Journal of Economics and Behavioral Studies
Vol. 4, No. 2, pp. 75-86, Feb 2012 (ISSN: 2220-6140)

Experiments in International Economics

*Baboo M Nowbutsing, Sonalisingh Ramsohok
University of Mauritius, Mauritius
*b.nowbutsing@uom.ac.mu

Abstract: For many decades, economists have lamented the constraints on performing experiments in economics. However, with the birth of experimental economics this perception has changed. This field has developed considerably over the years. Now results from experiments are taken seriously. The experimental literature evolved in three directions: market experiments, game experiments and individual-decision making experiments. Over the years however, experimental methodology has been applied to more complex environments investigating macroeconomic issues and international economics. This paper provides a review of the experimental economics, its ingredients, its promises and skepticism. Further, we provide a review of the experiments that has been carried out in international economics.

Key Words: *Experiments Economics, International Trade and International Finance*

1. Introduction

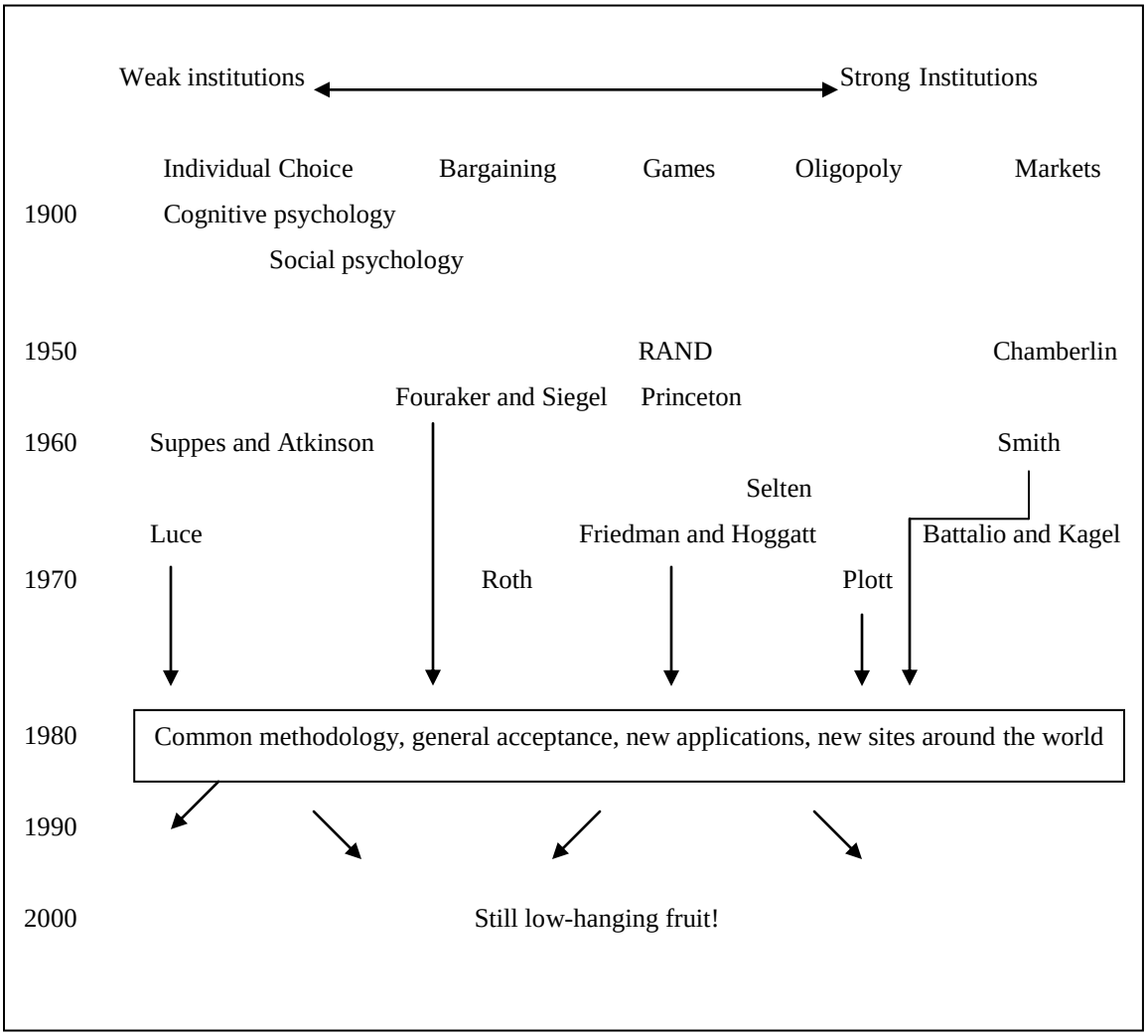
Many economists have lamented the constraints on performing experiments in economics. For example, this is true of all editions of Paul Samuelson's Principles of Economics. This continued after a while when William Nordhaus joined Samuelson as co-author. They wrote, "*One possible way of figuring out economic laws…is by controlled experiments…Economists…cannot perform the controlled experiments of chemists and biologists because they cannot easily control other important factors. Like astronomers or meteorologists, they must be content largely to observe*" (Samuelson and Nordhaus, 1985). Robinson (1979) expresses similar sentiments: "*Economist cannot make use of controlled experiments to settle their differences*". However, these perceptions have changed over time. For example, Samuelson and Nordhaus (1988) in the next edition of their book changed their perceptions about experiments. They acknowledged the increasing use of experiments in economics (although they claimed that experiments in economics are more difficult that in other science). Samuelson and Nordhaus went further to say that there have been four techniques that have formed the approach by which economics science has progressed and experimentation is the latest one (the other three are observation, analysis and statistics). The change in view about experiments in Economics occurs in the mid 20th century after the development of microeconomics theories in the 1960s including game theory, industrial organization, search theory, voting theory and so on. These theories offer competing ways to understand microeconomic data, which in turn has helped the development of experimental economics. In its simplest form, laboratory experiments usually involve a group of subjects (typically university students), who play simple economic decision-making games and are paid based on the decisions they make.

The game subjects play and the monetary rewards they can earn in the experiment are constructed in a manner that approximates the theoretical environment being studied so that the data can reflect on the validity of the theory. To date, primarily micro economists and game theorists to test individual or strategic behavior in various economic environments have used experimental methodology. In fact, the literature evolved in three directions: *market experiments*, *game experiments* and *individual-decision making experiments*. Over the years however, experimental methodology has been applied to more complex environments investigating macroeconomic issues and international trade. After 50 years and despite a lot of reluctance during its development, a growing numbers of economist have accepted experimental economics. Today, the prior belief that economics is not an experimental science is less and less widespread. The growing enthusiasm for laboratory experiments is characterized by an increase in experiments published in various mainstream economics journals, the introduction of the first academic journal relating to experimental economics called *Experimental Economics* in 1998 and recently a Nobel Price for one of its pioneers, Vernon Smith in 2002. This study provides the reader with an overview of what experiments in economics are about.

When it comes to empirical work in economics, we should note the deficiencies with field data. For example when it comes to international trade, a direct test of the law of comparative advantages is simple not possible because we rarely observed autarkic situation in the real world. Similarly, to test for theories on exchange rate, one need to unambiguously measure the price level of the economy and in the field data price indices may not be uniformly accurate measures of the short-term buying power of a good. The structure of the paper is as follows: section 2 provides a brief history of experimental economics, section 3 illustrates the ingredients of an experiment, section 4 provides the promises and skepticism about experimental economics, section 5 reviews the literature on experiments in international economics.

A Brief History of Experimental Economics: Figure 1 adapted from Friedman and Cassar (2004) shows the evolution of experimental economics. Chamberlin (1948) presented the first market experiment to show that competitive equilibrium does not explain everything. Together with Plott, the first economics lab was created at Purdue University. This marked the beginning of experiments in economics. The 1952-RAND conference volume "*The Design of Experiments in Decision Processes*" in Santa Monica produced five papers, which involve game theory and individual decision choice tasks. Based on the success of the RAND conference, Selten commenced a long-term experimental program in oligopoly theory. At the same time, Siegel and Fouraker (1960) presented experiments in bargaining and group decision-making. These few developments summarise the emergence of experimental economics in the 1960s.

Figure 1: Evolution of Experimental Economics *(adapted from Friedman and Cassar (2004))*



The 1970s was characterized by a development of computerization in experiments and an increase in the number of economists conducting experiments. More laboratories were constructed for example at Caltech, Arizona and Indiana and so on. As shown in Figure 1, experiments were conducted on different issues ranging from individual choice to market experiments. The 1980s experienced the emergence of experiments to other applications such as asymmetric information, auctions, and financial markets and so on. The 1980s also saw the launch of the *Economic Science Association* (ESA) in 1986 with the aim of creating a platform for discussion and collaboration among experimentalists in Europe and US. In the 1990s, the first issue of the journal on experimental economics, *Experimental Economics,* was launched which consolidate the emergence of experimental economics. In 1997, the Economic Science Association became fully international with subsequent annual meetings alternating between Europe and North America. What about 2000s? In many other fields of economics, it is hard for researchers to find a research topic, which has not been touched on. Even if he is able to do so easily, it will take him years to produce meaningful research. Experimental economics, on the other hand is still to be explored. Friedman and Cassar (2004) argue that there is still low-hanging fruit to attract young researchers. The fruit, which I want to pick, is experiments in international trade. In 2002, the founding president of ESA, Vernon Smith won the Nobel Price in Economics for his pioneering work in experimental economics. He shared the price with Danny Kahneman, a psychologist who has done important experimental research on decision theory.

Ingredients of an Experiment: According to Wilde (1980), the basic idea of a laboratory experiment is to create a small-scale microeconomic environment in the laboratory where adequate control can be maintained and accurate measurement of relevant behavior guaranteed. Smith (1982, 1989) who argued that a laboratory experiment could be thought as investigating the behavior of a microeconomic system picked up the idea of Wilde. According to Smith, a laboratory experiment consists of two components: environment and institutions The environment consists of a list of agents participating in the experiments {*1,…N*), each agent has preferences (u^i for agent i), their initial endowments (W^i), the number of commodities in the economy {*1,…K*} and the production technology (T^i).Thus, agent i is defined by a triplet of characteristics $E^i = (U^i, T^i, W^i)$ defined in the K-dimensional commodity space. A microeconomic environment is then defined by the collection $E = (E^1, EN)$ of these characteristics. The institution defines the language of communications in the economy, the rules that govern the exchange of information and the rules under which messages become binding contract. The language of communication is defined by $M = \{M^i…M^N\}$ consisting of message element $m = (m^i…m^N)$ where M^i is the set of messages that can be sent by agent i (i =1). An institution also states a set of allocation rules $h = (h^i(m), …h^N(m))$ and a set of cost imputation rules $c = (c^i(m), …c^N(m))$ where $h^i(m)$ is the commodity allocation to agents i and $c^i(m)$ is the payment made by i, each a function of the messages sent to all agents. Finally, the institution defines a set of adjustment process rules, common to all agents, $g\ (t_o, t, T)$ consisting of a starting rule $g\ (t_o…)$, a transition rule $g\ (..., t...)$ and a closing rule $g\ (…T)$. Each agent's property rights in communication is then defined by the collection $I^i = (Mi, h^i\ (m), c^i(m), g\ (t_o, t, T))$. A microeconomic institution is described by the collection of these individual property right characteristics $I = (I^i…I^N)$.

A microeconomic system is then described as an association of an environment and an institution, $S = (E, I)$. This system is activated by the behavioral choices of agents in the set M. Smith (1982) showed that in a static description of an economy, agents' behavior could be defined as a function $m^i = \beta^i\ (E^i/I)$ carrying the characteristics E^i of agent i into a message m^i, conditional upon the property right specifications of the operant institutions I. If E^i includes all the exchange relevant agent features, then $\beta = \beta^i$ for all i. Given the message sending behavior of each agent, $\beta\ (E/I)$, the institution determines the outcome $h^i(m) = h^i(\beta\ (E^i/I), …\beta\ (E^N/I))$ and $c^i(m) = c^i(\beta\ (E^i/I), …\beta\ (E^N/I))$. With this framework, it is possible to understand the roles of theory and experiment and their relationship, in a progressive research program. However note that not all elements of the microeconomic system are observed, for example, preferences are not observed but induced (Cobb-Douglas, CES or additively separable). The choice of institutions depends on the aim of the experiment and one of the research areas which have been explored over years tried to answer this question: Which trading institution yield the most nearly Pareto optimal outcome? Thus, the purpose of a laboratory experiment then can be thought of revealing the systematic relationship between the environment, the institutions and the resulting behavior. With control in place, the experimental data obtained from this interaction can be interpreted more easily than field data. If outcome X (say, competitive equilibrium) is always associated with Y (double auction), then we can conclude that Y causes X (unless there are other common factors in the lab

too). This causal relationship can is hard to find in field data. Given an absence of control an observed correlation between *X* and *Y* may be due to *Y* indirectly causing *Y*, or may be due to some unobserved variable causing both *X* and *Y*. Thus, field data gives a composite test of the environment and institutions.

2. Promises and Skeptisms

One of the arguments against laboratory experiment in economics is concerned with the control of factors (considered one of the advantages of experiments). Skeptics argued that control disregard reality and this lack of reality strips experimental work of its relevance. Accordingly, experimental results can be viewed as spurious. Most enthusiasts in laboratory experiments recognize this and have written much about it. These work include Smith (1976, 1982), Wilde (1980), Plott (1991b) and Starmer (1999). Smith and Wilde have argued that under certain precepts or assumptions, laboratory micro economies can be regarded as real economies systems; their behavior can be thought as real economic behavior and can be used to test theories. Although these precepts are not self-evident truths or sufficient conditions for a valid experiment, if these precepts hold it follows that the environment has desirable characteristics. These are:

- *Nonsatiation*. Subjects must prefer more reward medium to less, and not become satiated.
- *Saliency*. The rewards received by the subjects depend on her actions as defined by the institutional settings that she understands. Saliency requires that rewards earned by subjects be tied to their decisions.

These two precepts are related to the reward structure of an experiment. However, there is a need to control for motivational factors. Wilde (1980) identified two problems that can arise although no satiation and saliency are satisfied. First, subjects may place subjective valuations on their participation over and above the payoff they received. Second, subjects may also place subjective valuations on the rewards earned by other participants. To alleviate, two more precepts are introduced.

- *Dominance*. Changes in subjects' utility from the experiment come predominantly from the reward medium and other influences are negligible.
- *Privacy*. Subjects are informed only on her own payoffs.

Both Wilde and Smith argued that if these precepts are satisfied then the laboratory experiment could be considered as a small microeconomic environment where real people make real decisions. Although laboratory experimentation can be considered as real, one may question its validity. Validity is a crucial issue of all data sources. Laboratory data pose two types of validity questions. First, internal validity: Do the data bridge the gap between models and experiments? Second, external validity: Can the inferences obtained help to understand and predict the behavior of the real world? An understanding of the role of experiments in relation to both theory and experiments is required before further discussion about internal and external. From a formal point of view, a theory consists of a set of assumptions and definitions, together with the conclusion that logically follows from them. Skeptics may argue that laboratory experimentation is unnecessary because a theory is correct, as it is internally consistent. However, more is required from a theory than there are no errors in the underlying mathematics. In this sense, internal consistency is just a first step.

The assumptions of economics theories can be divided into two: *behavioral and structural*. In game-theoretic terms, structural assumptions determine the extensive form, and the behavioral assumptions pertain to the equilibrium concept. Experimentalists are not usually interested in inducing or imposing restrictions on key behavioral assumptions, for example, a belief that one's purchases have no effect on market price. However, by controlling agent's information and incentives, the laboratory environment can reflect quite closely the structural assumptions of a specific theory. This allows the experimentalist to evaluate the behavioral assumptions of a theory. Further, laboratory experimentation can be used to check the sensitivity of unrealistic structural assumptions. The task of establishing internal validity of an experimental result depends a lot on context-specific knowledge and techniques. Certainly there are no reasons for a laboratory experiment to model all the assumptions of a specific theory. One potential flaw of this process is that if all the assumptions are satisfied, given laboratory modeling is often assisted or even inspired by mathematics, then

there is a greater chance that the theory will survive the laboratory research. An additional flaw as pointed out by Plott (1991b) is that satisfying all the assumptions of a theory is practically impossible as assumptions in economies theories are rarely stated in operational terms and the theories are so unclear. Smith argues that experimentalist is interested in staging theory, which can be done in natural world as well as in simple situations. By staging theories in a simple laboratory environment, it permits the experimenter to have a better control over variables. So the experiment should be at least "as *rich* as the theories they test" (Smith, 1980). Smith (1982) wrote that if the variables are not parameters of the theory, then the criticism of "unrealism" applies equally to the theory and the experiment.

There are many opinions about the applicability of experimental methodology to real world phenomena and policy decisions. According to Nelson (1998**)** and Loewenstein (1999), experimentalists are often accused of producing results that are not transferable outside the economics laboratory: the problem of external validity or parallelism. According to Guala (2003), external validity is the most important methodological problem of experimental economics as well as the least discussed despite the fact that criticised against experimental economics stems precisely from the suspicion that their results cannot be 'exported' outside the laboratory. Smith (1982) proposed a precept that can be viewed as a sufficient condition for the transferability of experimental results to the real world, which he named *parallelism: "Proposition about the behavior of individuals and performances of institutions that have been tested in laboratory microeconomics apply also to non laboratory microeconomics where similar ceteris paribus conditions hold".* According to parallelism, it should be alleged that experimental results carry over to the world outside the laboratory. Smith considers that his proposition is equivalent to that quotation of Shapley (1964): "*As far as we can tell, the same physical law prevails everywhere"*. However, the advantage of control over the environment and the institution allows the experimentalist to modify the experiment to resemble the real world in many relevant aspects as possible.

Plott (1982) dealt with the general concerns of external validity by arguing that while laboratory processes are simple in comparison to naturally occurring processes, they are real processes in the sense that real people participate for real and follow real rules to make substantial profits. Further, he argued that the simplicity and the small-scale of laboratory environment relative to field environments are merits. General theories, by definition, apply to all special cases. Thus, general theories and models should be expected to work in the special case of laboratory market. If models are not to capture what is observed in this special case, they can be modified or rejected in the light of experience. This establishes the relevance of experimental methods. Using different examples, Plott (1987) identified five dimensions or forms of parallelism between policy problems and laboratory experiments. These are (1) ex-post evaluation of a decision (2) demonstration of theory (3) shifts in the burden of proof (4) direct extrapolation and (5) design of new types of organization. He concluded that: *Experimentation is a source of experience similar to the experience one acquires as one practices the piano before a concert of that a team acquires as it practices before a game. The connections between such experiences and final performance can have many dimensions. The kinds of useful practice undertaken in preparation for a football game can range from ballet to scrimmage. The scrimmage itself can involve plays that the coach thinks the opponent will use as well as plays that the coach is sure will not be used but are educational. Similarly, experiments that provide the best insights about the nature of upcoming options might include faithful reproductions of the anticipated situation, but there is no reasons to believe that good experiments take that form In fact, there is no priori reason to believe that faithful reproductions would be any use at all.*

Marc (2004) branded the Plott-Smith the empirical realism point of view. This standard justification of experimental economics sees theories as universal and so assumes implicitly that the laboratory- even with the absence of realism- must be a place where it is possible to test them. Surely, the evaluation process of laboratory experimentation should ideally begin not in the domain of the complex natural world, where numerous disconcerting events may impinge on variables of interest, but strictly on the domain of the theory. This localist realist approach of Cartwright (1983, 1989 and 1999) sees theories valid in its domain of application. Therefore, if the pertinent features of the theory's domain can be introduced in the laboratory settings then this give an important role of experiments in economics without considerations of external validity. *Replication* is another advantage that makes laboratory experimentation interesting. Replication includes three components: observation, interpretation and conclusion that must be satisfied one after the

other. Certainly, those economists who rely on field data will observe the same thing since they use the same data. One can say that he has replicated an experiment if he fails to reject the hypothesis that the experimental data come from the same population as the replicated experiment. This implies that the experimenter, his/her subjects and/or the procedures are not important treatment variables. The interpretation of observation requires theory or at least empirical interpretation of the theory in the context that generated the data. Either empirical interpretation of theory is important because the theory is not developed directly in terms of what is observed or the data are not collected for theory testing. Consequently, failure to replicate may be because there are differences in interpretation, which in turn result in different meaning being ascribed to the theory. The conclusion reached in two different research studies may be different even though the data and interpretation are the same. In economics, this is most often due to different model specifications. This problem is inherent in non-experimental methodologies, in which, at best one can usually estimate only the parameter of a prescribed model and cannot credibly test one model against another.

Starmer (1999) discussed two points that have put forward by sceptics about using human subjects in laboratory experimentation. The first results from the fact that human subjects are self-conscious behaving agents. Thus, behavior of human subjects is more variable than that of physical objects and may be sensitive to situation they faced; hence, the behavior observed in the laboratory may different from that in a natural setting. Starmer argued that such observations are weak as even sceptics about laboratory experimentation agreed that one purpose of building economic theories is to predict the actual behavior of economic agents. A skeptic might agree that human subjects' behavior appears to be sensitive to various features of the experimental design, but might interpret this as a sign that the results are largely the artifact of the environment in which they were produced. Thus, human behavior may be vulnerable to all kinds of biases from extraneous sources and from the way the experiment is set up and the way the decision problems are framed. As pointed out by Starmer, these observations do not undermine the use of laboratory experimentation rather it has implications for the appropriate design of experiments. He argued that subjects' pools could be divided into two groups: a control group and an experimental group.

To contribute to this discussion, we can say that these doubts can result in advantages of laboratory experimentation. In the laboratory, we can observe how human agents are able to operate under specific conditions. Economic theories rarely answer questions of how human agents process information, how they choose strategies, how they learn and observe and how they adapt to changing situations. Surely, answers to these questions are important to many core areas of economics (for example, monetary theory, industrial organization, international trade etc.). Through direct observation of human behavior, derived in well-defined economic environment, experimentalists seek to evaluate the capacity of competing theories to organize that data, and they provide data that can lead to the discovery of new phenomena. Moreover, unlike field observation, laboratory work usually allows the demonstration that the phenomenon in question is real and is robust to background factors.

3. Experiments in International Economics

When it comes to international trade, a direct test of the law of comparative advantages is not possible because autarky is never observed in the real world. To test for theories on exchange rate, one need to unambiguously measure the price level of the economy and in the field data price indices may not be uniformly accurate measures of the short-term buying power of a good. The experimentalist supplies consistent inflation data that have a known generating process. An international trade experiment involves many markets operating at the same time; it also involves production and consumption. Thus, it is more complex than individual- decision based experiment. However, there has been a development of well-defined institutions that can sustain more complex environments in the laboratory (for example MUDA). In addition, if the experiment is complex, pilot experiments can be run. In a pilot, volunteers work through the experiment in a dry run setting and provide feedback regarding the clarity of the instructions, the logic of the procedures and so forth. Arifovic (1996) analysed the behaviour of exchange rates in a laboratory setting and as a genetic algorithm. She used a fundamentally *non-stationary* environment since the subjects did not know when the experiment ends. However, her model states that the *stationary* nominal and real exchange rate is indeterminate. The subjects were trading one homogeneous good for two different currencies. The results of

the experiments showed continuing fluctuations of the exchange rate. At the heart of the model is the overlapping generation's framework that the author implemented. Subjects were assumed young in time t and old in time t+1. They were reborn such that they are young in odd numbered periods and old in even numbered periods.

In the Noussair, Plott and Reizman (1997) experiment, subjects are classified as either producers or consumers. There are six agents in each country: country A and country B with equal number of producers and consumers. There were two goods markets; *X*, Y, and one foreign exchange market (that of country A inside country B). Thus residents of country A wanting to buy goods from country B has to go to Country B and sell some currency in which he is endowed against currency B. Thus, suppliers in country A could not earn foreign currencies; they could only sell goods against their local currency. The functioning of the goods markets in these experiments were problematic as imports were allowed but exports were not (no agent could transform inventories held at home to the inventory of the same commodity held in the foreign country). These frictions created adverse conditions in the goods markets as pointed out by the author. The author did not found the presence of purchasing power parity although the predicted value for the exchange rate was accurate. Since the law of one price was violated in the market with the greatest friction, a simple notion of purchasing power parity was generally rejected. Furthermore, the predictions of the competitive model in an economy with two locations did not hold uniformly. Fisher and Kelly (2000) analysed experimental markets where subjects buy and sell two assets. They designed experiments where the market was not stationary. Compared to the other works, they add one basic element in their design: simultaneous trading in the two assets. This was added to capture the possibility of cross-asset arbitrage, which is present in foreign exchange markets. In fact, one of the main conclusions of this study is that subjects get the cross exchange rate right (the exchange rate was well behaved). The results however showed that there is overwhelming evidence of the existence of bubbles in each individual asset. Because the bubbles in the two asset markets were almost perfectly correlated, simple aspects of exchange rate theory did well enough even in that non-stationary setting. Fisher and Kelly also observed the existence of an exchange rate risk premium.

Noussair et al (1997) can consider the paper by Fisher (2001) as an improvement of the earlier paper partly because the goods markets are very simple. Good *x* are available in elastic supply at constant *x*-currency price in every period and good *y* are available in elastic supply at a *y*-currency price that is announced at the beginning of each period. In essence, the experimenter creates the supply side of the goods markets. The foreign market is also more transparent. Every subject is endowed with a supply of *x*-currency, more than sufficient for the liquidity needs of the entire session. However, in each round, there is a fixed supply of *y*-currency sold in a call market. Thus, the experimenter creates the supply side of the foreign exchange market. Subjects were allowed to buy as much of the *x*-good as they wanted at a fixed price. Similarly, they were allowed to buy as much of the *y*-good as they want. The only limit on their purchases of the y-good had to do with how much foreign exchange they had managed to purchase. The main conclusion of the paper is strong evidence of the relative version of purchasing power parity. Three other results were reported: purchasing power parity holds in absolute terms, strong support were found for covered interest parity and uncovered interest parity holds in these experiments. One can argue that these results may be dependent on the introduction of the call market where there is a fixed supply of foreign exchange. Modelling the foreign exchange market in this way enables only one market-clearing mechanism.

Noussair et al (1995) tried to answer questions related to the law of comparative advantage, factor price equalisation, terms of trade, efficiency in production and exchange as guided by multiple and interacting markets and the effects of tariffs on international transactions. Experiments comprise either eight or sixteen subjects. Two environments were invoked: the Ricardian model of international trade motivated Environment 1 and Environment 2 was very near to the Hecskcher-Ohlin model. Two models were identified that were supposed to provide intuition needed for help with the interpretation of market data. Those were the competitive model and the autarkic model. Among the main results of this study, we have the following: rejection of both the competitive model and the autarkic model as a representation of the market data, the presence of the law of comparative advantage, the convergence of production and consumption to the competitive model predictions, the presence of the factor price equalisation theorem and last but not the least existence of tariff reduces international trade and market efficiency.

Since the breakdown of the Bretton Woods system of fixed exchange rates in the early 1970s, exchange rates tended to fluctuate widely. A large theoretical literature exists illustrating the impact of exchange rate movements on the firm's export and import decisions. The basic assumptions underlying these models are that a firm must incur an entry cost to enter export markets and that this entry cost is sunk. In a simple world in which exchange rate changes are perceived to be permanent (and future exchange rate uncertainty zero), the firm will enter the export market when the expected gross profits from participating in that market are greater than the sunk cost entry. The firm however will not exit the market until the exchange rate reaches the point where the expected gross profits from remaining in the market are negative. This implies that temporary exchange rate misalignments have a persistent effect on trade, *trade hysteresis*. Ansic and Pugh (1999) provide an experimental investigation of trade hysteresis taking the model as representative of the literature on trade hysteresis.

Ansic and Pugh (1999) test the corresponding hypothesis that firms trading policy is unresponsive to exchange movements over a wide range of values and that this band is positively related to the magnitude of both concrete sunk costs and exchange rate variability. The experiment consisted of 100 students trading on a computerized market. There were 5 trading sessions each lasting 8 minutes. The exchange rates according to which subjects entered or exited the market were actually daily US dollar: ECU rates from Jan 7th 1980 to Jan 15th 1993. At the start of the experiment, subjects were informed of the cost of entering the market. They found that sunk costs are an important determinant of trade activity. When international trade is guided by exchange rate uncertainty and sunk cost, sunk cost of entry predisposes firms to wait and see. The experimental evidence of Ansic and Pugh (1999) showed that sunk costs are an important determinant of trade hysteresis when exchange rate variability is present. However, the experimental analysis does not show a positive relation between the degree of exchange rate variability and trade hysteresis. Engelman and Normann (2003) analysed the model of strategic trade policy proposed by Brander and Spencer (1985). They created a Cournot duopoly framework, matching the requirements of the Brander and Spencer (1985) theory. There are two countries consisting of a firm and a government. The firms export a homogenous good to a third country. Governments simultaneously decide whether to subsidize their firm. After the decisions of the governments are known, the firms play a Cournot duopoly game. The main question in this experiment is whether governments actually subsidize their firms. In the first stage, Government decides on the level of subsidy *s*, which can be either 0 or 12 (equilibrium rate) with the aim to maximize welfare. In the second stage, firms choose their level of production based on the choice of *s* by the government. They found that the data are not consistent with the predictions of the Brander and Spencer (1985) strategic trade policy model. Government tended to subsidies in too few cases (roughly 50% of the cases) to give conclusive evidence in favor of the theory. In addition, there were no indications of a learning trend towards the equilibrium. As more periods of the games are played, the number of subsidy decisions decreases, again suggesting a departure from the predictions. On the other hand, industry output tended to match the predictions.

Noussair et al (2003) created a large experimental environment to represent 3 countries trading in a perfectly competitive world, which they argued is the most complex to date to study market calibration. They were interested firstly, in whether equilibration is observed and secondly in whether there any other principles that emerge to govern system behaviour. The complexity introduced in the laboratory took the form of the number of goods (3 outputs: *x*, *y* and *z* and 2 inputs *k* and *l*), and to introduction of a separate currency for each country, the nature of economic activities and their interdependence. The laboratory economy is international in its economic "structure". The economy consists of 3 types of agents: *suppliers* who were given endowments of *l* and *k*, which they can supply, to the input markets; *producers* who were endowed with production capability and could produce one of the three outputs using the inputs; *consumers* who could purchase *x*, *y* and *z* from producers. Producers could sell *x*, *y* and *z* in any country whereas inputs were immobile. Each country had its own currency *A, B* and *C* that have their own market. Only domestic currency had value to agents. Thus, foreign currencies were only useful when importations of goods are conducted. In addition to interaction in the local country, international transactions were guided by a cash-in hand constraint, i.e. before agents can purchase goods internationally they need to buy currency of the particular country.

To maximise gains from trade, the following pattern of activity must occur. Suppliers sell input *l* and *k* to producers in their own country. The latter use *l* and *k* to produce *x*, *y* and *z* which are sold to consumers

irrespective of their location. To buy a good from a foreign producer, consumers need to buy the currency of the country from which he wishes to import. Each country has 7 markets in operation. Noussair *et al* (2003) found that even in this complex environment, the equilibration[1] hypothesis holds. Other interesting property of the experimental data reveals (1) the existence of a home bias property- the level of imports and production of export goods are lower than the predictions of the competitive model (2) the existence of growing GDP across time (period) (3) the gravity model property- GDP growth causes an increase in international trade (4) Purchasing Power Parity convergence.

Noussair *et al* (2007) created a large experimental environment to represent 3 countries trading in a perfectly competitive world, which they argued is the most complex to date to study market calibration. They were interested firstly, in whether equilibration is observed and secondly whether there are other principles that emerge to govern system behaviour. The complexity introduced in the laboratory took the following form: number of goods, currency for each country and nature of economic activities. The laboratory economy is international in its economic "structure". The economy consists of 3 types of agents: *suppliers* who were given endowments of *l* and *k*, which they can supply, to the input markets; *producers* who were endowed with production capability and could produce one of the three outputs using the inputs; *consumers* who could purchase *x*, *y* and *z* from producers. Producers could sell *x*, *y* and *z* in any country whereas inputs were immobile. Each country had its own currency *A, B* and *C* that have their own market. Only domestic currency had value to agents. Thus, foreign currencies are only useful when importations of goods are conducted. In addition to interaction in the local country, international transactions were guided by a cash-in hand constraint, i.e. before agents can purchase goods internationally they need to buy currency of the particular country. Noussair et al (2007) found that even in this complex environment, the equilibration[2] hypothesis holds. Other interesting property of the experimental data reveals (1) the existence of a home bias property- the level of imports and production of export goods are lower than the predictions of the competitive model (2) the existence of growing GDP across time (period) (3) the gravity model property- GDP growth causes an increase in international trade (4) Purchasing Power Parity convergence.

Noussair and Powell (2008) constructed experimental markets to observe behaviour of assets markets that experience a peak or trough in fundamentals. They focused on how well the market tracks the fundamental value, how well it reflects trends in the fundamentals and how well it reveals the timing of a change in trend. They also consider how these measures of pricing accuracy evolve as traders gain more experience through repetition of markets. The results are not obvious a priori in light of the string tendency of experimental asset markets to generate bubbles and crashes when traders are experienced, a result that nonetheless has only been established for assets with fundamental values that are monotonically decreasing of constant over time. Jones (1961) argued that in a 3 countries and 3 goods model and assuming that each country is assigned to produce one good, then for the law of comparative advantage the optimal assignment in the 3 x 3 case must be such that

$$\prod_{i=1}^{3} a_{Li}^{i} < \prod_{i=1}^{3} a_{Lj}^{i} \text{ for } j \neq i \text{ and all } j \text{ is different from each other}$$

Literally, this implies that the product of labor requirements in the efficient assignment of goods to countries must be less than the corresponding product in all possible assignments that allocate the same number of countries to each commodity as does the efficient assignment. Nowbutsing (2011) created an experimental environment, which mimic the 3 x 3 Ricardian Model. There are three goods *X*, *Y* ad *Z* and one factor of production labor, *L*, which is mobile across sectors in a particular country but immobile across countries. Subjects were divided into two types of agents namely consumers and producers. There was equal number of agents in all countries. Consumers own factors of production and have induced preferences over the three consumption goods. The utility function were additively and separable over the three goods. Producers have initial endowments of input, and earn profits buying *L* and selling *X*, *Y* and *Z*. Countries differ in their

[1] Both stabilisation and convergence were present.
[2] Both stabilisation and convergence were present.

production function such that one country was characterized as 'extreme' comparative advantage and the other two as 'intermediate' comparative advantage.

The market system works as follows: consumers sell their endowment of *L* to producers of their own, and then buy production goods from any of the three countries. Consumers get utility from consumption and any profit made by price speculation. Producers buy *L* in their own country and produce *X*, *Y* and *Z* for consumers in any country, getting utility from profits attained in the production and market activity. Therefore, the experiment includes nine markets that are organized according to a double auction. Nowbutsing (2011) found that the pattern of trade and output predicted by the theoretical model is observed in the extreme comparative advantage country; however, this is not the case for the two intermediate comparative advantage countries. Thus, the author concluded that the patterns of trade and output as predicted by the law of comparative advantage are not observed evolving within the experimental setting. Nowbutsing (2011b) explore the 3 x 3 Ricardian model in two scenarios multiple imports tariffs and customs union. The experimental environment was distorted version of the environment reported in Nowbutsing (2011a). The first environment consisted of multiple import tariffs and the second environment allowed the creation between two countries namely one 'extreme' comparative advantage country and one 'intermediate' comparative advantage country. The equilibrium was fully characterised under both environment. Starting from a tariff-distorted situation, it is found that when a customs union is formed there is an increase in trade flows among members; a rise in individual consumption of some goods; a clear term of trade effect and the existence of trade diversion. The experimental results support the simulation findings of Venables (2003), who showed that countries, which have extreme comparative advantage in a customs union, would be generally more vulnerable to trade diversion.

Binmore and Shaked have conducted many experiments over the years and they have contributed analytically to the advancement of experimental economics. However, in a recent article, they set a sceptical point about the use of experiments: '*Should we follow those experiments economists who seek recognition of their subject as a science by adopting the scientific standards that operate in neighbouring discipline like biology or psychology? Or should we….[treat] experimental results as just one more rhetorical tool to be quoted when convenient in seeking to convert others whatever your own point of view may be*? More specifically, they question the claim that experiments make about human behaviour when these conclusion are extrapolated from slender data. Eckel and Gintis (2010) provides several examples where experimental economics has not been faulty in this respect namely self and other regarding behaviour, application of several theoretical model to best suit the experimental data, modelling other regarding preferences, neoclassical economics and other regarding behaviour, the rationality of backward induction and inequality aversion.

4. Conclusion

Over the last 50 years, experiments have helped experimentalist to cultivate the ability to exploit the control permitted by the laboratory to evaluate economic theory. Field research rarely allows such control. However, we should note that experimental research does not undermine the importance of field research. Theories and models in the field make many judgments about assumptions, parameters and behavioral principles. By using experiments, however, experimentalists provide data that can be used to assess these judgments. I have tried to introduce the ingredients of an experiment as well as its promises and problems. The value experiments add to economics, much the same as to the natural sciences, comes down to one word: *control*. In experiments, rules of interaction, the flow of information and the reward system can all be controlled in ways that are rarely possible in the field. External validity is the ground on which experiments are criticized the most. Good experiments usually involve simplification. Simplification is an important means for obtaining the control that permits us to see causes and consequences. However, at the same time, this simplification means that most laboratory phenomenon are somewhat removed from the field phenomenon that we ultimately wish to understand. We nevertheless have good reasons to believe that insights and lessons learned in the lab will extend to the field: The subjects of economic experiments are actual people responding to real monetary incentives. With the increase use of computerization, it is possible to simulate even quite sophisticated economic environment.

Experimental economists employ a variety of strategies to challenge the robustness of their results. Perhaps the simplest is to stress test the aspects of the experiment that differ from the field. Are you suspicious that the students you have in your experiments differ from managers? Use managers (Cooper *et al*, 1999). Alternatively, certain aspects of the field environment are absent; systematically add them (a method known as parallelism (Grether *et al*, 1981). You can also gain confidence by checking whether the patterns found in the experiment agree with known facts in the field (Bolton *et al*, 1998). Finally, one can move the experiment out of the lab and into the field as Lucking-Rieley (1999) did in his Internet auction experiments. The scope of experiments is not limited to only academics, it has been also used by businesses, and for example, now there are economics laboratories at IBM's T.J Watson Research Center and at Hewlett-Packard Laboratories. Attaining internal validity or external validity surely depends on the purpose of the experiment. If our purpose is to speak to theorist, we need not bother about the problem of external validity.

In my opinion, there is a case for expanding the application of experiments to more complex environment such as international trade. I am surprised that even some experimentalists were pessimistic about the expansion of the application of laboratory experimentation. For example, Davis and Holt (1993) concluded that there are issues about parameters and preferences that do not permit us to address issues such as Ricardian Equivalence. However, a piece of work addresses Ricardian Equivalence in the laboratory- Cadsby and Frank (1991). One may also argue that trade experiments are not interesting as the environment are more complex. For example, there are many countries in the real world but it is not essential for subjects in an experiment to know what the aim of the experiment is. Empirical studies on trade theory tend to focus more in explaining real world phenomena. In this sense, it can be said that those studies move toward external validity. However, the experimental approach has several advantages compared to field data analysis of trade theories when it comes to testing the predictions of trade theories. In the laboratory, we can design markets according to the assertions of theory. By doing so, we can provide conditions suited to making the theory work well. A second advantage concerns interpretation of the data. In field markets, there are often market dynamics or other external factors that influence market outcomes and which sometimes make interpretation of the data difficult. In the laboratory, there are no such uncontrolled changes of the market determinants. As the cost and demand structure of the market are given by design, the data can unambiguously be interpreted with respect to the underlying theoretical model. Experiments in international trade can be categorised under the umbrella of market experiments. In addition, the development of new trading institutions such as the MUDA has made it is possible to sustain many markets.

References

Ansic, D. & Pugh, G. (1999). An Experimental Test of Trade Hysteresis: Market Exit and Entry Decisions in the Presence of Sunk Costs and Exchange Rate Uncertainty. *Applied Economics*, 31, 427- 436.

Arifovic, J. (1996). The Behavior of the Exchange Rate in the Genetic Algorithm and Experimental Economies. *Journal of Political Economy*, 104, 510-541.

Bolton, G. E., Katok, E. & Zwick, R. (1998). Dictator Game Giving: Rules of Fairness versus Acts of Kindness. *International Journal of Game Theory*, 27, 269-299.

Brander J. A. & Spencer B. J. (1985). Export Subsidies and International Market Share Rivalry'. *Journal of International Economics,* 18, 83-100.

Cadsby, C. R. & Frank, M. (1991). Experimental Tests of Ricardian Equivalence. *Economic Inquiry*, 29, 645-664.

Cartwright, N. (1983). How the Laws of Physics Lie. Oxford: Clarendon Press.

Cartwright, N. (1989). Nature Capacities and Their Measurement. Oxford: Clarendon Press.

Cartwright, N. (1999). The Dabbled World: a Study of the Boundaries of Science. Cambridge: Cambridge University Press.

Chamberlin, E. H. (1948). An Experimental Imperfect Market. *Journal of Political Economy*, 56, 95-108.

Cooper, D. J., Kagel, J. H., Lo, W. & Gu, Q. L. (1999). Gamint Against Managers in Incentive Systems: Experimental Results with Chinese Students and Chinese Managers. *American Economic Review*, 89, 781-804.

Davis, D. D. & Holt, C. A. (1993). Experimental Economics: Methods, Problems, and Promises. *Estudios Economicos*, 8, 179-212.

Eckel, C. C. & Gintis, H. (2010). Blaming the Messenger: Notes on the Current State of Experimental Economics. *Journal of Economic Behavior and Organization*, 73, 109-119.

Engelman, D. & Normann, H. T. (2003). An Experimental Test of Strategic Trade Policy. CERGE-EI Working Paper, 212.
Fisher, E. O. (2001). Purchasing Power Parity and Interest Parity in the Laboratory. *Australian Economic Papers*, 40, 586- 602.
Fisher, E. O. & Kelly, F. (2000). Experimental Foreign Exchange Market. *Pacific Economics Review*, 5, 365-387.
Friedman, D. & Cassar, S. (2004). Experimental Methods, Cambridge: Cambridge University Press.
Gray, P. & Plott, C. R. (1990). The Multiple Unit Double Auctions. *Journal of Economic Behavior and Organization*, 13, 245-258.
Grether, D. M., Isaac, R. M. & Plott, C. R. (1981). The Allocation of Landing Rights by Unanimity Among Competitors. *American Economic Review*, 71, 166-171.
Guala, F. (2003). Experimental Localism and External Validity. *Philosophy of Science*, 70, 195-1205.
Jones, R. W. (1961). Comparative Advantage and the Theory of Tariffs: A Multi-Country, Multi-Commodity Model. *Review of Economic Studies*, 28, 161-175.
Loewenstein, G. (1999). Experimental Economics from the Vantage Point of Behavioral Economics. *Economic Journal*, 109, 25-34.
Lucking-Reiley, D. (1999). Using Field Experiments to Test Equivalence between Auction Formats: Magic on the Internet. *American Economic Review*, 89, 1063-1080.
Marc, O. (2004). Realisms, Realisticness and Experimental Economics. Mimeo, GREQAM University of Aix-Marseille.
Nelson, A. (1998). Experimental Economics. In The Handbook of Economic Methodology, Davis B., Hands W. and Maki U. (eds.) Cheltenham: Edward Elgar, 179-180
Noussair, C. N., Plott, C. R. & Riezman, R. G. (1995). An Experimental Investigation of the Patterns of International Trade. *American Economic Review*, 85, 462-491.
Noussair, C. N., Plott, C. R. & Riezman, R. G. (1997). The Principles of Exchange Rate Determination in an International Finance Experiment. *Journal of Political Economy*, 105, 822-861.
Noussair, C. N., Plott, C. R. & Riezman, R. G. (1997). Production, Trade, Exchange Rates and Equilibration in Large Experimental Economies. *European Economic Review*, 51, 49-76.
Noussiar, C. N. & Powell, O. (2008). Peak and Valleys: Experimental Asset Markets with Non-Monotonic Fundamentals. Discussion paper 2008-49, Tilburg University.
Nowbutsing, B. M. (2011a). Fragility of Comparative Advantage: An Experimental Investigation. *Journal of Economics and Behavioural Studies*, 2 (4), 151-170.
Nowbutsing, B. M. (2011b). Winners and Losers in a Customs Union: An Experimental Investigation. *Journal of Education and Vocational Research,* 2(2), 49-72.
Plott, C. R. & Smith, V. L. (1978). An Experimental Investigation of the 2 Exchnage Institutions. *Review of Economic Study*, 45, 133-53.
Ricardo, D. (1817). On the Principles of Political Economy and Taxation.
Robinson, J. (1979). What Are the Questions? *Journal of Economic Literature*, 15, 1318-1339.
Samuelson, P. A. & Nordhaus, W. D. (1985). Principles of Economics, 13th Edition, New York: McGraw Hill.
Samuelson, P. A. & Nordhaus, W. D. (1989). Principles of Economics, 14th Edition, New York: McGraw Hill.
Shapley, H. (1964). Of stars and Men. Boston.
Siegel, S. & Fouraker, L. E. (1960). Bargaining and Group Decision Making: Experiments in Bilateral Monopoly, New York: McGraw-Hill.
Smith, V. L. (1976). Experimental Economics: Induced Value Theory. *American Economic Review*, 66, 274-79.
Smith, V. L. (1982). Microeconomic Systems as an Experimental Science. *American Economic Review*, 72, 923-955.
Smith, V. L. (1989). Theory, Experiment and Economics. *Journal of Economic Perspectives*, 3, 151-69.
Starmer, C. (1999). Experiments in Economics: Should We Trust the Dismal Scientists? *Journal of Economic Methodology*, 6, 1-30.
Wilde, L. (1980). On the Use of Laboratory Experiments in Economics. In The Philosophy of Economics, Pitt J. (ed.), Dordrecht: Reidel.
William, F. E. (1973). The Effect of Market Organization on Competitive Equilibrium: The Multi- Unit Case. *Review of Economics Studies*, 40, 97–113.