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SOCIAL CAPITAL AND THE REPRODUCTION OF INEQUALITY IN SOCIALLY POLARIZED ECONOMIES*

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Social Capital and the Reproduction of Economic Inequality in Polarized Societies

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Abstract

This paper explores the idea that how wealth is distributed across social groups (ethnic or language groups, gender, etc.) fundamentally affects the evolution of economic inequality. By providing microfoundations suitable for this exploration, this paper hopes to enhance our understanding of when social forces contribute to the reproduction of economic inequality. In tackling this issue, this paper offers contributions in two domains. First, it models social capital as a real capital asset with direct use and collateral value. Second, it extends the concepts of identity, alienation and polarization used by Esteban and Ray (1994). This generalization permits us to consider the multiple characteristics that shape social identity, inclusion and exclusion. It also underwrites a higher-order measure of socio-economic polarization that permits us to explore the hypothesis that economic inequality is most pernicious and persistent when it is socially embedded. Among other things we are able to show that holding constant the initial levels of economic polarization and wealth inequality, higher socio-economic polarization increases subsequent income and wealth inequality. Far from being a distributionally neutral panacea for missing markets, social capital in this model may itself generate exclusion and deepen social and economic cleavages.

Social Capital and the Reproduction of Economic Inequality in Polarized Societies

A number of factors have renewed interest in economic inequality, including demonstrations that inequality may slow the rate of growth, and that a number of economic forces may tend to reinforce inherited inequality. [1] While much of this work is exclusively economic in orientation, several authors have argued that economic inequality is most durable, problematic and pernicious when it is socially embedded, meaning that the wealthy and the poor are distinguished not only by their money, but also by their culture, language or physical appearance. In the case of Latin America, Adolfo Figueroa (1996 and 2003) argues that inequality is most severe and inhibits economic growth in the Andean and Central American regions where inequality is socially embedded. On a more global scale, Frances Stewart (2001) has argued that it is socially embedded inequality, or what she calls horizontal inequality, that is most economically and socially problematic.

The goal of this paper is to explore the idea that non-economic characteristics of society fundamentally affect the evolution of inequality. By providing microfoundations suitable for this exploration, this paper hopes to enhance our understanding of when social forces contribute to economic inequality. In tackling this issue, this paper offers contributions in two domains. First, it adds a dimension to the literature on social capital by showing how social relationships—directly valued for their own enjoyment—can serve as collateralizable social capital assets. Second, it offers a modest generalization of the concepts of identity, alienation and economic polarization used by Esteban and Ray (1994). This generalization permits us to consider the multiple characteristics that shape social identity, inclusion and exclusion. It also underwrites a higher-order measure of socio-economic

[1] The detrimental impact of economic inequality on growth (Alesina and Rodrik 1994, Deininger and Squire 1998, Persson and Tabellini 1994, Aghion et al. 1999, Birdsall and Londono 1997, to name just a few) has been well documented.

polarization that permits us to explore the ideas of Figueroa and Stewart. Among other things we are able to show that holding constant the initial level of economic polarization and inequality (the latter as defined by Esteban and Ray), increases in socio-economic polarization increase economic inequality.

The core of this paper is a model in which individuals not only directly value social ties as a consumption good, but can leverage economic benefits through these relationships. These benefits can come for example in the form of informal credit; business advice, employment or other economically valuable information. The key mechanism available to encourage reciprocation to the group by those who receive such benefits (*e.g.*, loan repayment, or mutual sharing of business tips) is social exclusion: a defector faces the penalty of having his or her social relationship with the group severed.

Underpinning this model is a concept of social capital as a feature of social structure that relaxes the incentive compatibility constraint in economic transactions. It is the inherent value that individuals attach to social relationships that enables such relationships to function as social collateral for the benefit provided. In the notion of social capital that we advance in this essay, then, we relate the intrinsic value of social capital to its instrumental value, with the existence of the former making possible the realization of the latter.

While this formulation of the concept is not so broad as to capture everything that travels under the social capital rubric, it permits us to explore the notion that resources committed to building up social capital are not equally productive for all individuals. Returns to social investment are strongly impacted by people's identity characteristics. In particular, each individual has an identity, which is a function of economic characteristics (wealth) and socially relevant immutable characteristics such as race, gender, or family background. In

deciding how much to invest in a given social group, each person's identity comes into play, determining the size of the social capital stock he or she can build up given a certain amount of social investment, and therefore by affecting the size of social collateral that this investment could represent.

Moving from this agent-level to an aggregate perspective, the paper provides an analysis of the creation of inequality in highly polarized economies in which social interactions underpin economic activity. The role of population distribution in identity space is examined, in order to investigate what types of initial distributions may make inequality in access to material benefits from the group, and consequently in economic welfare, more persistent. Special consideration is given to distributions depicting various degrees of 'polarization'. For this, we formalize the concept of socio-economic polarization as a specific feature of distribution, one that is distinct from the concepts of economic polarization and inequality. Numerical simulation of the model of social capital as social collateral shows that greater initial socio-economic polarization will lead to greater income and wealth inequality.

The remainder of the paper is organized as follows. Section 1 offers a brief review of the literature on social capital and its commonly recognized shortcoming. Section 2 builds on that literature, and tries to rectify some of its shortcomings with a model of the accumulation of social capital as social collateral in the presence of social identity and alienation. Section 3 defines a measure of (two-dimensional) socio-economic polarization and defines benchmark distributions for the numerical analysis of the social capital model. Section 4 then undertakes the numerical analysis, linking economic outcomes to the degree of initial socio-economic polarization and showing how social forces can deepen economic inequality in polarized

societies. Finally, Section 5 concludes the paper with thoughts on its policy implications and how the analysis might be deepened and carried forward.

1. Rethinking social capital

Scholars who have sought to incorporate social structure in economic analysis of human behavior have mostly done so acknowledging that the concept of 'social capital' has not yet intellectually matured. One of the most widely cited definitions refers to social capital as "features of social organization, such as networks, norms, and trust, that facilitate co-ordination and co-operation for mutual benefit" (Putnam 1993). Other definitions of the term vary in generality and focus. For example, while some of the literature focuses on the community as the unit of analysis (Woolcock and Narayan 2000, Putnam 1993, Bowles 1999), inherent in most definitions is the view of individuals as the "owners" and benefactors of social capital (Coleman 1988, Portes 1998).

Leaving aside the issue of who owns social capital, other critics have argued that social capital is a poor term for the idea it is supposed to represent (Bowles 1999a). Solow (2000) suggests that social capital as conventionally conceived does not have any of the key attributes of capital: It is not a stock of produced or natural factors of production that can be expected to yield productive services for some time; It is not a cumulation of past flows of investment, with past flows of depreciation netted out; etc.[2] Indeed, these concerns are understandable given the conceptual weaknesses in the literature on social capital.

[2] For example, while the best of the empirical literature on social capital concerns itself with the potential econometric endogeneity of social capital (*e.g.* in Narayan and Pritchett 1999, Maluccio et al. 2000, Grootaert 1999), it does not operate with an explicit view of where social capital comes from and what investments constitute it (Alesina and La Ferrara 2000 are an important exception to this statement).

Yet a third conceptual weakness in research on social capital is reflected in the oft reoccurring expression of ambiguity whether social capital is necessarily always "good", and where it is a "bad", whether we can still call social capital a 'capital'. Concern with the problematic nature of conceptualizations that already carry within them the alleged good outcomes of social capital have encouraged redefinitions that seek to circumvent tautologies (Durlauf 1999, Portes 1998).

While this paper does not pretend to unify the full complexity of what is meant by social capital into a conceptually satisfying whole, it does offer an understanding of how one type of social capital functions as an individually owned asset stock, how accumulating this asset requires investment which comes at a cost, and how economic returns from social capital arise because it is a form of collateral that mitigates incentive-compatibility problems. As modeled here, social capital is neither inherently "good" nor "bad". Rather, its social value or usefulness depends on the types of implicit contracts that become implementable because of the collateral value of social capital. As later analysis will show, social capital has the potential to be an equalizing, or an exclusionary, unequalizing force, depending on the way the social constellation of an economy frames its collateral value for each type of person in the economy, as later sections of this paper will explore.

2. A model of social capital and identity

This section puts forward a model of social capital as social collateral in which social capital is individually "owned" and is a true capital stock in the conventional meaning of the term. Critically, the collateral value of social capital as modeled here will be shown to depend on the owner's social identity. Social capital is neither intrinsically good nor bad, and while it

can potentially resolve problems of missing markets, it may in fact operate to deepen economic inequality and what we will call social polarization.[3]

We consider here a two-period model of individual investment in social relationships. In the first period individuals allocate their time between wage work and social relationships. Belonging to a social group not only generates intrinsic value, but they can expect to secure economic benefits conferred by the group on its members. The size of these benefits depends on the strength of social relationships the individuals develop within the group. In the second period, economic benefits obtained from the group are realized, individuals decide whether or not to reciprocate by providing in turn benefits to other group members, stocks of social capital are updated, and individuals enjoy both their consumption of material goods (purchased with wage and group benefits) and their stock of social relationships.

Each individual enjoys four endowments: Inherited wealth; an immutable social characteristic such as gender, language or ethnicity; time; and an initial stock of social relationships, or inherited social capital. Given these endowments, individuals must choose how to allocate their time between work and social activity, with which social group to invest their social time, and later whether to reciprocate by committing some of their time in a way that would generate benefits for other group members. The next subsection below describes the accumulation of social capital, followed by a discussion of identity and its significance. We will then establish the logic of social capital as social collateral.

[3] Durlauf and Fafchamps (forthcoming) make many of these same points in their comprehensive review of the concept and analysis of social capital.

The Intrinsic Value of Social Capital

In this two-period model, an individual gets utility both from consumption of material goods as well as from social interaction (friendship) with members of their social network:

$$U = u(c_1, S_1) + \beta u(c_2, S_2) \quad (1)$$

where c_t is consumption at time t and S_t is the stock of friendship (or, social capital) which the individual can enjoy. In period 1, total time L has to be allocated between labor L_{w1}, which earns wages w per time unit, and time spent participating in social relationships, L_{s1}. Time dedicated to social relationships comes at a cost of forgone labor income. In the second period, time is simply spent working and social relationships are enjoyed without any further costly investment. At the beginning of period 1, the stock of pre-existing, or inherited, social capital S_1 is given. Second period social capital is a mix of inherited and achieved social capital. Specifically we assume that the time committed to social relationships and friendships in the first period, L_{s1}, affects the rate, $\tilde{\delta}$, at which social capital increases:

$$S_2 = (1 + \tilde{\delta})\ S_1, \quad (2)$$

where $\tilde{\delta} = -\delta + (1 - T)L_{s1}, \delta \in (0,1)$ is the 'raw' depreciation rate of social capital, and the expression $T \in [0,1]$ is what we will term the degree of effective alienation between the individual and the social group in whom the individual invests time.[4]

Expression (2) captures the idea that time spent with friends results in a mass of shared experience which enriches the direct utility value of future social interactions. Importantly, the stock of experience which constitutes social capital is specific to the individuals or social group in which time has been invested.

[4] With δ we want to capture the notion that if someone does not commit any time at all to maintaining their inherited social relations, one can expect that the stock of these relationships will decline somewhat relative to its initial level.

While the next sub-section will precisely define the degree of effective alienation, T, the intuition underlying alienation and the accumulation of social capital is straightforward. As shown in expression (2), a given investment of time, L_{s1}, with a particular social circle will result in a more highly valued stock of social experience the more the investor's social identity lines up with that of the social circle (*i.e.,* the less alienated is the individual from social group). A high degree of alienation implies greater 'discomfort' of the individual with the group, and of the group with the individual. This greater discomfort is expressed here by saying that the individual achieves a lesser stock of social capital from time invested in a group from which she is alienated.[5] In the extreme, irrespective of time allocated to social activities, an individual will build up no social capital with a group if she is perfectly alienated from it (i.e. if $T=1$). In this event, the stock of social capital will decline over time from its initial level, to $S_2 = (1-\delta) S_1$. The same holds if no time at all has been allocated to fostering social relations, i.e. if $L_{s1} = 0$, regardless of the degree of alienation.

Identity and Alienation

This section puts forward a concept of alienation rooted in how strong and how disparate the identities of the individual and the group are. We will first elaborate on the two elements constituting identity in the model, and then develop the mechanism through which identity becomes economically important.

The idea that one's economic position is an integral part of one's identity has been suggested by authors from varied disciplines (e.g. Esteban and Ray 1994, Deutsch 1971,

[5] Most of us relish escaping uncomfortable social situations and ascribe little value to the option to revisit the group and build on the "good times" already had together. One of the authors of this paper recently joined a golf club only to discover that "golfing alone" is far preferable to playing with members of rather distinct political and social persuasion.

Gurr 1980, Shanin 1966, Coser 1956). The economic literature has hardly explored the income- or wealth-dimension of identity, and even less so non-economic dimensions such as race, ethnicity, language, religious affiliation, etc.[6] Research on the *interaction* of these two elements of identity and its economic implications (see Stewart 2001) is particularly scarce.

The basis for the model is the notion that identity affects people's ability to accumulate and make economic use of their social capital. Since T refers to the degree of alienation between an individual and a group, it is a function that depends on the identity characteristics of the group (represented by the vector E),[7] as well as the identity characteristics of the individual (D), so that $T = T(E,D)$. We assume that there are two dimensions to identity. The first is an economic component, measured as inherited wealth, denoted D_y for the individual and E_y for the group. The second component is an observable, but immutable characteristic that a particular society deems as socially relevant to the construction of identity (D_x and E_x). Ethnicity, [8] skin color, and maternal language are all examples of such characteristics. While seeing people as different based on their ethnicity or skin color is of course a social construction (which evolves over time—see de la Cadena, 2000), our analysis here applies to a time scale in which people take the rules of social identity as given. For simplicity's sake, we will refer to this socially constructed, identity

[6] A recent study (Akerlof and Kranton 2000) explores the role of identity for economic outcomes, drawing on some elemental ideas from sociology and social psychology to create a model in which one's identity informs, and is informed by, one's actions and the actions of others. In this model, people care not only about economic goods in the broadest sense of the term, but also about affirming their identity, which can mean doing things to differentiate themselves from the advantaged groups even if these actions are not optimal from the standpoint of material welfare.

[7] As a composite of many individuals, the group's identity vector will be defined by a measure of central tendency for the group's current or historical membership.

[8] In examining how people choose actions according to behavioural social codes, ethnicity has been an issue of focus. This is often modelled by changing the basic assumptions regarding the motivation for action. For example, in Kuran (1998) utility is composed not only of personal taste, but also of the desire to gain approval of those in one's ethnic group, which may require actions such as practicing a cultural ritual.

relevant characteristic as "color," though, as indicated, color is only one of many possible characteristics which is ascribed such a role.

For purposes of analysis, we will assume that we can characterize both wealth and color with a continuous numerical range.[9] The interpretation of such a range for wealth is straightforward, in that low numbers refer to relatively low wealth levels, and vice versa. Similarly, low numbers will be given to color, representing a position along a continuous color spectrum. To simplify later discussion, we will assign low numbers to colors that are more strongly correlated with low wealth levels in the initial state. This numerical scale is of course arbitrary and implies nothing about the intrinsic value of any person or group characteristic.

Consider the range of identity to be given by the plane $[x, y] \in [0, A]$. A particular person's identity is described by the vector $D = [D_x , D_y]$ and the centre of the location of a social group in the same plane is given by $E = [E_x , E_y]$. Let $h(x, y)$ denote the joint distribution of agents in the two-dimensional, wealth - social characteristic space.[10] A person's identity influences her sentiments towards a given group, and the sentiments of the group towards her. There are two elements that influence the sentiment, or the degree of

[9] While continuity of wealth is immediately intuitive, there may be alternative ways to model social characteristics. Continuity here has been assumed for analytical convenience and as a way to generalize the notion of diversity in social characteristics. In some cases, such as where the sole critical social characteristic is gender, or when the society exhibits sharply delineated religious groups, a special case of discrete social categories may be more applicable. In other scenarios however, continuity would be distinctly more appropriate than a discrete treatment, for example when skin color as a social characteristic is considered in a society such as Brazil (see Telles 2002).

[10] Two simplifications are undertaken here. Firstly, the group in the initial state is solely defined by its central point E. One may extend this to determine the initial total group composition, but given the way that initial group characteristics play a role in the framework, group composition beyond its central point is unlikely to influence our results importantly. Secondly, in this initial condition, the location of the group's centre is set exogenously, and we will consider in Section 3 the implications of different initial population distributions in x-y-space holding initial group locations constant. A more complex modeling strategy would make initial group composition and location dependent on initial population distribution, but the simpler approach here ultimately permits isolating the effect of central interest in this paper, namely that of varying socio-economic polarization in the initial state on subsequent economic inequality, for a given initial social group constellation.

'alienation' toward a given group. The first is the social distance between the individual and the group. The second is the strength of group- and self-identification, *i.e.* the extent to which existing members of the social group and the individual feel strongly about their respective identities. We will use these components to define a concept of social alienation. Someone whose characteristics make her very different from the group, who is strongly identified with her characteristics, and who faces a group that has a strong sense of its identity, is considered to be highly alienated from the group in question.

Formally, we define the degree of effective social alienation between an individual with characteristics D and a group with characteristics E as:

$$T(E,D) = t(\phi(E,D) \cdot J(E,D)), \tag{3}$$

where $\phi(E,D)$ measures social distance, $J(E,D)$ measures the strength of individual and group identities, and $t(\,)$ is a monotonic function which normalizes the alienation function to range from 0 (not at all alienated) to 1 (most alienated).[11] Social distance between the individual and the group is simply defined as the norm of the vector of attributes of the social group's centre, E, and of the individual, D:

$$\phi(E,D) = \| E - D \| \equiv \sqrt{(E_x - D_x)^2 + (E_y - D_y)^2} \tag{4}$$

Following Esteban and Ray (1994), we posit that the strength of an individual's self-identification depends on how many other people are like her. If there are only a handful of people like the individual, then her "peer group" will not be comprised of the critical mass of

[11] Specifically, $t(\,)$ increases linearly in its argument, and reaches the level of 1 at the highest alienation level toward the high group in the case of a bipolar distribution (see the appendix for formal expression of $t(\,)$, and Section 3 for a detailed treatment of unimodal and bimodal distributions). For all higher levels of the "raw" alienation $\phi(E,D)\cdot J(E,D)$, $t(\,)$ remains equal to 1. The rationale behind employing such a "kinked" normalization function for $T(E,D)$ – as opposed to the linear alternative in which the highest overall alienation is set to 1 – is to consider scenarios in which for those who are very alienated toward the high group, $T(E^{hi}, D)$ is indeed close to 1, which results in identity constituting a formidable barrier to effectively deriving intrinsic and material benefits from this high group.

people necessary to develop a strong identity. Intuitively, strong identification requires the existence of group-related institutions that give members a forum in which to interact with each other and build a strong sense of group identity. With economies of scale in group institutions, a significant presence of a particular category of the population must exist for identity-forming institutions relating to this category to emerge.[12]

Formally, we define the component identification function in (3) as

$$J(E,D) = \omega J(E) + (1-\omega) J(D), \tag{5}$$

where $J(E)$ measures the strength of the group's identity, $J(D)$ measures the same for the individual, and $\omega \in (0, 1)$ signifies the weight placed on the group's identification relative to that of the individual. Setting $\omega = 0$ would say that alienation and uncomfortable social relationships result when the individual's identification with her own socio-economic characteristics is very pronounced, and therefore feels that she is not being true to herself when socializing with the group. The converse case ($\omega = 1$) would say that the alienation and discomfort are a result of a strongly self-identified group making the individual feel uncomfortably different, unwanted and ill-fitting. In later empirical analysis we will attempt to capture both forces by specifying an intermediate value of ω.

Finally, the identity functions in (5) are defined as

$$J(i) = \int\int h(x,y)\ \pi(x,y,i_x,i_y)\ dx\ dy\ ,$$

for $i = E, D$, and where $\pi(z, i)$ is a weight function that places greatest weight on density that is close to the group's central characteristics (or close to the individual's characteristics) and

[12] Theoretical and empirical work has established such a relationship between identity and population mass. For example, Bodenhorn (2003) finds that antebellum light-skinned African Americans were more likely to identify as "mulatto" (as opposed to identifying as "Blacks") when there were already a substantial number (in absolute and relative terms) of other mulattos in the community. Yinger (1986) shows that individuals are more likely to adopt a racial identity the larger and the more racially concentrated it is.

increasingly smaller weight on identities that are further away. We will use the tricube functional form to represent the weight function:[13]

$$\pi(x,y,i_x,i_y)=\pi(z,i) \;=\; I[||z-i||<\varepsilon_i]\cdot\left[1-\left(\frac{||z-i||}{\varepsilon_i}\right)^3\right]^3;$$

where ε_i is a constant. *J(D)* thus straightforwardly measures the strength of the individual's identity based on how many people are like her. The group identification function, *J(E),* measures the weighted density of people who form the core of the group, *i.e*. those within a radius ε_E of the group's centre. For the analysis here we will take ε_E as an exogenous given that reflects the group's past history or reputation. An obvious extension of the model would be to dynamically update or otherwise endogenize the group's central location and core. It is important to stress that ε does not signify the borders of group membership, but rather what can be deemed its core around the centre.

The Instrumental Value of Social Capital as Social Collateral

Social relationships are not only intrinsically valuable, as expressed in (1), but can also be economically valuable, especially where imperfect or missing markets prevail and where information is costly. The economic value of social ties can take on many forms. For example, an individual may obtain information about business or employment opportunities from those with whom she shares social relationships.[14] Alternatively, she may be provided a loan for entrepreneurial activity, which can be a vital source of financial capital especially in

[13] As Cleveland (1979) shows, the general tricube weight function $(1-u^3)^3$ has the desirable properties that it takes on the value of *1* for $u=0$, equals zero for $u=1$, is monotonic in u, has smooth contact with zero at $u=1$. Therefore, despite the use of the indicator variable $I(||z-D||<\varepsilon)$, the weight function is everywhere differentiable.

[14] In their analysis of traders in Madagascar, Fafchamps and Minten (1999, 2002) give many concrete examples of the types of business advantage that can be leveraged through social capital.

settings in which formal financial markets are poorly functioning. The individual may also obtain the benefit of labor assistance on her farm or in her business from others in the same social group. This paper does not specifically focus on any of these forms of benefits. Rather, it proposes a general framework in which the determinants of economic gain through the accumulation of social capital can be examined.

We then consider an individual who, in addition to directly enjoying social relationships, can also garner material benefits *B* from the social group to which she belongs that help her achieve a higher rate of return on her inherited resources. We assume that benefits are received in the first period and that the size of the benefits an individual can obtain depends on the resources of the group. Holding other things constant — such as the strength of the social ties that an individual has built up with others in a given group — an individual is potentially able to extract greater material benefits from a social network with on average wealthy members, than from a network consisting of poor people. Letting $\overline{B}(E)$ denote the maximum capacity for some given group to provide benefits to an individual, we capture this by the constraint $B \leq \overline{B}(E)$.[15] These benefits, be they information about employment or business opportunities, access to local public goods, etc. produce returns on initial wealth D_y in the second period, where the rate of return *r(B)* is increasing in *B* at a diminishing rate.

If the social group is to sustainably provide such services, beneficiaries need to reciprocate in some form. Following one of the above examples, this may mean that that someone, having increased her profits using valuable price or demand information from

[15] For simplicity, we focus on the case where *B* is a non-rival good. That is, the size of *B* received by one individual does not depend on the amount of *B* that other group members receive. A model with *B* as a rival good would require a general equilibrium treatment in which $B_j^* = B_j^*(\sum_{j' \neq j} B_{j'}^*)$ for person *j*.

others in her social circle, faces the social obligation to in turn instruct other members on how to take advantage of new opportunities in her area of business. Whatever the particular forms of reciprocation, however, their common element is that reciprocation is costly. To capture this, we assume that a group expects an individual to commit some of her time to efforts that generate benefits for others in the social group, where this time commitment is proportional to the benefits she herself received. We define this expected level of reciprocation as $l_B B$ time units. We assume that reciprocation occurs in the second period.

However, because we take this reciprocal obligation not to be contractually or legally enforceable, the group faces a commitment problem in terms of the individual's willingness to reciprocate after the receipt of social benefits. Using the utility function (1), the net gain an individual would experience by reneging on her obligation to reciprocate after receiving B units of social benefits would be:

$$[u(Lw + r(B)D_y, S_2)] - [u((L - l_B B)w + r(B)D_y, S_2)], \tag{6}$$

where $S_2 = [1 - \delta + (1 - T(E,D))L_{s1}]S_1$, and L_{s1} is the time that was devoted to social relationships in period 1. Expression (6) is obviously strictly greater than zero, indicating that a person is better off reneging on her social obligations.

While there are various ways in which this commitment problem might be solved,[16] here we explore the idea that the fact that social capital investment is sunk and intrinsically valuable to the individual gives it a potential collateral value that might solve this commitment problem. In particular, suppose the group adopts a rule that anyone who fails to reciprocate is socially shunned and their stock of sunk, achieved social capital is destroyed

[16] For example, Coate and Ravallion (1993) explore the penalty of termination of future co-operation in a repeated-game model of informal mutual insurance. Ghosh and Ray (1996) show how co-operation can prevail in equilibrium in a setting in which players, of which there are different types distinguished by their time preferences, are randomly matched in stage games.

(i.e., their second period social capital reverts to depreciated inherited social capital, $(1-\delta)S_1$. In this case, the utility comparison of a reciprocator versus a reneger becomes:

$$[u(Lw + r(B)D_y, (1-\delta)S_1)] - [u((L - l_B B)w + r(B)D_y, (1-\delta+(1-T(E,D))L_{s1})S_1)] \qquad (6')$$

Whether or not this expression is positive of course depends on the size of the penalty imposed, *i.e.,* the value of the lost social capital. A deeply alienated individual will feel little regret (indeed, perhaps relief—see note 3) at being shunned by a group that was uncomfortable with her and with which she was uncomfortable. If *T(E,D)* is large, then the penalty of social exclusion is necessarily low.

For a given individual with characteristics *D* and a group with characteristic vector *E*, expression (6′) implicitly defines an incentive compatible benefit schedule, $B^{IC}(L_{s1}|E, D)$ as the amount of benefit that just keeps (6′) non-positive. Benefits extended to the individual in excess of the schedule would not be reciprocated, while those less than the schedule would be. If we assume that utility is strongly separable in its arguments and that the marginal utility of material goods is linear, the two-period utility function given in (1) becomes:

$$a\, c_1 + v(S_1) + \beta \cdot (\, a\, c_2 + v(S_2)\,)$$

where $a>0,\ v'(.)>0,\ v''(.)<0$. Using this expression, the incentive compatibility condition becomes:

$$a\,[(L - l_B B)\, w + r(B)D_y] + v((1-\delta+(1-T(E,D))\, L_{s1}\,)\, S_1\,) \geq$$

$$\geq a\,[L\, w + r(B)D_y] + v((1-\delta)\, S_1) \qquad (7)$$

Under these assumptions, the incentive compatible benefit schedule becomes:

$$B^{IC}(L_{s1} \mid D, E) = \frac{1}{awl_B}\left[v(S_2) - v((1-\delta)S_1)\right], \qquad (8)$$

where as before $S_2 = [1-\delta+(1-T(E,D))L_s]\ S_1$.

The IC schedule (8) reveals how the instrumental value of social capital — the economic gain it enables — and its intrinsic value are linked. B^{IC} is determined by the excess direct utility one obtains by not being socially excluded, discounted by the cost of reciprocation for each unit of B. It is also apparent that the supply of benefits is not exogenous from the individual's point of view, but that she affects it by her decision on how much time to invest in the group.

We are now in a position to formulate the full choice-theoretic model of social capital formation for an individual facing a given social group:

$$
\begin{aligned}
&V(E,D) \equiv \max_{L_{s1}, L_{wt}, B} [u(c_1, S_1) + \beta\, u(c_2, S_2)] \\
&\textit{subject to}: \\
&L_{x1} + L_{w1} = L; \\
&c_1 = L_{w1} w; \\
&S_2 = (1+\widetilde{\delta}) S_1; \\
&c_2 = L_{w2} w + r(B) D_y; \\
&L_{w2} = L - l_B B; \\
&B \le \overline{B}(E); \\
&B \le B^{IC}(L_{s1} \mid E, D).
\end{aligned}
\tag{9}
$$

It is of course possible that neither the incentive compatibility constraint, nor the group's capacity constraint will bind if, given the individual's initial wealth, the optimal material benefit to her is smaller than what the group can offer her and smaller than the largest benefit size she would be willing not to renege on.

In this framework, friendship serves in a sense as social collateral for the benefit made available to the group member.[17] The notion of social collateral has commonalities with more familiar forms of physical/economic collateral, but it is also distinct in some ways.

[17] In the context of credit, Besley and Coate (1995) analyze social collateral by modeling social sanctions as a cost that other group members can impose on a defaulter, but the ability of the group to sanction is taken as exogenous in their game-theoretic framework.

Just like traditional collateral for a loan (such as land or physical assets), it can be taken away in the event of default, and the borrower is thus made worse off. Also, a social collateral requirement can be insufficiently large, in which case the individual may be denied the economic benefits of being part of a group.

However, a significant difference between social and economic collateral is the former's specificity: The particular social network is valuable to an individual in the network, but it is not a good that can be easily transferred to someone outside of the group and that can be found immediately valuable by the outsider.[18] A second difference is that social collateral is not of direct value to the group and does not, unlike economic collateral, provide economic redress to it in the event of member defection. Indeed, if the group is sufficiently small, it might actually bear a *cost* from excluding one of its members, in the sense of suffering a thinned out social network.[19] Hence the only value of social collateral to the group is its ability to create appropriate incentives for the individual member by imposing costs of deviation on her.

A number of comparative-static results on the individual's equilibrium choice of time allocation between work and fostering social ties can be derived from this model. Insights from these include the finding that, in considering how social investment varies with the group's resources, the limitation on group benefits imposed by imperfect enforcement inherent in the social collateral mechanism interacts with the limitation imposed by the group's resource constraint to effect nonlinearities in equilibrium social investment. For very poorly and very highly endowed groups, a marginal relaxation of the resource constraint does

[18] This conception of social capital as idiosyncratic (or network-specific) collateral finds its analogue in firm-specific human capital (Hashimoto 1981, Laing 1994) in which training or education is of value to the specific firm that provided for this training, but of little to no value to other firms.

[19] This paper does not incorporate in the model the group size, nor the impact of individuals' social investment decisions on the group. This is an interesting area for future research.

not change equilibrium social investment in such groups. Social investment increases in the group's resources only for moderately-endowed groups. Also, the scope of group membership for each of two groups (a poor and a rich one) can be derived. For a given population distribution, by establishing the threshold degree of alienation T that will result in an individual optimally choosing zero social investment, one can draw the boundaries of group memberships for the two groups. Not surprisingly, group membership with the more poorly endowed group is equal to or smaller than that with the wealthier group, and for sufficiently large differentiation between the two groups' resources, the former is significantly smaller. For more details, see Mogues (in progress).

3. Socio-economic polarization

The prior section has modeled how identity-sensitive individuals invest in social capital and form social relationships in a world in which relationships are costly to develop and have both intrinsic and instrumental economic value. At the heart of the model is a concept of alienation that makes individuals sensitive to the social distance between themselves and others and to the overall distribution of individuals in socio-economic space (that is, it matters if there are many other similar people to reinforce individual identities). This vision of social capital and identity opens the way to exploration of how the joint distribution of individuals across the space of wealth and skin color[20] shapes the creation of social capital and ultimately the distribution of income. As a foundation for that exploration, the goal of this section is to develop a way to meaningfully typify that joint distribution and establish distinctive benchmark distributions that can be used for the numerical analysis of the model in section 4.

[20] Recall that our discussion uses skin color as an example of a personal characteristic that society and its members see as relevant for an individual's identity.

A Measure of Socio-economic Polarization

This section develops a two-dimensional measure of socio-economic polarization based on Esteban and Ray's (1994) one-dimensional measure of economic polarization. Esteban and Ray contrast their measure with conventional income inequality measures. Intuitively, a society is highly polarized with respect to some characteristic *D* when the distribution of *D* is such that the population is grouped into a few, significantly-sized clusters, where people in each cluster are very similar to each other in terms of their characteristic *D* and are very different from people in other clusters. As they show, economic polarization may increase even as income inequality decreases (the two may of course also move together in some circumstances). Underlying their analysis is the contention that it is high polarization (not inequality *per se*) that creates the potential for costly social conflict. From this perspective, analysis of the economic costs of inequality (e.g. Alesina and Rodrik, 1994) would be better cast as analysis of the economic costs of polarization.

From the perspective of this paper, two modifications of the Esteban and Ray polarization measure are needed. First, the Esteban and Ray measure implicitly adopts a materialist or Marxian posture in that it presumes that only economic class shapes identity and polarization. And yet as the work of Frances Stewart (2001) and others suggest, the potential for destructive social conflict (and self-replicating inequality) is highest when economic class is somehow related to other characteristics relevant to identity, such as ethnicity or language. Accordingly we extend the Esteban and Ray measure to the case where each individual has two characteristics relevant to identity and polarization. The second

modification of the Esteban and Ray measure is simply its adaptation to the case of continuous distributions, a change we make purely for purposes of analytical convenience.

Making these changes, we define two-dimensional socio-economic polarization (P_2) as:

$$P_2 = \iint_{z^1} \iint_{z^2} h(z^1)\ J(z^1)\ h(z^2)\ \phi(z^1, z^2)\quad dz^2 dz^1 \tag{10}$$

where as in Section 2 above, $z = [x, y]$ (so that (10) integrates over four variables: social characteristics and initial wealth of persons 1 and 2), x is inherited wealth and y is a characteristic like skin color or ethnicity that society treats as relevant for social identity; $h(.)$ is the population distribution; $J(z^j)$ the identification function for person z^j; and $\phi(.)$ the social distance function. Analogous to Esteban and Ray's measure, (10) is the sum of all effective alienations in the society. Mogues (in progress) presents a more formal treatment of the socio-economic polarization measure, P_2, and its properties.

Like the Esteban and Ray polarization measure, the intuition behind P_2 is that increased socio-economic polarization (which may or may not correspond to changes in economic inequality, or to one dimensional economic polarization for that matter) may have real economic effects. The model developed in the prior section proposes a specific mechanism through which polarization operates. Higher levels of P_2 will signal a society in which individuals will find it increasingly costly to form social relationships and reap their intrinsic and instrumental benefits. Intuitively, we anticipate that a given level of initial wealth inequality will become economically more significant as it becomes socially embedded, meaning that the social characteristic of ethnicity or language becomes an increasingly good predictor of wealth.

Benchmark Distributions of Polarized and Non-polarized Societies

To explore this intuition and study the impact of socially embedded inequality, we need an analytical strategy in which we can isolate and hold constant the degree of initial economic inequality and one-dimensional economic polarization. As first step, define the marginal truncated normal distribution of initial wealth, y, as:

$$h(y) \sim \begin{cases} N(\mu,\sigma^2) \ \ for \ \ y \in [0,2\mu] \\ 0, \ otherwise \end{cases} \tag{11}$$

The solid curve in Figure 1 graphs this distribution for the parameters that will be used in the numerical analysis, $\mu=5$ and $\sigma^2=2$. As can be seen, the parameters have been chosen so that the marginal distribution is nearly normal (that is, the truncation is trivial). The Gini coefficient implied by this initial wealth distribution is 0.15 (and the one-dimensional

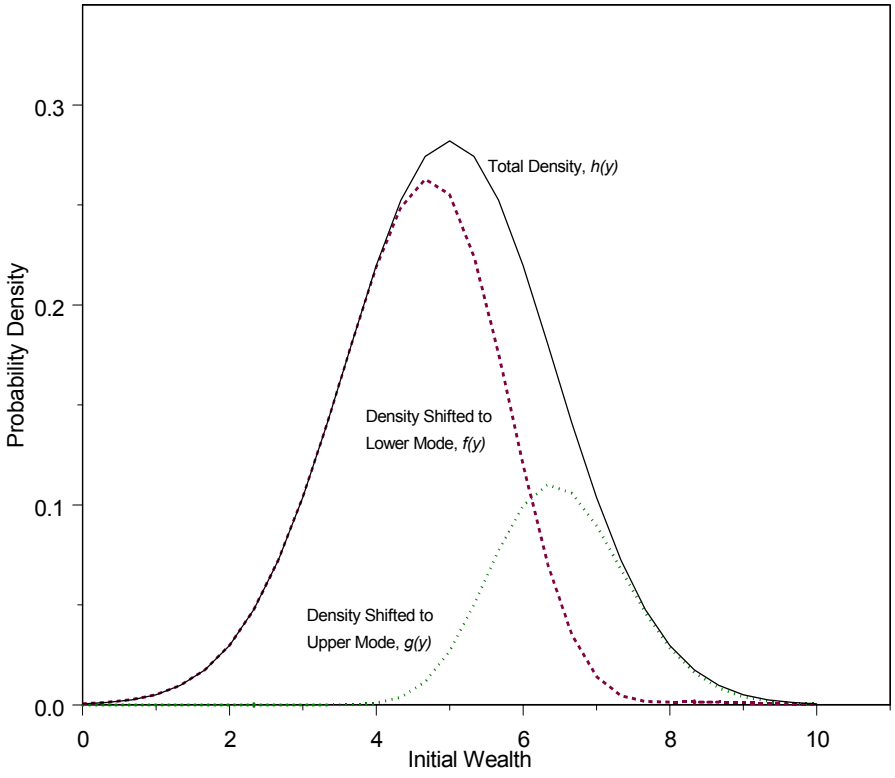

Figure 1. Marginal Distribution of Initial Wealth

economic polarization measure of Esteban and Ray is 0.06). These values will be held constant across all the joint distributions considered here.

As a second step, we define a series of joint distributions of wealth and skin color, x, all of which preserve the marginal distribution of initial wealth given by (11). By preserving this marginal wealth distribution, inequality and one-dimensional economic polarization are also held constant for all the joint distributions. Letting ρ denote the correlation between x and y, the family of bivariate normal distributions, defined as

$$h(x,y) \sim \begin{cases} k_{xy,1} N\left(\mu, \mu, \sigma^2, \sigma^2, \rho\right) \text{ for } x, y \in [0, 2\mu] \\ 0, \text{otherwise} \end{cases} \tag{12}$$

where $k_{xy,1}$ normalizes the distribution so that the area under it in the plane $x,y \in [0,2\mu]$ equals 1, will of course preserve the marginal distribution of initial income, y, given by (11).[21] The northwest panel of Figure 2 displays this joint distribution for the base case of $\rho = 0$. Note that in this case, the social characteristic x is completely uninformative about initial wealth as $E(y \mid x) = E(y)$. The P_2 measure of socio-economic polarization is 36 for this case. Within the bivariate normal distribution family, socio-economic polarization can be increased by increasing ρ, the correlation between initial wealth and the social characteristic. Note that as this correlation increases, skin color becomes an increasingly informative predictor of initial wealth. Figure 2 illustrates the shape of the joint distribution for the cases where ρ equals 0.6 and 0.9. Socio-economic polarization in turn increases to 42 and 55, respectively, as ρ rises.

[21] Note that by defining identical ranges to x and y, (14) assures that both components of identity will receive equal weight in the two-dimensional polarization measure defined by (12).

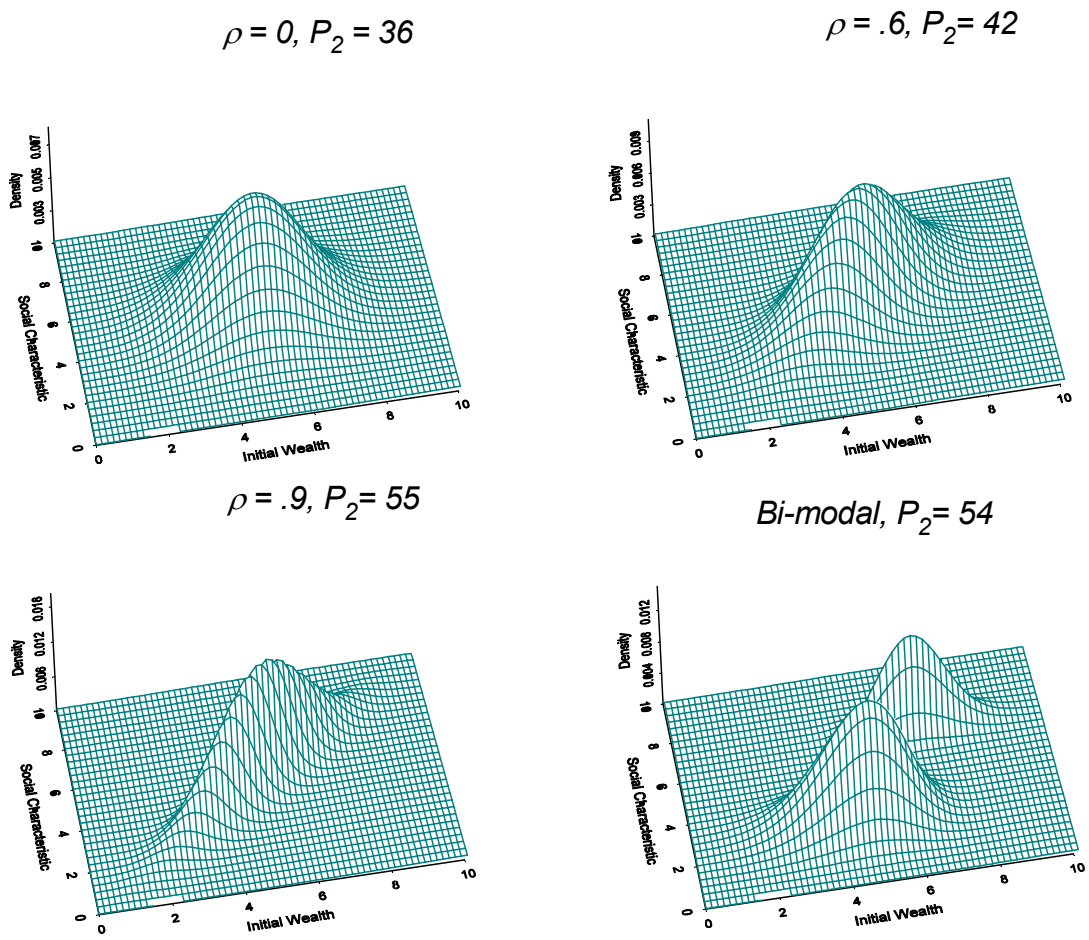

Figure 2. Joint Distributions of Wealth and Social Characteristic

While these three bivariate normal distributions capture a type of increasing socio-economic polarization that is independent of one-dimensional economic and social characteristic polarization,[22] they do not seem to fully capture the sort of multi-modal polarization that is characteristic of societies like Brazil, South Africa and the United States. For exploratory purposes, we define a bi-modal distribution that preserves the marginal distribution of initial wealth through the following procedure. First the normal marginal distribution $h(y)$ is partitioned into two parts: $g(y)$ and $f(y) \equiv h(y)-g(y)$, where $g(y) < h(y) \forall x,y \in [0,2\mu]$ and $E(g(y)) > E(f(y))$. This partition is done numerically using a gamma function

[22] Note that the marginal distributions of both initial wealth and skin color are undisturbed by changes in ρ.

for *g(y)*. The dashed, dotted and solid curves in Figure 1 show *f(y), g(y)* and *h(y),* respectively. These two functions are expanded into two dimensions by multiplying them with a marginal normal distribution over *x*, $h^i(x)$, with means such that $E(h^{hi}(x)) > E(h^{lo}(x))$. The resulting bivariate distribution, normalized so that it has the properties of a density function, is described by:

$$h(x,y) = k_{xy,2}\begin{cases} g(y)\ \ h^{hi}(x),\ \ for\ \ x+y>2\mu;\ \ \ x,y\in[0,2\mu] \\ [h(y)-g(y)]\ \ h^{lo}(x),\ \ for\ \ x+y\le 2\mu;\ \ \ x,y\in[0,2\mu] \\ 0,\ otherwise \end{cases}$$

and is shown in the southeast panel of Figure 2. Socio-economic polarization is 54 for this bi-modal distribution. We turn now to explore the economic implications of these different levels of socio-economic polarization.

4. Numerical analysis of polarization and economic inequality

Using the benchmark distributions shown in Figure 2, this section uses numerical methods to analyze how socio-economic polarization affects the distribution of earned income. The analysis presumes that there are two pre-determined social groups, a group located close to the high mode shown in the bi-modal distribution in Figure 2, and a group located close to the low mode. Under the assumptions of the model laid out in section 2, the wealthier "high" group has more resources and opportunities to potentially offer its members. The poorer "low" group has fewer economic resources to offer but is less distant from many poor households.

While a fuller treatment of the model might ultimately treat group location as endogenous, the analysis here can be taken to represent a world in which group identities and reputations change only slowly in response to the decisions of individuals to join or not join a particular group. In this sense, this is a short run analysis, indicative perhaps of the sort of

processes that characterized post-apartheid South Africa in which individuals became legally free to affiliate with pre-existing social groups that carried with them deeply entrenched social identities based on their past histories. More generally, the analysis here is meant to give initial insights into the ways in which social forces can contribute to the creation of economic inequality.

Table 1 presents the basic results of the numerical analysis. The appendix below reports the exact parameterization of the model. As a baseline for the analysis, we first consider a world of anonymous, equal access perfect markets. In this world, we assume that social relations are of only intrinsic value and that all individuals receive the same rate of return on their wealth. The utility specification used for the numerical analysis (constant marginal utility of income) assures that under these assumptions all individuals will choose equal amounts of work and social time.

As shown in Table 1, the Gini coefficient for income (wage plus interest on inherited wealth) is a modest 0.12 for this perfect markets case. While this figure is low compared to real world Gini coefficients, it is not surprising given the relatively egalitarian distribution of inherited wealth shown in Figure 1 (and the completely egalitarian distribution of labor endowments).

	Initial Conditions		**Economic Outcomes**	
	Inherited Wealth Inequality (Gini)	*Socio-economic Polarization (P_2)*	*Income Inequality (Gini)*	*Terminal Wealth Inequality (Gini)*
Anonymous Equal Access	*0.15*	--	*0.12*	*0.14*
Unimodal				
ρ 0.0	0.15	36	0.18	0.17
0.3	0.15	37	0.20	0.18
0.6	0.15	42	0.23	0.19
0.9	0.15	55	0.27	0.20
Bimodal	0.15	54	0.27	0.20

Table 1. Socio-economic Polarization and Income Inequality

As soon as we move away from the equal access world, social relationships take on an instrumental economic value. Even assuming the relatively modest socio-economic polarization of a joint normal distribution when inherited wealth and ethnicity are uncorrelated ($\rho=0$), the Gini coefficient for earned income (labor plus capital income) increases from 0.12 to 0.18. The Gini coefficient for final wealth (initial wealth plus income) rises from 0.14 to 0.17.

As Table 1 shows, further polarization of the joint distribution of wealth and color leads to ever higher Gini coefficients, with the Gini coefficient for the income distribution rising to as much as 0.27 for the most polarized distributions. Note that this level of economic inequality is more than two times the inequality level under the equal access, perfect markets counterfactual.

Figure 3 presents further results from the model that help to explain the forces that generate this relationship between polarization and inequality. Both panels of the figure display the space of initial wealth and skin color. The dotted concentric lines mark the contours for the population distributions, with the top panel displaying the contours for the joint normal distribution ($\rho=0$), while the bottom panel displays the contours for the bi-modal distribution. The marginal distribution of initial wealth (which would be obtained by integrating out ethnicity) is the same for both distributions, as explained earlier.

Two other pieces of information are displayed in the Figure 3 graphs. First, the thick gray contour line represents the boundary between those who join the high group, and those who join the low group. Endowment locations to the east of this boundary are those where

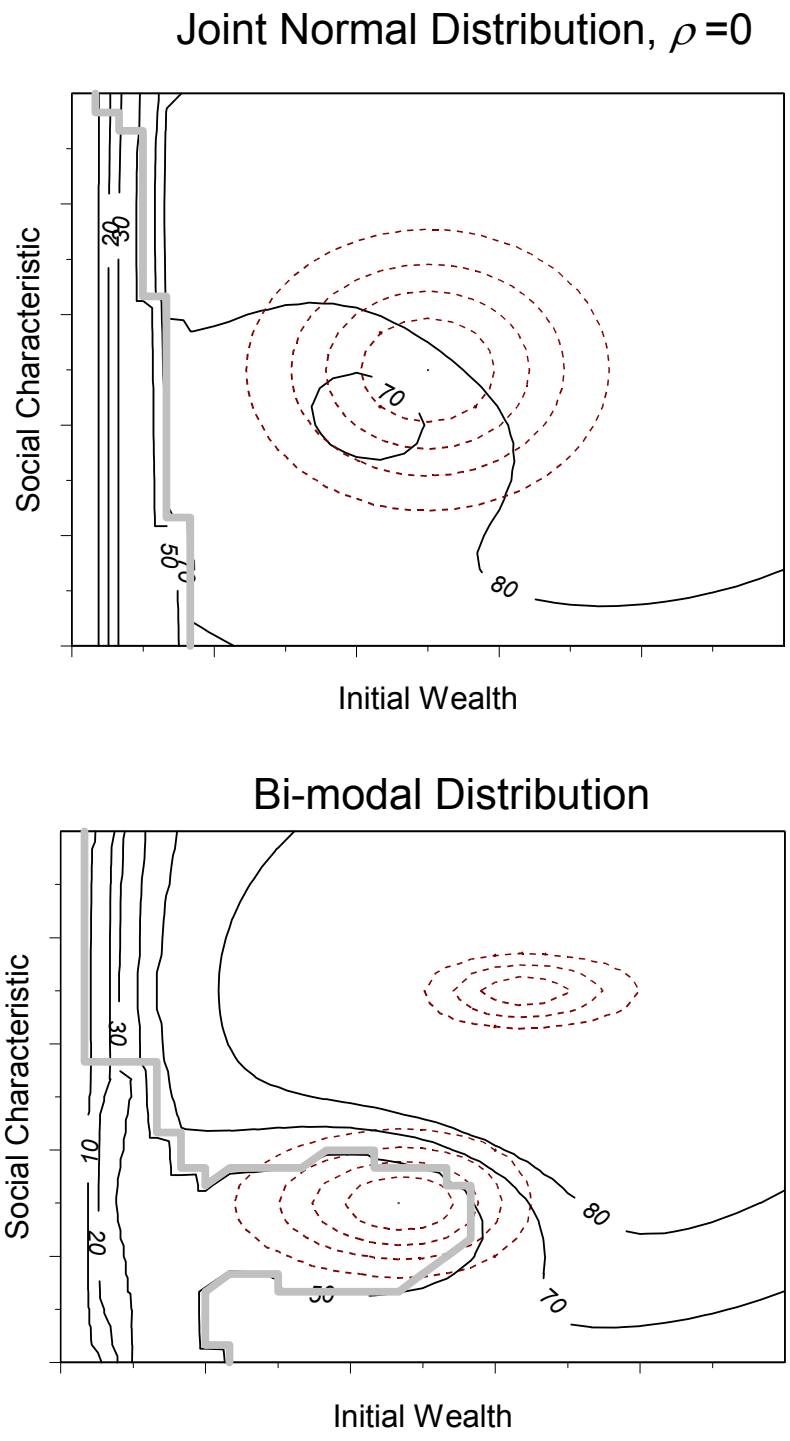

Figure 3. Group Memberships and Rates of Return on Wealth

individuals find it optimal to join the high group, while to the west of the boundary, individuals optimally join the so-called low group.[23]

The other piece of information contained in Figure 3 are contours for the realized rate of return on wealth. As can be seen in the top panel, under a joint normal distribution with $\rho=0$, individuals located just to the northeast of the mode of the population distribution earn a rate of 80% (or higher) on their wealth. Individuals located in the densely populated area just to the southwest of that mode still earn returns in excess of 70% on their inherited wealth. These high rates of return reflect the fact that nearly all individuals in this low polarization world choose to join the high group (all but 0.2% of individuals join the high group in this world). While this creates fairly even and high rates of return on wealth for all, agents that are more distant and alienated from the high group have to sacrifice more work time in order to establish their incentive compatibility. The net result is the rather sharp rise in income inequality compared to the perfect markets case shown in Table 1.

The lower panel in Figure 3 displays the sharply different behavior that occurs when the socio-economic polarization rises under the assumption of a bi-modal distribution of initial wealth and ethnicity. A large portion of the wealth-ethnicity space is now comprised of locations where individuals find it optimal to join the low group. Under this distribution, 58% of individuals join the high group, while the remaining 42% join the low group. The income distribution consequences of these choices are as would be expected. Those that join the upper group—which are now predominately wealthy people—continue to earn high rates of return on inherited wealth. With higher degrees of effective alienation, individuals near the lower mode no longer find it worth joining the upper group, despite its potential advantages.

[23] At endowment locations right at the western edge of the graph, individuals would not join either group. Since these locations are sparsely populated under both distributional assumptions, we ignore them to avoid cluttering the graph.

The net result is that these individuals join the low group, reaping some direct social benefits, but only modest economic benefits. Compared to the less polarized situations with the same initial wealth inequality, the society itself has become increasingly unequal through the operation of these individually optimal choices. The Gini coefficient for income is nearly two and a half times higher than it would be in the perfect markets case, and 50% higher than it was in the uncorrelated, unimodal case. In addition, ex post socio-economic polarization as measured by P_2 is 50% higher in the bi-modal case as compared to the unimodal ($\rho=0$) case. Matching the insights of Stewart and Figueroa discussed earlier, we see that social forces tend to make economic inequality more durable when it is socially embedded, even controlling for the initial levels of economic polarization and inequality.

4. Conclusions

This paper proposed a model of social capital as a collateralizable asset. It takes account of features that, while being referred to as important, are not well developed in the existing literature. These include the process of creating and accumulating social capital, and the costs associated with this process; an explicit framework showing what may be particular to the mechanism by which economic goods can be accessed through social relationships, namely the intrinsic value of this form of capital; and the role of identity in individuals' ability to realize economic value from social relationships.

This paper then analyzed the implications of socio-economic polarization for economic inequality in a setting where getting ahead economically depends on one's ability to accumulate and collateralize social capital. Holding constant initial levels of economic inequality, greater subsequent economic inequality results when increased polarization

erodes the ability of those in low-wealth categories to successfully invest in the well-endowed group. Their alienation from the highly endowed group increases as society becomes more polarized, which disproportionately curbs the efficiency with which they can accumulate social capital with this group.

The stylized model of this paper does not do justice to the full complexity of the social factors that perpetuate inequality in actual economies.[24] However, it does provide a theoretical perspective to potentially important forces underlying the reproduction of inequality that have so far hardly been explored by economists. It speaks especially to developing economies in which economic status and social categories like race, skin color or ethnicity are strongly correlated and which can be described as polarized along these dimensions. Empirically, it suggests that analysts interested in the endogenous growth implications of inequality need to consider its broader social embeddedness, a point echoed by Stewart (2001) and Figueroa (2003).

Finally, from a policy perspective, it suggests that there may be critical threshold levels of socio-economic polarization, beyond which decentralized social and economic processes are likely to preserve inequality and perhaps deepen social instability. Social capital in such environments is not the "missing link" for development (as the World Bank 1997 termed it). Instead social capital—or rather economically effective social capital—is simply unattainably missing for some individuals.[25] In such environments, efforts to either deepen the reach of markets, or to pursue affirmative action or wealth transfer policies, would have particular salience.

[24] Expanding the model put forward here to an overlapping generations framework and letting group identity endogenously evolve suggest themselves as natural extensions.
[25] Fine (1999) critiques the concept of social capital in terms that are largely consistent with the model put forward here.

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Appendix: Parameterization of numerical analysis

Initial population distribution and central location of groups:

Wealth-social characteristic space: *[x, y]* $\in$ *[0, A]; A=10;*

Group centre: $E_x^{lo} = E_y^{lo} = 3; E_x^{hi} = E_y^{hi} = 7$.

Distributions: $k_{xy,i} = \int_{x=0}^{A} \int_{y=0}^{A} h(x,y)\, dx\, dy$ for *i = {1,2}*

Unimodal distributions: $\mu_x = \mu_y = 5; \sigma_x^2 = \sigma_y^2 = 2.$

Bimodal distribution: $h(y): y \sim N(\mu_y, \sigma_y^2)$; $h^{hi}(y): y \sim N(E_y^{hi}, {}^{9}/_{50})$;

$h^{lo}(y): y \sim N(E_y^{lo}, {}^{3}/_{5})$; *g(y): y ~ θ gamma( ),* i.e. $g(y) = \theta \frac{\lambda^{\alpha}(x-\gamma)^{\alpha-1} e^{-\lambda(x-\lambda)}}{\int_0^{\infty} u^{\alpha-1} e^{-u}\, du}$,

where $\alpha = 53$, $\lambda = 8$, $\gamma = -{}^{1}/_{10}$, $\theta = ¼$.

Social capital accumulation:

$\delta = {}^{1}/_{20}$; $S_1 = 1$; $L^B = {}^{9}/_{20}$; $B^{max}(W^i) = W^i$; $W^{hi} = 2\,{}^{2}/_{9}$; $W^{lo} = ½$; $\varepsilon_E = \varepsilon_D = 2$; $\omega = ½$.

Alienation: $T(E^i,D) = t(\phi(E^i,D) \cdot J(E^i,D)) = I[\phi(E^i,D) \cdot J(E^i,D) \geq T^{hi}]$

$+ I[\ \phi(E^i,D) \cdot J(E^i,D) < T^{hi}] \cdot \phi(E^i,D) \cdot J(E^i,D) / T^{hi}$ where $T^{hi} = \max_{D_x, D_y} (\phi(E^{hi},D) \cdot J(E^{hi},D))$ in

the bipolar distribution.

Income:

Wage income: $w = {}^{3}/_{5}$; $L = 1$; Rate of return on wealth: $r(B) = M B^{\eta}$ where $M = ½$; $\eta = {}^{7}/_{10}$.

Total income underlying actual and "perfect markets" income Gini measure:

$$Y(D_x, D_y) = c_1^* + c_2^* = L_{w1}^*(D_x, D_y)w + (L - l_B B^*(D_x, D_y))w + r(B^*(D_x, D_y))D_y$$

$$Y^{pm}(D_x, D_y) = 0.8Lw + Lw + r(\overline{\overline{B}})D_y$$

where $\overline{\overline{B}} = \int h(x,y)\ B^*(D_x, D_y)\ dx\ dy$ and *h(x,y)* is the unimodal distribution with $\rho=0.6$.

Utility: $\beta = {}^{19}/_{20}$; $a = {}^{1}/_{10}$; $v(S_t) = b\ S_t^{\ \xi}$ where $b = {}^{2}/_{5}$; $\xi = {}^{1}/_{4}$.