2. MARKET ECONOMICS OF UNCERTAINTY AND INFORMATION

In the decades of the 1970's and 1980's economic theory experienced an evolution of the economic problem from simply "allocating scarce resources" to a problem of the "proper use of knowledge" as Hayek put it. Allocation efficiency began to be supplemented with informational efficiency. The principles based on purposeful behavior, which have always been at the foundations of economics, began to expand to explain the acquisition of information and its use, including both the information that might be carried in the actions of others and in the behavior of markets. This evolution was accompanied by the development of more precise principles of behavior as well as modifications of those of classical origin.

This section on uncertainty and information contains six contributions in which the evolving principles cover increasingly complex phenomena. The section begins with two papers focused on the ability of individuals to acquire information and on how they behave when doing so. The last three papers deal with the interaction of human behavioral tendencies with the special instruments and institutions that are designed to facilitate commerce and use information in the light of individual decisions.

Kelly and Friedman report on the expectations development of individuals and in particular the capacity of individuals to condition their expectations of some events on the observation of multiple other events. That is, they measure the implicit conditional subjective probabilities of events that have a stochastic dependence on other observable events. Unlike other modeling of expectations the environments they study have no prominent lag structure. Specifically they test the ability of beliefs to accurately reflect an equation of the form

$$y_t = a_0 + a_1 x_{1t} + a_2 x_{2t} + ve_t,$$

where x_{1t} and x_{2t} are observed and subjects are asked to estimate y_t. That is, the subject observes the pair (x_{1t}, x_{2t}) and then asked to predict the value of y_t, which is then used to statistically estimate the coefficients of the equation. The estimated coefficients are then interpreted as subjective conditional probabilities and are compared to the true coefficients, the true conditional probabilities. Kelly and Friedman report that for the most part the estimates are accurate but the analysis goes deeper to provide insights about the dynamics of the adjustment process. The tendency is for the estimates to be exaggerated at first, in the sense that the conditional means are as if they were multiplied by a positive scalar. They call this property "over-response." From this position of exaggeration the beliefs tend to slowly converge toward the truth. The potential for exaggeration is exacerbated by increased noise and when subjects are faced by a change in parameters

of the data generating equation, the response is slow but in the proper direction. Thus, the new set of parameters is approached from the direction of the old set of parameters.

Cox and Oaxaca focus on information acquisition that shares a deep relationship with concepts of search and sequential decisions. Motivations are found in models of job search, search for lowest prices, and decisions to invest. Their focus is on classical models, which is appropriate because of the connection of those models to many areas of economics. The experiments thus provide a vehicle through which the consequences of any inaccuracies of the basic theory can be traced through to other contexts. They report that when put to the task of predicting when a person will stop searching and choose in a stationary environment, the classical, risk neutral model captures the behavior of a large proportion of subjects but subjects typically stop short and choose sooner than the model suggests. The abbreviated search is a property of the risk-averse model.

During the course of the research they successfully tested a method of measuring expectations during the search process, a variable which if measured would be an important tool for assessing model inaccuracies. They force subjects to precommit to a termination strategy and discover that this process has no effect on decisions after subjects become experienced. The effect exists at first but then wears off. Thus the methodology provides an opportunity to compare observed stopping rules with those predicted by theory. The risk averse model survived direct tests. They end the summary with a paradox. When subjects are allowed to return to previously passed over opportunities, like returning to a job offer that was previously refused, they behave as if they were facing a more risky task rather than less.

The third (Gachter and Fehr) and fourth (Fehr and Falk) papers illustrate the effects of other regarding attitudes and the importance of such attitudes in the design of institutions and in the behavior of markets. Their study is focused on attitudes of reciprocity in the context of contracts and in markets.

The concept of a contract is at the heart of information and uncertainty. Under conditions of certainty, the contract plays a mechanical role, acting something like an escrow account in which a third party inspects the deliveries to both sides of a contract before either can take the contracted amount away. The person who buys knows the delivery has taken place and inspects the goods before the money is released and the person who delivers the goods knows that payment has taken place before the goods are released. The structure of the relationship is so tight that it can be imagined as physical.

Under conditions of uncertainty the contract acquires additional dimensions. Payments can precede delivery and in such cases there may be no physical guarantee that appropriate delivery will take place. The success of the contract depends on incentives. The fundamental issue raised by the two papers is whether other regarding preferences act to enforce contracts that are otherwise unenforceable. The answer they give is “yes, to some degree” and that an understanding of this fact can be used to suggest ways to improve contract performance.

The interpretation of the research tends to be a relationship between an employer and a worker who can deliver effort that is costly to the worker and not monitored by the employer. The data demonstrate that subject employers who offer high wages can

depend on subject workers to deliver more than the minimum (best Nash response) work. While the worker response is less than it would be if the contract were fully enforced, the workers do engage in reciprocity.

Can this tendency toward reciprocity be enhanced by additional features of a contract or by a change in the market organization? The second paper demonstrates that the power of reciprocity survives several market organizations. When focused on the terms of the contract the relationships prove to be delicate and intuitions drawn from economic theory alone can be misleading. A contract can include the possibility for retribution by a dissatisfied employer or reward by a satisfied employer. In a subgame perfect equilibrium, a reward would not be forthcoming and a costly retribution would not be exercised. Game theory suggests that the contract would make no difference – but it does. Not only do the employees deliver more, the employers also anticipate that they will deliver more. On the other hand, if enforcement is exercised through fines for shirking that results from randomized inspections, the benefits of reciprocity are reduced.

The patterns of these results emphasize several important points. First, from the individual level to the system level the basic principles of economics and game theory organize important features of how individual and systems cope with uncertainty. Secondly, they demonstrate that individual can be other-regarding. Importantly, for the next parts of this section, people have a tendency to understand the behavior of other people and factor that into their own decisions. We have seen how that property finds its way into contracts. The next papers demonstrate how that factors into the way in which information becomes transferred from one individual to another in the context of the operation of an economic system. Not only do individuals act purposefully, but they also see others as acting purposefully. By using a principle of invertability they incorporate the information held by others into their own information. This property of invertability is the amazing feature of rational expectations.

The Anderson and Holt paper reviews data on "cascades." The early discussions of cascades viewed them as a "herd," an odd, undesirable and even irrational behavior that was compared to mechanical, mimic-like or even thoughtless behavior that leads to disastrous lemming-like consequences. In part, it was thought to be related to a preference for conformity. Now the phenomenon can be seen in a completely different light as a remarkable demonstration of the invertability principle and how it facilitates information through social relationships. A pure preference for conformity can be ruled out.

The cascade experiment is deceptively simple. Each individual receives a private signal about the state of nature. In sequence, individuals make a guess about the state, and at the time of the guess know the private signal and the guess of all previous individuals. Since the reward is for being correct an individual can infer the information of others but "inverting" a postulated decision rule. A guess of "X" suggests that the individual believed that X would occur thereby revealing the belief to an observer who can add that information to whatever other information might be available and thus make better-informed decisions. Interestingly enough, people do not trust the decisions of others completely. It is as though they do not trust the rationality of others and thus, to the

extent that errors exist, they reflect the fact that people rely on their private information too much.

Aside from an analysis of individuals, the questions posed are related to the magnitude and accuracy of this information transfer and how it is influenced by incentives and organization. When decisions are sequential, a cascade develops in which information held by individuals other than the first few never finds its way into the system. While individual decisions are better than if based on private information alone, the system is not "informationally efficient." All available information does not become public and incorporated into individual decisions. A change in the institution, for example to a majority rule voting system, dramatically improves the informational efficiency. Changes in the incentives to, say, one that rewards conformity, dramatically reduce the informational efficiency.

The basic principles of economics as applied to information and uncertainty merge naturally into a theory of rational expectations. The models suggest that markets can collect and aggregate information that is dispersed in small bits across many individuals. According to some models, the prices contain a summary of all economically relevant information that exists anywhere in the system. Of course the full force of that powerful claim is not supported by experiments but the claim has many elements of truth. The paper by Chen and Plott illustrates the implementation of experiments to study the phenomena of information in markets and demonstrate the operation of aspects of the principles through a series of experiments that are more complex than any reported in the literature. Two important points are made. First the development of rational expectations is a dynamic process, as reflected in a process of equilibration. The process can be contrasted with the instantaneous equilibrium selection presupposed in some game theoretic models. Secondly, the capacity of markets to perform the task is sensitive to the instruments that exist in the market. While the paper does not demonstrate it, the suggestion is that the nature of successful instruments could be closely related to the nature of the uncertainty that exists and how information is distributed.

The final section of the paper demonstrates that the concept of mechanism design can be extended to what Chen and Plott call Information Aggregation Mechanisms. These are market processes that have no other purpose than to collect information. The concept is developed and a field application is reviewed, demonstrating not only the scientific feasibility, but also the practical relevance of the idea.