International Journal of Forecasting 33 (2017) 988–1006

Contents lists available at ScienceDirect

International Journal of Forecasting

journal homepage: www.elsevier.com/locate/ijforecast

Adaptive expectations versus rational expectations: Evidence from the lab

Annarita Colasante *, Antonio Palestrini, Alberto Russo, Mauro Gallegati

Università Politecnica delle Marche, Piazzale Martelli 8, Ancona, Italy

ARTICLE INFO

Keywords:
Price forecasting
Financial market
Experiment
Panel data
Forecasting practice

ABSTRACT

The aim of the present work is to shed light on the extensive debate about expectations in financial markets. We analyze the behaviors of subjects in an experimental environment in which it is possible to observe expectations directly, since the sole task of each player is to predict the future price of an asset. We investigate the mechanism of expectation formation in two different contexts: first, where the fundamental value is constant; second, where the fundamental price increases over repetitions. First of all, we look at whether there is a convergence to the rational equilibrium even if agents have adaptive expectations, according to the main results of Palestrini and Gallegati (2015). Moreover, we concentrate on the accuracy of aggregate forecasts compared with individual forecasts. We find that there is *collective rationality* instead of *individual rationality*. In the context of an increasing fundamental value, contrary to theoretical predictions, players are able to capture the trend, but underestimate that value. This implies that there is no full convergence to the rational expectations equilibrium if all agents make their forecasts according to an adaptive scheme.

1. Introduction

The recent financial crisis highlighted the importance of agents' behaviours in the financial market, as well as the impacts of individual financial choices on the real economy. Agents make choices based on their expectations. As was suggested by Assenza, Bao, Hommes, and Massaro (2014), we should think of an economy as an expectation feedback mechanism in which expectations influence individual decisions, and these choices define the realisation of the main macro or financial variables.

The present work analyses individual behaviours in an experimental asset market in which the sole task of each player is to predict the future price of an asset, based on two sources of information: (i) past realizations of the asset price in the market, which are a function of the average individual expectations, and (ii) current information about the mean dividend and the interest rate. We run two different treatments, where the only difference is the fundamental price. Each treatment involves six groups of six players. In Treatment 1, the fundamental price is constant and equal to 60, while in Treatment 2, the fundamental price increases over repetitions. The aim of this work is to obtain an understanding of the way in which agents form their expectations about future prices, and we seek to determine whether aggregate expectations are unbiased, even in the absence of communication. The key difference between this study and the existing literature is that we analyse expectation formation in a context that is characterised by price instability. The only contribution in which an increasing fundamental is presented is the work by Noussair and Powell (2010), but their focus is on bubble formation in an asset market with trade. We analyse the mechanism of the *error correction bias* by taking into account a dividend with a drift. This theoretical approach is based on the evidence that rational expectations are mean-zero expectation schemes. However, even though adaptive expectation schemes often seem to be an accurate

* Correspondence to: University Jaume I, Castellón de la Plana, Spain.
E-mail address: colasante.a84@gmail.com (A. Colasante).

http://dx.doi.org/10.1016/j.ijforecast.2017.06.003
0169-2070/

representation of actual agent behaviours in an empirical analysis (see Chow, 2011), this scheme does not seem to satisfy the unconditional mean-zero requirements, i.e., the necessary condition for rationality. The idea behind the error correction is to include a term in the adaptive expectation scheme that will fulfil the requirement of the zero unconditional mean. We discuss this approach in more detail in Section 2.

We use the learning-to-forecast experiment to analyse not only players' forecasting abilities, but also the level of coordination in the group. Each player must predict the price, but the price depends on the expectations of other players. This means that players should be forecasting an endogenous price, but in order to do so, they must be able to infer the predictions of other participants.

The rational expectation hypothesis (REH), first introduced by Muth (1961) and analysed in detail by Lucas Jr. and Prescott (1971), is the bearing-wall of the mainstream approach. According to this hypothesis, agents make no systematic errors in forecasting, taking into account the entire set of available information.[1] Muth takes into account the early work of Galton (1907), who pointed out that individual expectations are wrong, but that an aggregation of individual predictions can provide unbiased expectations. Recent studies, based on both simulation and experimental evidence, have showed that this approach is often unrealistic; that is, agents do not have sufficient capabilities to make rational predictions (Branch, 2004; Evans & Honkapohja, 2001; Sargent, 1993 see for example). An alternative hypothesis is that agents form their expectations based on an adaptive rule, namely that the forecast is a function of both past expectations and past realisation.

The mainstream approach does not consider the adaptive expectation scheme to be appropriate for forecasting models, since it may not satisfy the necessary condition for rationality. This condition is based on the assumption that agents make non-systematic prediction errors, and as a result, the errors' unconditional mean is equal to zero. The increasing body of experimental evidence (Anufriev & Hommes, 2012; Hommes, 2011) shows that individuals make forecasting errors when predicting the future value of an asset or the price of a commodity. Moreover, it has been shown that a combination of different forms of adaptive expectation rules produces a process that fits the experimental data very well.

This work introduces the possibility of revising the classical adaptive expectation scheme in order to achieve the condition of a zero unconditional mean. We propose a theoretical model for proving that the unconditional mean is equal to zero if we include *bias correction parameters* in the baseline scheme. Indeed, it can be proved that this correction does not alter the stability of the system, but instead increases the volatility of the variables. This mechanism introduces a trade-off between volatility and bias that can be analyzed in detail in the model validation step of an economic analysis.

The paper is organised as follows: Section 2 introduces the error correction approach, and Section 3 describes the experiment and the main results. Expectations are analysed in Section 4, while Section 5 checks the error correction bias in our setting. Finally, a conclusion is provided in Section 6, after which Appendix A describes the experimental instructions.

2. Error correction mechanism

This section shows how, under certain assumptions, the adaptive expectation scheme should satisfy the rationality condition, i.e., the zero unconditional mean. Usually people's behaviour is consistent with the *adaptive expectation* (Nerlove, 1958). This means that agents adjust their expectations at $t+1$ by comparing their expectations at t with the price information set available in period t. In Nerlove's classic work, the price information set is the realized price at time t, whereas our experiment follows Hommes, Sonnemans, Tuinstra, and Van de Velden's (2005) line of research, in which an agent's information set is the realized price at time $t-1$. For the sake of explanation, the rest of this section follows Nerlove's convention. In this case, agents look at the past realisation of the price (p_t) and try to correct their forecasting errors (p^e_{t-1}) in each period. The expected price can be written either as

$$p^e_{t+1} = p^e_t + \lambda(p_t - p^e_t) \quad 0 < \lambda \leq 1, \tag{1}$$

or as a linear combination of past realisations and past predictions:

$$p^e_{t+1} = \lambda p_t + (1-\lambda)p^e_t. \tag{2}$$

The formulation of Eq. (1) suggests that agents make systematic forecasting errors ($p_t - p^e_{t-1}$), and moreover, that they include this error in their own future predictions. This implies that individuals should underestimate (overestimate) the realized price because of this correction mechanism. Taking into account this definition, it is possible to assert that adaptive expectation schemes may generate a bias.[2] Indeed, adaptive expectations are *backward looking* because they take into account only past information when predicting future values. For example, if agents use the mean of the past three periods

$$x^e_{t+1} = \frac{1}{3}(x_t + x_{t-1} + x_{t-2})$$

as an expectation of variable x_t and the variable has a drift, say $\Delta x_{t+1} = d$, then the error/bias $\Xi_{t+1} = x^e_{t+1} - x_{t+1}$ is

$$\Xi_{t+1} = \frac{1}{3}((x_{t-2} + 2d) + (x_{t-2} + d) + x_{t-2}) - (x_{t-2} + 3d)$$

[1] Muth's analysis is based on three assumptions: (1) information is scarce, and the economic system generally does not waste it; (2) the way in which expectations are formed depends specifically on the structure of the relevant system describing the economy; (3) "public predictions", in the sense of Grunberg and Modigliani (1954), will have no substantial effect on the operation of the economic system (unless they are based on inside information). In a sense, Muth stresses that the rational expectation hypothesis is designed only to represent the heterogeneous behaviours of entrepreneurs: "It *does not* assert that the scratch work of the entrepreneurs resembles the system of equations in any way; nor does it state that predictions of entrepreneurs are perfect or that their expectations are all the same" (p. 317).

[2] This is the reason for our introduction of rational expectations into macroeconomic models within the *determinate parametric space* (Blanchard & Kahn, 1980).