Helena Chytilova

University of Economics, Prague, Czech Republic

Methodological Considerations of Macroeconomic Experiments

Abstract:

Macroeconomic theories have traditionally been tested by using non-experimental field data, where controlled manipulation of the economy with consequent insight regarding the effects of alternative institutions and policies was considered as relatively impossible. However, the situation has changed tremendously, with a particular reason being the widespread application of macroeconomic models with explicit micro-foundations. We argue that less objection should be made against using these macroeconomic experiments based on individual behavior, since they might provide guidance for how subjects perceive examined phenomenon. This is documented with help of selected laboratory experiment. We claim that in context of unsuitable data or empirically non-testable models, controlled laboratory experiments might be understood as a complement to standard econometric techniques, where both the aggregate and individual predictions of micro-foundation models might be tested.

Keywords: Macroeconomic Experiment, Individual Behavior, Micro-Foundation Models, Aggregate Predictions, Individual Predictions, Controlled Environment.

JEL Classification: C91, B41, E0

1 Introduction

Experimental macroeconomics as a subfield of experimental economics is aimed to use controlled laboratory method to test predictions and assumptions of macroeconomic models and to analyze aggregate economic phenomena. This subfield has gained considerable attention in the last decade as mentioned by Ochs (1995), Duffy (1998) and Ricciuti (2008), however has still long way to go. As argued by Sims (1996, p. 107) "Economists can do very little experimentation to produce crucial data. This is particularly true of macroeconomics."

This is also emphasized by Blanchard (1997) in following quotation: "When an engineer wants to find out how the temperature affects material´s conductivity, she builds an experiment in which she changes the temperature, makes sure that everything else remains the same, and looks at the same changes in conductivity. But macroeconomists, who want to find out, for example, how changes in the money supply affect aggregate activity cannot perform such controlled experiments; they cannot make the world stop while they ask the central bank to change the money supply." (Blanchard 1997, cited in Ricciuti (2004, p.1)).

According to Duffy (2008), macroeconomic theories have traditionally been tested by using non-experimental field data, where controlled manipulation of the economy with consequent insight

regarding the effects of alternative institutions and policies was considered as relatively impossible. Generally, it was argued that macroeconomic questions are not to be derived with the help of experimental methods, (among others, Sims [1996]). Despite that, there is a growing body of literature in the past twenty years as indicated by Duffy (2008) that encompasses macroeconomic theories and models examined through controlled experimental framework.

This article aims to discuss possible justifications for conducting of macroeconomic experiments, followed by identification of frequently mentioned lacks of macroeconomic experiments. Consequently discussion will follow related to possible solutions, which may alleviate these deficiencies present in experimental design. Finally, concrete macroeconomic experiment is used in order to strengthen common argument that less objection should be made against using controlled laboratory experiments of macroeconomic nature due to contemporary trend of micro-founded macroeconomic models.

2 Brief Overview of Experimental Macroeconomics

According to Duffy (2008) precise origins of macroeconomic experiments are rather not clear. Sometimes it is pointed to Phillips´ (1950) experiment, which used a colored liquid-filled tubular flow model of the macroeconomy, which however did not involve human subjects.

Vernon Smith´s (1962) double auction experiment, which demonstrated the importance of centralized information in order to move to competitive equilibrium might be also considered as the first macroeconomic experiment. Additionally, John Carlson´s (1967) experiment, which aimed to examine price expectations in stable and unstable versions of the Cobweb model is one of the first possible attempts. However, origins are mostly dated to Lucas´s (1986) invitation to macroeconomists to conduct controlled laboratory experiments to cope with coordination problems, which remained unsolved by macroeconomic theory. Notwithstanding, his invitation was followed up on by many influential economists, among them Lim, Prescott and Sunder (1994), Marimon and Sunder (1993), (1994), (1995), with a consequent expansion of macroeconomic theories tested in the laboratory, among others by Duffy and Fisher, (2005), Van Huyck et al. (1990), (1991), 1994), Arifovic, Sargent (2003), Bernasconi, Kirchkamp (2000), Deck (2004), Duffy, Ochs, (1999), (2012), Fehr and Tyran (2007), Fehr and Tyran (2008), Heinemann, Nagel, Ockenfels (2004), Hey (1994), Noussair, Plott, Riezmann (2007), Lei, Noussair, (2007) and others.

Macroeconomic experiments might be classified according to Ricciuti (2008) as follows:

First approach is related to examination of system effects, equilibration and spillowers between markets. This approach was applied by Charles Plott in several of his experiments and is the one, which has a real macroeconomic content due to its focus on inter-relations between several markets and the spill-over between them. Although laboratory economy is much more simple than the real economy, its simplified version may provide clue whether the model can or cannot be applied to more complex real world. If a simplified version of the economy in the laboratory does not reject the model of macroeconomic behavior, it means that the model may be actually plausible. The second approach is aimed to isolate specific issue and rather tests specific theory based on single market. Since focus is usually on single market, it is easy to apply ceteris paribus condition. Additionally, this approach is more consistent with current character of macroeconomic modeling, based on micro-foundations. As a result, most experiments fall rather within this latter category.

3 Justification for Macroeconomic Experiments

One might ask what was the major impulse which caused the use of controlled laboratory experiments (with implications derived for macroeconomic theory), to be on the increase nowadays? So far macroeconomic issues have been perceived to be too great to be examined via controlled laboratory experiments with a small number of subjects, according to Duffy (1998). However, the situation has changed tremendously, with a particular reason being the widespread application of macroeconomic models with explicit micro-foundations. The focus of these models is how institutional changes or policies may affect the decision making of households and firms.

Firstly, experimental macroeconomics may provide insights to various issues on which models are silent.

For instance, equilibration as the process by which competitive equilibrium is achieved is mostly not present in modern macroeconomic models as emphasized by Duffy (2008). These macroeconomic models frequently assume instantaneous market clearing. Experimental economists have tested many mechanisms, trough which equilibration might be achieved or at least improved. As example might serve Smith (1962) with his double auction mechanism, the availability of information, futures markets, Forsythe (1982), Plott and Sunder (1982), Sunder (1995) with partial equilibrium approaches and Lian and Plott (1998) with a general equilibrium approach. These studies generally conclude that small population of 5-10 subjects with enough trading experience is sufficient in order to achieve efficiency consistent with competitive equilibrium in various market environments. Additionally, experimental macroeconomics may contribute to explanation, why in certain market environments equilibration may fail to happen and instead price bubbles and crashes are observed as documented by Smith (1988), Lei, Noussair, Plott (2002), Hommes (2005) with important role being assigned to the level of experience of subjects.

Another contribution of experimental macroeconomics may be attributed according to Ricciuti (2008) to the analysis of environments with multiple equilibria on which standard macroeconomic theory is mostly silent. Coordination problem is of a great interest, since it plays substantial role in the persistence of business cycle fluctuations as indicated by Mankiw, Romer (1991). Experiments may indicate, how agents coordinate, which equilibrium they select or whether they will move between equilibria and even which equilibrium is mostly selected. Many experimental studies are devoted to this issue. Van Huyck et.al (1990) show that minimum effort, team production payoff function can lead to coordination by groups of subjects on Pareto inferior equilibria and thus Keynes-type coordination failure is the case. Fehr and Tyran (2005) in their study find that subjects tend to converge to the Pareto inefficient equilibrium if they are provided by representation in form of nominal pay-offs. If they are provided by information about decision making in the form of real pay-offs, the Pareto-efficient equilibrium is selected. Duffy and Ochs (1999, 2002) conclude that subjects have no difficulties with coordination on efficient monetary exchange equilibria if they have to apply fundamental cost-minimizing strategies. However, subjects tend to have difficulties in coordination on efficient monetary equilibria if more costly, forward-looking or speculative strategy has to be applied, which is much difficult if other subjects are not willing to apply it too. Duffy and Fisher (2005) show that when information is highly centralized, subjects use realization of a sunspot variable as an instrument for coordination in an environment with multiple equilibria. In this case they tend to coordinate on low or

high price equilibria, whereas in case of decentralized information (double auction mechanism), this system may not work.

Experimental economics may also provide insights into the theory of expectation formation. There are many experimental studies which focus on this issue and test expectation formation in different environments. For instance Hommes et.al (2004) find out that individuals in a standard asset pricing model tend to form adaptive expectations and cooperate on common prediction strategy in groups. Fehr and Tyran (2005) prove that expectation formation is necessary for optimal decision making in a strategic environment, however money illusion may shape these expectations and lead agents to coordinate on inferior equilibria. Rotheli (2010) find out that pattern based expectations are very similar despite cultural and historical differences. Burke (2010) shows that economic literacy contributes to more accurate expectation formation. Marimon, Sunder (1994) examine how agents expectations affect outcomes in monetary overlapping generation economies under alternative policy regimes

Secondly, it may happen that representative agent's characteristic, where artificial restrictions are imposed on his behavior, is not embraced in any available field data.

As a result, the aggregate predictions that emerge from these micro-founded models are often not empirically testable according to Duffy (2008). In this case there may be space for experimental macroeconomics. In order to test whether theory is confirmed by data sometimes one needs to impose some restriction. Sometimes it may happen that the possibility to test the aggregate predictions of models is the case with available field data, but these data are unsuitable to test whether the behavior adjusts to the prediction or assumptions of macroeconomic models. Again in this context, controlled laboratory experiments might be understood as a complement to standard econometric techniques, where both the aggregate and individual predictions of micro-foundation models might be tested.

As an example could serve test on money demand mentioned by Ricciuti (2008). If we want to test money demand, we need to identify money demand by separation of the transaction demand from other motives and add all important explanatory variables which determine money demand. It may happen that field data does not involve all important information. As a result, experiments may be considered to be good method to construct the economy, where only transaction motive exists.

Lastly, the endogeneity of policy in real-world economies makes it difficult to analyze data and formulate correct conclusions about the process and possible changes which took place. Experimental economics as opposed to real data offers full control over parameters in the lab, since the experimenter is flexible in modeling and can set parameters in a desirable manner and direction. As a result, he has precise information about the factors, which changed during the experiment, (Ricciuti (2008)).

4 Discussion about Lacks of Experimental Method in Macroeconomics

Motivation issues

Students are frequently used subjects in most of the laboratory experiments, because these are most available participants. This subject pool is not only accessible directly at university, where most of the laboratories conduct their research, but also students are willing to participate in experiments and are almost always available. Ball and Cech (1993) on the basis of an extensive survey suggest, that "using

student subjects has the potential to produce anomalous results and efforts should be made to replicate results using subjects from more representative populations," Ball, Cech (1993, pp. 31-32). Additionally, students are not representative of the needs and aspirations of an agent in a large economy. In macroeconomic systems individuals take several roles according to Ricciuti, (2008), such as employees, which are paid a basic salary, necessary to cover basic expenses or consumers who use their rewards for consumption or for short term or long term saving purposes. On the other hand firms are present, which try to maximize profits and interact with each other. Students represents subjects which are not motivated enough in order to satisfy status of the real agent in the economy. Mostly financial incentives are used to increase motivation of subjects. Some opponents propose that inclusion of professionals might improve credibility of experiment. However, it was proved empirically that professional players do not perform better than students, because they are affected by course of knowledge. Course of knowledge describes the fact of transferring daily routine of every day work to the lab situation. Behavior of professionals is more intuitive and less analytic, despite superior knowledge they posses when acting at real markets. This is because in the real environment, they are not confronted with given and known probability distributions or pay-off functions, but they must rely on intuitive evaluation (calibration) of prospects. It was proved by many studies that these routines are successful in the real world, but highly inapplicable in experimental environment. (Bolton, Ockenfels, Thonemann, 2008, Abbink, Rockenbach, 2006). Qualitative reasoning used in daily practice, is not suitable for the laboratory environment, where exact information is actually available. On the other hand, students receive strong formal and technical training and when they are confronted with abstract task, it is similar to task in a student exam. Highly technical task in well-defined formal laboratory environment is therefore something which is more favorable to the abstract approach used by the students and their ability to find a specific solution to an exactly specified problem. Thus performance of students is comparable to that of professionals on the real market, (Abbink, Rockenbach, 2006).

Notwithstanding, higher pay-offs reduce noisy behavior as noted by Ricciuti (2008) and may weaken partly critique of opponents related to insufficient incentives.

Number of individuals involved

Number of subjects in the economy is usually large as opposed to the artificial economy in the laboratory, where number of subjects is restricted. Laboratory experiments involving small groups of subjects interacting for a short period of time represent a problem in view of opponents. The analysis of aggregate economic phenomena or even testing of predictions or assumptions of models is met with some skepticism due to non-representativeness of the laboratory experiment from macroeconomic point of view. However, with current trend of macroeconomic models with microeconomic foundations, the issue of number of subjects may not represent a problem. These experiments are classes of experiments centered on single market and are considered to be rather simplification of the real economy, which is aimed to test exactly microeconomic foundations of macroeconomic models, which is consistent with current trend of macroeconomic modeling. Moreover, their scientific strength is in building on economic theory, (Ricciuti, 2008, Duffy, 2008). Additionally, we should not rest on too restrictive definition of macroeconomic experiment, since there are many experiments like coordination issues, which have purely microeconomic content with macroeconomic flavor as noted by Duffy (2008).

Validity of Macroeconomic Experiments

External validity seems to represent a problem mainly for experimental macroeconomics, which tries to explain aggregate economic phenomena based on small scale laboratory evidence. There are many arguments which speak in favor of validity of experimental results. Firstly, already discussed macroeconomic models with microeconomic foundations can be tested even in conditions with small number of subjects. Additionally, the laboratory may even strengthen micro-level causal relationships, since experimenter can directly isolate phenomenon which he aims to test via parameters setting. Moreover, unaccounted factors are highly eliminated. Causal relationship is secured by specification of experimental group, which is exposed to tested effect and control group, which is not exposed to this effect, but otherwise groups face the same conditions ceteris paribus. If we make comparison of experimental data with field data, they cannot be described by the same degree of internal validity in terms of causal relationship, (Duffy 2008). If we return to the problem of external validity, this might not to be considered as serious problem, since the degree of external validity is dependent on type of the experiment. According to Schramm (2005) highly theoretical experiment doesn´t necessarily require high degree of external validity, but rather of internal validity. In this case experiments are used to test performance of theories in light of working institutions or to test the initial assumptions of the theory. Exemption is represented by experiments designed to test-bed policies. In these experiments external validity is of a major importance. This is usually common, when some new institutional design is tested and requires unique practical skills, which are out of student´s domain.

Learning

Experiments are often designed in a way, which requires subjects to repeat the experiment many times and get them acquainted with the rules of the game. However, in some experiments the objective according to Ricciuti (2008) is investigation of learning process of individuals. In contrast in some other experiments it is impossible to distinguish between learning rules of the game and learning the game with a given set of parameters.

Illustrative Macroeconomic Experiment

We opted for illustrative laboratory experiment of Fehr and Tyran (2001) in order to further support afore-mentioned methodological discussion and provide possible justification for conducting macroeconomic experiments. Before we approach to the main discussion, the character of experimental design will be outlined with all its features.

Experiment of Fehr and Tyran (2001) is based on n-player pricing game with unique equilibrium. The game has 40 rounds plus one trial period, with a group size of n=4. Experiment is divided into a pre-shock and a post-shock phase, all of which has T=20 periods. Fully anticipated negative monetary shock is implemented during the game, which is common knowledge to participants, (reduction of money supply from M_0=42 to M_1=14). Treatment groups received payoff functions, which provide them with information about their pricing strategy. Pay-offs of participants are expressed either in nominal or real terms. In order for subject to decide correctly about the price of his product (price lies between 1 and 30) in the nominal environment, he needs to re-count nominal pay-off into the real pay-off. The nominal pay off is given by $P_{-i}. \pi_i$, therefore in order to compute real payoff, individuals have to divide their nominal payoffs $P_{-i}. \pi_i$ by P_{-i}.

The real pay-off of subject i is given by:

$\pi_i = \pi_i (P_i, P_{-i}, M)$ i=1,.... n

where P_i stands for nominal price, P_{-i} is the average price of the other n-1 group members, and M is nominal shock variable. Subjects are informed about payoffs of other subjects in the group, since x and y types players are present in nominal treatment. For more detailed specification of payoffs and payoff tables see Fehr, Tyran (2001).The need to recount nominal pay-off into real pay-off is a cognitively challenging task, which is the main barrier to optimal behaviour. This experiment aimed to test ability of subjects to adjust to the equilibrium after full anticipated negative monetary shock depending on whether they face nominal or real environment. Their results show that subjects which have to face money illusion in form of nominal pay-offs tend to adjust in much slower way, which proved that money illusion is persistent phenomenon. Consequently, implications are derived for the economy at the aggregate level, which strengthen New Keynesian predictions.

Based on previous comments one may ask, whether it is possible to derive such implications at the aggregate level from the laboratory experiment of microeconomic nature. Based on afore-mentioned methodological discussion, the following comments are worth mentioning with regards to laboratory experiment used for our illustrative purposes:

One dimension concerns the well discussed number of subjects under scrutiny due to the belief that it is difficult to approximate macroeconomic world through a laboratory experiment with a small number of subjects. However, this macroeconomic experiment rests on experimental design in the vein of Fehr and Tyran (2001), which is based on micro-foundations, where the number of participating subjects need not be the relevant issue, as already suggested above. Moreover, as emphasized by Duffy (2008), evidence from many auction experiments since Smith (1962) suggests that equilibration to competitive equilibrium occurs reliably with just a few individuals on supply or demand side market, so a large number of subjects need not be a necessary condition. Microeconomic foundations of experiment are initially based on a monopolistically competitive economy, where pricing behavior of individuals, who try to maximize the profit function, is tested after the shock. Based on evaluation of microeconomic foundations, this experiment enables to derive conclusions at the aggregate level with respect to conclusions of New Keynesian theory about non-neutrality of money in a short run.

Secondly, this experiment enables the collection of a type of data less directly observed in the field. For instance, the examination of expectation formation after the shock is valuable output, which cannot be obtained otherwise. Additionally, it is extremely difficult to collect individual information sets regarding the actual price in the pre-shock and the post-shock phase in the field, needed for comparison with ideal equilibrium prices to identify nominal inertia. Also identification whether the monetary shock is anticipated or not is a serious constraint. The experimental method (as opposed to field data) possesses an immense advantage in its control over the environment and information conditions. This is closely associated with causal relations, which are directly under experimental control, where the frame can be easily set by specification of treatment conditions as emphasized by Fehr and Tyran (2000), (2005). In this case environment of nominal and real pay-offs was created in experimental design. Examined phenomenon is secured by specification of treatment condition with possible elimination of all other factors, which should be constant, (See Table 1 for more details). Experimental group faces environment of nominal pay-offs, which represent the need of subjects to cope with some

barrier, i.e. the need to recount nominal pay-off into the real pay-off. On the contrary, control group has to work with environment of real pay-offs when deciding about the price of production. This does not represent any cognitive barrier and subjects should be pretty comfortable in this environment. When keeping other factors constant, we are able to examine phenomenon of confusion by nominal values by comparing the difference between these two examined groups. If otherwise equal conditions are secured for both groups and with sufficient elimination of all other effects, we may consider causal relation to be strong enough. Furthermore, we may also say that this method "allows a dramatic reduction in the number of auxiliary hypotheses involved in examining a primary hypothesis", as emphasized by Davis and Holt (1993, p.16).

Table 1: Treatment Conditions

	Treatment	Other factors
Experimental Group	Nominal pay-off	constant
Control Group	Real pay-off	constant

Additionally, objections might be raised regarding the external validity of experimental results. However, in the case of the more theoretical character of the experiment examined in this case, there are fewer objections against lower external validity, which is supported also by study of Schramm (2005). In case of these experiments internal validity is predominant. The same holds for the critique of students as experimental subjects, where it is claimed that participation of graduate students instead of professionals does not make a substantial difference based on previously mentioned studies. Students are able to get quickly into the structure of highly theoretical experiment and face abstract tasks with ease, based on a background course of knowledge related to academic training.

5 Conclusion

Although economists need to be careful in making generalizations based on the results of an experiment that involves a small number of subjects, still less objection should be made against using experiments in order to test predictions of macroeconomic models based on explicit micro foundations. Exactly because these models are based on individual behavior, experiments might provide guidance for how subjects perceive examined phenomenon. For instance, in the economy with multiple equilibriums it might indicate what equilibrium subjects consider as more relevant. Additionally, experimental data should be understood as a complement to standard econometric analysis of field data if there is no possibility how to gather some specific data or if field data do not possess the character, which is desirable for examination of specific phenomenon. Indeed, experimental data offer also possibility, how to secure sufficient internal validity in terms of micro-level causal relationships and exhibit better characteristic in this sense than standard field data. Last but not least, we have to bear in mind in vein of Duffy (2008) that all experimental work should be judged by its findings and not deficiencies, since all empirical methods have their strengths and weaknesses.

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