NBER WORKING PAPER SERIES

ECONOMIC ANALYSIS OF SOCIAL INTERACTIONS

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Working Paper 7580
http://www.nber.org/papers/w7580

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
March 2000

This research was supported in part by NSF grant SBR-9722846. The views expressed herein are those of the author and are not necessarily those of the National Bureau of Economic Research.

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NBER Working Paper No. 7580
March 2000

ABSTRACT

Economists have long been ambivalent about whether the discipline should focus on the analysis of markets or should be concerned with social interactions more generally. Recently the discipline has sought to broaden its scope while maintaining the rigor of modern economic analysis. Major theoretical developments in game theory, the economics of the family, and endogenous growth theory have taken place. Economists have also performed new empirical research on social interactions, but the empirical literature does not show progress comparable to that achieved in economic theory. This paper examines why and discusses how economists might make sustained contributions to the empirical analysis of social interactions.

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1. Introduction

Economists have long been ambivalent about what social interactions constitute the proper domain of the discipline. The narrower view has been that economics is primarily the study of markets, a circumscribed class of institutions in which persons interact through an anonymous process of price formation. The broader view has been that economics is defined fundamentally by its concern with the allocation of resources and by its emphasis on the idea that persons respond to incentives. In this view, economists may properly study how incentives shape all social interactions that affect the allocation of resources.

Throughout much of the 20th century, mainstream economics traded breadth for rigor. In the first half of the century institutional economics, which thought broadly but loosely about social interactions, gradually gave way to the neoclassical theory of general competitive equilibrium, which formalized the analysis of idealized competitive markets (e.g., Arrow and Hahn,1971). From the perspective of general equilibrium theory, non-market interactions were not phenomena of intrinsic interest. Instead they were problems of incomplete markets that may prevent the economy from achieving a social optimum. Welfare economics prescribed that the externalities created by non-market interactions should, if possible, be eliminated by setting property rights that would permit trade to take place (e.g., Coase, 1960).

From the vantage of today, it is clear that the narrowing of economics ended by the 1970s. Since then a new phase has been underway, in which the discipline seeks to broaden its scope while maintaining the rigor that has become emblematic of economic analysis. Major theoretical developments in microeconomics, labor economics, and macroeconomics have played important

roles in launching this new phase. [1]

In microeconomics, perhaps the defining event of the late 20th century was the adoption of non-cooperative game theory as a language and set of tools for the study of market and other interactions. The concepts of dynamic game theory developed in the 1970s and 1980s enabled economists to describe and analyze a broad range of market structures, and so gave new life to the field of industrial organization. A more radical consequence of the game theory revolution was that it broke down the sharp distinction that economists had maintained between markets and other social interactions. Game theory encouraged economists to see all interactions as games, markets being special cases. As a result, economic theorists have in recent years studied phenomena as far from traditional economic concerns as the evolution of social norms (e.g., Akerlof, 1980; Jones, 1984; Cole, Mailath, and Postlewaite, 1992; Kandori, 1992; Young, 1996).

A second pivotal development was the transformation of labor economics from a field narrowly concerned with work for pay into one broadly concerned with the production and distributional decisions of families and households (e.g., Becker, 1991). Modern labor economists study a wide range of family and household behaviors that earlier economists thought peripheral to or outside the domain of the discipline; marriage and fertility, education and health care, drug addiction and criminal activity, inter vivos transfers and bequests. Much of the research of labor economists on these subjects has viewed the family or household as a single utility maximizing entity, thus abstracting from the complex interactions that may occur among the members of this entity. A considerable body of work, however, uses non-cooperative game theory to model families

[1] See Lazear (1999) and Myerson (1999) for two recent perspectives on the broadening of economic theory. These authors differ substantially in their emphases but agree that the broadening is well underway.

and households as groups whose members may have differing objectives (e.g., Becker, 1974; Bergstrom, 1989).

A third important development was the emergence in macroeconomics of endogenous growth theory. Whereas classical growth theory assumed that the production technology available to an economy is exogenous, endogenous growth theory supposes that today's technology may depend on earlier investments in human capital or R&D, which themselves may have been influenced by the past output of the economy (e.g., Lucas, 1988; Romer, 1990). Endogenous growth theory has also generated study of cross-sectional and dynamic spillovers in the production of human capital: children may learn more when they share school classes with high achievers or when they have well-educated parents (e.g., Benabou, 1996a, 1996b).[2] Many of the interactions in R & D and human capital formation emphasized in endogenous growth theory occur in non-market environments. Hence new research on macroeconomic growth shows a concern for externalities that was absent from classical growth theory.

The broadening of economic theory has coincided with the performance by economists of new empirical research on social interactions. Unfortunately, the empirical literature does not show much progress. Empirical studies that seek to maintain a tight connection with economic theory typically impose auxiliary assumptions that severely diminish the credibility of the reported findings. Other studies maintain little or no connection to theory. Many recent empirical investigations seek

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[2] Social interactions in schooling is also a major concern of microeconomic research on schooling. For example, research on the effect of class size on learning is concerned with the congestion problem that may arise because a classroom of students share a common resource, the teacher (e.g., Hanushek, 1998; Lazear, 1999a). Research on vouchers has been concerned with the effect of these subsidies on class composition, which may affect efficiency of learning (e.g., Manski, 1992; Epple and Romano, 1998).

only to determine whether statistical associations among the experiences of different persons indicate the presence of some loosely specified form of interaction amongst them.

The weak state of empirical research on social interactions should be a matter of strong concern to economists who want the discipline to contribute effectively to the formation of public policy. For years economists and others have speculated about the role of non-market interactions in determining such matters of public interest as schooling outcomes, employment patterns, participation in welfare programs, crime rates, and residential segregation. To inform policy, we need to replace speculation with empirical analysis that is both relevant and credible.

The weak state of empirical research should also be disturbing to economists performing theoretical analyses of social interactions. The canonical theoretical study hypothesizes some class of interaction processes and seeks to characterize their implied outcomes. There are countless logically distinct interaction processes that a theorist might entertain. To the extent that theorists want their research to be useful to economic practice, they need to know what classes of processes are prevalent in the real world. In the absence of a connection to reality, economic theory risks reduction to a self-contained exercise in mathematical logic.

Why is it that empirical analysis of social interactions has achieved so little? I believe that two difficulties have combined to produce the status quo. One part of the problem is an unfortunate dearth of clear thinking in the empirical literature. Borrowing jargon from sociology and social psychology, empirical economists may write that they are studying "peer influences," "neighborhood effects," "social capital," or some other form of social interaction. Yet empirical analyses commonly fail to define these concepts with any precision, and they often explain only obliquely how the reported findings shed light on the interactions being studied.

The other part of the problem is the inherent difficulty of inference using the forms of data that economists commonly bring to bear to study social interactions. The prevailing practice has been to try to infer the presence of interactions from observations of the outcomes experienced in a population of interest. However, inference on interactions from observed outcomes is a rather subtle problem. In usual empirical settings, the observed outcomes of the population can plausibly be generated by many different interaction processes or, perhaps, by processes acting on individuals in isolation.

How might economists progress in the empirical analysis of social interactions? Empirical researchers will need to become much more specific about the questions they address. Clear thinking, however, will not suffice. I also see a compelling need to enrich the data that researchers bring to bear. Empirical analysis would particularly benefit from performance of well-designed experiments in controlled environments and from careful elicitation of persons' subjective perceptions of the interactions in which they participate.

In what follows, I flesh out the story begun here. In Section 2, I exposit the economic perspective on social interactions and compare it with that of sociology. In Section 3, I describe empirical practices and elaborate on the two difficulties preventing progress. This discussion leads in Section 4 to a discussion of new data collection that would, I think, improve prospects for economics to make sustained contributions to the empirical analysis of social interactions. Section 5 gives conclusions.

2. Perspectives on Social Interactions

Coherent study of social interactions requires a clear conceptualization of interaction processes. What are the units that interact with one another? How do they interact?

The various disciplines that refer to themselves as *social sciences* have yet to form a common set of answers to these basic questions. There does, however, seem to be a consensus that the perspective of economics is so distinct as to separate economics from the other social sciences. [3] Section 2.1 describes what I see as the main elements of economic thinking on social interactions. Section 2.2 compares the economic perspective with that of sociology.

2.1. Social Interactions in Economics

The particularity of economics begin with its conceptualization of *agents* as decision makers endowed with preferences, forming expectations, and facing constraints. Preferences are given formal expression through utility functions, expectations through subjective probability distributions, and constraints through choice sets. Economists usually go on to assume that agents maximize expected utility, but we shall not require this degree of specificity for the present discussion.

In economic terms, agents are the units who interact with one another. The notion of an agent embraces persons, firms, and other entities such as non-profit organizations and governments. The essential characteristic of an economic agent is not its physical form but rather its status as a

[3] Indeed, the distinctiveness of economics is institutionalized in the name of the major unit of the National Science Foundation that houses the NSF Economics Program – the Directorate for Social, Behavioral, and Economic Sciences.

decision maker.

The concept of an agent as a decision maker carries within it a straightforward answer to the question: How do agents interact? Agents interact through their chosen actions; an action chosen by one agent may affect the constraints, expectations, and/or preferences of other agents.

Constraint Interactions

Markets form the classical economic illustration of constraint interactions. The decisions of agents to purchase certain commodity bundles collectively determine prices, which in turn determine the bundles that are feasible for agents to purchase.

Another familiar form of constraint interaction is congestion, which may occur when multiple agents share a common resource. Whereas market analysis imagines agents endowed with money budgets who purchase commodities having money prices, congestion analysis often imagines agents endowed with time budgets who choose activities that consume time. The time cost of some activities depends on the number of agents choosing them; road travel, web surfing, and restaurant dining are examples. The decisions of agents to engage in these activities collectively determine their time costs, which in turn determine the activity bundles that are feasible for agents to choose.

Markets and congestion exemplify negative constraint interactions; the more that some agents choose a commodity or activity, the less available it is to others. In contrast, decisions by agents to engage in research and development may generate positive constraint interactions. R & D enlarges the production set of the agent performing it. To the extent that findings are public knowledge, R & D by one agent enlarges the production sets of other agents as well.

Expectations Interactions

Economic analysis supposes that an agent facing a decision problem will form expectations of the outcomes that would follow from choosing different actions. An agent forming expectations may seek to draw lessons from observation of the actions chosen and outcomes experienced by others.[4] Such *observational learning* generates expectations interactions.

Expectations interactions pervade the modern economics of information. A central concern is to understand the interactions of agents who possess private information; that is, knowledge not directly available to one another. A recurring theme is that observation of chosen actions may reveal private information; for example, health insurance purchases may reveal consumers' health status and acceptance of job offers may reveal workers' skills (e.g., Akerlof, 1970). This theme takes particularly strong form in the theory of efficient markets, where observation of prices suffices to reveal all relevant private information.

Statistical discrimination is an information interaction (e.g., Arrow, 1973; Cain, 1986). An employer who observes the job performance of current employees with certain demographic attributes may use this information to forecast the performance of new job applicants with similar attributes. A provider of insurance may likewise use data on the claims paid to current current policy holders with certain covariates to forecast the claims that would be payable to new applicants with these covariates.

It should be said that economists have not been unanimous in the view that expectations interactions form an important subject for study. A very large part of modern economic analysis

[4] Some studies assumes that only actions are observable while others assume that actions and subsequent outcomes are observable. In general, economists have assumed that agents do not directly observe the expectations of other agents.

presumes that agents have rational expectations, wherein agents' subjective beliefs about future events are the best predictions possible given the available information. Studies assuming rational expectations typically do not attempt to explain how agents may come to form such optimal forecasts. This fundamental question is addressed only in a relatively small literature seeking to characterize when observational learning processes will or will not generate rational expectations (e.g., Cyert and DeGroot, 1974; Kalai and Lehrer, 1993).

Preference Interactions

Preference interactions occur when an agent's preference ordering over the alternatives in his choice set depends on the actions chosen by other agents. Such everyday ideas as conformism, jealousy, and paternalism suggest forms of preference interaction. Neoclassical consumer theory long rejected these ideas in favor of a presumption that agents care only about their own consumption, or perhaps only about the consumption of their families. Yet there is nothing in the logic of economic thought that mandates this narrow view of preferences (see Pollak, 1976).

Preference interactions are at the heart of non-cooperative game theory. The standard setup considers a set of agents who simultaneously choose actions, each from his own choice set. The utility that each agent receives depends on the actions chosen by the other agents. Hence an agent's preference ordering on the alternatives in his choice set depends on the actions chosen by the other agents.

A simple example is the Schelling (1971, 1978) model of residential segregation. Here the choice set is a set of alternative neighborhoods in which one might reside. Schelling supposed that the utility a person associates with each neighborhood may depend on the racial distribution of the

persons who choose to reside there. Another simple example is the formation of driving conventions in the absence of road laws, as discussed by Young (1996). Each driver chooses between driving on the right or the left side of the road. The utility of driving on one side or the other clearly depends on the choices made by other drivers sharing the same road.

Equilibrium

If economics were content to describe how agents may interact, an extended version of the above verbal discussion might suffice. The discipline has, however, set for itself a much more ambitious objective. Economists want to characterize the outcomes of interactions processes. Words do not suffice for this purpose. Mathematical formalization seems essential. So economists commonly pose formal models of agent behavior and explicit specifications of the manner in which chosen actions may affect constraints, expectations, and preferences. This done, analysis of the outcomes of interaction processes may begin.

The discipline has long focused attention on equilibrium outcomes; that is, outcomes that occur when agents' actions are mutually consistent. Much of the theoretical literature has been concerned with basic qualitative questions that can be addressed in considerable generality: Do equilibria exist? If so, is equilibrium unique? Of course, economists want to go further and characterize as fully as possible the nature of such equilibria as may exist. Pursuing this objective, researchers have reported illuminating algebraic or graphical analyses of some simple interaction processes. At the same time it has become clear that many processes of substantive interest are too complex to be analyzed abstractly. Hence researchers have increasingly used numerical methods to characterize the equilibria of specific processes, as well as to study their dynamics (e.g., Arthur et

al., 1997).

More General Processes

I have briefly described here a wide variety of social interactions that may be studied with standard economic tools. Much more is possible. I have restricted attention to processes in which agents affect each other through their actions. A more general class of interactions permits the preferences, expectations, and constraints of one agent to affect the preferences, expectations, and constraints of another agent in ways that are not mediated through actions.

Consider preference interactions. It is one thing to say that my preferences depend on your actions, and another to say that my preferences depend on your preferences. Or consider expectations interactions. The processes that we have discussed suppose that agents extract information from observation of the actions chosen and outcomes experienced of others. Agents may also obtain information directly from one another. After all, humans do communicate about all sorts of things.

Going beyond the question of how agents interact, our discussion has been incomplete in the more basic sense that we have not considered how agents come to be. Economics has given much attention to the entry and exit of firms in markets, and some to the formation and evolution of families. The discipline has done less, however, to explain the creation and dissolution of governments, non-profit organizations, and other decision making entities.

2.2. Social Interactions in Sociology

An enhanced sense of the particularity of economic thinking emerges when one compares economics with sociology.[5] The sociologist Charles Camic has written engagingly on how the discipline of sociology emerged out of economics (Camic, 1987). According to Camic, separate university departments of sociology came into being as a consequence of the triumph of neoclassical economics over institutional economics in the 1920s and 1930s. As neoclassical economists sought to formalize analysis of market interactions, they disparaged the broad but loose study of social interactions characteristic of institutional economics. Sociology departments emerged to study the range of non-market interactions that neoclassical economists judged to be outside the proper domain of the discipline.

Sociology has had a substantial period of time within which to develop as a separate discipline, so one might expect a coherent sociological analysis of social interactions to have developed by now. Not so. Examination of recent sociological research does not reveal a shared, discipline-wide perspective. Some sociologists describe interactions in language that suggests economic thinking. Others give prominence to concepts that play little or no role in modern economics: class, community, culture, influence, status, gender roles, and so on. Indeed, an economist reading sociological research is struck by the sheer number of concepts that sociologists employ. Economics has sufficed with a remarkably small set of basic concepts (preferences,

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[5] A different sense of the particularity of economics comes from comparing the discipline with psychology, which does not begin from the premise that humans have well-defined preferences and expectations. Comparison of economics with psychology is enlightening, but is not as germane to the topic of this article as is comparison with sociology.

expectations, constraints, equilibrium). Why does sociology require so many more concepts?

I believe that the abundance of concepts in sociology is connected closely to the dearth of formal analysis in the discipline. Whereas the typical research article in economic theory uses mathematical language to define concepts and then goes on to state and prove propositions, most articles in sociological theory begin and remain verbal throughout. [6] Verbal reasoning may be more evocative than mathematical argument, but it is also less precise. The ambiguity of words permits a proliferation of concepts. Readers of verbal sociological research can never be certain that they understand a concept in the way that an author intends, nor the relationship among concepts. Hence they cannot readily distinguish between concepts that are truly basic and ones that are derivative or, worse, ill-defined.

An apt illustration is the term "social capital," which came into vogue in the 1990s. There is some uncertainty about the origin of the term. Many associate it with Coleman (1988) and Putnam (1993), but Durlauf (1999) credits it to Loury (1977) and Glaeser et al. (1999) date it back to Jacobs (1961). The origin of "social capital" should be a resolvable matter, but the meaning of the term may not be. So many authors have sought to define the term in so many ways that I shall make no attempt to provide a definition here; the interested reader may want to see Bowles (1999), Durlauf (1999),

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[6] There was a period in the 1960s and 1970s when sociology seemed to be on the verge of a methodological transformation that might yield a rigorous discipline akin to economics. Social network analysts developed a formal, graph-theoretical language to represent the myriad informal bonds that connect humans to one another (e.g., Holland and Leinhardt, 1970). James Coleman sought to lay the foundations for a mathematical representation of sociological theory in Coleman (1964). The *Journal of Mathematical Sociology* began publication in 1971. The sociological methodologist Otis Dudley Duncan worked with the econometrician Arthur Goldberger to develop a common empirical approach to analysis of market and non-market interactions (Goldberger and Duncan, 1973). For whatever reason, the transformation did not take hold. Indeed, sociology today appears no more rigorous a discipline than thirty years ago.

Glaeser et al. (1999), and Portes (1998) for varying perspectives.

The only salient question, as I see it, is whether this vague term conveys an idea that is missing in modern economic thought; an idea that cannot be expressed using the core concepts of preferences, expectations, constraints, and equilibrium. If so, the ongoing efforts to interpret "social capital" may be productive. If not, social scientists should use "social capital" only as a lesson in the ambiguity of words.

3. Empirical Analysis of Observed Outcomes

Throughout the modern development of economics, empirical analysis of social interactions has lagged far behind theory, with distressing consequences. Even the most ambitious economic theory does not aim to give a complete description of reality. Each leaves the magnitudes of critical quantities – demand elasticities, returns to scale in production, time discount rates, risk preferences, and so on – to be determined empirically. Alternative theories put forward different visions of reality. Empirical analysis is essential to determine which theories should be taken seriously as descriptions of the world as it is, rather than as it might hypothetically be.

The practice in empirical economics has been to infer the nature of an interaction process from observations of its outcomes. This presents a rather subtle problem of identification. In usual empirical settings, the observed outcomes can plausibly be generated by many alternative interaction processes acting on constraints, expectations, or preferences. Or the observed outcomes may be the result of processes acting on agents separately. Outcome data typically have only limited power to

distinguish among the alternative plausible hypotheses.

Most every student in economics receives instruction on one instance of the problem of identification of social interactions, this being inference on supply and demand from observations of prices and quantities in competitive markets in equilibrium. I begin with this familiar case and then move on to inference on other interaction processes.

3.1. Econometric Analysis of Markets

The theory of equilibrium in markets with price-taking consumers and price-taking (or quantity-taking) firms was well under development over a century ago, but the corresponding problem of empirical inference on demand and supply was only dimly understood until the 1940s. At that time, econometric analysis of the *simultaneity problem* developed under the maintained assumption that the quantity of product demanded by consumers varies linearly with price, and similarly that supply functions are linear. Of course economic theory gives no reason to think that demand and supply functions are generally linear. Nevertheless, it was reasonable for early econometricians to begin with the study of linear models if only because they are relatively easy to analyze.

The central finding of early structural econometrics was that observation of equilibrium prices and quantities does not suffice to untangle the market interaction of consumers and firms, even if one somehow knows a priori that demand and supply functions are linear.[7] Some further

[7] The reason is simple. Observation of an equilibrium (price, quantity) reveals only that demand and supply intersect at this point. There are innumerable pairs of linear functions that intersect at any given point.

prior information is necessary if one is to distinguish demand and supply from one another. This further information can take various forms, but the essential requirement is expressed well in the familiar idea of exclusion restrictions; a priori knowledge that some factor, an *instrumental variable*, affects supply but not demand, while some other factor affects demand but not supply. Economists have become well aware that credible exclusion restrictions or other identifying assumptions are elusive in practice. Thus, the early econometrics literature on identification of linear simultaneous equations has made economists appreciate the subtlety of inference on social interactions.

It has now been a half-century since the codification of econometric analysis of linear simultaneous equations in the work of the Cowles Commission (see Hood and Koopmans, 1953). How has structural econometric analysis of market interactions progressed since then? The answer has two parts, presently in much tension with one another.

Part of the answer is that the scope of econometric analysis of markets has enlarged substantially over time, as a result of the development of econometric methods for estimation of nonlinear models of consumer and firm behavior. Econometric research on discrete choice analysis has enabled empirical researchers to analyze the demand for consumer durables, schooling, and other differentiated products typically purchased in discrete units (e.g., Dubin and McFadden, 1984; Manski and Wise, 1983). Discrete choice analysis, research on maximum likelihood estimation of limited dependent variable models, and work on method of moments estimation has combined to enable empirical analysis of firm pricing behavior in oligopolistic markets (e.g., Green and Porter, 1984; Berry, Levinsohn, and Pakes, 1995). Thus, the early restriction of empirical analysis to market settings that can reasonably be represented by linear simultaneous equations has been overcome.

The other part of the answer is that structural analysis of markets remains as subtle an

inferential problem as it was fifty years ago. Modern developments in econometric method do not, indeed cannot, resolve the basic identification problem that economists have long appreciated. The fact remains that observation of market transactions reveals only so much about the behavior of consumers and firms. Today, as fifty years ago, structural econometric research interprets data on transactions with the assistance of exclusion restrictions and through the lens of tightly specified models of consumer and firm behavior, chosen in large part for their tractability. Today, as fifty years ago, empirical findings are only as credible as the particular exclusion restrictions and modeling assumptions imposed. [8]

Juxtaposition of the two parts of the answer indicates that modern empirical researchers can analyze a wide range of interesting market interactions if they are willing to maintain strong assumptions that may be difficult to motivate. This appears to pose a stark choice: report findings that may lack credibility, or retreat from the objective of econometric analysis of market interactions. The result has been much controversy in empirical economics, with researchers segmenting into camps that advocate one or the other of these unpleasant alternatives. In macroeconomics, the controversy has taken the form of a debate about *calibration*; see the recent *Journal of Economic Perspectives* symposium with contributions by Kydland and Prescott (1996), Hansen and Heckman

[8] The empirical literature shows a curious asymmetry in the concern researchers show about the realism of different assumptions. The realism of exclusion restrictions is a recurrent theme, with much criticism befalling the researcher who uses an "invalid" instrumental variable. Yet researchers often regard functional form and distributional assumptions in models of consumer and firm behavior as convenient approximations that do not materially affect inference. In fact, exclusion restrictions, functional form, and distributional assumptions all play essential roles in prevailing approaches to structural econometric analysis. This can be seen by unbundling the various assumptions and determining their identifying power in isolation from one another (e.g., Manski 1995, 1997a).

(1996), and Sims (1996). In labor economics, empirical researchers using data on observed outcomes to perform structural econometric analysis have become estranged from ones who hold that empirical research should be based as closely as possible on the paradigm of randomized experimentation; for example, compare the analysis of the returns to schooling in Willis and Rosen (1979) with that of Angrist and Krueger (1990).

I do not want the reader of this article to have the impression that I have been a disinterested observer, regarding the various camps from a distance. I have for more than a decade advocated a mode of empirical research that explicitly recognizes the tension between strength of assumptions and credibility of findings. As described in Manski (1995), one begins with a conservative analysis that imposes only assumptions enjoying considerable consensus. Such assumptions typically imply bounds on parameters of interest, not point identification. [9] One then invokes further assumptions that yield stronger findings at the cost of diminished credibility.

[9] For example, Manski (1997a) examines the simultaneity problem under the sole assumption that demand functions slope downward. Manski and Pepper (2000) examines the inferences that are possible when the classical notion of an instrumental variable is replaced with a weaker but more credible notion of a *monotone instrumental variable*.

3.2. Econometric Analysis of Games

A wide spectrum of social interactions, from divorce proceedings to union-management negotiations, can usefully be thought of as non-cooperative games, each player choosing an action from some set of feasible alternatives. It is common to assume that the players have reaction functions specifying the action that each would choose as a function of the action chosen by the others. An equilibrium of the game is a set of mutually consistent actions.

The problem of inference on players' reaction functions from observation of game equilibria has much the same structure as the problem of inference on supply and demand from observations of market equilibria. Hence econometric research on the analysis of markets has found considerable application in the analysis of non-market games as well. Consider, for example, labor economists studying interactions within the family. McElroy (1990) has interpreted data on the labor supply of husbands and wives as the equilibrium of a game in which the hours worked by each spouse varies with the hours worked of the other spouse. Rosenzweig and Wolpin (1994) has applied game theory to interpret data on intra-family monetary transfers. Flinn and Del Boca (1994) has interpreted data on child custody outcomes in divorce proceedings as the equilibrium outcome of a game in which the separating spouses and the government are the players.

The fundamental identification problem that shadows econometric analysis of competitive markets persists in econometric analysis of non-market games. Hence empirical research on games generates the same tension between assumptions and credibility. Indeed, many games are much more complex than competitive markets. Players may be uncertain of each other's strategies, equilibria may not exist or may not be unique, and so on. These complexities, when taken seriously,

intensify the inferential problem considerably. [10]

Crime and Punishment

An illuminating illustration of the difficulty of empirical inference on games arises in the economics of crime, which has long sought to learn the deterrent effect of sanctions on criminal behavior. In the early 1970s, it became common for economists to analyze observed crime rates and sanction levels as equilibrium outcomes of two-person games in which criminals (player 1) choose a crime rate and society (player 2) chooses sanctions. Linear reaction functions were used to specify the crime rate that criminals would choose given specified sanctions, and the sanctions that society would choose given a specified crime rate.

The simultaneity problem in inference on deterrence became a concern beyond the academic community when the Solicitor General of the United States argued to the Supreme Court that a study by Isaac Ehrlich provided empirical evidence on the deterrent effect of capital punishment. Ehrlich (1975) used annual data on murders and sanctions in the United States to estimate a "murder supply" function specifying the murder rate that would occur as a function of sanctions levels, including the risk of capital punishment faced by a convicted murderer. He concluded (Ehrlich, 1975, p. 398): “In fact, the empirical analysis suggests that on the average the tradeoff between the execution of an offender and the lives of potential victims it might have saved was of the order of 1 for 8 for the period 1933-1967 in the United States.”

This finding, and its citation before the Supreme Court as evidence in support of capital

[10] See Jovanovic (1989) and Tamer (1999) for analysis of the problem of inference on games with multiple equilibria.

punishment, generated considerable controversy. A constructive outcome was the establishment by the National Research Council (NRC) of a panel to investigate in depth the problem of inference on deterrence (Blumstein, Cohen, and Nagin, 1978). The NRC Panel on Research on Deterrent and Incapacitative Effects focused much of its attention on the simultaneity problem and stressed the difficulty of finding plausible exclusion restrictions to identify deterrent effects. Regarding the deterrent effect of capital punishment, the Panel concluded (p. 62) "The current evidence on the deterrent effect of capital punishment is inadequate for drawing any substantive conclusion."

Understanding the deterrent effects of sanctions remains an important unresolved problem today. An account of the evolution of Ehrlich's thinking on the subject has appeared recently in Ehrlich (1996).

3.3. Experimental Research

Econometric analysis of markets and other games has generally sought to analyze data on outcomes generated as the world turns. A distinct tradition of experimental research analyzes data on outcomes generated through purposeful interventions.

As long as fifty years ago, social psychologists reported provocative experimental findings on interactions in small groups (Asch, 1952).[11] The 1980s and 1990s saw a blossoming of experimental research in economics, the primary objective being to ascertain the realism of equilibrium concepts developed in game theory (see Kagel and Roth, 1995). Recently, economists have begun to perform experiments seeking to shed light on the expectations interactions commonly

[11] Jones (1984) provides an economic perspective on experimental social psychology.

called "trust" (Fershtman and Gneezy, 1998; Glaeser et al., 1999).

Experimental research clearly has limitations. Only some kinds of interactions are amenable to experimental manipulation and, even then, only in somewhat artificial settings. A longstanding criticism of the experiments conducted by psychologists, and more recently by experimental economists, is that the groups whose interactions are observed are formed artificially for the sake of the experiment. This raises obvious questions about the credibility of extrapolating findings from experimental settings to populations of interest.

It is often suggested that experimental research would be more credible if the experiments were performed on randomly selected subjects. This is difficult to achieve. The unit of analysis for a study of social interactions is the group that interacts, not the individuals that comprise the group. Harris (1985) and Garfinkel et al. (1992) discuss issues that arise in randomization of groups and offer some suggestions for practice. [12]

The limitations of experimental research should not dissuade researchers from judicious use of experiments to complement observation of naturally occurring outcomes. I expect that economists will make increasing use of experimental data in the years ahead.

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[12] Occasionally, one can learn something about social interactions from "natural experiments;" that is, naturally occurring outcomes that can credibly be viewed as arising from randomized experiments. For example, Angrist and Lavy (1999) uses random variation in school class sizes, induced by institutional rules, to examine how class size may affect educational outcomes.

3.4. Why do Persons in the Same Group Tend to Behave Similarly?

Whatever their difficulties, econometric and experimental analysis of markets and games at least aim to analyze well-defined forms of social interactions. Much recent empirical research conceptualizes interaction processes only in broad terms that lack the clarity of markets and games. A common objective has been to learn whether some form of interaction may explain the often reported descriptive finding that persons belonging to the same group tend to behave similarly.

Many social scientists have hypothesized that this empirical regularity is due to interactions in which the propensity of a person to behave in some way varies positively with the prevalence of this behavior in the group. Such interactions may be called "social norms," "peer influences," "neighborhood effects," "conformity," "imitation," "contagion," "epidemics," "bandwagons," or "herd behavior." See, for example, Hyman (1942), Merton (1957), and Granovetter (1979). Some, however, have hypothesized that similarity in behavior is due to processes operating entirely at the level of the individual (see, for example, the Friedman 1957, criticism of Duesenberry 1949.) Jencks and Mayer (1989) describe the long running debate about the nature of neighborhood effects.

Stripped to its basics, empirical research has sought to distinguish among three hypotheses:

endogenous interactions, wherein the propensity of a person to behave in some way varies with the behavior of the group.

contextual interactions, wherein the propensity of a person to behave in some way varies with exogenous characteristics of the group members.

correlated effects, wherein persons in the same group tend to behave similarly because they have similar individual characteristics or face similar institutional environments.

Endogenous and contextual interactions express distinct ways that persons might be influenced by their social environments, while correlated effects express a nonsocial phenomenon. Consider, for example, the high school achievement of a teenage youth. There is an endogenous interaction if, all else equal, individual achievement tends to vary with the average achievement of the students in the youth's high school, ethnic group, or other reference group. There is a contextual interaction if achievement tends to vary with, say, the socioeconomic composition of the group. There are correlated effects if youth in the same school tend to achieve similarly because they are taught by the same teachers, or because they have similar family backgrounds. [13]

Distinguishing among endogenous interactions, contextual interactions, and correlated effects has been thought important because these hypotheses imply different predictions for the impact of public policy. Consider, for example, an educational intervention providing tutoring to some of the students in a school but not to the others. If individual achievement increases with the average achievement of the students in the school, then an effective tutoring program not only directly helps the tutored students but, as their achievement rises, indirectly helps all students in the school, with a feedback to further achievement gains by the tutored students. Contextual interactions and correlated effects imply no such feedbacks. [14]

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[13] Tiebout (1956) made economists sensitive to the idea that residential location decision processes will tend to produce communities made up of families with similar attributes.

[14] Juxtaposition of endogenous and contextual interactions reveals a disciplinary contrast between economics and sociology. A central objective of economists has been to understand the

The Reflection Problem

Unfortunately, outcome data do not readily differentiate among endogenous interactions, contextual interactions, and correlated effects. In Manski (1993a; 1995, Chapter 7) I examined a familiar linear-in-means regression model in which individual behavior is permitted to vary linearly with mean behavior in the group (expressing endogenous interactions), with the mean values of exogenous attributes of group members (expressing contextual interactions), and with personal characteristics that may be similar across group members (expressing correlated effects). In this setting, I found that data on equilibrium outcomes cannot distinguish endogenous interactions from contextual interactions. The researcher may be able to distinguish these two forms of interactions from correlated effects, but even this limited form of inference is possible only in some situations; the exogenous attributes of individuals must vary within and across groups in certain ways.

This identification problem arises because mean behavior in the group is itself determined by the behavior of group members. Hence data on outcomes do not reveal whether group behavior actually affects individual behavior, or group behavior is simply the aggregation of individual behaviors. This *reflection problem* is similar to the problem of interpreting the almost simultaneous movements of a person and his reflection in a mirror. Does the mirror image cause the person's movements or reflect them?

Brock and Durlauf (2000), Manski (1993a, 1997b), and Moffitt (1999) investigate

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feedbacks generated by endogenous interactions. Some sociologists share this objective but modern sociological research has emphasized contextual interactions, which lack feedbacks. Contextual interactions became an important concern of sociologists in the 1960s, when substantial efforts were made to learn the effects on youth of school and neighborhood environment (e.g. Coleman et al., 1966; Sewell and Armer, 1966). The recent resurgence of interest in spatial concepts of the underclass has spawned new empirical studies (e.g. Crane, 1991; Mayer, 1991).

alternatives to the linear-in-means model that open other possibilities for identification, in principle if not in practice. One alternative supposes that individual behavior varies with lagged rather than contemporaneous values of group mean behavior. This resolves the identification problem if one a priori knows the appropriate lag length. Another alternative supposes that individual behavior varies in a specified nonlinear manner with group mean behavior. This resolves the identification problem if one a priori knows the correct nonlinear function. A third alternative supposes that individual behavior varies with some feature of group behavior other than the mean; the median say. This resolves the identification problem if one a priori knows the relevant feature of group behavior. These and other alternative models may sensibly be applied in some settings but here, as in econometric analysis of market interactions, empirical findings are only as credible as the identifying assumptions imposed.

The discussion thus far assumes that the researcher a priori knows the group, or groups, with whom a person may interact. Outcome data do not reveal group composition, so researchers must somehow obtain this information in other ways.[15] Lacking empirical evidence, economists have typically made assumptions about group composition and then proceeded with analysis.[16] For example, the Borjas (1991) analysis of "ethnic capital" presumes that persons interact with members of their own ethnic group. The Glaeser et al. (1996) study of social interactions in crime applies an abstract spatial model of neighbors on a lattice to precinct and city-level data, the Case (1991) study

[15] The need for prior information on group composition also arises in studies of markets and games. In market analyses, the researcher must a priori specify the relevant consumers and firms. Games are not well-defined until the players are specified.

[16] Empirical evidence on group composition may be elicited from group members. This practice has a long history in sociology (e.g., Coleman et al., 1957; Marsden, 1990), but economists typically do not collect or use such data. A recent exception is Woittez and Kapteyn (1998).

of demand interactions measures strength of the interaction by distance, and the Case and Katz (1991) study of inner-city youth defines neighborhoods as units one or two square blocks in size. Often, however, it is not obvious what the relevant groups should be. Consider, for example, the definition of "neighborhood" in studies of neighborhood effects. Considering the geography of residences, should the neighborhood be assumed to be an apartment house, a block, a census track, or a city? Or might the relevant geography be that of schools, workplaces, or church parishes? And what of telecommunications that may diminish the importance of physical geography entirely?

However severe the reflection problem may be when group composition is known, the problem becomes insurmountable when group composition is unknown. Mean group behavior is, by definition, the average of the individual behaviors in the group. It follows that, given any specification of group composition, the regression of individual behavior on group mean behavior is linear with coefficient one.[17] Hence, when observed outcomes constitute the only empirical evidence available, a researcher who conjectures the presence of endogenous interactions within any hypothesized group cannot be proved wrong.

4. Inside Endogenous Interactions

Suppose that an empirical researcher is able to find credible evidence indicating the presence

[17] This is easy to show. Let the hypothesized group be all persons with attributes x. Let y denote the behavior or other outcome of interest. Let $E(y^{\star}x)$ be the mean of y in group x. Suppose that a researcher hypothesizes the linear regression model $y = a + bE(y^{\star}x) + u$, with $E(u^{\star}x) = 0$. Taking expectations of both sides yields $E(y^{\star}x) = a + b\,E(y^{\star}x)$. Hence the linear model holds tautologically with $a = 0$ and $b = 1$.

of endogenous interactions. How much does this accomplish? From the perspective of economics or policy, not very much.

The concept of endogenous interactions is too broad to be very useful. This concept aggregates all three of the basic economic processes described in Section 2.1 – preference, expectations, and constraint interactions. Each of these processes describes a distinct channel through which group behavior may affect individual behavior; hence each is endogenous. If empirical analysis is to be useful, it needs to do more than show the presence of endogenous interactions writ large.

To make the point concretely, consider the public concern about high rates of drug use among youth in areas of concentrated poverty. Suppose that credible empirical evidence for endogenous interactions should emerge. Such evidence would leave open basic questions about the processes at work. Does the stigma associated with drug use fall as the prevalence of use rises (a preference interaction)? Or do youth learn about the attractiveness of drug use by observing it in their environs (an expectations interaction)?

Understanding interactions at a deeper level seems essential to evaluate the effectiveness of anti-drug initiatives providing information on the deleterious effects of drug addiction. Consider the crack cocaine epidemic of the 1980s, which appears to have subsided during the 1990s. A plausible explanation of the course of the epidemic begins with positive expectations interactions as youth of the ‘80s may have observed some of their peers initiate crack usage and apparently enjoy it. There also may have been positive preference interactions of the stigma-reducing type. Eventually, however, youth of the ‘90s may have observed the devastating long-term outcomes experienced by addicts of the ‘80s, and subsequently may have chosen not to initiate crack use themselves. If this

story of observational learning is correct, then an information campaign warning of the devastating effects of crack addiction might have been effective in the early stages of the epidemic but superfluous later on.

Abstracting from the case of drug use, it is important in general to distinguish preference interactions from the expectations interactions generated by observational learning. The phenomenon of interest may be epidemics in drug use or queuing for tables at well-regarded restaurants or herd behavior in stock trading. In these and many other situations, one person may "imitate" another because the former person prefers to act like the latter, or because he believes the latter person to have superior information.[18] These explanations are distinct and have differing implications for policy. Interventions that provide new information may alter the nature of expectations interactions or even cause them to disappear, but should have no effect on preference interactions.

Subjective Data for Subjective Concepts

Preferences and expectations are the core subjective concepts of economics. Having devoted much of my own research to revealed preference analysis of discrete choice behavior, I have become keenly aware that observation of the action that a person chooses places only mild restrictions on the

[18] Explanation of imitation as an expectations interaction has been a recurring theme in theoretical research on observational learning. See, for example, Conlisk (1980), Bannerjee (1992), Bickchandani et al. (1992), and Manski (1993b). However, Bernheim (1994) models imitation as a preference interaction. Among empirical researchers, Foster and Rosenzweig (1995), Munshi (1999) and Munshi and Myaux (1999) have been careful to separate imitation based on preference and expectations interactions.

person's preferences and expectations.[19] Rather than try to infer preferences and expectations from observations of chosen actions, why not elicit them directly?

Pose this question to an economist, and chances are that one will receive an instant hostile response. Economists tend to be deeply skeptical of subjective statements. Early in their careers, they are taught to believe only what people do, not what they say. Economists often assert that respondents to surveys have no incentive to answer questions about their preferences or expectations carefully or honestly; hence, there is no reason to believe that subjective responses reliably reflect respondents' thinking.[20] As a result, the profession has enforced something of a prohibition on the collection of subjective data.

In the absence of data on preferences and expectations, economists have compensated by imposing assumptions. The profession has shown a striking asymmetry in its attitude toward preference and expectations assumptions. Economists tend to show discomfort imposing assumptions on preferences. Yet researchers easily impose severe assumptions on expectations,

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[19] The theory of reveal preference analysis pioneered by Samuelson in the 1940s posed a thought experiment in which a person with perfect foresight chooses an action from each of many distinct choice sets. A researcher observing the set of chosen actions can then infer the person's preferences. The Savage (1954) theory of subjective expected utility posed such a thought experiment in a setting where the person does not know the *state of nature*. Savage found that, if the set of chosen actions adheres to certain axioms, the observer can infer the person's preferences and expectations.

Empirical applications of revealed preference analysis do not have the extensive data presumed available in the Samuelson and Savage thought experiments. The empirical researcher usually observes a sample of heterogeneous persons, each of whom makes a single choice from a single choice set. Observation of a single choice from a single choice set reveals something, but not much, about a persons's preferences and expectations.

[20] Interestingly, economists do not apply this reasoning to self-reports of "objective" data. Empirical researchers routinely accept as fact survey respondents' reports of their socioeconomic and demographic characteristics, choices, and experiences.

often without comment. It has become especially commonplace to impose rational expectations assumptions.

My experience in econometrics has led me to conclude that there is only limited scope for productive theorizing about preferences and expectations alike. Rational expectations assumptions should be particularly suspect. Agents forming forecasts of the consequences of choosing alternative actions confront the same difficult inferential problems that economists face as they attempt to perform empirical research. Research in econometric method emphasizes that empirical findings depend on the data available and the assumptions maintained. How can a theorist presume to know what data individuals have available and what assumptions they maintain? And what reasoning justifies the rational-expectations assumption that individuals share a correct understanding of the structure of the economy, when examination of the state of economic science shows substantial disagreement among professional economists? [21]

Unable to answer these questions, about ten years ago I began to question seriously the conventional economic wisdom about elicitation of expectations. I sought to determine the scientific basis underlying economists' hostility, and found it to be meager. [22] I subsequently began a program

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[21] A concrete instance may be helpful to have in mind. In Manski (1993c), I pointed out that youth forming earnings expectations as they contemplate schooling choices confront the same inferential problems as do labor economists when they study the returns to schooling. The literature on labor economics exhibits much debate on the credibility of various assumptions and many disagreements about findings. If experts disagree on the returns to schooling, is it plausible to assume that youth have rational expectations?

[22] During the 1950s, economists reported negative evidence on the usefulness of a certain type of qualitative questioning about expectations in predicting consumer behavior. This narrow finding appears to have led economists to draw the broad, but unsubstantiated conclusion that all expectations data are suspect. Dominitz and Manski (1997a, 1999) discuss this history.

There seems to be a similarly narrow basis for the hostility of economists towards elicitation of preferences. In this case, the available negative evidence largely concerns the practice of

of research eliciting economic expectations in the form of subjective probabilities (e.g., Dominitz and Manski, 1997a, 1997b). Research along similar lines has been initiated by others (e.g., Hurd and McGarry, 1995; Guiso et al., 1992).

Enough has already been accomplished to make clear that the conventional wisdom is unfounded. Survey respondents do provide coherent, useful information when queried about their expectations. However, the new literature on elicitation of expectations is still in its infancy. Research needs to move beyond its current focus on measurement of expectations to the more challenging task of eliciting information on how persons form their expectations. Only when that happens will it be possible to assess the contribution that collection of subjective data can make to our understanding of expectations interactions.

5. Wanted: Clear Thinking and Adequate Data

Development of an informative, cumulative body of empirical research on social interactions will require clear thinking and adequate data. The very first step must be to get the concepts right. The core concepts of present-day economics – preferences, expectations, constraints, and equilibrium – offer a coherent framework within which one can define rigorously and analyze constructively many interaction processes. These economic concepts may not suffice to characterize all of the ways that humans interact with one another, but I cannot envision how social science might flourish

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contingent valuation, where respondents are asked about their willingness to pay for public goods (e.g. Hausman, 1993).

without them.

The next step must be to respect both the logic and the credibility of scientific inference. Empirical researchers obviously need to understand how the conclusions of an empirical analysis depend logically on the data and assumptions brought to bear. They must also appreciate how the strength of the assumptions they maintain affects the credibility of the empirical findings that they report.

Clear thinking is a prerequisite for productive empirical analysis but it does not suffice. The data brought to bear must be adequate to make credible inference possible. The practice has been to infer interaction processes from observations of their outcomes. The discussion of Section 3 makes plain that outcome data do not, per se, provide an adequate foundation for empirical research. Sustained progress will require richer data. In Manski (1993a), I concluded that experimental and subjective data will have to play important roles in future efforts to learn about social interactions. Having observed the subsequent evolution of empirical research, I feel even more strongly about this today.

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