most of the salient features of the pair-wise model. If for example, n was fixed, then an increase in community size would reduce the chance that two agents would meet in the same group next period.

**Assumption (ii): Games are Private.**

If the play of all individuals is public knowledge, then the viability of the cooperative equilibrium can be unrelated to community size. For example, suppose everyone plays a strategy of c until d is observed in any trade. Since
trades do not become more anonymous as community size grows, the bridge in the previous examples would have no effect on social capital.

While the assumption that games are private is important, it is not necessary. In a large community, it becomes practically difficult to observe or gather information on the many trades which occur each period. An alternate assumption is that each trader observes some subset of the trades which occurred. If the proportion of trades observed decreases with community size, then trades become more anonymous as communities grow. As in the above examples, community size may grow large enough that friendly trade is no longer an equilibrium.\footnote{Kocherlakota (1998) discusses the role that money can play in summarizing the history of trade. If money balances or any other identifying feature of a trader perfectly reveal past trades, then the viability of the cooperative equilibrium is unrelated to community size. A discussion of social capital would have to focus on a different feature of the economy rather than community size.}

For simplicity, we restricted strategies so that when trader 0 faced agent \( j \), agent 0 could not condition her move on the past play of some third party \( i \). For example, consider a strategy for 0 that plays \( c \) initially until \( d \) is played against 0. After observing a \( d \) by \( i \), 0 plays \( d \) against all \( j \) in future trades. This strategy can support cooperative trade. However, analogous to the Proposition in Section 2.1, this strategy will support cooperation only if the frequency of trade is high enough. In a large community, a trader has an incentive to deviate and play \( d \) against \( j \) since the likelihood of trading with \( j \) or anyone who has interacted with \( j \) (directly, or played someone that \( j \) played) is small in the near future. Again, as community size grows, the viability of friendly trade decreases preserving the key features of the social capital examples.

Assumption (iii): \( \text{All gains from trade are non-negative.} \)

Important to all the examples is that agents prefer unfriendly trade to no trade at all. Changing this assumption would significantly change the nature of our model since agents would no longer have the incentive to increase their opportunities for trade.
Assumption (iv): Meeting for Trade probability is history independent.

We have ruled out agents taking actions to avoid trading with certain players while seeking trade with others. Agents are not allowed to ostracize agents for punishment as in Hirshleifer and Rasmusen (1989). In their model, if trader 0 plays d, she is prevented from receiving any gains from trade in subsequent periods since the trader is ostracized with $\pi_{0j} = 0$. They find that the ability of agents to ostracize others can be powerful enough to support cooperative play even in finitely repeated prisoners’ dilemmas. Alternatively, Carmichael and MacLeod (1997) model the influence of gift giving on the probability of trade. In their model agents may trade with only one agent per period. In contrast to our model, traders can choose their partner; in effect they select $\pi_{0j}$. If there is no cost to switching trading partners, then cooperative trade is not possible in a large community since traders cannot commit not to seek a new trading partner. Carmichael and MacLeod point out that a dissipative gift exchange makes switching partners costly and allows agents 0 and j to credibly commit to $\pi_{0j} = 1$. In both these papers, the customs which facilitate friendly trade are different forms of social capital. However, since there is not a natural analog to community size, these models make it harder to address questions about changing social capital.

Assumption (v): Agents will trade cooperatively if it is an equilibrium.

How an equilibrium is selected when many are available is a complex question beyond the scope of this paper. Whether or not agents actually play the Pareto optimal equilibrium is not crucial to the examples. As long as agents do not always play the unfriendly equilibrium when other equilibria are available ($\pi_{ij} > \pi^e$), social capital can be defined and measured. Focusing on the friendly trade equilibrium in the examples maximizes the relevance of social capital.

Equilibrium selection is often viewed as a coordination problem. An alternative view of social capital would be to view social capital as helping to solve coordination problems. For example, Schelling (1978) discusses how larger
communities, by increasing the set of possible equilibria in a coordination game, decreases the focal quality of the Pareto optimal equilibrium.

Perhaps the more salient restriction imposed by the assumption is that traders in community $R$ cannot discriminate based on community of origin. In the first example, section 2.2.1, the ability to play a strategy that is $d$ if playing against a player from $L$, would be sufficient to preserve the social capital. More generally, the definition of a community need not be physical. There is a large literature in sociology that attempts to characterize the network topology of communities. Typically, these papers, pioneered by Burt (1980), Burt (1992), often refer to these networks as social capital since the network is defined in terms of trust or cooperative play.

**Assumption (vi):** The probability of trade for all individuals $i$ and $j$ in a community of size $N$ is given by $\pi_{ij} = \pi(N) = \min\left(1, \frac{N}{N-1}\right)$

The final assumption used in the examples is required to tie social capital to a more primitive feature of the economy. Here we focus on community size. The key feature of the specific functional form, $\pi_{ij} = P(N)$, used is that $\frac{dP(N)}{dN} < 0$ and $\frac{d[NP(N)]}{dN} > 0$. The chance of trading with any one person decreases with community size, but the total opportunities for trade increase with size. These features create the tension that drives the three examples. Individuals prefer the more abundant trading opportunities of a larger community, but more frequent trade is more friendly.

3 Social Capital, Technological Change, and Growth

Thus far, we have considered social capital in a simple trade environment. To better explore the public policy aspects of social capital, we consider the role of social capital in a simple growth model. The structure of the model
is similar to Jones and Newman (1995).\textsuperscript{10} Technological innovations typically require a reallocation of labor. The reallocation of labor – turnover – changes the set of trading partners. This provides a link between technological change and social capital. The model demonstrates the connection between the frequency of technological innovations and the mobility of labor. In particular, frictionless labor mobility leads to higher productivity. However, the mobility affects the community structure and changes the feasibility of cooperative trade. Labor mobility, to some extent, is a policy variable. By setting laws that reduce mobility like a rigid seniority system or a harsh unemployment scheme, governments can increase the social capital at the expense of a less efficient allocation of labor.

3.1 Growth Model

The economy, in this section, consists of a single community of a large number of individuals evenly distributed about the unit circle. For convenience, we assume a continuum of individuals uniformly distributed.\textsuperscript{11} An individual's location on the circle determines who the person trades with as well as their efficiency. An individual's output in the economy is the product of three factors: (1) The state of aggregate technology, (2) an individual's labor efficiency, and (3) the resources acquired from trade. The state of aggregate technology is $\Gamma_t$. Aggregate productivity shocks arrive each period with probability $\lambda$. If

\textsuperscript{10}Jones and Newman (1995) consider the effect of technological innovation in a stochastic labor search.

\textsuperscript{11}The continuum of traders assumption will be relied on later when we consider labor mobility. If community sizes are discrete as in Section 2, then the decision to relocate is itself a strategic game. By assuming a continuum of individuals uniformly distributed about the circle, a decision to relocate does not affect the aggregate opportunities to trade. Relaxing this assumption may offer some interesting insights into “agglomeration economies” – the spatial concentration within industries as well as the more general economies of scale due to city size. See Rosenthal and Strange (2001), for example.
a productivity shock arrives, productivity grows at the fixed rate of \( \gamma > 1 \).

\[
\Gamma_{t+1} = \begin{cases} 
\gamma \Gamma_t & \text{with probability } (\lambda) \\
\Gamma_t & \text{with probability } (1 - \lambda)
\end{cases}
\]  

(3)

The average growth in the technology is constant at \( \bar{\gamma} = \lambda \gamma + (1 - \lambda) \).

An individual’s efficiency is determined by his location, \( i_t \), on the unit circle at period \( t \), relative to his “ideal” employment location, \( i_t^* \). The model is intended to capture the need to match worker skills to the requirements of the job. Let

\[
\rho(i, i^*) = 2 \min\left( |i - i^*|, 1 - |i - i^*| \right)
\]  

(4)

be the distance between \( i \) and \( i^* \) on the unit circle. Note that \( \rho \) is normalized so that all distances lie in the \([0, 1]\) interval. We define the efficiency of individual \( i_t \) at period \( t \), \( e_{i_t} \), based on this distance as,

\[
e(i_t, i_t^*) = 1 - \rho(i_t, i_t^*).
\]  

(5)

As in Jones and Newman (1995), we assume that a positive technological shock changes the optimal allocation of workers in the economy. A technological shock increases the importance of some skills and decreases the usefulness of others. We capture this by assuming that if a technological shock occurs, then ideal employment locations are uniformly redistributed about the unit circle. For simplicity, this re-shuffling is independent of the current location of the individuals. That is, if there is a technological shock at \( t + 1 \), then \( i_{t+1}^* \) can lie anywhere on the circle with equal probability. Therefore after a technological shock, the expected efficiency is the same for all traders. It is

\[
\bar{\epsilon} = \int e(i_t, i_t^*)di_t^* = 0.5.
\]

Since the efficiency of individuals depends on their location relative to an ideal location, individuals will want to alter their location. We assume a very simple relocation technology. If \( i_t = i_t^* \), the individual will not move. If \( i_t \neq i_t^* \), then the individual will attempt to move. With probability \( r \), the move is successful and the new location is \( i_t^* \). With probability \( 1 - r \) the move
is unsuccessful and the location remains $i_t$. The parameter $r$ captures, in a very reduced form, labor market frictions. Below, we will consider three cases: Frictionless labor mobility ($r = 1$), no labor mobility ($r = 0$), and sticky labor mobility ($0 < r < 1$).

The final element of production allows us to consider the role of social capital. As in the previous section, individuals will meet for trade. Each trade has the structure of the prisoner’s dilemma and, for concreteness, has the payoffs listed in Table 1. In addition, we maintain assumptions (i) to (v) of Section 2. Each period, individual $i$ and $j$ will meet to trade with a probability that depends on the distance between the two traders. An individual trades more frequently with near-by individuals. We capture this by assuming that the probability the $i$ and $j$ meet in period $t$ is given by

$$
\pi_{ij} = 1 - \rho(i, j)
$$

This specification implies that individuals trade with their immediate neighbors ($\rho \approx 0$) each period, but rarely trade with individuals located on the opposite side of the circle ($\rho \approx 1$).\(^{12}\)

Each of the three elements of production are reflected in the following time-additive risk-neutral preferences,

$$
U_0 = (1 - \beta)E \left[ \sum_{t=0}^{\infty} \beta^t \left\{ \Gamma_t \epsilon_{i,t} \left[ \int \pi_{ij} u(s_{ij}, s_{ij}) \, dj \right] \right\} \right]
$$

where $\beta$ is the discount factor, and $u$ is the outcome from the trade between $0$ and $j$ from Table 1. These preferences are analogous to equation (1) used in the previous section. Expectations are required in (7) since the arrival of the technological shock and the related re-shuffling of ideal employment locations are stochastic. Note that instead of summing all of the traders gain from trade in a period, here we consider the average gain to trade. This is necessary since

\(^{12}\)A simple alternative specification is to set $\pi_{ij} = \frac{1}{1 + \mu \rho(i, j)}$ where $\mu \geq 1$ is a scaling parameter that controls the importance of location for trade. As $\mu$ gets large, the probability of any two traders meeting, regardless of location, approaches one.

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we are assuming that there is a large number of trades per period. Finally, to ensure that utility is bounded, the expected growth rate in the technology, \( \bar{\gamma} = \lambda \gamma + (1 - \lambda) \), cannot be too large. Specifically, \( \beta \bar{\gamma} < 1 \).

### 3.2 Frictionless Labor Mobility \((r = 1)\)

A high rate of technological growth is typically viewed as desirable. However, the technological shock changes the optimal allocation of workers in the economy. If workers can relocate to improve their efficiency, the technological innovation will effect social capital by changing the probabilities for trade between individuals. In essence, cooperative trade is hard to sustain with your neighbor if she is likely to move next period. In this section we consider perfect labor mobility. After a technological shock, all individuals relocate to a new position on the circle to achieve maximum efficiency, \( \epsilon(i, i^*) = 1 \).

Since a technological shock alters the location of the traders, to generate value functions, we need to conjecture about the likelihood of cooperative trade following a technology shock. Consider agent 0\(^{13}\) and conjecture that trade is cooperative for individuals on the interval \((1 - \hat{r}, \hat{r})\) of the unit circle. See Figure 1. Since the circle is of unit length, \( \hat{r} < 0.5 \). Given this, the value function of trader 0 trading with an individual located at \( i < 0.5 \) (the case of \( i > 0.5 \) is symmetric) \( V(\Gamma, i, \sigma) \) where \( \sigma = \{c, d\} = \{2, 1\} \) indexes if the current trade between 0 and \( i \) as friendly or not (see payoffs in Table 1). As in Section 2.1, assumptions \((i)\) to \((iv)\) allow us to focus on the trade between two individuals. Note that from equation (6), \( \pi_{0i} = 1 - 2i \).

\[
V(\Gamma, i, \sigma) = (1 - \beta)\Gamma(1 - 2i)\sigma \\
+ \beta(1 - \lambda)V(\Gamma, i, \sigma) \\
+ \beta \lambda(2\hat{r})V(\Gamma, 0.5\hat{r}, e) \\
+ \beta \lambda(1 - 2\hat{r})V(\Gamma, 0.5(0.5 + \hat{r}), d)
\]  

\(^{13}\)After a shock, we can renormalize the circle to keep individual 0 at 0.
The first line in equation (8) is the current payoff from being in friendly, 2, or
unfriendly, 1, mode. The second line is the continuation value if there is no
technological shock. The third and forth lines are the continuation value given
a shock happens. If the new location of the trading partner \( i'' \), is close by,
the value of cooperative trade is received. Given the uniform redistribution
assumption, this happens with probability \( 2i'' \). Conditional on \( i'' < i'' \), the
expected value of the new location is \( 0.5i'' \). Alternatively, with probability
\( 1 - 2i'' \), the trading partner will be located outside the cooperative region.
Given \( i'' > i'' \), the expected location is \( 0.5(0.5 + i'' \). It is useful to note that
these last two lines in the equation do not depend on \( i \).

By conjecturing and verifying, the value function is:

\[
V(\Gamma, i, \sigma) = \frac{(1 - \beta)\Gamma(1 - 2i)\sigma}{1 - \beta(1 - \lambda)} + \frac{\beta \Gamma \lambda \gamma}{(1 - \beta(1 - \lambda))} [2i(1 - i'' + 0.5)]
\]

(9)

This value function is under the equilibrium strategy that cooperation is played
if \( i < i'' \). If a trader deviates from this and plays a \( d \), there is no future
cooperative trade so the last term in equation (9) is simply 0.5 (which is a
payoff of 1 per period times the unconditional probability any two people 0
and \( i \) meet). In order for cooperation with \( i < i'' \), to be an equilibrium, the
incentive compatibility requires that at \( i = i'' \):

\[
\frac{(1 - \beta)\Gamma2 + \beta \left( \frac{(1 - \beta)\Gamma(1 - 2i'')}{1 - \beta(1 - \lambda)} \right) + \frac{\beta \Gamma \lambda \gamma}{1 - \beta(1 - \lambda)} [2i''(1 - i'') + 0.5]}{(1 - \beta)\Gamma3 + \beta \left( \frac{(1 - \beta)\Gamma(1 - 2i''1)}{1 - \beta(1 - \lambda)} \right) + \frac{\beta \Gamma \lambda \gamma}{1 - \beta(1 - \lambda)} [0.5]} \geq 1
\]

(10)

Note that in this case, all traders are identical, so each trader has an identical
incentive compatibility constraint. This equation implies

\[
2 \left[ (\beta \lambda \gamma - (1 - \beta))i'' + \beta \lambda \gamma (i'')^2 \right] > \frac{1 - \beta}{\beta} (1 - \beta(2 - \lambda))
\]

(11)

This condition is hard to characterize it is an inequality that is quadratic in \( i' \).
However, note that if the probability of the technological shock is zero, \( \lambda = 0 \),
equation (11) reduces to \( (1 - 2i'') > \frac{1 - \beta}{\beta} \) (or by equation(6), \( \pi_{oi} > \frac{1 - \beta}{\beta} \)) which

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is the same as in simple model of Proposition 1. Moreover, if cooperation is to be feasible at all, it must be feasible for traders located close to individual 0. Therefore, evaluating equation (11) at $\hat{\tau} = 0$ implies that $\beta > \frac{1}{2\lambda\gamma}$. Recall that in the case of $\lambda = 0$ of Proposition 1, $\beta > 0.5$ is required for cooperation to be feasible. If the technological shock is too frequent, high $\lambda$, then $\hat{\tau} = 0$, and cooperation will not be feasible and there will be no cooperative trade in the economy. Second, note that $\hat{\tau} = 0.5$ is never feasible. It is never the case that cooperation is achieved on the full circle.\footnote{To see this, recall that for regularity, we require $\beta \gamma = \beta(\lambda \gamma + (1 - \lambda)) < 1$. Intuitively, cooperation around the full circle is not possible since by (6), $\pi(0,0.5) = 0$.}

Assuming that some cooperative trade is feasible, $\hat{\tau} \in (0, 0.5)$, we need to choose the maximum $\hat{\tau}$ that satisfies equation (11). This satisfies the assumption that individuals will play cooperatively if possible (Assumption (v)). Since the left-hand side of (11) is decreasing $\hat{\tau}$ over the region $[0, 0.5]$, a simple upper-bound is obtained by determining the $\hat{\tau}$ that minimizes the left-hand-side. This implies

$$\hat{\tau} < 0.5 \left[ 1 - \frac{1 - \beta}{\beta \lambda \gamma} \right] \quad (12)$$

In order for $\hat{\tau} > 0$ and cooperation to be feasible, $\beta > \frac{1}{2\lambda \gamma}$. Therefore, in equation (12), hold $\beta$ and $\lambda$ fixed and consider the effect of increasing the technological growth, $\gamma$. Increasing $\gamma$ increases the value of future cooperation and hence increases the region of cooperation. However, an increased frequency of technological growth has a negative effect on social capital by tightening the constraint $\beta > \frac{1}{2\lambda \gamma}$. Interestingly, optimal growth in this setting would consist of huge, infrequent technological shocks.

[Insert Welfare in this case]

### 3.3 No Labor Mobility ($r = 0$)

In the previous example, labor mobility reduces social capital. While technological shocks make the economy more productive, the change in social struct-
ture that accompanies the shock can make cooperative trade uncommon. Burt (2000) and (2001) document the rapid decay in social capital. He finds that, in the course of one year, there is a remarkably high turnover in the network of people an individual deals with. This churning in the social network reduces the ability to sustain cooperation. Since labor mobility is, to some extent, a policy variable, it is possible that everyone can be made better off by reducing labor mobility. With labor-market frictions, labor is not efficiently allocated since agents cannot move from i to i*. However, since people are in their locations longer, social capital is higher. The friction increases the proportion of trades that are friendly. As a base case, we consider the case where individuals are fixed in their location and can never move to improve their efficiency (r = 0). In this stark case, the probability that any two traders meet, from equation (6), is fixed. Analogous to Proposition 1 and the r = 1 case, we can determine the critical probability that is needed to sustain friendly trade. In this setting, the critical probability is more complicated since it may depend on the state of the economy. It turns out, that while the aggregate technology, \( \Gamma_t \), does not affect the equilibrium trade, the critical probability does depend on labor efficiency. For individual located at i with efficiency \( \epsilon(i, i^*) \) and an individual j with efficiency \( \epsilon(j, j^*) \), define \( \varepsilon_{ij} = \max(\epsilon(i, i^*), \epsilon(j, j^*)) \).

**Proposition 2:** For individuals located at i and j, cooperative trade is an equilibrium if \( \pi_{ij} \geq \pi^*(\varepsilon_{ij}) \) where

\[
\pi^*(\varepsilon) = \frac{(1 - \beta \bar{\gamma})(1 - \beta(1 - \lambda))(\bar{\tau} + (\varepsilon - \bar{\tau}))}{\beta((1 - \beta \bar{\gamma})(\varepsilon - \bar{\tau}) + (1 - \beta(1 - \lambda)) \bar{\tau})}
\]

(13)

The proof is similar in detail to the discussion in the previous section, so it is left to the appendix. Recall that \( \bar{\gamma} \) is the expected rate of technological growth, and \( \bar{\tau} \) is average labor efficiency. For cooperative trade to be an equilibrium, the value of future cooperative trade, relative to unfriendly trade, must be higher than the one-time gain from playing exploitively (i.e., play a d when the other plays a c). If the likelihood of future trade is small, the continuation value is small and cooperation is not an equilibrium. Thus, cooperative trade is feasible if \( \pi_{ij} > \pi^*(\varepsilon_{ij}) \). Not surprisingly, the critical value, \( \pi^* \), is decreasing.
in $\beta$. Increased patience makes cooperation easier to sustain. Interestingly, the critical probability is also decreasing in the growth rate, $\bar{\gamma}$. Higher growth makes future trade more important and increases the value of cooperative trade reducing the incentive for exploitive trade.

The level of labor efficiency plays an important role in determining if cooperation is feasible. Note from equation (13) that the critical value is increasing in efficiency parameter, $\varepsilon_{ij}$. If $i$ currently has a high efficiency level, $\epsilon(i, i^*)$, then the temptation for exploitive trade is very high since there is a large current payoff. Since, the high level of efficiency is not expected to continue indefinitely (it will revert back to average at the next technology shock), the cost of giving up cooperative future trade is relatively small. Since cooperative trade must be incentive compatible for both traders for it to be an equilibrium, the individual with the higher efficiency determines the feasibility of cooperative trade.

Using equation (6), we can convert $\pi'(\varepsilon)$ into the maximum distance between two individuals that fosters cooperative trade. Consider the individual located at 0. She can cooperate with trader $i$, if $i \leq \iota'(\varepsilon_{ai})$, where $\iota'(\varepsilon_{ai}) = 1 - \pi'(\varepsilon_{ai})$. Recall that this distance depends on the maximum efficiency of the two traders, $\varepsilon_{ai} = \max(\epsilon(0, 0^*), \epsilon(i, i^*))$. Therefore, the unconditional expected level of utility for trader zero depends on $\varepsilon = \int \int \max(\epsilon(0, 0^*), \epsilon(i, i^*))d0^*di^* = 0.66$ since this determines the proportion of cooperative trades. Of course, the average level of utility also depends directly on agent 0's expected labor efficiency directly, $\bar{\varepsilon} = \int \epsilon(i, i^*)di^* = 0.5$. This allows us to calculate the expected utility for an individual in the economy as:

$$U_0 = \left[ \frac{(1 - \beta)}{1 - \beta\bar{\gamma}} \Gamma_0 \right] \left[ \bar{\varepsilon} \right] \left[ (2\iota'(\varepsilon)) 2 + (1 - 2\iota'(\varepsilon)) 1 \right]$$

(14)

The first term contains the effect of average growth rate in the technology of $\bar{\gamma}$. The second term, $\bar{\varepsilon} = 0.5$, is the average labor efficiency. Since there is no relocation in this case, labor is not allocated efficiently. The final term of equation (14) is the equilibrium average trade value. The size of the region
$2i^r$ is a measure of the social capital in the economy. As noted above, the size of this region is larger with higher growth. It is also affected by the lack of labor mobility. Since individuals cannot move, they will continue to trade frequently with their neighbors. However, the lack of labor mobility inhibits social capital development by not allowing traders to change their efficiency. Since the cooperation region is decreasing in the maximum of the two individual efficiencies, the variance in efficiencies reduces social capital. Labor mobility will allow traders to become more efficient and thus have less variability in efficiencies. However, as we saw in Section 3.2, altering efficiency requires relocating, mobility will impact social capital directly. Combining these two features is the topic of the next section.

3.4 Sticky Labor Mobility ($0 < r < 1$)

[This section is in progress$^{15}$]

The final case to consider in this section is that of sticky labor movement. In this case, following a technological shock, all individuals are inefficiently allocated. With probability $r$, an inefficient individual, $e(i, i^*) < 1$, can move to his or her optimal location. An efficient worker, $e(i, i^*) = 1$, will not move.$^{16}$ Solving for the equilibrium in this model setting is complicated. Since traders can move, the continuation valuation function, as in Section 3.2, depends on the size of the cooperative region. In addition, since individuals may be inefficient, their level of inefficiency will affect the ability to sustain cooperation as in Section 3.3. Cooperation in a trade between an efficient and inefficient traders, in contrast to Section 3.3, will be more difficult since one individual is attempting to move. Trade between two inefficient traders is even harder to sustain since both are attempting to relocate. However, given two inefficient traders, it is the trader with the higher inefficiency whose incentive

$^{15}$Relatively speaking, of course, since the whole paper is in progress.

$^{16}$Recall that the relocation decision simplified by the assumption that there are a continuum of individuals.
compatibility condition will bind. This is an interesting non-monotonicity in
the connection between efficiency and social capital. Finally, this section will
produce interesting time-series pattern for growth. Following a technological
shock, all traders will be inefficient and, since they are attempting to relo-
cate, it is difficult to sustain cooperation. However, as time passes, people
will become more efficient and trade more cooperative. This growth will con-
tinue until the next shock producing a boom-bust cycle of growth. The final
question this section will address is the optimal labor mobility, \( r \). The trade-
off being increased social capital from sticky mobility and increased efficiency
from perfect mobility.

4 Conclusions

There has been much discussion of social capital over the past decade since
Coleman (1990) and Putnam, Leonardi, and Nanetti (1993) sparked the dis-
ussion of social structure as a form of capital. There is also now a great deal
of the evidence that points to strong links between social capital and social
and economic problems. However, it is difficult to make policy conclusions
without a complete picture of the costs and benefits of social capital. In this
paper, for example, we demonstrate that changing the level of social capital
produce a welfare gain, loss, or be Pareto non-comparable. In a more com-
plicated setting, where we consider growth, mobility, and social capital, the
policy conclusions are difficult. However, this model identifies a trade-off be-
tween an efficient allocation of labor and a stable allocation that increases the
stock of social capital.

\footnote{This is a similar result to Jones and Newman (1995) who generate the pattern with a
search model.}
References


Appendix

**Proof of Proposition 1**: This proof is standard. Assumptions (i) to (iv) imply that player 0 is effectively playing \( N \) separate infinitely repeated games. We can re-write (1) as:

\[
U_0 = \sum_{j=1}^{N-1} \left\{ (1 - \beta) \sum_{t=0}^{\infty} \beta^t \pi_{0j} u(s_{0j}(x_t), s_{0j}(x_t)) \right\}. \tag{A1}
\]

Consider the game between 0 and \( j \). Given the proposed profile strategy \( s^c \) (as well as for \( s^d \)), the expected utility of the repeated game with 0 for agent \( j \) can be represented recursively with a time independent value function. For agent 0, playing trader \( j \), let \( V(j, \sigma) \) be the value function where \( \sigma = \{c,d\} = \{2,1\} \) indexes the trade (and payoffs) as friendly trade or unfriendly. It is easy to verify that the value functions is

\[
V(j, \sigma) = \pi_{0j} \sigma \tag{A2}
\]

Following Abreu (1988), we need only consider possible one shot deviations from the proposed equilibrium strategies for all possible histories. If agents are in the punishment phase \( (d,d) \), neither has an incentive to deviate, regardless of \( \pi_{0j} \). In the cooperative phase, one deviating to play \( d \) yields the one-time payoff of 3 (see Table 1) but future trade is unfriendly. The incentive comparability condition is:

\[
(1 - \beta)3 + \beta(V(j, d)) \leq (1 - \beta)2 + \beta(V(j, c)). \tag{A3}
\]

Note that both the left and right-hand sides of equation (A3) are the value functions conditional on 0 and \( j \) meeting in the current period. This inequality implies \( \pi_{0j} \geq \frac{1 - \beta}{\beta} \). Since traders meet at most once per period, \( \beta > 0.5 \) is necessary condition for the cooperative equilibrium.

**Proof of Proposition 2**: As above, assumptions (i) to (v) imply that player 0 is playing a separate repeated game with each \( j \). We can re-write equation (7)

\[
U_0 = (1 - \beta) \int E \left[ \sum_{t=0}^{\infty} \beta^t \Gamma_t \epsilon_{0,t} \pi_{0j} u(s_{0j}, s_{0j}) \right] dj \tag{A4}
\]

The proof is analogous to the simple case in Proposition 1. However, the value functions are more complicated due to the technological shock that changes both \( \Gamma \) as well as the efficiencies, \( \epsilon(0,0^t) \) and \( \epsilon(j, j^t) \) of the two traders.

[INSERT REMAINDER OF PROOF HERE. ... Lots of algebra – similar to Section 3.2]