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SOCIAL REWARDS, EXTERNALITIES AND STABLE PREFERENCES

by

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Abstract:

This paper examines the role of social rewards as a corrective mechanism for activities which generate externalities. The focus of this paper is the circumstances under which social rewards provide effective and feasible incentive mechanism that may replace laws and regulations. In particular, social mechanism is effective only in a society in which individuals care about their standing in the society. Thus, as part of our analysis of the effectiveness of social mechanisms we address the question: "why should a selfish individual care about what other people think about him?". The purpose of this paper is to characterize the circumstances in which evolution would lead to the survival of socially minded individuals, even though relative fitness is determined only by economic payoff. The paper identifies an interesting asymmetry. It is possible to use social mechanism to induce individuals to increase activities which generates positive externalities while it is impossible to induce them to curtail activities which cause negative externalities.

Social Rewards, Externalities and Stable Preferences

1. Introduction.

Generally speaking, there are three broad types of incentives that govern the behavior of individuals in society: (i) private rewards such as wages and profits, (ii) social rewards such as prestige and status, (iii) rules and laws that enforce certain types of behavior and penalize deviations. Casual observation indicates that societies differ in the mixture of incentives and rules they employ. Thus, in order to understand how societies function, one of the fundamental questions is why certain activities are subject to enforcement while others are governed by social rewards and conventions.

As is well recognized in the economic literature, activities which affect other members of the society, but cannot be priced, are not efficiently regulated by private rewards. It was Arrow (1971) who first suggested the role of social norms as a mechanism designed to resolve the inefficiencies arising from externalities[1]. In this paper we consider a similar role for social rewards such as prestige and status. That is, an individual who chooses an action that has a positive externality is appreciated and esteemed by the other members of society, while an individual who causes a negative externality is treated with contempt. In this paper, we demonstrate that the use of such social mechanism is not always effective and there are types of externalities which need to be regulated by rules or laws.

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[1]See Elster (1989) for a criticism on Arrow's approach and Fershtman, Murphy and Weiss (1995) for an analysis of the implications of social rewards for the allocation of talent in society.

The use of any enforcement mechanism is typically costly. Besides the direct cost of implementation, one can imagine the costs of living in a society with too many laws and regulations. In contrast, social rewards, such as prestige and status, appear to be relatively cheap. It may be costly to identify the deserving individuals, but the transfer of esteem to those who benefit society does not detract resources from the givers of social appreciation. The main question is under which circumstances social rewards provide effective and feasible incentive mechanism that may replace laws and regulations. In particular, social mechanism is effective only in a society in which individuals care about their standing in the society. Thus, as part of our analysis of the effectiveness of social mechanisms, we address the question: "why should a selfish individual care about what other people think about him?". The purpose of this paper is to characterize the circumstances in which evolution would lead to the survival of socially minded individuals, even though relative fitness is determined only by economic payoffs[2].

We consider a simple model in which individuals are randomly matched and are involved in a two-person interaction. Their actions generate externalities which influence all individuals in society. We assume that the social status of an individual is determined by his own action and the actions taken by the other members of society. Individuals, however, can differ in the importance which they assign to social rewards. Some may care about the opinion of others while others do not. We do not assume any initial profile of types but rather look for the one that emerges as an outcome of an evolutionary process.

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[2] For evolutionary models that endogenize preferences see Dekel and Scotchmer (1994) and Robson (1994) who discuss risk aversion and Rogers (1994) who discusses time preference. For evolutionary models of ethical values and social norms see Hirshleifer (1980) and Basu (1992). Bester and Guth (1994) analyze the evolution of altruistic preferences.

We define actions in such a way that individuals always wish to choose a positive level of activity. However, an increase in activity level may generate positive or negative externality. Our analysis points at an inherent asymmetry in the effectiveness of social rewards. It is possible to induce individuals to increase activities which cause positive externalities, while it is impossible to induce them to curtail activities which cause negative externalities. The basic reason is that social rewards are effective only if they increase fitness, in equilibrium. Both negative and positive social rewards induce a direct reduction in fitness, as individuals maximize utility rather than fitness. As we show, however, in the case of positive social rewards, the increased level of activity by a socially minded individual causes other players, in equilibrium, to modify their behavior in a way which increases his fitness. In contrast, in the case of negative social rewards, the reactions of other players reduce, in equilibrium, the fitness of socially minded individuals. For example, if polluting yields negative externalities, it is not sufficient to punish the polluter by reducing his status. Such a mechanism is not evolutionary stable. Therefore, legal enforcement is commonly used. In contrast, higher status can induce more schooling. Provided that the status given to educated workers is not excessive, individuals who care about status and who therefore increase their schooling can survive in the long run.

A social rewards mechanism requires that individuals' actions are observable to other members of society. It is also required that in each match the equilibrium outcome will depend on the true types of the two individuals. Otherwise, the socially minded individuals cannot gain fitness. Throughout our analysis, we assume that types are indeed observable to the partners of each match. This assumption can be justified by the fact that the equilibrium generated by perfect observability is identical to the steady state of a Cournot adjustment process, where each partner myopically determines his action as a best response to his rival's past action.

2. The Model

Consider a society in which there is a large number of identical individuals. In each period, individuals are randomly matched into pairs and play the following game: Each player chooses an action $x_i \in R_+$. The monetary payoff of player i when matched with player j is given by

$$m_i = E(x^e)P(x_i,x_j) \qquad (1)$$

where $P(x_i,x_j)$ is the direct payoff from the interaction of the two players and $E(x^e)$ is an externality term which depends on the average actions of *all* the players in society, x^e. The payoff of player j is correspondingly given by $m_j = E(x^e)P(x_j,x_i)$.

We assume that $P(x_1,x_2)$ is twice continuously differentiable, strictly concave in x_i and that $P_{11}(x_1,x_2)\,P_{11}(x_2,x_1) > P_{12}(x_1,x_2)\,P_{12}(x_2,x_1)$, where subscripts are used to denote partial derivatives. We define actions in such a way that the first partial derivative of $P(x_i,x_j)$, with respect to x_i, is positive when evaluated at $(0,x_j)$. That is, an action for player i is defined to have a positive impact on his payoff, for a sufficiently low level of activity, which implies that he will always choose a positive level of x. Finally, we require the effects of the rival's action on both the total and the marginal payoffs to be of the same sign, i.e., $P_2(x_1,x_2)$ and $P_{12}(x_1,x_2)$ are either both positive or both negative. We assume that $E(x^e)$ is a differentiable function which is positive for all x^e and is either monotone increasing or monotone decreasing. When $E(x^e)$ is an increasing (decreasing) function we say that there are positive (negative) externalities.

We follow a traditional sociological approach and assume that individuals care about their standing in the community. Social rewards take the form of conferring prestige or social status. We assume that social status depends on comparisons of individual actions to those chosen by other members of society. For simplicity, we assume that only the average action of other members of society matters in these comparisons and write

$$s_i = \sigma(x_i - x^e) , \qquad (2)$$

where s_i represents the social status of individual i and σ is a parameter representing the marginal increase in social status associated with higher levels of individual action. A positive (negative) σ indicates a favorable (unfavorable) social evaluation of the individual's action, x_i.

The objective function of all individuals is postulated to be of the following additive form:

$$U^i(x_i,x_j,x^e) \equiv m_i + \alpha s_i = E(x^e)P(x_i,x_j) + \alpha\sigma(x_i - x^e) , \qquad (3)$$

where α, $\alpha \in \{0,1\}$, is a preference parameter that describes how important is social status to the individual. An individual with $\alpha = 1$ cares about what other individuals think about him, while an individual with $\alpha = 0$ does not care what others think about him. This formulation captures the idea that people may differ in the importance they assign to their status. Although we allow only two types, the analysis can be extended to any finite number of types when types may vary only with respect to the importance they assign to social status. Note the different roles of the parameters α and σ. The parameter σ describes what other members of society think about an individual, while the parameter α describes whether an individual cares about what other individuals think about him. We assume that when two players are matched, each player recognizes the type of the player he is matched with. One possible interpretation of our observability assumption is that each pair of players play the one shot game many (but finite) rounds. In each round, both players myopically react to the action chosen by their rival at the previous round. Given our assumptions on the payoff function, the players' strategies converge to the Nash equilibrium strategies of the game with observed types (see Fudenberg and Tirole (1992, pp. 23-29)). Assuming that this convergence is fast relative to the number of rounds that each pair plays, we can use the Nash equilibrium payoffs to approximate the average payoff of each individual during the period he is matched with a certain type of opponent.

Since there is a large number of players, each player views x^e as given. In particular, the choices that he and his opponent make have a negligible effect on x^e. Thus, in making their strategic choices, players do not take into account the externalities which they generate. Their aggregate choices, however, determine x^e.

Consider a society with a given status function, $\sigma(x_i-x^e)$. Let q be the proportion of individuals in the society with $\alpha = 1$ who cares about social status. We restrict our attention to symmetric equilibria where all agents of a given type choose the same strategy. We denote by $x(i,j,x^e)$ the strategy of type i when matched with type j and when he believes that the average action in the population is x^e.

Given $q\in[0,1]$, we define equilibrium as a triplet consisting of x^e, and strategies for players of type 1 and 0, $x^*(1,j,x^e)$ and $x^*(0,j,x^e)$, respectively, such that:

(i) The pair of strategies $(x^*(i,j,x^e),x^*(j,i,x^e))$ is a Nash equilibrium in a game with players of types i and j when the expected average action is x^e.

(ii) The average action x^e is consistent with the choice of actions and the distribution of types in the population. That is, the average behavior of all pairs must be consistent with the average action that each pair takes as given. Specifically,

$$x^e = \frac{1}{2}[q^2 2x^*(1,1,x^e) + 2q(1-q)(x^*(0,1,x^e) + x^*(1,0,x^e)) + (1-q)^2 2x^*(0,0,x^e)]. \tag{4}$$

Our assumption that $P_{11}(x_1,x_2)\,P_{11}(x_2,x_1) > P_{12}(x_1,x_2)\,P_{12}(x_2,x_1)$ guarantees the uniqueness of the Nash equilibrium for a given x^e. We shall also assume that the impact of x^e on the aggregate output of each pair is less than two, i.e., $\partial x^*(i,j,x^e)/\partial x^e + \partial x^*(j,i,x^e)/\partial x^e < 2$ for all $i,j \in \{0,1\}$ whenever x^e satisfies equation (4). This condition is sufficient to guarantee a unique solution for x^e in equation (4).

For a given q, we denote by $x(i,j,q)$ the equilibrium action of type i who is matched with type j, i.e., $x(i,j,q) = x^*(i,j,x^e)$ where x^e satisfies equation (4). The equilibrium monetary payoff of type i when matched with type j is denoted by $M(i,j,q)$.

3. The Evolution of Preferences

Why would anyone care about the opinion of others? To answer this question, we consider the evolutionary formation of preferences. While most of the evolutionary game theory literature discusses the players' choice of strategy and tries to justify certain notions of equilibria, in this paper we consider the *evolution of preferences* rather than the *evolution of strategies*. That is, we assume that players play the Nash equilibrium strategies and analyze the formation of their preferences.

We follow the biological models of evolution and assume that the proportion of individuals of a given type in the population increases if their expected monetary payoff exceeds the average payoff in the population[3]. We thus define the fitness of a particular type in terms of his *monetary* payoffs, rather than his utility which takes into account also social rewards. The underlying assumption is that even when people care about social rewards, their fitness is determined by their economic success.

In considering the evolutionary process of preferences, imitation cannot be the main engine of transmission, as in the discussion of the evolution of strategies. Instead, we consider the transmission of preferences across generations. A possible mechanism is one in which parents spend resources to shape the preferences of their children. Wealthy parents can spend more, and are therefore more successful, in reproducing their own preferences (see Becker (1992) and Becker and Mulligan (1993)[4]. Specifically, let

$$W^1(q) = qM(1,1,q) + (1-q)M(1,0,q) \quad (5)$$

and

$$W^0(q) = qM(0,1,q) + (1-q)M(0,0,q) \quad (6)$$

be the expected equilibrium payoffs of types 1 and 0, respectively. Let

$$\overline{W}(q) = qW^1(q) + (1-q)W^0(q) \quad (7)$$

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[3] See Maynard Smith (1982) for the biological foundation and the surveys of economic applications by Hammerstein and Selten (1994) and Weibull (1995).

[4]An alternative, but probably less realistic, hypothesis is that wealthy individuals have higher reproduction rate and that preferences are transmitted within families through a process of imitation (see Basu (1992)).

be the average payoff in the population. The difference $W^i(q) - \overline{W}(q)$ is a measure of the (relative) fitness of type i. By assumption, the (relative) reproduction rate of type i is increasing in his (relative) fitness. Therefore,

$$\dot{q} = \frac{dq}{dt} = q(W^1(q) - \overline{W}(q)) = q(1-q)(W^1(q) - W^0(q)). \quad (8)$$

The dynamic equation (8) has rest points at $q = 0$ and $q = 1$. A type α_k is evolutionary stable if when almost all members of the population are of this type then the fitness of these typical members is greater than that of any possible mutant (see Maynard Smith (1982, p.14)). That is, given the dynamics assumed in (8), the proportion of invading mutants in the population must decline. Thus, the type $\alpha = 1$ is evolutionary stable if $W^1(q) > W^0(q)$ for every q close to 1. Similarly, the type $\alpha = 0$ is evolutionary stable if $W^1(q) < W^0(q)$ for every q close to 0.

Necessary and sufficient conditions for the evolutionary stability of type k are that for $j \neq k$:

(i) $M(k,k,q_k) \geq M(j,k,q_k)$,

(ii) $M(k,j,q_k) > M(j,j,q_k)$, whenever $M(k,k,q_k) = M(j,k,q_k)$,

where q_k is close to 1 if $k = 1$ and q_k is close to 0 if $k = 0$[5].

The first condition requires that k is a best reply against itself. The second condition requires that if j is doing as well as k against k, then k is doing better against j than j itself.

While we allow the profile of individual preferences to vary over time, we hold the social

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[5] Observe that this formulation differs from the standard formulation in that the payoffs in a particular match depend on q. This reflects the presence of externalities. In the standard formulation, conditions (i) and (ii) are independent of the distribution of types in the population.

status function constant. That is, a society is characterized by its social status function and *all* individuals within the society, irrespective of their α, evaluate their colleagues according to this status function. A mutant cannot change the criterion by which other members of the group evaluate him. The only dimension in which he can differ from other members is the importance he assigns to what people think about him.

4. An Evolutionary Stable Society

We now wish to describe the sustainable preference profiles which are induced by alternative social status functions in a given society. For this purpose we need to consider the equilibrium fitness of different types of individuals.

For a given q, consider the equilibrium actions for each combination of types, i.e., $x(1,1,q)$, $x(1,0,q)$, $x(0,1,q)$ and $x(0,0)$ and the corresponding payoffs evaluated at these points. (Note that according to (3), when two players of type 0 meet, the equilibrium actions are independent of q.)

Lemma 1: Consider an action which yields positive (negative) social rewards, then, a socially minded individual with $\alpha = 1$ chooses, in equilibrium, a higher (lower) level of such action than an asocial individual with $\alpha = 0$, irrespective of the type of the matched partner. That is, for $\sigma > 0$, $x(1,0,q) > x(0,0)$ and $x(1,1,q) > x(0,1,q)$, while for $\sigma < 0$, $x(1,0,q) < x(0,0)$ and $x(1,1,q) < x(0,1,q)$.

Proof: The result follows directly from the first order conditions characterizing the Nash equilibrium and our assumptions regarding the payoff function $P(x_1,x_2)$. ∎

Lemma 2: (i) For any q, if $\sigma < 0$, then a socially minded individual with $\alpha = 1$ will have a *lower* equilibrium payoff than an asocial individual with $\alpha = 0$, in any possible matching. That is,

(ia) $P(x(1,0,q),x(0,1,q)) < P(x(0,0),x(0,0))$,

(ib) $P(x(1,1,q),x(1,1,q)) < P(x(0,1,q),x(1,0,q))$.

(ii) For any q there exist a positive σ_0 such that for all $0 < \sigma \leq \sigma_0$, a socially minded individual with $\alpha = 1$ will have a *higher* equilibrium payoff than an asocial individual with $\alpha = 0$, in any possible matching. That is,

(iia) $P(x(1,1,q),x(1,1,q)) > P(x(0,1,q),x(1,0,q))$,

(iib) $P(x(1,0,q),x(0,1,q)) > P(x(0,0),x(0,0))$.

Proof: See Appendix.

Lemma 2 implies that individuals who maximize fitness may end up, in equilibrium, with lower fitness than those who maximize another objective. This occurs because the departure from individual maximization of fitness can induce favorable reactions by the matched partner[6].

To describe this idea in more detail, let $R_i(x)$, i=0,1, denote the reaction function of type i and let $\Psi_j(x_i) = P(x_i,R_j(x_i))$. We assume that $P(x_i,R_j(x_i))$ is single peaked in x_i.[7] The relationships $\Psi_0(x_i) \equiv P(x_i,R_0(x_i))$ and $\Psi_1(x_i) \equiv P(x_i,R_1(x_i))$ are depicted in Figures 1 and 2 below. The slope of each curve is given by $\Psi'_j(x_i) = P_1(x_i,R_j(x_i)) + P_2(x_i,R_j(x_i))R'_j(x_i)$. Note that by our assumptions on $P(x_1,x_2)$, the product $P_2(x_i,R_j(x_i))R'_j(x_i)$ is always positive. In addition, our definition of actions

[6] This result has already been noted in the analysis of strategic delegation (see for example Fershtman and Judd (1987)).

[7] This assumption is equivalent to the requirement of a unique Stackelberg equilibrium for each pair-wise game.

implies that $P_1(0,R_j(0)) > 0$.

Figure 1 is used to illustrate part (ia) of Lemma 2. Point a^- represents the equilibrium action and the payoffs of a type 0 who is matched with another individual of type 0. Since in such equilibrium $P_1(x(0,0),R_0(x(0,0)) = 0$, the slope $\Psi'_0(x(0,0))$ is positive which implies that this point is to the left of the peak. From Lemma 1, $\sigma < 0$ implies that $x(1,0,q) < x(0,0)$. Thus, point b^-, which represents the equilibrium action and payoff of a type 1 who is matched with an individual of type 0, must be on the left of the point a^-. As seen in Figure 1, $P(x(1,0,q),x(0,1,q)) < P(x(0,0),x(0,0))$.

Figure 2 is used to illustrate part (iia) of Lemma 2. Point a+ represents the equilibrium action and the payoffs of a type 1 individual who is matched with type 1. It can be shown (see Appendix) that for a small positive σ, the slope $\Psi'_1(x(1,1,q))$ is positive, which implies that a^+ is to the left of the peak. From Lemma 1, $\sigma > 0$ implies that $x(1,1,q) > x(0,1,q)$. Thus point b^+, which represents the equilibrium action and payoff of a type 0 who is matched with an individual of type 1, must be to the left of point a^+. As seen in Figure 2, $P(x(0,1,q),x(1,0,q)) < P(x(1,1,q),x(1,1,q))$.

Proposition 1: (i) Consider a social status function which confers negative rewards to individual actions, $\sigma < 0$. Then, a society in which all individuals are asocial (i.e., have preferences with $\alpha = 0$) is evolutionary stable, while a society in which all individuals are socially minded (i.e., have preferences with $\alpha = 1$) is evolutionary unstable.

(ii) Consider a social status function which confers positive rewards to individual actions, $\sigma > 0$. Then, there exists a positive σ_0, such that, for all $0 < \sigma \leq \sigma_0$, a society in which all individuals are socially minded (i.e., have preferences with $\alpha = 0$) is evolutionary stable, while a society in which all individuals are asocial (i.e., have preferences with $\alpha = 0$), is evolutionary unstable.

Proof The proof of Proposition 1 follows directly from Lemma 2 and equations (5)-(8). □

Note that Proposition 1 does not imply that every increasing social status function leads to an evolutionary stable society where everyone is socially minded. If the marginal social reward, σ, is positive but too high, the socially minded individual may select an action which reduces his fitness and, although his rival is induced to act in a favorable way, the net impact on fitness can be negative. This situation is illustrated by points a^{++} and b^{++} in Figure 2.

The reasoning leading to Proposition 1 is as follows. Consider a Nash equilibrium and suppose that player i deviates by increasing x slightly. There are two effects on i's payoff:

i) The direct effect resulting from increased action.

ii) The indirect effect resulting from the reaction of the rival.

The indirect effect is always positive because of our assumption that $P_2(x_1,x_2)$ and $P_{12}(x_1,x_2)$ are either both positive or both negative. If $P_{12}(x_1,x_2) > 0$, strategic complements, the rival increases his action and i gains, because $P_2(x_1,x_2) > 0$. If $P_{12}(x_1,x_2) < 0$, strategic substitutes, the rival decreases his action and i gains, because $P_2(x_1,x_2) < 0$. The direct effect of a small increase in x depends on σ. If $\sigma = 0$ then, in equilibrium, the marginal fitness is zero and the direct effect is negligible. If $\sigma < 0$ then, in equilibrium, the marginal fitness is positive, and the direct effect is positive. If $\sigma > 0$, then, in equilibrium, the marginal fitness is negative and the direct effect is to reduce i's fitness, but for a small σ, the indirect effect dominates. Thus, starting from a Nash equilibrium, it is always possible to increase fitness by *increasing* the activity level.

The observation that it is possible to have evolutionary stable preferences that differ from the maximization of fitness is also made by Bester and Guth (1994). They examine altruistic preferences, such that each player cares about his rival's payoff in pair-wise interactions, and demonstrate that strategic complementarity is required for this kind of altruism to be evolutionary stable. Our results apply to substitute as well as complementary actions.

5. Status and Externalities

Externalities arise whenever an individual action influences the payoff of other members in society, and there is no mechanism which enforces him to internalize these effects in his decision. In our model, there are two types of such external effects. The inability of members in each pair to reach binding contracts generates a Nash equilibrium, where each member ignores the effects of his own actions on his partner. The other externality arises when individual actions have impact on other members of society with whom they do not interact directly. For instance, imagine an industry consisting of two firms who engage in a Cournot competition in the product market, each using the same polluting factor of production.

To gain a clearer understanding of these externalities, consider the original state in the absence of social rewards. Since all individuals are identical, and there is only one action for each player, we may define an efficient action as a maximizer of the common economic payoff. Suppose that there is a unique maximizer of $E(x)P(x,x)$, denoted by x^*. Lack of coordination within each pair means that the equilibrium outcome need not maximize $P(x,x)$. The neglect of external effects, means that partners to each pair ignore the impact on others. These two types of externality may work in opposite directions, but, in general, the equilibrium action differs from x^*. We refer to the situation in which the equilibrium action is below (above) x^* as under (over) provision[8]. To obtain efficiency, a society can use positive (negative) social rewards to increase (decrease) the equilibrium outcome back to the efficient level. That is, social rewards may cause individuals to internalize their impact on other members of society. The question is whether individuals who respond to social rewards can survive. Based on our previous analysis, we conclude :

Proposition 2: Activities which generate positive externalities, leading to under provision, can be regulated by social rewards. Activities which generate negative externalities, leading to over provision, cannot be regulated by social rewards and require an enforcement mechanism.

Proof: These results follow directly from Proposition 1. □

The asymmetry between positive and negative externalities is a consequence of the basic tension between private and collective interest which is built into our model. By assumption, an increase in x_i raises private payoffs, at least initially, which is conducive to fitness. In the case of negative externalities, an increase in x_i is harmful to others. A social reward mechanism will cause each person to internalize the negative impact on others and reduce the social damage. However, a person who is concerned about others, and thus reduces the level of his activity, loses fitness. Therefore, the socially minded type will eventually be replaced by non caring individuals. This

[8] A single efficient action arises only if all individuals are of the same type. If the population is not homogenous, there will be a multiplicity of (Pareto) undominated actions for the two types. Moreover, in the context of evolution, the composition of the population changes and tastes vary. However, x^* remains efficient as long as all individuals are identical, irrespective of whether they care about status. This property is a consequence of our assumption that status is measured in terms of deviations from the mean.

conflict does not arise when there are positive externalities and it is possible to counteract them without a reduction in fitness, provided that the social reward for raising x_i is not too large.

Recall that individual actions are directly beneficial only at low level of activity. It is, therefore, not at all obvious whether in the original state, i.e., in the absence of social rewards, an individual gains or loses fitness from modifying his behavior. The main contribution of this paper is to show that *in equilibrium,* accounting for the reaction of others, fitness is reduced if one responds to negative social rewards, and increases if one responds to (small) positive social rewards.

6. An Example

To obtain our results, we have made several assumptions on the payoff function. In this section we show that the assumptions are consistent and that there is a pair of functions $P(x_i,x_j)$ and $E(x^e)$ that together satisfy all the pustulated requirements. Specifically, let

$$P(x_i,x_j) = (1-\gamma)x_i + \gamma x_i x_j - x_i^2/2 \qquad (9)$$

where, $-1/2 < \gamma < 1/2$, and let

$$E(x^e) = (1 + x^e)^{\epsilon} \qquad (10)$$

where, $-1 < \varepsilon < 1$.

Under specification (9), $P(x_1,x_2)$ is strictly concave in x_i, $P_{11}(x_1,x_2)\,P_{11}(x_2,x_1) > P_{12}(x_1,x_2)\,P_{12}(x_2,x_1)$, and $P_2(x_1,x_2)$ and $P_{12}(x_1,x_2)$ are both positive (negative) if γ is positive (negative). The implied reaction functions of types 0 and 1 are $R_0(x) = (1-\gamma) + \gamma x$ and $R_1(x) = (1-\gamma) + \gamma x +$

$\sigma/E(x^e)$, respectively. Substituting these reaction functions, we see that $P(x,R_i(x))$ is concave in x for i=0,1, and thus single peaked. Under (10), $E(x^e)$ is positive and is monotone increasing (decreasing) if ε is positive (negative). A positive (negative) ε indicates positive (negative) externalities.

Using (9), it is easy to calculate the equilibrium actions and payoffs, for any given x^e. If two players of type 0 meet then, in equilibrium, $x(0,0) = 1$ and

$$P(x(0,0),x(0,0)) = 1/2. \tag{11}$$

If two players of type 1 meet then, in equilibrium, $x(1,1,q) = 1 + \sigma/(1-\gamma)E(x^e)$ and

$$P(x(1,1,q),x(1,1,q)) = 1/2 + \frac{\gamma}{1-\gamma}\left(\frac{\sigma}{E(x^e)}\right) + \frac{\gamma-1/2}{(1-\gamma)^2}\left(\frac{\sigma}{E(x^e)}\right)^2. \tag{12}$$

If players type 0 and type 1 meet then, in equilibrium, $x(1,0,q) = 1 + \sigma/(1-\gamma)^2E(x^e)$ and $x(0,1,q) = 1 + \sigma\gamma/(1-\gamma)^2E(x^e)$ and the equilibrium payoffs are:

$$P(x(1,0,q),x(0,1,q)) = 1/2 + \frac{\gamma^2}{1-\gamma^2}\left(\frac{\sigma}{E(x^e)}\right) + \frac{\gamma^2-1/2}{(1-\gamma^2)^2}\left(\frac{\sigma}{E(x^e)}\right)^2, \tag{13}$$

$$P(x(0,1,q),x(1,0,q)) = 1/2 + \frac{\gamma}{1-\gamma^2}\left(\frac{\sigma}{E(x^e)}\right) + \frac{1}{2}\left(\frac{\gamma}{(1-\gamma)^2}\right)^2\left(\frac{\sigma}{E(x^e)}\right)^2. \tag{14}$$

Using specification (10), we can now demonstrate that the average action, x^e, is unique.

Taking expectation over all possible pairs, equation (4) can be reduced to

$$x^{e} = 1 + \frac{q}{1-\gamma}\left(\frac{\sigma}{E(x^{e})}\right). \qquad (15)$$

The uniqueness of x^e, given σ and q, follows from the fact that, under (10), $E(x^e)(x^e-1)$ is monotone increasing in x^e. The monotonicity of $E(x^e)(x^e-1)$ implies that the average level of activity increases (decreases) with q, if σ is positive (negative), and for any positive q, an increase in σ raises the average activity level, irrespective of whether the externality effect is positive or negative. It can also be verified that the equilibrium activity level of any pair increases in x^e, whenever x^e satisfied equation (4) in the text.

We can now verify Proposition 1. From equations (11) and (13), it is immediately seen that, for $\sigma < 0$, $P(x(1,0,q),x(0,1,q)) < P(x(0,0),x(0,0))$. Thus, type 0 is evolutionary stable. By comparing (12) and (14) it is evident that for $\sigma < 0$, $P(x(1,1,q),x(1,1,q)) < P(x(0,1),x(1,0))$. Thus, type 1 cannot be evolutionary stable, as stated in part (i) of Proposition 1.

Examining equations (11) to (14), it can be verified that for $0 < \sigma < \gamma^2 E(x^e)$, $P(x(1,1,q),x(1,1,q)) > P(x(0,1,q),x(1,0,q))$ and $P(x(1,0,q),x(0,1,q)) > P(x(0,0),x(0,0))$. Therefore, type 1 is evolutionary stable for $0 < \sigma < \gamma^2 E(x(1,1,1)$, while type 0 is evolutionary unstable for $0 < \sigma < \gamma^2 E(x(0,0))$. Since $x(0,0)=1$ and is independent of σ, it follows immediately that a population consisting only of type 0 individuals is evolutionary unstable, for *all* σ such that $0 < \sigma < \gamma^2 2^{\varepsilon}$. Since $x(1,1,1)$ depends on σ, it is more difficult to obtain an explicit expression (in terms of the parameters of equations (9) and (10)) for the condition that σ is sufficiently small for status to have a positive effect on the fitness of type 1. Here we need to separate two cases, positive externalities, $\epsilon > 0$, and negative externalities, $\epsilon < 0$. In the case of positive externalities, it is easy to show that type 1 is evolutionary stable for *all* σ such that $0 < \sigma < \gamma^2 2^\epsilon$. This follows from the observation that for a positive σ, $x(1,1,1) > x(0,0)=1$ and, therefore, if $\epsilon > 0$ then $E(x(1,1,1) > E(x(0,0)) = 2^\epsilon$. For the case of negative externalities, we can only say that the sufficient condition $0< \sigma < \gamma^2 E(x(1,1,1)$ is satisfied for all $\sigma < \sigma_0$, where σ_0 is some critical value satisfying $0 < \sigma_0 < \gamma^2 2^\epsilon$. To see that such a value exists, consider the difference $\gamma^2 E(x(1,1,1)) - \sigma$ as a function of σ. Observe that, for $\epsilon < 0$, this function is monotone decreasing, positive at $\sigma=0$ and negative at $\sigma = 2^\epsilon$. We have thus verified the existence of a positive critical value for σ, such that for all positive σ which are less then this critical value, type 1 is evolutionary stable while type 0 is evolutionary unstable, as stated in part (ii) of Proposition 1.

Finally, we can use the example to describe the conditions for under and over provision. Define $f(x) = E(x)P(x,x)$ and assume the specifications (9) and (10). Then,

$$f'(x) = (1+x)^{\epsilon-1}[x(\epsilon(1-\gamma)+\gamma) + x^2(\gamma-1/2)(\epsilon+2) + 1-\gamma] \quad , \qquad (16)$$

$$f''(x) = \frac{(\epsilon-1)f'(x)}{1+x} + (1+x)^{\epsilon-1}[(\epsilon(1-\gamma)+\gamma) + 2x(\gamma-1/2)(\epsilon+2)] \, . \qquad (17)$$

There is a unique positive maximizer of $f(x)$, x^*, since at the point where $f'(x)=0$ and $x>0$, $f''(x) <0$. Recall that when all individuals don't care about social status they will all choose $x=1$. From (16), it is evident that the sign of $f'(1)$ is determined by the sign of $\epsilon/2 + 2\gamma$. Thus, in the absence of social rewards, the equilibrium is efficient if $\epsilon/2 + 2\gamma=0$, because the externalities within and across pairs cancel each other. However, a positive (negative) $\epsilon/2 + 2\gamma$ implies under (over) provision and there is a potential corrective role for social rewards. As stated in proposition 2, such a mechanism can be effective, in the long run, only in the case of under provision, where a positive σ is used. For this case, we do not claim that the efficient level, x^*, can be supported by a suitable choice of σ. We only claim that some improvement can be made by the use of positive social rewards. This qualification arises because it is possible that the σ required to support x^* is too large and, therefore, socially minded individuals will not survive in the long run.

7. Further Remarks on Observability

A key assumption in our model is that both the actions taken by individuals and their types are fully observable. Clearly, there are many cases in which types and actions are not observable and in such cases it will be more difficult, if not impossible, to use social rewards as part of the individual incentive structure.

If actions are unobservable then individuals' choice of x will be unaffected by their desire for social status. For example, if stealing is a completely unobservable activity then, as long as stealing adds to fitness, it would be impossible to use social pressure to curb such an activity. Although we assume observable actions, there is no need to assume complete observability. One can assume that actions are observed with some exogenous probability without affecting any of the results.

Our assumption on the observability of types is, in a way, even stronger than the assumption on the observability of actions. If types are completely unobservable then the social mechanism discussed in this paper will not work. In particular, socially minded individuals, who do not maximize fitness, will not survive in the long run.

As we have already indicated, a Cournot adjustment mechanism converges to a steady state which is identical to the Nash equilibrium of a game in which the players' type is observable. The Cournot adjustment process requires no prior information on the type of the players, since each player makes his choice based on the past *action* of his opponent. An apparent drawback of this adjustment process is that players react myopically without considering the impact of their choice of action on the behavior of their opponents. It should be noted, however, that in the context of evolutionary models it is customary to endow agents with only limited foresight (or rationality).

Alternatively, we can consider a model with rational learning as in Kalai and Lehrer (1993) and Fudenberg and Levine (1993). Assuming that players in each pair play an infinitely repeated game and learn through Bayesian updating, these authors show that the players will eventually play the Nash equilibrium strategies with the true payoff functions. Here again, if we assume that the convergence is relatively fast, the Nash equilibrium payoff will be an approximation to the players' average payoff during the period in which they are matched.

It is interesting to compare our results to the analysis of social norms in matching games (e.g. Kandori (1992) and Okuno-Fujiwara and Postlewaite (1989)). While we assume that the type of each player is observable, the assumption in this literature is that each player has a label. These labels are observable by partners but may change as a result of the players' action. Assume now that the label is "behave like type 1" and once a player behaves differently, his label is switched forever to "type 0". In such a case, if behaving like type 1 yields higher fitness, type 0 will imitate such a behavior, since his objective is to maximize fitness. The equilibrium outcome is that all players behave as if they are of type 1, irrespective of their true type. In such a model, there seem to be no role for the evolution of types. The existence of types, however, can eliminate some equilibria. For instance, an equilibrium where all players act asocially cannot exist if some individuals truly care about social status. However, to support the evolutionary stability of type 1 players, it is necessary to assume that imitation involves some (arbitrarily small) cost in fitness.

In addition to the acquisition of reputation, based on observed actions, one may consider the use of costly signals to advertise one's interest in social status. In our previous work, Fershtman and Weiss (1993), Fershtman, Murphy and Weiss (1995), Weiss and Fershtman (1992) we assumed that the actions or characteristics of an individual are estimated to be the average of the group (e.g., occupation) to which he belongs. For signaling to work, it is necessary that individuals who care about status will have lower costs (in terms of fitness) associated with "status symbols" such as schooling or occupation, otherwise, the socially minded individuals will be unable to separate themselves in equilibrium. This requires some heterogeneity in capacities, in addition to the heterogeneity in tastes. Alternatively, one can assume that signals are imperfect and that mimicry is costly as in Frank (1987).

We finally remark that it is not required that both partners to the match recognize the type of their rival. For the evolutionary stability of the socially minded type, it is sufficient that members of this class recognize their *own* kind (see Robson 1990).

Concluding Remarks.

This paper examined the role of social status as a corrective mechanism for externalities. We considered two sources of inefficiency; the inability of partners who meet randomly to coordinate their activities and the incosiderartion by members of each pair of the impact of their actions on other members of society with whom they do not interact directly. To restore efficiency, it is possible to use legal rules, subsidies or taxes. However, each of these means is costly either because of direct loss of resources (e.g. jailing) or because of negative effects on incentives (dead weight loss). We have shown that, under some conditions, society can use social rewards, such as status which are relatively cheap. The main constraint on the use of social rewards as a corrective mechanism is that socially minded individuals, who care about social status, may have lower fitness than asocial individuals who selfishly maximize their fitness and, therefore, will be eventually driven out by evolutionary forces. We have identified, however, a potential evolutionary advantage for the socially minded individuals, derived from an impact on the behavior of other individuals who they meet randomly and with whom they engage in economic interaction. We have then derived a basic *asymmetry* result; social rewards can be an effective corrective mechanism only for positive externalities. In the case of negative externalities, social rewards are ineffective because those who care about status cannot survive in the long run. In this case, society must rely on costly means such as legal enforcement. There may also be an "inflation of status", where too much emphasis on social status creates an environment where only those who do not care about the opinion of others survive. In this case, too, society must rely on enforcement.

These considerations can help us to understand the different mixture of rules and social incentives in different societies. Broadly speaking, legal means are used to restrict undesirable activities ("do not"), while social status is used to encourage desirable activities ("do"). The basic asymmetry can be traced to the interaction between status and fitness in equilibrium. In our model, the only way a person who cares about status can gain fitness is by inducing his rivals in economic interactions to select actions which are beneficial to his fitness. This idea is quite distinct from a possible *direct* effect of status on fitness, based on *economic benefits* that high social status may entail. It is clear that if social status directly influences fitness then social rewards are much more effective, in particular, they can be used to correct both negative and positive externalities. However, since economic resources must be transferred, the mechanism may have the same dead weight costs as regular taxes (or subsidies).

Our analysis was simplified by the assumption that each person is engaged in a single activity. In real life, individuals are involved in many activities. Some of the activities yields positive externalities while other negative externalities. Individuals that care about status receive both negative and positive feedbacks from their actions. Praise if they do the right things, contempt if they do the wrong things. The question is under what circumstances will the socially minded individuals survive against those who do not care about social rewards. The answer to this question depends on the profile of activities that individual need to choose. A society is more likely to have stable equilibrium with socially minded individuals, if most activities involve positive externalities.

In this paper, we considered an isolated society and did not specify the mechanism which generates the social status function. A natural extension is to allow individuals of each type to migrate from one society to the other if they can get a higher utility level, including the utility they derive from social status. The option for migration may broaden or narrow the sustainable class of social reward mechanisms, i.e., the set of values of σ for which an evolutionary stable equilibrium exists. For instance, a society subject to negative externalities and which uses a negative σ to correct them, may attract new immigrants who care about status. This flow, motivated by *absolute* advantage, may offset the decline caused by the poor *relative* performance of such types. On the other hand, in a society subject to positive externalities which uses a positive σ, immigration can reinforce the increase in the number of individuals who are socially minded. The impact of immigration on social rewards is an important topic for further research[9].

[9] Immigration across societies which differ in the cost of identifying cooperative behavior is considered by Bowles and Gintis (1996).

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Appendix: Proof of Lemma 2:

When two individuals of type 0 are matched, the first order condition for player i, i=1,2, is

$$E(x^e)P_1(x_i,x_j) = 0 . \qquad (18)$$

When the first player is of type 1 and the second is of type 0, the first order conditions are

$$E(x^e)P_1(x_1,x_0) + \sigma = 0 , \qquad (19)$$

and

$$E(x^e)P_1(x_0,x_1) = 0 . \qquad (20)$$

When two individuals of type 1 meet, the first order condition for player i, i=1,2, is

$$E(x^e)P_1(x_i,x_j) + \sigma = 0 . \qquad (21)$$

Let $R_i(x)$, i=0,1, denote the reaction function of a player who is type i and let $\Psi_j(x_i) \equiv P(x_i,R_j(x_i))$, j=0,1, then, differentiating $\Psi_j(x_i)$, conditions (18)-(21) imply that, in equilibrium:

(i) $\Psi'_0(x(0,0)) = P_2(x(0,0),x(0,0))R'_0(x(0,0))$,

where, $R'_0(x(0,0)) = -P_{12}(x(0,0),x(0,0))/P_{11}(x(0,0),x(0,0))$.

(ii) $\Psi'_0(x(1,0,q)) = -\sigma/E(x^e) + P_2(x(1,0,q),x(0,1,q))R'_0(x(1,0,q))$,

where, $R'_0(x(1,0,q)) = -P_{12}(x(0,1,q),x(1,0,q))/P_{11}(x(0,1,q),x(1,0,q))$.

(iii) $\Psi'_1(x(0,1,q)) = P_2(x(0,1,q),x(1,0,q))R'_1(x(0,1,q))$,

where, $R'_1(x(0,1,q)) = -P_{12}(x(1,0,q),x(0,1,q)/P_{11}(x(1,0,q),x(0,1,q))$.

(iv) $\Psi'_1(x(1,1,q)) = -\sigma/E(x^e) + P_2(x(1,1,q),x(1,1,q))R'_1(x(1,1,q))$,

where, $R'_1(x(1,1,q)) = -P_{12}(x(1,1,q),x(1,1,q))/P_{11}(x(1,1,q),x(1,1,q))$.

By assumption, $P_{11}(.,.) < 0$ and $P_2(.,.)P_{12}(.,.) > 0$. It follows that $\Psi'_0(x(0,0))$ and $\Psi'_1(x(0,1,q))$ are positive for *all* σ, and that $\Psi'_0(x(1,0,q))$ and $\Psi'_1(x(1,1,q))$ are positive for $\sigma < 0$. If σ is positive, the terms $\Psi'_0(x(1,0,q))$ and $\Psi'_1(x(1,1,q))$ may be positive or negative. However, as σ approaches 0, the terms $P_2(.,.)R'_j(.)$ all approach $P_2(x(0,0),x(0,0))R'_j(x(0,0))$, which is strictly positive and the term $E(x^e)$ approaches $E(x(0,0))$ which is a positive number. Since $\Psi'_j(.)$ are continuous functions of σ, there exist a σ_0 such that $\Psi'_0(x(1,0,q))$ and $\Psi'_1(x(1,1,q))$ are all positive for all σ such that $\sigma < \sigma_0$.

Using the results above and the assumption that, for j=1,2, $\Psi_j(x_i) \equiv P(x_i,R_j(x_i))$ is single peaked, we can now prove the four parts of Lemma 2.

To prove part (ia) of Lemma 2, we use the fact that, $\Psi'_0(x(0,0)) > 0$ and that for a negative σ, $x(1,0,q) < x(0,0)$. To prove part (ib) of Lemma 2, we use the fact that $\Psi'_1(x(0,1,q)) > 0$ and that for a negative σ, $x(1,1,q) < x(0,1,q)$.

To prove part (iia) of Lemma 2 we use the fact that, for $0 < \sigma \le \sigma_0$, $\Psi'_1(x(1,1,q)) > 0$ and $x(1,1,q) > x(0,1,q)$. To prove part (iib) of Lemma 2, we use the fact that, for $0 < \sigma \le \sigma_0$, $\Psi'_0(x(1,0,q)) > 0$ and $x(1,0,q) > x(0,0)$. ∎

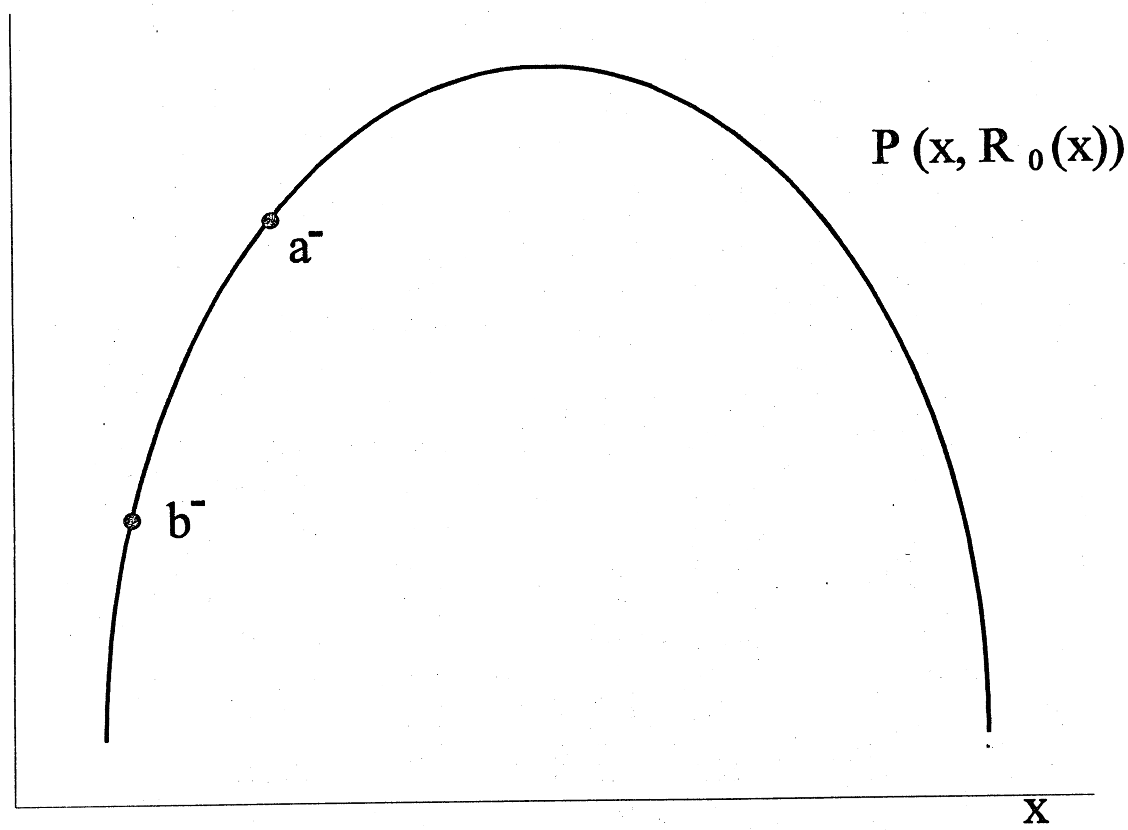

Figure 1

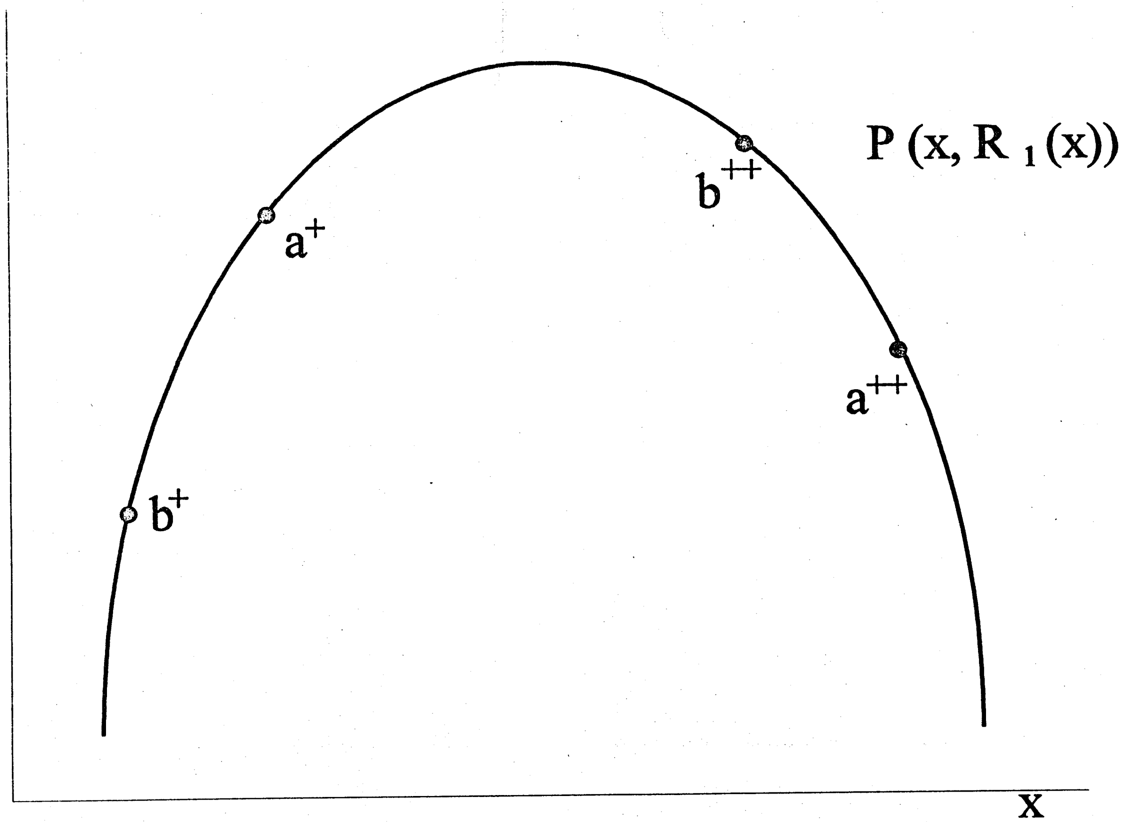

Figure 2

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