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Rational Expectations and the Struggle over Measurement and Policymaking in Empirical Macroeconomics*

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Abstract

This article deals with an analysis of the historical and methodological influences of rational expectations theory on econometrics and policy practice.

As point of departure the paper presents the rational expectations theory viewed in the light of the Cowles Commission method showing the impact of the "Lucas-Sargent's critique" on standard identification methodology and exogeneity treatment.

Then, it goes on focusing on the status of empirical macroeconomics after that "critique" and presenting the two main approaches we usually face in recent literature, that is, the "calibration" approach (proposed by Kydland and Prescott) and the "vector auto-regressive" (VAR) methodology (proposed by Sims).

Finally, we present the method of Hansen and Sargent to reconcile (rational expectations) theory and vector auto-regression.

The main thesis we try to argue in this work is that the rise and success of these different and competitive approaches to the issue of "measurement" comes directly from the rational expectations revolution.

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*“Ideas are like children.
You may give them life,
you may nourish and support them,
but you cannot control their future”
(John F. Muth, 2001 in Sent, 2002, p.314)*

1 Introduction

The controversy between advocates of a deductive-theoretical and advocates of a more inductive-empirical approach on the relevant issue of measurement in macroeconomic science has a long and fascinating history. It has been a hard and striking battle upon the very meaning and significance of economic research and it is still alive and being fought even now¹.

Indeed, recent literature on empirical macroeconomics shows that different and rival streams of research appear to be contending on this subject. On one hand we find the “calibration” approach proposed by Finn E. Kydland and Edward C. Prescott in 1982 presenting a strongly (rational expectations) theory-based approach and characterized by a non-econometric approach to the business cycle measurement; on the other hand, we find the “vector auto-regressive” (or VAR) methodology proposed by Christopher A. Sims in 1980 suggesting a more empiricism-econometrics based approach not relied on a well-defined theoretical background². Placed on a middle ground, finally, we face the efforts of Thomas J. Sargent and Lars P. Hansen to merge VAR with general dynamic equilibrium and rational expectations seen as a way to re-conciliate new classical theory with traditional econometric practice.

The main (but not the sole) thesis we try to show in this paper is that the achievement and success of these different and for several aspects competitive approaches to the question of “measurement and theory” in macroeconomics is not just a mere re-proposal of

¹Two important antecedents are particularly famous: the first is the Keynes-Tinbergen debate on econometric method of 1938-1940 (see Leeson, 1998; Louçã, 1999; Garrone and Marchionatti, 2004) and the second is the Vining-Koopmans debate on “theory and measurement” in macroeconomics of 1947-1949 (see Koopmans, 1947, 1949; Vining, 1949, 1949b; Mirowski, 1989).

²James Heckman (2000), nevertheless, suggests that besides the “VAR” methodology, present development of empirical economics show the existence of other two arising approaches featured by an “empirically grounded” orientation: (a) the *natural and social science experimentalism* and (2) the *non-parametric econometrics and statistics*.

the old controversy between a "deductive" versus "inductive" vision of economic science (as many authors have highlighted³) but rather it derives "directly" from the *rational expectations revolution* occurred during the '70s.

In order to argue our thesis we begin with a short overview of the causes back the rise of rational expectations in macroeconomics. Then, we consider the rational expectations theory viewed in the light of Cowles Commission method showing the implications of the "Lucas-Sargent's critique" on standard identification methodology and exogeneity treatment. Successively, we will go on by looking at the status of empirical macroeconomics after that "critique" and presenting the calibration and VAR approaches viewed as methodological attempts in order to prevent and overcome that critique. In order to give greater depth to our analysis, we will focus on the limits of the VAR approach as "atheoretical macroeconomics" centering then our attention on the "Lucas-Sims's debate" on policymaking considered as one of the most interesting recent debates on the central issue of "structural invariance" and "policy effectiveness" after the Lucas-Sargent's critique. Finally, we present the Hansen and Sargent proposal to reconcile (rational expectations) theory and vector auto-regression interpreted, in turn, as a procedure to overcome the problem of "observational equivalence" and to offer a compromise between "structural econometrics" and VAR, or, in other words, between theory and measurement, offering then a concise assessment of the accomplishment of this goal.

Finally, some concluding remarks follow.

2 The rise of REH in macroeconomics: a brief overview

The rational expectations hypothesis (hereafter REH) can be seen as one of the most revolutionary concepts developed in economic theory. The impact of this methodological category on theoretical and applied macroeconomics represents a typical case of a notion that has severely modified and changed the conventional way of thinking about economic reality, causality and policymaking (Begg, 1982; Snippe, 1986).

Although the REH became well-known to the scientific community for its macroeconomic applications it did not firstly originate in a macroeconomic environment. Indeed John F. Muth, the first author introducing rational expectations in a formal model, developed this hypothesis in a context of microeconomics restricting his attention to a single market in a partial equilibrium that had nothing to do with its elaborations in macroe-

³See, in particular, Simkins (1999).

conomics. On the contrary, as suggested by the historical reconstruction done by Sent (2002), Muth thought it was a dumb idea to do go in this direction⁴. In his seminal paper "Rational Expectations and the Theory of Price Movements" of 1961 Muth defined and utilized the REH in a simple "cobweb model" showing the properties of rational expectations and comparing them to the properties of other hypotheses in expectations' formation.

From a macroeconomic point of view, instead, REH is a notion strictly linked to the business cycle theory. As Robert E. Lucas (1975) suggested, in fact, through the REH business cycle can be fully seen as an equilibrium phenomenon since expectations have to be considered as systematically fulfilled⁵. The concept of rational expectations, indeed, starts from the idea that individuals should not make systematic mistakes when they want to forecast future patterns of macroeconomic variables. They are not stupid in the sense that they learn from their mistakes and they draw intelligent inferences about the future using any information available from what is happening around them (Sent, 1999, p.440). An important implication of models built on this assumption is that they can explain the existence of fluctuations just deriving them from "erratic" and not rationally predictable (i.e., systematic) mistakes. Using REH Lucas (1972) provided a micro-foundation (Arrow-Debreu general equilibrium consistent) for a new version of the neoclassical "quantitative theory of money" proving the famous and revolutionary proposition of "inefficacy of policy". The rational expectations manifesto, the Lucas and Sargent's well known paper "After Keynesian Macroeconomics" published in 1979, represented a sticking attack to Keynesian macroeconomic paradigm and suggested an alternative paradigm which began the basis for macroeconomic orthodox theory up until

⁴It is of worth to observe the scientific context in which rational expectations were born. Indeed, during some part of the '60s, the father of rational expectations (Muth), the prophet of "bounded rationality" (Simon), and the future developers of rational expectations (Lucas, Sargent, and Rapping) were all colleagues at the Graduate School of Industrial Administration (GSIA) at Carnegie-Mellon University (Sent, 1997). It was within this particular and favorable environment that Muth provided the REH. Following the Sent (2002) reconstruction, in fact, Muth was firstly strongly influenced by the Emile Grunberg and Franco Modigliani (who was the Muth's PhD dissertation director at Carnegie in 1962) paper "The Predictability of Social Events" of 1954. His interests moved from studies on bounded rationality to rational expectations when he was engaged in economic proper and econometrics and, under the influence of Simon and others, from rational expectation back to bounded rationality when he moved toward the study of production management and operations management.

⁵For a wider treatment of the equilibrium business cycle theory in historical perspective I suggest to see Kyun (1988).

today.

As pointed out by Sent (1998, pp. 1-22) depending on the focus different causes can be found to explain the rise of rational expectations in economics. She related it to five main factors: availability of new data, use of new techniques, development from existing theory, problems of existing theory and finally, the need to link theory and econometrics. The author however suggests at least "ten" useful sub-perspectives⁶:

1. *Expiration of the Phillips curve*: rational expectations economists were able to explain the expiration of the Phillips curve in the late 1970s. They showed that government actions caused an adverse shift of the Phillips curve leading to higher inflation with no benefit in terms of lower unemployment on average;
2. *Policy irrelevance*: they proved and justified the ineffectiveness of government intervention in the context of the failure of traditional Keynesian policies of '70s. They recognized the limitations of the economists' profession maintained that the economy would basically be stable if it were not subjected to the shocks repeatedly administered by the government;
3. *Using available techniques*: rational expectations theorists used more developed and sophisticated tools in order to predict. They learned and used the techniques of inter-temporal optimization developed by mathematicians and control scientists and contributed to improve tools of optimal prediction and filtering of stochastic processes. Even if some of these techniques were already known in the '50s and '60s they helped to make them more accessible to economists.
4. *Restoring symmetry*: they considered themselves just as smart as economic agents and policymakers placing all of them on an equal footing by postulating that forecasts made by agents within the model were no worse than those made by economists or econometricians who knew the true model. The hypothesis of adaptive expectations used heavily up until the late '60s, in fact, by postulating systematic error correction in agent expectations' formation created a separation between the researcher and the object of his research (the agents' behaviors). As we will see, REH eliminate this inconsistency making the researcher as part of his own experiment.

⁶I omitted for brevity the references supporting each of these stories. The reader interested can find them directly in the book of Sent (1998).

5. *Optimization over information*: since rational expectations are the agents' best predictions for a given set of information (including their understanding of how the economy works), that is, they minimize the conditional Mean Square Error for estimating future data, they introduced expectations theory into the wider optimizing behaviors theory. Following this interpretation if expectations were not optimally chosen, unexploited utility or profit-generating possibilities would exist within the system. Hence, rational expectations economists insisted on the disappearance of all such unexploited possibilities;
6. *Endogenizing expectations*: mechanism of rational expectations' formation does not depend on modelers' taste, but it is endogenously motivated and, since they are correct in average, agents remain satisfied with their expectation choice (it means that agents are individually in equilibrium). Before REH expectations were taken as given (Keynes, 1936, Chaps. 12, 15) or as a result of past observations (adaptive expectations) incorporating systematic errors. The REH asserted that the resulting predictions might still be wrong, but that the errors would be random (orthogonality property) since, if the errors followed a pattern, they held information that could be used to forecast better.
7. *Making correct public predictions*: rational expectations theorists were able to fight the threat of indeterminacy of economic outcomes. Since outcomes depend on what people expected those outcomes to be if people's behaviors depend on their perceptions, economic systems were thought to be self-referential and open-ended. Some economists despaired that economic models could produce so many outcomes that they were useless as instruments for generating confident predictions. The REH was a powerful hypothesis, however, for restricting the range of possible outcomes since it focused only on outcomes and beliefs that are consistent with one another. The REH is an equilibrium allowing for correct public prediction because predictions are essentially the same as the predictions of the relevant economic theory and people are supposed to know and uniformly to believe in this theory;
8. *Countering bounded rationality*: the REH was born at the same place and in the same time of bounded rationality, namely, at the Graduate School of Industrial Administration (GSIA) at Carnegie Mellon University. Here Muth and Simon were colleagues and participated in the Planning and Control of Industrial Operations Project. Nevertheless, while Simon saw the strong assumptions underlying this

project as an instance of "satisficing", Muth saw this special case as a paradigm of rational behavior under uncertainty. Some argue that Muth, in his announcement of rational expectations, explicitly labeled his theory as a reply to the doctrine of bounded rationality (Sent, 2002).

9. *Restricting distributed lags*: some suggest that the REH began as an attempt at incorporating uncertainty and randomness in optimizing economic theory and using the outcome to understand, interpret, and restrict the distributed lags that abounded in the decision rules of dynamic macro-econometric models. They promised to create a link between "theory" and "estimation" by incorporating uncertainty and randomness in macroeconomics⁷;
10. *Incorporating vector auto-regressions*: rational expectations theorists, as we will see, were able to revive "theory" by showing that vector auto-regression was not completely a-theoretical but that it can be consistent with restrictions offered by (rational expectation) theoretical models. In particular rational expectations economists exploited "cross-equations restrictions" to connect the vector auto-regressive parameters of decision rules with the theoretical parameters of taste, technology, and other stochastic environments.

An eleventh cause can be found, however, even in the need of *making macroeconomics consistent with microeconomic theory* (micro-foundation). As suggested by Rodano (1987) and Saltari (1990), macroeconomic theory of the '60s showed a strong delay compared to the Arrow-Debreu framework consistency because of its Keynesian "out of equilibrium" derivation. For Lucas and the other neoclassical economists it needed a serious micro-foundation of macroeconomic theory consistent with the Arrow-Debreu modeling. The principals of full agents' rationality, optimizing behaviors and competitive clearing markets had to lead to a representation of macroeconomic system strictly consistent with the micro-system as described by Arrow-Debreu avoiding all "ad hoc" macro hypothesis to explain empirical evidences and justify discretionary policy interventions⁸.

⁷Hansen and Sargent (1991a) suggested that: "*the hypothesis of rational expectations has invaded economics from a variety of sources, including game theory and general equilibrium theory. But in macroeconomics, the first invaders were time-series econometricians, who in the late 1960s were seeking methods of restricting the parameters of lag distribution in their econometric models. In the late 1970s the focus of attention changed from restricting distributed lags to restricting vector auto-regressions*" (p.1).

⁸In particular Rodano (1987) suggested that the hypothesis of rational expectations substituted, in a

Starting from this background rational expectations theory has developed increasingly after Lucas article of 1972⁹. In fact, although the REH program had provided a more scientifically consistent basis for a new defense of laissez-faire and positive theory in macroeconomics it remained to show that actual empirical fluctuations could be understood only referring to rational expectations models. As it is known, indeed, the REH in macro-models asks for a non-systematic and non-serially correlated relation between the rational expectations and the actual realized variables (orthogonality property) so that the REH models should predict "white noise" fluctuations around the "natural" level of macro-variables. Nevertheless empirical evidences showed, as Muth himself tested, a structural correlation in macroeconomic outcomes. An important stylized fact discovered during the '70s, indeed, was that the recurrence property of cycles can be generated by low-order random or stochastic difference equations (Sargent, 1979). That is, the low-order serial correlation of errors is the appropriate mathematical expression to represent actual cycle's fluctuations. According to the equilibrium business cycle approach, if agents' information set includes the history of variable being forecasted, then the forecast errors should be serially uncorrelated. In other words, the agent's forecast error in this period should not be systematically connected with the forecast error in previous periods. If an agent commits a systematic error of this sort he apparently would violate the REH. According to this relevant empirical inconsistency, rational expectations theorists have tried to incorporate serial correlation into their models. Apart from some initial minor justifications relying on the "incompleteness" of historical published data surveys¹⁰, the way to escape from this apparent inconsistency was found in the analytical distinction between *sources of macroeconomic uncertain environment*, the Arrow-Debreu microeconomic hypothesis of *perfect complete markets*.

⁹There are many interpretations of the development of rational expectations economics along the years. Thomas Sargent, for example, gives us a sense of the richness of it. Sargent entertained different interpretations of rational expectations in different periods. In the late 1960s through early 1970s, he used an econometrically motivated interpretation of rational expectations with a focus on restricting distributed lags. In the late 1970s through early 1980s, this emphasis changed to restricting vector auto-regressions. In the early to mid-1980s, Sargent focused on how rational expectations in a general equilibrium framework could lead to vector auto-regressions. In the late 1980s through early 1990s, Sargent tried to show convergence to rational expectations through learning by agents, economists, and econometricians alike through the use of adaptive expectations or artificial intelligence (Sent, 1998).

¹⁰As suggested by Sargent (1979, p.331), if "*the price indexes appropriate to agents' decisions are never collected, so that the published price indexes are error-ridden*", rational expectations predictions could be not achieved.

impulses and *propagation mechanisms* of business cycle (Lucas, 1980). The leading idea was to construct propagation mechanisms converting unexpected impulses (or shocks) into serially correlated movements, while keeping those impulses serially uncorrelated. The main implication of this procedure is that observed fluctuations are not deviations from the natural rates of macro-variables but they have to be understood as the optimal dynamic response of agents to an external random shock still allowing the orthogonality property to hold (Kyun, 1988, pp.9-13). What kind of propagation mechanisms have been proposed? Since the Lucas model proved that the "demand side" policy had not real effects on macro variables, the only way to explain such a phenomenon was to refer to the "supply side" effects. With the well-known paper "Theory ahead of business cycle measurement" published in 1986 by Edward Prescott, the "real business cycle theory" became the basic paradigm to deal with fluctuations in orthodox economic theory. Using the tools offered by "linear dynamic programming"¹¹ to deal with agents' dynamic optimization over time and technological shocks, this celebrated paper showed that a neoclassical growth model in which there are economic agents with rational expectations and markets that clear, can produce business cycle fluctuations of the type experienced in capitalist economies (Dal-Pont, 2004). These models have two striking implications. First, since they are rational expectations equilibrium models, government intervention advocated by Keynesian economists are not welfare improving. Second, they indicate that in the post World War II period, technology shocks, and not monetary shocks, have been the major source of business cycle fluctuations. Although diverse propagation mechanisms has been introduced in the real business cycle literature, the common theme is that (a) produced inputs, and (b) interrelations between sectors, are important for understanding the persistence and co-movement of time series¹² (King and Plosser, 1984). Finally, it is worth to observe that REH soon has become a non-discussible principal also in the New Keynesian Economics (NEK) approach to business cycle of '80s and '90s. The NEK's criticism of equilibrium business cycle refers to two relevant issues: (a) the use of representative

¹¹The narrative about how rational expectation theory met "linear dynamic programming" to explain macroeconomic dynamics is well treated by Sent (1996). Speaking about Sargent and his connection with engineering mathematics, Sent pointed out that this was a typical case in which "convenience" met a "well-defined" scientific purpose.

¹²Long and Plosser (1983), for instance, emphasize intra-temporal and inter-temporal substitutions of consumer preferences and production possibilities, while Kydland and Prescott (1982) present a business cycle model based on the assumptions of multi-period construction and non-time-separable utility function.

agent paradigm and (b) the hypothesis of perfect competitive markets. Greenwald and Stiglitz (1986, 1993) showed that the presence of asymmetric information in market places can provide microeconomic foundations for explaining business cycle fluctuations. Other authors as Goodfriend and King (1997), Rotemberg and Woodford (1999), McCallum and Nelson (1999) and others showed that imperfect competition, externalities, costly price adjustment, information breakdowns and other kind of "stickiness" can represent important elements in producing nominal rather than real shocks providing business cycle fluctuations. Nevertheless, since these new approaches to business cycle strictly refer to the general equilibrium model as micro-foundation framework, they can not be able to renounce to rational expectations macro-consistency so that, at least to some extent, they all show a certain strong degree of continuity with the Lucas program even if their normative recommendations are sometimes contrasting to those provided by equilibrium business cycle theorists¹³.

3 REH and the econometric practice of the '70s

In 1976, Lucas provided a revolutionary proposition deriving from adopting REH in macroeconomic models: the so-called "Lucas critique" that had devastating implications for the usefulness of Keynesian econometric models for evaluating policy. Policy evaluation with Keynesian econometric models involved as assumption that the parameter estimates in the model's equations, which have been estimated from past data, are invariant to changes in policy. Then a policymaker can conduct simulations under different policy scenarios to decide which scenario produces the best outcomes. Optimal control procedures derived from engineering literature can be used to solve for optimal policy given a particular loss function. Lucas' challenge of this procedure for evaluating policies is based on a simple principle of rational expectation theory: the way expectations are formed (the relationship of expectations to past information) changes when the behavior of forecasted variable changes. So when policy varies, the relation between expectations and past information will change, and because expectations affect economic behavior, the relationships in econometric model will modify. The econometric model, which has been estimated with past data, is then no longer the correct model for evaluating the response

¹³For a complete overview of current "normative" macroeconomic trends in models adopting REH, see the works of Taylor (2000), Blanchard (2000) and Woodford (1999).