The 'Materials' of Experimental Economics: technological versus behavioral experiments

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Abstract

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Abstract

In the natural sciences there is a general consensus on the epistemic value conferred to by the participation of the 'material world' in the experimental process of knowledge production. This is no different in experimental economics. However, an inquiry into the epistemic role of the 'materials' of economics is still incipient. The present paper is meant as a contribution to this inquiry. Two categories of experiments are identified according to the differentiated role of the 'materials' of economics. Technological experiments produce knowledge of how to design market institutions for specific purposes. The crucial 'material' of these experiments is the institution that organizes the interactions of the experimental participants. Behavioral experiments produce knowledge of individual behavior in varied decision contexts. The crucial 'material' of these experiments is the agency of the experimental participants. FCC spectrum auctions and ultimatum game experiments illustrate technological and behavioral experiments, respectively. General policy implications are also drawn for each kind of experiment.

Keywords:

experimental economics, incentive compatible mechanisms, institutions, auction experiments, ultimatum game experiments

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1. Introduction

There is a general consensus on the epistemic value conferred to by the participation of the 'material world' in the experimental process of knowledge production of the natural sciences. This is no different in experimental economics. However, an inquiry into the epistemic role of the 'materials' of economics is still incipient. The present paper is meant as a contribution to this endeavor. It investigates how the 'materials' of economics experiments shape the kind and the content of knowledge. It does that by distinguishing two categories of experiments: technological experiments and behavioral experiments.

Technological experiments produce knowledge of how to design market institutions for specific purposes. The crucial 'material' of these experiments is the institution that organizes the actions and interactions of the experimental participants. Behavioral experiments produce knowledge of individual behavior in varied decision contexts. The crucial 'material' of these experiments is the human agency of the experimental participants. Even though the same 'materials' are present in both kinds of experiment, the institution and the experimental subjects play different roles in them. In technological experiments, economists manipulate the institutions in order to learn about their characteristics (e.g. dissemination of information, compatibility between private incentives and social goals, etc.). The experimental participants are simply instrumental to that end. They allow the testing of institutions by observing how individuals interact under the institutional rules and what aggregate outcomes result. The experimental subjects play a crucial role in behavioral experiments. Their goal is to study how social institutions influence and shape individual motivations and thereby human behavior. Thus, whereas the focus of technological experiments is the relationship between the institutional set-up and the performance of the economic system, the focus of behavioral experiments is the relation between the institutional set-up and individual behavior.

The paper is structured as follows. Section 2 highlights the epistemic role of the 'material world' in scientific experimentation. Section 3 presents a stylized definition of an economics experiment. Sections 4 and 5 define the technological experiment and the behavioral experiment, respectively, and illustrate the role of economic institutions and of experimental participants in them. Section 6 concludes the paper.

2. The Materiality of Laboratory Experiments in the Natural Sciences

The direct participation of the 'material world' in the experimental process of knowledge production is the distinguishing feature of scientific experimentation as compared to other modes of scientific inquiry. This participation is epistemically relevant because the actual properties of the aspect of the world under scrutiny play an active role in the production of knowledge about them.

The participation of the material world in knowledge production is particularly evident when the experimental process of knowledge production produces unexpected results. In the course of experimental practice there are always unknown or insufficiently understood aspects of the material world that generates unanticipated results. This is, in fact, where the interest of scientific experimentation resides – to learn a not fully understood aspect of the material world. But it should be noted that this is the case because the material world cannot be manipulated so as to conform to scientists' anticipations. Were scientists able to control the material world at will, the results of science would convey scientists' actions rather than the agency of the material object under scrutiny. Scientific results would no longer carry new knowledge about it.

Mary Morgan (2003, 2005) expresses the epistemic superiority of scientific experimentation relative to mathematical modeling in terms of 'confoundment' and 'surprise'. While scientists can be confounded by experimental results, she argues, they can only be surprised by the results of models. In model experiments, 'we know the resources for the result that we do find because we built those resources into the model that constitutes the experimental setup'. Only the computational limitations of the scientists prevent them from knowing beforehand the models' solutions. In contrast, in laboratory experiments 'the resources for the result we expect to find are not necessary present in the experimental setup: we might have the wrong account or theory about what will happen or our knowledge of the world might be seriously incomplete' (2003: 120 emphasis omitted).

'Confoundment' in scientific experimentation expresses scientists' incapacity to exercise full control over the material world or over 'material agency'. As Morgan put it, 'however ingenious the scientist, the material world can only be controlled and manipulated to an extent' (2003: 119). In contrast, scientists' control is the most effective in 'mathematical model experiments' in which the material world is absent. From this it follows that the potential for generating new knowledge depends on the extent to which the experimental set-up constrains the participation of the 'material world' or 'material agency'. However, control is necessary to create intelligible experimental systems that produce relevant results for scientific scrutiny.

Thus, in experimental practice there is a trade-off between the exercise of control and the potential to generate new knowledge. The more control is exercised, the more the results are the outcome of scientists' actions rather than the agency of the material world. This trade-off constitutes the central methodological and epistemological question of scientific experimentation which calls for the analysis of the extent to which the results of experiments are determined by the agency of the material world or that of the experimenters. In economics, it calls for the analysis of the trade-off between economists' actions and that of the experimental subjects.[3] Here is how Morgan frames the issue in experimental economics:

> It is this potential for independent action by the experimental participants from which new phenomena emerge that supports greater epistemic power of laboratory experiments over mathematical model experiments. In laboratory experiments, much is determined and constrained by the design set-up and rules of experiments. This is clearly as it should be – there must be experimental controls . . . Laboratory experiments, by their design, investigate tamed economic behaviour . . . However, if the behaviour of those taking part in the laboratory experiment is entirely constrained, then the results will be determined absolutely by the experimental design and rules . . . They raise the danger of over-taming the participants in the particular way so that participants are no longer domesticated, but agents whose behaviour is directed by models of the world, models dictated by the economist. *An important question for any experimental design therefore is: Where is the potential for independent action in the experiment?"* (Morgan 2005: 325 emphasis added)

Below I will show that the question Morgan raises applies differently to technological and behavioral experiments. But before coming to that, some terminological clarification is in order.

[3] In experimenters' jargon this is known as the problem of "artefacts".

3. Creating and Controlling Microeconomic Experimental Systems

The goal of a laboratory experiment is the production of a phenomenon under favorable conditions for scientific scrutiny. In order to study the phenomenon of interest, experimenters must produce it and control the interference of factors that may have an effect on it but which are not the object of inquiry. The control exercised over the experimental conditions therefore shields the phenomenon of interest from extraneous influences so that the experimental results pertain to the object of study and this object only. The relevance of scientific experimentation is given by the fact that interesting phenomena do not generally occur naturally or they do not occur in conditions that allow for close scrutiny (Hacking 1983).

In the natural sciences, experimental control is exercised by designing and implementing special material apparatuses that produce the phenomenon of interest and by materially shielding it from the outside world. In economics, according to Vernon Smith,

> The fundamental objective behind a laboratory experiment is to create a manageable «microeconomic environment in the laboratory where adequate control can be maintained and accurate measurement of relevant variables guaranteed» [reference omitted]. 'Control' and 'measurement' are always matters of degree, but there can be no doubt that control and measurement can be and are much more precise in the laboratory experiment than in the field experiment or in a body of Department of Commerce data. (Smith 1982: 930)

On this view, then, economists produce and control experimental phenomena by creating isolated 'microeconomic environments' for the purpose of observing and measuring variables that are relevant to the study of economic institutions and individual behavior.

Defining the Microeconomic System

Smith's definition of an experimental microeconomic system is, to date, the most elaborate philosophical account of an economics experiment. It provides a 'description of the methodology and function of experiments in microeconomics' and offers 'a taxonomy for laboratory experimentation which allows methods, objectives and results of . . . experiments to be interpreted and perhaps extended' (1982: 923). Even though this definition, as will become apparent below, conveys a narrow portrait of an economics experiment, it supplies a framework that can usefully organize various categories of experiments, including the technological and the behavioral experiments. This is, in fact, the exercise to be carried out. The definitions of

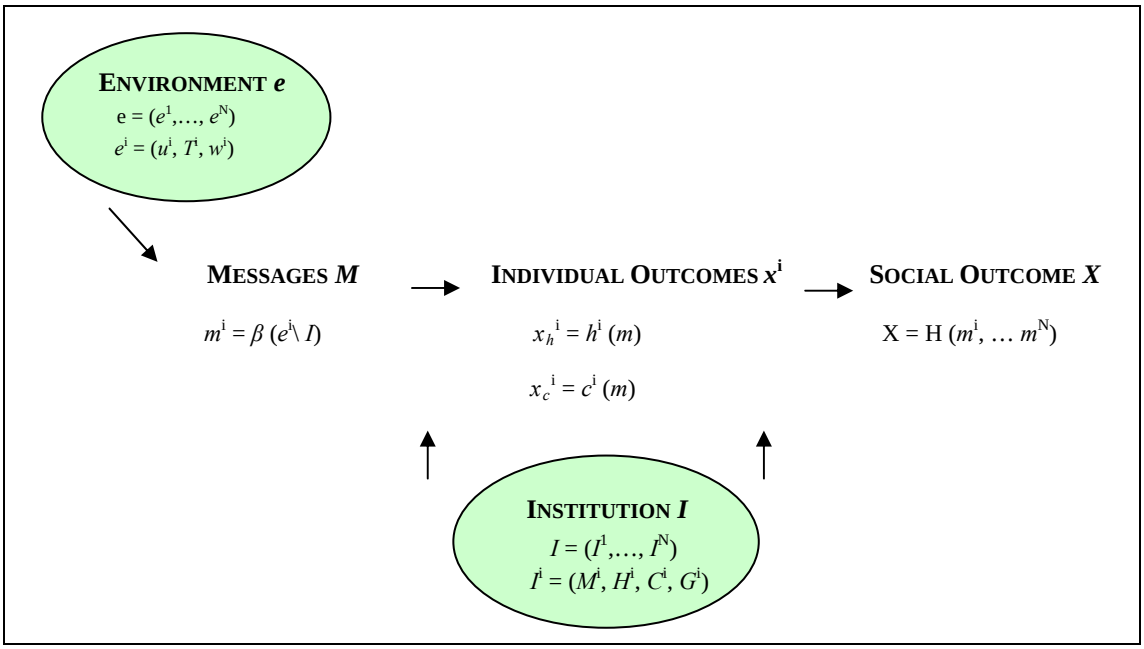
technological and behavioral experiments presented below are both constructed by reference to Smith's conception of an experimental microeconomic system.

Following closely the work of welfare economists, in particular their work on the design and evaluation of resource allocation mechanisms, Smith defines a microeconomy as a system made up of two component parts: the environment and the institution.[4] The environment (e) consists in the collection of the characteristics of the economic agents operating in the microeconomy: $e = (e^1,\ldots, e^N)$. Each agent i is characterized by a utility function u^i, a technology endowment T^i, and a commodity endowment w^i: $e^i = (u^i, T^i, w^i)$. The environment defines the initial circumstances that cannot be altered by the agents. However, agents can change preferences and technology during the exchange or production process. The institution (I) consists in the collection of the rules of individual property rights, $I = (I^1, \ldots, I^N)$, under which the economic agents communicate, exchange, or transform commodities for the purpose of modifying the initial endowments in accordance with their preferences and knowledge. More specifically, the institution comprises: the language (M) that defines the set of admissible messages that individuals may use in communication; the adjustment process rules (G) that govern the sequence and exchange of those messages; the cost imputation rules (C) that assign the costs to be applied to the messages; and, finally, the allocation rules (H) that compute the outcome of the exchange process. For agent i, these rules define the messages that i has the right to send, the rules that govern those communication rights and the right to claim commodities or payments as a result of that process: $I^i = (M^i, H^i, C^i, G^i)$. For instance, the first-price sealed-bid auction is an institution that governs the sale of a single item. It begins with a request for bids after which each buyer submits one bid price. When all bids have been received the allocation rule determines that the item should be awarded to the highest bidder who buys the item at his bid price.

In sum, a microeconomic system is composed of an environment and an institution, $S = (e, I)$. Its performance depends on both the behavior of the individual agents and the institution. Economic agents do not choose commodity allocations (X). Agents choose messages, $m^i = \beta (e^i \backslash I^i)$, which depend on their individual characteristics (e^i) and the institution (I^i) that guide their actions and interactions. Neither does the institution I determine the final outcomes X. The institution simply determines how individual messages translate into final outcomes $X = H (m^i,\ldots, m^N)$. (see fig. 1 below)

Figure 1. The performance of a microeconomic system: $S = (e, I)$

[4] Smith relied on Leonid Hurwicz's 'Informational Efficiency of Resource Allocation Mechanisms' which provides a formal theoretical framework for the study of resource allocation mechanisms that are 'the unknown of the problem, rather than a datum' (1960: 28).



On this view, economists create microeconomic systems in the laboratory to study the relationship *environment (e) – institution (I) – individual behavior (m) – aggregate outcomes (X)* that had long been central to economic analysis but largely unobservable and undetectable by non-experimental means. The major difficulty concerned the measurement of the variables pertaining to the environment, i.e. preferences, and the commodity and technological endowments. The experimental method allows the study of the relation between the attributes of the economic agents, the set of rules of communication and exchange whereby agents interact with one another, the actions they take under those rules, and the performance of the microeconomic system. This relation is examined by investigating the effect of varying one of these variables at a time while keeping the rest constant. The performance of the microeconomic institution is then evaluated by reference to relevant criteria such as dissemination of information, transparency, administrative feasibility, compatibility between private incentives and social goals, and so forth.

The precepts of experimental economics

Economists create and control microeconomic systems in the laboratory by designing an economic institution and by making sure that it is meaningful to the experimental subjects in the intended way. An institution *I* is easily created and controlled by design. It consists of the rules of communication and exchange that define the task to be carried out during the experiment. The major methodological difficulty concerns the control of the environment *e* and, in particular, ensuring that the experimental subjects perceive the experimental situation as intended by the experimenters. In experimental economics this is achieved by a reward structure

that induces prescribed monetary value on the experimental variables. This means that subjects' payoff functions must take as arguments the experiment's variables and that subjects must be given the property right over the monetary outcomes of the actions taken in the course of the experiment.[5] Specifically, the experimenters induce value on the experimental tasks when the reward structure satisfy 'the set of sufficient conditions for a valid controlled microeconomic experiment' – nonsatiation, saliency, dominance and privacy (1982: 931-5).[6] Briefly, nonsatiation dictates that the amount of the reward earned by participating in the experiment must be important to the experimental subjects and saliency prescribes that this amount must be related to the outcomes of the individual actions in an appropriate way, that is, 'individuals are guaranteed the right to claim a reward which is increasing (decreasing) in the goods (bads) outcomes'. Dominance requires that the reward structure must be capable of offsetting the subjective costs or values associated with the process of making and executing decisions. Finally, privacy restricts the information of each subject to his own rewards forcing them to concern only about their own payoffs.[7]

Nonsatiation and saliency together ensure that individuals act in accordance with the rules defined by the institution so that individual behavior and aggregate outcomes can be interpreted by reference to it. Dominance and privacy, in turn, ensure that the factors pertaining to the environment and the institution are the major determinants of subjects' actions. In short, the four precepts of experimental economics endeavor ensuring that the behavior observed in the laboratory is determined by factors pertaining to the experimental design and by these factors only.

Insofar as subjects' motivations are controlled by a payoff function that prizes successful decisions made in a context of relative anonymity, the reward structure of economics experiments induce self-interested and reward-maximizing motivations on the experimental subjects. The goal is to ensure the intelligibility of the experimental economies. Only then can the experimenters understand how the environment and the institution translate into individual behavior and how this, in turn, affects the performance of the microeconomy. As Smith expressed it:

[5] The use of money to induce value on abstract experimental outcomes applies the same principles prevalent in real economic systems. As Smith remarks, in an economic system agents have also property rights over "intangible property on which value is induced by specifying the rights of the holder to claim money or goods" (1982: 931, n. 11).

[6] Note that these are deemed sufficient, but not necessary, conditions for a valid microeconomic experiment.

[7] In the double oral auction experiment value is induced on the commodities transacted by a reward structure that pays buyers the redemption values of the goods bought and pays sellers the market prices of the units sold, and by property rights rules that confer subjects the right to claim the gains obtained with these transactions (after deducing the prices buyers paid and the cost of production of the goods sold). The precepts of nonsatiation and saliency are satisfied insofar as the amounts earned are important and vary positively with the gains from trade. The precepts of dominance and privacy are satisfied insofar as these amounts compensate for the transaction costs and subjects do not know the other subjects' payoff functions.

> When great care is used in an experiment to make induced value be the primary source of motivation, it is *not* for the purpose of making sure that subjects have self-interested motivations; it is for the purpose that we *know* what were the preference patterns of the subjects in the experiment. (1982: 933, n. 13 emphasis in original)

Even though, the inducement of self-interested and income maximizing motivations is not a methodological prescription of experimental economics, the importance of these behavioral postulates in economic theories, and the need of controlling subjects' motivations, so that human behavior may be interpreted by reference to the design of the experiment, has rendered these *de facto* the central motivations of the participants of experimental economics.

The procedures of experimental economics

A controlled microeconomy is a transparent system that elicits behavior that can be interpreted in the light of the motivations induced by the reward structure and the institution that organizes subjects' actions. But the implementation of the precepts of experimental economics invokes a larger set of principles and procedures. The central principles to the practice of experimental economics are: *simplicity*, *neutrality*, *abstraction* and *anonymity*.[8]

The design of simple tasks is crucial to guarantee that subjects understand the experimental problem in the intended way and that they can solve it within the available time. Misunderstandings on the part of the subjects render the results of experiments unintelligible and therefore jeopardize the whole enterprise. Simple tasks also minimize the costs associated with the effort of executing experimental tasks and therefore prevent behavior caused by insufficient attention or fatigue. In order to improve subjects' comprehension, experimenters concede time for practice prior to running the experiment and, whenever adequate, they design multi-period experiments with stationary conditions so that subjects can acquire experience with the task.

The experimental tasks are abstract and described in fairly neutral terms to control the interference of unintended subjective perceptions of the context of interaction. The concern is to prevent subjects acting in conformity, or defiance for that matter, to what they might perceive that is expected from them rather than the actual experimental situation. To this end, the use of terms loaded with suggestive connotations (e.g. maximization, competition, collusion) and

[8] This section conveys the stylised view of the experimental procedures of economics (cf. Davis and Holt 1993; Friedman and Sunder 1994; Friedman and Cassar 2004). However, it should be noted that it does not apply equally to all the experimental work done in the field. As will become apparent below, its relative importance depends on the purpose of the experiment.

references to concrete real world situations (e.g. firm *x*, consumption of product *y*, etc.) are ruled out.[9]

Anonymity is other important principle of experimental economics. It aims at controlling the effect of intersubjective considerations, i.e. subjects caring about other subjects. In addition to the implementation of privacy, anonymity is promoted by avoiding as far as possible the contact between subjects. Thus, the structure of the experiment must take into account subjects' interaction outside the laboratory prior to the experiment, during breaks, and after the experiment is finished.

There are other factors that do not affect subjects' understanding of the situation but may have an impact on the experiment's results. These factors raise problems of confounding effects due to correlations with the treatment variables. Factors that may be expected to be strongly correlated with particular variables may be controlled directly by blocking, that is, by including them as treatment variables.[10] Other background factors may be indirectly controlled by randomization, that is by assorting at random background factors to treatment variables.[11]

The way in which control is to be achieved in experimental economics is now well ingrained in the field. The conceptualization of a microeconomic experiment, the set of sufficient conditions for a valid microeconomic experiment, the principles and procedures of experimental economics are all part of the established culture of the field. This can be easily ascertained in the field's textbooks (e.g. Davis and Holt 1993; Friedman and Cassar 2004; Friedman and Sunder 1994; Hey 1991), in the field's methodological discussion (e.g. Loomes 1991; Starmer 1999; Guala 2001, 2005) and, most expressively, in the experimental disputes that often revolve around the conformity to these standards (e.g. Harrison 1994).

The standards of experimental economics not only promote the transparency of the experimental systems, but they also favor the replicability and the robustness of experimental results by other researchers. Indeed, the adoption and adaptation of previous instructions and procedures in the design of new experiments are pervasive practices in experimental economics, as we shall see below. To summarize, the creation and control of microeconomic systems is realized by well-established methodological procedures that include:[12]

[9] The neutrality and abstract nature of the experimental tasks reveal a central difference in scientific experimentation between the natural and the human sciences. In the latter, scientific experimentation involves conscious human beings whose behavior depends on how they perceive the situation they are in. The abstractness and the neutrality of the experimental contexts therefore aim at controlling for factors that affect subjects' perceptions of the context but which are not the object of study. These issues have also been dealt with by other experimental disciplines of the human sciences (see footnote 10 below).

[10] For example, if experience is considered such a background factor, its effect may be isolated by running a session with experienced subjects and another with inexperienced subjects.

[11] The order of subjects' arrival to the experiment, subjects' relationship with one another, the order of treatments are all examples of factors that can be controlled by randomization.

[12] These procedures apply generally to economics experiments. In fact, conformity to these procedures allows distinguishing economics experiments from social psychology experiments (cf. Hertwig and Ortmann 2001).

1. The definition of a salient reward structure capable of inducing the desired set of motivations on the experimental subjects;
2. The creation of fairly neutral and abstract experimental contexts to avoid the interference of background factors;
3. Guaranteeing anonymity among subjects to avoid the effect of interpersonal considerations;
4. The use of stationary repetition whenever adequate to ensure that subjects understand and acquire experience with the experimental situation;
5. The prohibition of deceiving experimental subjects to enhance the efficacy of the experimental instructions (in present and future practice) ;
6. The convention of providing fairly complete reports of the procedures underlying the production of experimental results so that they can be replicated and robustness checks made by other experimenters.

It is now clear that the principles and the procedures of experimental economics aim at creating fairly aseptic systems shielded from the contamination of the outside world. However, the isolation of experimental systems from the outside world can only be achieved to some extent. And so it should be. As mentioned above, the incomplete control over the experimental systems, or over the 'materials' of the experiment, is the source of the epistemic value of scientific experimentation. How the 'materials' of an economics experiment participate in knowledge production is the topic I now turn to.

The 'materiality' of the experiments of economics

It is now easy to see that the 'materials' of a microeconomic experiment, i.e. its subject matter, are the 'microeconomic environment' and the 'microeconomic institution', or more generally, the experimental participants and the institutional rules that define and organize the experimental problem and subjects' actions.

Given that the methodological requirements of experimental economics control the agency of the experimental subjects by inducing self-interested and income-maximizing motivations, the results of experimental economics are significantly determined by the actions of the experimental economists. But it does not follow from this that the actions of the participants cannot frustrate scientists' expectations or that the epistemic value of economic experiments

However, and depending on the problem the experiment is designed to solve, some of these precepts might be relaxed.

calls for a different explanation. It only means that the role of 'human agency' in experimental economics needs closer inspection. To be sure, the source of epistemic value of economic experiments is 'human agency' or the potential for 'independent action' on the part of the experimental participants. This is the major source of 'confoundment' and thereby of the growth of economic knowledge. However, the frustration of scientists' expectations is jointly caused by the characteristics of the experimental subjects and the experimental institution. This is clearly stated by Smith when considering the use of a microeconomic experiment as an empirical test:

> Microeconomic theory abstracts from a rich variety of human activities which are postulated not to be of relevance to human economic behavior. The experimental laboratory, precisely because it uses reward-motivated individuals drawn from the population of economic agents in the socioeconomic system, consists of a far richer and more complex set of circumstances than is parameterized in our theories. Since the abstractions of the laboratory are orders of magnitude smaller than those of economic theory, there can be no question that the laboratory provides ample possibilities for falsifying any theory we might wish to test. (Smith 1982: 936)

Smith does not explain how and to what extent the increased levels of richness, complexity, and concreteness of the microeconomic systems enhances the falsifying conditions of the experimental system. But it is not difficult to see that these conditions derive from 'human agency'. That is, the possibility of having experimental subjects behaving differently from the behavior postulated by economic theory and induced in the laboratory. Insofar as experimenters control human motivations by inducing self-interest and income maximizing goals, the 'human agency' of economic experiments manifests itself when the subjects behave in a non-self-interested manner or fail to maximize the experimental payoff. The relevance of 'human agency' in economics experiments is now scrutinized for the technological experiments.

4. The Technological Experiments of Economics

Three grand categories of experiments may be found in economics according to their relation to economic theory: market experiments, game theory experiments and individual decision-making experiments (cf. Davis and Holt 1993; Kagel and Roth 1995). Whereas technological experiments are more common in market experiments, behavioral experiments are pervasive in the other two kinds of experiments.

To put it briefly, in market experiments subjects perform the roles of buyers or sellers in the exchange of a particular good to study the market rules of exchange and communication. In game theory experiments subjects engage in strategic interactions which are governed by a set of rules specifying the possible moves for each participant and a set of outcomes for each possible combination of moves. Thus, whereas the former focus on the microeconomic institutions to investigate the performance of the microeconomic system, which is not known prior to the experiment, the latter focus on the study of the microeconomic environment to investigate how and which among the possible outcomes is actually arrived at. But in both kinds of experiments the individual outcome is determined by the combined effect of the set of rules and the subjects' interaction with other individuals. In individual behavior and decision-making experiments the individual takes decisions that affect himself only. Here the goal is to study individuals' preferences or appraise individuals' decisions in contexts of uncertainty or risk. In these experiments, the final outcome for the individual depends only on the decisions she made and the states of the world after the decision is made (this type of experiment can also be described as a game against nature). There are also hybrid experiments that combine aspects of the various kinds of experiments.

Technological experiments produce knowledge about the characteristics of market institutions that structure the organization of particular industries, special markets, or the transaction of commodities with special properties.[13] The knowledge they generate bear on the organization of real world markets. In fact, they have been important tools for the design and implementation of market institutions in real world economies. This potential use of technological experiments as devices for institutional engineering is therefore what explains the label attributed to them. Whether in the laboratory or in real world economies, their ultimate goal is to design market institutions that guarantee the accomplishment of specific goals.

The crucial 'material' of these experiments is the institution that organizes the interactions of the experimental participants in the experimental market. Experimenters learn about the properties of institutions by observing in the laboratory how individuals behave and what outcomes emerge when their actions are organized by a specific set of rules.

[13] Examples of technological experiments can be found in the sets of experiments that Kagel and Roth (1995) organized under the labels of industrial organisation, asset markets and auctions.

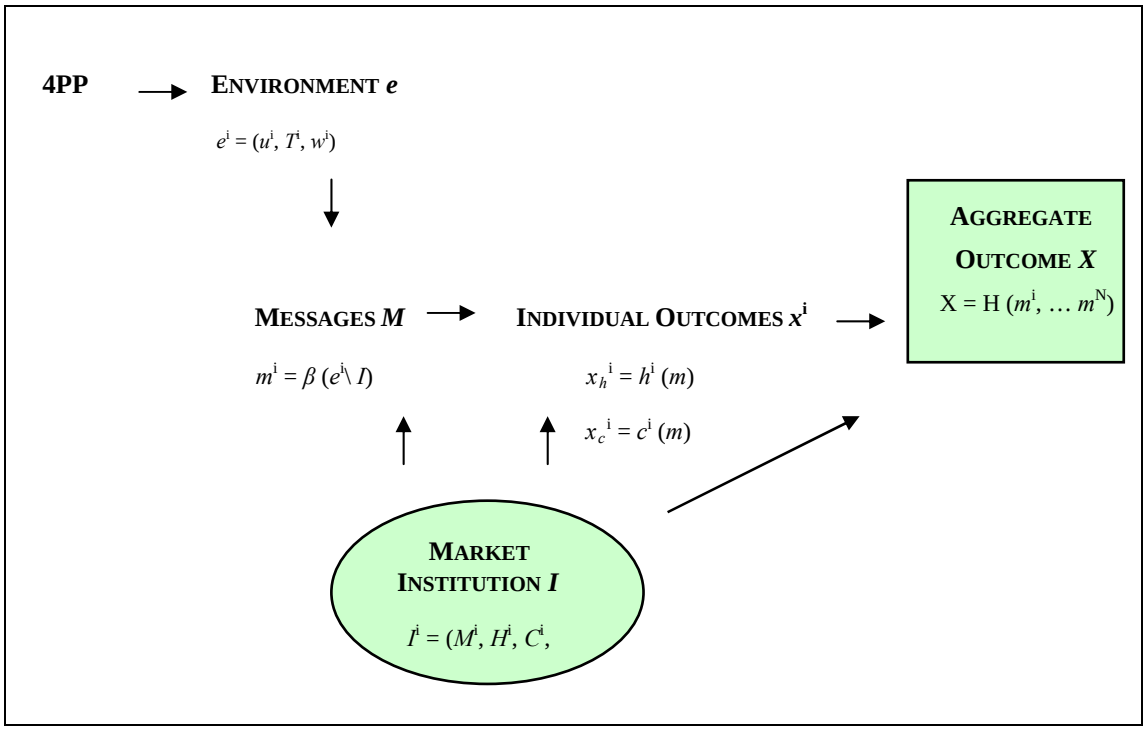
In these experiments a high level of control is exercised over human motivations and actions. Experimenters exercise this control by following closely the four principles and the four precepts of experimental economics (4PP from now on). This means that in technological experiments the 4PP induce self-interested and income maximizing motivations via a reward structure that prizes economically successful decisions undertaken in a context of relative anonymity that is substantially shielded from the wider socioeconomic context. The prospects for learning about human motivations and behavior are therefore modest. But the characteristic trait of technological experiments is the high level of control that the institutional rules exercise over individual actions. This is what justifies the robustness of the institutions of technological experiments and their potential implementation in real world economies.

The ultimate goal of technological experiments is to learn how to design incentive compatible rules of communication and exchange that achieve the best alignment between individuals' actions and desirable aggregate outcomes at the market level. Experimenters investigate the incentive compatibility of these rules (I) by observing their impact on the messages (m^i) individuals send and the effect of these on individual (x^i) and aggregate outcomes (X). The performance of different rules can then be compared and appraised according to relevant criteria for the problem at hand (see fig. 2 below).[14] The market institutions can then be classified on the basis of their relative performances, or on the basis of the mappings they generate from the rules of private property to the aggregate outcomes they bring about (i.e. I and X).[15]

Figure 2. The Technological Experiment of Economics

[14] For instance, an allocation mechanism is incentive compatible if it yields a Nash equilibrium that is a Pareto Optimum. Under these circumstances, the communication and exchange rules guide each individual in choosing messages that constitute the best response to the others messages and the final allocation arrived at maximizes social welfare.

[15] For a review of established mappings for trading institutions see Holt (1995, section 5).



The mappings established from the institution into aggregate outcomes are robust to changes in the environment. This robustness is due to the high level of control exercised over subjects' motivations and actions. The experimental procedures and the experimental institution together produce a stable relationship between the institution (I), subjects' messages (m^i), individual (x^i) and the social outcomes (X), and thereby between the institution (I) and the aggregate result (X).

Technological experiments are not trivial, however. Strict adherence to the methodological prescriptions of experimental economics does not ensure that individuals are self-interested income maximizers or that they succeed in taking the course of action that best suits their interests. For one thing, subjects' motivations are multiple and not easily controlled. For another, the cognitive limitations of the individuals and the complexity of the decision problems may prevent them from perceiving and pursuing the best course of action. And even when perceived and pursued, the best course of action may produce undesirable collective outcomes. It is precisely in this potential mismatch between individual motivations and individual actions, or between individual actions and aggregate outcomes where the relevance of the technological experiments resides. Their goal is precisely to learn how to design institutions that best align individual goals with individual actions (e^i and m^i), or individual actions with some desirable social goal (m^i and X). As it will be shown below, this means finding an incentive structure that elicits behavior that is needed to achieve social optima.

Technological experiments can be, as Plott put it, 'testbed' experiments in the sense that they can test 'a working prototype of a process that is going to be employed in a complex environment' (1997: 605), or as Guala had it, they can be devices for building 'economic

machines' which 'are supposed to work for several years, in different contexts and without constant supervision of their manufacturer' (2001: 464). The main factor responsible for the potential implementation of the experimental 'machines' of economics is the high level of control they exercise over human behavior. That is, insofar as experimenters are successful in creating institutions that control human actions in the laboratory, there is at least the possibility that the same control can be obtained in similar non-laboratory contexts. In short, technological experiments can produce robust market institutions that operate in a reliable way in real world contexts.

The Federal Communication Commission (FCC hereafter) auction is a market institution first designed and tested in the laboratory and implemented in the field in 1994. It allocates the licenses for wireless Personal Communication Systems (PCS) that give the right to use airwave spectrum for communication.[16] Until 1982, the PCS licenses were assigned by an administrative hearing process, which was recognizably a slow and non-transparent process that allocated licenses for free instead of selling them for their market value. After 1982, the licenses were allocated via a lottery system that significantly improved the speed and transparency of the allocation mechanism. However, it did not prevent opportunistic behavior on the part of the bidders. Licenses could be bought and resold by individuals who did not want to use them and thereby appropriated undeserved returns.

The FCC wanted to replace the lottery system by an auction system that guaranteed efficient allocation of the airwave spectrum rights, i.e. the sale of the PCS licenses to those who most valued and therefore would pay the highest prices for them.[17] This would ensure the selling of the licenses to those who could make best use of them and at the same time the maximization of the revenue of the auctioneer. The auction system should also target simplicity, speed, and transparency. In sum, the auction mechanism should align individual behavior with socially desirable ends by ensuring that the individuals and firms who most valued the licenses would be the successful bidders and the maximization of the FCC's revenue. This, in turn, required the design of an auction mechanism that induced bidders to reveal their true valuations and that prevented opportunistic behavior.

The auction designed and later implemented in the field was a 'simultaneous ascending-bid auction'. This auction allowed bidders to operate in several markets at the same time in which they could tender increasing bids in subsequent rounds. The simultaneity of the auction

[16] The account provided here is based on Guala (2001).

[17] In fact, the goals of the FCC auction were varied. These encompassed: the expansion of public access to new technologies, products and services; the decentralisation of licenses among a variety of applicants, including small businesses, rural telephone companies, and those owned by minority groups; and the public appropriation of revenue raised with the commercial use of the public spectrum. But these goals subsequently reduced to the sole goal of 'economic efficiency'. See Nik-Khah (2006) for a detailed account of the political process involving the FCC auction.

mechanism allowed bidders assessing the chance of composing desirable aggregations of items. The highest bid would then win the license and pay the bid price. Given the high stakes in presence, the experimenters were also concerned with simplifying the tasks and minimizing the occurrence of errors. To this end, the traders were given information of the bids presented at every round and the value of the standing high bid.[18] The use of computer terminals simplified the bidding procedure and reduced confusion and misunderstandings on the part of the bidders. The possibility of uncontrollable mistakes was also taken into account by allowing the withdrawal of bids. All these procedures were meant to help bidders purchasing their most preferred items.

Opportunistic behavior on the part of the traders was controlled by imposing eligibility conditions. These demanded the constitution of a deposit (proportional to the number of licenses the bidder wanted to bid) at the beginning of the auction and by forcing compulsory bidding in the first round. Other rules, such as inflicting a cost on withdrawals, also contributed to speed up the auction's rounds and prevented the strategic slowing down of the auction.

After being assured of the comparative superiority of the 'simultaneous ascending-bid auction' by experimental means, the experimenters subsequently tested it in the laboratory under conditions that closely resembled the real world market in terms of the number of traders, the items to be traded, the complementarities between them, the number of rounds, etc. This test allowed assessing the combined effect of the auction's rules (withdrawal rules, the eligibility conditions, the increments, and so forth) which could not possibly be predicted by non-experimental means.

Because the data collected from the laboratory and from the FCC auction were equivalent in many relevant aspects (e.g. bidding patterns, price trajectory, license aggregations, etc.) the experimenters were confident that an efficient allocation had also been achieved in the FCC auction.

> The strength of Plott's argument [that justifies the efficiency of the FCC auction] lies in the work he and other consultants did to ensure that the same processes took place in reality as those they had observed in their laboratory. The same causes are supposed to operate because experimenters built the two systems so as to be structurally similar to one another. The transportation of the mechanism outside the laboratory was as smooth, gradual and carefully as possible. (Guala 2001: 473)

[18] This procedure aimed at providing information about the valuations of other traders and thereby prevent the 'winners' curse', that is, the selling of the licenses to traders who overestimate the value of the licenses (cf. Kagel and Levin 1986).

On this view, 'institutional engineering' hinges on the possibility of enforcing rational behavior in a fairly constrained context that prevents opportunistic behavior and which is especially tailored for a particular market:

> To build a successful auction one needs to pay attention to the computational abilities and preferences of its users. One has to make sure that the tasks the bidders face are not too complicated or the rules unclear. Bidders' reactions to possible strategic situations must be analysed in the light of realistic cognitive capacities at the individual level. One cannot just presume that buyers behave 'as if' they were rational . . . it is by designing and implementing an adequate mechanism that the engineer ensures that rational choice models can work. Since it is partly in virtue of the structure of the situation that economic agents behave rationally, a great part of economic engineering is devoted to ensuring that the structure is 'right'. (Guala 2001: 474)

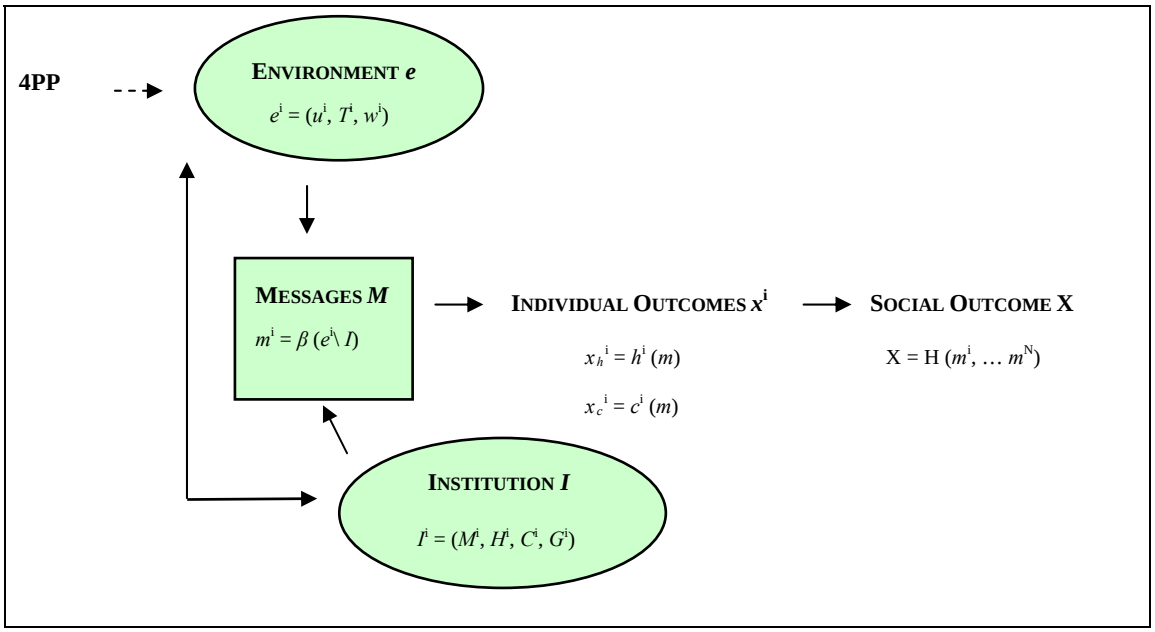
To put it in another way, 'institutional engineering' relies on the feasibility of designing, in the laboratory market, institutions that help economic agents to behave rationally. This behavior must be robust to the variability in individual motivations and individual cognitive capabilities so that the same observations obtain for different groups of individuals. 'Institutional engineering' also depends on the extent to which the rules that exercise such control in the laboratory can be equally implemented in the field. From this it follows that the institutions of technological experiments are rationality facilitators that control for the opportunistic behavior of self-interested individuals. These experiments do not provide much knowledge about human motivations and behavior, at least not beyond the manifestation of opportunistic behavior and specific sources of cognitive error. They do not require searching into the cognitive processes of the individuals and their motivations.[19]

[19] It should be noted that the success story of the FCC auction mechanism as presented here has been contested. Charges have been made that the auction was tailored to suit the business plans of large corporations: "With hindsight it appears the auctions have been less a story of lowered barriers to entry, robust competition, and decentralization – or even stabilization, efficient allocation, and low transaction costs – than one of bankruptcies, court battles, and concentration" (Nik-Khah, 2006: 31). However this may be, the experiments did produce a mechanism that is deemed responsible for the market outcomes. The auction did affect who bought the licenses and the trading prices. To be sure, the alleged failure of the FCC auction does not undermine the technological character of economics experiments. It shows instead the vulnerability of 'institutional engineering' to the constituted interests in presence, among other social factors.

5. The Behavioral Experiments of Economics

The behavioral experiments of economics also study how institutions shape human behavior. But in contrast to the technological experiments, the institutions of behavioral experiments call for the scrutiny of the effect of the institutional setting on the principles underlying human behavior that brings to the fore the psychological and the social make-up of the experimental subjects. This difference is depicted in figure 3 by the arrows connecting the institution (*I*) with the environment (*e)*, which is the focus of the behavioral experiments. These experiments study the effect of the institutions on the principles guiding human action by varying the elements of *I* and observing the effects on individual messages m^i. The ultimate goal is to arrive at the behavioral models (β) that account for the way by which individual values (*e*) and institutions (*I*) interact and together bring about human behavior.

Figure 3: The Behavioral Experiment of Economics



It is no accident that the research domains of behavioral and technological experiments differ. Technological experiments concern the allocation of special resources in the market where the behavior of experimental subjects is predominantly guided by self-interest and income maximizing motivations. Behavioral experiments instead concern the study of decision problems in various social contexts where other motivational forces are also in operation. They investigate how the institutions influence the perceptions of the social contexts and thereby the

courses of action therein. These then provide evidence for individuals' preferences and/or shared norms of conduct.

The level of control exercised over human motivations and actions is therefore lower in the behavioral than in the technological experiments (which is represented by the dashed line depicting the implementation of the 4PP). The behavioral experiments trigger a variety of motivational factors which have a central role in interpreting the results they generate. To put it differently, insofar as experimental control in economics is exercised by inducing self-interested and reward-maximizing motives, the reduced level of control of behavioral experiments means that they carry a higher potential to produce knowledge about the factors that trigger other-regarding considerations and the pursuit of social goals. How this is achieved in actual experimental practice is illustrated below with the ultimatum game experiment.

The ultimatum game experiment

The ultimatum game experiment, first conducted by Werner Güth, Rolf Schmittberger and Bernd Schwarz (1982) to test the Nash equilibrium prediction, consists in the partition of a fixed amount of money between two subjects. Subjects are randomly divided into two groups and placed in opposite sides of the same room. One group is composed of subjects that perform the role of player 1, also called the proposer, and the other of subjects that perform the role of player 2, called the responder. Each player 1 engages in a two-round game with a player 2, but nobody knows with whom they are playing with. In the first round, player 1 divides the amount of money between the two. In the second round player 2 decides whether or not to accept the proposed distribution. If player 2 accepts, each receives accordingly, otherwise both receive nothing. Under these conditions a very asymmetric distribution should follow. The Nash equilibrium prediction (assuming that each subject is rational and nonsatiated with money) is that player 1 receives the bulk of the fixed amount. Player 1 will always prefer the alternative that yields the higher payoff and therefore he will offer the smallest positive payoff. He will expect that this offer will be accepted by a nonsatiated rational player 2, who accepts any positive offer rather than rejecting it and earning nothing. But the experimental results depart from the theoretical prediction. Not only the proposers make more generous offers, but the responders also refuse positive payoffs by opting for no rewards.

A wide range of experiments have since been carried out to investigate the effect of potentially relevant factors. However, the results turned out to be robust to varying conditions. The original results of the ultimatum game were not affected by: subjects' experience in multi-

period games (e.g. Slonim and Roth 1998), culture (e.g. Roth *et al.* 1991)[20], and the amount of the total payoff (e.g. Hoffman *et al*. 1996).[21]

The results of the ultimatum game experiment have since become well-accepted stylized facts, which can be summarized as follows: (i) there are almost no offers below 10% or above 50% of the amount to be distributed; (ii) the modal and median offers are in the interval between 40%-50%; (iii) the means are around 30-40%; (iv) offers of 40-50% are rarely rejected; (v) offers below 20% are rejected about half the time; (vi) the rejection rate increases with the decrease of offers.

The ultimatum experiment generated results whose interpretation bears directly on individuals' perceptions of the social context and the suitable courses of action therein. Güth *et al.* (1982) suggest that the ultimatum experiment creates a situation that renders the exploitation of the position of advantage unacceptable. This is the case because the bargaining situation consists of a game between two opponents who would stand in an equal position were it not for the arbitrary allocation of the different roles between them. Because the fifty-fifty split is the salient distribution under symmetric conditions, proposers offer generous partitions and responders reject low offers to punish what is perceived as the exploitation of an underserved position of advantage. An asymmetric relation would be more acceptable in a market context such as the consumer markets of industrialized countries where 'buyers . . . might be used to have less strategic power' (1982: 369).[22] The distinctive features of behavioral experiments are further scrutinized below by way of confronting auction experiments with ultimatum game experiments.

Behavioral versus technological experiments

The goal of auction experiments was to study the performance of alternative auction mechanisms for the sale of a particular commodity - airwave spectrum licenses. In these experiments, the experimental subjects were merely instrumental to that end. They allowed designing and testing the auction mechanism which would allocate the licenses to the individuals who value them most. The relevant data consisted in the licenses' prices and their respective allocation to the bidders. In contrast, the aim of the ultimatum game was to observe

[20] The experiments by Roth *et al*. were carried out among the student population in the USA, Japan, Slovenia and Israel. The study by Henrich *et al*. (2001, 2004) in fifteen small-scale societies of Latin America and Africa revealed sharper differences across cultures. However, the theoretical prediction based on self-interested income-maximizing behavior was not observed in any of them.

[21] For an up-to-date account of the main results of the ultimatum game see Camerer (2003, ch. 2).

[22] This conjecture is based on Fouraker and Siegel's bilateral monopoly experiment (1963) in which the seller is successful in exploiting his monopoly position. It points to the framing effects of market institutions in the technological experiments. Not only do market institutions reduce human agency by constraining human action, but they also affect subjects' perceptions by rendering salient a particular set of motivations: self-interest.

how individuals' behave when faced with a particular decision problem. The relevant data of this experiment consisted in individuals' decisions – the proposed partitions and the rates of acceptance or rejection. Thus, while in the former the analysis of the experimental results bear on the allocation rules (e.g. whether or not they produce efficient allocations), in the latter the results bear on the individual perceptions of the social context (e.g. (un)acceptability of exploiting an asymmetric situation).

'Human agency' is higher in ultimatum game experiments than in auction experiments.[23] In auction experiments the level of 'human agency' is lower because experimental subjects are explicitly told that they should try to make the highest profit by buying the licenses at the lowest price and subjects have no reason to do otherwise. Moreover, in these experiments it is clear that to accomplish that goal the subject must raise his bid incrementally as long as it does not exceed his private value so that he raises the chances of buying the item at the lowest price. In the ultimatum game, proposers are asked to divide a fixed amount of money. Even though it is in the self-interest of the proposers to offer the lowest amount of money, the ultimatum game brings about other-regarding considerations that are not present in the auctions. Various distributions are therefore viable, from very unequal to the equal partition. The selection of a given distribution of income depends on how subjects perceive the particular context of interaction. To be sure, whereas in auction experiments subjects' perceptions render salient self-interest motivations and thereby a single course of action, which is common to all subjects, in the ultimatum game subjects' perceptions are far more sensitive to the bargaining context.[24] It affects the proposers' views on what an adequate proposal is under those circumstances and what must be the responders' expectations, and it affects the responders' views about the adequacy of the offer made which then guide his decision to either accept or reject it. In sum, a variety of courses of action are likely. Different proposals can be made which can be accepted or rejected.

The behavioral variety in the ultimatum game is strictly related with the impossibility of satisfying the precept of 'privacy'. 'Privacy' is not guaranteed in the ultimatum experiment due to the nature of the game. Since the payoffs of the players are the very object of the decision problem, each player knows the payoff of the player they are interacting with. Thus, despite the fact that the experimental subjects do not know with whom they are interacting with, intersubjective considerations cannot be avoided. These intersubjective considerations may be

[23] Leonard (1994) provides an early account of the relative high level of 'human agency' in bargaining games that stems from the relevance of the personal attributes of the bargainers to the haggling process. More recently, Camerer and Fehr (2004) review seven game theoretical experiments each of which depicts a social situation that is interpreted in terms of social preferences, such as preferences for reciprocity, inequity aversion and altruism.

[24] As mentioned above, subjects' may fail to take the course of action that suits their interests in the technological experiments. However, the ultimate goal of these experiments is precisely to learn how to design error-free institutions that succeed in attaining pre-determined goals.

further stimulated by the fact that the ultimatum game consists in a bilateral interaction as opposed to the market context in which subjects address a group of traders. In sum, while in the auction experiment subjects only know their own payoffs, which depend on their decisions and on those of the group as a whole, in the ultimatum experiment the payoffs are public information and depend on the details of the interactive process with another (unknown) individual.

The auction offers a rather impersonal and, apparently, fairly interactive context that does not bring about evident intersubjective considerations. Because they do not know the payoffs of the other traders, in the auction experiments subjects may believe that they stand in a fairly symmetric relation to each other. That is, they may believe that they enjoy equal opportunities to maximize the experimental payoffs. Eventual asymmetries may be unperceived by the subjects, and if perceived they may be evaluated as more acceptable in the market context. Consequently, a preference for a more balanced distribution, or resistance towards inequality, does not act as a strong countervailing motive to self-regarding and income maximizing behavior.

In the ultimatum game one of the parties possesses a discretionary power which may be interpreted differently by the subjects. How subjects interpret it depends on the social context. Subsequent experiments demonstrated that subjects' views on the exploitation of the position of privilege by player 1 depend, among other factors, on: (1) the framing of the decision problem; (2) individual entitlement; (3) social pressure; and (4) intentionality. For example, the explicit framing of the experimental problem-situation as pertaining to the market, where self-regarding behavior is socially more acceptable, produces a higher rate of unequal offers which are more likely to be accepted by the responders (Hoffman *et al*. 1994). Experiments have shown that when the right to make the offer is earned, not only does the proposer make lower offers but these are also more easily accepted by the responder (Hoffman *et al*. 1994). The 'social distance' between subjects and between subjects and the experimenter also affect negatively subjects' generosity. For instance, the amount of offers decreases when subjects' contributions are anonymous, i.e. when it is not possible to identify the identity of the offers made (Hoffman *et al*. 1996). This is in line with other empirical studies that show that knowing the identity of the recipient raises the amount of voluntary offers (Bohnet and Frey 1999). Ultimatum game experiments conducted in the workplace revealed that workers more easily share gains with their co-workers than with strangers (Carpenter *et al*. 2005). Finally, experimental evidence shows that responders more likely accept small uneven offers when these are generated by a random device rather than when they are the result of the decision of an interested party, i.e. the rejection rates of intentional uneven offers are higher than just as uneven but non-intentional offers (Falk *et al*. 2003).

Taken together, these results show that in contexts where human agency is high and evident intersubjective considerations are present, individuals search for cues to guide them in their social interactions. These help subjects interpreting the social situation they are in and thereby selecting the appropriate norm of conduct.[25] Market contexts tend to trigger and legitimize self-interest behavior, non-market contexts where social proximity is higher tend instead to raise expectations that the social interaction should be guided by shared norms of conduct. Thus, whereas technological experiments establish mappings from market institutions into aggregate outcomes, behavioral experiments allow mapping subsets of social norms into the contexts that bring them about.[26]

It should be clear by now the extent to which the ultimatum game experiment constitutes a behavioral experiment as defined here. Ultimatum game experiments have focused on the study of the effect of the institution (*I*) on the perceptions of the individuals (*e*) about the social context and thereby individual behavior (*m*). Of course, the results of the ultimatum experiments have also motivated the study of the relation between the institution (*I*), the environment (*e*) and aggregate outcomes (*X*).[27] But the point here is that the study of the behavior of the experimental subjects is specific to this category of experiments.

The explanatory success of behavioral experiments

Behavioral experiments generate knowledge about the effect of institutions on human behavior. It is therefore unsurprising that the data generated by these experiments have been extensively used to construct models and theories of individual behavior. In fact, the field of behavioral economics, whose proclaimed goal is to generate more realistic models of the psychological underpinnings of human behavior, grew in tandem with the accumulation of results from behavioral experiments (Camerer and Loewenstein 2004). The 'economics of reciprocity' is a case in point (Feher and Gächter 2000; Gintis *et al*. 2005). This field of research has interpreted a wide range of experimental results in terms of the individuals' predisposition to cooperate with others and to punish those who violate the norms of cooperation even when it is implausible to expect future gains from it. Bicchieri's (2006) theory of social norms constitutes

[25] Space constraints do not allow me to delve into the way by which the participants of an experiment select and abide by shared norms of conduct. Bicchieri (2006) presents a theory of social norms in which norm compliance is an automatic response to contextual stimuli that render salient a given norm. On this view, the salience of a social norm involves identifying the norm as adequate to the social situation in question; the expectation that others will conform to it; and the belief that one is expected to conform to it. For the purposes of the presence paper it suffices to note that the experimental subjects bring with them their repertoires of norms of conduct. When presented with a problem that possesses evident intersubjective considerations, subjects have recourse to social norms that guide them in their interactions.

[26] This is clearly illustrated in the cross-cultural ultimatum experiment carried out in fifteen small-scale societies (see Henrich *et al*. 2001, 2004) that identified the social norms specific to each society.

[27] For instance, Fehr and Schmidt (1999) analysed the interplay between the distribution of preferences within the population and the context of interaction and its effect on aggregate outcomes.

other recent example of a formal theory that has been built upon experimental evidence produced by behavioral experiments.

Besides its contribution to theoretical development, the results produced by behavioral experiments can also be brought to bear on 'real world' situations. For instance, Fehr and Gächter take the reciprocal behavior observed in the ultimatum game (and in other experiments) as relevant to provide understanding about the rise in employees' theft rates after firms have cut employees' wages, the social ostracism exercised by co-workers against strike breakers during and after industrial disputes, and the resistance of employers to reduce wages in periods of recession by fearing retaliation on the part of the workers (2000: 161).

Even though behavioral experiments are not suitable to perform the role of 'test-beds', their results are certainly relevant for policy-making. Behavioral experiments have produced evidence that demonstrates that the introduction of monetary incentives might generate counterproductive effects in areas of human conduct previously guided by socially established norms of conduct. This is the case when the monetary incentives erode conformity to social norms. Rather than contributing to the achievement of optimal social outcomes, the pecuniary rewards and penalties cause an overall reduction of the behavior to be promoted (Gneezy and Rustichini 2000; Frohlich and Oppenheimer 2003). The introduction of monetary incentives 'crowds out' intrinsic motivations, i.e. the motives that come 'from within the person' and that guide human action without any reward in view other than performing the activity itself (Frey 1997; Frey and Jegen 2001). Under these circumstances, the external intervention affects intrinsic motivation by reducing individuals' sense of self-determination and self-esteem. The external intervention is then perceived as an unacceptable attempt at controlling individual actions and one that does not acknowledge the individual's voluntary commitment to perform the activity. Because individuals are deprived of the possibility of expressing their involvement, the behavior induced by intrinsic motivations diminishes. These insights are particularly relevant when considering that the removal of the incentive compatible mechanism does not necessarily re-introduce the previously prevalent intrinsic motivations. The inhibition of ethical reasoning is deemed to produce an irreversible damage on individuals' 'ethical muscles':

> With the ICD [incentive compatible device], individuals confront a situation in which their self-interest and the interests of all others coincide exactly. What is best for them is, by explicit design, best for the group as a whole. There is no tension whatsoever between the best strategy from a rational self-interested point of view and the ethically best strategy. Thus, subjects need not take into account the effects of their choices on others *as distinct* from their own calculated self-interest. They can make the calculations solely on a self-interested basis without conflict with other-oriented values. That is, after all, the essence of incentive compatibility. Thus, the implementation of an incentive compatible device actually obviates the need for ethical reasoning. As Steve Turnbull commented: "They

> don't have to flex their ethical muscles". (Frohlich and Oppenheimer 2003: 290 emphasis in original)

By the same token, when individuals perceive external interventions as supportive, self-esteem is fostered and individuals acquire a stronger sense of self-determination. Socially desirable outcomes are thereby promoted.

To conclude, behavioral experiments produce relevant information for policy-making. But rather than designing institutions that align individual self-interest with the collective good, the behavioral experiments generate knowledge about the factors that affect the successful implementation of incentive compatible mechanisms and the factors that render salient extant and desirable norms of conduct. The characteristics of technological and behavioral experiments and their policy implications are now synthesized in table 1 below.

Table 1: The Technological and the Behavioral Experiments Compared

	Technological Experiments	**Behavioral Experiments**

Epistemic Goal	Institutional engineering: how to create economic incentive compatible mechanisms.	The role of social values: how individual perceptions and behavior are shaped by the wider social context.
Experimental Procedure	Institution: Manipulate the institutional rules and investigate the impact on social outcomes. Environment: Induce self-interested income-maximizing behavior; create simple decision-problems; and help subjects avoiding error.	Institution: Manipulate the institutional rules and investigate how it interacts with individual perceptions and behavior. Environment: Induce self-interested income-maximizing behavior while allowing for human agency.
Epistemic Factor	The institution: it produces stable regularities in human behavior and stable outcomes at the social level.	The experimental participants: they bring into the laboratory their psychological and social make-up that accounts for the observed phenomena.
Inference	Local: Inference to closely replicated systems. General: Inference to structurally similar situations.	General: Inference to structurally similar situations.
Policy Implications	Induce changes in human behavior via the design of monetary incentive mechanisms.	Identify the limits of incentive compatible mechanisms. Identify the contexts that elicit desirable norms of conduct.

The Individual Decision-Making Experiments

So far I have concentrated on two kinds of economic experiments: market experiments and game theory experiments. I left out individual decision-making experiments that do not involve interaction between experimental subjects. In these experiments subjects are asked to solve problems whose outcomes depend on their own decisions and the resulting states of the world after the decision is made. The goal is to study individuals' preferences and/or appraise individuals' decisions by reference to pre-defined (rationality) standards.

Even though the behavior of experimental subjects in these experiments is not so significantly affected by social institutions, these experiments fall into the behavioral kind of experiments insofar as they focus on the relation between the environment (*e*) and the messages individuals send (*m*). In particular, their goal is to study the individual and the social preferences of the subjects and how individuals solve particular decision-problems. This is how Loomes presented this research program by reference to its theoretical counterpart:

> Instead of continuing to try to devise some general theory of an essentially conventional (e.g. axiomatically based) form, perhaps we should switch our attention and our efforts to understanding more about the processes by which people select and apply rules/strategies for dealing with particular forms of decision problems. As part of *this* agenda, we would need to examine how robust such rules/strategies are, how they may evolve or be modified in response to feedback or experience, and in what ways the predictions (and, where relevant, the prescriptions) that follow from them may diverge from those derived from more conventional models. (Loomes 1998: 486 emphasis in original)

It should be clear by now that this study requires the design and implementation of behavioral experiments. A high level of agency on the part of the experimental subjects must be allowed in order to examine how individuals select and apply particular decisional rules to solve specific decision-problems. Still in Loomes own words:

> The challenge is not to refashion existing experiments to incorporate even tighter controls until they succeed in generating results consistent with conventional theory by reducing participants to barely more than 'zero intelligence traders'. Rather, the real challenge for the future is to device experiments which allow for the heterogeneity of human behaviour, and to develop techniques which give greater insights into the interactions between people's imprecise basic values and the environments in which they have to operate, tracing how they construct their responses and/or modify them in the light of experience. (Loomes 1999: F44)

Indeed, these experiments have identified a host of systematic errors in decision-making, the so-called anomalies (Thaler 1992), that show that human behavior departures in significant ways from the predictions of conventional economic theory. To give an example, experiments have

shown that people have a taste for immediate gratification being averse to delaying present consumption (Laibson 1997). This bias towards present-preferences accounts for a wide range of behavioral patterns such as insufficient saving, credit-card debt, procrastination at work and at home, premature dying from smoking, gambling, and other risky activities. And similarly to game theory experiments, the knowledge produced by individual decision-making experiments can and has been used to inform policy-making. It can guide the design of 'debiasing' policies that induce people to behave more in accordance with some desirable model of behavior or their true preferences, such as dealing with self-control problems.

6. Final Remarks

This paper presented two categories of experiments using as criterion the epistemic role of the 'materials' of economics – the institution and the experimental participants. This classification not only brought to the fore the content of knowledge generated by each kind of experiment, and its significance for policy-making, but it also put into a new light the trade-off between the control economists exercise over the experimental systems and the participants' 'potential for independent action'.

The potential for independent action is not equally relevant in technological and behavioral experiments. Technological experiments produce knowledge about market institutions. Their ultimate goal is to establish stable mappings of market institutions into their performances at the aggregate level. Specifically, technological experiments investigate whether the actions of self-interested and income-oriented individuals mediated by a particular market institution bring about the best outcome at the social level. In general, the market institution guides individuals to take up the course of action that best serves their interests (i.e. maximizes income) while curtailing opportunistic behavior. In this way the market rules are designed and tested to control human actions for specific purposes. The potential for independent action is therefore not very relevant here. In fact, a high level of control can be a sign of experimental success. It conveys the design of a market institution that generates stable results. The potential for independent action is, however, crucial in behavioral experiments. Only then do the experimental results convey information about the cognitive and the psychological make-ups of the individuals as well as their repertoires of values and social norms.

The taxonomy of economics experiments presented here clearly shows that self-interest and other-regarding considerations coexist in every context. However, the relevance of each set of motives depends on the particulars of the social interaction. Human action is sometimes predominantly guided by self-interest and other times by other-regarding motivations. Behavioral experiments identify the contexts in which other-regarding motivations are more

likely to guide human behavior. Technological experiments make patent that self-interested motivations and rational behavior is mainly observed in highly structured and constrained markets.

References

Bicchieri, Cristina (2006) *The Grammar of Society*, Cambridge: Cambridge University Press.

Bohnet, Iris and Frey, Bruno S. (1999) 'Social Distance and Other-Regarding Behavior in Dictator Games: Comment', *The American Economic Review*, 89: 335-9.

Camerer, F. Colin and Fehr, Ernst (2004) 'Measuring Social Norms and Preferences Using Experimental Games: A Guide for Social Scientists', in J. Henrich, R. Boyd, S. Bowles, C. Camerer, E. Fehr and H. Gintis (eds.) *Foundations of Human Sociality: Economic Experiments and Ethnographic Evidence from Fifteen Small-Scale Societies*. Oxford: Oxford University Press. pp. 55-95.

Camerer, F. Colin and Loewenstein, George (2004) 'Behavioral Economics: Past, Present, Future', in C. Camerer, G. Loewenstein and M. Rabin (eds.) *Advances in Behavioral Economics*, Princeton: Princeton University Press, pp. 3-51.

Camerer, Colin F. (2003) *Behavioral Game Theory: Experiments in Strategic Interaction*. Princeton: Princeton University Press.

Carpenter, Jeffrey P., Burks, Stephen and Verhoogen, Eric (2005) 'Comparing Students to Workers: The Effects of Social Framing on Behavior in Distribution Games', in J. P. Carpenter and G. W. Harrison and J. List (eds.), *Field Experiments in Economics*, Research in Experimental Economics, Vol. 10, Elsevier: JAI, pp. 261-89.

Davis, Douglas and Holt, Charles (1993) *Experimental Economics*. Princeton, NJ: Princeton University Press.

Falk, Armin, Fehr, Ernst and Fischbacher, Urs (2003) 'On the Nature of Fair Behavior', *Economic Inquiry,* 41: 20-6.

Fehr, Ernst and Schmidt, Klaus M. (1999) 'A Theory of Fairness, Competition, and Cooperation', *The Quarterly Journal of Economics*, 114: 817-68.

Fehr, Ernst and Gächter, Simon (2000) 'Fairness and Reputation: The Economics of Reciprocity', *Journal of Economic Perspectives*, 14: 159-81.

Fouraker, Lawrence E. and Siegel, Sidney (1963) *Bargaining Behavior*, New York: McGraw-Hill.

Frey, Bruno (1997) *Not Just For The Money – An Economic Theory of Personal Motivation*, Aldershot: Edward Elgar.

Frey, Bruno e Jegen, R. (2001) 'Motivation Crowding Theory', *Journal of Economic Surveys*, 15: 589-611.

Friedman, Daniel and Sunder, Shyam (1994). *Experimental Methods*. Cambridge: Cambridge University Press.

Friedman, Daniel and Cassar, Alessandra (2004) *Economics Lab*, London: Routledge.

Frohlich, Norman and Oppenheimer, Joe (2003) 'Optimal Policies and Socially Oriented Behavior: Some Problematic Effects of an Incentive Compatible Device', *Public Choice*, 117: 273-93.

Gintis, Herbert, Bowles, Samuel, Boyd, Richard and Fehr, Ernst (2005) 'Moral Sentiments and Material Interests: Origins, Evidence, and Consequences', in H. Gintis, S. Bowles, R. Boyd and E. Fehr (eds.), *Moral Sentiments and Material Interests*, Cambridge, Mas.: The MIT Press.

Gneezy, U. and Rustichini, A. (2000) 'Pay enough or don't pay at all', *Quarterly Journal of Economics*, 115: 791-810.

Guala, Francesco (2001) 'Building Economic Machines: The FCC Auctions', *Studies in History and Philosophy of Science*, 32: 453-77.

Guala, Francesco (2005) *The Methodology of Experimental Economics*, New York: Cambridge University Press.

Güth, Werner, Schmittberger, Rolf and Schwarz, Bernd (1982) 'An Experimental Analysis of Ultimatum Bargaining', *Journal of Economic Behavior and Organization*, 3: 367-88.
Hacking, Ian (1983) *Representing and Intervening*, Cambridge: Cambridge University Press.

Harrison, Glenn W. (1994) 'Expected Utility Theory and the Experimentalists', *Empirical Economics*, 19: 223-53.

Henrich, Joseph, Boyd, Robert, Bowles, Samuel, Camerer, Colin, Fehr, Ernst, Gintis, Herbert and McElreath, Richard (2001) 'In Search of Homo Economicus: Behavioral Experiments in 15 Small-Scale Societies', *American Economic Review*, 91: 73-8.

Henrich, Joseph, Boyd, Robert, Bowles, Samuel, Camerer, Colin, Fehr, Ernst and Gintis, Herbert (eds.) (2004) *Foundations of Human Sociality: Economic Experiments and Ethnographic Evidence from Fifteen Small-Scale Societies*, Oxford: Oxford University Press.

Hertwig, Ralph and Ortmann, Andreas (2001) 'Experimental Practices in Economics: a Methodological Challenge for Psychologists?', *Behavioral and Brain Sciences*, 24: 383-451.

Hey, John D. (1991) *Experiments in Economics*, Oxford: Basil Blackwell.

Hoffman, Elizabeth, McCabe, Kevin and Smith, Vernon L. (1996) 'On Expectations and Monetary Stakes in Ultimatum Games', *International Journal of Game Theory*, 25: 289-301.

Hoffman, Elizabeth, McCabe, Kevin, Shachat, Keith and Smith, Vernon L. (1994) 'Preferences, Property Rights and Anonymity in Bargaining Games', *Games and Economic Behavior*, 7: 346-80.

Holt, Charles A. (1995) 'Industrial Organization: A Survey of Laboratory Research', in J. H. Kagel and A. E. Roth (eds.), *The Handbook of Experimental Economics*, Princeton: Princeton University Press, pp 349-443.

Hurwicz, Leonid (1960) 'Optimality and Informational Efficiency in Resource Allocation Processes', in K. Arrow et al. (eds.), *Mathematical Methods in The Social Sciences*, Stanford: Stanford University, pp. 27-46.

Kagel, John H. and Roth, Alvin E. (eds.) (1995) *The Handbook of Experimental Economics*, Princeton: Princeton University Press.

Kagel, John H. and Levin, Dan (1986) 'The Winner's Curse and Public Information in Common Value Auctions', *American Economic Review*, 76: 894-920.

Laibson, D. (1997) 'Golden Eggs and Hyperbolic Discounting', *Quarterly Journal of Economics*, 112: 443-77.

Leonard, Robert. J. (1994) 'Laboratory Strife: Higgling as Experimental Science in Economics and Social Psychology', in N. B. De Marchi and M. S. Morgan (eds.) *Higgling*. History of Political Economy Supplement, Vol. 26. Durham: Duke University Press, pp. 343-69.

Loomes, Graham (1991) 'Experimental Methods in Economics', In D. Greenaway, M. Bleaney and I. Stewart (eds.), *Companion to Contemporary Economic Thought*, London: Routledge, pp. 593-613.

Loomes, Graham (1998) 'Probabilities vs Money: A Test of Some Fundamental Assumptions about Rational Decision Making', *The Economic Journal*, 108: 477-89.

Loomes, Graham (1999) 'Some Lessons from Past Experiments and Some Challenges for the Future', *The Economic Journal*, 109: F35-45.

Morgan, Mary (2003) 'Experiments without Material Intervention: Model Experiments, Virtual experiments and Virtually Experiments', In H. Radder (ed.), *The Philosophy of Scientific Experimentation*. Pittsburgh: University of Pittsburgh Press. pp. 216-35.

Morgan, Mary (2005) 'Experiments versus Models: New Phenomena, Inference and Surprise', *Journal of Economic Methodology,* 12: 317-29.

Nik-Khah, Edward (2006) "A Tale of Two Auctions", paper presented at the INEM Conference, Iowa, 23 June.

Plott, Charles R. (1997) 'Laboratory Experimental Testbeds: Application to the PCS Auction', *Journal of Economics and Management Strategy*, 6: 605-38.

Roth, Alvin E., Prasnikar, Vesna, Okuno-Fujiwara, Masahiro and Zamir, Shmuel (1991) 'Bargaining and Market Behavior in Jerusalem, Ljubljana, Pittsburgh, and Tokyo: An Experimental Study', *American Economic Review*, 81: 1068-95.
Slonim, Robert and Roth, Alvin E. (1998) 'Financial Incentives and Learning in Ultimatum and Market Games: An Experiment in the Slovak Republic', *Econometrica*, 66: 569-96.

Smith, Vernon L. (1982) 'Microeconomic Systems as an Experimental Science', *American Economic Review,* 72: 923-55.

Starmer, Chris (1999) 'Experiments in Economics: Should we Trust the Dismal Scientists in White Coats?', *Journal of Economic Methodology*, 6: 1-30.

Thaler, Richard H. (1992) *The Winner's Curse: Paradoxes and Anomalies of Economic Life*. Princeton: Princeton University Press.