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Review

Ideas and work of Richard M. Cyert

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Abstract

Richard M. Cyert's seminal contribution to economics is the development of behavioral theory of the firm. This theory has become an important plank in the bridge from economics to management. His other contributions include applications of Bayesian theory to economics, statistical sampling in accounting, experimental economics and developing an economic theory of stragetic management.

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1. Introduction

Richard M. Cyert is one of the two central figures in the development of the behavioral theory of the firm. He and James G. March gave body to the black box of the neoclassical firm in the form of empirically relevant, process-oriented models of concrete decisions in organizations. This achievement provided a solid theoretical foundation for the development of management, and created a bridge between economics and organizations theory as well as to the behavioral sciences. In developing the behavioral theory of the firm, Cyert also established a firm tradition of field-based observation and computer simulation as important research tools for the study of markets and organizations.

But his contributions are more varied; they include applications of Bayesian theory to economics, statistical sampling in accounting and auditing, experimental economics, and the application of strategic management principles to higher education. The following

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pages summarize Cyert's ideas and work, and identify some of their links to the current research reported in this volume.

2. Behavioral theory of the firm

Cyert's overarching contribution to the economic sciences has been to turn the lights on inside the black box of the neoclassical model of the firm. He led and enabled social scientists to explore and understand the internal decision-making processes of the firm within the context of factor and product markets in which it operates.

The neoclassical abstraction of the firm is an entrepreneur who maximizes profit subject to various resource constraints. This model yielded powerful results about the role of firms in determining prices and allocations in competitive and oligopolistic markets. By mid-century, as most economic activity in industrialized countries gradually came to be conducted by large publicly-held firms, economists became increasingly curious about the internal workings of the firm. Berle and Means, Chester Barnard, Ronald Coase and Herbert Simon began to raise and address many such questions.

In spite of its simple elegance, the neoclassical model had its weaknesses. Many important classes of externally observable actions of firms are difficult to understand in terms of this model. And as business schools began to flourish after World War II and to develop serious research programs into the management process, the neoclassical model was wanting as a foundation for building a theory of management. Cyert, in partnership with James G. March, addressed this problem by building a behavioral theory of the firm on specific, empirically verifiable assumptions about the behavior of the decision makers.

Cyert had studied price behavior of oligopolies under Abramovitz, Burns and Stigler at Columbia. In his thesis, he tried to bring together the theory and the case streams of oligopoly literature by empirically testing the proposition that the price behavior of oligopolies varies over the business cycle. He could find scant support for it, and began to wonder if the traditional models could adequately capture the behavior of markets in which a small number of large firms compete: "It seemed to me, that the way information was gathered and processed within the organization had to be incorporated into the decision-making process." He grew uncomfortable following the beaten path of mainstream theory. Yet, he had no training or background in organization theory, and shared the reluctance of most economists of his day to look inside the black box of the firm.

A teaching position at Carnegie Mellon (then Carnegie Institute of Technology) brought him into contact with Herbert Simon and organization theory. In this environment, his doubts about the traditional oligopoly theory led him to ask if an understanding of the organization structure and information flow within the firm may help understand its behavior in markets. He discussed the idea with an enthusiastic colleague, James G. March, and a remarkable partnership and friendship was started. They published their first co-authored paper, "Organizational Behavior and Pricing Behavior in an Oligopolistic Market" in the *American Economic Review* in 1955. In approximately ten years, they completed their landmark work, *A Behavioral Theory of the Firm.*

The behavioral theory of the firm was based on a four-fold research strategy. First, it focused on a few key economic decisions of the firm – price and output in early work, adding internal allocation and market strategy later. Focus on only a few key economic variables kept the behavioral theory from becoming excessively general; theories had to successfully predict specific values of these variables, forcing them to be operational at a concrete level. It also kept this work within the fold of economics, even as it built bridges to organization theory, social psychology and other behavioral sciences.

Second, it departed from the dominant strains in both theoretical as well as empirical traditions in economics by developing a model of the decision-making *process* of the firm; not merely on the *data* generated by the process. This importation of the process methodology from psychology and social sciences enabled the authors to probe and learn what was beyond the traditional tools of economics.

Third, Cyert and March kept this research program rooted firmly in the ground by their insistence that the models of the firm be based closely on the empirical observations of both the decisions as well as decision-processes that the authors observed in actual business organizations. Direct observations were used to formulate process models, and the predicted consequences of these models were tested in three different ways – in the field on actual organizations, in the laboratory with human subjects, and by computers that were programmed to mimic the process models. This not only strengthened the tradition of scientific field research in economics, it also introduced laboratory experimentation to economics and developed computer simulation as a new social science methodology.

Fourth, Cyert and March were not interested in mere case studies; they wanted, and succeeded in developing, new concepts and models of business organizations that apply to a variety of organizations in a variety of decision situations.

The result of this remarkable, decade-long research program was the development of "an empirically relevant, process-oriented, general theory of economic decision making by business firms." In doing so, they helped shift the primary unit of theoretical as well as empirical analysis from industry to the firm. They linked economics and organization theory with enough structure on which a meaningful theory of management could be built in the ensuing quarter century.

Williamson, who arrived at Carnegie toward the end of the fifties to do his graduate work, captures the flavor of the atmosphere in his autobiographical contribution to this volume. The first decade of the new school that Cyert and his colleagues founded at Carnegie was marked by an extraordinary congregation of men of ideas. In another place and time, these diverse ideas might have clashed, and retreated to their own cubicles of academic disciplines. It was, perhaps, the fortuitous presence of unique personalities in this group of scholars who closed the exits for retreat, and forced the ideas to clash, even spark, fuse, and generate new disciplines and lines of research. He was introduced at Carnegie to Simon's bounded rationality, Muth's rational expectations, and Cyert and March's behavioral theory of the firm.

Williamson developed his own theory of transactions cost economics from the behavioral theory of the firm kernel of an idea that managers maximize their slack. He dropped the assumption of hyperrationality in favor of bounded rationality, without resorting to a totally myopic formulation of decision making. He supplanted stewardship

with the assumption of opportunism on part of the managers to build the foundations of transactions cost economics. Some thirty years later, Williamson's work has generated a new focus and important research stream, combining economics, organization theory and law, and yielding implications in many fields of policy.

Early applications of the behavioral theory focused on operating decisions. Yet, many aspects of financial economics still cry out for better explanations. Dividend policy, for example, is an open, unresolved important puzzle in theory of the firm. Miller and Modigliani's theory, qualified for absence of taxes, predicts that dividend is merely the residual earning of the firm that it cannot profitably reinvest. Yet, dividend data gathered in the field do not exhibit the characteristics expected of such a residual series.

In their contribution to this volume, Cyert, Kang and Kumar set out to build a model of dividend decision making based on three key ingredients of the behavioral theory of the firm: uncertainty avoidance, sequential decision making, and self-seeking managers. Their model of optimal dividend policy in this context makes concrete predictions about the effects of various economic variables on the probability of increases or decreases in dividends. Specifically, lagged capital productivity, lagged investment, and change in equity base should raise (lower) the probability of increase (decrease) in dividend. Lagged dividend should have the opposite effect. Earnings persistence should raise the probability of increase as well as decrease in dividends. The effect of systematic and unsystematic risk on the probability of dividend increase (decrease) should be negative (indeterminate).

Their test of the model on dividend policy of larger U.S. firms yields strong support for the predictions of the model. All effects turn out to have the predicted direction, and all except two (systematic risk and change in equity base) turn out to be highly significant. It is quite remarkable that a behavioral theory of such a controversial aspect of theory of the firm receives such a strong support from empirical data. Especially noteworthy is the consistency of the dividend data with the asymmetric impact of certain variables on chances of dividend increases and decreases, as predicted by the behavioral theory of the firm.

3. Bayesian statistics and economic theory

About the time *A Behavioral Theory of the Firm* went to press, Cyert became the dean of the Graduate School of Industrial Administration, and shortly thereafter, March left for California. This phase of his work came to a close. Again, Cyert returned to his thoughts from his thesis on oligopoly theory. Traditional theory not only lacked any specification of the decision process, it was also bereft of any learning on the part of the firm or its decision makers. Models like the "kinked demand curve" could not be sustained under learning. This was a natural direction to build on *A Behavioral Theory of the Firm.* In the late sixties, in his Saturday meetings with Morris DeGroot, a distinguished Bayesian statistician, he set out to show that Bayesian learning creates an empirically adequate account of economic behavior. They published their first paper in 1970, and their book, *Bayesian Analysis and Uncertainty in Economic Theory* in 1987. Their sequential

decision processes brought the same power to dynamic models as marginalism had brought to the static models a hundred years earlier.

Cyert built on his research with March by giving a concrete shape to the idea of organizational learning. Bayesian statistics provided both the framework as well as the discipline for the models. The major contribution of this work is to flesh out what had previously been bare-bones duopoly theory in the context of more realistic assumptions about the behavior of the duopolists. While this work was not accompanied by field work in parallel, Cyert continued to use his observations as the member of the board of directors of several large corporations as guideposts for his work on how firms learn and behave. He used this experience as a director to develop a control theory of the firm which addresses the problem faced by the upper management in using imperfect instruments to steer the firm to meet its targets.

All of Cyert's work is rooted firmly in formal or informal empirical observation. It is interesting to contrast Cyert's approach to Bayesian learning in organizations against two well-known alternatives: Bayesian game theory on one hand and the rational expectations theory on the other. Expectational assumptions of game theory have a weak empirical basis. The empirical relevance of the mathematical game theory to actual decisions and decision-making processes remains to be established. Cyert and DeGroot have shown that, while in special cases the Bayesian learning may converge to rational expectations, in general it is not so. While rational expectations lighten economists' burden of narrowing down the range of possible assumptions to be made about expectations in dynamic models, the empirical validity of rational expectations remains in doubt. Recent experimental work (some of it published in this journal) suggests that the predictions of adaptive models robustly organize the data gathered in laboratories and easily dominate the rational expectations models.

Cyert and DeGroot (1970) introduced Bayesian decision theory to industrial organization to examine strategic interaction among firms in an industry. Savage (1954) had formulated the theory of simultaneous learning and decision making that became a benchmark for the theory of decision making under uncertainty. As behavioral theory, it concerns itself with predicting and recommending decisions. In Savage's theory, acts are not primitives; they are defined in terms of consequences and states of nature. Consequences of acts, often being uncertain, require a researcher's judgment about their importance.

In their contribution to this volume, Green and Park bypass this difficulty by reformulating a new version of Bayesian subjectivist decision theory built on acts and observations of evidence as primitives. They define the utility of an act as a state-dependent function of the act itself, avoiding the problematic reference to consequences altogether. They study *contingent plans* that consist of planned acts conditional on various possible sequences of observations. They show that contingent plans that maximize Bayesian conditional expected utility also fulfill, necessarily and sufficiently, an intuitively appealing consistency condition. The authors show that Savage's (1972) minimal decision theory also fulfills the consistency condition for singleton-valued plans. In contrast, they find that weighted utility theory developed by Hong (1983) to get around the violation of Allais' Paradox does not fulfill the consistency condition.

4. Statistical sampling in accounting and auditing

Cyert's third important contribution is in business economics, as the pioneer, with Robert M. Trueblood, of statistical sampling in accounting and auditing. From its origins in his 1953 work, statistical sampling has spread to cover virtually all aspects of accounting and auditing, bringing great economies in effort and time spent.

What is the contribution of business economics research to society? Not all research develops ever more clever techniques of playing zero-sum games in the world of business. Development and application of statistical sampling in accounting and auditing by Richard M. Cyert and his various colleagues (William W. Cooper, H. Justin Davidson, Gerald L. Thompson and Robert M. Trueblood) is a frequently cited exception. Beginning in 1953, Cyert and Trueblood (an accountant who went on to become a leader of the profession in the US) teamed up to pool their statistical and accounting expertise to improve the efficiency of bad debt estimates of accounts receivable. In this very first application, they cut the amount of work needed by an order of magnitude. Cyert reported his results to the December 1953 meeting of the American Statistical Association, while Trueblood reported them to the National Association of Certified Accountants. Cyert and his colleagues went on to conduct many other field experiments with statistical sampling, and to write and publish their reports. They pioneered the application of statistics to accounting and published the first books (including a textbook) on the topic. Statistical sampling has revolutionized accounting and auditing practice in all parts of the world, saving billions of dollars worth of accountants' effort and time.

5. Computer simulation

Carnegie Mellon was one of the first universities in the US to get a computer. Since the computer was located inside the Graduate School of Industrial administration where Cyert worked, he and his graduate students started using computers for conducting their research experiments for testing their process-oriented ideas about the behavioral theory of the firm. Algorithmic languages were ideally suited for translating the ideas about decision processes and information flows into computer programs for a speedy determination of the consequences of their process hypotheses. Carnegie Tech Management Game (Cyert, Cohen, Dill, Kuehn, Miller, Winters and Van Wormer, 1960) and other advanced uses of computers in all aspects of economics and management education followed. Cyert developed computer simulation of organizations (also called computational experiments) as a new method of economics and social science research. Today, computer simulations have become an essential tool in the methodological arsenal of all social sciences. During his presidency of Carnegie Mellon University, these developments led to the creation of a world-class School of Computer Science at Carnegie Mellon.

Formal modeling of organizations, and testing the performance of models through computer simulations was an important methodological innovation in behavioral theory of the firm. Carley's contribution to this volume develops this computational

organizational theory tradition by comparing the performance of four different types of agents in four different organization structures operating under two different conditions.

Of the four types of agents, three are artificial and the fourth is human. The three artificial types are (1) experiential learning agents who have completed their learning, (2) experiential learning agents who have had incomplete training, and (3) non-learning agents who simply follow a fixed set of rules with no adaptation.

Carley examines four different organizational designs defined by two factors: team or hierarchical structure, and blocked or distributed access to information. In team structure, nine agents recommend a decision, and the organizational decision is determined by the majority rule operating on the nine recommendations. In hierarchy, the nine recommendations are considered by another agent who picks the organization's decision. In blocked access to information, the nine agents are divided into three groups, and all three agents within each group have information about the same three factors. In distributed access, each of the nine agents has access to information about a unique combination of three factors.

Decision making with and without feedback constitute the two operating conditions. All sixteen combinations of agents and organization structures are observed for 30 rounds with feedback on the actual outcome, and for 30 rounds without feedback. Carley reports that organizational performance (1) differs by the agent characteristics, (2) differs by organizational design, (3) relative performance rankings of different agent types vary across organization designs, and (4) as organizations become more complex, their performance with simple artificial agents appears to get closer to their performance with human agents.

Jamal and Sunder's contribution examines the effect of three different artificially intelligent agents on the output of another aggregation mechanism – the market. In their contribution, Carley's organizations are replaced by a double auction asset market, and the three artificially intelligent agents differ in how they process imperfect information about state uncertainty (i.e. uncertainty about the dividend each asset will pay at the end of the trading period).

The first type agents are Bayesians who calculate the posterior expected value of the dividends conditional on the imperfect signal received. The second type of agents are empirical Bayesians who ignore the prior distributions and the likelihoods furnished at the outset, and proceed to keep their own count of the relative frequencies, and use them to compute the conditional posterior expected values. These two agents are control groups for the treatment agents who are called "biased heuristic traders." The biased heuristic traders process information using the two heuristics well-documented in the cognitive psychology literature: representativeness and anchor-and-adjust. According to the representativeness heuristic, these agents ignore the prior probabilities furnished to them, and proceed as if the realized state is the one which is more likely to have generated the observed imperfect signal. They use the dividend corresponding to this state as that initial value they assign to the asset. According to the anchor-and-adjust heuristic, these agents observe the market transaction prices, and the actual dividends paid at the end of the period, and use a first order adaptive process to adjust their assessed value in the direction of the observed transactions or dividends. All three types of agents used their

assessed values as upper limits of their randomly drawn bids and lower limits of their randomly drawn asks in the double auction trading.

Jamal and Sunder report that irrespective of which type of agents populate them, the central tendency of the transaction prices in all three markets is the same. This central tendency is derivable as the market equilibrium from the assumption that the individual traders are Bayesians. Biased heuristics used by the agents affect their initial individual behavior, but the market feedback steers them in the direction of Bayesian aggregate outcomes.

6. Experimental economics

Richard M. Cyert was an early and vigorous proponent of experimental economics. In 1955, Cyert and March wrote:

> In general, economists have not utilized laboratory studies to validate propositions concerning firm behavior to the same extent that students of the other social sciences have. On the basis of the experience of social psychologists in the use of the laboratory for the observation of organizational phenomenon, it seems possible to utilize such techniques for the study of pricing behavior. For example, Harold Guetzkow of the Carnegie Institute of Technology has recently developed a laboratory design for testing certain propositions in organization theory. In his design, individual participants assume roles in sales and production departments in a firm and attempt to maximize firm profits in an experimentally standardized environment. Tests are made of the differences in profitability associated with differing organizational structures. It is anticipated that such a design can be modified, or a new design of this type developed, to provide experimental tests for the hypotheses relating price behavior and organizational characteristics discussed in this paper (p.138).

Laboratory experiments constituted one of the three empirical legs of behavioral theory of the firm. Cyert et al. (1961) used the laboratory to study the effect of internal communications on decision processes. Cyert and Lave (1964) conducted experiments to study collusion and conflict in prisoners' dilemma games. In the summer of 1964 and 1965, Cyert et al. organized Faculty Research Workshops in Experimental Economics at Carnegie Mellon University, with support from the Ford Foundation. This early experimental economics tradition continues to this day at Carnegie Mellon University, as the applications of experimental methods to all aspects of economics have blossomed in the interim.

Field observation of decision making in actual organizations was an essential part of the behavior theory of the firm agenda. The rules of behavior abstracted from this observation were then used to build computer simulation models of organizations to test out the predicted behavior of organizations under such rules. Examination of human behavior under laboratory organizational settings was the natural next step in this development. Cyert took these steps in the early sixties just as the development phase of the behavioral theory of the firm was close to completion. In cooperation with Lester

Lave and Vernon Smith he organized Summer Research Workshops in Experimental Economics at Carnegie Mellon University. Vernon Smith and Charles Plott vigorously pursued experimental research in the seventies and helped develop it into a form that made it increasingly acceptable as a mainstream research tool in economics.

In their contribution, Plott and Porter describe a novel and ambitious application of the technique of experimental economics to develop an efficient resource allocation scheme for National Aeronautics and Space Administration's (NASA's) space station project. They develop the most elaborate laboratory experiment in economics ever conducted in order to help the NASA officials choose a method for allocating various scarce resources of the space station and associated launch vehicles (mass, electrical power, and manpower) among competing projects and used. They evaluate four mechanisms for resource allocation and compare the allocative efficiency and ability to generate correct signals for project development.

Cost-Based Administered Process (CBAP) is NASA's current method of allocating resources on space missions among competing claims on the basis of pre-assigned priorities, posted unit prices based on marginal or fully allocated costs. Barter is a system of multilateral voluntary exchange of resources among participants who are given predetermined allocations of resources. Adaptive user selection mechanism (AUSM) is a computer assisted "smart market" in which participants submit their orders for resources, the computer calculates the imputed prices and efficient allocations, and prompts the participants to submit revised orders until the process arrives at a stationary point. The fourth mechanism consists of eighteen (3 resources×2 priority levels×3 time periods) simultaneous open markets (double auctions). Participants on these laboratory experiments are students or NASA managers/engineers assisted by students.

In spite of the complexity of eighteen simultaneous markets, they turn out to be the most efficient allocation mechanism, easily outdistancing the other three, of which the CBAP is the poorest. The market mechanism also yields the best signals for action by the managers. Plott and Porter provide an excellent example of how carefully designed laboratory experiments can provide useful guidance for the purpose of designing resource allocation mechanisms for new problems for which no field data can be available.

7. Economics, strategic management, and higher education

During his ten years as the dean of the Graduate School of Industrial Administration, and eighteen as the President of Carnegie Mellon University, Cyert applied economics, and particularly economics and strategy, to the management of higher education. At the same time, he continued his active research program in Bayesian analysis applied to uncertainty in economic theory.

Just as he has been a pioneer in developing a behavioral theory of the firm, computer simulation, and Bayesian applications to economic theory, he has also pioneered the idea of applying economics and strategy to university management. He did this in his writings, and speeches, and in his practice. In practice he used a concept of comparative advantage from international trade as a means of organizing the university. He imbued this concept in the minds of his deans and department heads. The university as a whole followed good

economic theory in this respect, and the stature of Carnegie Mellon University was raised to the point where it ranks among the best technologically oriented and innovative universities in the world. He has been able to be both a pioneer and a successful practitioner of economics in his various functions as scholar and educational manager, and innovator.

After leaving the presidency, he has been breaking new ground with his co-authors in developing the field of economics and strategy using significantly new analytic approaches. In the past this field has been dominated by case studies.

How to design organizations to promote innovation has been a major theme in Cyert's scholarly writings, as well as in his work, first as the dean of the Graduate School of Industrial Administration at Carnegie Mellon University, and then as the president of that university. In his contribution, David Teece examines the links between economic environment, organization design, and the rate and direction of innovation.

Teece identifies uncertainty, path dependency, cumulative nature, irreversibility, interrelatedness, tacitness and inappropriability as the fundamental characteristics of innovation. Innovation has to occur in environments that vary in market power, hierarchy, scope, internal integration, organizational culture and external linkages.

Innovation needs capital, which is likely to come, in early stages of innovation at least, from equity or internal cash flow. Few firms can have access to debt capital to finance innovation, even if they are large and have significant market power. Hierarchies can accomplish complex tasks, but their structure tends to discourage innovation. Firms with a broad scope of market activities have the advantages of using cash flow from product to develop another, find multiple applications of a single technology, and integrate diverse technologies into new ones. Systemic innovation is easier to carry out in vertically integrated firms. Organizational culture consists of mutual expectations of the members of the organization from one another, and its receptivity to innovation is a major determinant of success. Finally, business organizations develop a variety of external alliance and joint ventures tailored to the needs of specific projects.

Teece identifies six archetype organizations – stand alone laboratory, multiproduct integrated hierarchical firm, high flex "Silicon Valley"-type firms, virtual corporations, conglomerates, and alliances — and links their effectiveness in promoting innovation to the combination of two environmental factors – whether innovation is autonomous or systemic, and whether facilities to implement the innovation exist inside or outside the firm or need to be created. An understanding of the innovation process needs a richer framework that combines the traditional economic (e.g. market structure) as well as organizational factors that are critical to innovation. Such a combination will yield a better understanding of the history of innovation as well as development of organizational forms, and will lead to more effective policy prescriptions.

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