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Social Interactions and Economic Behavior

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Abstract - This paper is a critical introduction to the new wave of economic literature on the effect of social interactions on individual behavior and aggregate economic outcomes. I refer to this research program, also known as new social economics, as the socioeconomic analysis of behavior, to distinguish it from the more popular economic analysis of social behavior. I discuss the main features of so-called interactions-based models, and I show how they help us to understand substantive economic phenomena. In order to restrict the focus, I choose five possible applications: matching in the labor market, welfare participation, poverty traps and inequality, investor behavior, and consumer behavior. Then I dwell upon two key undecided questions: (i) why economic behavior is affected by social interactions, and (ii) how the social context is shaped by rational individuals. Finally, I briefly discuss the main empirical routes so far used.

JEL Classification Codes: D10, D85, Z13, Z19

Keywords: new social economics, social interactions, neighborhood effects, social networks, social norms, social multiplier.

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Economists study the actions of individuals, but study them in relation to social rather than individual life (Marshall, 1949, p. 25)

-Alfred Marshall, *Principles of Economics*, 1890

1 Introduction

Social scientists are familiar with the *economic analysis of social behavior*, i.e. the application of standard microeconomic analysis to phenomena which are not, directly, economic phenomena, such as mating, divorce, sexual behavior, crime, and addiction. Such an application is a natural consequence of the evolution of neoclassical economics: once a theory of human behavior is built, there is no reason why it should remain confined to a particular domain of human action. A different enterprise is the *socioeconomic analysis of behavior*, i.e. the consideration of both individual incentives and social interactions as determinants of individual behavior. I group under this label research referred to as new social economics, and social interactions economics (see Durlauf and Young, 2001). By social interactions I am referring to direct interdependencies, not mediated by markets and enforceable contracts, between individual decisions and the decisions and characteristics of others within a common sociological group (Brock and Durlauf, 2001a and 2003). In this sense this kind of analysis is both economic and social. Sometimes the more popular expression "neighborhood effects" is used, but the geographic meaning of such an expression may be misleading. Indeed, what matters in social interactions models is the existence of a "social metric space", i.e. a set of individuals and a social distance function (see Akerlof, 1997). In order to appreciate the difference between economic and socioeconomic analysis of behavior, one can contrast two different explanations of the sharp increase in out-of-wedlock childbearing in the US and Europe after the early 1960s. Willis (1999) explains such phenomenon in terms of pure economic forces: the increase in female labor force participation, and the rise in female-male income ratio shifted the marriage market equilibrium into a state where men optimally free ride on women in the upbringing of children, which causes the out-of-wedlock rate to raise. On the contrary, Crane (1991), who refers to teenage childbearing, explains such phenomenon through a theory of peer influences: when individuals, because of sociological forces, are affected by others' choices, particular behaviors can spread like an epidemics. Beyond a critical threshold the epidemics explode, and the incidence of such behaviors shifts from a low- to a high-frequency equilibrium. Both explanations are consistent with aggregate data, but they have different comparative statics properties, and different policy implications. If Willis' explanation is correct, then a shock that hits a particular subset of women when the labor market is stationary should have no aggregate effects beyond the sum of individual responses in the subset. But this is not true if the underlying process is an epidemic one. Therefore, the out-of-wedlock rate can be reduced in the first case through any tax scheme that reduces men's gains from free riding. Furthermore, the tax scheme should be permanent. In the second case, such a tax may be ineffective, and a policy maker whose goal is to reduce out-of-wedlock childbearing should organize large and widespread interventions, e.g. information campaigns, so to push the system into a desirable and stable equilibrium. At that point, the intervention can be ceased. Of course the two explanations are not mutually exclusive, but there is an important difference. While the economic analysis of social behavior enlarges the domain of economics, the socioeconomic analysis deepens its foundations, since it draws from sociology, social psychology, evolutionary biology and political sciences. As such the two programs set complementary research agendas, but the latter is still in its infancy. Although neither of the two requires any substantial departure from the neoclassical paradigm, studying the effects of social influences on economic behavior raises several theoretical and econometric issues. The goal of this paper is to offer a synthetic, accessible, and critical introduction to the socioeconomic analysis of behavior, and to show how it helps us to understand substantive economic phenomena. Several surveys of the contributions to this large research area have already been written. Among these are Kirman (1997), Durlauf (2003b), Jackson (2003), and Verbrugge (2003). In order to avoid duplications, I will work out issues which are complementary to those these authors have already discussed. After a sketch of the evolution of the role of social interactions in economics (section 2), I present and discuss the main features (section 3) and economic applications (section 4) of so-called interactions-based models. Then I focus on two specular, and unresolved, questions: (*i*) why social interactions should affect economic behavior (section 5)? And (*ii*) can economic behavior affect the kind of social interactions one experiences (section 6)? Finally, I discuss the main econometric issues involved in the empirical analysis of social interactions, and the main solutions so far implemented (section 7).

2 Economic and social interactions

One of the main goals of microeconomics, for a long time identified with general equilibrium theory, is to account for one of the most fascinating hypothesis in social theory, namely Adam Smith's "invisible hand" conjecture. Essentially, this is a conjecture about the social optimality of a system of competitive markets when individuals are self-interested. Theoretical efforts to account rigorously for such an hypothesis, culminated in the proof that a general economic equilibrium exists, first by Abraham Wald and then by Arrow and Debreu, and in the two fundamental theorems of welfare economics. Choices had to be made about the kind of interactions between agents that are relevant for market outcomes. Since the question concerns markets, and for the sake of mathematical tractability, it was a natural working hypothesis to assume that only market interactions, i.e. those mediated by prices and enforceable contracts, matter. However, as one expands the set of plausible interactions that are relevant for market outcomes, the optimality result of the first fundamental theorem doesn't hold in general: a competitive equilibrium is not necessarily Pareto optimal. The reason is that social interactions, being a form of non-market interdependence, generate externalities. Furthermore, in presence of social effects, the traditional micro-macro relationship breaks down: for given micro characteristics multiple aggregate equilibria are possible, and we cannot recover the former from the observed macro equilibrium. This was first pointed out in a pioneering paper by Föllmer (1974), who built on previous work by Hildenbrand (1971). Hildenbrand allowed for random preferences and random endowments in a general equilibrium model, and showed that, by some law of large numbers, a unique equilibrium vector of prices still exists in the limit. Föllmer added non-market interactions to randomness, allowing for interdependent preferences and interdependent constraints across individuals. The result was that the law of large numbers breaks down when interactions are sufficiently wide-range and strong enough. In this case the microeconomic characteristics of the economy no longer determine univocally the macroeconomic outcome. Thomas Schelling (1971, 1978) had already shown that when individual preferences have a social component, unexpected aggregate results are possible. For instance, in his celebrated segregation model, Schelling (1971) showed that if people have no preference for segregation, but they want to be within a certain distance from certain other individuals, then the very segregated state is an equilibrium. Clearly, from such a macro outcome, one cannot recover the individual motives that generated it. Such results were suggestive of the possible importance of social interactions in macroeconomics. However, this couldn't be a very compelling research direction at a time when the problem of the microfoundations of macroeconomics was still in its infancy. At present, much of the research on social interactions in economics is motivated, beyond its pure theoretical glamour, by the belief that social effects on individual behavior are empirically relevant, and have important macroeconomic consequences that haven't received adequate attention so far. In this sense, Loury (1998), among others, has vividly expressed the importance of non-market interactions, stressing that

> each individual is socially situated, and one's location within the network of social affiliations substantially affects one's access to various resources. Opportunity travels along the synapses of these social networks. Thus, a newborn is severely handicapped if its parents are relatively uniterested in (or incapable of) fostering the youngster's intellectual development in the first years of life. A talented adolescent whose social peer group disdains the activities that must be undertaken for that talent to flourish is at risk of not achieving full potential. An unemployed person without friends or relatives in a certain industry may never hear about the job opportunities available there. An individual's inherited social situation plays a major role in determining ultimate economic success. (Loury, 1998, p. 119)

The revival of such awareness has brought several economists closer to the boundary between different social sciences, where complementary explanations of individual behavior can be fruitfully integrated. Such integration, as opposed to mere export of economic analysis, is a fascinating intellectual challenge for social scientists. An important step towards this goal is the introduction into economics of concepts which constitute the traditional domain of sociology and social psychology. Some of these concepts, social capital is a prominent example, have little operational and empirical content. This is the main reason why many economists are skeptical: as long as new concepts are not sharply and operationally defined, they are not useful for analytical purposes, and as long as they are not empirically verifiable, they add little to our knowledge (see Manski, 2000, for a more structured critique). One may dislike this extreme positivist conception of the social sciences, but such skepticism has a strong argument. For this reason, several researchers in new social economics are devoting a lot of effort to the development of suitable theoretical tools and empirical strategies. The next section deals with the former, while a synthesis of the latter is put off till the end of the paper.

3 Interactions-based models

The general premise of an economic theory of social interactions, is that the economic and the sociological perspectives both capture something important about the way individuals behave. In a famous paper, Granovetter (1985) argued against two extremes, namely the under- and the over-socialized conceptions of individual behavior. Granovetter envisaged a solution to this dilemma in the so-called "embeddedness approach", based on the idea that people make purposeful choices, but the process of choice is embedded into social relations, rather than being atomized. In the economist's jargon, this is tantamount to say that individual utility has a private and a social component. Indeed, this is the main feature of the new generation of interactions-based models of individual behavior. As such, they are related to the research program advocated, among others, by James Coleman (1988 and 1990), namely taking the rational choice paradigm as a starting point, and then introducing social structure into it. A convenient way to absorb the realm of social interactions into an economic model, i.e. to give operational content to the definition given in section 1, is to allow individual preferences, constraints and expectations to influence each other within a reference group (Manski, 2000). These concepts need no explanation, except perhaps the notion of reference group, originated by social psychologist Herbert Hyman in 1942 (see Hyman, 1960). Hyman defined a reference group "a social framework for comparison" (p. 384). For our purposes, we can define an individual's reference group, with respect to some individual choice $\omega \in \Omega$, as the set of agents with whom the individual interacts, in the sense defined above, when choosing ω. Therefore, if when choosing an element of Ω individual i's preferences, constraints, or expectations are influenced by the preferences, constraints or expectations of individual j, then j belongs to i's reference group. Following Manski (2000), I will refer mainly to the special case in which such influence is mediated by j's choice, or expected choice. This is not an excessive restriction, as long as j's choice is determined by her preferences, constraints, and expectations. As a matter of terminology, it is important to keep in mind that Manski defines preferences over behaviors rather than over outcomes. As a consequence, preferences are always endogenous in interactive contexts. At the other extreme, if one defines preferences over the set of outcomes, where each element is contingent to what others are choosing, then preferences are never endogenous, rather incentives are.

The difference between a conventional and an interactions-based model, can be represented as follows. The conventional economic model assumes that agents have a principle of behavior in the optimization of an objective function, u. Restricting to individuals, this function represents preferences over the levels of some activity, ω, and is characterized by some individual trait in the set of characteristics, X:

$$u_i = u(\omega_i; X_i) \tag{1}$$

where $i = 1, ..., I$ indexes agents in the economy. Resources and market parameters define the choice set, $\Omega_i(X_i)$, whose content depends on the individual characteristics. For instance, in classical consumer theory ω_i is a consumption bundle, and income, y_i, is the only characteristic in X_i that influences the budget constraint. Rational individuals will obtain a level of welfare given by their indirect utility function, v:

$$v_i(p, y) \equiv \max_{\omega_i} u(\omega_i; X_i) \quad \text{s.t.} \quad \omega_i \in \ \Omega_i \equiv \{\omega : p \cdot \omega \leq y_i\}$$

where p is a parametric price vector. Since in a competitive market, given supply, prices are determined by the interaction of individual demands, in this model individuals influence each other *indirectly*, through market prices. This is an example of a *pecuniary externality*: one's demand influences prices, and so others' welfare, which is a basic form of market interactions. In an interactions-based model, *in addition*, agents may influence each other *directly*, because of social, or non-market, interactions. These are forms of *non-pecuniary externalities*, associated with a "social" component of utility, and can be represented as the direct influence of the sets of others' choices, $\boldsymbol{\omega}_{-i}$, and characteristics, $\mathbf{X}_{-i}$, on i's behavior. Since this model tries to capture a sociological perspective, it assumes that individual i, when choosing her behavior, is not influenced by the whole population, but by a subset of individuals, i.e. her reference group, g_i. The set of reference groups defines a social structure. Each individual may have multiple reference groups, possibly one for each different interpretation of ω. For each ω, the reference group may be exogenous (e.g. race, gender, and native language), or a matter of choice, possibly on the market (e.g. residential neighborhood, school, and social affiliations). Assuming that utility is separable (hence additive) in its private and social components, utility function (1) is extended as follows:

$$u_i = \upsilon\left(\omega_i, X_i, Y_{g_i}\right) + s\left(\omega_i, \mu_i\left(\boldsymbol{\omega}_{-i}|g_i, \mathbf{X}_{-i}, Y_{g_i}\right)\right) \tag{2}$$

where $\mu_i\left(\boldsymbol{\omega}_{-i}|g_i, \mathbf{X}_{-i}, Y_{g_i}\right)$ is a subjective probability measure, a belief, over the choices of the other individuals in the reference group, given group composition, g_i, the set of characteristics of individuals other than i, $\mathbf{X}_{-i}$, and the contextual characteristics of group g_i, Y_{g_i}. This formulation should clarify the key feature of interactions-based models, namely the synergy between private motives, represented by individual utility $\upsilon(.)$, and social influences, represented by social utility $s(.)$, in determining individual incentives (see Brock and Durlauf, 2001a). Analogously, one's alternatives may depend on others' expected behavior: $\Omega_i = \Omega\left(X_i, \mu_i\left(\boldsymbol{\omega}_{-i}|g_i, \mathbf{X}_{-i}, Y_{g_i}\right)\right)$. Furthermore, when the reference group is not exogenous, a second constraint must be added to the model, namely $g_i \in G_i$, where G_i is the set of groups which are accessible to individual i. Therefore, an optimizing individual will choose group and behavior as follows:

$$\begin{aligned}
(g_i, \omega_i) &= \arg\max_{g,\omega} u_i \\
&\quad \text{subject to} \\
g &\in G_i \\
\omega &\in \Omega_i\left(X_i, \mu_i\left(\boldsymbol{\omega}_{-i}|g, \mathbf{X}_{-i}, Y_g\right)\right)
\end{aligned}$$

Up to separability, this is a general model with social interactions effects, in which preferences, constraints and expectations are possibly interdependent, and the social structure, if appropriate, is endogenously determined. In such a setting, an equilibrium is defined as a set of groups, and a probability distribution over individual behaviors, such that utility is maximized for each individual, and the market for memberships, if any, clears. The different social structures implicit in the two frameworks, (1) and (2), are represented in figure 1. Notice that such representation implies that market interactions are not social interactions, which is the prevailing terminological convention in this literature.

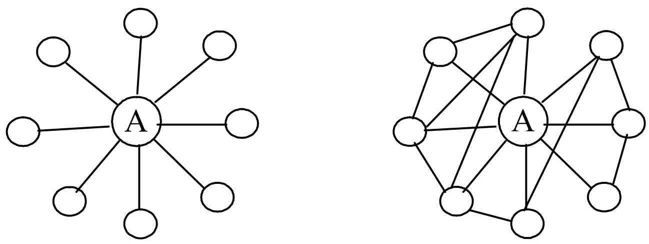

Figure 1. In the traditional model (left) individuals interact through the Walrasian auctioneer, A. In an interactions-based model (right) individuals *also* interact directly within reference groups. An individual's reference group is the set of agents connected with the individual through an edge.

Three remarks about this framework are called for. First, the kind of preferences represented by (2) are by no means a novelty in mainstream economics. For instance, Arrow and Hahn (1971) studied an economy in which utility depends on the entire allocation, e.g. preferences over goods depend on others' consumption, and showed that, under standard assumptions, a competitive equilibrium exists when utility has a form like (2). Second, looking at such interactive formulation of utility, one may wonder what is the difference with a standard game-theoretic model. As a matter of fact, non-cooperative game theory provides a tool for the analysis of any kind of interactions, being an interactive decision theory. According to Blume and Durlauf (2002), social interactions models are merely coordination games, which are interesting on their own because they offer a convenient framework to think about multiple social equilibria, and because of econometric implementability. However, the overlapping between an interactions-based model like (2) and a game-theoretic model is not perfect. The latter requires that the strategic structure of the game be common knowledge among players. This is not necessarily the case when the interactions are determined by particular sociological or psychological forces: in this case agents may interact without fully realizing the pattern of reciprocal influence. This doesn't mean that individuals don't know their preferences, rather that their preferences are shaped by the social context in a way that may be beyond their perception. According to this view, individuals learn their preferences in the same sense in which they learn their native languages or tastes for particular cuisines, through a process which is not necessarily intentional (Bowles, 1998). In this case, an individual is not necessarily interacting with others in the game theoretic sense. That is to say, any strategic interaction is a non-market interaction, but the converse is not true. For instance, Bowles (1998) emphasizes the importance of "social interactions affecting the diffusion of cultural traits in a population *in ways often unrecognized by any of the participants*" (Bowles, 1998, p. 81, emphasis mine). However, I think this is a peripheral discussion: one can approximately regard interactions-based models as standard game theoretic models, with special emphasis on the aggregate properties implied by the structure of interaction. Indeed, the main equilibrium notion in this literature is some version of Nash equilibrium. Finally, the synergy between private and social utility captures the main explanations of behavior advocated by economists and sociologists. Therefore, interactions-based models can be regarded as an answer to Granovetter's (1985) criticism of the over- and under-socialized methodologies of traditional sociology and economics. However, it must be noticed that methodological individualism is not superseded: in a framework like (2), social interactions affect individual behavior, yet the latter is the unit of analysis. Such framework enlarges the set of explanatory variables for individual behavior, and so it extends the traditional neoclassical model, without relaxing any of the neoclassical assumptions.

The specification of social utility $s(.)$, i.e. the description of the way $\boldsymbol{\omega}_{-i}$ and $\mathbf{X}_{-i}$ enter the model, determines the kind of social interactions at work within the group. For instance, a popular specification of (2) is the model with conformity effects, where the social effect stems from the desire to minimize a function of the distance between own behavior and neighbors' behavior:

$$u_i = \upsilon(\omega_i; X_i, Y_g) - \frac{1}{2} \sum_{j \neq i} J_{ij} \left(\omega_i - \omega_j^e\right)^2 \tag{3}$$

where ω_j^e is i's subjective expectation of j's behavior, as derived from the subjective probability measure μ_i, and J_{ij} is the strength of interaction between individuals i and j. The latter can be interpreted as the entry of a social distance, or adjacency, matrix. Think of the pattern of interactions in the population as a nondirected graph, i.e. a collection of nodes, representing the I individuals, and arcs connecting the nodes, representing social ties among them. Each arc has a value, J_{ij}, which represents a measure of social distance. Such values are stacked into the adjacency matrix $\{J_{ij}\}$, where

$$
\begin{aligned}
J_{ij} &\neq 0 \text{ if } j \in g_i \\
J_{ij} &= 0 \text{ otherwise}
\end{aligned}
$$

Therefore, i's reference group can also be expressed in set notation: $g_i = \{j \in I : J_{ij} \neq 0\}$. Of course the "interactions matrix" $\{J_{ij}\}$ varies with the kind of behavior, ω, under study. Ioannides (2003) interprets $\{J_{ij}\}$ as a topology of social interactions, and discusses the implications of alternative topologies for interactions-based models. Notice that in the conformity model (3), assuming $J_{ij} \geqslant 0 \ \ \forall i, j$, individuals suffer a loss, i.e. are punished, when deviating from the expected behavior of other individuals in their reference group. The first function on the right hand side of (3) is private utility, i.e. the private value of choosing ω_i in group g, and the second is social utility, i.e. the disutility of not conforming. Therefore, this model allows the handling of sociological phenomena within traditional economic analysis, such as social norms, Veblen's emulative consumption, "keeping up with the Joneses", peer-group, and role models. Such effects can be interpreted in terms of strategic complementarities, whereby the marginal utility of increasing one's action increases with the level of action chosen by other agents (see Cooper and John, 1988). A stochastic version of this model, with the remarkable advantage of direct econometric implementability, has been developed by Brock and Durlauf (2001a,b and 2003). They assume that individuals are influenced by mean behavior in the group with uniform social distance, and add a behavior-specific i.i.d. random term to individual utility. As a consequence, the equilibrium probability of a certain social social configuration, $\boldsymbol{\omega} = (\omega_1, ..., \omega_I)$, is a likelihood function, and the model parameters, in principle, can be estimated using for instance a logistic regression (see Brock and Durlauf, 2001b for a discussion of identification conditions). The Brock and Durlauf model has been imported into economics from statistical physics. The aforementioned work of Föllmer (1974) is important because it was the first to use a statistical mechanics approach in economics, as a way to model social interdependence. The idea is that people in a social system interact in the same sense as particles do in a physical system. Of course the fundamental difference is that interaction is governed by physical laws in one case, and by economic, sociological and psychological laws in the other. This approach has turned out to be very useful for modeling purposes, and especially for econometrics: it exploits the strict similarities between statistical mechanics models and random utility models, which, as well known, form the basis of an important branch of microeconometrics (Durlauf, 1997).

A simple model like (3) produces several interesting results, which are usually associated with complex systems, such as multiple equilibria, non-ergodicity, and phase transitions (or threshold effects). Such properties, as emerging in interactions-based models, are described by Durlauf (2003a,b). Intuitively, multiple equilibria emerge because when the private utility of a certain behavior is small enough with respect to social utility, the incentive to behave like others is stronger than the incentive to choose any particular alternative. For instance, suppose that, in a certain community, kids' expected return to education (private utility) is positive but low, and that social approval from friends requires one not to be too far from the mean level of education in one's clique (social utility). One can show that when the social pressure to conform dwarfs the perceived private returns to education, there exist two stable Pareto-rankable equilibria, one associated with high average education and one associated with low average education, even if the intrinsic value of education is positive. Since the second equilibrium is stable and inefficient, it can be interpreted as a poverty, or "social", trap. Therefore, interactions-based models offer a convenient framework to think about poverty traps as determined by social interactions rather than market imperfections or individual incentives only. Such multiplicity is easy to visualize, as shown in figure 2, since interactions-based models are naturally solved in a way that produces a fixed point equation.

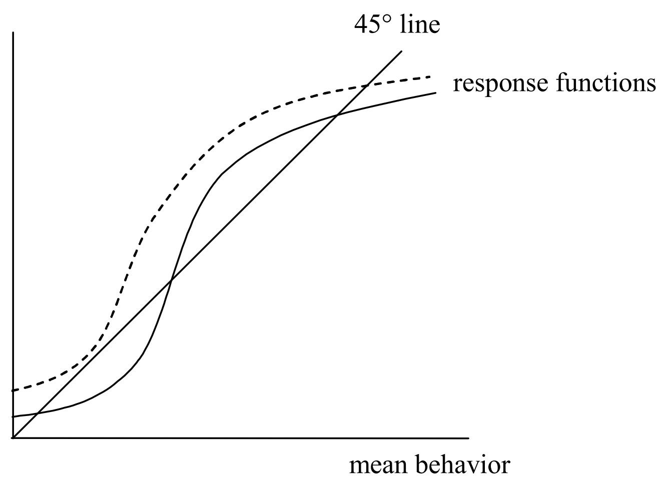

Figure 2. Unique and multiple equilibria.

In figure 2, two different response functions are drawn. The s-shape requires some kind of nonlinearity in the model, which is easily obtainable, for instance, by introducing stochastic structure. The dashed function corresponds to a case in which private utility is large relative social utility, and so the behavioral equilibrium is unique. The solid function corresponds to the opposite case, and multiple equilibria appear. The passage from a state of multiplicity to one of uniqueness, and vice versa, occurs at a critical threshold related to the ratio between private and social utility. In analogy with physical models, such passage is sometimes referred to as a "phase transition", since the qualitative properties of the system change. The threshold effect follows: the incentive to behave similarly prevails until private utility becomes large enough to reward a non conformist behavior more than social utility punishes it. That point is the watershed between unique and multiple equilibria. For this reason it is often referred to as *tipping point*, since when the system is in the neighborhood of that point, a "tip" (e.g. a small change in the parameters) may result in an abrupt change of its qualitative properties, and of the equilibrium. This idea, originated in biology and fruitfully used in political sciences, is receiving increasing attention in economics (see Lustick and Miodownik, 2004, for an historical account, and Brock, 2003, for a mathematical illustration). Finally, when multiple equilibria exist, and provided that the model has a stochastic structure, ergodicity breaks down because of the path-dependency aspect of equilibrium: once a group is trapped into a particular state, only a coordinated change in behavior can move the system to a different, possibly Pareto-superior, equilibrium. Alternatively, as an example of policy implication, if a group is stuck into the inefficient equilibrium, then a subsidy that increases private utility beyond the critical threshold of multiple equilibria will lead the system directly into the desirable equilibrium, as shown in figure 2. Other interesting properties of interactions-based models, from the point of view of the social sciences, are (i) the existence of a social multiplier of behaviors, and (ii) the tendency toward equilibrium stratification in the social space.

(i) **The social multiplier**

The social multiplier of behavior is a matter of the relation between the aggregate response and the sum of independent individual responses after a common shock. It works like the Keynesian multiplier of expenditure; indeed they have the same analytical expressions. The idea is that a common shock across agents has a direct effect on individual behavior through private utility, and a cumulative indirect effect through social utility. As a consequence, the final aggregate response to the shock exceeds the sum of the initial individual responses, while the two are equal when agents don't interact. The social multiplier can be defined as the ratio between the former and the latter. The simplest way to derive it is to consider another popular specification of (2), i.e. the model with uniform (i.e. with $J_{ij} = J \;\; \forall i, j$) proportional spillovers:

$$u_i = x_i \omega_i - \frac{1}{2}\omega_i^2 + J\omega_i \frac{\sum_{j \neq i} \omega_j}{I} \tag{4}$$

where $x_i \in X_i$ is the only relevant individual characteristic. Individual behavior has a net private benefit, given by the difference between the first two terms on the right hand side, which is private utility. Individuals also receive a spillover from average group behavior, proportional to the level of their own behavior. For simplicity, let's assume that the group is large enough, so that $\frac{\sum_{j \neq i} \omega_j}{I-1} \rightarrow \frac{\sum_j \omega_j}{I}$. Also, normalize J so that $0 \leqslant J < 1$. From the first order necessary condition, we can recover the optimal individual behavior as a function of the relevant individual characteristic, and of mean behavior in the group:

$$\omega_i^* = x_i + J \frac{\sum_j \omega_j}{I} \tag{5}$$

Therefore, summing up across individuals, mean behavior is:

$$\frac{\sum_i \omega_i^*}{I} = \frac{\frac{1}{I}\sum_i x_i}{1 - J} \tag{6}$$

Imagine that a common shock hits the individuals in the group. The individual response, using (5), is:

$$\frac{\partial \omega_i^*}{\partial x_i} = 1, \tag{7}$$

while the average response, using (6), is:

$$\frac{\partial}{\partial x_i}\left(\frac{\sum_i \omega_i^*}{I}\right) = \frac{1}{1-J}. \tag{8}$$

The ratio between the latter and the former, i.e. $1/(1-J) \geqslant 1$, is the social multiplier: the aggregate response exceeds the sum of the individual responses, because of strategic complementarities across the members of the group. The social multiplier has a key theoretical and empirical implication: when the magnitude of interactions is large, a small change in the individual fundamentals, x_i in this case, can produce a large aggregate response. Therefore, this model seems particularly apt to explain aggregate shifts across time and space that seem unrelated to fundamentals.

(ii) **Stratification in the social space.**

In presence of spillover effects individuals are not indifferent, other things being equal, between different locations in the social space. In particular, rational individuals will choose, if possible, the group that maximizes their expected benefit with respect to membership. For instance, if parents believe that the performance of their kids is influenced by the performance of their classmates, they are not indifferent between different schools in a city. This implies a tendency toward stratification along individual characteristics, for instance income, or human capital. The traditional approach to spatial stratification, uses the same single crossing condition that produces separating equilibria in signaling models. Assume that memberships are costly, and consider, again, a model with proportional spillovers, where private utility is affected, perhaps through budget constraint, by membership price, ρ_g,

$$u_i = u\left(\omega_i, x_i, Y_g, \rho_g\right) + J\omega_g\omega_i, \tag{9}$$

where $\omega_g \equiv \frac{1}{I}\sum_j E\left(\omega_j\right)$ is mean behavior in the reference group. Suppose that the relevant individual type is $x \in X_i$, and that Y_g contains only group characteristics that are independent of the sorting process. Then there is a tendency to spatial stratification along x if the marginal rate of substitution between mean behavior and membership price increases with the relevant individual characteristic, i.e.

$$\frac{\partial}{\partial x} MRS_{\omega_g\rho_g} = \frac{\partial}{\partial x}\left(\frac{\partial u_i/\partial \omega_g}{\partial u_i/\partial \rho_g}\right) > 0. \tag{10}$$

This condition says that the willingness to pay for the spillover associated with social interactions increases with one's type. A possible objection is that this approach to stratification relies too much on preferences. It is possible to introduce a memberships market, e.g. a housing market, and show that the equilibrium prices contain a social premium, because individuals value positive spillovers (e.g. Bénabou, 1996). If the social premium is large enough, some individuals will be pushed beyond the boundary of their budget constraint. In this case, if income and the relevant type are correlated, stratification will occur because of constraints too, rather than preferences only.

There are two main questions to be addressed in the interactions-based framework, namely (a) what is the source of interdependence between individuals, i.e. why should we plug into the utility function objects like $\boldsymbol{\omega}_{-i}$ and $\mathbf{X}_{-i}$, and (b) how the social context, i.e. group composition, is determined in the presence of endogenous interactions, i.e. of simultaneous influences across agents. As it will be clear, these questions can be better tackled after taking a look at possible applications of interactions-based models. Therefore, the next section reviews some applications, and sections 5 and 6 tackle the two questions above.

4 Economic Applications

This section illustrates some applications of the interactions-based framework to strictly economic problems, and in which interdependence is driven by sociological and psychological forces. This choice cuts out important applications, such as technological interactions, which lie at the core of endogenous growth theories, crime and other social pathologies, evolution of science and language, behavior of political parties, and national security. A synthetic descriptions of such applications is provided by Brock and Durlauf (2001b), and Blume and Durlauf (2001). It also cuts out the related literature on the economics of network industries (Katz and Shapiro, 1985, and Shy, 2001), which is based on technological complementarities in the form of network effects, the new economic geography (Krugman, 1991 and 1996), which builds upon the idea of agglomeration economies, and trade networks (Kranton and Minehart, 2001), which focuses on strategic trade agreements in presence of spillovers from previous agreements. I have selected six applications: matching through social networks, welfare participation, memberships theory of poverty and inequality, herd behavior in financial markets, and consumer behavior. Constraints, preferences, or expectations interactions, or a combination of the three, are present in all the applications I have mentioned.

4.1 Allocation of jobs

In a seminal paper, Rees (1966) tried to explain evidence showing that referrals by present employees, hence social networks, often outperformed markets, e.g. employment agencies, in the allocation of jobs. Rees' explanation, inspired by Stigler's (1962) pioneering work in search theory, anticipated one of the fundamental topics in the economics of information: the key to the comparative advantage of social networks is an information asymmetry that characterizes labor markets. Rees defined two aspects of search: the intensive margin is characterized by collection of additional information about an individual, while the extensive margin is characterized by additional search of potential employees. When quality of labor is unobservable, and there is enough variation in it, from the employer's viewpoint the intensive margin of search is more important than the extensive margin. The reason is that when ability is sufficiently dispersed, the expected net gain from inferring the position of an individual in the distribution of ability is higher that the expected net gain from an additional draw. In this case, social networks outperform markets in terms of transaction costs, provided that employees tend to refer people with whom they interact, i.e. people similar to themselves, under the pressure of a reputation effect. This gives employers who are satisfied with their current employees a cheap screening device when hiring new workers. This theory was corroborated by Granovetter's (1974) [1995] study of how people find a job. According to his survey data, roughly 50% of jobs are allocated through social networks. This suggests that one's success in the labor market may depend on social interactions, a possibility with obvious implications for the distribution of opportunities across distinct groups in a society. Such phenomenon can be easily modeled using the few concepts introduced in section 3. Redefine social distance, J_{ij}, as the probability that individual i is successfully referred by j, and rename it p_{ij}. Of course $p_{ij} > 0$ only if $j \in g_i$. Given the nature of the problem, such probability depends on j's labor supply, $1 - l_j$, where l is leisure: for instance, an unemployed individual cannot refer other individuals. It also depends on j's characteristics: for instance, a high skilled worker can be a more persuasive referee. The expected number of offers to individual i is:

$$p_i = \sum_j p_{ij} \left(l_j, X_j\right) \tag{11}$$

and her expected wage is $E\left(w\right) = \phi\left(p_i\right)$, where ϕ is a non decreasing function. Therefore, defining utility over leisure and consumption, the individual objective function is:

$$u_i = u\left(l_i, \left(1 - l_i\right) \phi\left(p_i\left(\mathbf{l}_{-i}, \mathbf{X}_{-i}\right)\right)\right), \tag{12}$$

which has the same structure as model (2). This research area regained attention in economics with the work of Montgomery (1991). One of his findings is that stronger interactions (measured by network density), and more ability-stratified societies (measured by inbreeding bias) cause more wage dispersion. This finding is reminiscent of the adverse selection situation. Indeed the underlying mechanism is the same: workers who end up using the formal channel are subject to a "lemon effect" and receive low expected wages relative to workers relying on social networks. Montgomery's simple and insightful model has been complicated in several ways by Calvo-Armengol and Jackson (2003), who use a stochastic setting to generate additional interesting results, such as duration dependence in unemployment, and dependence of labor force participation on social interactions, via information spillovers. Notice that when social networks are geographically defined, the hypothesis that they affect labor market outcomes implies spatial clustering of unemployment. Interesting empirical tests of this implication are provided by Topa (2001) and Conley and Topa (2002). These authors use spatial econometric techniques to estimate significant local spillovers, interpreted as social interactions effects, under different definitions of the social space. These developments suggest a possible way to enrich the microfoundations of the theories of unemployment and labor force participation. In such theoretical models, though, the social context is exogenous. This means that people are not allowed to form ties strategically, in order to reap the benefits of information spillovers. A natural extension of these models would be to allow for this possibility. An example, is provided in the review by Ioannides and Loury (2003).

4.2 Welfare dependency

Evidence, in the USA, shows that people applying for welfare benefits are less than those who are eligible. Early work by Moffitt (1983), building on previous sociological work, showed that such anomaly can be explained in terms of the stigma associated with welfare dependence. Extending this work, Lindbeck et al. (1999) conjecture that stigma stems from the *presence* of a social norm prescribing that one must live on the profits of his own work. However, the *intensity* of such norm is determined, endogenously, by the fraction of people who live on welfare rather than, as Moffitt assumed, by the level of welfare benefits. In terms of a specification like (4), presence of the social norm means $J > 0$, and intensity is determined by average behavior. Specifically, Lindbeck et al. (1999) work with a binary choice model, where $\omega = 1$ means work, and live on after-tax wage, $(1-t)\,W$, and $\omega = -1$ means do not work, and live on government transfer, T. These options determine private utility, $\upsilon\,(.)$. However, living on welfare implies stigma, which has a disutility cost. If $\omega_{ig} \in [-1, 1]$ is i's subjective expectation of mean behavior in group g, then the expected fraction of people living on welfare is $w_{ig} = \frac{1}{2}\,(\omega_{ig} + 1)$. Social utility, $s\,(w_{ig})$, is a function of such fraction, with $s'\,(w_{ig}) \leqslant 0$, so that the disutility of stigma, i.e. the embarrassment of living on the profits of others' work, decreases as more people live on welfare. Assuming that population is a continuum with measure 1, such preferences are represented by the following utility function:

$$u\,(\omega_i) = \upsilon\left[\tfrac{1}{2}\,(1+\omega_i)\,(1-t)\,W + \tfrac{1}{2}\,(1-\omega_i)\,T\right] - \tfrac{1}{2}\,(1-\omega_i)\,s\,(w_{ig}) \qquad (13)$$

The choice between labor and welfare depends on the relation between $u_i\,(1)$ and $u_i\,(-1)$. Under mild assumptions, there exists a unique critical wage level W^* such that $u_i\,(1) = u_i\,(-1)$. So, assuming that wage is a random variable distributed according to the probability function $F\,(.)$, and closing the model through rational expectations, i.e. $w_{ig} = E\,(w_g) = \frac{1}{2}\,(E\,(\omega_i) + 1)$, the expected welfare participation rate in group g is:

$$E\,(w_g) = F\,(W^*) = F\left[(1-t)^{-1}\,\upsilon^{-1}\,(\upsilon\,(T) - s\,(E\,(w_g)))\right], \qquad (14)$$

which is a fixed point equation. Depending on the specification of $F\,(.)$, it can generate a diagram similar to figure 2. This means that when a social norm against living on welfare exists, and its intensity in endogenously determined by the participation rate, there may exist two stable equilibria, one with a high, and one with a low welfare dependency rate. This holds for given wage distribution, and for given level of taxation. On the contrary, one can check that if there is no such social norm, i.e. $s(w_{ig}) = 0$, then the right hand side of (14) is a constant, and there is a unique equilibrium dependency rate. Of course, a unique equilibrium is also possible if private utility dwarfs social utility. As Lindbeck et al. (1999) suggest, an important extension of this model is to account explicitly for the role of endogenous reference groups. The hypothesis that social interactions affect welfare participation and labor supply has been tested empirically by Bertrand et al. (2000), who assume that one's reference group, with respect to welfare choices, is approximated by language spoken at home. They find a significant effect of social interactions on welfare participation, although this does not provide information on whether the reference group matters because of stigma, social learning, information spillovers or other possible mechanisms. I will return on this "identification problem" in section 5.

4.3 Persistent poverty

The possible effect of social interactions on the probability of being successful in the labor market is an example of how the social situation affects ultimate economic success. Economics has traditionally explained poverty focusing mainly on individual and family characteristics, or on market imperfections. An alternative perspective focusing on social interactions is related to important works in political sciences, such as Wilson (1987) and Jargowsky (1997), and has recently been elaborated by Durlauf (2001) into a "memberships theory of poverty". Such a theory emphasizes the role of group influences in determining economic success.

> Suppose that an individual is a member of an ethnic group that suffers from discrimination, grows up in a poor community whose role models and peer groups militate against economic success, and subsequently finds himself in a series of poor schools and jobs. This sequence constitutes an explanation of why such an individual is in poverty (Durlauf, 2001, p. 394).

The reason why this sequence constitutes an explanation is clear if individual behavior is governed by an interactions-based model like (2) rather than the traditional model (1). Such memberships theory has important policy implications. For instance, it is suggestive of the effectiveness of group-based more than individual-based interventions, according to the principle of the social multiplier. It also sheds new light on the theory of poverty traps, as discussed in section 3. De Bartolome (1990), Benabou (1996), and Durlauf (1996a,b) showed how the presence of neighborhood effects at the level of human capital production function may generate stratification, which is a necessary condition in a memberships theory of persistent poverty.

4.4 Investor behavior

Among the regularities observed in financial markets, three are puzzling with respect to the efficient markets theory, namely excess volatility of prices and returns, fat tails of the distribution of returns, and abrupt changes of the kind associated with market crashes. Research programs as diverse as econophysics (see Mantegna and Stanley, 2000) and behavioral finance (see Shleifer, 2000) have developed in the attempt to explain such puzzles. While the former, so far, lacks a complete theory of individual behavior (Durlauf, 2003a), the latter seems to rely too much on the existence of irrational agents on the market (Barberis and Thaler, 2002). Indeed, it is possible to explain such anomalies using microeconomic models of rational, but interdependent, decision making, such as an interactions-based model. Provided that agents have different information, it is fully rational to try to anticipate and imitate the behavior of others. Thus, herd behavior, and the associated contagion process, are rational when others' choices are believed to convey information about the fundamentals (Banerjee 1992, Bickhchandani et al. 1998, Morris 2000), or simply about where the market is going (think of the Keynesian "beauty contest" parable). Notice that a model like (3), where agents are punished when deviating from the group average, is consistent at least with abrupt changes in investor behavior. This can be seen considering the stochastic binary (buy and sell) version of the model, of the kind used by Brock and Durlauf (2001a): abrupt changes can be explained by small shocks to individual private utility (Brock, 1997 and 2003). The latter can either bring about a phase transition, with appearance of multiple equilibria if the system is in the proximity of the tipping point, or simply shift the equilibrium from one point to the other due to the effect of the social multiplier. In either case, the two stable equilibria depicted in figure 1 correspond to market exuberance and market depression, and the shift from one equilibrium to the other corresponds to an episodic market crash or market boom.

4.5 Consumer behavior

Many years ago, James Duesenberry (1948) elaborated a theory of consumer behavior, based on the idea of relative consumption. Duesenberry questioned one of the fundamental assumptions of consumer theory, namely that consumers behave independently of each other. His argument was that there is no empirical basis for such an assumption, and that indeed consumption patterns seem to have a social character. Such social character is associated with a *demonstration effect*:

> People believe that the consumption of high quality goods for any purpose is desirable and important. If they habitually use one set of goods, they can be made dissatisfied with them by a demonstration of the superiority of others. But mere knowledge of the existence of superior goods is not a very effective habit breaker. Frequent contact with them may be [...]. What kind of reaction is produced by looking at a friend's new car or looking at houses or apartments better than one's own? The response is likely to be a feeling of dissatisfaction with one's own house or car. If this feeling is produced often enough it will lead to action which eliminates it, that is, to an increase in expenditure (Duesenberry, 1948, p. 27).

This theory can be formalized as follows. In order to simplify the exposition, assume that quality is measured by the absolute level of consumption. It follows that in presence of a demonstration effect an individual's utility depends on own consumption, C_i, and consumption of other people, $\mathbf{C}_{-i}$, in i's reference group, g_i:

$$U_i = U\left(C_i, \mathbf{C}_{-i}\right), \tag{15}$$

Let's measure the social distance between i and j, J_{ij}, with the frequency of contacts that generate the demonstration effect. The latter can be expressed by the ratio $C_i/C_j,\ j \in g_i$, weighted by the frequency of contacts. Therefore, a possible specification of (15) is:

$$U_i = \log \left[C_i \prod_{j \in g_i} \left(\frac{C_i}{C_j} \right)^{J_{ij}} \right]. \tag{16}$$

Using lower cases for logs, we can use the transformation

$$u_i = c_i + \sum_{j \in g_i} J_{ij} \left(c_i - c_j \right), \tag{17}$$

which has the structure of model (3), with the difference that now individuals have an incentive to consume more than others, when possible. Duesenberry's hypothesis has been developed by Binder and Pesaran (2001) into a model of consumption in a life-cycle economy under various forms of social interactions. Bowles and Park (2003) show that a model like (17) has interesting implications for labor supply, namely the latter increases with the degree of income inequality in a society. They interpret this finding as a Veblen effect, i.e. the desire to emulate the consumption patterns of the rich. In this case the rich constitute the reference group of the less well-off. They also show that this hypothesis is supported by robust empirical evidence.

5 Sources of interdependence

What are the underlying mechanisms generating social interdependence of the kind illustrated so far? As remarked by Samuelson (2004), one cannot be satisfied with the radical shortcut of writing others' behavior and characteristics into the utility function in order to explain behavioral anomalies of the kind generated by social interdependence. There exist at least two important "identification problems" when a researcher observes that individual behaviors are correlated within a group. First, as elucidated by Manski (1993), individuals in a group may behave similarly because (a) they have similar characteristics (*correlated effect*), (b) they are affected by the same contextual variables (*exogenous social effect*), and (c) because they directly influence each other. The latter, referred to as the *endogenous social effect*, is present when $J \neq 0$. Second, even if one can isolate the endogenous social effect, and the associated social multiplier, a question is still there, namely why $J \neq 0$. Therefore, one needs a theory that explains a formulation like (2). Glaeser and Scheinkman (2001) discuss four possibilities, for positive interactions effects: (i) pure physical externalities (ii) social learning, (iii)

stigma, and (iv) direct preferences for imitation. However, if we exclude (i), these are epiphenomena rather than proper causes of social interactions. I will focus on two general mechanisms generating direct interactions between preferences, constraints, and expectations: uncertainty and the associated transaction costs, and the psychology of social life. The first lies within the traditional domain of economics, while the second lies beyond it. I leave out technological mechanisms, which already receive a great deal of attention in economics (see Shy, 2001).

5.1 Uncertainty and transaction costs

A logical reason why non-market interactions matter is that markets do not solve all aspects of the coordination problem. In this sense, for instance, Arrow (1971) maintains that social norms, which fit a model like (3), are a reaction of society to market failures. On the other hand, social interactions are themselves costly, since they require, for instance, maintenance of a social network. Therefore, we observe a mix of market and non-market interactions when both are costly: markets economize on non-market interactions, but the converse is also true. Think of the matching application described above: an anonymous and perfect labor market allocates jobs efficiently, and economizes on the need to have the right "connections" in order to get a job, other things being equal. But because of the transactions costs generated by information asymmetries, the labor market is far from ideal. As a consequence, social networks come to play an important role in the allocation of resources, beside the very market mechanism. Transaction costs are usually due to uncertainty, and so the latter is a reason why people are affected directly by others' behavior. If any relevant variable were perfectly observable, and if any possible future contingency were foreseeable and writable in costless enforceable contracts, i.e. if markets were for free, people would economize on costly non-market interactions. Social learning is an instance of a social effect due to uncertainty. An interesting approach to the economic consequences of social interactions based on incomplete contracts has been developed by Bowles (2004). Summarizing: social effects in a market economy may be due to the transaction costs generated by the combination of uncertainty and incomplete contracts. However, since social interactions are themselves costly, there must be an optimal mix of market and non-market interactions in a market economy.

5.2 Psychology of social life

In many instances, social effects arise because of the mere psychology of social life, which constitutes the proper domain of social psychology. This is the case, for instance, when one is sensitive to other's behavior because of feelings of envy, considerations of status, concern for social comparison, or existence of social norms of behavior with associated stigma or other forms of punishment. Sometimes it is possible to explain such feelings in terms of standard economic mechanisms, possibly driven by evolutionary forces. For instance, Samuelson (2004) has explained the existence of relative consumption effects in evolutionary terms, whereby individuals who imitate the consumption of people around them are making optimal use of information in uncertain environments. Therefore, it is possible that evolution optimally generates utility functions like (17). But this instance should fall under the heading of the previous subsection, and so the two causes of social effects I am considering are not independent in an evolutionary perspective. However, it is not always so, i.e. it is not always the case that, for instance, the concern for relative positions solves an economic problem stemming from uncertainty or transaction costs. Therefore, one has to concede something to the interaction between human nature and social organization. This should persuade of the importance of an interdisciplinary approach, and of the need to look towards neighboring social, human, and biological sciences. Another aspect, one that is receiving considerable attention in economics, concerns the role of identity in determining individual behavior (Akerlof and Kranton, 2000, and 2002). Identity, defined as the self-image category one inherits or chooses, works like a reference group: people tend to behave as others in the same identity group, in order to reduce a possible cognitive/identity dissonance, although identity too can matter for purely economic reasons, as an inferential device (see Keely and Tan, 2004, and, more generally, Manski, 2004). These examples, and indeed many of the ideas discussed so far, suggest that the social interactions approach is closely related to behavioral economics: it is striking that, so far, these two research areas developed apart.

One of the problems that arise in empirical work is how to distinguish between these different mechanisms. Indeed, identification of the interactions parameter, J, doesn't reveal the source of social interactions. It is a problem since different sources have different policy implications. For instance, suppose that we have estimated positive correlations between individual consumption and group consumption, after controlling for individual and group characteristics. An individual who imitates his neighbors' consumption pattern, does so because of relative consumption effects or because of social learning? In the first case preferences are literally endogenous (a change others' consumption induces a change in i's preference ordering among the elements of the consumption set), but not in the second (a change in others' consumption induces a change in i's choice through social learning of the true state of the world). Both cases are consistent with $J > 0$, a case of observational equivalence. However, rather than weakening the research program, this problem is an incentive to refine the theory and to sharpen the econometric tools.

6 Memberships

Even if we were able to tell why social effects matter, it is far from clear who influences whom, and how two individuals become members of each other's reference group. A theory of social interactions needs to answer such questions, for both theoretical and empirical reasons. From a theoretical point of view, we need an explanation of why people are possibly subject to social influence within a group when they can avoid such influence moving to another group. This issue is related to Tiebout's (1956) model of community formation. Indeed, models with exogenous neighborhood effects and endogenous sorting (such as De Bartolome 1990, Benabou 1996, and Durlauf 1996a,b) are examples of Tiebout models where people consider fiscal policy as well as social effects when choosing a community. The issue here is slightly more complicated, since I am focusing on endogenous social effects. When memberships are a matter of choice, rational individuals will take into account interdependencies if they perceive them. In this case, the maximization problem following model (2), can be thought of as occurring in two stages: at the first stage individuals choose their group, and at the second stage their behavior. Proceeding backward, at the first stage individuals know that the second stage payoff will be the maximum, with respect to their behavior, expected utility, with respect to the distribution of others' behavior, conditional on membership in group g:

$$v_i\left(X_i, Y_g, \rho_g\right) \equiv E_\mu \max_\omega u\left(\omega_i, \mu\left(\boldsymbol{\omega}_{-i}|g_i\right); X_i, Y_{g_i}\right) \quad \text{s.t.} \quad \omega \in \Omega_i, \tag{18}$$

Therefore, the reference group, if subject to choice, will be chosen at the first stage maximizing the second stage payoff:

$$\max_{g} v_i \left(X_i, Y_g, \rho_g \right) \quad \text{s.t.} \quad g \in \ G_i \tag{19}$$

This is a quite mechanical way of conceiving group formation. We know that memberships, even when are not exogenous, are often not determined by such a purposeful behavior. When making friends with somebody, for instance, it is unlikely that people are reckoning all the possible costs and benefits of friendship. People attract each other in many ways, and in the majority of cases they come to interact in ways that are outside the conceptualizations of economics. Therefore, this question too is, at least in part, outside the traditional domain of economics, and suggests the insufficiency of a strict economic approach to social interactions. On the other hand, the economics approach cannot be neglected, since it has a strong rationale. Think, again, of the application to labor market matching. If certain networks help in getting a job, people have an incentive to become part of those networks, i.e. to build links. Or think of the memberships theory of poverty. If parents believe that particular interactions have negative influences on offspring's economic success, they will avoid the corresponding memberships. To be clear, this does not imply that observed memberships reflect a strategic purpose. Nonetheless, it would be misleading to think that people don't select their, or their offsprings', peers.

There exists a related stream of game theoretic literature on network formation, reviewed by Jackson (2003). The issue of group formation found a fertile ground in cooperative game theory, in the context of research on coalition formation. Aumann and Myerson (1988) discuss such issue, modeling coalitions as sets of nodes and arcs, and the process of group formation as a sequential game in which players establish links, i.e. acquire memberships, considering future payoffs of the cooperative game. The key idea is a straightforward one: if groups are a source of benefits for members, agents will try to join the groups which maximize their benefit, as expressed by model (19) above. This approach has evolved into models of equilibrium networks: the key idea is that players establish costly links and enjoy the benefits of their connections. This approach offers several insights, and is an important step for a full fledged interactions-based framework, in which behavior and the social context that influences it are both object of choice.

From an empirical point of view, modeling sorting when studying social influences is important because spatial correlation of individual behaviors or individual outcomes, may be due to the fact that individuals who are similar in some respect tend to be members of the same groups. If one does not pay attention to the sorting process when people can choose their memberships, estimates of the social effects may be very misleading, because of selection-bias. To overcome this problem, one can use experimental settings with random memberships. In either case, assumptions are needed on who influences whom. Empirical work, so far, has relied on approximations of reference groups based on geographic proximity, or broad categories such as language spoken at home and ethnicity, and has focused mainly on influences occurring within classrooms or small residential neighborhoods. Such choices are driven by data availability, and by the appeal of "natural" reference groups. But what if one lives in neighborhood A, goes to school in neighborhood B, and attends some group (e.g. a scout group) made up mainly of people from neighborhood C? A promising perspective, suggested by Brock and Durlauf (2004), is to use a model uncertainty framework (Brock, Durlauf and West, 2003) when evaluating policies whose effects are potentially affected by the presence of social effects. This would allow to overcome the problems stemming from our ignorance about actual reference groups, and to robustify the model with respect to the relevant reference group for the particular behavior under study. Using Brock, Durlauf and West's (2003) framework, suppose the policy maker can observe individual and group characteristics, X_i and Y_g, in the population. Also assume that the effect of a certain policy, p, summarized into a loss function, $L(.)$, depends on the magnitude of social interactions between the members of group g, J_g. However, the policy maker is uncertain about the boundaries of g, i.e. about what the actual reference group is. The objective is to minimize, with respect to p, the expected loss, given data. Such expected loss is:

$$E\left[L\left(p, J_g | \{X_i\}_{i\in g}, Y_g\right)\right] = \int L(p, J_g)\, \mu\left(J_g | \{X_i\}_{i\in g}, Y_g\right) dJ_g \tag{20}$$

where $\mu\left(J_g | \{X_i\}_{i\in g}, Y_g\right)$ is the probability of the magnitude of interactions given data. Such model accounts for reference group uncertainty if we specify the latter as:

$$\mu\left(J_g|\left\{X_i\right\}_{i\in g},Y_g\right)=\sum_{\gamma\in G}\mu\left(J_\gamma|\left\{X_i\right\}_{i\in\gamma},Y_\gamma,\gamma\right)\mu\left(\gamma|\left\{X_i\right\}_{i\in\gamma},Y_\gamma\right) \quad (21)$$

where G is the set of all plausible definitions of g from the policymaker viewpoint.

7 Empirical approaches

How can the social effects discussed so far be detected empirically? Three main empirical routes have been followed. A first, traditional, route consists of using microdata. More recent approaches use either few macrodata or either randomized or natural experiments. Brock and Durlauf (2001b) and Durlauf (2003b) discuss such approaches at length. I will provide a summary here for the sake of completeness. The traditional route uses microdata to estimate directly the effect of group behavior on individual behavior, ω_i, after controlling for individual characteristics, X_i, and group characteristics, Y_g. The baseline model is a linear one, and describes the continuous behavior of an individual, ω_i, drawn from a certain group, g. For instance, the following is known as the linear-in-means model, since group *expected* mean behavior, ω_g, enters linearly:

$$\omega_i=a+cX_i+dY_g+J\omega_g+\varepsilon_i \quad (22)$$

It well known that this route suffers from two major econometric problems. The first is a classical identification problem. Notice that expected mean behavior in i's group, ω_g, is endogenous by definition. Closing the model through rational expectations, under the assumption that the contextual vector Y_g is independent of the error term, we obtain:

$$\begin{aligned}\omega_g &= E\left(\omega_i|Y_g\right)=a+cE\left(X_i|Y_g\right)+dY_g+J\omega_g\\ &= \frac{a}{1-J}+\frac{c}{1-J}E\left(X_i|Y_g\right)+\frac{d}{1-J}Y_g.\end{aligned} \quad (23)$$

Using the second line, we obtain the model in reduced form:

$$\omega_i=\frac{a}{1-J}+cX_i+\frac{d}{1-J}Y_{g_i}+\frac{Jc}{1-J}E\left(X_i|Y_{g_i}\right)+\varepsilon_i. \quad (24)$$

It is clear that when mean individual characteristics in the group, $E\left(X_i|Y_{g_i}\right)$, is a linear function of Y_{g_i}, the number of reduced form parameters that can be identified is smaller than the number of parameters we need to estimate, i.e. (a, c, d, J). In particular the main parameter of interest, J, is not identified. However, this problem can be overcome: Brock and Durlauf (2001a, 2001b, 2004) discuss identification conditions in parametric and non parametric settings, and suggest nonlinear techniques which overcome altogether the multicollinearity problem of the baseline linear model. Indeed, there is evidence that social effects are nonlinear (see Ioannides, 2002). The second problem is selection bias. If individuals choose their groups, their membership in group g is not random, and so the observations from group g to be used in estimating (22) do not constitute a random sample (see Brock and Durlauf, 2001b, and Moffitt, 2001). This is the inferential problem studied by Heckman (1979). Such problem can be overcome too: Ioannides and Zabel (2002) have shown how to integrate choice of group and choice of behavior subject to intra-group social effects. In general, modeling sorting in presence of social effects allows to perform a selection bias corrected regression. Therefore, a traditional model like (22) can be used after taking the proper steps. However, reliable and detailed datasets linking individual to group-variables are hard to find.

The second route consists of estimating indirectly the social effect, exploiting few macrodata, namely the estimates of the variance-covariance structure of individual behaviors. The rationale of this methodology, which economizes on data, is elucidated by Glaeser and Scheinkman (2002). The key idea is that, by their very nature, social interactions produce high variance across time and space, not necessarily because of multiple equilibria. To see how this strategy works, imagine that individual behavior is correctly described by a model like (22). Then, as population size goes to infinity, and denoting with N group size, Glaeser and Scheinkman (2002) show that the variance of group average converges to

$$var\left(\frac{1}{\sqrt{N}}\sum_{i\in g}\omega_i\right) = N\left(\frac{c}{1-J}\right)^2 var\left(X_i\right) + N\left(\frac{d}{1-J}\right)^2 var\left(Y_g\right) + var\left(\varepsilon_i\right) \quad (25)$$

They conclude that if one can find reasonable upper bounds for the variances on the right hand side (and for the individual and contextual effects, c and d), then high aggregate variance can be associated with significant social interactions. However, it seems that this procedure does not solve the selection-bias problem. Glaeser and Scheinkman (2002), and Glaeser, Sacerdote, and Scheinkman (2002) have devised another route to measuring interactions using macrodata, exploiting the fact that endogenous interactions imply a social multiplier, as described in section 3. If one can identify the social multiplier, $1/(1-J)$, the main parameter of interest, J, is clearly identified too. However, this approach requires the a priori exclusion of sorting, which is an excessively restrictive assumption in many contexts of interest, although it might well be appropriate in others.

Finally, experimental techniques can be of great help in the empirical detection of social effects (Durlauf, 2003b, discusses such route in depth). Several researchers have used experimental settings with random memberships (e.g. Sacerdote, 2001, Ichino and Falk, 2003, and Zimmerman, 2003). However, genuine randomization and reliable extrapolations from a particular experimental context are not always possible. In this case we need a theory of group formation in presence of social influences of the kind sketched in section 6, in order to correct for self-selection in a microfounded way.

8 Conclusions

The paper has discussed an extension of the traditional neoclassical model to various forms of social interactions, showing how an interactions-based framework helps us modeling substantive economic phenomena, which elude conventional economic thinking. The strong point of this research area is that it brings into economics the richness of sociological and sociopsychological explanations of individual behavior. An evident weakness is that social interactions are incorporated in an extremely stylized fashion. Such weakness is related to the need of keeping the models simple, but I think it stems mainly from the difficulty of clarifying the sources of direct interdependence affecting economic behavior. Therefore, the issues discussed in section 5 require more research. Nonetheless, along this research direction, the realism of economic modeling has definitely increased. In order to assess the social interactions approach, the following is a natural question: is such a realism necessary? At the outset of an old paper become famous for other reasons, Robert Solow (1956) gave a short methodological lecture:

> All theory depends on assumptions which are not quite true. This is what makes it theory. The art of successful theorizing is to

> make the inevitable simplifying assumptions in such a way that the final results are not very sensitive. A "crucial" assumption is one on which the conclusions do depend, and it is important that crucial assumptions be reasonably realistic. (Solow, 1956, p. 65)

As I have argued, the assumption about what kind of interactions are relevant for economic outcomes is indeed a crucial one, especially with respect to policy conclusions. For instance, the evaluation of a certain policy is different if the social multiplier is greater than one, with respect to the case in which it is equal to one and so there are no multiplier effects. Since it seems reasonable that people are affected to some extent by the social context, interactions-based models have a possible good point in economic research. This is why I think this is an important research area. In this regard, Chwe (2003) has written that "the full flowering of this paradigm in the decades to come might produce work which is comparable to the entire disciplines of economics and sociology, making these disciplinary categories seem quaint and archaic" (Chwe, 2003, p. 907). I agree with the view that the achievement of such an ambitious goal very much depends on whether the remarkable theoretical advances brought about by the social interactions approach will find an empirical counterpart. The assessment of this research area also depends on whether extending the set of assumptions is worthy in terms of additional explicative power. The possible applications I have described show that such models can explain a variety of interesting and important economic phenomena, and so I think it is worthy working at the full flowering of the paradigm. In this respect, the latter is not yet an interdisciplinary research area, at least with respect to other research programs, such as behavioral economics. It is clear that issues such as why people react to each other in a group, or how groups are formed, cannot be completely answered within the traditional boundaries of economics, but require the contribution of social psychology. In this respect, there is a strategic bridge to be built between behavioral economics and new social economics. Such a bridge would spur more interdisciplinary work. The latter, in turn, will help us answer the main unsettled questions in new social economics, namely the nature and causes of social interactions in market economies, what kind of interactions are relevant, and who influences whom with respect to economic behavior.

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