



## Living in an imaginary world that looks real

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### ABSTRACT

In the paper we show – using standard approaches, general equilibrium modeling and the assumption of complete rationality – that the macroeconomic environment is endogenous and is indeterminate. Specifically, it is argued – without resorting to sunspot type arguments – that microeconomic fundamentals do not suffice to characterize the economy at the macro level. In particular, we show how perceptions of rational agents of the workings of the economy (a) shape the environment, (b) affect the environment sufficiently to ensure that rational economic agents find the observed environment consistent with their beliefs even though it is not. As a by-product, we illustrate that endogenous macro uncertainty can arise as an outcome if rational economic agents whose expectations are anchored on endogenous variables expect them to arise. Finally, we show that systematic errors can persist indefinitely under rationality.

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## 1. Introduction

We construct an economy occupied by fully rational economic agents who base their actions on beliefs that stem from an underlying theory, which includes a complete description of the economy at the micro-level. Individual actions based on private beliefs lead to real outcomes and determine the actual allocation. Rational economic agents observe the ensuing allocation and confront their beliefs with the observed outcomes and find their beliefs consistent with the observed environment despite the fact that their beliefs do not reflect reality. Naturally, we consider the former condition to be in fact a prerequisite for logical macroeconomic modeling as it has long been recognized that macroeconomic systems are self-referential. However, at the same time it may appear that the assumption of complete rationality implies that the former and the latter condition are mutually exclusive as systematic errors of perception cannot perpetuate indefinitely. In the paper we argue the opposite and show in a general equilibrium framework that rational agents can consider themselves to be correct all the time even though they constantly err. More precisely, we show that economic agents can become convinced that they possess a complete description of the economy despite the fact that their data-verified beliefs do not correspond to the true description of reality.

We derive our results in a number of steps. First we make a noncontroversial observation and note that beliefs held by economic agents influence their decisions and consequently shape market equilibria and in turn determine aggregate

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outcomes. Naturally, we require that the beliefs themselves be in equilibrium, i.e., that the beliefs held by economic agents correspond to the observed equilibrium outcomes. In other words, we do impose on the beliefs the standard notion of consistency and require that they be at a fixed point. In that sense, our contribution fits fully into the standard framework. However, we show that the standard requirement that the beliefs be consistent with observables does not suffice to identify a model. Specifically, we show in a general equilibrium model based on Matsuyama (1999) that beliefs held by economic agents can sufficiently affect the equilibrium dynamics to ensure that the equilibrium dynamics are consistent with the beliefs despite the fact that in reality the dynamics are generated by a different, but still endogenous, process. In other words, we show that it can be the case that agents rationally consider themselves to be correct all the time despite the fact that they happen to be constantly wrong. Formally, we construct a model in which perceptions held by economic agents affect the equilibrium and the observed dynamics are consistent with the underlying perceptions. However, the observed dynamics are generated by a process distinct, but still endogenous, from the one deemed correct by economic agents.

Despite the fact that our agents err in equilibrium, we never depart from the assumption of complete rationality. In fact, all our agents are fully rational all the time. Specifically, our rational agents postulate a theory that is to describe the workings of the economy, and, in particular, the theory comprises a complete description of the micro-structure of the economy. Then given the theory, agents behave rationally and, in particular, derive the correct macro-level relationships stemming from the underlying micro-level description. Having derived the macro-level relationships rational economic agents test – using the observables (macro-level data generated by an endogenous process) – the theory and find the theory consistent with the data. In that sense, our agents are both rational and correct since their perceptions of reality are confirmed by the data. However, we show that at the same time our agents are wrong since the micro-structure they postulate to occur is in fact nonexistent.

There are numerous contributions that we consider related to our paper. Specifically, in spirit we perceive our paper to be most closely related to the sunspot idea of Cass and Shell (1983) who point out that forward looking equations can admit more than one solution. In our paper, however, the results are derived without appealing to the presence of exogenous coordination devices and without shocks to expectations. Moreover, in the case of our paper agents form expectations with regard to endogenous equilibrium variables with expectations being always rational and given by a time invariant rule.

Our approach can be considered to be complementary to that presented in Hommes et al. (2013) who show that it can be the case that expectations based on a simple linear forecasting rule can be in fact consistent with the underlying process even if the underlying process is nonlinear. Naturally, we share main premise of Hommes et al., however, pursue a dual approach as we try to reconcile the concept of Consistent Expectations Equilibrium with perfect rationality of economic agents. Hommes et al., on the other hand, extend the concept of CEE in the opposite direction and study the existence and stability of Stochastic Consistent Expectation Equilibria while adhering to the notions of bounded rationality.

The paper shares a major theme with a recent contribution by Eusepi and Preston (2011) who studied a feedback mechanism between private decisions and perceived aggregate equations. However, in our context the link between micro and macro relationships is fully identified and known by economic agents. Moreover, agents in our model are fully rational whereas agents described by Eusepi and Preston must rely on constant gain learning and only have a limited picture of the economy. Finally, in our context the uncertainty is endogenous and constitutes an outcome rather than an assumption.

From the conceptual point of view our contribution can be viewed as a constructive response to the challenge posed by Grandmont (1998) who introduced the notion of a self-fulfilling mistake. Specifically, we provide an explicit example of an economy where rational economic agents err, but never learn that they do as the underlying observables make not only the identification of errors impossible, but, in fact, justify also the original misperceptions and, thus, make the mistakes self-fulfilling.

We consider our paper to be related to the work of Sorger (1998) who in his contribution presents an example of an economy where economic agents make a self-fulfilling mistake. Specifically, Sorger shows that it can be the case that economic agents who believe that the interest rate follows a random process decide to accumulate physical capital at the rate, which is consistent with private beliefs, and at the same time results in the path of the interest that looks as if it were random validating the beliefs. In the paper, we share the basic premise expressed by Sorger; however, our contribution makes an extra step – we constructively bring the concept of CEE proposed by Hommes (1998) to the standard of the REE of Lucas (1972) – as it never departs from the assumption of complete rationality. Agents in our model are always fully rational; they incorporate and understand the micro-structure of the economy. In particular, they are aware of the true relationship that describes the actual values of the interest rate, whereas in Sorger's case agents are boundedly rational and the actual relationship defining the interest rate escapes their attention.

Many contributions, e.g., Brock et al. (2006), argue, in particular, that there could be numerous descriptions of macroeconomic data. Specifically, Brock et al. show that a rational external observer could, in principle, mistakenly accept a model as valid even though the reality is described with an unrelated model. In the paper we make a similar point, but we differ substantively as mistakes in our framework are made within the model by an internal actor whose actions shape the reality, which, thus, is endogenous and affected by the mistakes.

From the technical point of view we build on and extend the noise traders literature, which has gained some popularity without earning a universal appeal since it incorporates irrational behavior, originated by Grossman and Stiglitz (1976). Specifically, in this paper, we show that we effectively can, without ever departing from the notion of complete rationality, obtain the effects that appear when irrational noise traders are present. This occurs, in our framework, as the imputed behavior of nonexistent irrational agents who are presupposed to exist affects the beliefs of fully rational agents – all

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