

Too much cooperation - Work exchange in Peruvian communities

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Abstract: The general assumption in the social capital literature is that cooperation is good for development. However, such studies often analyze tasks where, in reality, compliance depends on institutional powers. This data set of 49 Peruvian highland communities - a questionnaire survey conducted by the author - includes work exchange as an example of a truly voluntary agreement between rural peasants. A regression analysis gives a significant hump-shaped effect. Some work exchange increases income, but the marginal effect actually turns negative for the 40 percent most cooperation minded communities. A game theory model demonstrates that rational agents will cooperate too much in traditional work tasks if the prevailing norms do not change as individual solutions become more efficient during the modernization process.

Code-words: Social capital, Reciprocity, Work exchange, Collective action, Institutions, Modernization, Peru

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1 Introduction

Modernization is an all-embracing and often speedy process in poor communities in developing countries. The physical world and the pattern of society around their traditional way of life might change dramatically from one decade to the other. New roads facilitate communication in and out of previously isolated societies. Artificial electric light makes it possible to work and socialize during the night. The introduction of market economies gives access to a whole new range of goods. The consumption pattern might change, but also production since the use of modern inputs like fertilizers and machinery make it possible to farm in a different way. Furthermore, marketable products often differ from their traditional counterparts. The internal life of previously relatively isolated rural communities is in a deep change, not at least because these communities are exposed to new ideas, norms and moral values through interaction with modern society at large. The pessimists in development research predict a breakdown in the "social fabric" of the community. More individualism reduces cooperation, which leads to less production, more internal conflicts, more individual risks as traditional insurance systems weather, etc. The optimists on the other hand emphasize increased productivity due to learning, specialization and trade, which in the end improves welfare in general as the material living standard rises.

Most papers in the extensive social capital (SC) literature focus on negative effects of modernization. A prominent line of thought is as follows: Contacts with the outside reduce the effect of internal sanctions, leading to an increasing number of defectors from cooperative setups, which may imply a collapse in collective action. One example is Bardhan (2000), who finds the functioning of the irrigation systems (which are based on collective action both in maintenance and administration) in a cross-section of Indian communities to be worse, the higher their trade volume compared to total income, and the shorter the distance to urban areas. Such studies on the effect of integration into the modern society on traditional forms of cooperation is interesting in itself. However, a similar economic interpretation is only possible if one assumes that cooperation is technically efficient and that the collective action inducing phenomena does not affect income negatively through other channels.

There are three important reasons to question the relevance of this traditional collective action approach if the aim is to explain income¹. (i) More individualistic norms might be dev-

¹This paper does not consider welfare in general. Other motives for cooperation, for example as an exercise of religion or to confirm the unity of the community, might increase peoples' sense of happiness. Such motives are

astating to cooperation, but at the same time nourish individual progress with a counteracting effect on the income level. (ii) The integration to modern society can reduce the ability to sanction defectors, but at the same time increase the payoff from cooperation in new fields. (iii) Cooperation can actually be unproductive, but still be maintained due to some social payoff or norms that prevent the use of more efficient individualistic production techniques. A fundamental issue is hence to assess the productivity of cooperation before I conclude anything about the desirability of collective action and social capital. The general observation that poor tend to cooperate more than rich (at same level of institutions) seems like a puzzle if SC is an important productivity factor and this opens for the paraphrased question: "If cooperation is so smart, how come you ain't rich?"

The Peruvian highlands are chosen for field research since traditional small scale farmers are often assumed to risk becoming losers in the modernization and market integration processes. I conducted a questionnaire survey on cooperation, institutional organization and income at the community level in all 49 rural communities in a highland district of Peru. An official household level agricultural survey from the same area from earlier years supplements the econometric analysis. It reveals that the estimated effect of some cooperation is positive, but the marginal effect on income decreases and actually becomes negative when cooperation becomes the normal way of working. The results reveal that 40 percent of the sample communities "cooperate too much". The negative effect of "restricted access groups" exploiting outsiders (e.g. mafia, racism) is commonly recognized in the literature. However, the results of this study imply further that "open access groups" can lead to greater cooperation than what is economically optimal. This notion of "negative SC" hence represents a new approach in the literature.

The very success of the social capital concept in social research and politics has made the assessment of its importance and productivity a pressing issue. It is now legitimate to use development aid on social activities with the expectation that improving the "social fabric" will have productive implications at a later stage. Realized investments in the main village of the survey district of this study are one example. The main "plaza" was converted from a rustic common room with lots of different uses including trade, as vividly described by Vílchez Amésquita (1961), to a recreational park with fountains and statues. paid for by municipal funds. Vegetable markets and small-scale traders are now restricted to the back streets, while the "arena" is left for military parades and Sunday strolls by the new village (state and NGO employed) middle-

not included in this analysis, since utility of non-material nature is not measurable.

class. The money has hence not just been wasted from an economic development point of view, one may speculate if it has actually led to a reduction in income generating infrastructure².

2 Theory

2.1 General discussion

The fundamental characteristics of societies that facilitate informal cooperation have in recent years been labeled social capital (SC) and loosely defined for example by La Ferrara (2002) p.1 as "...the stock of norms, trust and civic networks". It is supposed to decrease in traditional societies during the dynamic process of modernization, but the underlying reasons for its decay may actually reveal whether it can be regarded as a good or a bad thing. The introduction of formal institutions might render traditional institutions and norms superfluous. Business partners will in a modern society rely on contracts and law enforcement instead of handshakes and rumor based punishment in closed circles as described in the seminal work on Magribi traders by Greif (1993). A breakdown of SC as the third party contract enforcement improves, is then just an indication of economic development. The impact might be disastrous on the other hand if no formal institutions evolve, either before or after the decay of SC. High crime rates in urban slums are striking examples. The collapse of traditional production arrangements in the countryside might be just as destructive. A typical example of sub-optimal exploitation of common property resources is overgrazing on community lands by individually owned herds. Income generating infrastructure is hard to construct and maintain if people loose their ability to coordinate actions, as Bardhan (2000) finds in his study of irrigation communities in Southern India.

These examples illustrate how SC can both induce collective action in the creation of a public good and facilitate private exchanges between individuals. The latter is a necessary condition for a society to use its resources in an optimal way in order to exploit both specialization and economies of scale. Trust between individual contractual partners is important even in developed economies since forced compliance through the legal system is costly. Trust is even more important in order to achieve efficient production in rural areas in developing countries, where most state institutions are weak or absent. The labor market is normally thin in rural areas

²SC projects are thought not to distort markets directly and hence induce unfair competition in contrast to production related projects. Their popularity in multilateral organizations might hence be more due to the assumed lack of negative effects rather than the existence of positive ones.

of Peru, and it might be difficult to hire people on the spot market, according to Gonzales de Olarte (1994) and Blum (1995). Reciprocity then often becomes an important part of a work exchange deal even in cases when monetary compensation is paid in each individual turn. "If I work for you today, I expect you to do the same for me in the future when I call upon you", represents a normal way of thinking.

The causal chain in the economic analysis is assumed to go from trust to cooperation that improves economic efficiency and hence entails higher income. The lack of SC is by many researchers and policy makers seen as "The hidden variable" which explains the puzzle of large-scale poverty in the technically advanced and integrated world of today, e.g. Platteau (2000)³. Increasing SC at given levels of official institutional power is hence assumed to be a good thing and a pronounced goal of development-oriented policies. The first objection to this way of reasoning is the question whether it is actually more efficient to work together on a given task rather than solving it alone.

The immediate answer is that it will depend on the actual circumstances. Rational utility maximizing agents will always choose the optimal solution. But an individual who decides on whether to enter into a cooperation scheme or not, also considers non-monetary utility and future payoffs besides the immediate production effect. If the latter are large, for example due to individual preferences and norms of the society, tasks can be solved by cooperation even if the former is actually negative. The contra-intuitive result that more cooperation-minded people will actually earn less is perfectly possible.

The fundamental condition for an individual to enter a cooperation scheme is trust in partners to fulfill their agreed obligations. This can either be interpreted as higher expected payoff or as a lower coordination costs. More trust hence leads to more cooperation, *ceteris paribus*. But many sources of trust are actually not related to the SC concept at all. Furthermore, the trust inducing reasons might have a decisive impact on both monetary and non-monetary payoffs. Trust is hence not only an exogenous variable that just influences the expected cost of cooperation, but the underlying source of trust also affects the income and utility level. The notion that trust in general improves economic efficiency and increases income is hence not a trivial assumption.

³However, empirical relations between trust and income are often contaminated by a simultaneity problem, i.e. higher income makes it relatively less costly to trust someone, as demonstrated by Durlauf and Fafchamps (2004).

The following discussion of possible reasons for human action and their potential implications for cooperation is useful in order to trace the effect of trust on income. (i) A rational agent just maximizing (hedonic) utility would defect in a one-shot prisoners dilemma type of situation which characterizes what Ostrom (1990) calls "social dilemmas", i.e. situations where people are tempted by short term profits to defect from cooperation agreements. When repeated interaction is possible, the individuals will include the effect on possible future cooperation agreements and the associated payoffs when they choose whether to fulfill their agreed immediate obligations or not⁴. (ii) Institutional intervention of a third party in deals between individuals alters the individual payoff from defection, for example through monetary fines or imprisonment. (iii) Breaking existing norms of accepted behavior will similarly entail retaliation from the affected individual and/or others members of the society that implies reduced income opportunities in the future. (iv) An individual has preferences for both material and non-material payoffs. The latter also includes consequences for others. An altruist will for example include the utility of others as an element in his own utility function. The perception of oneself as a "just and good man" can further give some people utility in itself. So even if the individual knows for sure that defection in cooperation schemes is not detected and no retaliation of any kind is expected, it does not mean defection will take place.

Rational agents will take all the preceding points into consideration when making their choice of action. People are supposed to weigh the possibility of being caught and the effect of the punishment vs. the hedonic utility (the utility from material consumption) derived from their action, before they make up their minds on what to do. People's inherent preferences and customs often imply that cost-benefit analysis at the margin in "moral" matters do not take place. According to Elster (1998) such general preferences represent categorical imperatives that tell you what to do and what not to do. The very act of calculating and aggregating utility then often implies a break with your own moral⁵. Distinguishing between institutional and normative origin of retaliations to defectors in trust based cooperation schemes in developing countries is

⁴Since market integration increases the possibility area, contact between two individuals will become less frequent and induce less trust and hence less cooperation. This is interpreted as a SC-effect in the literature even if the causal mechanism is pure (hedonic) utility maximization.

⁵Elster further emphasizes how people normally internalize a norm as own preferences, often represented as feelings like "guilt". Theories within social psychology underline the dynamic and endogenous aspect of individual preferences, for example the theory of cognitive dissonance in Festinger (1957) that assumes people will tend to change preferences in order to minimize the difference between the actions they (might be "forced" to) do and feelings about it. Political changes can hence have a rather strong social engineering effect. If market economies induce and reward individual actions, then people will start perceiving individual actions as more morally defensible even if this reduces the degree of collective actions. This implies a spillover effect from (i), (ii) and (iii) to (iv) as norms and institutions slowly change.

further complicated by the blurred nature of formal boundaries of institutions and the effects often lumped together as SC in the literature⁶.

Some actions will in the end not seem rational at all under the given circumstances. The field of behavioural economics has in the latter years given strong evidence of "other" forms of rationality in experimental settings. Kahneman (2003) stresses limits to the use of all available information. The information processing of the human brain is influenced by attribute substitutions, prototypes, framing effects etc. and this gives rise to actions that might systematically depart from the expected utility maximizing optimum. The process of learning is probably important in the context of transformation from traditional rural society to a market economy in this article. People tend to act upon their experiences without processing existing information. "If it worked yesterday, I will do it again today " or "I never try out anything which is not proven to work" are common rules-of-thumb in human decision making. It will hence take some time before changes in the underlying aspects of the society actually trickle down to change people's behaviour. But when it does, large changes might come in a short time⁷. This implies that cooperation might persist for a long time after it has become an inferior solution in modern societies. This point will be thoroughly discussed in a formal game theoretical model in the next sub-section.

This discussion of different underlying reasons of human actions that make people trust each other illustrates that cooperation might give a negative income effect. Some common examples known from standard economic theory are signaling games (i.e. rewards are associated with the action itself and not only the outcome), strong preferences for social interaction rather than material consumption, lags in learning and biased perceptions of the actual world.

The second objection to the assumed productivity enhancing role of trust inducing social phenomena is their potentially negative side effects on other aspects of productivity and economic activity. One example is norms of conformity that put significant pressure on people to act like

⁶A constructive suggestion in Torsvik (2000) to the problem is to separate between Institutional SC and Civic SC. However, most types of human interaction is supported by some combination of both institutional capital and social capital aspect. Extremes in either direction is hard to find. On the one hand, even the worst criminal will take human considerations. On the other hand, only experimental economists believe in complete anonymity and hence the possibility of constructing games where the players only rely on trust. The point in my empirical study is to use work exchange as the type of cooperation that is most trust based in my communities. It is furthermore more trust based than the variables used in other empirical studies of social capital.

⁷The sudden increase in onion production for commercial sales in the late 1980's (long after markets were introduced and the access road constructed) in some of my field research communities is a typical example of copying behavior in rural areas.

others and hence facilitate cooperation since it is easier to assess what to expect from others. Negative reactions from fellow community members might counterweight expected higher income from education, trying out new business ideas, etc. Norms can hence constitute a barrier to creativity and development⁸. Individualism is thought to be a fundamental characteristic of a modern market economy, and it seems reasonable to expect that individual development is realized at the cost of collective solutions. "Knowing ones place in society" is a potential element of the conformity norms, which might constitute an effective hindrance to competition and economic efficiency⁹. Leadership in the community often follows family lines and is not contested even if the leader is incompetent. Shop owners are free to set monopoly prices since a potential competitor will be punished socially for being too ambitious.

Collective solution enhancing institutions, norms and preferences are features of the culture of a society in general and might go hand in hand with other seemingly unrelated restrictions on individual actions that are not consistent with economic maximization. The most striking examples are probably religious bans which leave resources unexploited with a negative effect on economic development, e.g. the prohibition of female participation in the work force, consumption of certain animals which induce a sub-optimal allocation of lands, etc.

2.2 Game theory model

2.2.1 Intuition

The purpose of this game theory model is to show that norms, which originally sustain an efficient level of cooperation through punishment, might induce too much cooperation after a transition of the society. I will first give an intuitive description of how the model works, and then proceed with a formal set-up.

The model is meant to capture cooperation in the form of work exchange between two

⁸The famous (conformity) Law of Jante in the novel Sandemose (1962) facilitated cooperation between traditional fishermen on the coast of Denmark, but blocked individual initiatives to improve their own livelihood through education, new business ideas, etc. Strong British labor unions coordinated strikes to improve the general working conditions and income for all, but group pressure at the same time undermined individual progress through education and career. The explicit costs of reproducing a cooperative minded culture can in a developing country context take enormous proportions. For example Rao (2002) finds expenditures on religious festivals to take 20 percent of total income in a study of Indian communities. Such spending is seen as necessary in order to be accepted and be part of the society and in the end obtain income. This money could alternatively have been used for productive investments. The need to get out of such "high cost" social equilibrium by the individuals has been used as an explanation for the protestant awakening which has swept through my field research district of Tambo in the latter decades.

⁹I am indebted to Kjetil Storesletten for this innovative hypothesis of social capital as a hindrance to competition.

individuals. There is an individual specific stochastic element to each episode of work exchange, implying that one player may gain while the other may lose from cooperation. In the model, there turns out to be multiple Nash equilibria with different degrees of cooperation in the short and medium term, i.e. a low, high and full cooperation equilibrium. The two first will not give cooperation in the long run since there exists some stochastic payoff that will lead one of the parties to refuse cooperation and hence end the game. Only the full cooperation strategy is viable in the long run.

However, the full cooperation equilibrium does not exist if the payoff from cooperation is too low. The agent will then have a short-term incentive to deviate. A punishment for the individual who deviates from cooperation in these tasks is hence collectively rational as it induces efficient cooperation. Direct punishment, for example through imprisonment, can be defined as institutional capital. Indirect forms of punishment like gossip and "guilt" as previously discussed, are aspects of social capital. Punishment will, independent of source, facilitate coordination and make full cooperation a Nash equilibrium in all tasks with positive payoff.

I assume the punishment level for a deviation from cooperation is persistent for a given task even if the payoff from cooperation changes due to aspects of modernization, e.g. market integration. It can take decades to change traditions, while the productivity of cooperation might change almost from one day to another¹⁰. Thus, such abrupt change can make the average payoff negative, yet the individual with payoff higher than the average will still propose cooperation. The individual with lower than average will still accept. Otherwise, he would suffer since there is a punishment for refusing to cooperate in tasks that traditionally have been solved by work exchange. The remainder of this chapter gives the details of the game theory model leading to the hypothesized negative relation between work exchange and income. Readers mainly interested in empirical evidence can go straight to Chapter 3.

2.2.2 Game description

The game analyzes whether two individuals, A and B , will cooperate through work exchange in various tasks $i \in \{1, 2..m\}$. A task is a specific work operation that can take place nearly continuously (food preparation), once or several times during the year (sawing, harvesting, etc.) or rarely (house construction). There are two ways to solve a given task i , either working alone

¹⁰For example the introduction of markets will increase the demand for quality. Summoned labour might work fast, but are normally less careful in handling the plants. The resulting lower quality did not matter much in the previous regime of self-sufficiency agriculture.

or by work exchange. The latter implies that one individual first helps the other to do the needed work, and then the beneficiary reciprocates by working for the other in the same task later. Each work exchange episode is defined as an episode of the game. The agreement to cooperate is an oral contract for the specific episode of the given task. If the partners wish to repeat the interaction in another episode, for example by sawing together next season too, they will have to agree on a new contract.

In practice, the content of work exchange agreements is set by norms of the community where one-to-one is the "rule of thumb", i.e. a labour hour for a labour hour. This rule actually prevents work exchange schemes between different tasks since the perceived cost of labour depends on the given task, e.g. it "costs" more sweat to hand plow than construct houses. I will hence assume work exchange will only take place within the same task in this game theory model.

The payoff from cooperation differs between the individuals in a given task i . A stochastic element, denoted $Y \in [-Y^M, Y^M]$, is added to the average payoff, denoted Π_i , for task i for each individual, i.e. individual A receives the payoff $\Pi_i - Y$ and individual B receives the payoff $\Pi_i + Y$ in a given episode of work exchange. The origin of the stochastic element can for example be that rainfall affects the peasants differently through their choice of crops and the fact that they often have plots in different places. Y is normalized to be equal for all tasks i to facilitate the presentation. I further assume that the average payoff Π_i is constant over time, i.e. equal in all episodes of the game. This implies that the efficiency of cooperation differs between tasks. Tasks are ranked according to their profitability of cooperation, i.e. $\Pi_1 > \Pi_2 > \dots > \Pi_m$. All forms of side payments are ruled out in this model due to the "one-to-one" restriction set by norms.

2.2.3 The strategies.

This is a repeated game with three subsequent steps in each episode. In the first step *Nature* draws the stochastic value Y . In the second one of the individuals put forward a cooperation proposal. For brevity, I go directly to the equilibrium strategies. Then players A and B have the following pair of strategies $S_i^P = \{S_i^{P,A}, S_i^{P,B}\}$ for task i :

$$S_i^{P,A} = \left\{ \begin{array}{l} \text{Propose if } \left\{ \begin{array}{l} (i)^P \Pi_i - Y \geq 0 \\ (ii)^P Y < 0 \\ (iii)^P \text{ all previous cooperation proposals accepted} \end{array} \right\} \\ \text{Not propose otherwise} \end{array} \right\} \quad (1)$$

$$S_i^{P,B} = \left\{ \begin{array}{l} \text{Propose if } \left\{ \begin{array}{l} (i)^P \Pi_i + Y \geq 0 \\ (ii)^P Y \geq 0 \\ (iii)^P \text{ all previous cooperation proposals accepted} \end{array} \right\} \\ \text{Not propose otherwise} \end{array} \right\} \quad (2)$$

These are necessary conditions for a proposal with the following explanation and justification:

$(i)^P$ The players will only propose cooperation in tasks i if the immediate payoff is non-negative. There is no explicit condition for total discounted stream for future payoffs. The reason is that I assume episodes where no proposals take place will just be passed in silence. It is as if it never existed. Profit maximization is hence covered by this condition, which further prevents strategic proposals, i.e. propose with the aim to induce a refusal by the other players.

$(ii)^P$ The individual with the highest immediate payoff proposes cooperation (hereafter denoted *proposer*). When the payoff are identical, i.e. $Y = 0$, individual B will propose by convention.

$(iii)^P$ The players will only propose cooperation in tasks where previous proposals by either player have always been accepted by the other. This reflects that a refusal is perceived as breaking the general agreement of cooperation by the two individuals and neither of them wishes to repeat such failure again (even though both parties might profit from cooperation in the current episode).

When a proposal has taken place, the other individual decides whether to accept (hereafter denoted *responder*). If no proposal is set forward, the "potential" *responder* will not take any action at all. The pair of *responder* strategies $S_i^R = \{S_i^{R,A}, S_i^{R,B}\}$ is as follows:

$$S_i^{R,A} = \left\{ \begin{array}{l} \text{Accept if } \left\{ \begin{array}{l} (i)^R Y \in [0, Y'_i] \\ (ii)^R \text{ all previous cooperation proposals accepted} \end{array} \right\} \\ \text{Refuse otherwise} \end{array} \right\} \quad (3)$$

$$S_i^{R,B} = \left\{ \begin{array}{l} \text{Accept if } \left\{ \begin{array}{l} (i)^R Y \in [-Y'_i, 0], \\ (ii)^R \text{ all previous cooperation proposals accepted} \end{array} \right\} \\ \text{Refuse otherwise} \end{array} \right\} \quad (4)$$

The necessary conditions in the *responder* strategies are given the following explanation and justification:

(i)^R The *responder* will accept if the expected total discounted stream of payoffs after the realization of Y in the given episode, denoted Ψ_i , is non-negative. The strategies of the players are hence directly related to Y since this constitutes the only stochastic element. The critical value where the player is equally well off by accepting or not is denoted Y'_i . This condition implies that individual A will refuse cooperation proposals if $Y \in \langle Y'_i, Y^M \rangle$ and individual B will refuse when $Y \in [-Y^M, -Y'_i \rangle$.

(ii)^R The *responder* will only accept proposals as long as there is no episode in the history of the game where a cooperation proposal by either part has been refuted by the other player. The justification is given in the parallel condition in the propose strategies.

Once the cooperation proposal is accepted, the work exchange will take place, i.e. no defection is possible. But refusing to accept cooperation proposals in a given tasks i where work exchange is the tradition, is regarded as defection to a more generalized agreement of cooperation within task i . as covered by (iii)^P and (ii)^R However, a refusal in one task is assumed not to affect the individuals' cooperation behavior in other tasks. This reflects that people tend to perceive each task as a separate arena¹¹.

¹¹Spillover between tasks will only make the argument of this game theory model stronger since marginal changes in norms is then more difficult. This might explain why some communities seems to cooperate a lot more than what seems to be economically optimal, as is shown later in the empirical chapter. However, this dimension is not included formally since it complicates the model unnecessarily. Neither do I consider interaction with other individuals if the game ends.

2.2.4 Subgame-perfect Nash equilibria

I will first deduct the critical value Y'_i in condition $(ii)^R$ and then show that the according pair of strategies S_i constitutes a subgame-perfect Nash equilibrium.

The stochastic payoff Y is included in the players' immediate payoff in a symmetrically opposite manner. The absolute value of the critical stochastic payoff element Y'_i is hence identical. I will use the example when $Y \geq 0$ in the following deduction of the critical value. This implies that individual A is the *responder* (and individual B the *proposer*). I will further suppress the individual index in order to simplify the presentation, since the expected payoff from cooperation in each future episode ex-ante, denoted Φ_i , for a task i is equal for both individuals players due to the symmetry in the stochastic element Y , i.e. $\Phi_i = \Phi_i^A = \Phi_i^B$. Given the density function $f(Y)$ for the distribution of $Y \in [-Y^M, Y^M]$, we have the following expression:

$$\Phi_i = \int_{-Y^M}^{-Y'_i} 0f(Y)dY + \int_{-Y'_i}^{Y'_i} (\Pi_i - Y) f(Y)dY + \int_{Y'_i}^{Y^M} 0f(Y)dY \quad (5)$$

There are three elements in equation (5). In the first, $Y \in [-Y^M, -Y'_i]$ and individual B will refuse cooperation, which implies that the game end with zero payoff for individual A . In the second, $Y \in [-Y'_i, Y'_i]$ and the *responder* will accept cooperation proposals, which gives the payoff $\Pi_i - Y$ for individual A . In the third, $Y \in [Y'_i, Y^M]$ and individual A will refuse to accept the cooperation proposal from individual B with zero payoff for both as the result since the game ends.

I will all throughout the analysis assume that Y is uniformly distributed on $[-Y^M, Y^M]$ with normalized $Y^M = 1$ which implies $f(Y) = \frac{1}{2}$. Then $\int_{-Y'_i}^{Y'_i} Y f(Y)dY = 0$ and the probability function $P(Y'_i) = \int_{-Y'_i}^{Y'_i} f(Y)dY = Y'_i$. Equation (5) then simplifies down to:

$$\Phi_i = Y'_i \Pi_i \quad (6)$$

The expected total discounted stream of payoffs after the realization of Y is denoted Ψ_i, δ

is the discount factor¹², is given by:

$$\begin{aligned}\Psi_i &= \Pi_i - Y + \delta\Phi_i + \delta^2P(Y^1)\Phi_i + \delta^3P(Y^1)^2\Phi_i + \dots + \delta^tP(Y^1)^{t-1}\Phi_i + \dots \\ &\Downarrow \\ \Psi_i &= \frac{1}{1 - \delta Y'_i} \Pi_i - Y\end{aligned}\tag{7}$$

We find the critical value Y'_i for task i with Π_i when $Y = Y'_i$ and $\Psi_i = 0$. From equation (7) we get:

$$\begin{aligned}\frac{1}{1 - \delta Y'_i} \Pi_i - Y'_i &= 0 \\ &\Downarrow \\ \Pi_i &= (1 - \delta Y'_i) Y'_i\end{aligned}\tag{8}$$

Equation (8) gives the critical value Y'_i as an implicit function of the average payoff Π_i in task i . From equation (7) we see that $\Psi_i \geq 0$ for $Y \leq Y'_i$ and $\Psi_i < 0$ for $Y > Y'_i$. This implies that playing the strategy S_i^A with the critical value Y'_i constitutes a best reply for individual A given the same strategy for individual B , and vice versa.

The strategy pair $S_i = \{S_i^A, S_i^B\}$ where $S_i^j = \{S_i^{P,j}, S_i^{R,j}\}$ for $j = A, B$ with the critical value Y'_i in condition $(i)^R$ of S_i^R must have two characteristics in order to constitute a Nash equilibrium. Neither of the players will achieve a higher payoff by using an alternative strategy given the strategy of the other. The strategy S_i with Y'_i must further be a Nash equilibrium in all subgames of the game. As this is a repeated game, it is sufficient to test for alternative strategies in the initial episode when Y is drawn by *Nature*. It follows from the standard analysis of trigger strategy equilibrium that the strategy S_i with $Y'_i \in [0, Y^M]$ in task i is a subgame-perfect Nash equilibrium if $\Psi_i \geq 0$ for $Y \leq Y'_i$ (better to accept cooperation than end the game with zero payoff), and if $\Psi_i < 0$ for $Y > Y'_i$ (better to end the game with zero payoff than accept cooperation and proceed the game).

We can see from equation (7) that the critical value Y' satisfies condition $(i)^R$. Then $Y = Y'_i$ give $\Psi_i = 0$ in the task i where $\Pi_i = (1 - \delta Y'_i) Y'_i$. If $Y < Y'$, then $\Psi_i > 0$. If $Y > Y'_i$, then $\Psi_i < 0$. This shows that S_i with Y'_i given in the implicit function of equation (8) are subgame-perfect Nash equilibria for the discount factor δ .

¹²I assume the same constant time between the episodes in all tasks i in order to use the same discount factor.

The condition $(ii)^R$ also holds. A change in strategy to accept "profitable" cooperation even if such proposals have been refuted in the past, will still give zero in payoff since the *proposer* will not propose anyway.

The conditions in the *proposer* strategies will also be satisfied. I will split the tasks in two types in order to discuss condition $(i)^P$. When $\Pi_i + Y \geq 0$ and $\Pi_i \geq 0$ the immediate payoff for the *proposer* is non-negative and he can do no better by not proposing since bypassing this episode will give zero in immediate payoff and the same expected payoffs in future episodes. When $\Pi_i + Y \geq 0$ and $\Pi_i < 0$ the *proposer* receives zero in immediate and future payoff since the *responder* will refuse and end the game, i.e. same payoff whether he proposes or not. It is superfluous to discuss condition $(ii)^P$ since this is a convention reflecting that the player with most to gain should be the most eager to initiate cooperation. Furthermore, the *proposer* have nothing to gain by deviating from condition $(iii)^P$ since the *responder* will refuse any proposals anyhow¹³.

This proves that the pair of strategies S_i where the critical values Y_i' are given in equation (8) represents subgame-perfect Nash equilibria.

2.2.5 A numerical example

If $\delta = 0.9$ and $Y^M = 1$ in equation (8) Y_i' will be the following implicit function of Π_i :

$$\Pi_i = (1 - 0.9Y_i') Y_i' \tag{9}$$

The curve in figure (1) below gives the combinations of Π_i on the vertical axis and Y_i' on the horizontal axis from equation (9).

¹³A coordinated deviation by both the *proposer* from $(iii)^P$ and the *responder* from $(ii)^R$ can increase their expected payoff, e.g. the *proposer* will "try again" when the realized Y is smaller, which will then be acceptable for the *responder*. This implies that the given Nash solution is not renegotiation proof, but this problem is not considered since I assume a non-cooperative game.

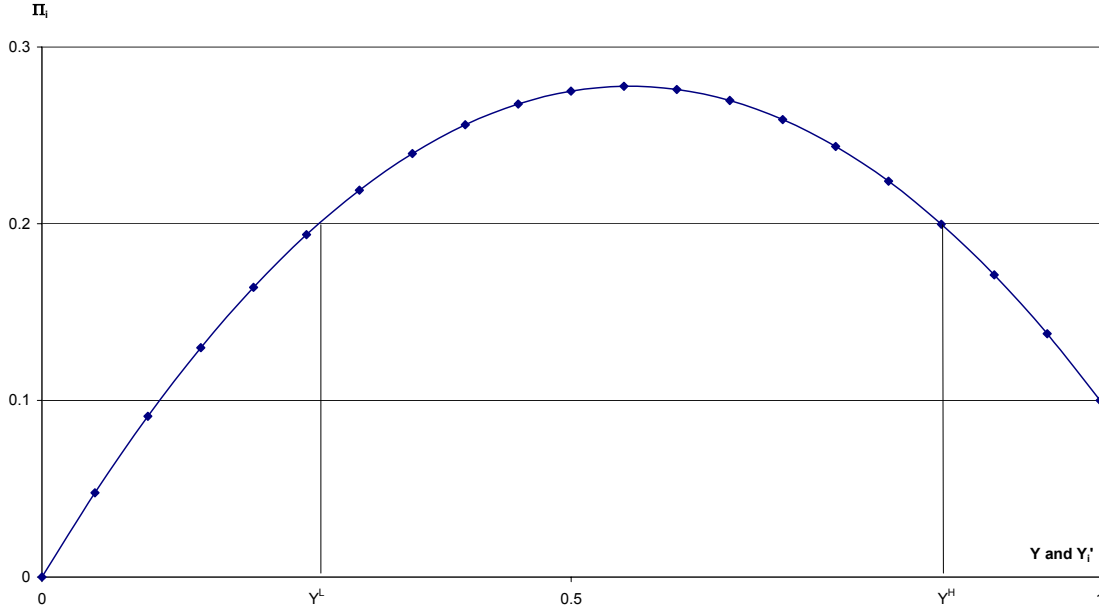


Figure (1): The curve $\Pi_i = (1 - 0.9Y_i')Y_i'$ in this figure represents the critical values Y_i' in the strategies S_i on the horizontal axis in tasks i with different Π_i values measured on the vertical axis when $\delta = 0.9$. In the specific example of task i with $\Pi_i = 0.2$ discussed in the text, $Y_i' = Y^L$ is the low cooperation equilibrium and $Y_i' = Y^H$ the high cooperation equilibrium.

The curve in figure (1) gives the critical values Y_i' in S_i that represent subgame-perfect Nash equilibria for a various tasks i with payoff Π_i measured on the vertical axis. The figure should be read in the following manner. In a task i with Π_i , the associated critical value(s) Y_i' are given on the horizontal axis. I will take task i with $\Pi_i = 0.2Y^M = 0.2$ when $Y^M = 1$ as an example. Then three different strategies S_i sustain subgame-perfect Nash equilibria. The first is S_i with $Y_i' = Y^L$. A realized stochastic value Y lower than the critical value Y_i' will induce the *responder* to accept cooperation proposals since equation (7) demonstrates that $\Psi_i \geq 0$ for $Y \leq Y^L$. The *responder* will on the other hand refuse cooperation if $Y > Y^L$ since $\Psi_i < 0$ according to equation (7). The second is S_i with $Y_i' = Y^H$ which is proven to be a Nash equilibrium in the same manner. The third is for S_i with $Y_i' = Y^M = 1$. Then $Y \leq Y^M$ give $\Psi_i \geq 0$ in equation (7).

Intuitively, in the equilibrium with higher cooperation, the *responder* will accept more adverse proposals (greater absolute value of Y), because he correctly perceives the value of continued cooperation as greater, due to the higher critical value Y_i' . The curve in Figure (1) is hump-shaped for $\delta = 0.9$. There are hence three different categories of task i depending on the

average payoff Π_i . When:

- $\Pi_i < 0.1Y^M$ only a low interior subgame-perfect Nash equilibrium will exist.
- $\Pi_i \in [0.1Y^M, 0.2776Y^M]$ there will be one low and one high interior subgame-perfect Nash equilibrium strategy in addition to the full cooperation strategy as described for task i with $\Pi_i = 0.2Y^M$ above.
- $\Pi_i > 0.2776Y^M$ give S_i with $Y'_i = Y^M$ as the only subgame-perfect Nash equilibrium. Then any strategy S_i with $Y'_i < Y^M$ implies $\Psi_i > 0$ for $Y > Y'_i$ and the *responder* would hence accept cooperation proposals when he is not supposed to according to the proposed strategy.

How stable will the subgame-perfect Nash equilibria strategies be? The low interior equilibrium when $Y'_i = Y^L$ is stable in the sense that if there is a slight stochastic change in the critical value $Y'_i = Y^L - \varepsilon$, then the *responder* will say yes to all $Y \leq Y'_i$. If $Y'_i = Y^L + \varepsilon$, the *responder* will say no to all $Y > Y'_i$. Thus a small stochastic noise to the expected Y'_i will not change the attitude of the *responder*. The high interior equilibrium $Y'_i = Y^H$ is on the other hand unstable because if the *responder* expects stochastic element $Y'_i = Y^H - \varepsilon$, then he will say no to $Y = Y'_i$. This may cause a successive reduction in the critical value Y'_i in the strategies and end in Y^L . If the *responder* expects $Y'_i = Y^H + \varepsilon$, he will say yes to $Y = Y'_i$, which may cause successive increases in critical values Y'_i in the strategies. This process will end with full cooperation, i.e. $Y'_i = Y^M$.

However, another type of dynamic process shows that the interior solutions, Y^L or Y^H , are only applicable in the short and medium term. For a given critical value $Y'_i < Y^M$, sooner or later there will be a work exchange episode where the stochastic $Y > Y'_i$. Then the *responder* says no and cooperation breaks down. Thus, over time only work exchange in tasks i is sustainable if the players have the critical value $Y'_i = Y^M$ in the strategy S_i . Only peasants in communities that were able to coordinate their expectations at full cooperation will cooperate in the longer run in this second category.

We see in figure (1) that S_i with $Y'_i = Y^M = 1$ is not a subgame-perfect Nash equilibrium in tasks i with low average payoff, i.e. category one in the numerical example. The marginal task i where full cooperation is a subgame-perfect Nash equilibrium can be calculated by setting

$Y'_i = 1$ and $\Psi_i = 0$ in equation (7), i.e.

$$\begin{aligned} \frac{1}{1-\delta}\Pi_i - 1 &= 0 \\ \Downarrow \\ \Pi_i &= 1 - \delta \end{aligned} \tag{10}$$

The subgame-perfect Nash equilibrium strategy of full cooperation hence exist in tasks i with $\Pi_i \geq 1 - \delta$. In the long run there will hence be no cooperation in all tasks i with $\Pi_i < 1 - \delta$. The latter hence represents an efficiency loss in the economy due to lack of cooperation.

2.2.6 Necessary punishment level

As shown above there is an efficiency loss because cooperation is not sustainable for tasks i where $\Pi_i < 1 - \delta$. In this section I show that if there is a norm involving a punishment of a *responder* who refuses to cooperate, then cooperation can be sustained in all tasks i with $\Pi_i \geq 0$. Such punishment is denoted $Z < 0$. The punishment level must be strong enough to make full cooperation strategy S_i with $Y'_i = Y^M = 1$ give $\Psi_i^Z = Z$ for a realized $Y = Y^M = 1$ in order to be sustainable in the marginal task i when $\Pi_i = 0$. From equation (7) I hence deduct the necessary punishment level, i.e.

$$\begin{aligned} \frac{1}{1-\delta}\Pi_i - Y &= Z \\ \Downarrow \\ Z &= -1 \end{aligned} \tag{11}$$

With $Z = -Y^M = -1$ S_i with $Y'_i = 1$ will sustain subgame-perfect Nash equilibrium in task i with $\Pi_i = 0$ since $\Psi_i^Z > 0$ for $Y < 1$ and $\Psi_i^Z = 0$ for $Y = 1$. This punishment level is a necessary condition to secure full cooperation as a sustainable strategy. However, S_i with critical value $Y'_i < 1$ can still be subgame-perfect Nash equilibria for some task i with $\Pi_i > 0$ when $Z = -1$, but I do not consider these cases at this stage as they do not represent long term equilibria¹⁴.

¹⁴A punishment $Z \leq -1.19Y^M$ is necessary avoid such solutions, but I will keep $Z = -1$ to simplify the presentation in the rest of the analysis. However, the starting point in this discussion is the assumption that collectively rational norms will develop over time. Some social scientists argue that norms changes slowly. Norms should hence be considered as exogenously given constants, e.g. Elster's vision of "brut norms". However, the sudden entry of women in the labor market is an example of how fast the norms of the society might change. This has happened not only in western countries, but there are also examples of how women in some Palestinian villages were suddenly expected to work outside the house when the men were prevented to enter the labor market

2.2.7 Negative payoff shock

The punishment Z will actually never be implemented if both players uses the critical value $Y'_i = Y^M = 1$ in task i with $\Pi_i \geq 0$, since cooperation will be proposed and accepted in each episode in this subgame-perfect Nash equilibrium. Such communities might be perceived as rich in social capital as they choose to cooperate without any realized threat of punishment. However, if the payoff from cooperation is reduced of some reason, the *responder* will prefer not to accept cooperation and a potentially existing punishment mechanism will be activated.

For simplicity, I assume there is a negative constant shift in the average payoff for all traditional tasks¹⁵ to $\Pi_i - k$ where $k > 0$. I will initially give a solution where the players are slow to adjust strategies and stick to the only long term sustainable strategy of full cooperation, i.e. S_i with critical value $Y'_i = Y^M = 1$. The punishment $Z = -1$ is one motivation for this assumption. Keeping the old strategy before the stochastic Y value is known for the given episode is reasonable if the players do not understand there has been a shift in the payoff. Then a shift to $\Pi_i - k$ might be interpreted as unexpectedly high $Y > Y^M$ value and the *responder* will refuse to cooperate according to the strategy S_i with $Y'_i = Y^M = 1$

The discounted stream of payoff, now denoted $\Psi_i^{Z,k}$ with punishment and change in payoff, that corresponds to equation (7) will be as follows:

$$\Psi_i^{Z,k} = \frac{1}{1-\delta} (\Pi_i - k) - Y \quad (12)$$

However, if the stochastic element Y takes the maximum value 1 in tasks i with negative payoff, i.e. $\Pi_i - k < 0$, then $\Psi_i^{Z,k} < Z = -1$ according to equation (12) and the *responder* will refuse to accept. Thus, cooperation breaks down.

If the stochastic element Y takes a lower value than 1, accepting the proposition may be profitable for the responder. Thus, this implies the players can keep on cooperating in tasks i where $\Pi_i - k < 0$ as long as $Y < Y^M = 1$. The limit value, denoted \bar{Y} , that will be accepted

in Israel during the first Intifada. As an economist who believe most institutions and norms have an economically rational motivation, I hence find it necessary to demonstrate the origin of my results.

¹⁵I will not consider other or new tasks where cooperation might have become more profitable. It will in practice often take long time before the players are able to coordinate cooperation after a transition in tasks where there is no such tradition.

will depend on the payoff $\Pi_i - k$ in a given task i . To find \bar{Y}_i we set $\Psi_i^Z = Z$ in equation (12):

$$\begin{aligned} \frac{1}{1-\delta} (\Pi_i - k) - \bar{Y}_i &= -1 \\ \Downarrow \\ \Pi_i - k &= (\bar{Y}_i - 1)(1 - \delta) \end{aligned} \quad (13)$$

Equation (13) hence gives the implicit function $\bar{Y}_i = g(\Pi_i - k)$. The "worst" task i to ever be accepted will have the payoff $\Pi_i - k = -(1 - \delta)$ since cooperation proposals will be accepted when $Y = 0$. The full cooperation strategy is not really contested as long as $Y < \bar{Y}_i$ and cooperation can hence take place even if the average payoff is negative¹⁶. When $Y > \bar{Y}_i$, the responder will refuse to cooperate and the game ends. Inefficient cooperation, i.e. cooperation in task i with $\Pi_i - k < 0$, is hence not sustainable in the long run but might persist in the short and medium term.

I will now show that inefficient cooperation might persist even if the players realize that the change in payoff will affect their strategies both as a *proposer* and a *responder*. I will only discuss task i with $\Pi_i - k < 0$ since tasks with negative payoff is the main interest of my analysis. I will deduct the solution by changing the strategies in three subsequent steps.

First, I observe that the critical value for the *responder* will be lower, i.e. a new critical value $Y'_i < Y^M = 1$ for the tasks i with $\Pi_i - k$. Both individuals understand that the opponent will change the strategy accordingly. The expected payoff in each episode, denoted $\Phi_i^{Z,k}$ when there is a punishment $Z < 0$ and negative shift in payoff $-k$, corresponds to equation (5) in the following way:

$$\Phi_i^{Z,k} = \int_{-Y^M}^{-Y'_i} 0f(Y)dY + \int_{-Y'_i}^{Y'_i} (\Pi_i - k - Y) f(Y)dY + \int_{Y'_i}^{Y^M} Zf(Y)dY \quad (14)$$

In the first term in equation (14) is $Y \in [-Y^M, -Y'_i]$ and individual A will get zero since individual B refuses to cooperate. In the second term when $Y \in [-Y'_i, Y'_i]$ there is cooperation with payoff $\Pi_i - k - Y$. In the third term when $Y \in \langle Y'_i, Y^M \rangle$ individual A will get the punishment Z since he refuses to accept cooperation. Given the same explicit Y distribution as before where

¹⁶The proposer might now prefer not to propose, but this will first be discussed when I later assume a change in strategies.

a normalization of $Y^M = 1$ implies $\int_{Y_i'}^{Y^M} f(Y)dY = \frac{1-Y_i'}{2}$, equation (14) will be as follows:

$$\Phi_i^{Z,k} = Y_i' (\Pi_i - k) + Z \left(\frac{1 - Y_i'}{2} \right) \quad (15)$$

The second term equation (15) reflects the punishment given if $Y > Y_i'$. With $Z = -1$, the discounted expected stream of payoff of accepting for a *responder* faced with an episode with stochastic element Y , corresponding to equation (7), will then be

$$\Psi_i^{Z,k} = \frac{1}{1 - \delta Y_i'} (\Pi_i - k) - Y - \frac{\delta}{1 - \delta Y_i'} \left(\frac{1 - Y_i'}{2} \right) \quad (16)$$

The only difference from a pre-transition solution is hence that the average payoff element that is reduced by a constant k . I find the new critical value Y_i' by imposing $\Psi_i^{Z,k} = Z = -1$ and $Y = Y_i'$ in equation (16), which gives the following result:

$$\begin{aligned} \frac{1}{1 - \delta Y_i'} (\Pi_i - k) - Y_i' - \frac{\delta}{1 - \delta Y_i'} \left(\frac{1 - Y_i'}{2} \right) &= -1 \\ \Downarrow \\ \Pi_i - k &= (1 - \delta Y_i') (Y_i' - 1) + \delta \left(\frac{1 - Y_i'}{2} \right) \end{aligned} \quad (17)$$

Equation (17) implicitly defines the critical value Y_i' as a function of the payoff $\Pi_i - k$ in task i . This is illustrated by the curve denoted $\delta - 0.9$ in figure (2) below for the explicit case when $\delta = 0.9$. Then $\Psi_i^{Z,k} \geq -1$ for $Y \leq Y_i'$ and $\Psi_i^{Z,k} < -1$ for $Y > Y_i'$. It corresponds to the curve of critical values Y_i' in figure (1) and the description of the solutions is identical. Given a proposal of cooperation, the *responder* will accept in tasks i with negative average payoff $\Pi_i - k < 0$ as long as Y is equal to or smaller than the value given on the horizontal axis indicated by the $\delta - 0.9$ curve.

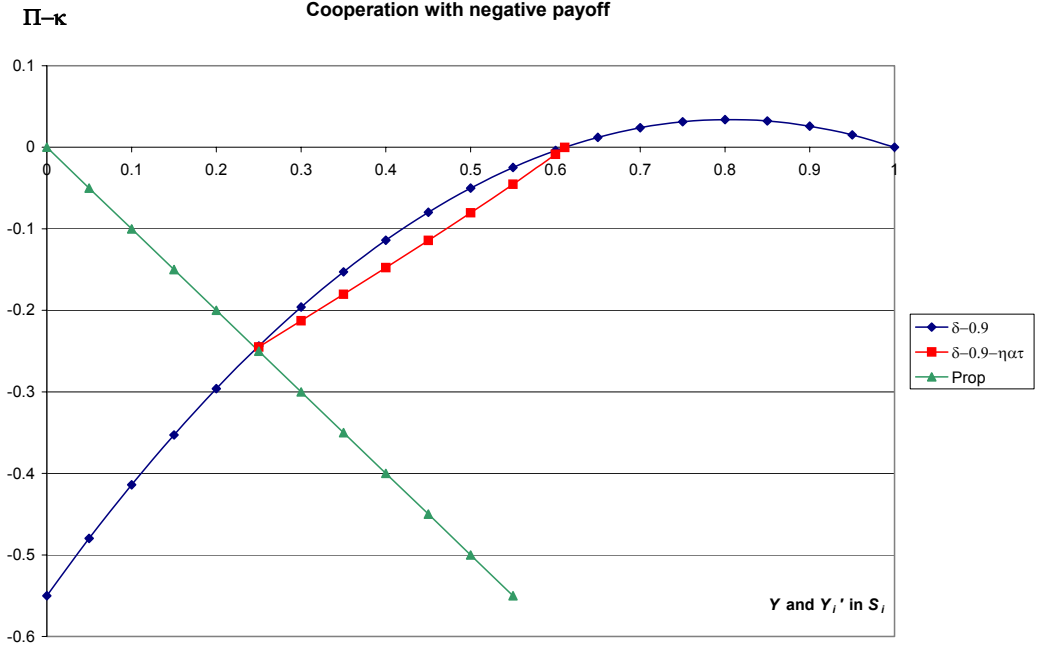


Figure (2): The three curves indicate the three stages of change in strategies after a negative shift in payoff. The first is the $\delta - 0.9$ curve, which gives the critical values Y_i' for the *responder* on the horizontal axis for the task i with payoff $\Pi_i - k$ on the vertical axis. The second is the *prop* line, where a realized Y equal or higher than the according point on the line for task i will induce a proposition. If Y is lower, there is no proposition because $\Pi_i - k + Y < 0$. The third is the $\delta - 0.9 - \hat{h}$ curve, which is similar to the $\delta - 0.9$ when the *responder* incorporates the fact that there will be less propositions. The "inefficiency triangle", i.e. combinations of task i with average payoffs $\Pi_i - k < 0$ and realized Y that induces cooperation, is hence given by the area between the X-axis, the $\delta - 0.9 - \hat{h}$ and the *prop* line.

Second, I assume the *proposer* will not propose if his immediate payoff is negative¹⁷. Since I discuss the situations when $Y \geq 0$ individual B will be the *proposer* and his immediate payoff of the given episode is $\Pi_i - k + Y$. The *proposer* condition $(i)^{P,B}$ for individual B is then:

$$(iv)^{P,B} \quad \Pi_i - k + Y \geq 0 \quad (18)$$

This gives the critical value for the *proposer* $Y_i'' = -(\Pi_i - k)$ as illustrated by the *Prop* line in Figure (2). In a given task i with $\Pi_i - k < 0$, the *proposer* will initiate cooperation if $Y \geq Y_i''$. There are no proposition when $Y < Y_i''$ and the current episode is bypassed in silence.

Third, a *responder* will take into consideration this expected reduction in realized episodes of work exchange in the task i with $\Pi_i - k < 0$ when he decides whether to accept a proposal.

¹⁷I will disregard the possibility that the *proposer* will strategic proposals with the intention to make the *responder* refuse.

Since the average payoff is negative, this reduction in episodes will reduce the future loss of accepting the proposal today. He will hence be willing to accept a worse stochastic outcome Y in the present episode, *ceteris paribus*.

To derive the critical value for the *responder* facing a stochastic element Y we must first find the expected payoff in each episode of the game before *nature* has drawn Y , now denoted $\widehat{\Phi}_i^{Z,k}$, which is equivalent to equation (15):

$$\widehat{\Phi}_i^{Z,k} = \int_{-Y^M}^{-\widehat{Y}'_i} 0f(Y)dY + \int_{-\widehat{Y}'_i}^{-Y_i^S} (\Pi_i - k - Y) f(Y)dY + \int_{-Y_i^S}^{Y_i^S} 0f(Y)dY \quad (19)$$

$$+ \int_{Y_i^S}^{\widehat{Y}'_i} (\Pi_i - k - Y) f(Y)dY + \int_{\widehat{Y}'_i}^{Y^M} Zf(Y)dY$$

↓

$$\widehat{\Phi}_i^{Z,k} = P(Y_i'^S) (\Pi_i - k) + \int_{\widehat{Y}'_i}^{Y^M} Zf(Y)dY \quad (20)$$

↓

$$\widehat{\Phi}_i^{Z,k} = \left[\widehat{Y}'_i + (\Pi_i - k) \right] (\Pi_i - k) - \frac{1 - \widehat{Y}'_i}{2} \quad (21)$$

The first term of equation (19) gives zero payoff for individual A when $Y \in [-Y^M, \widehat{Y}'_i]$ since individual B will refuse cooperation proposals and hence end the game. In the second term individual A obtains the payoff $\Pi_i - k - Y$ when $Y \in [-\widehat{Y}'_i, -Y_i^S]$ since individual B will accept his proposals. In the third term none of them will find it profitable to propose since $Y \in \langle -\widehat{Y}'_i, \widehat{Y}'_i \rangle$ and the payoff is zero. In the fourth, individual A will accept proposals when $Y \in [Y_i^S, \widehat{Y}'_i]$ and receive the payoff $\Pi_i - k - Y$. In the fifth, individual A will refuse cooperation when $Y \in \langle \widehat{Y}'_i, Y^M \rangle$ and hence prefer to take the punishment that give the payoff Z . Equation (20) follows since the probability that a game will be proposed and then accepted is $P(\widehat{Y}'_i'^S) = \int_{-\widehat{Y}'_i}^{-Y_i^S} f(Y)dY + \int_{Y_i^S}^{\widehat{Y}'_i} f(Y)dY$. Then equation (21) follows due to the normalized $Y^M = 1$ and a redefined probability function $P(\widehat{Y}'_i'^S) = \int_{-\widehat{Y}'_i}^{\widehat{Y}'_i} f(Y)dY - \int_{-Y_i^S}^{Y_i^S} f(Y)dY = P(\widehat{Y}'_i) - P(Y_i^S) = \widehat{Y}'_i - Y_i^S$. The last step is valid because Y is uniformly distributed. The *proposer* strategy gives $Y_i^S = -(\Pi_i - k)$ and then $P(Y_i'^S) = \widehat{Y}'_i + (\Pi_i - k)$ for our tasks i of interest where $(\Pi_i - k) < 0$ and $Y_i' > -(\Pi_i - k)$.

Thus, when the players incorporate the change in *proposer* strategy into the *responder* strategy, the discounted stream of future payoffs, now denoted $\widehat{\Psi}_i^{Z,k}$, is given by the following expres-

sion:

$$\widehat{\Psi}_i^{Z,k} = \frac{1 - \delta(\widehat{Y}_i' + (\Pi_i - k))}{1 - \delta\widehat{Y}_i'} (\Pi_i - k) - Y - \frac{\delta}{1 - \delta\widehat{Y}_i'} \left(\frac{1 - \widehat{Y}_i'}{2} \right) \quad (22)$$

The critical value of \widehat{Y}_i' is then deducted from equation (22) when $\widehat{\Psi}_i^{Z,k} = -1$ and $Y = \widehat{Y}_i'$, i.e.

$$\frac{1 - \delta(\widehat{Y}_i' + (\Pi_i - k))}{1 - \delta\widehat{Y}_i'} (\Pi_i - k) - \widehat{Y}_i' - \frac{\delta}{1 - \delta\widehat{Y}_i'} \left(\frac{1 - \widehat{Y}_i'}{2} \right) = -1 \quad (23)$$

Equation (23) gives the critical value \widehat{Y}_i' as a function of the $\Pi_i - k$ in the task i with negative payoff that are considered in this part of the analysis. This function is difficult to solve analytically, but a numerical simulation give the $\delta - 0.9 - hat$ curve in figure (2) in the numerical example when $\delta = 0.9$. For a given task i with payoff $\Pi_i - k$, the *responder* will accept cooperation proposals if Y is at or on the left side of the curve $\delta - 0.9 - hat$, i.e. $Y \leq \widehat{Y}_i'$. If Y is on the right side, i.e. $Y > \widehat{Y}_i'$, the *responder* will refuse, take the punishment $Z = -1$ and hence end the game.

When we compare equation (16) and equation (22) we immediately see that $\widehat{\Psi}_i^{Z,k} \geq \Psi_i^{Z,k}$ for a given task i with $\Pi_i - k \leq 0$ and $\widehat{Y}_i' = Y_i'$ since $1 - \delta(\widehat{Y}_i' + (\Pi_i - k)) \leq 1$ in the interval of Y where proposals actually will take place. A *responder* will hence put more emphasis on the immediate punishment Z of refusing to accept cooperation compared to the "indirect punishment" of a negative average payoff $\Pi_i - k$ in future interactions as cooperation will take place more seldom. This induces the downward shift in the subgame-perfect Nash equilibrium strategies to the $\delta = 0.9$ *hat* curve line in Figure (2).

I have hence showed that the adjusted strategy S_i with the critical value \widehat{Y}_i' from equation (23) in condition $(ii)^R$ and the change in $(i)^P$ given in equation (18) for the *proposer* sustains a subgame-perfect Nash equilibrium.

Inefficiency "triangle". Whether cooperation will take place in the tasks i with negative average payoff, i.e. $\Pi_i - k < 0$, will hence depend on the realized Y value. When we assume the players understand there has been a shift in payoff for task i from Π_i to $\Pi_i - k$, it also seems reasonable to assume they adjust their strategies from long term Nash equilibria of full cooperation. Individual B as the *proposer* will not propose if the immediate payoff is negative, i.e. only propose if the Y value is on or at the right hand of the *prop* line in figure (2). Furthermore, the *responder* will know about the adjusted *proposer* strategy and hence take the reduced number of future work exchange episodes into consideration, i.e. he will accept proposals when Y is at or on the left side of the $\delta - 0.9 - hat$ curve for a given task i with

$\Pi_i - k < 0$. My focus of interest is combinations of task i with $\Pi_i - k$ and realized Y in the area restricted by the (i) X axis, (ii) *prop* line and (iii) $\delta - 0.9 - hat$ curve in figure (2). This "inefficiency triangle" gives the tasks i with negative average immediate payoff, i.e. $\Pi_i - k < 0$, that will be solved by work exchange as long as the stochastic payoff element Y is in as the indicated range¹⁸.

2.2.8 Summary and extensions

Cooperation with negative payoff is not viable in the long run¹⁹. As soon as the stochastic element is higher than what the *responder* will accept, cooperation proposals will be refused and the game ends. The longer time has passed since the shift in payoff, the less inefficient cooperation is hence expected to take place. The longer time between each episode, the longer time will the adjustment process take. As communities differ in both respects, we also expect them to have reached different stages in the adjustment process. If we assume all communities are able to cooperate when the payoff is non-negative, then more cooperation actually implies that the community cooperates in more tasks with a negative average payoff. The result is lower income. This game theory model hence gives a negative relationship between the level of cooperation and income.

The individual that refuses to cooperate are only punished once. An alternative would be that the game did not end if someone refused to cooperate, and the same individual could hence be punished again and again. If norms of cooperation are frequently broken, people will become more reserved against taking actions of punishment since sanctions often imply a real cost for the punisher too. Then cooperation in tasks with negative average payoff will cease over time. A less dispersed distribution will make high Y values less likely and inefficient cooperation hence more persistent. It might then take a long time before the immediate payoff is so bad that the *responder* prefers to take the punishment.

¹⁸Reasoning in figure (2) indicates that strategic proposals, which are ruled out in the formal model, do not constitute a problem. Such behavior implies that the *proposer* will propose on the left side of the *prop*-line. It does not make sense in tasks i with $\Pi_i - k$ above the intersection of the *prop*-line and the $\delta - 0.9 - hat$ curve since the *responder* will accept anyway. Neither in task i with $\Pi_i - k$ below the intersection level does strategic proposals make sense. If Y is on the left side of the $\delta - 0.9 - hat$ curve, proposals will be accepted with an immediate loss for both players as the result. If Y is on the right side, the responder will refuse and the game ends. But there is no point in ending the game since there will be no proposals in later potential episodes of the game anyway. The only possibility is that the *responder* of today is perceived to be "crazy" enough to propose in these tasks later. Then it is better for the *proposer* of today to propose first in order to end the game.

¹⁹I assumed in the preceding discussion that the players knew the punishment level Z . However, in practice there might be considerably insecurity attached to its level since was never enforced in the long term Nash equilibrium. If people perceives a strong punishment, e.g. $Z < -Y^M = -1$, then players might keep their full cooperation strategies also after a negative change in the immediate payoff from cooperation.

The examples in this chapter emphasize the theoretical possibility that people who cooperate more earn less. I will now proceed to estimate the effects of cooperation on income in a given rural area in the developing country Peru. The district of study consists of several small communities in the middle of the modernization process from being isolated traditional societies to modern market economies. The dispersion in cooperation level is surprisingly large taking the high degree of cultural and geographical similarities in this district into consideration.

3 Empirical study

3.1 Social capital and cooperation productivity measurement

Much of the empirical SC-literature focuses on norms and preferences and proxy this by some kind of perceived level of trust and trustworthiness in a given society. Putnam et al. (1993) argue that civic activity, i.e. being members of organizations, reading newspapers etc., make people more empathic and hence more willing to cooperate in "social dilemmas", which then constitutes an indirect measure of SC²⁰. Other authors have later preferred to measure the level of trust and trustworthiness directly. Either by experimental games, i.e. Glaeser et al. (2000), or by survey questionnaires, like Knack and Keefer (1997) using the World Value Survey where people were asked if "...most people can be trusted?" for cross-section analysis on country level. A similar approach can be used on all empirical levels, like Narayan and Princhett (1999) who carried out a household questionnaire survey for 1376 households in 87 rural Tanzanian villages mixing the two approaches. Each family was asked about membership in groups and its characteristics, and then about their subjective level of trust in others and perceptions of social cohesion in the village. Most studies hence actually try to measure the underlying variable for norms directly in order to apply these in econometric work, and *not* the efficiency of the actions resulting thereof as I have approached in my research.

Most of the empirical literature relates SC-proxies to some "social dilemma" and it is tacitly understood that the resulting cooperation has a positive effect on income. Preceding the SC-literature, Ostrom (1990) studied how local societies organize the exploitation of common pool resources (CPR) as a problem of "collective action". She finds different variables like homogeneity of the society to have a significant impact on the cooperation level. In Ostrom (2003) she argues that the effects work through cooperation inducing norms, "trust", "cultural

²⁰Putnam et al. (1993) found a positive effect on the efficiency of local governmental institution in their famous study of Italy.

identity" and the equilibrium combinations of reciprocal action rules chosen by the population, i.e. what I would call SC in this paper. The CPR-literature uses variables that are thought to work through the SC-effect in the econometric models, to explain the cooperation level. The negative impact of integration on cooperation in the set of Indian irrigation communities found in Bardhan (2000) is meant to be interpreted this way. Similarly, the Dayton-Johnson (2000) study of irrigation communities in Mexico finds homogeneity within the community to have a positive impact on cooperation²¹. None of these studies actually go beyond estimating the effect of trust on cooperation in exemplified "social dilemmas", nor do they measure the impact of cooperation on income.

Narayan and Princhett (1999) is one of the few studies that try to estimate the total income effect of SC. They find that income of the individual households increases with proxies for "trust" in reduced form regression models. The average number of organizational membership in the village had a significant positive impact on income level, while the households had no positive effect of belonging to more organizations themselves. SC is hence more a public than a private good²². But group membership can depend on the income level as some kind of consumption good, and the authors hence use "trust in strangers" and "trust in government" as instrument variables which renders significant results. These instruments are not valid in the opinion of Durlauf (2002), being incorrectly excluded from the original econometric model since he finds it rather non-controversial that societies with higher generalized trust also achieve more economic progress. Knack and Keefer (1997) do a similar exercise on a cross-country level and find the World Value Survey question of "...most people can be trusted" to be positively correlated with the average income level, but the endogeneity problem is expected to be just as important at this aggregation level. My paper follows the approach taken by Narayan and Princhett (1999) in using the income level as the left hand side variable, but differs by introducing cooperation resulting from SC as the explanatory variable rather than a proxy for SC itself.

²¹These resemble the communities of the Peruvian highland in this study both in natural conditions, infrastructure and culture.

²²Their estimated effect is surprisingly strong. Increasing average membership in groups by one standard deviation increases expected incomes by 20-50 percent. A similar increase in schooling entails just a 3 to 5 percent increase in income, while non-farm physical assets is associated with 19-22 percent more income.

3.2 Econometric analysis of work exchange in Tambo

3.2.1 Reciprocal traditions and community characteristics

Social anthropologists like Mayer (2002) often characterize the Peruvian highland as "the heartland of reciprocity". The forefathers of the inhabitants of the district Tambo in the Department of Ayacucho, where the survey of this author took place, were once part of the Incan empire. Quechua is the spoken language, even though people are now able to communicate in Spanish, and old traditions are still in place. The fundamental unit of social identification is the community. The communities differ considerably in size - from 12 to 180 households in this sample of 49 communities - but are organized in a rather similar manner (see summary statistics of main variables table A1 in the appendix). Community assemblies with compulsory attendance for (at least) all heads of households are held about four times a year. The assembly elects the president and other members of the community council, representatives for other offices like the defense committee, irrigation committees, etc. Even the official state representative is defacto elected by the community, since the government tends to appoint the candidate proposed by the community assembly.

The communities might have different juridical status. Some are Recognized peasant communities with registered common property rights to land. Others are non-registered communities where people have individual property rights even though few have legally registered entitlement papers²³. The difference is rather superficial. Most land has been handed out to households for individual use as well as the fact that family based inheritance rights are practiced in all communities. Most communities were forced to choose between the two property right systems when they were handed over land from the large estates during the land reforms of the 1970s. The result is a rather even distribution of land independent of the property rights system in place²⁴. Both common property rights to land and missing official property documents impede reconcentration of land without the acceptance of the community assembly. An important explanation for the existence of communities as units of organization is the need to protect individual property rights from outsiders according to Gonzales de Olarte (1994). A family alone would not

²³A large-scale entitlement program financed by the Inter-American Development Bank is now registering all plots and houses in both rural and urban areas in Peru. The official explanation is that a public property register makes it possible for the owners to use property as collateral in order to loan money for productive investments in line with the thoughts of de Soto (2001). Formal entitlement is furthermore necessary in order to introduce property tax in the future, something that is assumed by many as the government's hidden agenda.

²⁴Fairly equal land distribution is probably a necessary condition for reciprocal work exchange not being replaced by a market oriented labor market.

have the power to stop encroachments, either from other poor farmers or large capital owners, if they stand outside a mutual defense organization. The state apparatus is nearly absent in this poor part of the countryside and documents of formal property rights have played a minor role until today.

With this fundamental basis of institutional power, the community assembly and council are able to organize different forms of collective action like building and maintenance of infrastructure on irrigation systems, schools, roads, etc.; make attendance to assemblies compulsory; put pressure on people to take part in defense committees and Mothers' Clubs²⁵, or purely voluntary organizations like dance and music groups. Different forms of sanctions are imposed on people who do not comply with their obligations, starting with oral warnings and monetary fines and ending in the most extreme cases with confiscation of property, imprisonment and eviction from the community. Well functioning communities have hence institutional power to carry through collective action projects.

The line between institutional power and truly individual based voluntary cooperation is hence blurred. The aim of this paper is to measure the productivity of SC induced types of cooperation and it is hence important to select the variants that are less influenced by institutional aspects of power²⁶. The community authorities do not interfere or influence the implicit contracts of work exchange between individuals. At most they mediate between the partners if a conflict erupts. *Work exchange* is then a variable that is based on trust that originates in social capital rather than institutional factors and is hence chosen for this analysis.

3.2.2 Productivity effects

The agricultural production function is normally assumed to be homogenous of degree one in the basic inputs land, water, labor, capital, fertilizers and other chemicals for agricultural production, i.e. a general increase in all inputs entail an identical increase in income. The technical efficiency in the use of these inputs and the prices obtained from the products might however depend on cooperation, knowledge and transport facilities through higher production volumes, better prices and easier access to profitable markets.

²⁵The voluntary aspect of the defense committees is low since the military in practice made it compulsory. Membership in Mother Clubs is considered a necessity in order to receive governmental food aid.

²⁶Incumbent leaders can impede real democracy within the community by making the life of opponents difficult, for example by refusing to sign individual petitions for public documents, make false reports to central authorities and abuse their power in other ways. People hence often feel forced to participate in communal works that are initiated by the community elite, often in combination with central authorities.

Work exchange might lead to more efficient use of resources in the Peruvian highlands in several ways. The fundamental characteristic is to increase the number of people working on a given project at the same time, which opens for economies of scale effects. In the poor district of Tambo this is related to the lack of production capital. Tractors and other modern machinery are hardly existent and even plough oxen are scarce. The solution is to apply the traditional hand plow (*Chaquitaccla*). Three people working together - two trampling the hand plough into the ground and one taking a grip on the tuft of grass in order to till it over - are supposed to be able to turn the land faster than when each is working alone equipped with a separate hand plow. This system also gives rise to specialization gains since the labour power of youngsters is best exploited as tilling assistants.

A concentrated effort is often necessary in order to exploit short windows of opportunities given by nature or human organization in traditional agriculture. The land is for example humid and soft just after rainfalls. One man-hour of work with the hand plough will then till a lot more land than later when the land dries up and hardens. The same applies to irrigated land, since water is distributed in turns. Working for each other is hence technically efficient in the sense that land is tilled while soft and the others have also something to do while they are waiting for their turn of the water. Geographical distribution of land, soil types, etc. makes people have different needs at different times and work exchange can hence induce the optimal use of labour over time for the whole community as such. The freed resources can be used to increase the use of the other inputs, for example to till more land (if such is available), improve irrigation systems or engage in other fertility improving activities, ranging from collecting cow dung to engage in wage labour in order to buy commercial fertilizers and pesticides. Work exchange is not restricted to purely manual work since two and three teams of plough oxen working together is common in most places and were also observed in Tambo.

The farmers themselves tend to mention competition between participants in work exchange schemes as the most important production-enhancing factor. Working faster, doing more and better than the others becomes a more important element the larger the group. "Working alone, you fall asleep" is the standard comment²⁷. If this is an inherent characteristic of self-motivation and hence the people's ability to work hard, it stands in direct contrast to the assumed shirking effect when people work for others in modern societies.

²⁷I experienced variants of this phenomenon when I unexpectedly showed up in the fields to make interviews. People were more than willing to talk when they were working alone. A small group would sooner or later become impatient even though just some of them were asked to respond while the others kept on working. In large groups people could refuse to take time off at all.

On the other hand there are several aspects of work exchange that might reduce income. Large distances in this highland area force people to walk up to several hours to a given plot. If one person stayed for a longer time in order to work the land alone, or actually construct the house close to the field instead of clustering in groups, a lot of travel time would be spared. Even though the speed of work is high, the quality of work potentially is lower since people might be more careless and hurt the plants while working in the field. This becomes more important with market integration as quality has a large impact on the sales prices.

Other goals than maximization of expected income can be important to explain behavior that does not necessarily seem rational. Working together is often regarded as a social happening and hence juxtaposed to a consumption good, and Mayer (2002) hence doubts this custom will ever disappear. The expected standard of decent treatment is high, since good food, alcohol and coca leaves are served several times during the day²⁸. This should only represent an expense and not influence gross income. Meanwhile, this reduces physical working capabilities in some degree and people might turn too sociable, taking too many pauses. Since people also derive utility from the social interaction in itself, technical efficiency and optimal time allocation might be considered to be of secondary importance. Income insurance is further an important feature of reciprocal work exchange. Not to repay your obligations is normally accepted in case of "force majeure". One example is to send your son - who is normally not as productive - as replacement in work exchange schemes if the farmer is not able to attend due to illness or injuries, for example with a broken leg. People who normally work together can further constitute an "insurance club" for goods in case some of the members do a very poor harvest. According to Gonzales de Olarte (1994) agricultural production is considered to be individual property in good times, but turns common property when hunger strikes. Finally, accidents and injuries unfortunately constitute an important part of physical labour. The farmers can hence prefer to work together as a precaution in case of accidents.

Few people depend purely on wage income in these rural highland communities, since most households have their own plots. It is hence a risky business even for well-situated farmers not to take part in work exchange schemes since there is no labour market as such. The anthropological and peasant theory literature is full of examples of how peasants punish non-cooperative minded

²⁸When good service is a cultural obligation in work exchange arrangements, the general result is that participants (mostly men) hence consume a larger stake of the available family resources than the people doing household tasks (mostly women). A parallel might be the obligation for business leaders to "wine and dine" in the business community, a social equilibrium where the stockholders and consumers pay the cost (the former through lower business profits and the latter in form of higher product prices).

people by refusing to give a hand when help is most needed, no matter how much money they are offered²⁹. The fear of being stamped as "non-cooperative" can hence force people to take part in a proposed work exchange scheme that actually does not lead to higher income in itself, since they do not want to risk being prevented from making similar propositions when it is actually productive. Indirect and often unrelated rewards from taking part in work exchange (and hence labeled cooperation minded) can be access to public funds, political power and positions in the community, could hence take the character of rent-seeking activity and represent a drag on the economy.

The rules of the game of reciprocity are culturally given and seldom open for negotiation. Tit-for-tat exchange measured in hours under similar circumstances is the basic rule. There might exist ratios of exchange between different kinds of work (and those might change over time as the composition of tasks in the community changes), but not between different levels of inherent working capabilities. According to Mayer (2002), disproportional exchange between people with different levels of working capacity will "infer poison in a relationship". Gonzales de Olarte (1994) finds work exchange groups (of either highly productive or low productive) individuals to seldom cross. Total production would probably increase if people with low and high capabilities work together - which is the implication of a wage labour system where the market decides how the "cake" should be split between the different partners - but this is in practice ruled out. The "cake" splitting problem of cooperation between unequals hence leads to a sub-optimal combination in the use of the community's total labour resource of the community in general. Asymmetrical relations within the community might further induce the less powerful to trade work for influence with the more powerful according to Mitchell (1991) and the marginal productivity of labour might hence be lower under such conditions than when the community members are on an equal footing. However, fieldwork observations indicate that such systems of "Patronage" do not constitute the major component of work exchange relationship in this area.

The specialization and economies of scale effect on technical efficiency implies that communities where people do more work exchange should have a higher average income. But other aims than the maximization of expected income might lead people to cooperate more than optimal to maximize income. As shown in the game theoretical model above, norms might entail coop-

²⁹Mayer (2002) mentions an example of pure revenge and Gonzales de Olarte (1994) stresses the lack of labor in peak seasons which imply a rather high shadow wage on labor. The latter point is emphasized by Blum (1995), who calculated the marginal productivity of work during peak seasons to be 10 times higher than the going wage rate, but this becomes irrelevant since no one would work for such low wages if there were no reciprocity attached.

eration even if it reduces income. The 49 communities in the district of Tambo in the Peruvian highland differ a lot in their use of work exchange, even though they are geographically and culturally quite similar. The mean number of days per worker spent in work exchange schemes is 90 days a year, but the standard deviation is 78 with maximum 300 days a year and a minimum of 0. This rather high spread between the communities makes it more likely to find significant estimation results in the econometric analysis.

3.2.3 Community cross-section regression model

I conducted the questionnaire survey during spring 2002. All rural communities in the district of Tambo in the Peruvian highland were included (leaving out the urban district capital). The division into communities in the statistical material follows the lines of the municipal authorities in COZODES, i.e. units which were made responsible for organizing the Defense Committees during the civil war initiated by the Shining Path guerrilla, see Municipality (2002).

The intention of this fieldwork survey was to register the level of different forms of cooperation within each community, how the community institutions worked and the degree of economic integration with the rest of society. The respondents were normally one or more elected representatives of the communities ("an authority") who would assess production, sales, other income sources, average days of work exchange and other cooperation variables and institutional aspects for the whole community as such. Household interviews (even a stratified sample) were beyond the reach with the given time frame of this project. I was willing to accept less accurate estimations of community averages in order to obtain a larger sample of communities, since the point of interest of this study is the effect of community level culture on the living standard in general. The positive effect of interviewing representatives of the community is probably a lower risk of intended misinformation, since households would be more scared about abuse of information, e.g. individual taxation³⁰.

However, the roughness of the survey made it difficult to assess some variables that are normally included in production functions. The exclusion of labour probably does not represent a major source of estimation bias since most people are occupied in different work related activities most of the day. Attempts to register the use of labour within the agricultural sector

³⁰This method does not guarantee truthful information, as community leaders might believe an impression of poverty would entail help from NGOs and state run agencies. However, the problem is less severe since there are no personal implications for the respondent. The hard work of the field researcher is to dig deeper for correct information when the answer does not seem correct. Too many interviewers take a short cut by making their own estimations in order to save time and appear more credible.

would have further been insecure as people would have had problems in separating from the other sources of income such as animal husbandry, other sales and wage labour³¹. Capital is further left out since most people just use simple traditional technology. The use of plough oxen is not very extensive and hence the exclusion probably does not give rise to serious estimation biases. Some aspects of soil fertility like the use of chemical fertilizers and pesticides are neither included. These basic production factors are hence part of the residual of the econometric model.

All basic production variables are measured in units per person, i.e. the estimated total for community as such, divided by the number of people living there. Income is restricted to agricultural income, defined as *Agri income* and measured in New Soles per year per household, since work exchange is supposed to be more common within this field. This income source constitutes about 50 percent of all income in the survey. The income from agriculture is calculated by aggregating production by crops using a market price as weight, i.e. this figure is the total production value and not only the profit element. Animal husbandry also constitutes a large part, but the calculation is probably more inaccurate. The same applies to salary work outside the community, and production for sale that is mostly transformed agricultural products, for example the traditional freeze-dried potato. *Agri income* is measured in average New Soles per year per household.

The following explanatory variables will be included in the regression model explaining *Agri income*. *Land*; measured in units of valley bottom equivalents since land in valley sides and highlands are less useful for agricultural production. *Water*; the units of water supplied through irrigation system is calculated by multiplying different areas with assessed supply of water within the given system (area of well irrigated land is hence an alternative interpretation). *Ecology*; an indicator for natural soil fertility, which has a higher value the larger share of the land is in the valley bottoms compared to valley sides and highlands. *Road*; a dummy for being connected with a road or not. *Work exchange*; the average number of days adult men work together with others in work exchange schemes that directly or indirectly imply a duty to reciprocate (including some where money is given in return as discussed in the theoretical model).

The simple correlation coefficient of *Work exchange* and *Agri income* is small and even negative (-0.0433). The discussion of several potential negative income effects of *Work exchange*

³¹There is no real monetary labor market in the district. Exchange of work or non-monetary rewards are common within the communities, and there is little contact between members of different communities. The type of wage labor in this study is hence mostly farm work in the distant jungle or in the district capital.

given in the preceding chapter opens for a negative relation in general. On the other hand, it does seem reasonable that some types of work exchange have a positive income effect. The most obvious is economies-of-scale situations like ploughing after rainfalls and after given turns in the irrigation system. A quadratic function that allows for a non-monotonous relationship seems proper and is applied in the econometric model below. Few variables are included in the econometric model in order to not lose degrees of freedom since only 49 observations are included in the sample. The results of the OLS model estimations are given in table 1 below.

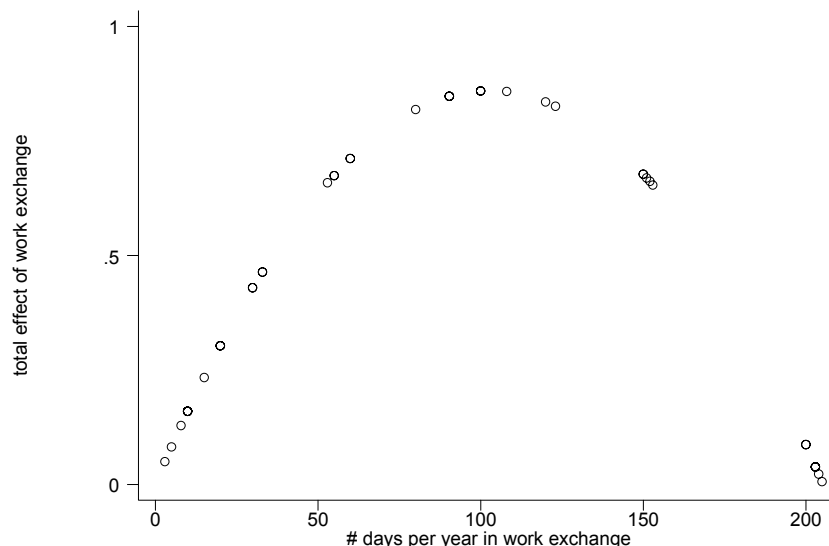
Variables	Full sample		No outliers	
	Coef.	St.dev.	Coef.	St.dev.
ln(Agri Income)				
Constant	5.14***	(0.68)	4.64***	(0.66)
ln(Land)	0.1526	(0.12)	0.1894	(0.11)
ln(Water+0.5)	1.7128**	(0.84)	1.2051	(0.79)
ln(Ecology)	0.6198	(0.52)	1.0172*	(0.51)
Road	0.6166**	(0.27)	0.6659**	(0.27)
<i>Work exchange</i>	0.0105*	(0.0057)	0.0167**	(0.0075)
<i>Work exchange</i> ²	-0.000044*	(0.000023)	-0.000081**	(0.000034)
<i>N</i>	49		45	
<i>R</i> ²	33%		46%	
<i>Adjusted R</i> ²	23%		38%	

Table 1: Results of OLS regression on a log-linear model explaining average agricultural income per person (*Agri income*) in the highland district of Tambo in Peru. *Land* is hectares of good land per person, *Water* is the water equivalents of hectares good irrigated land, *Ecology* is an indicator of natural soil fertility, *Road* is a dummy for road connection, *Work exchange* is days under such arrangement during the year, *Organization* is a dummy for private land. Significance levels * 10 percent, ** 5 percent and ***1 percent. *R*² is the overall explanatory power, *N* is number of observations .

The explanation power with *R*² equal to 32.5 percent in this model using all observations is rather high compared to similar regression models using cross-section data sets with few observations by other authors. *Water*, *Ecology*, *Road* and *Work exchange* are significant at 10 percent level, while *Land* and *Ecology* turn out to be insignificant. In order to check for model robustness, four outliers are taken out of the sample, reducing the numbers of observations to 45 communities³². The coefficient estimations are still rather robust to the model specifications.

³²One observation of 300 days a year, which seems excessive, and three communities reporting no work exchange at all.

All signs are as expected. All variables are nearly significant at 10 percent level when outliers are taken out of the sample. The positive coefficient for *Work exchange* and negative coefficient for *Work exchange* squared give rise to a hump-shaped effect of *Work exchange* on income and the estimated total effect is given in graph 1.



Graph (1): Aggregated effect using estimated coefficients for both level and squared *Work exchange* effect on income, when outliers are taken out of the sample.

The positive effect of *Work exchange* reaches its maximum at 103 days a year. The result is that 18 out of the 45 communities included in this sample actually choose to work more together than income maximizing behavior should imply³³. The significance of the estimated coefficients giving rise to this hump-shaped effect of *Work exchange* is robust to different estimation strategies³⁴. A sensitivity analysis using constant values from 0.25 to 2 in the logarithmic transformation of irrigation area (which is necessary since about 1/3 of the communities have no irrigation at all), reveals that the coefficient value for *Work exchange* is just altered in a minor way. Since the separation of land and irrigated land might seem artificial, I also tried

³³A contagion effect between different tasks can prevent changes. The communities might prefer to keep the unnecessary high level of cooperation rather than risk that all cooperation falls apart if they try to adjust the norms.

³⁴A quadratic model is sensitive to multicollinearity if the variable and the variable squared is too correlated. This problem is reduced transforming the variable to the departure from the mean value. This approach gives an insignificant value of the first coefficient for the mean adjusted *Work exchange*, but a highly significant negative coefficient value for the adjusted *Work exchange*². This result hence further supports the estimation result of negative payoff from *Work exchange* given in the text.

an alternative specification using a weighted sum of dry and irrigated land. The applied relative productivity relation of 1.48 for irrigated land compared to rain fed land is estimated from household level data in the same area, see discussion below. In this alternative model specification all coefficients are still significant at 10 percent level both in the full sample and when the outliers are taken out of the sample, and hence support the findings in the original setup given in table (1). There is also a distinctive inverse pattern when I use dummies for different intervals of *Work exchange* rather than the quadratic form. Communities with between 50 and 150 days of *Work exchange* have a significant higher income than the reference group between 0 and 50, while the estimated coefficient for communities with more than 150 days is positive but insignificant.

Latent variables might bias the estimated coefficients if *Work exchange* is correlated with the residual. One class is variables that affect both income and the productivity of *Work exchange*. Draught oxen is a striking example since they both raise the production per person and further reduce the productivity of *Work exchange* since it is possible to plough the field alone (or assisted by close family members) within an acceptable time frame. If this is the case, the effect of both capital and the interaction of capital and *Work exchange* will spill over on *Work exchange*. However, the effect is not so clear-cut as cooperation is normal also in more advanced technologies. I observed for example several teams of plough oxen work together in work exchange arrangements. More important is the lack of draught animals in general to minimize this potential source of bias, as most were slaughtered during the war. The other latent variables, labour and fertilizers with similar effects, will probably not be important sources of bias due to expected low variation between communities.

Other variables might be correlated with *Work exchange*, but have no direct effect on production. Then there is no interlinkage element, but the direct income effect spills over on *Work exchange*. An interesting example is norms of conformity, which both leads to work exchange through lower coordination costs but at the same time may lower levels of human capital since standing from the crowd by trying out new ideas is punished socially³⁵. The last variant are variables that only affect the productivity of work exchange but has no independent effect on the income level. Tests of such models are discussed in the end of this chapter.

³⁵Norms of conformity and "knowing your place" might lead to even more inefficient solutions if challenging people within the community is considered to be wrong, e.g. "we already got one shop, why make another one", or this family has always been the leaders of the community. The lack of competition might hence lead to low productivity and income levels.

Income simultaneity is also a possible source of estimation bias. The development literature in economics and social sciences and practitioners in the field often uses arguments for cooperation like "rings of survival", "being so poor that you have to cooperate" or "poor people do not have the money to hire labour and hence have to exchange between themselves". These phrases do not give any direct explanations why cooperation should be more productive for the poor than the rich³⁶. However, the poor might have stronger preferences for non-monetary results of *Work exchange* as discussed in previous sections of this paper. This applies to the sociability effect since poor people often need to work all day in order to feed the family. If they want to spend time with their friends and family they will have to do this during working hours. People with more resources can afford to spend time just interacting with their friends, for example doing sports, drinking beer at the canteen, etc. Casual observations in the field also indicate that especially youngsters (who still have little income) prefer not to organize work exchange schemes in order to prevent the accompanying consumption cost. This would hence give rise to opposing income simultaneity effect, since richer people can hence afford to work together.

Risk aversion is another potentially important source of income simultaneity as the utility increases with expected income and decreases with the variability of income. The closer to the limit of survival, the more emphasis they put on minimizing risk (see Fafchamps (1999) for a survey on risk in development agriculture). The "demand" for work exchange as an income insurance mechanism will then depend on the interaction of a risk parameter and *Income*³⁷.

However, observations in the field indicate that the insurance mechanism does not constitute a major part of the work exchange relationship. Neither does the data set indicate any serious income simultaneity bias since the correlation between *Total income* and *Work exchange* is only -0.15 and insignificant. An instrument variable that is uncorrelated with the residual (i.e. uncorrelated with all latent variables and does not have an impact on income in itself) and correlated with *Work exchange* will correct for both the latent variable and income simul-

³⁶Poverty should not in itself prevent functioning monetary labour markets, just imply lower equilibrium wages. The real explanation can be some kind of moral hazard problem in renting labour that is harder to overcome by poor/traditional than by the richer/modern farmers and communities. Fluctuating monetary income in combination with scarcity of saving opportunities for the poor will further lead to a fluctuating "shadow-price" on money. Other means of exchange then reduce this insecurity. Lack of contract enforcement is the classical explanation for social capital. Durlauf and Fafchamps (2004) show how perfect markets give first best resource allocation, while trust based exchanges constitutes the second best solution. No exchange is of course the worst possible solution. The third party contract enforcement in the labour market and first best is hence not possible in any of the communities in Tambo.

³⁷The agricultural development literature has increasingly started to use local variance in rainfall as a risk indicator, e.g. Nugent and Sanchez (1999). The level and variability of rains do also differ between the communities in the rather small district of Peru, but I do not have any rainfall data at such detail levels.

taneity problem. The IV model discussed below indicates that these effects do not give rise to considerable bias in the estimated coefficients of the OLS model.

Whether the community is juridically a "registered peasant community" with common property rights to the land or a more loose organization where the farmers have private property right to their own land, is a potential instrument variable. The correlation between the dummy for individual property rights to land (*Organization*) and *Work exchange* is -0.37 . One possible explanation might be that close-knit communities chose common property rights in the 1970's and the underlying norms and culture behind this decision prevail.

Even though farmers in the two systems experience no difference in their practical lives, the very possibility that the community council can question their property rights might induce people to be friendlier towards cooperation³⁸. *Organization* is not thought to have a direct impact on agricultural productivity nor income since people behave, as their land is their private land independently of their juridical status. It is hence no reason to expect it to be correlated with the capital level, (e.g. plough oxen) or other forms of excluded production-enhancing investments (e.g. soil erosion prevention) since the security of investment is more or less the same. However, a problem using *Organization* as instrument for *Work exchange* is the possible link from the underlying norm system working through the latent variable of individual human capital as earlier described. This effect is not thought to be very strong and I will hence ignore this possible source of estimation bias for now. In neither type of community do the leadership introduce any form of taxation directly on the production volume since the indirect taxation through compulsory work on community infrastructure is related to the number of household members and total plot area. The communities in practice chose the form of organization in the early 1970's and it has been impossible to change until today. Casual evidence from the fieldwork indicates that there is no direct underlying productivity effect of *Organization* due to reasons behind choice of organizations. The communities that chose common property rights historically do not seem to be more traditional today when it comes to other aspects of life. They have the same level of education, speak equally well Spanish and are not more isolated geographically. This indicates that *Organization* is a valid instrument variable for *Work exchange*.

However, one instrument variable of dummy nature is not enough to estimate a quadratic function. Yet, other good instrument variables are difficult to find. A way of testing whether

³⁸Tossing people out of the community if they for example do not comply with their obligations to work on communal infrastructure is mentioned as a possibility in some communities with common property rights to land. However, no concrete examples were given and such statements do probably just reflect the theoretical possibility.

the simultaneity problem is a major concern in this analysis is to first run a regression model with linear effect of *Work exchange* in OLS, and then use 2SLS model with *Organization* as instrument for *Work exchange*. The former gives a positive but insignificant coefficient. The latter increases the estimated coefficient value slightly as expected from the discussion of possible estimation bias, but the coefficient is still not significant (see table A2 in the appendix). This supports the hypothesis that income and latent variables do not constitute the major source for the estimated humpshaped effect of *Work exchange* on *Agri income*.

As mentioned above, cooperation might be productive under some circumstances while not in others. Different interaction variables for *Work exchange* and other variables are included one at the time in quadratic *Work exchange* effect regression models. None of the "suspects" from the discussion in the section 3.2.2 above turns out to be significant. Neither irrigation water (economies of scale due to time pressure), land³⁹ (similar reason), better functioning community organization represented by the ability to impose monetary fines, nor the organization of commonly or privately owned land, give a significant interlinkage effect with *Work exchange*⁴⁰. Further, the coefficient for *Work exchange* is again significant at less than 10 percent and is hence robust to the inclusion of these interlinkage variables. Interlinkage with the share of maize or potato of agricultural income on the other hand, gives significant effects. But choice of crop is endogenously set by the natural conditions and the availability of inputs, and would hence just steal explanation power from the basic inputs already included in the regression model. The introduction of maize-share or potato-share as separate effects does not yield significant coefficients.

If work exchange were more efficient than working alone, there would be more production for the same amount of basic input factors. This liberates resources that can actually be used to produce more inputs in order to increase production. Regression models explaining alternatively *Land* and *Water* give no significant effect of *Work exchange*. It hence seems like *Work exchange* does indeed have a direct effect on income rather than an indirect effect through other explanatory variables in the regression model.

³⁹Blum (1995) finds small amounts of work exchange to be a sign of poverty rather than modernity, since farmers with small plots are able to work their land alone in a rather short time. This is probably of minor importance for the analysis since average land holdings are controlled for in the regression models even though we do not know the average number and hence size of the plots.

⁴⁰Significant interlinkage effects would have implied that the optimal level of work exchange differs between the communities. Then the estimated curve in figure 1 would have been constant with income maximization behavior. Such differences can still not be ruled in spite of insignificant interlinkage coefficient due to stochastic elements in the residual.

3.2.4 Household cross-section and community panel data

I have demonstrated that average agricultural income of the community first is increasing in the average number of days spent in work exchange schemes and then decreases when work exchange is more common. The choice of work exchange probably reflects general norms and perceptions in the actual community, and this differs substantially within the same geographical district of Tambo. Average community values of control variables like land and irrigation hide variations at the individual level. The Central Bureau of Statistics in Peru (INEI) has given access to individual observations from the Agricultural census covering all households in the area in 1994. The same hump-shaped quadratic effect of *Work exchange* also appears in this data set as reflected in the estimated coefficients given in table 2 below.

Tambo was severely affected by the war between the Shining Path guerrilla and the Peruvian military in the 1980's and 1990's. Many communities were hence deserted when the survey took place. I have been able to cross information for 26 of the communities in my own survey with 1300 households in the same communities from the INEI survey. The underlying causal factors for *Work exchange* like norms, natural conditions, etc. is not expected to change radically over the rather short time span of 8 years between the INEI survey and my own. By comparison, Williamson (2000) assesses that it takes 100 years to change the fundamental characteristics of norms in a society. Institutions and norms are further path dependent as for example Acemoglu et al. (2004) demonstrate in their work on long run economic growth. *Work exchange* in 2002 hence seems like a valid proxy for the same type of cooperation in 1994 in this context. Each household in the model below is given their community level average in the model described below.

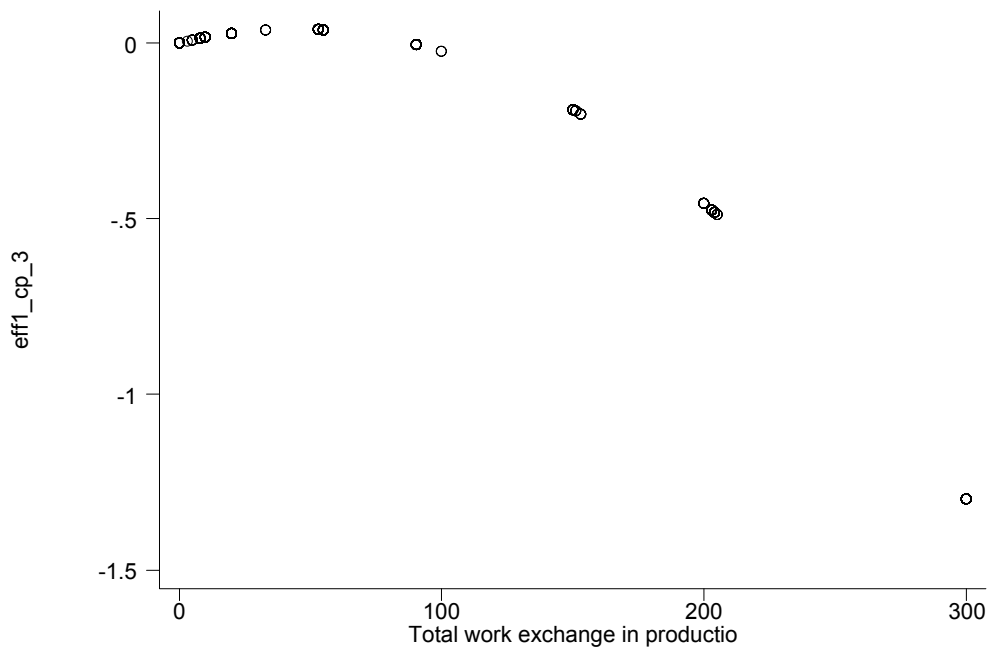
The INEI household level data set includes other potential explanatory variables and the higher number of observations improves the accuracy. A non-linear model is estimated using maximum likelihood. The data set gives information on hectares of irrigated and rain-fed land, but no details on the amount of water available. I hence denominate the former variables as *Irrigated* and the latter as *Dry*, and their relative productivity β is estimated in the non-linear estimation procedure and then simultaneously estimating the effect of $(Dry + \beta \cdot Irrigated)$. *Fertilizer* is dummy for the use of (chemical) fertilizers in any of the plots of the household. *Plough-oxen* is a dummy for ownership of draught animals in the household. *Age* is years of age of the household head. *Sex* is a dummy for a male household head and *Literacy* is a dummy for the ability to read and write by the household head. There is a potential endogeneity problem

for many of the included variables. For example income is correlated over time and hence leads to better schooling of the present household head, but I will not adjust for this potential bias in the following analysis.

Variables/Models	Full sample		No outliers	
	Coef.	t-value	Coef.	t-value
Constant	7.23***	32.03	7.48***	34.43
Irrigated (i.e. β)	1.45***	22.61	1.19***	22.75
$\ln(\text{Dry} + \beta \cdot \text{Irrigated})$	0.98***	43.69	0.98***	45.38
Fertilizer	0.0059	0.14	-0.0217	-0.54
Plough-oxen	0.0166	0.35	0.1311***	2.84
$\ln(\text{Age})$	-0.1468***	-2.68	-0.1251**	-2.37
Sex	0.0048	0.12	-0.0635	-1.59
Literacy	-0.0151	-0.49	0.0051	0.18
<i>Work exchange</i>	0.0017**	2.21	-0.0034***	-3.32
<i>Work exchange</i> ²	-0.00002***	-6.62	-0.000003	-0.66
<i>N</i>	1300		1173	
<i>R</i> ²	67%		69%	
<i>Adjusted R</i> ²	67%		69%	

Table 2: Non-linear model estimated by maximum likelihood procedure on INEI household cross-section data set from 1994. The estimated coefficient for *Irrigation* is the relative productivity of irrigated land compared to rain fed lands (β) which constitutes a part of the next variable $\ln(\text{Dry} + \beta \cdot \text{Irrigation})$ which is the weighted aggregation of dry and irrigated land. The full sample includes all observations, outliers with 0 or 300 days a year of *Work exchange* are taken out in the reduced sample. *Fertilizer* is a positive dummy if the household applies chemical fertilizers, *Plough-oxen* is similar for ploughing technique, "Age" is the age of the household head, the dummy *Sex* is positive for male household heads, *Literacy* is positive if the household head knows how to read and write and *Work exchange* is the number of days in work exchange schemes recorded in the community survey of 2002. Significance levels * 10 percent, ** 5 percent and ***1 percent. R^2 is the overall explanatory power and adj- R^2 is the adjusted explanatory power. The significance level, t-values and R^2 are asymptotic approximations in non-linear model estimation, but this is probably a minor problem due to the large number of observations.

The coefficients in the quadratic model of *Work exchange* are significant and the result is a hump-shaped effect on income also in the household sample. The negative effects of *Work exchange* seems to overshadow the positive (see Graph 2 below) and the estimated total effect on *Agri income* reaches the peak at 88 days when the contribution is hardly positive. The negative contribution to the income level is substantial for households that live in communities where work exchange is more frequent.



Graph 2: The total effect of days under work exchange schemes on the logarithmic transformation of agricultural income, full household sample.

The negative effect becomes even more pronounced when the outliers are taken out of the sample. These results at the household level support the hypothesis that social capital induced work exchange might have a negative effect on income, but the results should be used with caution due to following weaknesses of this sample; (i) Several communities were not included in the sample in 1994 since they had not yet returned after the guerrilla war. (ii) The variable *Work exchange* from 2002 is an imperfect representation of the same variable eight years earlier and (iii) *Work exchange* is the only community level variable in the model, and hence incorporates other community level effects that might be correlated with this variable. Anyhow, the results show a similar pattern as in the community sample and hence support the conclusions given in the preceding analysis⁴¹.

⁴¹In theory it would be possible to calculate the average for income and other variables in the communities for 1994, which in combination with the 2002 figures would give a panel data set. However, this is a futile exercise since the measurement differs between the two years and the less number of communities makes reduces the precision of econometric considerably.

4 Conclusions

In the regression model analysis, based on a sample of 49 peasant communities in the Peruvian highland, I find a significant hump-shaped effect of reciprocal work exchange on agricultural income. The marginal effect of more work exchange is positive at low levels of cooperation, but negative at medium and high levels. This represents a break with much of the existing social capital literature, where it is generally concluded that "the more cooperation, the better" at given levels of institutions and third party contract enforcement. Trust and trust inducing phenomena can actually make traditional societies cooperate more than what is economically optimal. Norms and institutions in traditional societies often do not keep up with rapid transformation from isolated enclaves to integrated parts of the market economies and modern society. They might induce collective solutions when working individually has become more efficient, and pressures of conformity can further represent obstacles for individual development. This notion of cooperation friendly but economically harmful traditional norms and institutions is more in line with the early development economists of the 1950's. The so-called Modernization theory, represented for example by Rostow (1990), then regarded resistance to modernization to be based on superstition, low levels of knowledge and irrational beliefs. Traditions hence represent roadblocks on the path to modernity and development that had to be surpassed or overrun. The analysis in this paper shows that cooperation might be individually rational even though it is collectively irrational. The truth probably lies somewhere in between the now-a-days politically correct positive view of traditional cooperation in the social capital literature and the old-fashioned negative view on traditional ways of organizing the society.

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5 Appendix

5.1 Variable summary

Variable	Mean	St.dev	Min	Max
ln(Agri income)	4.9	1.03	1.9	6.86
Agri income	210	206	7.2	955
Animal income	161	124	0	719
Other sales	32	60	0	366
Wage income	31	48	0	259
Total income	436	279	41	1468
Households	60	37	12	180
Population	277	224	50	1200
Work exchange	90	78	0	300
Ecology	1.74	0.57	1	3
Land	0.52	0.62	0.008	2.665
Road	0.48	0.50	0	1
Irrigation*	0.08	0.13	0	0.76

Table A1: Summary of variables used in the regression models. *Mean* is the average value in the sample, and *St.d.* is the standard deviation. *Min* is minimum value in the sample and *Max* the maximum.

5.2 Comparing OLS and IV models

	OLS - ln(Agri income)		IV - Ln(Agri income)		OLS - Work exchange	
	Coeff	St.dev.	Coeff	St.dev.	Coeff.	St.dev.
Constant	5.45***	0.58	4.80***	1.49	128***	17
ln(land)	0.19*	0.12	0.18	0.12		
Ln(water+0.5)	1.51*	0.86	1.33	0.97		
ln(Ecology)	0.52	0.53	1.01	1.11		
Road	0.58**	0.28	0.49	0.35		
Work exchange	0.0001	0.002				
Organization as IV			0.0039	0.0078		
Organization					-59***	21
Pseudo R ²		0.26		0.20		0.13
N		49		49		49

Table A2: The first regression is a OLS on agricultural income. The second is an 2SLS where *Organization* is used as instrument for *Work exchange*. The third is the first stage of the 2SLS where *Work exchange* is explained by *Organization* in an OLS model. *Land* is hectares of good land per person, *Water* is the water equivalents of hectares good irrigated land, *Ecology* is an indicator of natural soil fertility, *Road* is a dummy for road connection, Work exchange is days under such arrangement during the year, *Organization* is a dummy for private land. Significance levels * 10 percent, ** 5 percent and ***1 percent. R² is the overall explanatory power, N is number of observations and Rho is the fraction of variance due to the unobserved individual effects. A Hausman test comparing the OLS and 2SLS models give Chi²=-025, which imply we got strong evidence that we can not reject the H₀ hypothesis of no difference between them.