1

Macroeconomics: A Survey of Laboratory Research

John Duffy

1 INTRODUCTION: LABORATORY MACROECONOMICS

Macroeconomic theories have traditionally been tested using nonexperimental field data, most often national income account data on GDP and its components. This practice follows from the widely held belief that macroeconomics is a purely observational science: history comes around just once and there are no "do-overs." Controlled manipulation of the macroeconomy to gain insight regarding the effects of alternative institutions or policies is viewed by many as impossible, not to mention unethical, and so, apart from the occasional *natural* experiment, most macroeconomists would argue that macroeconomic questions cannot be addressed using experimental methods.[1]

Yet, as this survey documents, over the past twenty-five years, a wide variety of macroeconomic models and theories *have* been examined using controlled laboratory experiments with paid human subjects, and this literature is growing. The use of laboratory methods to address macroeconomic questions has come about in large part due to changes in macroeconomic modeling, though it has also been helped along by changes in the technology for doing laboratory experimentation, especially the use of large computer laboratories. The change in macroeconomic modeling is, of course, the now widespread use of explicit microfounded models of constrained, intertemporal choice in competitive general equilibrium, game-theoretic or search-theoretic frameworks. The focus of these models is often on how institutional changes or policies affect the choices of decision makers such as household and firms, in addition to the more traditional concern with responses in the aggregate time series data (e.g., GDP) or to the steady states of the model. While macroeconomic models are often expressed at an aggregate level—for instance, there is a "representative" consumer or firm or a market for the "capital good"—an implicit, working assumption of many macroeconomists is that aggregate sectoral behavior is not different from that of the individual actors or components that comprise each sector.[2] Otherwise, macroeconomists would be obliged to be explicit about the mechanisms by which individual choices or sectors aggregate up to the macroeconomic representations they work with, and macroeconomists have been largely silent on this issue. Experimentalists testing nonstrategic macroeconomic models

have sometimes taken this representativeness assumption at face value and conducted individual decision-making experiments with a macroeconomic flavor. But, as we shall see, experimentalists have also considered whether small groups of subjects interacting with one another via markets or by observing or communicating with one another might outperform individuals in tasks that macroeconomic models assign to representative agents.

While there is now a large body of macroeconomic experimental research as reviewed in this survey, experimental methods are not yet a mainstream research tool used by the typical macroeconomist, as they are in nearly every other field of economics. This state of affairs likely arises from the training that macroeconomists receive, which does not typically include exposure to laboratory methods and is instead heavily focused on the construction of dynamic stochastic general equilibrium models that may not be well suited to experimental testing. As Sargent (2008, p 27) observes,

> I suspect that the main reason for fewer experiments in macro than in micro is that the choices confronting artificial agents within even one of the simpler recursive competitive equilibria used in macroeconomics are very complicated relative to the settings with which experimentalists usually confront subjects.

This complexity issue can be overcome, but, as we shall see, it requires experimental designs that simplify macroeconomic environments to their bare essence or involve operational issues such as the specification of the mechanism used to determine equilibrium prices. Despite the complexity issue, I will argue in this survey that experimental methods can and should serve as a complement to the modeling and empirical methods currently used by macroeconomists as laboratory methods can shed light on important questions regarding the empirical relevance of microeconomic foundations, questions of causal inference, equilibrium selection and the role of institutions.[3]

Indeed, to date the main insights from macroeconomic experiments include (1) an assessment of the microassumptions underlying macroeconomic models, (2) a better understanding of the dynamics of forward-looking expectations, which play a critical role in macroeconomic models, (3) a means of resolving equilibrium selection (coordination) problems in environments with multiple equilibria, (4) validation of macroeconomic model predictions for which the relevant field data are not available, and (5) the impact of various macroeconomic institutions and policy interventions on individual behavior. In addition, laboratory tests of macroeconomic theories have generated new or strengthened existing experimental methodologies, including implementation of the representative-agent assumption, overlapping generations, and search-theoretic models, methods for assisting with the roles of forecasting and optimizing, implementation of discounting and infinite horizons, methods for assessing equilibration, and the role played by various market clearing mechanisms in characterizing Walrasian competitive equilibrium (for which the precise mechanism of exchange is left unmodeled).

The origins of *macroeconomic experiments* are unclear. Some might point to A. W. Phillips' (1950) experiments using a colored liquid-filled tubular flow model of the macroeconomy, though this did not involve human subjects! Others might cite Vernon Smith's (1962) double-auction experiment demonstrating the importance of centralized information to equilibration to competitive equilibrium as the first macroeconomic experiment. Yet another candidate might be John Carlson's (1967) early experiment examining price expectations in stable and unstable versions of the cobweb model. However, I will place the origins more recently with Lucas's

1986 invitation to macroeconomists to conduct laboratory experiments to resolve macrocoordination problems that were unresolved by theory. Lucas's invitation was followed up on by Aliprantis and Plot (1992), Lim, Prescott, and Sunder (1994), and Marimon and Sunder (1993, 1994, 1995), and, perhaps as the result of their interesting and influential work, over the past two decades, there has been a great blossoming of research testing macroeconomic theories in the laboratory. This literature is now so large that I cannot hope to cover every paper in a single chapter, but I do hope to give the reader a good road map as to the kinds of macroeconomic topics that have been studied experimentally as well as to suggest some further extensions.

How shall we define a macroeconomic experiment? One obvious dimension might be to consider the number of subjects in the study. Many might argue that a macroeconomic experiment should involve a *large* number of subjects; perhaps the skepticism of some toward macroeconomic experiments has to do with the necessarily small numbers of subjects (and small scale of operations) that are possible in laboratory studies.[4] The main problem with small numbers of subjects is that strategic considerations may play a role that is not imagined (or possible) in the macroeconomic model that is being tested, which may instead focus on perfectly competitive Walrasian equilibrium outcomes. However, research has shown that attainment of competitive equilibrium outcomes might not require large numbers of subjects. For example, the evidence from numerous double-auction experiments beginning with Smith (1962) and continuing to the present reveals that equilibration to competitive equilibrium can occur reliably with as few as three to five buyers or sellers on each side of the market. Duffy and others (2011) study bidding behavior in a Shapley-Shubik market game and show that with small numbers of subjects (e.g., groups of size two), Nash equilibrium outcomes are indeed far away from the competitive equilibrium outcome of the associated pure exchange economy. However, they also show that as the number of subjects increases, the Nash equilibrium subjects coordinate upon becomes approximately Walrasian; economies with just ten subjects yield market-based allocations that are indistinguishable from the competitive equilibrium of the associated pure exchange economy. Thus, while more subjects are generally better than fewer subjects for obtaining competitive equilibrium outcomes, it seems possible to establish competitive market conditions with the small numbers of subjects available in the laboratory.[5]

A more sensible approach is to define a macroeconomic experiment as one that tests the predictions of a macroeconomic model or its assumptions or is framed in the language of macroeconomics, involving, for example, intertemporal consumption and savings decisions, inflation and unemployment, economic growth, bank runs, monetary exchange, monetary or fiscal policy, or any other macroeconomic phenomena. Unlike microeconomic models and games, which often strive for generality, macroeconomic models are typically built with a specific macroeconomic story in mind that is not as easily generalized to other nonmacroeconomic settings. For this reason, our definition of a macroeconomic experiment may be too restrictive. There are many microeconomic experiments—coordination games for instance—that can be given both a macroeconomic interpretation or a more microeconomic interpretation, for example; as models of firm or team behavior. In discussing those studies as macroeconomic experiments, I will attempt to emphasize the macroeconomic interpretation.

The coverage of this chapter can be viewed as an update on some topics covered in several chapters of the first volume of the *Handbook of Experimental Economics*, including discussions of intertemporal decision making by Camerer (1995), coordination problems by Ochs (1995), and asset prices by Sunder (1995), though the coverage

here will not be restricted to these topics alone. Most of the literature surveyed here was published since 1995, the date of the first *Handbook* volume. In addition, this chapter builds on, complements, and extends earlier surveys of the macroeconomic experimental literature by myself, Duffy (1998, 2008), and by Ricciuti (2008).

Continued...