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## Markets and Organizations

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## Introduction

Research on markets and organizations has been important in several social and behavioral sciences, especially since the late 1960s. For several hundred years a central problem in economics has been to understand how a society organizes or should organize its economic activity. Until recently, the main objective has been to understand how a system of markets does its job. But there are also other mechanisms for coordinating economic activity, many of which play important parts in the existing economies of the world. One of the most important developments in economics of the past two decades or so has been the introduction of rigorous methods for the study of this broader class of mechanisms. A main objective of this effort is to provide a theory of organization and a related body of empirical knowledge and experimental results that can serve as a basis for the design of efficient organizations to carry out specified objectives of performance, taking into account the underlying constraints that apply to organizations, including those arising from limited capacity to process information and from divergence of goals among economic agents.

Study of organizations has been an important field of sociology. In sociological analysis organizations play a pivotal role because they link broad institutional change to individual action and outcomes. Individuals shape social structure mainly by participating in organizations; organizations filter the impacts of broad-scale changes for individuals. Understanding these links requires theories of (1) the effects of broad social, political, and economic changes on organizations; and (2) the effects of organizational structures on the life chances of individuals. Here, we concentrate on the first problem. Study of organizations has also been an important part of anthropology, organization behavior, political science, and social psychology. Since these disciplines were not represented in our group, we have limited ourselves to noting briefly points at which we feel those disciplines touch on the questions we address.

The objectives of research on organizations may be put in the form of questions the field needs to answer:

1. What laws or constraints govern the (design of) internal processes of organizations, including markets? These internal processes in-

clude decision processes and processes that determine the internal objectives of organizations.

2. What relationships exist between internal processes and performance? How does performance relate to centralization or decentralization? to hierarchical or parallel structures? How should different organizations be compared?
3. What criteria can be used to evaluate organizations, including markets and other institutions? Such criteria may be externally generated or may come from internally generated organizational goals. In economics, the criterion of Pareto optimality is widely used, and others, such as fairness, have also been studied.
4. What laws or constraints govern the endogenous adaptation of organizations to changing environments, especially when environmental changes are unpredictable?

### *Useful Knowledge*

The acquisition of fundamental knowledge about organization is important as a scientific enterprise, but it is also important from the standpoint of usefulness to society. It has been asserted that the superior competitive performance of the Japanese in the economic sphere is due to special characteristics of their organization of economic life, in the context of Japanese culture and society. The knowledge needed to decide whether this assertion is true would come from a deeper understanding of the principles governing economic organization, of the factors and relationships conditioning the possibilities of organizational design, of the way in which performance depends on the organizational design, and of the role of historical and social factors in organizational design.

We can cite a few examples of important problems in areas to which knowledge about organization could be usefully applied. These include defense contracting, or government contracting more generally (McAfee and McMillan, 1988). (Here, the relevant scientific models are those of mechanism theory, including the so-called principal-agent models discussed below.) The granting of rights to explore or drill for oil at offshore locations is another example. (Here, the recently developed theory of auctions provides important insights (McAfee and McMillan, 1987; Wilson, 1987.) Another example is that of unemployment. The impact of economic changes on employment depends in part on the internal processes of employing organizations. The impact of an economic change, say, a recession, makes itself felt on employment as the result of a chain

of effects working its way through the structure of positions in those organizations (Akerlof and Yellen, 1986).

We are now in the middle of a profound change in the technology of information processing. In the light of the importance of information processing in organizations, this change constitutes a profound change in the technology of organization itself. Therefore, relationships that may have prevailed in the past between organizational characteristics and processes on the one hand, and performance on the other, may no longer be valid in the future. In that case, experience alone, or empirical regularities that may have been observed in the past, cannot be a reliable guide to the design of efficient organizations in the future. If, as is often asserted, organization and management are important determinants of economic competitiveness and productivity, more fundamental knowledge of the relationships governing organizations will be a valuable, perhaps indispensable, basis for policy.

We may also expect that the accumulation of knowledge in this field will eventually affect the education of managers in professional schools. While this is not a direct objective of scientific research, the patterns established in the past show that fundamental scientific progress in a field eventually influences how professional practitioners are trained. The effect of progress in microbiology on medicine is an example. The effect of the development of mathematical models of allocation, for instance, linear programming, on industrial practices in a wide range of industries—and on the training of managers—is another.

### *Formal Models*

Market systems, governmental organizations, private firms, and various other economic institutions have been viewed as instances of a general concept of resource allocation process (Hurwicz, 1960, 1972), or mechanism (Mount and Reiter, 1974). Because the concept of a mechanism has been given formal mathematical expression, it is possible to analyze mathematically important properties of different mechanisms, or organizations. This facilitates comparison of organizations and makes possible an efficiency analysis.

The explicit representation of organizations makes possible a formal analysis in which the organization is a variable of the problem; it plays the role of an “unknown” to be solved for. Important properties and features of organizations can be expressed as mathematical properties of these formal entities, and so can be used to define subsets of the set of formalized organizations. Hence they provide a basis for normative analysis via constrained optimization models.

Two types of properties have been stressed so far in the analysis of economic organization: (1) information processing; and (2) incentives. In the area of information, major emphasis has been on "bounded rationality"; on communication requirements entailed by specified performance; on the informational requirements of stability; on the informational requirements of Pareto optimality in both static and dynamic models, including an overlapping generations model; and on rational expectations. The relationships between information processing problems and methods in economics and in computer science are being examined (Mount and Reiter, 1980, 1983). Finite state automata expressing the boundedness of memory are being used to study the consequences of bounded rationality of players in repeated games (Neyman, 1985; Kalai, 1987; Kalai and Stanford, 1988; Rubinstein, 1986). Relationships between decentralized resource allocation processes and distributed computing are also under study, as is the potential impact of the availability of supercomputers.

In the area of incentives, major emphasis has been on the use of (noncooperative) game theory to study the interactions of individuals in response to their own incentives in single-period and repeated games. Many important aspects of divergence of goals among economic agents, and of dispersion of information, have been analyzed with the aid of game theoretic models.

The two strands of research come together in a number of important topics, such as principal-agent models, and the incentive aspects of economic situations involving asymmetric or incomplete information.

### *Effect on Applied Work*

These models and the results obtained from them have had a revolutionary effect on several important applied fields. Topics or fields to which such models have been applied include, among others, industrial organization, the internal economy of large firms, the study of economic regulation and of law and economics, and the study of financial markets and labor markets.

### *Experimental Work*

The past decade or so has also seen the development of controlled experimental methods in economics (Plott, 1982; Smith, 1982). (There is, of course, a long history of sophisticated experimentation with human subjects in psychology.) The ability to study interactions among human agents in economic institutions has been greatly facilitated by modern computing equipment. Many experimental studies of markets, and more

recently of other allocation mechanisms, have been carried out. It appears to be the case that the formal representation of allocation processes or mechanisms referred to above is particularly well suited to experimental investigation, because of the explicit formulation of the processes involved. Experimental work has helped to bring the models of abstract theory to useful application.

While (nonexperimental) empirical research on organizations in economics has tended to rely on econometric methods, research in sociology has used surveys and direct observation of internal processes of organization. Instruments such as questionnaires are frequently used in sociological research. The theoretical formulations used in sociology are rather less formal and mathematical than those seen in economics. The now standard approach to organizational research in sociology is *contingency theory* (Galbraith, 1973; Lawrence and Lorsch, 1967; Thompson, 1969). This stresses the influence of uncertainty and change in the environment on organizational forms. The importance of social values and norms in shaping individual behavior, and therefore organizational performance (Di Maggio and Powell, 1983; Meyer and Rowan, 1977; Meyer and Scott, 1983; Parsons, 1956), has been stressed, as has the influence of networks of social relations on the behavior of individuals (Baker, 1984; Faulkner, 1983; Granovetter, 1985; White, 1983; White, Breiger, and Boorman, 1976). In more current lines of work, attention is being paid to the effect of internal political conflict on resource allocation and on organizational performance (Pfeffer, 1981; Pfeffer and Salancik, 1978). The notion of efficient organization is important in sociology, as it is in economics (Eccles, 1981).

### *Other Approaches*

Another approach, used in both economics and sociology, views organizational structure as the result of an evolutionary process (Carroll, 1985; Hannan and Freeman, 1977, 1984, 1986, forthcoming; Nelson and Winter, 1985). Competition among and survival of organizations are modeled as an evolutionary process analogous to natural selection. Models of population ecology are also being used in sociology to study populations of organizations (Carroll and Delacroix, 1982; Delacroix and Carroll, 1983; Freeman and Hannan, 1983; Hannan and Freeman, 1987).

Economic historians have studied the appearance of and changes in economic institutions in different places and times, and have sought to account for the development of specific institutions in historical and economic terms.

Some agricultural economists, interested in institutional change, have also studied innovation of institutions. Like some economic historians,

they view institutional changes as endogenously generated. In one view, institutional change is a response to a demand derived from demand for improvement in production.

We have mentioned the existence of mathematical models in which the concept of organization has an explicit formalization, and in which various important properties of organizations can be expressed mathematically. This opens the way to relating different investigations and contributions to one another. This is essential, for it permits investigations to build on the basis of preceding ones, and so for knowledge to accumulate in a coherent structure. The existence of a rigorous general model allows each investigation to be justified by its relationships to elements of the general structure. This permits an investigation to contribute one brick to the building under construction. We may therefore hope to escape from a situation described by the sociologist David Zeaman, "One of the differences between the natural and the social sciences . . . [is that] in the natural sciences [we are told] each succeeding generation stands on the shoulders of those that have gone before, while in the social sciences, each generation steps on the face of its predecessors."

The broad picture presented by the research referred to above is one of great activity and high promise for future research. The same underlying problem—to elucidate the laws governing the processes and performance of economic organizations—is being approached from several points of view in different fields.

The research developments sketched above form a solid base of models, techniques, and results for research on organizations and markets in the next decade. A substantial development of these models is needed to extend and enrich theory by incorporating phenomena important to understanding organization, and to derive and test new results.

### Selected Directions of Recent Research Mechanisms

We present here a more detailed account of certain important lines of research on organizations, including markets. We begin with existing formal models of allocation processes in economics. These have the following elements:

1. A relation between the set of environments regarded as possible and the set of possible outcomes or actions. This relation expresses desired performance.

2. A space of messages, signals, or strategies, expressing the behavior open to individual agents in the process.
3. A relation between complexes of messages or strategies, and outcomes, determining which outcome results from any given complex of message or strategy choices of the agents.
4. An initial distribution of information about the environment among the agents.

The elements listed above are used to define a *game form*, a model used to analyze incentives (Gibbard, 1973; Hurwicz, 1986). In that structure the solution concept employed induces a relation between environments and strategies, which expresses the strategic behavior of the agents; for example, if the solution concept is Nash equilibrium, then the relation induced is the correspondence that associates to each environment the set of Nash equilibrium strategies of the players for that environment.

The set of admissible relations between environments and strategic choices, or messages, can be restricted, thus expressing restrictions on behavior of agents. Where the focus of investigation is on informational issues, the relation between environments and messages is, in some cases, specified in advance. This may be regarded as a limiting case in which the domain of admissible relations is reduced to a single element.

The elements of this model together constitute a formal representation of a system for organizing economic action, that is, an organization (Hurwicz, 1981, 1986; Radner, 1987a).

One basic formulation of this type of model in economics is dynamic. The process of interchange of messages among the agents is represented by a set of difference or differential equations.

### *An Example*

It may be helpful to have before us a concrete example to which we can refer the concepts and theorems of these models before continuing a discussion of them in more general terms.

The renegotiation of defense contracts provides a transparent illustration of the way in which this type of mechanism model captures essential features of the situation and of the relevance of analytical results obtained in those models. Early in World War II, a concerted effort was made to convert industrial production to defense. At the same time, there was concern that there should be equity of sacrifice, in particular that "profiteering," so prominent in previous wartime periods, should

be prevented. Cost-plus contracts were used to induce firms to convert to defense production, and the renegotiation of these contracts to recover "excess profits" was to be the instrument to prevent profiteering. Congress passed legislation providing for the renegotiation of government contracts. The act specified five factors to be taken into account in determining whether a given profit was excessive. These included such items as *unusual efficiency*, *special value to the defense effort*, a sufficient *degree of innovation*, and the like. A federal agency, the Renegotiation Board, was set up to administer the act.

Connections between this example and the models referred to above may be seen as follows:

1. Specification of the goals or desired outcomes. This is expressed in the legislation by defining (implicitly) allowable profits.
2. The information processing tasks entailed by the goals in the context of the conditions that prevail outside the control of the Congress or the administrators of the act; for example, technical conditions of production. In this case the task of gathering data on costs, on comparative efficiency of production in different firms, on technical innovation, and on the relative values of different products or acts of production to the defense effort, is implied by the information needed to realize the goals expressed in the act.
3. The incentive problems implicit in the situation. Incentive issues appear in several forms. Cost-plus contracts are used expressly to induce firms to change over to defense production. Having done so, firms have an incentive to inflate costs and, in providing information to the renegotiators, to rationalize as normal as much as they can of the actual profit made.

Because of the informational and incentive aspects of the problem, it is likely that the performance achieved by the mechanism actually set in place bears only a very rough approximation to the performance prescribed by the Congress, especially in view of the fact that the resources given to the Board to administer the act bear little or no relation to the informational requirements imposed by the goals. Was this the best, or even an acceptable, way to achieve the desired goals? The formal structures of mechanism theory provide an analytical framework in which such considerations can be formalized and in which such questions can be addressed.

We may now add a few words in more general terms, explaining further the four elements listed above and giving a sample of some results on the informational side:

1. A relation between the set of environments regarded as possible and the set of possible outcomes or actions. (An environment includes the economic data, such as preference, technological relations, resources, and the like, relevant to the desired outcome but not subject to the control of the economic agents or the designer of the process.) This relation expresses the goals or performance desired of the economic mechanism. Modeling of the environment may be timeless or involve intertemporal relations, such as production, consumption, and accumulation of capital over time.
2. A space of messages, signals, or strategies. This expresses the behavior, whether strategic or simply communicative, open to individual agents in the process.
3. A relation between complexes of messages or strategies and outcomes, determining which outcome results from any given complex of message or strategy choices of the agents. This relation, usually called the outcome function, formalizes institutional arrangements, for example, in the context of public goods economies, the tax laws, and rules for determining the production of public goods. This relation expresses the way in which the institutions translate final messages or strategy complexes (i.e., the behavior of agents) into outcomes.
4. An initial distribution of information about the environment among the agents. Usually, what one agent knows directly about the environment is private information, either not observable by others or, in some formulations, partially observable at a cost.

### *Information*

As noted above, the basic formulation of this type of model is dynamic, modeling a process of interchange of messages among the internal parts of the organization. As the renegotiation example makes clear, the communication requirements imposed by a specified performance are essential dimensions of the problem of mechanism design. The communication requirements of various kinds of stability have been studied in the context of dynamical systems that achieve the specified performance (Jordan, 1987; Mount and Reiter, 1987). Analytical difficulties with dynamic mechanisms make it easier in some cases to study associated static mechanisms. The equilibria of the dynamic system are used to define a (static) equilibrium relation between environments and equilibrium messages. This formulation has been used to study the communication requirements of a given desired performance (Hurwicz, 1972, 1977; Mount and Reiter, 1974; Sato, 1981; Chander, 1983).

Results of these investigations are in the form of lower bounds on the communications required by any organization in the set of organizations defined by the model to achieve the specified performance. These theorems tell us that for any organization to be capable of the specified performance, it must be provided with the capacity to communicate among its members the values of at least the number of variables given by the applicable lower bound theorem.

In some cases, the lower bound has been shown to be infinite, e.g., when increasing returns to scale prevail in production. Such a result may be interpreted as telling us that we must settle for second-best performance. It is notable that this trade-off between performance and informational costs follows from communication constraints alone.

Analogous informational theorems have been obtained for models where the focus is on incentive issues. The communication requirements of implementing a specified performance relation by a game form in dominant strategy equilibria, for example, have been analyzed, and a theorem giving a sharp lower bound on the number of strategic variables each agent must have has been obtained. Similar results exist for some important cases of implementation in Nash equilibrium and Bayes equilibrium.

In addition there are results giving methods for constructing mechanisms with minimal communication requirements that can achieve a specified performance relation (in cases that meet certain technical regularity requirements).

Constraints that apply to organizational design and performance include those related to the complexity of the required information processing, a major subject of investigation in mathematical and computer science. This has also been studied in mechanism theory. It has been shown, in the context of one formal model of computation and complexity, that trade-offs can exist between the degree of complexity and the number of variables communicated among agents in an organization achieving a specified performance. It has also been shown, by modeling each player in a two-person repeated game, such as the finitely repeated Prisoners' Dilemma, as a finite state automaton, that the bounded memory capacity of each player can be used by the players to reach a cooperative equilibrium (Radner, 1986a).

Results of this kind are highly relevant for understanding the performance of organizations and for guiding the design of organizations to attain a specified performance.

It should be noted that the development of statistical decision theory following World War II contributed to a wide variety of economic models by providing a foundation for rational decision making under uncer-

tainty. The theory of teams, which is rooted in statistical decision theory, is an important contribution to the study of organization in economics (Marschak and Radner, 1972; Marschak, 1986).

### *Principal-Agent Models*

On the side of incentives, the large body of work on principal-agent models and models with asymmetric information has already had profound effects on the way in which institutional and organizational arrangements are viewed (Mirrlees, 1974; Holmstrom, 1979; Grossman and Hart, 1983; Arrow, 1986). The fields of industrial organization, labor economics, and managerial accounting, among others, have been fundamentally changed by these models. A similar development is taking place in the field of law and economics. The legal framework of social and economic life includes, of course, important institutions of society. Many of the important areas of law, such as contracts, are being analyzed at a level of fine detail, using these models and the techniques for working with them (Hart and Holmstrom, 1987). Sociologists are interested in these models and some are relating them to their own research. Indeed, the past decade has seen an explosion of work on organizations that falls into the category of principal-agent models. The neoclassical model of the firm or other organizations in economics did not explicitly model the information that various agents in the organization had, or were able to observe. At the heart of the principal-agent model is the careful modeling of precisely what information each of the agents in an organization has at the outset, and what information he is able to observe during the operation of the organization. This careful modeling is particularly important for problems in which there is asymmetry of information, that is, where one party knows more about some aspects of the environment in which an organization is operating than others. One of the first applications of this manner of modeling organizational problems was to the so-called sharecropper problem (Cheung, 1969; Stiglitz, 1974). This problem is of interest because it contains in a simple setting phenomena of general importance. The problem involves the nature of the contract, commonly observed in both the United States and other countries, between a landowner and a tenant farmer, by which the parties share the output in some fixed proportions. This contract was somewhat difficult to explain given the previously generally accepted models of the economics of organization, because it resulted in the landowner and the farmer bearing the same amount of risk as to their total compensation from this activity. The accepted models in economics suggest that the risk should be borne asymmetrically, with the landowner bear-

ing more of the risk than the tenant farmer, since the possibility of a bad crop (and hence a small share to each party) would be much more serious for the relatively low income tenant farmer than for the landowner. Conventional models in economics would have suggested that the landowner, who is much more able to absorb such risk, would in fact bear most of the risk.

What seems to be anomalous from the point of view of previous models of organization is much easier to understand when viewed in the light of the principal-agent model. The emphasis on the possible asymmetries of information in monitoring difficulties led people to focus on the problems that would be raised by a contract between the tenant farmer and the landowner in which the landowner bore most of the risk. Such a contract would leave the tenant farmer with a share of the output that did not vary much as the total output varied. Such a contract would cause incentive problems as the tenant farmer would be likely to exert less effort in farming activity if his share was not likely to be affected significantly by such exertion. The tenant farmer will obviously know the amount of effort exerted in farming activity, but the landowner typically would only be able to observe such activity at very high cost. Having carefully modeled the information and the monitoring difficulties, researchers then asked what kinds of contracts would lead to the largest net output (output minus the cost and effort of producing this output). When done carefully, the model will show that the kinds of contracts and organizational structure that we observe are in fact consistent with these models of organization.

The principal-agent paradigm has been extremely important in many areas of organizational behavior in rationalizing the kinds of organizational structures and interactions that we observe. There are many questions of public policy that presuppose some notion of organizational behavior. The entire question of what kinds of contracts and transactions firms should be allowed to engage in can be analyzed only with some hypothesis in mind as to why firms would want to utilize such structures or transactions. A specific question of this sort addressed in recent years has been the question of retail price maintenance. Retail price maintenance is the practice by which a firm will sell goods to an intermediate firm but restricts the price at which the goods can be resold to the final customer. This practice has at various times and places in recent years been both legal and illegal. The discussion of whether it is in the ultimate customer's interest that such practices be prohibited cannot be answered without some explanation as to why the original firm wants to restrict the price at which the goods can be resold. Consistent explanations as to why a firm would want to do so have been lacking until

recently. The principal-agent model has provided explanations that many people find plausible. This model facilitates careful consideration of the conditions under which such practices would be in the best interest of the ultimate consumer. In a similar matter, the question of whether it is in the general interest to encourage or discourage mergers between large firms can be discussed sensibly only if there is some understanding of the purpose that the merger might serve. In the case of a vertical combination, that is, a merger between a firm and one of its suppliers, it has long been a question as to what advantages a merger would serve that could not be served equally well by some sophisticated contract between the two firms (Williamson, 1975; Grossman and Hart, 1986). A focus on the difficulty of monitoring contracts between separate firms, as opposed to internal processes in a single (merged) firm, has led to a better understanding of the purposes served by a vertical combination (Alchain and Demsetz, 1972; Hart and Holmstrom, 1987; Holmstrom and Tirole, 1988). This better understanding provides the groundwork for a more informed policy regarding such business practices.

The above examples focus on the need for models that better explain the existing structure of organizations. Questions involving the benefits of changing organizations can be answered only if we understand why organizations are structured as they are in the first place. Besides giving us a range of models to better understand existing organizational structures, the principal-agent model has also helped in the design of alternative organizational structures. Once we have carefully specified the kinds of information and incentives that agents within an organization have, we can begin to ask what organizational structures and reward schemes will induce the outcomes that we would like. We mentioned the problem of the tenant farmer above as an example in which the principal-agent paradigm was helpful in understanding why a particular type of organization evolved. For the same problem we could use these techniques of modeling to ask whether there were alternative organizational structures. Since people have had centuries to experiment with alternative organizational structures it is not surprising that the structure that we see now is efficient relative to the alternatives. There are many problems of organization for which we have not had centuries of experimentation. The careful analysis of such organizational problems, using the principal-agent paradigm, allows us to identify, at least in crude form, the kinds of organizational structures that are optimal for the problems we face. The principal-agent paradigm has been extremely successful in several areas; among the most successful is managerial accounting. Managerial accounting deals primarily with the question of how firms use accounting information for internal operations and man-

agement. This is opposed to financial accounting, which has to do with the use of a firm's accounting data by people outside the firm. The internal use of information by a firm has to do precisely with the question of monitoring the activities of the various parts of a firm and the use of that information to reward the employees of the firm. The principal-agent model has revolutionized the way in which managerial accounting is thought about and is taught in business schools. To a large extent, the principal-agent model has *become* managerial accounting. While some of this may be faddish, such an extensive change in such a short time in the way this field is viewed by its practitioners must be taken as evidence of the usefulness of the principal-agent model for analyzing organizations.

While the contribution that the principal-agent paradigm has made to our understanding and analysis of organizations is substantial, the possibilities for extending and applying the paradigm over the next decade are equally exciting. It has begun to be used extensively in international trade problems to model the relationship between industries in various countries and the governments that must set the rules for competition, with only partial information as to the internal structure of the industries. Many of the techniques of the principal-agent model are now being applied to bargaining and arbitration problems (Chatterjee and Samuelson, 1983; Myerson and Satterthwaite, 1983; Roth, 1985). The application of bargaining problems in which an arbitrator is only partially aware of the costs and benefits of various alternatives to the parties involved is difficult, but some progress has been made. Last, there have been initial attempts to study the evolution of organizations over time in an attempt to understand what characteristics of organizations best allow them to have the flexibility to respond to changes in the environment.

A forerunner of the literature on principal-agent theory was Simon (1953). Early contributions to the analysis of static principal-agent models were made by Ross (1973), Stiglitz (1974), Mirlees (1975, 1976), Hurwicz and Shapiro (1978), Shavell (1979), and Holmstrom (1979). For further analysis and references see Grossman and Hart (1983) and Stiglitz (1983). For results and references about repeated principal-agent relationships see Radner (1986b).

### *The Internal Economy of Large Firms*

The large size of modern firms forces the de facto decentralization of information and decision making, whatever the structure of formal organization. Even the smaller firms are forced to decentralize information

to some extent, given the very limited capacities of decision makers to observe, process, and communicate information. This is even true of decision makers aided by large computer systems.

Table 12.1 gives some idea of the size of the largest U.S. firms, as reported by *Fortune* magazine in its report on "The Fortune 500" for 1983. In terms of employees, the largest is General Motors, with approximately 700,000 employees. This is roughly the same as the number of persons employed in manufacturing in all of the Netherlands in the same year. Most of the Fortune 500 are, of course, much smaller; the mean is 28,100 employees, and the median is 13,100. Nevertheless, it is clear from the table that the internal economies of these firms are very large indeed.

The private information of a decision maker gives him some measure of private power to pursue his own goals, which may sometimes be in conflict with corporate goals. The private power conferred by informational decentralization and the conflicts of interest among the members of the firm will in general give rise to inefficiencies, whatever the structure of formal organization, compared to what would be ideally attainable with the given distribution of information among the decision makers.

Although uncertainty obviously makes decision making more complex, the picture of the firm as headed by a rational, profit-maximizing entrepreneur persists in the mainstream economic model of the firm, although not without dissent. The mainstream model was fortified by the burst of activity in statistical decision theory and by operations research during and after World War II. This activity not only showed that very complex decision problems could be solved but also led to fundamental reconsiderations of the foundations of the theory of probability and uncertainty.

One current of dissent stressed the importance of "bounded rationality" in the decision making of individuals and groups. Another current questioned the mainstream picture of the "unitary" direction of the firm, especially arising out of the separation of management from ownership. This separation of owners and managers gives rise to a loss of control of the managers by the owners. The discretion of the managers to do things other than maximize the profits of the firm is enhanced by any monopoly power of the firm, the actual degree of which is better known to the managers than to the owners. This partial loss of control extends to the relationship between the management and the workers (or between different levels of management). It is possible for the owners to improve their monitoring of the information and actions of managers and

**Table 12.1 Some Large U.S. Firms, 1983**

<i>Sales Rank</i>	<i>Company</i>	<i>Sales \$ Bill.</i>	<i>Assets \$ Bill.</i>	<i>Net Income \$ Bill.</i>	<i>Number of Employees in Thousands</i>	<i>Number of Employees (Rank)</i>
1	Exxon	88.6	63.0	4.98	156	(9)
2	General Motors	74.6	45.7	3.73	691	(1)
250	Monfort	1.32	.199	.016	3.5	(472)
308	Ex-Cello	.955	.690	.050	13.1	(250)
500	Tandem	.418	.415	.031	4.4	(454)
	Mean	3.37	2.71	.138	28.1	

Source: "The 500," *Fortune*, April 30, 1984, pp. 274-322.

workers, but only with the expenditure of resources, and so the net benefit to the owners of such increased monitoring may not be unambiguously positive. Formal models of this loss of control were introduced in a more general setting (theory of incentives in teams). The post-World War II development of the theory of games provided the methodology needed for the formal analysis of the conflicts of interest within the firm, and it is the methodology of game theory that underlies most of the recent developments.

We should emphasize three points. First, there are many “players” in the firm’s internal economy: shareholders, directors, managers, and workers (and sometimes creditors). These different players typically have at least partially divergent interests, hence, the difficulty of imputing to the firm a single objective. Among the objectives of the several players in the firm are profits, growth, monetary compensation for managers and workers, quality of work, perquisites, and status. In addition, in the pursuit of these objectives, the different players may have different attitudes toward risk.

Second, the constituent parts of a firm may have technologies that do not conform to the “neoclassical” hypotheses. The internal economy of the firm will usually be full of instances of increasing returns to a scale (up to a point), indivisibilities, and externalities. These technological features may also be important at the level of the entire firm as well, and the neoclassical hypotheses about the technology of the firm are no doubt inadequate for the analysis of many questions about the interactions of firms in markets. For a theory of the internal economy of the firm to be successful, it must broaden the neoclassical assumptions for the firm’s constituent parts.

Third, a study of the internal economy of the firm should pay attention to the structure of information processing within the firm (observation, communication, computation), and also to the structure of authority, which limits the things that the players may and may not do (Dalton, 1959).

The rules for the transfer of goods and services from one part of the firm to the other, and for the pricing of such transfers, are not given a priori but can be designed by the firm itself, as can the rules for compensating the managers of different units and at different levels. Indeed, the very division of the activities of the firm into separate units can be determined by the headquarters.

The following summary lists the main conclusions for the internal economy of firms from study of the existing models of decentralized decision making:

1. Equilibria of decentralized organizations are typically inefficient, relative to what could theoretically be attained with the given distribution of information among the several decision makers.
2. The inefficiency of equilibria is caused by various incentive problems that arise from conflicts of interest among the decision makers and/or between the decision makers and the organizer. These incentive problems can be classified under three headings:
  - a. misrepresentation
  - b. moral hazard
  - c. free-riding
3. Misrepresentation can be remedied by suitably designed compensation mechanisms, provided "budget balancing" is not required (Groves-Clarke-Vickrey mechanisms).
4. The inefficiency due to moral hazard alone may be remedied in long-term equilibria to the extent that the players are not too short-sighted, that is, to the extent that they do not discount future utility very much (principal-agent games).
5. Free-riding and moral hazard together may be only partly remedied in long-term equilibria (of repeated games) with far-sighted players, unless there are individual measures of performance that are publicly observable (partnership games).
6. Efficiency can be improved in long-term equilibria with far-sighted players if they are not too "greedy" (approximate equilibria).
7. Long-term games (repeated games) typically have an infinite number of equilibria.

The fact that long-term games typically have an infinite number of equilibria poses a problem for the theory, because it makes the predictions of the theory relatively imprecise. The situation is even more extreme than is implied by the statement that the set of equilibria is infinite; equilibria of a long-term game are typically not isolated, so that an equilibrium will have other equilibria arbitrarily close to it. The situation is analogous to that of a ball on a slightly sticky horizontal surface; the ball will stay put wherever you place it, and small shocks to the ball will result in correspondingly small displacements.

This state of affairs is probably not a comfortable one for contemporary economic theory, which tends to explain observed economic states as locally stable equilibria in a system with a finite set of equilibria. On the other hand, a theory that leads to a continuum of equilibria is open

to completion by adding considerations of history, the social and cultural environment, and an explanation of the particular equilibrium that is currently observed. This could lead the economic theory of organization back toward the older institutional and historical approaches from which it rebelled not so many decades ago (Hess, 1983; Radner, 1986c; White 1983).

### *Labor*

We have referred in the Introduction to new approaches to analyzing the effect on employment of changes in economic activity. There is a big difference between labor employed in small units highly permeable to market influences and labor in large organizations with their own internal labor markets (Granovetter, 1984). Both economics and sociology have incorporated this distinction in recent research. In economics, the realization that many workers are employed in large organizations with internal processes in allocating labor has spurred interest in the allocation efficiency of those internal processes (sometimes referred to as internal markets) and in the allocative efficiency of the large organizations themselves. Here, the impact of specific human capital and transaction costs of living and training are important elements. The focus on larger organizations has encouraged the development of formal models to analyze the long-term relationships that develop. This has led to the literature on implicit contracts, deferred compensation, and mandatory retirement. Conflicts of interest among those making work assignments and those executing them have been studied with the aid of principal-agent models.

In sociology the field of labor is also a "hot area." There was already a substantial literature in "industrial sociology" dealing with the day-to-day operations of large organizations by ethnographic research methods (Abegglen, 1958; Blau, 1955; Buraway, 1979; Burns and Stalker, 1961; Crozier, 1964; Dalton, 1959; Gouldner, 1954; Selznick, 1949; Whyte, 1955). This literature had not been integrated into more systematic work on the overall structure of labor markets. Recent work has corrected this imbalance (Baron and Bielby, 1984). Research on contact networks in labor markets has studied how such networks, based on both professional and social contacts, allocate workers to positions in the status hierarchy of society as well as in its organization of productive labor (Boorman, 1975; Granovetter, 1974, 1981). Many recent sociological monographs have traced the impact of the labor market position of an individual, increasingly identified by the characteristics of the employing organization, on his status and life chances (Sorensen and Tuma,

1981). The extent to which personal unemployment results from the details of one's career history is also discussed in this literature, which incorporates analyses in economics of heterogeneity versus state dependence as causes of labor market position (Granovetter, 1986; Sorenson and Tuma, 1981).

Work in sociology beginning in 1970 has opened up another line of research (White, 1970). When new positions are created or old ones vacated by death or retirement, a cascade of vacancies flows through a system of organizations, as each position is filled by someone who leaves a vacancy in his previous position (White, 1970; Stewman and Konda, 1983). Mathematical models of such cascades make better predictions of system turnover than models oriented to characteristics of individuals, and cascade models focus attention on exogenous demographic constraints on mobility: rates of retirement and of entrance of new recruits, and macroeconomic parameters such as rates of creation and abolition of jobs (Jacobs, 1981; Pfeffer, 1983; Rosenbaum, 1978; 1979a and b; 1981). Research stemming from these ideas has shed important new light on the demography of promotion and the structure of internal labor markets (Granovetter, 1974, 1981; Rosenbaum, 1978, 1979a and b; 1981; Stewman and Konda, 1983).

Though the two disciplines of sociology and economics have independently made rapid progress in understanding labor markets, the most exciting prospect lies in a surge of interdisciplinary work in the coming years. The general theoretical frameworks of sociology and economics have converged somewhat, and each has important insights to offer to the other. Sociological work will benefit from the discipline of formal models and the emphasis on efficiency and on the optimal structuring of incentives. Economic argument will become more sophisticated when it takes account of the structure of social relations, the impact of noneconomic motives and the constraints of demographic stocks and flows (Granovetter, 1985; Pfeffer, 1983; White, 1983). Interdisciplinary work will enable these two bodies of already booming research to complement one another in ways that should yield genuine breakthroughs.

### *Experimental Economics*

One of the important developments in economics over the past two decades or so is the emergence of controlled experimentation. A substantial number of experimental studies has been conducted on markets and more recently on other types of organizations for allocating resources (Smith, 1982). Experimental work mirrors theory. Experimental methods require specification of the detailed structure of the processes op-

erating in the market or organization under study. The models of mechanism theory described above appear to be particularly well suited to the needs of experimental research, because these models contain explicit formulations of essential processes. This connection between mechanism theory and experimentation has already led to fruitful interaction in which theoretical investigations provide models for experimenters and experimental results provide guidance for new theoretical formulations. An illustration of this sort of interaction is given by a recent experiment involving a mechanism (the Walker mechanism) for allocating a public good. This mechanism has been shown to yield certain optimal allocations (Lindahl allocations) at its Nash equilibria, but it does not guarantee individual feasibility, that is, individuals can experience bankruptcy (negative payoffs) as a result of the actions of others in the experiment (Walker, 1981). This possibility is not acceptable in the experimental setting. The experimenter introduced a variant mechanism to prevent bankruptcy, but this opened the possibility that the strategic structure of the game was distorted. Stimulated by this situation, a graduate student at Minnesota came up with a modification of the Walker mechanism that preserves its essential strategic structure but guarantees individual feasibility. There has also been deeper analysis of the variant mechanism by another theorist. What might appear to be a mere theoretical nicety turned out to be a crucial point for experimental investigation; in turn, the experimental need gave rise to improvements of theory.

Experimental work has confirmed some theoretical contributions. It has supplemented theoretical models with the detailed arrangements needed to put them into practice, producing important organizational and institutional design achievements. It has also opened up new issues for theory as the limits of applicability of certain theoretical models are found. These matters are discussed below in more detail.

The pattern of results from experience demonstrates that the game-theoretic approach to understanding auctions has much power of explanation. In first-price auctions and in second-price auctions the Nash equilibrium model is remarkably accurate for most parameter values. It is as though individuals are capable of calculating incredibly complicated game-theoretic solutions. Hundreds of observations document the phenomenon. The importance of the discovery is derived not only from its practical usefulness in understanding auctions but also from the applicability of the deep insights derived from mechanism theory, should the Nash equilibrium prove to be behaviorally reliable.

The Nash equilibrium concept was clearly not the end of the story. As research moved from auctions in which no information processing is

involved to auctions that involve a heavy information component, paradoxes began to emerge. For example, a winner's curse can be observed in common-value auctions. When estimating the value of an object, some participants will draw information that suggests the object has a value much higher than it actually does. It is a purely statistical phenomenon that should be discounted when tendering a bid. If it is not discounted, the winning bid will actually be higher than the value of the object—the winner's curse. Why the participants fail to anticipate the strategic interactions under this institution is a challenge to theorists and to experimentalists. If the phenomenon persists under close examination, theorists will be forced to search for a modification of basic principles that are now widely applied. In addition, a search will be initiated for institutions that prevent what can be perceived as a problem. On the basis of current theory, the phenomenon should not exist. Data from related experiments also suggest that it should not exist. The lone voice that has claimed otherwise has been that of oil companies involved in bids for leases; they, of course, were believed by no one. Existing data suggest they should be taken seriously.

The mechanism literature has added a new type of question to those traditionally asked by economists. Is it possible to design a set of institutions that solve a problem and use only a limited, clearly stated set of behavior principles? the Groves/Ledyard process was an answer to such a question regarding the provision of public goods. The response of experimentalists has been along two lines. First, an effort was made to explore the reliability of the Groves/Ledyard process. The positive results encouraged experimentation with closely related processes. Based upon the foundation of this work, a series of experiments was performed for the Public Broadcasting System on ways to choose programs and allocate the costs among member stations (Forejohn et al., 1979). The most recent application was a check to see if one of the proposed processes was sufficiently reliable to allocate the common costs that would exist on the space station now being designed by NASA. Initial experiments indicated that the process, while a great advance over other processes, was nevertheless not sufficiently reliable to use as a foundation for the cost-recovery problem. The experiment provided an inexpensive means of testing the process. A field test could have cost hundreds of thousands of dollars in mistakes and delays. Experimental debugging of new ideas is much less expensive.

The design motivation from mechanism theory can be clearly identified in the most recent attempts to solve the congestion problem at airports. Litigants at Westchester County, New York, recently achieved an out-of-court settlement on a method of allocating rights to use the ter-

minal facility. The rights are to be distributed by lottery with an after-market—a process first proposed for Washington National Airport as the product of experimental analysis (Grether et al., 1981). Parties at Westchester had agreed to an auction process in which a new method of tendering bids would define those parts of the facility a carrier would use. The Westchester process was constructed upon a previously studied decentralized auction mechanism for allocating landing rights. The Westchester process was “near” demand-revealing in the mechanism sense, and was therefore “near” perfectly efficient. Like its predecessor, it was designed with the aid of mechanism theory and debugged with experiments. The auction mechanism would have been used except for intervention by the Federal Aviation Administration. Similar auction mechanisms are under review by the New York Port Authority for potential application at the major airports. In all cases, the processes being used and those under consideration have evolved from the benefits of both mechanism theory and experimental analysis.

A third area of investigation is the phenomenon of asymmetric information in markets. The topic was originally explored in the context of markets that involve expert advice such as mechanics, insurance, consultants, and physicians. With the basic framework established, the investigation has expanded to include insider warranties and auditing contracts. Many experimental studies are now underway to explore the nature of principal–agent relationships.

For formal treatments and overviews of the literature on market equilibrium under uncertainty, including theories of rational expectations and “symmetric” information, see Radner (1981) and Jordan and Radner (1982). For a less technical summary see Radner (1987b). On overlapping-generations models and “sunspot equilibria,” see Shell (1987).

### *Organizational and Market Uncertainty*

Businessmen are responsible for making economic decisions in the face of uncertainty. Some of this uncertainty is the result of uncertainty about economic fundamentals—tastes, endowments, and production possibilities. The weather, for example, affects the economy through its influence on crop yields and on the final demand for umbrellas and swimsuits. This type of uncertainty, transmitted to the economy through uncertainty about the fundamental parameters of the economy, is successfully modeled by conventional general-economic-equilibrium theory.

Businessmen face another, significant source of uncertainty. This is market uncertainty, generated within the economy itself, about the eco-

economic outcomes (such as prices) given the fundamental parameters. Businessmen wonder whether the economy will be healthy or unhealthy, whether consumers' confidence will be high or low, whether credit will be loose or tight, whether prices for their factors will be low or high, and so forth. Most businessmen quite properly worry more about the uncertainty of the outcome of the market process than they do about the uncertainty of the fundamental parameters.

The formal modeling of market uncertainty until recently has lagged far behind the modeling of uncertainty about its fundamental parameters. The recent work in economics game theory on correlated equilibrium (Aumann, 1974, 1987) and so-called sunspot equilibrium (Cass and Mitra, 1987; Cass and Shell, 1983; Peek and Shell, 1987; Shell, 1977) represents substantial advances in our understanding of market uncertainty. We now have serious rational-expectations models in which the equilibrium allocation of resources can be probabilistically distributed even if the economic fundamentals are immune from random disturbances. We can show how economic actors can be uncertain as to whether markets will be "thick" (with many trades taking place) or "thin" (with few trades taking place), or even whether these markets will be open or closed. In attempting an assessment of market thickness, an economic actor must judge the confidence of other economic factors. A wide range of such beliefs is rational (i.e., confirmed by subsequent events). If, for example, demand in a particular market is weak, then in response supply is weak, which in turn justifies (establishes the rationality of) the weak demand.

Market uncertainty—or, more generally, organizational uncertainty—is a topic of obvious social importance. Macroeconomics, for example, asks what policies the government should adopt to counteract disturbances generated by the economy itself. When we design organizations—or choose mechanisms—we shall want to know how uncertainty is created and transmitted by these new forms.

This is one of the most promising areas of research for the next decade. The problem is there. A start has been made, but much more work remains. Since the economic models of market uncertainty (or organizational uncertainty) are not determinate, there are serious grounds here for collaboration with social scientists from other disciplines.

### *Dynamics*

Allocation processes have been studied in a dynamic context not only in the sense that the internal processes of communication have been modeled in time but also in the broader sense that action unfolds in time.

Some results on the informational requirements of Pareto optimal allocation have been obtained for an infinite horizon overlapping generations model (Balasko and Shell, 1980, 1981a, b; Majumdar, 1987; Samuelson, 1958; Shell, 1971). In addition, there is an extensive, sophisticated literature devoted to analysis of markets in the context of capital theory, where intertemporal phenomena are of the essence. Overlapping generations models have helped explain the role of money, a problem previous analyses could not handle. They have also been used to study the role of expectations in macroeconomics.

Another important area of intertemporal phenomena is that of exhaustible resources (Cass and Mitra, 1987). Dynamic models have been used to analyze optimal utilization of exhaustible resources, such as petroleum reserves. The area of economic dynamics, broadly understood, has had a strong development in the past two decades, and has a solid base of achievement in methods and results important for the study of organization, including markets, in the coming decade. The connections with nonlinear dynamics, currently undergoing rapid development in mathematics and being applied in the physical and biological sciences, opens up interesting possibilities for use in studying organizations, particularly in light of the increased availability of supercomputers. Particularly interesting is the possibility of obtaining fluctuations that come from the structure of the mechanism itself, without a stochastic source, as is the case with chaotic dynamics.

### *Research on Organizations in Sociology*

The past twenty years have seen considerable progress in theory and research on the determinants of organizational structure. The first phase in this program of research developed what has come to be known as contingency theory (Thompson, 1967). According to this perspective, optimal organizational design buffers the technical core (the actual processes of production) from environmental shocks by using peripheral structures specializing in deflecting or absorbing environmental turbulence. The optimal design depends on the detailed needs of the production system and the nature of environmental variations (Stinchcombe, 1959, 1965; Thompson, 1967; Woodward, 1965). This approach, now the standard textbook theory in sociology, has proved useful in sociological analysis of a broad range of market and nonmarket organizations in diverse cultural contexts (Scott, 1975).

Research in the past decade has added two complications with far-reaching implications: organizational politics and institutional constraints. Resource allocation within organizations is subject to intense political contest among subgroups and individuals in the organization

(Baker, 1983, 1984; Cyert and March, 1963; Dalton, 1959; March and Simon, 1958; Mintz and Schwartz, 1985; Perrow, 1979). Allocation (and thus ultimately structure and strategy) depend at least in part on processes of coalition formation and contest within organizations, especially when the costs and benefits of alternative allocations are difficult to measure and forecast (Pfeffer and Salancik, 1978). It might be argued that these processes simply produce random noise in an otherwise well-behaved allocation process. However, recent research shows otherwise (Cohen and March, 1974; Cohen, March, and Olson, 1972; March and Olsen, 1976).

A second line of active research has shown that organizations face strong institutional constraints (DiMaggio and Powell, 1983; Granovetter, 1985; Macauley, 1963; Meyer, 1977; Meyer and Rowan, 1977; Meyer and Scott, 1983; Mintz and Schwartz, 1985). Organizational designs are constructed and evaluated in a sociocultural context. Some designs have extensive social backing, for instance, by professional associations and schools or by government agencies (DiMaggio and Powell, 1983). Designs also stand as markers of difficult-to-observe competences such as managerial acumen, and are therefore used strategically to signal such competences (Meyer and Scott, 1983). Finally, seemingly neutral arrangements tend to become infused with moral value by members of organizations, turning means into ends (Selznick, 1948; Zucker, 1977).

Analysis of organizational politics and institutional processes has shown that the choice of organizational design reflects more than technical demands and environmental threat. Designs may proliferate even when they make little or no contributions to productive efficiency but serve political or institutional purposes (Carroll and Huo, 1986; Meyer and Scott, 1983; Tolbert and Zucker, 1983).

Research on organizational politics and institutional processes has also made clear that organizations face strong inertial pressures (Hannan and Freeman, 1984; Stinchcombe, 1965). Attempts at radical redesign, especially in large, established organizations, spark political opposition and activate institutional resistance. If such opposition delays organization in order to take advantage of changing opportunities (or to respond to changing threats), they make organizations relatively inert. Unfortunately, little is known about the relative rates of the various processes. A core problem in explaining the spread of organizational forms is to learn how structural arrangements affect the speed and flexibility of response of large organizations (Brittain and Freeman, 1980; Carroll, 1984; Fligstein, 1985).

When change in environments is rapid, it also becomes important to learn how new forms of organization arise and spread (Fligstein, 1985). This involves linking processes of entrepreneurial activity with organi-

zational dynamics. Since most entrepreneurs come from existing organizations, the dynamics of populations or organizations undoubtedly affect the rates at which entrepreneurs are spun off and the likelihood that new forms will establish footholds in competitive environments (Brittain and Freeman, 1980; Freeman, 1982).

Recent lines of theory and research have cast these issues in evolutionary terms. These theories disagree about key mechanisms: some emphasize adaptive learning and coping (Nelson and Winter, 1982); others emphasize competitive selection (Aldrich, 1979; Hannan and Freeman, 1977; McKelvey, 1982; McPherson, 1983; Singh, House, and Tucker, 1986). However, they agree that the processes of change are highly path-dependent. For example, the sequence in which organizational forms enter a system determines what other forms can proliferate (DiMaggio and Powell, 1983; Nelson and Winter, 1985).

Theory and research on organizational dynamics have developed considerable momentum. In particular, appropriate dynamic models are now in use for studying life histories of organizations and populations of organizations (Coleman, 1981; Tuma and Hannan, 1984). Promising starts have been made in modeling organizational learning and copying. However, much remains to be done. Convergences with other lines of social and economic dynamics have become clear but have not yet been developed. It seems highly likely that progress in understanding the issues here will be speeded by building bridges to research at the frontier of dynamic modeling.

### **Research on Organizations in Economic History and Agricultural Economics**

Historians of economics have studied the development of economic organization, including markets and other institutions. The point of view underlying much of this research is to see an institution as a solution to some functional problem or economic need. In this view, an institution can be seen, in a somewhat idealized way, as a solution to an optimization problem. This fits well with the formal approach, described above, in which the institution or organization is a variable whose value is to be determined. Beyond this, however, historians are interested in the development of institutions over time, and some study the endogenous aspects of historical phenomena. They examine the intertemporal and cross-cultural aspects of economic institutions and enrich abstract economic analysis by illuminating ways in which the performance of economic institutions is shaped by noneconomic factors. The phenomenon

of religious views about interest, and their effects on economic life over centuries, is an example.

A similar point of view has been developed in agricultural economics, where analyses have been made of innovation and institutional change as endogenous responses to a demand for institutional knowledge derived from demand for technical change in commodity production. The establishment and contributions of agricultural experiment stations in the United States has been studied from this point of view.

### *Data Problems in Empirical Research*

Empirical research on markets and organizations is being carried out in the various applied fields of economics and in sociology. Empirical research in this area faces a major difficulty. A large constraint on empirical studies of organizations is the absence of systematic data on representative samples of organizations over time. Most published research on organizations in economics and sociology suffers from one of a pair of resulting defects: (1) aggregation problems and (2) unrepresentativeness. Because the Census Bureau and other agencies aggregate data on establishments (and firms) to preserve confidentiality, most analyses of published data use information on aggregates to test propositions stated at the level of organizations. When researchers collect original data to avoid such problems, they are hampered by the existence of an adequate sampling frame for organizations. This problem, along with problems of nonresponse, makes these potentially more valuable studies subject to distortion due to unrepresentativeness. This is particularly problematic when data are used to evaluate the consequences of policy interventions.

The problem is not that the appropriate data do not exist. Rather, constraints due to confidentiality prevent the appropriate use of a wealth of data in the files of such government agencies as the Census Bureau, the Internal Revenue Service, and the Labor Department. Given this situation, it is worth exploring arrangements that would provide access to disaggregated data on firms and other kinds of organizations without impairing confidentiality unacceptably.

### *A Problem of Empirical Research*

The models underlying empirical studies of organizations are formulated with different degrees of precision and formality, different objectives, and different basic assumptions. This makes it difficult to interpret empirical results and to relate one study to another and to theoretical mod-

els. We need to build bridges between the formulations that guide empirical research and those that are used in theoretical investigations. This would be especially significant across disciplinary boundaries.

### **The Next Decade**

Research directions and opportunities for the next ten years can be viewed in two ways: first, in terms of the objectives of research, and second, in terms of the predictability of research topics on the basis of existing research.

The general objectives of research on organizations are:

1. To improve and extend the analytical basis for the evaluation of alternative methods of resource allocation, including markets and other forms of organization, and to bring to bear experimental and empirical studies and results.
2. To build bridges between the formulations of organization theory in the different social sciences, particularly between the models and the methods of different disciplines.
3. On the basis of (1) and (2), to construct an analytical basis for the optimal design of institutions.
4. To provide a basis for understanding the endogenous modification of the structure of ongoing markets and other institutions over time. This task involves theoretical, experimental, and empirical investigations. It appears to have important links to analogous problems in computer science, cognitive science, and biology.

Thus, research in the next decade will seek to model the internal processes of organization, to develop criteria for evaluating the performance of organizations, and to expose by experiment or systematic empirical investigation the relationships between the structure and internal processes of organizations and the resulting performance.

In terms of predictability, research directions and opportunities can be grouped into three categories: (1) those that can with reasonable clarity be seen to emerge from the base of existing research; (2) those that are further removed from current research and therefore of a more speculative character; (3) a residual category of the unexpected, provided to recognize explicitly that though we cannot foresee what new questions, ideas, or methods will appear, we can be quite confident that such things will appear.

### *Information*

In the first category of opportunities and directions is the extension and deepening of the analysis of information processing and incentives, and of the relationship between informational properties of organizations, their incentive properties, and their performance. We need to develop further models that give effect to the restrictions imposed by the technology of information processing, including the limitations of human beings as information processors, on the design and performance of organizations. Similarly, we need to continue the ongoing exploration of the effects of divergence of goals and dispersion of information on the design and performance of organizations.

### *Contracts over Time*

An important research topic in this area now in early stages of exploration deals with the endogenous revision of contracts over time. One of the principal conclusions of the theory of general equilibrium under uncertainty is that risk can be spread effectively if contracts can be written so as to be responsive to the realization of different events. For this to be operational, all of the parties to these contracts must be able to verify that each of the distinct set of circumstances specified in the contract has in fact occurred. When such verification is not possible, either control over the contract must rest with those who have the information necessary to administer it or the contract must specify the same outcome across several events. In the former instance, the propriety of this information creates incentives to use it for personal rather than collective ends. In the latter, the advantageous risk-spreading properties of contingent contracts are lost.

Much of the theory of incentives concerns the balancing of these two forces. In this context, the following problem often arises. Given an ongoing contract, and given that new information changes the beliefs of the parties to this contract, how should the contract be rewritten? The difficulty here is that even if a new contract were superior to the old one, it might not be possible for those with the new information to convince the other individuals that it is in fact in their interest to abandon the old contract and switch to a new one (Hart and Moore, 1988). Considerable progress has been made in this area, but there are many important unresolved questions, especially when new information is given simultaneously to more than one individual. Much is to be gained from further analysis of these problems. The implications go far beyond economics to the study of relationships within organizations and social networks, as well as to the fundamental structure of our legal institutions.

### *Normative Analysis*

We also need to develop criteria to be applied in a normative analysis of organizations. Current work in economics relies mainly on the Pareto criterion, but there are clearly other considerations to be taken into account, for example, fairness.

Along this line, but perhaps in the second category, is the problem of criteria for evaluating organizations when participants have preferences for processes and procedures as well as outcomes. This raises issues similar to those raised by endogeneity of preferences, a topic discussed below.

### *Stability*

Also in this first category of predictability is the problem of stability of dynamically modeled organizational processes, including the important study of structural stability (stability under variation of the environment).

A sophisticated body of research exists in the area of dynamic economics, ranging from the analysis of local stability of adjustment processes to analysis of infinite horizon overlapping generations models incorporating expectations and money.

### *Adaptation and the Larger Dynamics*

Also in the second category is a large variety of problems and questions related to the flexibility and adaptability of organizations, to their ability to adjust to changing environments. These can be viewed as problems of structural stability. But the nature of the problem is critically dependent on what is assumed to be known about the laws of motion of the environment. Phenomena of learning and adaptation have been studied in a number of disciplines, including economics. Learning models of the formation of expectations have been studied in the literature on rational expectations. But this area is still in an early stage of development, especially when viewed in the context of a richly dynamic setting.

One approach to the study of organization in a dynamic context views the process of organizational change as endogenous. While some models approach the problem in an optimization or rational decision framework, others do so with evolutionary concepts. Organizations are regarded as competing with one another in populations. Some selection process distinguishes between organizations by implicitly defining *survival value*, a concept that reflects the underlying processes and constraining elements

that constitute the “technological laws” governing adaptation, and, in the evolutionary context, survival.

### *Endogenous Uncertainty*

Organizations as well as individuals confront change, the nature of which is unforeseen and perhaps unforeseeable. The possibility of unforeseeable change gives rise to the need for a rigorous formulation of rational behavior in the face of this possibility. Existing models of rational behavior under uncertainty do not address this issue, because in one way or another they assume that the possible states of the world are known, and that uncertainty about them is expressed by probability distributions over the known set of states. The critical feature of unforeseeable change is precisely that the set of states is now known, and is perhaps not even well defined.

This is an important and exciting problem whose relevance extends far beyond the area of research on organizations. It seems likely that rational behavior in this broad context will involve adaptation, learning, complexity, and similar phenomena. These are topics in the second category, and must be regarded as speculative. Yet it is worth noting that the same kinds of problems and ideas—involving nonlinear dynamics, adaptation, learning, and complexity—are to be found now in a number of very different scientific fields. A conference held at the Center for Non-Linear Analysis at Los Alamos in May 1985, whose title was “Evolution, Games, and Learning,” included papers in physics, evolutionary biology, paleontology, ecology, biochemistry, computer science, complexity and artificial intelligence, machine learning, neuroscience, and economics. Many of the same ideas and questions were addressed in different languages and different contexts in these papers. The simultaneous emergence of these ideas as research topics in so many fields suggests that the time is ripe and the means are at hand to explore them.

### *Cross-Disciplinary Aspects of Research*

We have noted that the study of organization crosses disciplinary boundaries. This naturally gives rise to the idea of research at and across disciplinary boundaries, and to the possibility of support to facilitate and foster such research. Experience with such research in the behavioral and social sciences is mixed. It is therefore important to consider more closely what makes for successful research across disciplinary boundaries. Economic history is an example of a successful “interdiscipline”

between economics and history now so long and well established that it is not usually regarded as interdisciplinary but as a subfield in its own right. This parallels the situation in the natural sciences, where investigators approach the study of a common phenomenon from separate disciplines and, by combining their theories and techniques, develop a common paradigm. The eventual result is to establish a new subspecialty with its own methods and models. Physical chemistry and biophysics are examples. The essential feature of these cases seems to be the existence of a common model more or less formally defined that permits the research of different investigators to be related in a precise and systematic way.

An example in the social sciences where this can be seen clearly is that of the new field of "public choice," which brings together political science and economics. In recent years, the field of public choice has brought together researchers in voting theory and voting behavior from political science with social choice theorists from economics. Social choice theory provided the seed around which this field crystallized, by providing the initial formal framework. It is now well along in the process of becoming an independent subfield.

Another mode of cross-disciplinary interaction is a type of cross-fertilization of disciplines that takes place when one discipline incorporates material from another into its own models. For example, both economists and sociologists have pointed out that certain game-theoretic models cannot be satisfactorily closed within game theory itself. Solution concepts that reflect only the strategic structure of the game situation frequently result in a multiplicity of nonequivalent solutions. This is frequently the case with Nash equilibria of the game forms that arise in studying incentive problems. Sociologists have long pointed out the importance of values and norms as influencing behavior in such situations, and economists have come to recognize that such elements may have to be incorporated in their models to produce satisfactory results. There does not appear to be any serious obstacle to doing this, once the relevant values and norms are made explicit. There are no doubt several ways in which they could be incorporated, one of which would be to impose values and norms as constraints on the set from which a player may choose his strategy. This, if carried out, would be an example of one field (economics) using concepts (values and norms) from another (sociology) by incorporating them into a formal model.

A second example is that of endogenous preferences. Typically, in economic models preferences of economic agents are taken as unchang-

ing, given from outside the model, or if changing over time, doing so in a way determined outside the model. In short, preferences are assumed to be exogenous. Other behavioral and social scientists have pointed out that preferences of individuals are influenced by actions and events, by their experiences, some of which are typically endogenous variables of the model (Hirschman, 1982). Thus, the history of preferences over time becomes endogenous. The processes that describe the development of preferences over time may be central objects of study in sociology or social psychology, with the result that endogeneity of preferences may be a common feature of models in those fields.

It is doubtful that any person, whether or not an economist, would seriously dispute the proposition that education, experience, and other social influences affect people's preferences. Furthermore, it seems entirely possible to formulate dynamic models in which preferences are endogenously developed over time. Models, similar to those of capital theory, in which preference at any moment depends on past preference and on the events that influence preferences to change, can be formulated, and could perhaps incorporate knowledge of influences on preferences acquired from sociology or social psychology. But, in the context of research on economic organization, including markets, this has not been done. The difficulty is as follows: an important objective of research on organization is to be able to compare different organizations and to assess their efficiency. For that, it is necessary to have some criterion of efficiency. In economic models the criterion of efficiency usually depends on individual preferences, as is the case with the Pareto criterion, as well as various proposed notions of fairness. If preferences are endogenous, the logical basis for a normative analysis is unclear. In this case, the possibility of finding a formulation that provides a common ground for research between a discipline interested in modeling the endogenous evolution of preferences and one whose problem is to analyze the efficiency of mechanisms depends on being able to find a satisfactory efficiency criterion when preferences are endogenous.

Although the scope of productive interdisciplinary interaction is unclear at this time, there appears to be some convergence of interests, ideas, and perhaps models, between economics and sociology. The fact that there is now a larger number of sociologists who have mathematical and econometric interests and of economists interested in sociological models and results is helpful for communication.

It does seem clear that an essential condition for fruitful work on organization across disciplines is the ability to relate research in different fields in a precise, detailed, and rigorous fashion.

## Research Report

This report indicates that research on organizations is already an important area of research. New organizational designs and practices are likely to be needed as a result of new developments in computing and communication technologies. This increases the need for deeper scientific understanding of organization, and will offer new opportunities for analysis.

We strongly hold the view that this area of research will fare best if it is carried out via projects that grow out of the interests and ideas of individual investigators, or spontaneous collaborations among them. Such projects should compete for support in the review processes of institutions that support research, such as the National Science Foundation (NSF) and private foundations.

Because research on organizations can cross disciplinary boundaries it is important that proposals, especially unconventional proposals, or proposals that may not appear to be in the mainstream of any one discipline, not fall in the cracks during the evaluation process. Institutions interested in supporting research in the field of organization should be sensitive to the risk of too narrow a perspective.

### *Colloquia*

We think that it would be very productive to have a series of regular meetings, or colloquia, patterned to some extent on summer conferences in biological sciences. These meetings would take place at fixed and known times every year and last from one to three weeks. The group invited to participate, about thirty people, would have varying memberships, depending on the topic. The site for each meeting would be chosen at least a year in advance, allowing the organizers of each meeting a full year to plan the program. The meetings would be a mixture of formal sessions, sessions devoted to expository presentations, cross-disciplinary contacts, and time for informal work.

The Conference-Seminar on Decentralization, one of a number of conference-seminars supported by the National Science Foundation via a grant administered by the National Bureau of Economic Research, has been meeting since 1971, once or twice a year (depending on availability of funds) at different universities. These meetings have had an important effect on the development of research in the field of decentralized resource allocation, as was the case with their predecessor, the Purdue Symposium. Research on organization would benefit from an improved version of a program of regular conferences along the lines sketched above.

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