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## SOCIAL DISTANCE AND SOCIAL DECISIONS

BY GEORGE A. AKERLOF<sup>1</sup>

A model of social distance is presented that is useful for understanding social decisions. Status and conformity in previous models are discussed, and then a generalization is described. In this generalization agents have inherited positions in social space and an expected value of trade between two individuals as a function of the difference in their initial positions. An example of this system is constructed in which there is class stability. Agents who are initially close interact strongly while those who are socially distant have little interaction. In this example inherited social position, which may be interpreted as social class, plays a dominant role. The relevance of this model to social decisions such as the choice of educational attainment and childbearing is discussed in the context of specific ethnographic examples. Class position may play a dominant role in these decisions.

KEYWORDS: Social interaction, education, fertility, urban economics, social class.

### 1. INTRODUCTION

TRADITIONAL ECONOMICS HAS BEEN BASED on methodological individualism. Until quite recently, with some rare exceptions, it has not been appreciated that this method can be, or perhaps I should say, *should be*, extended in describing social decisions to include dependence of individuals' utility on the utility or the actions of others. Except under rare circumstances, such interactions produce externalities. These externalities typically slow down movements toward socially beneficial equilibria but in the most extreme cases they will create long-run low-level equilibrium traps that are far from socially optimal. Much of the existing literature is analytically complicated and the models appear quite special. It may therefore be of some use to strip the logic to the bone. I will do so in the form of three rudimentary models that will demonstrate the externalities involved in social interaction. One model presented is analogous to the Newtonian theory of gravity; the special case of this model that illustrates the low level trap is analogous to the three-body problem. A potentially productive outcome of this discussion is a characterization of groups that are of sufficient size to encompass the externalities so that coordination within those groups can attain the social optimum.

The emerging theory of social interaction, including some of the recent work of Becker and coauthors, gives an alternative to the early work of Becker, in

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which social decisions were based on individual values.<sup>2</sup> Social interaction theory explains why social decisions—such as the demand for education, the practice of discrimination, the decision to marry, divorce, and bear children, and the decision whether or not to commit crimes—are not simple choices based primarily on individual considerations. There is a significant difference between these *social decisions* and the conventional economic decision-making epitomized in intermediate microeconomic theory as choices among alternative fruits available at the supermarket.

This lecture will explain why rational choice analysis of social decisions must take into account the externalities involved in social decision-making. In principle, the analysis is an extension of Becker's earlier work; but in important special cases the incorporation of these social factors into rational choice analysis results in behavior that more closely corresponds to the intuition of sociologists than of economists. For example, the abstract models presented here will explain the existence of social class and linguistic dialect.

The key difference between social decisions and conventional economic decisions (e.g., the choice of fruits) is that the social decisions have *social* consequences whereas economic decisions do not. While my network of friends and relatives are not affected in the least by my choice between apples and oranges, they will be affected by my educational aspirations, my attitudes and practices toward racial discrimination, my childbearing activities, my marriage or divorce, and my involvement in drugs. All of these activities will affect *who I am* in an important way, and thus how I associate with my friends and relatives, as well as who those friends may be. As a consequence, the impact of my choices on my interactions with other members of my social network may be the primary determinant of my decision, with the ordinary determinants of choice (the direct additions and subtractions from utility due to the choice) of only secondary

<sup>2</sup> Previous highlights in linking social interactions with economic theory include Schelling (1971), Loury (1977), Jones (1984), Frank (1985), Axelrod (1986), Kolm (1994), Bénabou (1993, 1996), Crane (1991), Durlauf (1993), Bernheim (1994), Greif (1994), Brock and Durlauf (1995), Ellison and Fudenberg (1995), Glaeser, Sacerdote, and Scheinkman (1996). Epstein and Axtell (1996) have developed a computer simulation program that is capable of generating models with social interaction.

Becker's early work (for example, Becker (1971, 1964, 1968, 1973, 1974) Becker, Landes, and Michael (1977), and Becker and Murphy (1988)) did not take into account social interactions; in the intermediate stage of his career he showed special circumstances in which social interactions, if present, were not important since the externalities could be captured within the group. More recent work by Becker, has moved into the area where social interactions play a key role. For example, Becker (1991) has explained the popularity for crowded restaurants through social interaction and Becker and Murphy (1993) have examined the implications of advertising.

Of course sociology is all about the importance of social interactions and the whole extensive literature on social networks concerns the implications of social interactions. The classic theoretical perspective on this is given by Merton (1968). Any review of the literature should start there. Of course the dominant theme of social psychology is also social interaction.

Probably the model closest to the work here is the tradition model in Jones (1984). I have also written four previous papers on this topic (Akerlof (1976, 1980, 1985), Akerlof and Yellen (1994)).

importance. A proper theory of social decisions then must first spell out their consequences for social exchange.

In social decisions externalities abound. Externalities are important either when people try to distance themselves, in social space, from their friends and relatives (status seeking), or alternatively, when they try to move themselves closer (conformist behavior). I will first construct a pair of general models that demonstrate these externalities. I will then describe a specific model that abstractly roots people in social space, and explains the stability of class structure. The predictions of this model accord with the ethnographic and biographical sketches of life in the United States inner city that I will review.

It turns out that the examination of ethnographic and biographical sketches is necessary in order to discern the presence of social interaction. Empirical estimates tend to demonstrate that neighborhood effects are statistically significant and important<sup>3</sup> and there is no disagreement at all about the importance of family variables on behavior, but there is a fundamental problem of identification in interpreting both the neighborhood and, similarly, the family background effects, as evidence of social interaction. Borjas (1995) has found that the slow rate of convergence for different ethnic groups can be explained mainly by neighborhood fixed effects; Crane (1991) has found that approaching the bottom of neighborhood quality there is a jump in the incidence of social problems for individuals with fixed socioeconomic characteristics; and Case and Katz (1991) have found the behavior of individuals in poor areas of Boston is correlated with the behavior of others in the same and adjacent one or two block neighborhoods. In each of these cases the evidence is consistent with social interaction, but could also have a variety of other explanations (see Manski (1993)). The neighborhood characteristics may be predictive of unobserved individual characteristics that affect behavior but were omitted from the prediction equations; Evans, Oates, and Schwab (1992) show that endogeneity of neighborhood choice could account for the observed neighborhood effects without any effects from social interaction. A further problem of identification arises if neighborhood characteristics are indicative of exogenously determined neighborhood characteristics that affect children's performance—such as expenditures on schooling—even though the effect on performance does not operate through social interaction. The analogous problems of identification occur in the interpretation of coefficients of family characteristics in regressions of performance. This identification problem can only be resolved at a sufficient level of detail that it is possible to impute individuals' motives. For this reason we shall turn to ethnographies and biographies, which entail a level of thick description at which it may be possible to discern unambiguously the presence of social interaction.

<sup>3</sup> These results conform to the one-sentence recapitulation of previous work by Evans, Oates, and Schwab (1992) that "many studies find that these peer group effects exist and are quite important." For an alternative view of the importance of neighborhood effects in empirical studies, see the survey by Jencks and Mayer (1990).

## 2. SIMPLE MODELS OF STATUS AND CONFORMISM

Status seeking and conformism can be illustrated by a pair of simple reductionist models. In each model the agent chooses a variable  $x$  to maximize an indirect utility function. As in Robert Frank's *Choosing the Right Pond* (1985), in the case of status behavior utility depends positively on the difference between the individual's own status and the status of others. In contrast, in the case of conformist behavior, utility declines as distance between the individual's behavior and that of everyone else increases. Both of these twin models have representative agents, so that, in equilibrium everyone behaves in exactly the same way and "the behavior of everyone else" is well defined. These models show, as is already well known, that if people are either conformist or status-seeking, their behavior generates important externalities. Although the equilibrium outcomes are the same for all individuals in these models, they represent status-seeking or conformism because *ex ante* people would prefer to be respectively better than others in the status-seeking model, or more like others in the conformist model.

*The Status Model*

In the status model the individual chooses the status-producing variable  $x$  to maximize the indirect utility function

$$(1) \quad U = -d(\bar{x} - x) - ax^2 + bx + c.$$

The person loses utility in amount  $d(\bar{x} - x)$  insofar as she falls behind everyone else in her choice of  $x$ , where  $\bar{x}$  is the choice of everyone else. In addition,  $x$  has an intrinsic value to her of  $-ax^2 + bx + c$ .

Faced with this decision problem, each individual, in equilibrium, chooses

$$(2) \quad x = (b + d)/2a.$$

Because of the competitive race for status the value of  $x$  exceeds its optimum by the amount  $d/2a$ . The externality is similar to what occurs in the overfishing of a lake or of an ocean: Status seeking people fail to take full account of the consequences of their own social positioning on the welfare of their friends and relatives, just as fishermen fail to internalize the effect of their behavior on the availability of fish for others.

*The Conformist Model*

We shall now examine the alternative case—of conformity—in which the individual wants to minimize the social distance between herself and others.<sup>4</sup> In this case she does not seek to be better than other people, but instead wants to

<sup>4</sup> The classic work on the economics of conformism is Jones (1984).

be as much like them as possible. I will later explore some of the reasons why individuals want to conform.

In the twin model on conformity, the utility function is

$$(3) \quad U = -d|x - \bar{x}| - ax^2 + bx + c.$$

The agent loses utility  $d|x - \bar{x}|$  from failing to conform to others. As before,  $x$  has an additional intrinsic utility of  $-ax^2 + bx + c$ .

And, in equilibrium, since everyone is alike,

$$(4) \quad x = \bar{x}.$$

In this model, there are multiple equilibria as long as  $d$  is greater than zero. In fact the range of values of  $x$  between  $(b - d)/2a$  and  $(b + d)/2a$  constitutes a zone of equilibria for given  $d$ . As  $d$ , the parameter describing the taste for conformity, increases, the equilibrium zone will expand. The reason for multiple equilibria is quite simple. For the individual there is a discontinuity in the marginal utility of  $x$ . For  $x$  less than  $\bar{x}$ , an additional unit of  $x$  *increases* the conformist component to utility by  $d$ . However, beyond  $\bar{x}$  an additional unit of  $x$  *reduces* the conformist component of utility by  $d$ . Because of this discontinuity the choice of  $x$  at  $\bar{x}$  is no longer a marginal decision; over a range of parameter values, the individual would choose  $x$  at  $\bar{x}$ . A mathematical consequence of this accumulation of choices of  $x$  at  $\bar{x}$  because of the discontinuity of marginal utility is a range of possible equilibria—for both  $x$  and  $\bar{x}$ .

Over the range  $(b - d)/2a < x < (b + d)/2a$  a marginal change in one of the parameters that affect utility— $a$ ,  $b$ ,  $c$ , or  $d$ —will have literally no effect whatsoever on the equilibrium value of  $x$ . Thus what seems like a truism—that people pursue education, or discrimination, or, as the parodies of Becker's work have alleged, brushing one's teeth (Blinder (1974)), up to the point where the marginal cost is equal to the marginal benefit—is not a truism. In this model, over some range of parameter values, this standard result does not even apply. The welfare differences between status seeking and conformity are clear in this example. In the seeking of status there is a clear tendency to overindulge in the status-producing activity; it is overproduced by  $d/2a$ . With conformity, the tendency to mimic the status quo can result in either underproduction or overproduction of  $x$ , in amount ranging from  $-d/2a$  to  $d/2a$ .

### *Quadratic Utility*

It is important to recognize that the existence of multiple equilibria in the conformist model is sensitive to the choice of utility function. As the distance between the representative individual and others goes to zero, the marginal utility of moving closer, in the utility function given by (3), does not fall to zero. If, in contrast, the utility function were quadratic, of the form

$$(5) \quad U = -ax^2 + bx + c - d(x - \bar{x})^2,$$

there would be only one equilibrium value of  $x$ —precisely at the optimum value of  $x = b/2a$ . Although there is conformist behavior with this quadratic utility function, the multiple equilibria disappear because the marginal utility of  $x$  is nowhere discontinuous. I have considered utility functions of this sort—with the marginal utility of decreased distance vanishing at zero—to be a special case. As discussed below, in an analogue to a gravity model the marginal utility of moving closer at zero distance would be at the opposite extreme—not zero, but infinity.

### 3. A MODEL OF SOCIAL DISTANCE

The “representative agent” models presented so far ignore individual differences and as a result make it difficult—if not impossible—to illustrate the existence of subgroups that behave differently from the majority of the population. The potential existence of such groups—subgroups in the population with their own norms and values—is one of the most important consequences of social interaction theory. We shall now introduce sufficient heterogeneity into the previous models to show how social interaction can produce such groups, which can be interpreted as stable subcultures or social classes.

In broad terms, the new heterogeneous model can be described as follows. As before, each individual must choose a decision variable  $x$  and there is an inherent benefit associated with each potential choice of  $x$ . To introduce heterogeneity in social interactions, I shall let individuals occupy different locations in social space. Social interaction, which is represented as mutually beneficial trade between individuals, will increase with proximity in this space. Current social location is acquired and dependent on the decision  $x$ , but past social location for each individual is inherited. Both the acquired and the inherited social position affect social interactions—reflecting the social aspects of the adage on my friend’s living room pillow: “It is better to be nouveau than not riche at all.” Finally, to complete the model, individuals are given static expectations about the positions to be occupied by others in social space.

Such a model can portray stable groups in low level equilibrium traps because individuals’ incentives to choose  $x$  to conform with those whose inherited social locations are close may overwhelm their incentives to choose  $x$  for intrinsic reasons. This is a model of conformist behavior because those who are closer in social space are more likely to interact. Therefore there is an incentive to conform, with a further bias toward conforming to those who are initially close by in inherited distance; just as firms, geographically, have an incentive to remain close to their current customers, individuals too have good reason not to abandon their relatives and current friends, who, by analogy, are their current customers for social exchange.

Because one dimension of social location is geographic, the concept of social proximity yields a generalization of a geographic model.<sup>5</sup> Sociologists have a

<sup>5</sup> The concept of social geography and its implications are inspired by the work of Krugman (1990, 1991a, 1991b, 1992) on economic geography.



whole lexicon of their own for what might be considered "social geography." Important concepts in sociology are, for example, social networks and reference groups, usually comprised of individuals who are socially close.

Although the trades influenced by position in social space may be economic, we conceive of them primarily as social. We shall give a positive value in the model to the benefits from social interaction, as would occur from love and friendship. However, with no change in the behavior of the model, with the inclusion of a negative constant term the social interactions could yield negative benefits. Such negative benefits from social interaction may also reflect reality since not all social exchange contributes positively to utility and fear of negative sanctions, due, for example, to jealousy and envy, are potentially as important a motive for conformity as the desire for the positive benefits of love and friendship. The jealousy and envy of friends, relatives, and neighbors (see Mui (1995)) result in the same incentives to keep close to one's origins as the positive benefits portrayed in the model, and, irrespective of whether the total returns from social exchange are positive or negative, the model gives the same negative marginal incentives of social distance and similar analyses of behavior.

### *Benefits from Trade and Social Location*

To generate examples of the behavior I have described it will be necessary to give functional form to the benefits of social interaction between individuals at different locations in social space. I shall follow the common practice of basing trade, and, correspondingly, also the benefits of trade, on a "gravity" model. In a pure gravity model the trade between two countries is proportional to the GNP's of the respective countries (analogous to their respective mass) and inversely proportional to the square of the distance between them. In practice, to estimate such models (for example, Frankel and Wei (1993)) some modifications are usually made to this pure formulation. For our purposes we shall make two modifications. In the gravitational model in physics (Feynman (1963, p. 7-1)) with the force of attraction inversely proportional to the square of the distance, attraction increases without bound as the distance between the two masses approaches zero. Adoption of this exact formula to represent social exchange would place excessive benefits on proximity in social exchange. To dampen the effects of proximity I will therefore modify the formula so that as distance approaches zero the benefits from trade will rise but not without limit. I also want the concept of social distance to be a bit richer than would be captured in a pure gravity model since I want social exchange to depend jointly on the differences between peoples' current positions and also their inherited positions. A formulation that incorporates both of these desirable modifications to the pure gravity model assumes that trade depends on the inverse of the product of a constant plus the inherited social distance and a constant plus the acquired social distance. This product substitutes for the square of the distance in the canonical gravitational model of trade. In the pure case in which the constants



are both zero and there is no distinction between the acquired and the inherited social position, this will be an exact gravity model of the benefits from trade.

These modifications of the gravity model to the volume and benefits to trade yield the expected value of the benefits of trade between  $i$  and  $j$  as:  $e/(f + d_{0,ij})(g + d_{1,ij}^e)$ , where  $d_{0,ij}$  is the initial social distance between  $i$  and  $j$  and  $d_{1,ij}^e$  is the expected final social distance between  $i$  and  $j$ . This functional form has several beneficial features. First, as in the earlier conformist model, in the neighborhood of  $d = 0$ , there is still some marginal benefit from closer relations, but not infinite, as in the unmodified gravity model. Second, as either the initial or the acquired social distance between a pair of individuals increases, the value of social exchange between them declines asymptotically toward zero.

### *Intrinsic Returns to Choice of $x$*

The variable  $x$  plays two roles in this model. First, it determines acquired social position; but the variable  $x$  also has an intrinsic economic value. For example, education is an important determinant of earnings. As in the twin models of status and conformity, we posit that the intrinsic value of  $x$  is  $-ax^2 + bx + c$ . By focusing on the intrinsic returns to social choice, previous models of social decisions—such as the choice of education, childbearing, and discrimination—have ignored the important social externalities that are embodied in the returns from social exchange.

*Expectations and Choice of  $x$ .* The problem confronting each individual  $i$  is to choose  $x_{1i}$  contingent on her initial social position,  $x_{0i}$ . In order to make this decision the individual must form expectations about the position of her potential trading partners in social exchange. Many outcomes are possible depending upon how these expectations are formed. The simplest assumption is static expectations that the acquired social position of all the other individuals will coincide with their initial position. With such static expectations about social position,  $d_{1,ij}^e$ ,  $i$ 's expected acquired distance between herself and  $j$  will be  $|x_{1i} - x_{0j}|$ . In Jones' (1984) model of tradition, a similar assumption—that half the population (of workers) is new in each generation—plays a similar role, as each new generation finds itself conforming to the traditions of the older, inflexible half of the population.

In sum, each respective agent  $i$  chooses the respective value of  $x_{1i}$  to maximize

$$(6) \quad U_i = \sum_{j \neq i} e / [(f + |x_{0i} - x_{0j}|)(g + |x_{1i} - x_{0j}|)] + [-ax_{1i}^2 + bx_{1i} + c].$$

A solution to this maximization determines  $x_{1i}$  for all individuals contingent on the value of the  $x_{0i}$ 's.

The key question to ask is whether or not the equilibrium of such a model is welfare maximizing. Long-run welfare is maximized if each  $x$  is equal to  $b/2a$ . Are there situations where the vector of  $x_i$ 's does not converge to a vector

whose elements are all uniformly  $b/2a$ ? The answer is clearly yes: depending on initial endowments many possible equilibria are obtainable.

We shall first give a simple example where convergence to a social optimum does not occur. We shall then describe ethnographic evidence that shows that the clustering illustrated by our example accords with experience, leading to nonoptimal choices in education, child-bearing, and racial discrimination.

#### 4. A SIMPLE EXAMPLE OF CLASS STABILITY

Figure 1 depicts a simple three-person example. This figure shows the inherited social positions of three persons: 1, 2, and 3. In this figure the inherited social distance between 1 and 2 is small, but the inherited distance between 1 and 3 and also between 2 and 3 is large. In addition, 3's initial position is close to the social optimum  $b/2a$ .

If 1 and 2 are initially fairly close to each other and 3 is fairly distant—as pictured—and if the value of social exchange is sufficiently high relative to the intrinsic value of  $x$ , there is one stable solution in which 1 and 2 will exchange each other's positions while 3 will choose a point that is close to the economic optimum, only slightly influenced by the possibilities of trade with 1 and 2, because they are socially distant. The proof of this proposition is given in the Appendix. This outcome occurs if  $x_{01}$  and  $x_{02}$  are sufficiently close to each other, if  $x_{03}$  is sufficiently distant, and if the value of social exchange relative to the marginal intrinsic value of  $x$  is sufficiently high. And, since person 3 does not much value trade with persons 1 or 2 since she is initially so socially distant from both of them, she chooses a value of  $x$  that is close to the economic optimum value of  $b/2a$ .

#### *Commentary*

The manner in which expectations are formed plays an important role in determining the nature of the equilibrium of the model. With rational expectations, either in the three-person model or in its generalization described above, the social optimum with  $x$  equal to  $b/2a$  for all individuals is a possible equilibrium. Indeed, when expectations can be altered so that everyone expects the social optimum to be achieved, in fact it will be. Later we shall describe two "miracles" of social intervention in which expectations about the proper mode of behavior were at least arguably changed for everyone in the relevant social

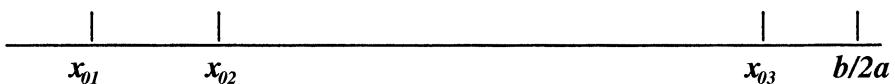


FIGURE 1.—The three-person model.

network, resulting in equilibria close to the economic optimum. But the social optimum need not be the only rational expectations equilibrium; for example, the solution I have described to the three-person model with static expectations will also be an equilibrium with rational expectations if persons 1 and 2 are close enough.

For simplicity we have represented only two time periods in the model: the initial time period, denoted 0, and the time period in which the choice is made, denoted 1. An acquired value of each  $x_i$  will be chosen conditional on the vector of initial endowments  $x_j$ . If the values of  $x_i$  that are acquired in a given period become the initial values that are used in next period's choices, this model will describe the full dynamic path of the  $x_i$  vector.

The conformist social distance model is based on an analogy with the Newtonian model of gravity. Because of the mutual advantages of possible social exchanges, people are motivated to move toward others who are close to them in social space. In the model this is seen in the behavior of 1 and 2, who are close to each other. Like twin stars, 1 is attracted to 2, while 2, symmetrically, is attracted to 1. Because of the analogy with the physical model of gravity we may also expect some of the other astronomical consequences of the Law of Gravity to be mirrored in social space. Perhaps the most obvious consequence of gravity is the existence of concentrations of mass such as stars and planets. The analogue in a social distance conformist model is the existence of subcultures.

While it is useful to point out the similarities between the social distance model and the Newtonian model of gravity, the analogy is not complete and the differences are also of some interest. We have already discussed the modifications made from the analogue to a pure gravity model in our formula for the gains from social interaction. We have made a further modification to the Newtonian system by deriving the law of motion of the system from the equation for "force" in quite a different fashion. The gravitational law of motion in physics is derived from the formulae for force by the assumption that "an object responds to a force by accelerating in the direction of the force by an amount that is inversely proportional to the mass of the object" (Feynman (1963, p. 7-1)). Instead of deriving such a differential equation for acceleration, the law of motion in our system comes from a difference equation, in which each person chooses his/her best social position on the assumption that the position of others will remain unchanged. This difference in construction of the law of motion may qualitatively change the nature of long-run equilibria. If we had assumed that the system was initially at rest and derived the law of motion in the social location model analogously to the physical gravitation model, the long run would always collapse to the single point with all individuals choosing  $x$  at the social optimum, equal to  $b/2a$ . However, with the assumed choice-theoretic law of motion of our social system, it is quite possible not to get such a collapse. Each person chooses where he/she wants to be next period; they choose their point given where everyone else was in the previous period; there are solutions, as just pictured, in which there is no convergence to the social optimum. In the

previous example if persons 1 and 2 were located at exactly the same point in social space, there would be a stable long-run equilibrium with persons 1 and 2 at that point and person 3 close to the social optimum,  $b/2a$ .

It is also useful to note that the preservation of a stable system does not necessarily depend on the property that the marginal utility of getting closer falls to zero as the distance approaches zero. We could easily imagine a situation in which individuals have no mass, but there are groups massed at given points in social space. Each individual finds that his/her optimum choice of  $x$  is exactly the value of his/her inherited social location. It is a nonmarginal decision to part from his/her subgroup because they have a measurable mass even though the marginal value of departing from a single individual just a little bit happens to be zero.

The astronomical analogy of concentrations of mass in stars and planets offers insight into important features of the social and economic landscape, particularly the division of society into different social classes with distinctive manners and customs. As discussed in the introduction, the existence of social clustering due to social interaction is hard to establish from econometric evidence. But the existence of stable dialects for subgroups of the population can only be interpreted as due to the clustering of social interactions such as modeled in this paper. (See also Durlauf (1993) and Brock and Durlauf (1995).) Thus dialects act as a diagnostic for social interaction. In discussing the model, we emphasized that the variable  $x$  could be interpreted as the choice of education, but alternatively,  $x$  could represent pronunciation or language, with the model showing theoretically why there might be a correlation between a choice variable, such as dialect, and subcultural membership. Massey and Denton (1993) relying on the intuitive notion that differences in dialect reflect social distances argue that the increasing disparity between White and Black English in the United States signals growing effective racial segregation. William Labov, a modern-day version of Shaw's Professor Higgins, has painstakingly analyzed the differences between White and Black speech.<sup>6</sup> The studies of Labov and his colleagues reveal that Black English of different metropolitan areas has converged, while it has been simultaneously diverging from Standard American English. Massey and Denton have interpreted these findings as a symptom of the slow pace of integration in the United States.

In the model we pictured both members of the conforming group, 1 and 2, as choosing too little of the variable  $x$ , in contrast to 3, who chose close to the optimum quantity. Viewing  $x$  as education, the model predicts that education may be underpurchased (relative to the welfare optimum) by the conforming group, which we shall later identify with inhabitants of the urban ghetto. Similarly, the variable  $x$  could represent drug consumption, with the model symmetrically predicting overconsumption in the ghetto relative to the welfare optimum. This could occur if 1 and 2 conform to each other's overconsumption

<sup>6</sup> See Labov (1972, 1975) and also Labov and Harris (1986). Also see Baugh (1983).

of the variable  $x$ , drugs, while the distant 3 chooses her value of  $x$  close to the economically maximizing level.

## 5. CLASS STABILITY AND THE ECONOMICS OF THE UNDERCLASS

As we have emphasized, a natural interpretation of  $x$  is educational attainment. The motivation for this interpretation comes from ethnographic observations. To this day the classic ethnography of working class youth is William Whyte's (1955) *Street Corner Society* based on observations in the Italian North End of Boston in the late 1930's. Whyte observed two groups of boys, dubbed for contrast "the corner boys" and "the college boys." In contrast to the college-bound group Whyte's corner boys mainly spent their time hanging around—in part, of course, because this was the Great Depression and jobs were not available. Follow-up studies showed that they later drifted into factory jobs. In the course of his description Whyte mused on the theoretical question: what was the difference between the upwardly mobile college boys and the stay-at-home corner boys? In particular, Whyte wondered why Doc, the leader of the streetcorner gang, was not upwardly mobile. Because of his intelligence, and natural curiosity, which Whyte considered exceptional, school would have been easy for him. Whyte concluded that Doc did not seek extra education out of loyalty to his group, whom he would be abandoning were he to advance beyond them educationally. Doc would also consider himself as deserting the neighborhood. In contrast Whyte viewed the "college boys," not as exemplars of the American dream of getting ahead, but rather as coldly disloyal to their neighborhood, and also potentially to each other. This is Doc's own view about his lack of social mobility:

"I suppose my boys have kept me from getting ahead ... But if I were to start over again—if God said to me, 'Look here, Doc, you're going to start over again, and you can pick your friends in advance,' still I would make sure my boys were among them—even if I could pick Rockefeller and Carnegie ... Many times people in the settlement ... have said to me, 'Why do you hang around those fellows?' I would tell them, 'Why not? They're my friends.'" (Whyte (1955, p. 108)).

The behavior of Doc and his corner boys corresponds, but not exactly, to the characterization of persons 1 and 2 in the three-person model. We might imagine that Doc is person 1, who in the absence of the other corner boys (collectively characterized as person 2) would choose a point close to the social optimum  $b/2a$ . Instead, because he wants to maintain his social contacts with the corner boys, he chooses a point close to them. There is a difference between the model and reality: in the model in the absence of being held back by their peers, individuals would all choose a point close to  $b/2a$ . In reality in Whyte's ethnography only Doc is restrained; the other corner boys would choose a point much closer to their origins. To make the model conform to reality requires a minor modification; we might imagine that in each succeeding generation one of persons 1 or 2 would of his own volition choose a point close to  $b/2a$ , but not

the other. This loyalty to the social network in each generation trumps the evolution toward the social optimum that would otherwise occur.

Whyte's interpretation of Doc's motivation translates into a theory of the demand for education that differs substantially from the standard model (due to Becker). While it may be true that Doc, like everyone else, pursues his education up to the point where the marginal benefit of extra education is equal to the marginal cost, the relevant cost includes not just lost wages, tuition, and the disutility of schoolwork—the ordinary interpretation of those costs. In addition the cost of the additional education includes the lost contacts with others. In the standard model with lost wages, tuition, and the disutility of the additional effort as the major costs of education, educational choices involve few externalities. In contrast, if the cost of education includes disutility from deviation from others in one's social network, the potential for large externalities is apparent. These externalities explain why even with generous scholarship aid available, students from low-education backgrounds commonly drop out too early while those from high-education backgrounds may stay in school too long.

The model, as epitomized in Doc's response to Whyte's question, explains how social structure—in this case the social structure of the white working class—tends to reproduce itself. It explains why there is less mixing in American society than might be expected if purely individual incentives combined with purely individual values.

Similar conclusions arise from Lee Rainwater's classic study (1970) of the Pruitt-Igoe housing projects in St. Louis in the late 1960's. This study presaged the subsequent developments in the Black inner city over the next 25 years. Rainwater's research questions the "old" sociological paradigm of discrimination in which "white cupidity [created] black suffering (1970, p. 3)." Such "old" sociological reasoning is embodied in the economic models of Becker where white discrimination coefficients cause decreased demand for Black labor, and possibly also for the products of Black-owned capital—so that Black incomes are significantly reduced. According to the "new" sociology (Rainwater (1970, p. 4)), which Rainwater's ethnography supports, "white cupidity creates structural conditions highly inimical to basic social adaptation to which Negroes adapt by social and personal responses which serve to sustain the individual in his punishing world but also to generate aggressiveness toward the self and others which results in suffering directly inflicted by Negroes on themselves and on others." In these personal and social responses individuals conform to the norms of the ghetto society, and the cycle of poverty is passed from one generation to the next. The meaning of this theoretical perspective, and its correspondence with the special three-person model above, can be illustrated by the biographies of two of Rainwater's subjects.

The first of many portraits of residents of the Pruitt-Igoe housing project in Rainwater's *Behind Ghetto Walls* is of Thomas Coolidge, a 21-year old Afro-American laborer. We first meet Coolidge as a young married father employed at a drive-in diner, living in the projects, but with his life basically in order, as indicated by the tidiness of his apartment. Over the next year Coolidge's life



disintegrates as he becomes childishly dependent on his parents after losing his job and his wife, who has pursued numerous affairs with other men. This is how Coolidge theorizes about ghetto life (p. 19):

“This place is like a jungle but you can’t get away from it so you submit yourself and submitting yourself is the worst thing that you can do. Submitting is like letting yourself do *what other people want you to do*. It’s like tilting the scale, if you have the bad on one side and the good on the other and the bad outweighs the good then the bad comes out best in the end. Now if you are one of the good and you’re constantly coming in contact with one of the bad and there are a whole lot of bad and very few good, then you don’t have any other choice but to go along with the bad whether you want to or not” (italics added).

Why do people, in Coolidge’s words, “do what other people want them to do?” In the face of poverty and joblessness the other world is too hard to obtain, and the social pressure to conform is simply too great. This interpretation of Coolidge’s predicament, consistent with Coolidge’s own view, conforms to the three-person model in which individual 1 and individual 2 respectively conform to one another.

Coolidge’s story typifies how men were captured in the orbit of ghetto life. The comparable dynamics for women is epitomized by the life-story of Alice Walker, who becomes a single-parent teenage mother, despite early ambitions otherwise. We first meet Alice Walker at the age of 15 when she is aspiring to become a secretary and move out of the ghetto. In fact Alice becomes pregnant at an early age. To have persisted in her prior ambitions would have kept her from participating in her friends’ web of activities centering around boyfriends and babies. Between lonely ambition and poverty among friends, Alice, understandably, like so many others, chose friends and companionship. This is exactly what the three-person model, in this case referring to the choice to have children at a young age, is meant to illustrate.

Ethnographies, like Rainwater’s and Whyte’s, tend to sample ordinary people. In *Behind Ghetto Walls* especially we meet young people, typically hopeful for the future, and then observe how the forces for conformity with the life of the ghetto turn these hopes sour, as these young people follow everyone else around them. In contrast, biographies of those who have escaped the ghetto or working class offer a different perspective. If our theory of social conformity is correct, upward class mobility, especially out of the ghetto, must be fraught with difficulties that are only surmounted by the exceptional.

Probably the most revealing autobiography in this respect is *Manchild in the Promised Land*, the autobiography of Claude Brown (1965), who grew up in Harlem in the 1940’s and 50’s. By the age of eight he had already been shot while attempting a robbery, had set his own house afire, had been hit by both a car and a bus, and been thrown into the Harlem River. By luck he was sent to the Wiltwyck School for Boys, a special reform school where under the influence of the counselors, he decided to reform. He worked days, attending remedial high school at night; but in order to make it he found it necessary to remove himself physically—to Greenwich Village—away from his family and friends.



A biography of an Afro-American youth from Harlem and an autobiographical essay by a Mexican-American from Sacramento both provide additional insight into the difficulties experienced by those achieving upward mobility through education. The biography (Anson (1985)) was motivated by newspaper reports describing the shooting of an African-American youth in the Morning-side Heights neighborhood of New York in an attempted robbery of a plain clothes policeman. The case drew national attention because the young man had just graduated with honors from Phillips Exeter Academy, perhaps the nation's most elite preparatory school, and had just won a full four-year fellowship to Stanford. Robert Anson decided to investigate fully the circumstances leading to this tragedy. The boy, Eddie Perry, had taken part in the so-called Special Program of his local New York public school. Over the course of 21 years 230 talented students from this program had been sent to 72 different prep schools (Anson (1985, p. 47)). The program has achieved great success, as judged by a comparison of the careers of its graduates to those of their peers left in the inner city. However, when Anson investigated the fate of Eddie Perry he discovered that the success of the program had been achieved at the cost of considerable psychological pain, because the students did not fit naturally into either their old world of the inner city or their new world of the prep school. In the lingo of the model their social distance at prep school was too great for psychological comfort; but then when they returned home to the inner city they were, similarly, ill at ease. A close mentor of Eddie's, who had also gone to prep school from the inner city, later graduating from Yale, explained the psychological tension:

"So that leaves people on the street. And how in the hell is he supposed to talk to them? . . . , this kid couldn't even play basketball. They ridiculed him for that, they ridiculed him for going away to school, they ridiculed him for turning white. I know because he told me they did." (Anson (1985, p. 205)).

This mentor viewed Eddie's death as a suicide induced from the stress of living in two separate and dissonant cultural worlds.

Richard Rodriguez' autobiographical essay (1982) depicts the clash in cultures between the customs and language of his Mexican-American home and the *Gringo* culture that he learned in school and at college. Rodriguez recounts with feeling that his family (especially his extended family) considered him increasingly alien, just as Eddie Perry's peers in Harlem no longer considered him Black, because of what he had learned at prep school. Rodriguez recounts that as English became his dominant language:

"*Pocho* then they called me. Sometimes, playfully, teasingly, using the tender diminutive —*mi pochito*. Sometimes not so playfully, mockingly, *Pocho*. (A Spanish dictionary defines that word as an adjective meaning 'colorless' or 'bland.' But I heard it as a noun, naming the Mexican-American who, in becoming an American, forgets his native society.)" (Rodriguez (1982, p. 29)).

Although they lived at opposite ends of the continent and came from different ethnic backgrounds, and although one life ended in tragedy while the other

continues as a remarkable success, Eddie Perry and Richard Rodriguez bore psychological costs of educational attainment that were strikingly similar: in the one case there was the cost of being labeled a White man in a Black neighborhood, in the other case there was the cost of being labeled a *Grimo* by his extended family. For both there was also the difficulty of living in the culturally alien white world. These were perhaps the costs that Doc, a generation earlier, had decided not to bear when he had made the opposite choice—to be a streetcorner boy, and not a college boy.

Stack's *All Our Kin* (1974) documents the intensity of social exchange for poor Black families and shows how these social exchanges are disrupted by upward social mobility. Stack details how these families swap and share a wide variety of things—furniture, cars, meals, childcare services, places to live, and, in times of distress, each other's children. In 1970, at the time of Stack's field work in an industrial town close to Chicago, almost 10 percent of Black children were living with neither of their biological parents. She reports survey results that 20 percent of Black children in the poor area of this town were living with relatives other than their mothers.

Stack gives an example of how going middle class results in the disruption of these exchange relations, especially with respect to the mutual sharing and discipline of children (Stack (1974, pp. 76–79)). She describes the relations between two sisters, Ethel and Wilma, and among their children and grandchildren. A third sister, Ann, and her brood make an appearance. Ann has become middle class and the distance between her and her sisters is especially clear in the mutual care of their respective children. For example, in an emergency, Ann's daughter Vilda let Georgia (Wilma's daughter) take care of her child Betty in return for pay (ten dollars per day.) But instead of allowing her to use her best judgment as childcare person and aunt, Vilda gave instructions to Georgia not to yell at Betty or to spank her. Georgia responded to this lack of confidence in her parenting abilities by preventing Ann from disciplining her own daughter. When Ann tried to prevent one of Georgia's daughters from chasing one of her own grandchildren with a red hot poker at a family barbecue, Georgia responded: "You won't let me touch your granddaughter, so don't you tell my child what to do." Stack interprets this event as more than the clash between two different personalities, but as symptomatic of the clash between two different life styles.

These snippets of ethnography, autobiography, and biography, of course, do not statistically prove that people try to conform to the social norms of their friends and relatives. Rather, such vignettes provide token reminders of what most of us already appreciate instinctively, which is the reality underlying the social distance/social exchange model of demand. Relative to education, we know that the education sought by most people will be the education that meets the approval of friends and relatives. Like children on the merry-go-round who look up to see if anyone is watching,<sup>7</sup> youth who are attaining an education look

<sup>7</sup> The image here of course comes from Erving Goffman.

around to see if their work is being appreciated by the adult and teenage worlds around them. The absence of a favorable response takes away the fun.

Economists have modeled the demand for children as if they were consumer durables. But children are a special kind of consumer durable whose enjoyment is enhanced by hobby clubs of other mothers and adoring relatives who share the pleasures of the new models. And, if everyone else is a member of a baby club, it is lonely to stay out. Thus, for example, Alice Walker chose to be a welfare mother rather than a secretary because the road to becoming a secretary was lonely, whereas being on the dole made her one of the gang.

## 6. FURTHER OBSERVATIONS WITH POLICY IMPLICATIONS

In the social distance model described above each person chooses her respective position in social space under the static expectation that the social positions of others would remain fixed. In the equilibrium this assumption turned out to be roughly true, since 1 and 2 were close and they merely interchanged positions. And 3 did not change her position much either. However, in special situations people may expect others to move in tandem rather than to remain in place, generating a motive for social movement that is normally absent. Interventions in a closed environment that attempt to change the social position of an entire social network simultaneously and, as a consequence, to alter the expectations of the individuals in the network about their neighbors' behavior can be quite successful in generating major social change. In terms of the model if everyone is expected to change their social position to the economic optimum, then that optimum will be the new equilibrium.

In practice the best known intervention where such a change in expectations most likely occurred is Eugene Lang's famous offer to give a college scholarship to every student of a sixth grade class in Harlem. Of the 51 students who remained in the New York area, 40 were considered likely to go to college six years later. Even more remarkable, all of these students could easily have obtained either scholarships or loans in the absence of Lang's program. (See Ellwood (1988, pp. 125–126).)

How then should we account for this success? One possibility is that Lang was successful because he put a lot of resources into the program and actively engaged a dedicated social worker who organized group activities, enlisted the support of parents, and also intervened at students' times of crisis. Lang did not just offer the money and then walk away from the children to await later claims for scholarship money, if any.

An alternative explanation is that the experiment was successful because the students formed a cohesive group in which each member received reinforcement from others who, like themselves, were on the academic track toward graduation from high school. In terms of the model each individual student would expect to be more isolated from her peers if she dropped out than if she kept up with her school work. Additionally, these students were perceived by the community as the recipients of a rare bit of good luck. By pursuing this unusual opportunity,

the community would not identify members of the class as departing from behavioral norms.<sup>8</sup> Both of these explanations—in terms of group dynamics and in terms of signaling—conform to our model of social distance. The students took advantage of Lang's rash promise because they could do so without creating great social distance between themselves and their social network.

Another social intervention commonly cited for remarkable results occurred in two New Haven schools in the 1970's. In this case too the intervention reversed the normal incentives governing behavior. When James Comer and his team (1980) first came to the New Haven schools they found a great deal of anger among teachers, students, administrators, and parents—all of whom were frustrated because they felt that they were being unfairly treated. Comer and his assistants used human relations tools to teach responses that were more constructive than anger. To give one concrete example, Comer taught methods for dealing with misbehavior resulting from children's frustration. He relates the story of an eight-year-old boy who was sent North by his family from North Carolina and was dropped off at school by an aunt on her way to work. When the boy was left in the classroom by the school principal without any introduction, the teacher showed some annoyance at the additional burden. In anger, the eight-year-old kicked the teacher and ran out of the classroom. By creating a school environment in which the teacher was trained to find out the reason for the child's unhappiness and misbehavior, the teacher and the student were able to reach a mutual understanding: the teacher would respect the boy's feelings and the boy would behave. Once the lesson had been learned that understanding, not anger, was the way to deal with difficulties, academic success followed.

Comer tells a vignette that shows that this message had been appreciated by the students (as well as the faculty and parents). When a student new to the Comer school had his foot stepped on, he raised his fists, ready to fight. Told by another youngster "Hey man, we don't do that here," the transfer student read the expressions on the faces of the others around him and dropped his fists (1988, p. 219). By creating a school spirit in which everyone reacted to anger with the attitude "we don't do that here," each member of the school community feared, like the transfer student, at least some degree of ostracism if he did not conform.

In terms of the model, in the old equilibrium anger was acceptable and often contributed to an individual's acceptance in her respective social group. In this equilibrium anger is uninhibited because it contributes positively to social exchange. In contrast, in the new situation, after Comer's intervention, each person understands that anger will have the opposite effect: a show of temper would reduce acceptance by one's peers and even by children on the playground. By reversing the social code for acceptance or rejection, a new socially optimal equilibrium was achieved in which learning could be the focus of attention.

<sup>8</sup> This observation corresponds to Bernheim's interpretation of conformist behavior. See Bernheim (1994).

## 7. CONCLUSIONS

Although the models presented here are only extensions of the early Becker framework for social decisions, it is my hope that the incorporation of these social externalities provides a broader and more accurate framework for the rational analysis of social choice. In contrast to standard economic models the social distance approach provides insight into sociological phenomena including class structure and patterns of behavior such as dialect.

The pervasive externalities that influence decisions in the social distance model have implications for economic policy. Because group interactions are an important influence on individual decisions, the analysis of social programs must include an evaluation of an intervention's impact on group interactions and not just the direct effects of the program. For example, in education the returns to programs such as art and athletics cannot be measured simply by their direct effects on grade point averages and added earnings of the participants. Similarly, the pros and cons of tracking in the schools depends upon the group interactions that are thereby engendered. Comer's school intervention suggests that with harmonious social relations, academic achievement may be easy to attain, even in schools in the most disadvantaged neighborhoods. Conceivably, there could be high payoffs to drama programs that enable students to learn an alien culture and language while curiously pretending that they are not.

Several recent books and reports (see, for example, Eisenhower Foundation (1993) and Schorr (1988)) have endorsed a community-wide, multiple-solution approach to the problems of the inner city. The theory of social interactions might be interpreted as providing a rationale for such an approach. But the analysis here suggests that the community is endogenously defined in terms of peoples' sense of social location. What may appear as a community to an outside reformer (a city neighborhood, for example) may be too large a unit in which to encompass the social interactions involved in social exchange. As Comer has shown, these externalities may be possible to capture in small, near total institutions such as schools.

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## APPENDIX

This appendix will show that in the three-person example person 1 chooses  $x$  at the initial position of person 2 and, similarly, person 2 will choose  $x$  at the initial position of person 1 if  $x_{01}$  and  $x_{02}$  are sufficiently close to each other, if  $x_{03}$  is sufficiently distant, and if the value of social exchange relative to the marginal intrinsic value of  $x$  is sufficiently high. And, if person 3, who is

socially distant from persons 1 and 2, does not much value trade with persons 1 or 2 she will choose a value of  $x$  that is close to the economic optimum value of  $b/2a$ .

The mathematics is surprisingly simple: Consider person 1's choice of  $x_{11}$ . We shall show that under the appropriate conditions it will be chosen at  $x_{02}$ . This variable will be chosen at the point where the derivative of  $U_1$  turns from positive to negative. The derivative is well-defined at all but the two points,  $x_{11} = x_{02}$  and  $x_{11} = x_{03}$ , where instead there are left-hand and right-hand derivatives, but of different magnitudes. According to (6) in the interval  $x_{11} < x_{02}$ ,

$$(7) \quad U_1 = [e/(f + (x_{02} - x_{01}))][1/(g - (x_{11} - x_{02}))] \\ + [e/(f + (x_{03} - x_{01}))][1/(g - (x_{11} - x_{03}))] - ax_{11}^2 + bx_{11} + c.$$

Note that the quantities  $x_{11} - x_{02}$  and  $x_{11} - x_{03}$  are both negative in this range, since  $x_{11} < x_{02}$  and also  $x_{11} < x_{03}$ .

Differentiating (7) we find that in the range  $x_{11} < x_{02}$ ,

$$(8) \quad \partial U_1 / \partial x_{11} = [e/(f + (x_{02} - x_{01}))][1/(g - (x_{11} - x_{02}))^2] \\ + [e/(f + (x_{03} - x_{01}))][1/(g - (x_{11} - x_{03}))^2] + [-2ax_{11} + b].$$

In this range each of the square-bracketed terms is positive. Remember that  $-2ax_{11} + b > 0$  since in our description of  $x_{01}$  and  $x_{02}$ , 1 and 2 were both underinvesting in  $x$ . In consequence  $x_{11} \geq x_{02}$ .

For the range  $x_{02} < x_{11} < x_{03}$ , the value of  $U_1$  is

$$(9) \quad U_1 = [e/(f + (x_{02} - x_{01}))][1/(g + (x_{11} - x_{02}))] \\ + [e/(f + (x_{03} - x_{01}))][1/(g - (x_{11} - x_{03}))] - ax_{11}^2 + bx_{11} + c.$$

And in this range,

$$(10) \quad \partial U_1 / \partial x_{11} = -[e/(f + (x_{02} - x_{01}))][1/(g + (x_{11} - x_{02}))^2] \\ + [e/(f + (x_{03} - x_{01}))][1/(g - (x_{11} - x_{03}))^2] + [-2ax_{11} + b].$$

Note that the sign of the first square-bracketed term changes at  $x_{11} = x_{02}$  from positive at  $x_{02}^-$  to negative at  $x_{02}^+$ . If the distance between  $x_{03}$  and  $x_{01}$ , is sufficiently large, and if the intrinsic value of  $x$  is sufficiently small relative to the value of the exchange, then the first term dominates the sign of (10) and  $\partial U_1 / \partial x_{11} < 0$  at  $x_{11} = x_{02}^+$ . Since  $\partial U_1 / \partial x_{11} > 0$  at  $x_{11} = x_{02}^-$ , this is a point where the sign of the derivative changes—discontinuously from positive to negative. Such a change of sign does not automatically guarantee that  $x_{02}$  is the optimal value of  $x_{11}$  for person 1.  $\partial U_1 / \partial x_{11}$  may turn positive as  $x_{11}$  gets closer to  $x_{03}$ : the first term in square brackets becomes smaller in absolute value as  $x$  moves away from  $x_{02}$ ; and the second term in square brackets becomes larger as  $x$  moves closer to  $x_{03}$ . However, if the initial distance between  $x_{02}$  and  $x_{01}$  is sufficiently small, and, more important, if the initial distance between  $x_{01}$  and  $x_{03}$  is sufficiently large,  $\partial U_1 / \partial x_{11}$  will not change sign from minus to plus as  $x_{11}$  approaches  $x_{03}$ , guaranteeing that  $x_{02}$  is preferred to any point in the range,  $x_{02} < x_{11} < x_{03}$ .

Finally, in the range  $x_{11} > x_{03}$ , the value of  $U_1$  is

$$(11) \quad U_1 = [e/(f + (x_{02} - x_{01}))][1/(g + (x_{11} - x_{02}))] \\ + [e/(f + (x_{03} - x_{01}))][1/(g + (x_{11} - x_{03}))] - ax_{11}^2 + bx_{11} + c.$$

And in this range we find

$$(12) \quad \partial U_1 / \partial x_{11} = -[e/(f + (x_{02} - x_{01}))][1/(g + (x_{11} - x_{02}))^2] \\ - [e/(f + (x_{03} - x_{01}))][1/(g + (x_{11} - x_{03}))^2] + [-2ax_{11} + b].$$

There is no guarantee that  $\partial U_1/\partial x_{11}$  is negative in this entire range  $x_{11} > x_{03}$  when it is negative for  $x_{02} < x_{11} < x_{03}$ ; nevertheless, if the marginal value of intrinsic utility,  $-2ax_{11} + b$ , is sufficiently small,  $\partial U_1/\partial x_{11}$  will be negative throughout this region. Thus we have found that if the intrinsic value of  $x$  is sufficiently small relative to the value of social exchange, and if 1 and 2 are sufficiently distant from 3 and also from  $b/2a$ , the optimal value of  $x_{11}$  will be  $x_{02}$ .

A similar proof will show that under these same conditions the optimal value of  $x_{12}$  will be  $x_{01}$ , and  $x_{13}$  will be chosen close to  $b/2a$ .

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