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Misperception-driven chaos: Theory and policy implications

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Abstract

In a large economy, it is extremely difficult, if not impossible, to immediately grasp the state of our surrounding environment with precision since we normally have access only to a subset of relevant information. In this paper, we introduce this information imperfection into an ordinary model of endogenous business cycles and examine how it would affect the dynamic nature of the model. We, in particular, present a mechanism by which observation errors result in chaotic fluctuations in a model that would behave regularly otherwise, thereby indicating the importance of potential misperception about the current state in a qualitative sense. Also, our model is tractable enough to explicitly derive a policy index of chaotic fluctuations under some conditions. This feature of the model allows us to draw some policy implications regarding the observability of macroeconomic state variables.

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1. Introduction

In real life, we often face problems arising from the lack of information about our surrounding environments. It is especially true at the aggregate level since it is hard to immediately grasp the state of the entire economy that we live in. In many cases we never know whether what we observe accurately reflects the true state of the economy: one prominent example to capture this situation is Lucas (1972) where agents are unable to distinguish real disturbances from nominal ones. There is little doubt that the limited observability of macroeconomic state variables is a ubiquitous feature of our life.

In this paper, we incorporate such an information imperfection into an otherwise ordinary model of endogenous business cycles and illustrate how it can affect the dynamic nature of the model. To this end, the present model builds on a model of endogenous business cycles, developed by Ishida and Yokoo (2004), which consists of two critical assumptions: first, it considers the effect of knowledge spillovers where firms are more productive when more firms engage in innovations; second, while each firm can innovate and upgrade its project, this innovation process is time consuming in that a firm which chooses to innovate its project must stay inactive for that period. Under these assumptions, the dynamics of the model is characterized by a piecewise linear difference equation with two distinct regimes and exhibits asymmetric periodic cycles of arbitrary period.[1] This baseline model is augmented by potential misperception about the current state, by which we mean that firms can observe relevant state variables only with some noise. The addition gives rise to complicated dynamics including both transient and observable chaos, i.e., chaotic fluctuations driven by misperception about the current state.

Given this structure, there are two main issues we would like to stress in this paper. First, the present model sheds light on a simple mechanism by which observation errors lead to chaotic fluctuations in an economy which would behave with some regularities otherwise. This result indicates that potential misperception about the current state can be an important source of dynamic diversity, especially complexity. Since the present model is based on a model of asymmetric business cycles, the model provides a simple way to capture the aperiodic and asymmetric nature of business cycles in a deterministic framework.[2]

Second, the present model, which turns out to be piecewise linear, is simple and tractable enough to compute the time average of technological innovations under some conditions by using the techniques of Frobenius–Perron operators to compute invariant measures (see, e.g. Boyarsky and Scarowsky, 1979; Boyarsky and Góra, 1997). This feature of the model allows us to explicitly compute and assess some policy

[1] Matsuyama (1999) is another notable example where the economy endogenously switches between different regimes.

[2] There is now ample evidence that business cycles are asymmetric in nature. See Hamilton (1989), Beaudry and Koop (1993), McQueen and Thorley (1993), Hess and Iwata (1997), Caner and Hansen (2001) and Razzak (2001).