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Experimental Microeconomics

Some Problems and Approaches

[ABSTRACT:] *This article examines problems in experimental economics that were developed in the work of Western economists in 1980s and 1990s. A survey is given of the literature on experimental investigations of different forms of market organization, the theory of choice, and distribution of public goods.*

The objective of this article is to "advertise" a branch of economic science—experimental microeconomics—in order to familiarize the Russian reader with its problems and methods, as well as the conclusions reached by a number of authors. This survey only covers individual subjects, such as choice, the free-rider problem, the use of various types of information, and comparative analysis of different forms of market organization.

The need for experimental economics is based on the fact that its methods can be used to solve the following critical problems: Is the hypothesis upon which a microeconomic model is based true or not? If it is true, then under what conditions is it fulfilled? How can it be tested without resorting to experimentation on the actual economic mechanism? Hypotheses are tested with the help of formal (i.e., logical and mathematical) calculations. We can try to observe analogous processes in real life, if it is possible to find an analog of the

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phenomenon or process under consideration; or, we can model a similar situation under laboratory conditions, using a computer simulation. Economic and mathematical procedures that can be used to predict particular results, with varying accuracy, and to check hypotheses that have been formulated cannot yet take into account subjective peculiarities of human "economic" behavior and thinking. In the computer version of a model, we sometimes simplify the situation in such a way that the modeling results are predetermined. Therefore, there is more and more talk about the need to check hypotheses and predictions that have been obtained theoretically, or with the help of computer methods, on "real" people, whose reaction to a particular event may show the researcher their true attitude toward realization of his or her conjecture. And, in spite of the fact that the degree of subjectivity is fairly high in experiments simulating the actions of real economic agents in a laboratory, this cannot be considered a shortcoming, since the subjective factor is fundamentally important for the hypothesis that is being advanced and the consequences stemming from it.

In the course of an experimental microeconomic investigation, two basic problems are solved: (1) testing an existing hypothesis, and/or (2) seeking and formulating (i.e., identifying) a new hypothesis or hypotheses about the behavior of economic agents. As a result of such investigations, a number of contradictions have been discovered between the behavior of economic agents in real and abstract microeconomic systems, among them Elias's "paradox," Wayson's problem, and the "chain-store" paradox (Kahneman et al. 1990; Laffont 1989; Rasmusen 1989; Tirole 1990).

This article surveys works on the experimental testing of microeconomic hypotheses using the methods of experimental economics.

Subject and Methods of Experimental Economics

Experimental economics is the direction of economic science whose subject is an economic experiment under laboratory conditions (Smith 1989). As a rule, the object of investigation in the experiment can be either a hypothesis about the behavior of an economic agent (a person, company, state, or player), or the mechanism by which the rules of these agents' behavior are realized. For this purpose, an experiment is conducted in a laboratory: an economic situation is modeled (see the example in the last section of this article).

The following questions are formulated in the experiment (Smith 1982): (1) The object of the investigation—"What do we intend to observe?" (i.e., what phenomena, processes, systems); (2) The goal of conducting the experiment— "What would be like to know about the object?"; and (3) The experimental design—"How will we achieve this?"

In the course of the experiment, different parameters may be varied, such as: the type of economic agents and the number of them; the list (i.e., assortment) of goods and resources or services; the characteristics of pro-

perty rights; and information aspects of the economic agents' interaction.

The method of experimental economics used most often utilizes "auction" models, which have been well covered (Smith 1989; Wilson 1989). Auctions are one of the most common objects of study in experimental economics, since they are the simplest type of market organization that encompasses all the basic elements of a market—for example, pricing, establishment of equilibrium between supply and demand, and the interrelations between sellers and buyers. On the one hand, the rules for organization of such markets are fairly simple (e.g., seller's price–buyer's price, and methods of setting them); on the other hand, they open up possibilities for variation (e.g., verbal auctions, written auctions, autions with prices set by the buyers or sellers, or by those and other parties [dual auctions], auctions with acceptance of the higher price [English auctions] and of the first or lower price [Dutch auctions] and of the second price, and auctions with differing completeness of information).

We will consider some basic concepts used in experimental investigations of microeconomic systems (Smith 1982).

By microeconomic, we mean an actual economic system that is largely subject to the influence of an individual's or company's behavior, the motives of this behavior, and factors acting on the formation of supply and demand for market goods.

A microeconomic system is formally represented as the whole environment in which the economic agents (i.e., participants in, or subjects of, the system) act, the institution or rules for conducting the experiment, and the economic agents' behavior.

The *economic environment* consists of all the various characteristics of the test subjects: the system of preferences, which reflect technological aspects and consumer tastes; the resource vector; and the production function or cost function. For example, individual demand (i.e., readiness to pay) or individual supply (i.e., readiness to accept payment or to accept goods) can serve as the characteristics of an economic environment (Smith 1982).

The *institutional part* of an economic system is the determination of rules according to which the economic agents act in exchanging goods and services. It is characterized by the language in which each of them communicates (since we are talking primarily about auctions, the buyers' increases in the initially offered price, or the prices set by the sellers in the course of trading, act as communications here), and by the set of rules for conducting the trading process, which consists of the conditions for the beginning, continuation, and end of this process. Communications determine the final distribution of each agent's goods sold in the market, depending on the communications sent by all of the agents. We can say that the institution determines the rules and conditions according to which the subjects of market demand get together with the subjects of market supply by entering into contracts.

The *behavior of an economic agent* consists of his generation of

communications that are sent according to the rules set by the appropriate institution. This behavior can be described by different characteristics. Thus, the criterion for evaluating an agent's activity is considered to be maximization of his utility function, profit or expected profit, and the expectation that the transaction cost (e.g., thinking it over, making a decision, acting on it) will be small.

The plan of the experiment includes three basic stages: (1) designing (i.e., setting up) the experiment; (2) implementing (i.e., conducting) the experiment and verifying the model; and (3) processing the results.

In the course of the experiment, when checking a hypothesis about people's behavior in the sphere of market relations, the variable elements of the microeconomic system and its responses to the economic agents' communications are carefully controlled. The organization of high-quality control of the conformity between the experimental and real environments in which the respondents and their prototypes interact, and the rules according to which the trading process is carried out, is the most important aspect of the experiment. If this conformity is achieved, we can then state with confidence that the theory under consideration has a right to exist, and that any possible discrepancy between theoretical hypotheses and the results of experimental investigations can just as confidently be attributed to an incorrect hypothesis. Smith (1989) suggested the following classification of types of experiments with microeconomic systems: (1) *functional*, depending on changes in the microeconomic system's main components (i.e., the economic environment and institutions); and (2) *methodological*, depending on the methodological problems facing the researchers.

We note that, in conducting an experiment, one or two factors composing a microeconomic system can be varied: the environment, and the institution or agent's behavior. The processes caused by these changes serve as the object of experimental investigation. Smith (1982) pointed out the possibility of conducting the following specific experiments with microeconomic systems in which one of the factors is strictly fixed, while the other factor can vary.

With changes in the environment and a strictly determined institution, the objects of investigation represent an oligopoly with the following attributes: variability in the number of participants, as well as the price or demand; cyclic, "seasonal" models with speculations, in which demand varies; and the process of group decision making, when the size of the group and the motives for its behavior change.

Under conditions of variation of the parameters of the experiment's institution and fixed components of the environment, it is interesting to analyze: the efficiency of setting a differentiated price for buyers in comparison with the version of a single price at closed auctions, with prices set by the buyers; the results of tests in different types of auctions; and the efficiency of a contract price that does or does not take into account the lower and upper limits of prices in simulating a verbal auction.

Study of changes in parameters of the experiment's institution calls for: a

comparison of markets with or without speculation, with cyclic demand for goods; the rules for setting a differentiated or single price for all buyers, in the presence of alternative conditions for stimulating demand; and auctions with different rules for accepting contract prices, when increases in the initial prices are set by the buyers for different numbers of participants in the bidding.

We now consider in greater detail some experiments and their results.

Experiments on the Theory of Choice and the Theory of Preference Reversal

Problems in analyzing economic agents' preference reversal during their decision-making process in relation to choosing one or another product, have been covered by Slovic and Lichtenstein (1968, 1971, 1983), Tversky and Kahneman (1986), Tversky et al. (1990), Tversky and Simonson (1992a, 1992b), and Shafir and Tversky (1992). Researchers are required to study the effects of a set of alternatives (i.e., quantitative and qualitative) and their contextual characteristics on the preferences and choices of economic agents.

One basic assumption of the classical theory of choice is that each alternative good has utility from the consumer's point of view. Some value or estimate is assigned to this alternative, and the consumer makes his or her choice according to a maximization criterion—a function that satisfies the condition of preference for the alternative with a greater value over the alternative with a lesser value, when there are several. Tversky's experiments showed that if a decision maker chooses one value from a set of alternatives, then simple expansion of this set does not necessarily lead to an increase in the "share" of that value itself (i.e., the number of times that the given value is chosen with an expanded set may be less than with the initial set).

The hypotheses called "trade-off contrasts" and "aversion to extremes" were considered by Shafir and Tversky (1992). They checked the hypothesis that the tendency to prefer extreme values, in comparison with the middle one (in the sense of "lying between the extremes of 'greatest' and 'least'") grows, if the decision maker rejects alternatives in which an improvement in quality is associated with a higher differentiated price. One basic premise of the classical theory of consumption is that an alternative is chosen from some given set according to the criterion of maximization. Tversky put forth the following hypothesis. If the contextual content of these alternatives is introduced, the consumer begins to act as a counterweight to this criterion according to two patterns of behavior: "contrasting," or "aversion to extremes." The essence of the former pattern is that a specific person's choice of a product is subjective (i.e., the same product may be more attractive against a background of less attractive ones, or less attractive in comparison with more attractive goods). The essence of the latter behavior pattern is that the respondent always tries to choose the middle of three alternatives that are offered.

Tversky and Shafir conducted twenty-two experiments with students, the number of which varied from 100 to 200 in each experiment. The students were given sheets with the heading "Respondents' preferences," which contained from three to fourteen questions requiring extended answers. For example, after the question "What brand of camera do you prefer of those listed?" three brands were listed, with their prices. Other experiments had two objects of investigation. For example, it was necessary to choose personal computer equipment characterized by a combination of memory and price (e.g., the set 600K/$650 and 620K/$950, or the set 740K/$1,250 and 1200K/$1,350).

To check the hypothesis about "trade-off contrasts"—according to which, when one more product is added to those offered, the respondents' preferences change to the opposite (i.e., they are "reversed")—a series of experiments was conducted on choosing personal computers with different memory capacities, and combinations of cash and monetary coupons (much like bonds). The results indicated that:

- The presence of preliminary data on the quality and price of similar goods affects the choice of those presented. For example, if the difference between the maximum and middle price is not very large, the consumer will buy the more expensive, but better quality product.
- The "share" of one of the extreme values can be increased by adding a third value to the set of two alternatives. Then, the number of respondents who choose the more expensive item increases.

Work on investigating the hypothesis that Tversky called "aversion to extremes" (Tversky et al. 1990; Tversky and Simonson 1992a, 1992b; Shafir and Tversky 1992) has been connected to the problem of "utility" strategy in making a choice under conditions with or without risk. The essence of this problem is that, in some situations, a decision maker can judge alternatives in terms of "utility" or "nonutility" from a contextual point of view, rather than from the standpoint of an arithmetic expression of the choice criterion. In this case, the alternatives with the extreme values within the bounds of the offered set will be less "beneficial" than the one with the middle value. This hypothesis has two "states": compromise, and confrontation. In the former state, the extreme values are chosen by the same number of respondents, while in the latter case preference is given to the more expensive or cheaper product. In Tversky's experiment (Tversky and Kahneman 1986), the players had to choose one brand of camera or tape recorder from a set of different brands and companies in the presence of two or three alternatives. The results showed that when there are three alternatives, preference is given to the more expensive good. This differs from the data from experiments in which a choice is made without consideration of the semantic load (i.e., according to the maximization criterion).

According to Tversky, new experiments (Tversky et al. 1990) have confirmed the need to use concepts of the construction of preferences different from the

classical theory of choice, which presumes that preferences are stable. When they investigated this problem, Slovic and Lichtenstein (1971, 1983) discovered that the choice between alternative goods with a high degree of risk is determined by the probability of gain or loss, and the selling price and buying price depend directly on the benefit that is obtained (1983). It often happens that, of two alternatives to which a monetary "estimate" must be given, an individual chooses one alternative and gives the highest estimate to the other one.

Tversky suggested the following experiments for studying a change (i.e., reversal) of preferences (Tversky et al. 1990):

- Slovic's research on choosing between undertakings with a high degree of risk (Slovic and Lichtenstein 1968)
- Grether and Plott's (1979) work on the relationship of preference reversal to questions of stimulating the players
- Slovic and Lichtenstein's (1971, 1983) research on explaining the phenomenon of preference reversal

To study the possibility of preference reversal with alternating change in the rationality conditions of the preferences' relationships (e.g., transitiveness, invariance of the procedure, independence and reduction axioms [Rasmusen 1989]), Tversky, Kahneman, and Slovic (1990) conducted a series of experiments simulating games in a Las Vegas casino. Two alternatives were presented as choices: (1) with a high probability of winning a small amount of money, and a low probability of winning a large amount; and (2) an added intermediate alternative. Analysis of the results of these experiments enabled the authors to draw the following conclusions:

- Violation of "invariance of the description" (i.e., structural effects) and "invariance of the procedure" (i.e., induced effects) is a fundamental problem for researchers in creating models of rational choice, which is more complex than violation of such properties as independence of the alternatives or transitiveness.
- Preference reversal does not belong to the class of problems in which the principle of independence or reduction axioms are violated; therefore, it cannot be studied with the help of methods of the general theory of utility.
- In the experiments that were set up, the main reason for preference reversal was setting the price too high for making bets with a low probability of high gain.
- Adding an additional choice factor, such as the need to give a "monetary estimate" of the offered good (i.e., "payments"), also leads to a change in preferences. People usually prefer goods that bring a profit in a short time, although on questionnaires they set a high "estimate" on long-run prospects; the percentage of respondents who change their preference decreases if the gain is introduced in natural units.

Thus, if the model of choice takes into account the effect of the contextual value of the parameters according to which the choice is made (i.e., they have different values according to the quality of the good or its price), then the following patterns can be revealed:

- The appearance of a third alternative, which lies between the ones initially offered, has a greater effect on the choice if the choice is made according to the quality of the product, rather than its price.
- For trade-in goods of the same type, the elasticity of demand with respect to quality exceeds the price elasticity.

The problem of respondents' rational and irrational behavior in decision making was studied by Tversky, Slovic, and Kahneman (1990), and also by Tversky and Simonson (1992a, 1992b). As their experiments showed, when people make a decision they sometimes act contrary to rational thinking (Tversky and Simonson 1992b).

When Tversky and Shafir conducted experiments in which they checked the interrelations of economic agents in making a choice under conditions of indeterminacy, they found that people are often afraid to make a decision "lying on the surface." Experiments were conducted in 444 pairs to investigate:

- The "prisoner's dilemma" in two versions—with, or without, complete information on the opponent's behavior
- "Newcombe's problem" (i.e., choosing one of two versions—a closed box, or a closed box plus $1,000, when the first box either may contain $1 million or be empty)
- "Wayson's problem" (i.e., choosing two out of four two-sided cards of the "even/odd/4/7" type). Cards have to be chosen on which "even/odd," written on one side, corresponds to the number written on the other side.

As a result, a number of discrepancies were revealed from hypotheses of the classical theory of choice. For example, it turned out that, in most cases, people do not choose the most logical decision, considering it too simple; consequently, they do not choose the best alternative, preferring "round-about ways" to attain it.

Tversky's works have confirmed the hypothesis about the difference between the logical simplicity of a decision, and the psychological complexity of making it. Thus, people's unwillingness or inability to think logically may significantly distinguish the human intellect from artificial intelligence.

Use of Different Types of Information and Free-Rider Problems

The free-rider problem is connected with the process of collective decision making and the individual behaviors of economic agents in the context of the collective formation of prices in the consumer market (Khaiman 1992). Its history dates back to the eighteenth century, when Hume first observed that, even

when making a collective decision, a person always proceeds from his own best interest, although that may be disadvantageous from the point of view of his collective interest. In the 1950s, Samuelson, Musgrave, and other economists who specialized in analyzing the logic of economic agents' collective and individual behaviors in collective decision making turned to this problem (see, in particular, McMillan 1979).

A "free ride" makes it impossible for economic agents who supply the market with a socially necessary good to obtain payment for their work from those who take advantage of a free association with them (Khaiman 1992). A "free rider" is one who uses some good without paying anything for it.

Collective equilibrium for net public goods presumes that the agents (e.g., consumers, companies, buyers, and sellers) do not conceal information about their individual marginal utilities and preferences. However, in reality there are weighty incentives not to provide such information. Consciousness of the possibility of obtaining the benefit of a public good, regardless of whether or not an agent makes any contribution to covering the cost of its production, incites the agent to make less expenditure than is objectively necessary. The agent acts on the hope that others will contribute an amount sufficient to cover the expenses of producing the good. Free riders try to underestimate the value of a public good, in hopes of obtaining the benefit of other people's contributions and efforts.

The free-rider problem arises any time the issue is payment of taxes, or when a question is raised about the possibility of profiting from participation or nonparticipation in decision making on setting the price for a product.

Experimental investigation of this problem can be approached from different points of view:

- Supplying the market with a public product and the utility of joint actions (i.e., each consumer of a public good should assist in its production paying the necessary expenses). Here, it is important to clarify how a participant in the experiment behaves if he or she knows the utility function and the possible behavior of the other participants (if he or she can predict it), or if the participant does not have the necessary information.

- The state's participation, if we are talking about a free ride in paying taxes or fees. In this case, it is necessary to set up an experiment for the purpose of analyzing the utility of disinformation on the central link or the partners, in relation to one's own utility function.

- The effect of the number of participants in the experiment on their collective behavior and on the amount of profit obtained (e.g., the effect from offering public goods, concealing information, and cooperation).

An explanation of an economic agent's choice of a particular type of behavior can be given in "cost–profit" terms as well as psychological conclusions, which introduce an element of indeterminacy in modeling the situation.

To solve the problem of constructing taxes that decrease the possibility of a

free ride, mechanisms have been created for state regulation of these processes (McMillan 1979).

McMillan (1979) investigated this problem from the standpoint of an economic agent's participation or nonparticipation in the process of decision making on setting the market price for consumer goods, and the agent's readiness to pay for the right to make the decision. He considered cases in which the products for which bidding takes place in the market enter into a production function or are used for consumption only. It was found that the players' aspiration to pay for the right to set their own price is fairly high.

McMillan's research is connected with McKelvey and Page's work (1990) on experimental study of the use of different private or public information and an empirical index of the closeness of the correlation between a subject's predicted and actual behavior. The purpose of their experiment was to check how closely the predictions of a theoretical model approximate the actual behavior of economic agents, with certain mathematical assumptions about how the participants behave. They focused on the process of revealing common information: the subjects of the experiment who have some data pool their knowledge and generate a common signal, which corresponds to socially useful information, which they then use in their subsequent work.

The result of this series of experiments analyzing the use of individual and public information was the conclusion that all of the participants behave rationally, and that the efficiency of their choice is close to optimum. These investigations proved the aspiration of players acting rationally to an equilibrium of common knowledge: the need to use public information to enrich their own information for the purpose of increasing their individual profit, and the importance of switching attention to common information in choosing optimum decisions. These investigations can be useful in setting up experiments on the free-rider problem.

Experimental Study of Attainment of Individual Efficiency in Solving the Coase Problem

In the process of trade it is often not possible, due to so-called externalities, to achieve efficiency in the allocation of resources for producing goods or income distribution.

In economics, efficiency (usually meaning efficiency in resource allocation) is understood as the distribution of resources with which, for a given period, they are used in such a way that it is not possible to increase the prosperity of one individual without causing a loss for another one (i.e., Pareto optimality [Khaiman 1992]).

Efficiency is the criterion for judging the activity of the people who use the resources; when efficiency is achieved, further trade of goods and services does not lead to an additional net gain. While many versions of resource allocation can

satisfy the criterion of efficiency, they are different from the point of view of the distribution of people's prosperity. Therefore, although the criterion of efficiency is used to judge the market structure and the directions of economic policy, decision making is guided by other stimuli.

In markets with perfect competition, efficient resource allocation is not always possible. When the production of goods and services is inefficient, so-called externalities appear—that is, either the cost or the profit from market transactions is not reflected in the price. Externalities can be positive (i.e., unaccounted profit), or negative (i.e., unaccounted costs). They need to be transformed into internal effects by correcting marginal individual costs or utilities so that they reflect the actual social costs or utilities, a process called internalization. But internalization requires the assignment of property rights to the resources in relation to which these externalities show up; then, owners can safely work with such rights to trade, buy, sell, or lease.

The Coase theorem states that with a negligibly low level of transaction costs (i.e., the costs of transactions ensuring the right to use resources, including expenses in guarding against a negative externality), the externalities can be internalized by the government or some other central agency or control link to assign the property right to resources and to adopt laws regulating the free trade of these resources (Khaiman 1992).

From the point of view of resource allocation, the Coase theorem has several interpretations: analysis of transaction costs, illustration of a monopolist's behavior, and comparison of monopolistic market organization with perfectly competitive markets. Kahneman, Knetsch, and Thaler (1990) were interested in this theorem; they considered it from the point of view of achieving individual efficiency in the receipt of income and the allocation of resources available to the respondents under conditions of transfer of "property rights" to some article of trade that is something like a voluntary donation (i.e., gift).

Kahneman et al. set up eleven experiments with a group of forty-four students, who modeled market relations in selling or buying ordinary consumer goods (e.g., pens and coffee pots) and "gifts," as part of a charitable fund. Each respondent, whether "seller" or "buyer," had to give a written response on specially prepared questionnaires as to how many goods he or she was prepared to buy or sell, and at what price. Then this information was collected by the person conducting the experiment, and a conclusion was drawn with respect to the shape of the supply and demand curve, the theoretical number of sales, and the presence or absence of surplus supply or demand. Three sellers and three buyers were selected at random; trading orally, they tried to carry out their intentions, relying on the information that they received about equilibrium prices.

Subsequently, a series of experiments was conducted on the subject of the players' distortion of information about their own supply and demand curves (i.e., their utility functions). The experiments simulated the behavior of sellers and buyers in consumer-goods markets and a "currency" exchange. The question

was examined of economic agents concealing their preferences so as to maximize their own profit. This problem is closely connected with the dilemma that each participant in the market has to resolve: whether or not to sell or buy: What is the probability of staying "out of action" if the bargaining is done as an open auction, or on the basis of bilateral agreements between randomly selected pairs?

These experiments showed the following:

- There really is a difference between the value of products in the two groups of goods (i.e., consumer goods or "gifts") for the buyer.
- Investigation of the effect of distortion of the information about their own preferences, which buyers and sellers make available for common use on the market's efficiency, showed that with a random choice of prices, a specific economic agent's decision does not have any significance, since it was in the participant's interest to give correct data on each selling or buying price that was communicated to the individual.
- Analysis of "unwillingness to sell" and "unwillingness to buy," and the readiness to make deals, revealed that participants in the experiment nevertheless endeavored to reach agreement.
- Individual resource allocation must be independent of the initial property right to a good. If the marginal substitution rate between two goods is subject to the effect of the initial distribution of property rights, then the agent who possesses the property right to a good will try to keep it.

The result of this series of experiments was that an overwhelming number of pairs of participants nevertheless reached an agreement, for the most part, by agreeing on prices at which the potential buyers gained more than the potential sellers. It was also found that the law of trade encourages the participants in trading actively to set a price; the bargaining rules that were studied did not give them an incentive to conceal information about their own preferences. In that case, the most important thing is that the cost of a good changing hands is directly determined by the amount that the researcher intended be paid for it; and, the "charity effect" (i.e., an increase in the cost of a good for the consumer after the good becomes his property) reduces the profit from trade. This effect occurs only when a good intended for direct consumption is sold, and does not take place in a "donation" of money or resale.

Investigation of a Natural Monopoly in Comparison with Competitive Markets

The results of experiments simulating a market with a single seller (i.e., a monopolist) and with two sellers (i.e., a duopoly) were provided by Coursey et al. (1981). The pricing mechanism in these experiments was a written price proposal by the seller and its acceptance by the buyer. The objective of this investigation was to study predictions obtained with the help of the so-called competitive-

market hypothesis, in the context of experimental economics, in order to reveal mechanisms that make it possible to decrease the discrepancy of monopoly prices and the amount of goods from competitive ones, and to find ways of forcing a monopolist to adhere to competitive prices.

Two possible types of participant behavior can make this hypothesis untenable: if the duopolists (1) establish a coordinated "group monopoly," or (2) try to attain pure monopolistic power.

The purpose of the experiments was to understand how the seller and buyer behave in monopoly (i.e., duopoly) and competitive markets. For example, a seller who is able to provide the whole market with his goods can sell them at a lower competitive price, provided that he knows the total amount of demand. When two sellers set the same prices and divide up the market between them, they cause losses that may be significant.

If one of these behavioral strategies leads to a result different from the predicted one, then the competitive-market hypothesis is false. This hypothesis can be formulated in "strong" or "weak" versions (Coursey et al. 1981). In the former case, the presence of two potential sellers who have the same costs is sufficient to establish a competitive price and the amount of goods sold; in the latter, such a market should tend to competitive equilibrium over time.

We will consider the formulation of the competitive-market hypothesis in its strong and weak versions.

Let (P, Q, E) be vectors of price, the amount of goods, and the efficiency of trade; (P_c, Q_c, E_c) the prediction of equilibrium in a competitive market; (P_m, Q_m, E_m) the prediction of these parameters in a monopoly market; (P_d, Q_d, E_d) the results of laboratory tests for a duopoly market; and (P_s, Q_s, E_s) the results of laboratory tests for a monopoly market.

Now we will formulate the competitive-market hypothesis in its strong version, in terms of the convergence of the results of laboratory investigations of a duopoly to competitive equilibrium over the course of time:

$$H_s : (P_d, Q_d, E_d) \to (P_c, Q_c, E_c) ; \; \hat{H}_s : (P_d, Q_d, E_d) \to (P_c, Q_c, E_c)$$

The formal description of the competitive-market hypothesis in **its strong and** weak versions looks like this:

$$H_w : P_d \leq 0.5(P_m + P_c), \; Q_d \geq 0.5(Q_m + Q_c), \; E_d \geq 0.5(E_m + E_c) ;$$

$$\hat{H}_w : P_d > 0.5(P_m + P_c), \; Q_d \geq 0.5(Q_m + Q_c), \; E_d < 0.5(E_m + E_c) .$$

The initial hypothesis determining that the sellers in a conditional **duopoly** market are more competitive than a monopolist is

$$H_0 : P_d \leq 0.5(P_s + P_c), \; Q_d \geq 0.5(Q_s + Q_c), \; E_d \geq 0.5(E_s + E_c) ;$$

$\hat{H}_0 : P_d > 0.5(P_s + P_c)$, $Q_d < 0.5(Q_s + Q_c)$, $E_d < 0.5(E_d + E_c)$.

If the hypothesis is not confirmed in its weak version, that means that a duopolist tries to attain a monopoly in the form of individual, group, or mixed power. In duopoly experiments, it needs to be determined whether or not prices and the amount of products sold actually tend to the predicted values. The following regression equation can be used to check the presence of a tendency to converge: $\ln Pt = \alpha + \beta_t + U_t$, where P_t is the normalized price above the top competitive price during the period t; α and β_t are regression coefficients; and U_t is the error.

The results of these experiments must be compared with data from analysis of the behavior of economic agents in a market with a single seller. This must be done in order to understand whether or not our conclusions with respect to competitive behavior are really true when actual monopoly behavior is used as the base. Moreover, experimental confirmation is needed that the average duopoly price is more competitive than the average monopoly price; that the average duopoly amount of goods is greater than the average monopoly amount; and that the average duopoly efficiency is greater than the monopoly efficiency.

The main conclusion of the research conducted by Coursey and his colleagues (1981) was that predictions in relation to the competitive-market hypothesis are true, for the most part. Study of companies functioning in a market showed that a reduction in costs and demand is sufficient to support no more than one company. The appearance of new competitors (i.e., sellers) disciplines the market (or rather, the sellers acting in it).

The interpretation of the competitive-market hypothesis, under conditions when increases are added to the initial prices, partially explains the different behavior of economic agents in these markets. As was noted by Smith (1985), buyers who do not actively accept risk add more, and sellers ask less, for each unit of goods that is bought or sold, than do buyers who are more neutral toward risk.

Investigation of monopoly markets with the help of experiments has become very important since researchers began to include larger numbers of players. However, the question of why there is rivalry in the market as a result of competition between sellers, or due to the strategy of buyers restraining demand, remains unresolved. In fact, real convergence of the average monopoly price to the predicted price, obtained with the help of a mathematical model, can only be revealed in an experiment over several periods.

Procedure for Conducting Experiments to Study Competitive Markets

By analyzing the literature on experimental economics in the last few years, we managed to find growing interest in the use of games to simulate different market forms—monopoly, oligopoly, and competitive—with different types of goods.

Smith (1962) conducted a series of experiments (i.e., business games with students) for the purpose of studying some of the hypotheses of neoclassical competitive-market theory.

Construction of the Experiment

The test group of twenty-two student subjects was divided into "sellers" and "buyers." Each buyer received a card indicating the maximum price that he was ready to pay for one unit of goods. The buyer's profit was the difference between the price on the card and the one paid for the good (i.e., the contract price).

The linear demand curve reflects possible purchases of some amount of goods at each hypothetical current price. Each seller received a card with the minimum price at which he was ready to sell one unit of goods belonging to him. His profit was the difference between the contract price and his minimum price.

The supply curve reflects the total amount of goods that can be sold at each hypothetical current price. Consequently, the buyer could not buy goods at a price higher than the one indicated on his card, and the seller could not sell goods at a price lower than his minimum price (with the exception of cases of the minimization of losses, rather than the maximization of profit).

Each experiment covered several trading periods simulating a "market day." The first period began when any seller (and/or buyer) announced his decision to sell (or buy) goods at a certain price. For example, a buyer with a card indicating a maximum price of $2.50 would say, "I am buying for $1." Then a seller with $1.50 on his card would say, "I am selling for $3.50," and bargaining would begin. Any buyer or seller could accept an offer stated aloud. When anyone reached an agreement, a contract was executed and the parties dropped out of the market until the end of the "trading day." Thus, the buyer and seller from this example agreed on a price of $1.90 per unit of goods, and their profit was $0.40 for the seller and $0.60 for the buyer. The trading period ended when no more deals were made. The market was closed, but a "second trading day" opened immediately, with the same players and initial conditions.

Next, the author studied the model market by varying the conditions of supply and demand. Smith conducted ten experiments, in eight of which the buyers acquired one unit of goods apiece and, in the other two, as many as they could buy.

The results of the experiments are given in the following table:

Column No.	Content
1	Test number
2	Trading period
3	Predicted number of deals
4	Actual number of deals
5	Predicted market-equilibrium price

6	Actual contract price
7	Average contract price for the period
8	Convergence coefficient
9	Possible number of buyers who could make deals during the period
10	Number of buyers who actually made deals during the period
11	Possible number of sellers who could make deals during the period
12	Number of sellers who actually made deals during the period

Analysis of the Experimental Results

This experiment was conducted by Smith to check the hypothesis about the existence of a difference equation that would prove the tendency of contract prices to converge to the predicted ones. Within the framework of this hypothesis, Smith checked more formalized hypotheses: (1) Walras; (2) excess; (3) modified Walras; and (4) modified excess.

The first hypothesis said that the contract price has a tendency to decrease in proportion to the marginal rent. The second stated that the price drops over the course of time in proportion to the difference between the total rent at the contract and predicted prices. Comparing the hypotheses, Smith focussed primarily on: (1) their ability to predict zero changes in price equilibrium; and (2) the standard errors of these predictions.

Supply and demand were shown in diagrams, where the theoretical (i.e., predicted) competitive-equilibrium price and the corresponding amount of goods were indicated. The functioning of the experimental market was depicted on a continuation of the diagram. These diagrams made it possible to get a clear picture of the game and the tendency to converge to the theoretical equilibrium.

Then the results of the experiment were analyzed mathematically and analytically—that is, from perspective of how peculiarities in the respondents' behavior affected the course of the game, or in some way interested the author. Smith drew the following conclusions:

- When the number of players is small, there is a tendency toward equilibrium, as long as the players do not try to cooperate.

- Changes in the conditions of supply and demand, and in how the market is organized, lead to a change in the number of deals during a trading period and the level of contract prices.

- Prediction of the statistical equilibrium of competitive markets requires a priori knowledge of the shape of the supply and demand curves.

- In markets where only the sellers set the prices, the tendencies to converge

to equilibrium are weaker than when prices are set jointly by the buyer and seller.

• The excess hypothesis more adequately reflects the tendencies to converge that exist in a competitive market than does the Walras hypothesis.

We have considered only a few works on experimental economics. The results of microeconomic research, conducted with the aid of experimental methods, are now a part of any course on microeconomics, game theory, or industrial organization, and their conclusions are included in standard Western textbooks or encyclopedias of the "handbook" type published in the 1990s (Rasmusen 1989; Tirole 1990). The field of practical application of experimental economics is rather broad. The use of these methods to carry out reforms in the transition period—in order to analyze the possible reaction of Russian economic agents to a new form of taxation, change in economic institutions, or inflation processes— appears promising.

References

Coursey, D., et al. 1981. "Natural Monopoly and Contested Markets: Some Experimental Results." *Discussion Papers* (July). University of Arizona Press.

Grether, D., and S. Plott. 1979. "Economic Theory and Preference Reversal Phenomenon." *American Economic Review*, no. 5.

Kahneman, D., J.L. Knetsch, and R.H. Thaler. 1990. "Experimental Tests of the Endowment Effects and the Coase Theorem." *Journal of Political Economics*, no. 6.

Khaiman, D.N. 1992. *Modern Microeconomics: Analysis and Application*, vols. 1 and 2. Moscow: Finansy i Statistika.

Laffont, J.J. 1989. *The Economics of Uncertainty and Information*. Cambridge, MA: MIT Press.

McKelvey, R.D., and T. Page. 1990. "Public and Private Information: an Experimental Study of Information Pooling." *Econometrica* 58, no. 6.

McMillan, J. 1979. "The Free-Rider Problem: A Survey." *The Economic Record*, no. 6.

Rasmusen, E. 1989. *Games and Information: An Introduction to Game Theory*. Oxford: Basil Blackwell.

Shafir, E., and A. Tversky. 1992. "Thinking through Uncertainty: Non-Consequential Reasoning and Choice." *Cognitive Psychology*, no. 24.

Slovic, P., and S. Lichtenstein. 1968. "The Relative Importance of Probabilities and Payoffs in Risk-Taking." *Journal of Experimental Psychology* 78, no. 2.

———. 1971. "Reversals of Preferences between Bids and Choices in Gambling Decisions." *Journal of Experimental Psychology* 89, no. 1.

———. 1983. "Preferences Reversals: a Broader Perspective." *American Economic Review* 73, no. 5.

Smith, V.L. 1962. "An Experimental Study of Competitive Market Behavior." *Journal of Political Economics* 70, no. 1.

———. 1982. "Microeconomic Systems as an Experimental Science." *American Economic Review* 82, no. 5.

————. 1985. "An Experimental Study of Contestable Markets Behavior." *Journal of Political Economics* 93, no. 12.

————. 1989. "Experimental Methods in Economics." In *The New Palgrave*. London: MacMillan Press.

Tirole, J. 1990. *The Theory of Industrial Organization*. Cambridge, MA: MIT Press.

Tversky, A., and D. Kahneman. 1986. "Rational Choice and Framing of Decisions." *Journal of Business*.

Tversky, A., and I. Simonson. 1992a. "Choice in Context: Trade-off Contrast and Extremeness Aversion." *Journal of Marketing Review* 29, no. 2.

————. 1992b. "Context-Dependent Preferences." *Management Science*, no. 12.

Tversky, A., P. Slovic, and D. Kahneman. 1990. "The Causes of Preference Reversal." *American Economic Review* 80, no. 1.

Wilson, R. 1989. "Bidding." In *The New Palgrave*. London: MacMillan Press.