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Introduction

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The papers in this volume were presented at a conference on the economics of information and uncertainty held in Boston in June of 1979 and sponsored by the Universities–National Bureau Committee for Economic Research.[1] The papers cover a broad range of topics and at first glance may appear unrelated. Of course, each of the papers is concerned with a particular aspect of either the economics of information or the economics of uncertainty, but this, in itself, is a relatively weak link. There is, however, a fundamental theme that does create strong interactions among these essays, namely, the role of incentives, risk, and risk sharing in organizational structure. Since this theme permeates and unifies much of the recent literature on the economics of uncertainty,[2] we begin this introduction with an elaboration of its origins and ramifications.

This basic theme has received considerable attention in three different literatures: the theory of finance, organization theory, and the economics of insurance. In the recent literature on organization theory and insurance, the intersection between the set of organizational concepts and the set of insurance concepts is so large that it is no longer useful to distinguish between these two disciplines. Thus, in our discussion of organization theory we see that topics like moral hazard and adverse selection, which formerly belonged exclusively to insurance theory, are precisely the problems that have vivified the new organizational research.

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The theory of finance was one of the first to recognize the importance of uncertainty in comprehending economic behavior. This is not surprising since the stock market cannot be ignored by financial analysts. The first tasks of finance were to explain the stochastic behavior of the stock market and its role in a capitalist economy. Thus, Bachelier, by inventing Brownian motion to explain stock price fluctuations, and Arrow, by perceiving the risk sharing function of the stock market, laid the groundwork for modern finance.

Arrow pointed to the stock market as the main institution for shifting the risks of business from entrepreneurs to the general public. Individuals can diversify their portfolios to achieve an acceptable level of expected return for a given level of risk. This ability to pool risks enables firms to undertake projects that would otherwise be unacceptable. Thus, society is better off. The stock market is not a perfect risk pooling entity like the futures market. It is unable to separate production and risk, leaving the former to the manager and transferring the latter to the general public. Instead, with the issuance of stock the firm's owners and managers are separated and the profit maximizing incentives of the managers are diluted. Thus, the inability of stockholders to monitor managers' efforts gives rise to a moral hazard problem.

The study of stock market fluctuations and the stock market as a risk pooling institution has led to important contributions like the capital asset pricing model, the options pricing model, the efficient market hypothesis, the Modigliani-Miller theorem, and recent research on the theory of the firm.[3] This last endeavor has given us new concepts like spanning and unanimity from which an entirely new perspective for evaluating a firm's behavior has emerged.

Several of the papers in this volume make important contributions to finance. In the past, ideas have tended to move from finance to economics. In his paper Brock returns the favor and shows how some of the recent economic research in growth theory and rational expectations can be used to enrich the extant financial models. Kreps conducts an intensive study of the Black-Scholes option pricing model and shows that its power depends on some very delicate properties that are not robust. Kihlstrom and Laffont extend the theory of the firm by including stockholders as decision makers. The efficiency of the ensuing competitive allocation of risk and capital is studied in detail. Grossman and Hart, by demonstrating how the financial structure of the corporation affects the incentives of the managers, suggest how the market resolves the moral hazard problem with the issuance of stock.

From our discussion of the finance literature it is clear that stochastic considerations have led to a reformulation of the theory of the firm. There is, of course, another vast literature on organization theory which has joined with the finance literature in promulgating this "new" theory

of the firm. Let us spend a moment reviewing this organizational literature.[4]

The basic problem in any organization from the beehive to IBM is to design decision making procedures that are "best" for achieving organizational goals. There are two reasons why this problem is difficult and interesting. First, members of the organization may possess individual goals that are quite different from the primary goal of the organization. Second, the decision making procedures must be based on incomplete information. From this description it is clear that organizational decision making takes place in an agency setting. Thus, the problems arise because of the divergence of incentives between the organization (principal) and its members (agents) as well as the differential cost of obtaining pertinent information.[5] For example, the manager observes an outcome that depends on the state of nature and the actions of the agent. Usually it is costly to distinguish the state of nature from these actions. If this cost is not incurred, the manager is unable to determine the relative contribution of each to the outcome. Since rewards are based on the outcome, the manager would surely like to separate the outcome into the part attributable to the actions of the agent and the part due to the state of nature. This is, of course, the essence of the moral hazard problem. Among the more "specific" results in this area are the recent ones of Harris and Raviv (1979). They demonstrate that monitoring the agent does not pay if the agent is risk neutral or if the relation between his action and the outcome is freely observable. When monitoring does pay, they show that "any Pareto optimal contract can be approximated by an 'all-or-nothing' type of contract." If the action is "acceptable," the agent is paid; otherwise he receives nothing.

In any firm there are at least three distinct groups of participants: stockholders, managers, and owners of nonmanagerial inputs. The three groups voluntarily collaborate in pursuit of a common goal. The common goal that binds these groups must be strong enough to withstand the disintegrating forces that are unleashed when each group pursues its own objective and each individual looks to his own welfare. Even when the common bond is sufficiently strong to preserve the integrity of the organization, the problems of decision making under uncertainty remain.

Because decisions must be based on imperfect information, the organization's welfare is always in jeopardy. A decision that was best in an *ex ante* sense may nevertheless impose great costs on the organization and indeed may even lead to its demise. These hazards or risks, which are fundamental and intrinsic to life as we know it, are allocated among the members of the organization. This allocation must be conducted in such a way that individual incentives are preserved. In order to obtain a proper allocation, due regard must be given to the timing of information, the risk preferences of the organization's members, and the role of chance factors

in determining outcomes. In many applications it is difficult if not impossible to "give due regard." It is especially hard to distinguish between the roles of chance and individual effort in determining outcomes. It is natural to attribute good outcomes to our personal effort while blaming fickle nature for untoward events. An appropriate allocation can be accomplished by means of the Pareto optimal contracting that was discussed in the theory of agency. Thus, in certain circumstances it will be in the interest of the employees to subject themselves to monitoring in order to control shirking and to dismissal if their conduct deviates from an agreed-upon norm.

The literature on decision making in organizations has till recently concentrated on the informational problem and assumed that all members possessed a common objective function. In their seminal work Marschak and Radner (1972) studied the behavior of organizations by developing a theory of teams. They recognized that the members of any organization differ in three important respects: first, they control different actions; second, they each have access to different information on which they base their actions; and third, they have different goals. Their theory of teams concentrates on the first two differences and for all practical purposes ignores differences in goals. Thus restricted, their analysis derives the optimal decision function for a particular information structure and evaluates alternative information structures.

The major point made by Alchian and Demsetz (1972) is that the genesis of the capitalist firm is founded on imperfect information. They emphasize that the firm is not a jail in which conflicts are resolved by decree. Members of the firm—employers and employees—are voluntary participants in a cooperative venture. But why all this confusion about the control that the boss exercises over the worker's welfare? Alchian and Demsetz argue that this control is not dictatorial but instead jointly agreed to by both employee and employer. The essence of the control is the monitoring function performed by management. Monitoring is necessary because the firm's production function depends on team output. In the absence of monitoring some team members would shirk. The main function of management is to deter shirking by monitoring inputs and firing malingerers. Management's reward for this monitoring takes the form of a residual claim on output.

In their recent paper Jensen and Meckling (1976) show how the financial structure of the firm is affected by moral hazard. They first study the moral hazard associated with the issuance of stock. If the manager owns the entire firm in the sense that he is the only stockholder, his decisions will be such as to maximize his utility. Assume that his utility derives from both pecuniary and nonpecuniary returns. The nonpecuniary returns flow from Alchian amenities like thick rugs, friendly staff, etc. Now suppose that he sells some fraction α of his stock to outsiders. The

outsiders and the manager have identical incentives with respect to pecuniary returns, but the outsiders do not share in the nonpecuniary returns. This gives rise to moral hazard and monitoring because the manager captures the full benefit of the nonpecuniary returns whereas he only pays $(1 - \alpha)$ for their total and marginal cost. As α increases, his incentive to spend resources on perquisites also increases and of course the outsiders will have a greater incentive to monitor the manager's behavior. The difference between the value of the solely owned firm and one in which the manager owns $(1 - \alpha)$ measures the cost of agency (apart from the tax benefits associated with the perquisites).

A similar moral hazard problem exists for debt. Suppose that the owner-manager has a small amount invested in the firm and relies on bondholders to finance the rest. Since he is the residual claimant, the smaller his stake in the enterprise relative to that of the bondholders, the greater his incentive to undertake investments that have high payoffs if successful. When such an investment is a success, he pays the bondholder a *fixed* fee and the owner gets the residual. If the investment fails, most of the cost is borne by the bondholders. Thus, it behooves the bondholders to police the manager's behavior.

Three of the papers in this volume address various aspects of the moral hazard problem that afflicts organizational decision making. The paper by Green extends the theory of teams to the situation where the two participants in decision making do not have identical utility functions. One participant gathers information and transmits it to the other, who makes the decision. Because of the different utility functions, it may pay the collector of information to dissemble. Green measures the value of information and shows that the value of improved information may be negative. Grossman and Hart show how the threat of bankruptcy can mitigate the moral hazard created by the inability of stockholders to monitor the manager's effort. Mortensen is concerned with the genesis of organizations. How do the members of an organization find one another? This is characterized as a problem of search. Mortensen shows how the allocation of the organization's output among its members affects the intensity with which they search. An externality occurs because the searcher in picking his search intensity only considers his own expected benefit from the match. Mortensen shows how contracts can be designed to solve this incentive problem.

Carlton, and Porter and Spence study other aspects of the theory of the firm. Carlton shows that the presence of uncertainty may alter our attitude toward monopoly. In particular, he argues that under uncertainty a market structure that has both monopolistic and competitive features may be preferable to either pure monopoly or pure competition. Porter and Spence present a practical application of organization theory that illustrates how an organization makes decisions under uncertainty

when there is a high degree of dependence between its actions and those of its rivals. Previous discussions focused on organizations operating within a competitive environment. Thus, conflict among firms and strategic considerations were absent. The papers by Carlton, and Porter and Spence investigate situations in which strategic considerations can no longer be ignored. In Porter and Spence's paper, the market structure is oligopolistic and the reactions of firms to their competitors is crucial. In Carlton's paper the market is monopolistic with a competitive fringe, and limit pricing is one of the strategic devices used by the monopolist.

We conclude the introduction with a more detailed summary of each essay.

The paper "Asset Prices in a Production Economy," by William A. Brock, generalizes the capital asset pricing model in two directions. First, it is made dynamic by constructing an intertemporal model; second, this dynamic model is formulated in a general equilibrium framework. Brock's intertemporal general equilibrium model is obtained by an artistic linkage of several relatively independent contributions in finance and economics. These include the stochastic growth model of Brock-Mirman, Merton's intertemporal capital asset pricing model, Lucas's asset pricing model, and Ross's arbitrage theory of asset pricing. The equilibrium concept is one of rational expectations. While the paper is very theoretical, Brock's goal is to answer basic economic questions like the effect of increased progessivity in income taxes on the relative prices of risky assets. Empirical research utilizing Brock's framework strikes me as very important. Depending upon one's perspective this work can be viewed as enriching the thriving finance theory "industry" or as arresting the decline of the growth theory "industry" by embedding market institutions into the standard stochastic growth models.

Dennis W. Carlton's paper, "Planning and Market Structure," evaluates alternative market organizations according to their ability to plan production in response to information about consumer demands. Carlton adopts a Schumpeterian stance and argues that the incentives in competitive markets are such that the acquisition of information about demand uncertainty is inefficient. Unlike the competitive firm, a monopoly does have incentives to gather this information and adjust its production accordingly. However, Carlton shows via an example that the benefits accruing to a monopolist from planning are unlikely to offset the monopoly's deadweight loss. Thus, even in the presence of imperfect information a competitive market structure may be preferred to a monopoly. Carlton then introduces a market composed of a dominant firm, which may be a cartel, and a competitive fringe. He shows that this mixed market structure is preferable to either pure competition or pure monopoly. In the mixed structure the incentives for planning reside in the

dominant firm, so society reaps the planning benefits of monopoly. At the same time, the deadweight loss of monopoly is reduced by the discipline imposed by the competitive fringe. In its effort to control the size of the competitive fringe, the dominant firm pursues a policy that looks like predatory pricing but is socially superior to the policy of either pure competition or pure monopoly.

The paper "Statistical Decision Theory Requiring Incentives for Information Transfer," by Jerry Green, studies the transfer of information within an organization. The organization is composed of two members. The distinguishing assumption of Green's analysis is that the utility functions of the two members are different. Thus, it may be optimal for the first agent to adjust the information before transmission. For this environment Green shows that, with two actions and two observations, either the information is valueless or a first-best can be achieved. If there are more than two actions, a randomized strategy may be optimal. The randomized strategy is remarkable in that positive probabilities may be attached to dominated actions. The reason for this is that such a strategy by the decision maker may induce veracity in his otherwise unreliable colleague. Green then proves that the decision maker may not want to improve the information structure of his unreliable agent; i.e., the value of "better" information, in the Blackwell sense, may be negative. Green concludes on a positive note by showing that, when there are only two possible observations, the value of improving the agent's information to the decision maker is necessarily nonnegative.

In "Corporate Financial Structure and Managerial Incentives," Sanford J. Grossman and Oliver D. Hart develop a new equilibrium concept to resolve the conflict that exists between the managers of a firm and the firm's stockholders. This conflict is another manifestation of the moral hazard problem. In general, shareholders will not be able to monitor management's actions *and* management's objective function may be quite different from that of the shareholders. The threat of takeover and management compensation schemes like stock options mitigate this moral hazard. Grossman and Hart suggest a third method, viz., the issuance of debt, which, by creating a probability of bankruptcy, an event which is assumed to impose high costs on management, induces the managers to take actions that reduce the bankruptcy probability. Of course, that probability is minimized when the managers maximize profits. Thus, if the costs of bankruptcy are sufficiently high, the issuance of debt eliminates the moral hazard problem. Grossman and Hart show how this resolution occurs in a mature corporation where the financial structure is determined by the management. The market value of the firm is positively related to its level of debt. But managers benefit from high market value because their compensation may be related to market

value, because the probability of takeover is nonincreasing in market value, and because the cost of raising additional capital is nonincreasing in market value.

In their paper "A Competitive Entrepreneurial Model of a Stock Market," Richard E. Kihlstrom and Jean-Jacques Laffont adopt Diamond's notion of efficiency and extend results like his to circumstances in which technologies do not exhibit stochastic constant returns to scale. In their model, firms are created and run by entrepreneurs who maximize expected utility. The entrepreneurs are permitted to make personal portfolio decisions in addition to the financial decisions that they make as managers. The firm is competitive in that it is a price taker in all markets. Entry is restricted only by the fixed fee that each entrant must pay. Furthermore, there are infinitely many individuals, each of which belongs to one of several types. Any individual is a potential entrepreneur. A final condition for competition is that returns across firms be stochastically dependent. One of the consequences of their model is that whether or not an individual becomes an entrepreneur is a matter of indifference in equilibrium. A necessary condition for this indifference is the absence of arbitrage opportunities in equilibrium. This will be the case when the Miller-Modigliani theorem obtains and the market value of the resources devoted to a firm equals its equilibrium value.

The authors introduce a special kind of rational expectations called "classical expectations" and prove that, when these expectations hold, an equilibrium exists. This equilibrium has several interesting properties. The optimal portfolio of an individual possesses a nondiversification property in that for entrepreneurs it includes shares in his own firm or in firms that are managed like his, whereas for nonentrepreneurs it includes shares in firms that are managed like firms he would establish. Another equilibrium property is that the number of types of firms equals the number of types of individuals in the economy. Each type of individual holds shares only in firms created by entrepreneurs of the same type. Kihlstrom and Laffont refer to this as a clientele effect and show that it results in unanimous agreement among shareholders in the firm's goals. The equilibrium presented reduces to Diamond's when the technology has stochastic constant returns to scale. Furthermore, the model reduces to the perfectly competitive equilibrium when uncertainty is eliminated. Finally, the model reveals that a stock market will be necessary only when all three of the following conditions are satisfied: costs of entry are fixed, and uncertainty and risk aversion are present for a large number of investors. In the absence of any one of these conditions, the economy achieves the same allocation without a stock market.

In "Multiperiod Securities and the Efficient Allocation of Risk: A Comment on the Black-Scholes Option Pricing Model," David M. Kreps conducts a sophisticated mathematical analysis of the Black-Scholes op-

tion pricing model. A Debreu-style economy is presented in which the Black-Scholes prices, which are exogenous in their model, are now endogenously determined. In this general equilibrium setting, Kreps specifies a necessary and sufficient condition for this Debreu economy to possess a complete set of markets. Of course, when this condition is satisfied, the equilibrium allocation corresponding to these equilibrium option prices is Pareto efficient. Unfortunately, the necessary and sufficient conditions involve the equilibrium prices. Kreps then examines the robustness of this model and asks whether, for small deviations from these necessary and sufficient conditions, the resulting economy will possess markets that are approximately complete and the allocation of risk will be approximately efficient. Answers to these questions are quite difficult. The following summary statement by Kreps is most illuminating:

> Frequent trading makes it *possible* for a few securities to span many states of nature. Whether markets are "perfectly" complete depends critically on the fine structure of the way in which uncertainty resolves. But the condition required for complete markets is not "nearly" required for "approximately" complete markets. If equilibrium prices approximate an ideal model in a fairly coarse sense, and if that ideal model has perfectly complete markets, then markets in the original model will give nearly efficient equilibrium allocations. Thus if actual security prices behave "like" those in the Black-Scholes model (meaning here the general class of diffusion process models for which markets are complete), risk is allocated approximately efficiently.

In his paper "The Matching Process as a Noncooperative Bargaining Game," Dale T. Mortensen investigates the formation of organizations. There is imperfect information in that the identities and/or locations of potential members are not known in advance. Information about potential members is acquired by search. The rule for dividing the surplus of any match among its members affects the intensity with which prospective members search. Matched agents do not search, and the rate at which matches form is endogenously determined by the search intensities selected by unmatched agents. Mortensen shows that in general the joint Nash choice of such intensities and the associated matching process are inefficient. In his quest for efficiency Mortensen considers linear and quadratic matching technologies. In the first the probability of forming a match in a small period of time is independent of the number of unmatched agents. In the second this probability is proportional to the number of unmatched agents.

Given a linear technology, the search intensities selected by unmatched agents are too low to achieve efficiency. The choice of a search intensity is not affected by the rewards received by the other number of the match. Mortensen shows that, if the agent responsible for the match

receives all of its surplus, joint wealth is maximized by the Nash choice of such intensities. However, this arrangement fails to achieve efficiency for the quadratic technology. In addition to the externality just discussed for the linear case, there is a second externality present in the quadratic technology: more intensive search reduces the probability of meeting an unmatched agent. Thus, by this second externality individuals search too much. Mortensen shows that efficiency is restored when the agent responsible for the match, the matchmaker, receives a fraction f of the surplus, where $\frac{1}{2} \leq f \leq 1$. Finally, Mortensen demonstrates that for both technologies there is a unique division of the match's surplus such that all unmatched agents search efficiently.

In their paper "The Capacity Expansion Process in a Growing Oligopoly: The Case of Corn Wet Milling," Michael E. Porter and A. Michael Spence vividly describe how uncertainty affects economic decision making. How should a firm in an evolving oligopolistic industry augment its productive capacity? The cost of not making such additions when it should is that its industry position will erode. On the other hand, overexpansion will also have a deleterious effect on profits. Factors that should be incorporated in this decision include the following: stochastic lead times with large expected values, expectations about future demand, and the usual strategic considerations that are characteristic of oligopolistic industries. Porter and Spence conduct their study of the capacity expansion decision for the corn wet milling industry. They conclude from this analysis that it is possible to calculate the most likely capacity decisions for firms in an expanding oligopolistic industry. The equilibrium concept used in making this calculation is one of rational expectations. They consider the study of expectations formation an extremely important topic of future research. Another significant finding is that a strategy of preemptive investment is rendered unattractive by the presence of uncertainty. Thus, uncertainty eliminates outcomes in which a large market share is lodged in a few firms.

Notes

1. For their help in organizing the conference, I am indebted to Buz Brock, Rich Kihlstrom, Steve Lippman, Dale Mortensen, Chris Mortensen, Mike Rothschild, Mike Spence, and George Stigler.

2. For two recent surveys of this literature, see Hirshleifer and Riley (1979) and Lippman and McCall (1981). The reader may also wish to consult the proceedings of two previous conferences on the economics of information published in the *Quarterly Journal of Economics*, November 1976, and the *Review of Economic Studies*, October 1977. See also Diamond and Rothschild (1978).

3. For excellent surveys of this recent research, see Baron (1979) and Kreps (1979).

4. For a glimpse of this literature, see "Symposium on the Economics of Internal Organizations" (1975).

5. See Arrow (1964), Harris and Raviv (1979), Hurwicz and Shapiro (1977), Ross (1973), Shavell (1979), and Stiglitz (1974, 1975).

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