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Inflation expectations and macroeconomic dynamics: The case of rational versus extrapolative expectations

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ABSTRACT

The motivation of this paper is to understand the effects of coupling a macroeconomic model of inflation rate dynamics, relying on an aggregate expectation, to a heterogeneous expectations framework. A standard model composed of Okun's law, an expectations-augmented Phillips curve and an aggregate demand relation is extended to allow agents to select between trend-following and rational expectations to predict the future inflation rate. Using a mixture of analytical and numerical tools we investigate the model's dynamics and discuss the conditions under which the extended model leads to endogenous fluctuations in macroeconomic variables. Some preliminary results are offered for the case in which a Taylor-like monetary policy rule is included in the model.

1. Introduction

The aim of our paper is to explore the interplay between heterogeneous expectation formation and macroeconomic dynamics. Our starting point is the monetary model. Its basic ingredients are Okun's law and the expectations-augmented Phillips curve, used to describe the supply side of the economy, and an output growth relation driven by changes in both nominal money growth and inflation. The novel feature of our model is how we treat the agents' expectation formation behavior.

To make matters as simple as possible, agents either use a sophisticated, costly predictor or they use an easy, cheap predictor (as in Brock and Hommes, 1997). Agents select between competing forecasting strategies based on forecasting accuracy, measured in terms of squared forecasting errors. The aggregate expectation, a weighted average of the two, is a factor in the expectations-augmented Phillips-curve. Except for the interacting expectation formation process, we therefore use a standard (textbook) macroeconomic model (Blanchard, 2005).

We have investigated the effects of heterogeneous expectations on the dynamics of the model through a combination of mathematical analysis and numerical simulations. The results should prove useful to the increasing number of scholars

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who are integrating the heterogeneous expectation framework into their own modeling environment.[1] Related studies include Westerhoff (2006a), Lines and Westerhoff (2006a) and Lines (2007a). In these papers, a basic goods market model is used and agents switch between prediction strategies depending on how far the economy has deviated from its long-run equilibrium value. For instance, there is a shift from extrapolative expectations to reversion expectations as national income moves away from its equilibrium value. Westerhoff (2006b) also uses a simple goods market model but focuses on a situation in which predictor choice depends on an evolutionary fitness measure.

Branch and McGough (2006, 2009) introduce heterogeneous expectation formation in a New Keynesian framework. In their model, agents have to predict both the future inflation rate and the future output level. A key goal of their papers is to derive a setting in which the heterogeneous expectation formation is consistent with a utility maximization framework. Another interesting contribution is by Franke (2007) in which agents use different forecasting rules to predict the inflation rate. Then the average of these inflation forecasts is used as a proxy for the current inflation climate which, in turn, is relevant for the agents' price and wage setting behavior, modeled via the Phillips curve. Anufriev et al. (2008) and De Grauwe (2008) are two recent interesting examples in which monetary policy rules are investigated in macroeconomic models with heterogeneous expectations.

Closely related to these contributions are models in which agents may display some kind of learning behavior (see Evans and Honkapohja, 2001, for a general survey on learning in macroeconomics). For instance, Berardi (2007) considers a model which is populated by two different types of agents who learn through recursive least squares techniques the parameter values of their forecasting strategies. Tuinstra and Wagener (2007) go one step further and study an evolutionary competition between two different estimation procedures. Overall, these models find that bounded fluctuations in macroeconomic variables may emerge even in the presence of learning behavior. Moreover, Marcet and Nicolini (2003) show that their model of "quasi-rational learning" mimics some key stylized facts observed during the recurrent hyperinflations experienced by several countries in the 1980s quite well. Other interesting learning models include Branch and Evans (2006) and Honkapohja and Mitra (2006). Given the explanatory power of these approaches they appear quite relevant for policy evaluation.

The complicated dynamics of our models are obviously due to the nonlinearities in the expectation framework. There are, of course, a number of other interesting macroeconomic models which use other mechanism to generate endogenous dynamics, e.g. Day (1999), Rosser (2000), Lines (2005) and Puu and Sushko (2006). In our case, fluctuating long run dynamics are due to a permanent evolutionary competition between the prediction rules. For example, if agents have the choice between rational and extrapolative expectations, the dynamics of the model may be sketched as follows. Suppose that a large fraction of the agents rely on the rational predictor. Then the dynamics is stable and a convergence towards a "normal" steady state sets in. However, the system does not necessarily settle down on this fixed point. For instance, close to the steady state the forecasting accuracies of both predictors become similar. If a sufficient number of agents switch to the extrapolation predictor, the steady state becomes unstable and oscillation in key macroeconomic variables are triggered. Rational expectations may gain in popularity again when the prediction errors of extrapolative expectations become strong. This sequence repeats itself, with the dynamics further complicated by macroeconomic feedback processes (which will be explained below).

In Section 2 we present the full model. In Section 3 we investigate dynamics in the case of rational versus extrapolative predictors. Conclusions are offered in Section 4. In the Mathematical Appendix we derive the critical values of parameters for loss of local stability of the unique fixed point for both pairs of expectations.

2. The model

The basic model we use to describe inflation rate dynamics combines three macroeconomic relations: Okun's law, an expectations-augmented Phillips curve and an aggregate demand relation. These quite standard macroeconomic tools are discussed in detail in Blanchard (2005), for example. The novel feature of our model is the introduction of a framework for exploring the effects of various expectation operators on the dynamics of the inflation rate. We first derive the results of assuming a single expectation strategy. Then, following Brock and Hommes (1997, 1998), we assume that the agents have the choice between different types of forecasting rules and select between them depending on their predictive capacity, which plays the role of an evolutionary fitness measure.

2.1. The macroeconomy

Consider Okun's law, which states that changes in unemployment are related to output growth. We denote by u_t the unemployment rate, by g_t the output growth rate and by g_n the so-called normal output growth rate, and Okun's law may be formalized as

$$u_t - u_{t-1} = -\beta(g_t - g_n), \quad \beta > 0. \tag{1}$$

[1] The most obvious applications have been to the modeling of financial markets, such as in the works of Day and Huang (1990), Lux (1995), Brock and Hommes (1998), and Chiarella et al. (2002).