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Abstract In this paper, we present the results of a Learning-to-Forecast Experiment (LtFE) eliciting short- as well as long-run expectations about the future price dynamics in markets with positive and negative expectations feedback. Comparing our results on short-run expectations to the LtFE literature, we prove that eliciting long-run expectations neither has an impact on the price dynamics nor on short-run expectations formation. In particular, we confirm that the Rational Expectation Equilibrium (REE) is a good benchmark only for the markets with negative feedback. Interestingly, our data show that the term structure of the cross-sectional dispersion of expectations is convex in positive feedback markets and concave in negative feedback markets. Differences in the slope of the term structure stem from diverse degrees of uncertainty on the evolution of prices in the two feedback systems: (i) in the negative feedback system, the convergence of the price to the REE mirrors into a tendency for coordination of long-run expectations around the fundamental value; (ii) conversely, the instability of the REE in the positive feedback system and the resulting oscillatory price dynamics are responsible for the diverging pattern of long-run expectations. Finally, we propose a new measure of heterogeneity of expectations based on the scaling of the dispersion of expectations over the forecasting horizon.

Keywords Long-Run Expectations · Heterogeneous Expectations · Experiment · Coordination · Convergence · Learning-to-Forecast Experiment.
JEL: D03, G12, C91

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1 Introduction

The expectations of an economic agent on the future state of the economy affects her individual choices. When aggregating all individual choices, their expectations influence the realizations of the macroeconomic quantities. At the same time, the evolution of macroeconomic aggregates impact how agents revise their expectations. The Economy can be, then, model as an expectations feedback system. How agents form their expectations at the individual level, therefore, plays an important role in understanding the dynamics of aggregate outcome in Economics. The rational expectation framework gives a normative indication on how expectations should be consistently formed within a given model, typically ignoring the presence of heterogeneity among agents' expectations. Nevertheless, it is widely accepted that individuals possess heterogeneous expectations about the evolution of macroeconomic aggregates. Put it differently, "not everyone has the same expectations", Mankiw et al. (2004). The origin of the heterogeneity across individual expectations and the role that it plays in shaping aggregate outcomes is an important topic in theoretical as well a empirical investigation in Macroeconomics. The fact that expectations are not directly observable, like prices or volumes, constitutes a relevant limitation for fully understand their precise role in driving the macroeconomic aggregates.

Conducting forecasting surveys is one of the methods traditionally used to elicit individual expectations (see Manski (2004)). This methodology has been extensively used in Macroeconomics, for instance, in testing for forecasters accuracy and rationality. Only recently, disagreement about expectations, measured as the cross-sectional dispersion of forecasts, and its evolution over time have become in itself a variable of interest. It seems to carry information on the uncertainty about, for instance, future development of business cycles or inflation rate (see Mankiw et al. (2004)). In order to disentangle whether the origin of the observed forecasts dispersion is a measure of intrinsic uncertainty of macroeconomic variables or it reflects heterogeneous priors of forecasters, Patton and Timmermann (2010) focus on how expectations dispersion evolves over different time horizons. They study the term structure of cross-sectional dispersion of forecasts, observing that it typically increases with the forecasting horizon. Their analysis reveals that such persistent heterogeneity of expectations among forecasters in the short-run stems from different private information, whereas in the long-run is due to the forecasters heterogeneity regarding their priors and/or prediction models.

Laboratory experiments, like surveys, give us the possibility to directly elicit individual expectations, with the additional advantages of monitoring the information available to the subjects and using performance-based incentives. Within the experimental literature, LtFEs, introduced by Marimon et al. (1993), allow to study the formation of individual expectations within different expectations feedback systems, where the price depends on subjects' predictions. By using this experimental framework, many experiments investigate agents' expectations in financial markets (Hommes et al. (2005),Bao and

Ding (2016)), commodity markets (Bao et al. (2013)) and in a macroeconomic framework (Assenza et al. (2011); Cornand and M'baye (2016)), just to cite a few contributions. In those articles, subjects have to predict prices within an horizon of one or two steps-ahead. One of the most pervasive empirical findings is that often rational expectations do not constitute a good predictor for subjects' expectations. Subjects, instead, show a certain degree of heterogeneity in their predictions. However, the reported level of heterogeneity is based on subjects' short-run predictions, which might distort the evaluation of their level of disagreement. What would happen if we evaluate subjects' heterogeneity eliciting long-run expectations?

In order to answer to this question, we conduct a LtFE in which, unlike the standard settings[1], subjects submit predictions at time horizons ranging from one- to more than ten-steps ahead. We elicit subjects' long-run expectations at the beginning of every period, giving the possibility to revise their expectations as new information becomes available. We extend the novel setting introduced by Colasante et al. (2018), comparing two different expectations feedback systems, following the original contribution of Heemeijer et al. (2009), that considers short-run predictions only. As in Heemeijer et al. (2009), we run two treatments: one with positive and one with negative feedback system. The positive feedback system mimics the behavior of financial markets where prices typically raise if investors expect positive changes. Conversely, the negative feedback system describes commodities markets where, due to the delay in the production adjustment, market prices move in the opposite direction with respect to expectations. The aim of our experiment is to investigate the impact of the expectation feedback system in the formation of long-run expectations.

Our results on coordination and convergence of short-run expectations, as well as on the evolution of prices, are in line with those reported in the LtFEs literature (see Hommes (2015)). Moreover, following the literature on macroeconomic forecasts based on surveys, we investigate the degree of disagreement of subjects' expectations at different time horizons, measuring the term structure of the cross-sectional dispersion of expectations. We propose a one-parameter term structure model to characterize the degree of disagreement of expectations in the two treatments. Such characterization provides us with relevant information on how subjects form their long-run expectations. Enlarging the forecasting horizon reveals that subjects learn the REE in markets with negative feedback. We observe that the dispersion of long-run expectations around the fundamental price reduces over time to reach almost fully convergence and coordination on REE. By estimating the term structure of expectations, we demonstrate that mutual coordination of expectations and their convergence to the fundamental price follow the same pattern. Conversely, in the market with positive feedback, we find a persistently high level of disagreement among forecasters, measured as a convex shape of the

[1] For a comprehensive survey on macroeconomic experiments on expectations see Assenza et al. (2014)

term structure, which is compatible with a heterogeneous extrapolative rules employed by subjects when forming their expectations.

The rest of the paper is organized as follows: in section 2, we describe the experimental setting; in section 3, we introduce the theoretical framework and the working hypotheses; section 4 presents the results of our empirical analysis; section 5 summarizes the main findings and concludes.

2 Experimental Design

We conduct a LtFE similar to Colasante et al. (2018) where the task of subjects is to forecast the evolution of prices at different time horizons. In order to test the effect of the feedback system on expectations formation, we implement two treatments: in the first treatment, we consider a market with a positive feedback, whereas in the second treatment we consider a market with a negative feedback between subjects' expectations and market price.

Each market consists of 6 subjects playing the role of professional forecasters for 20 periods (see the translated instructions in Appendix B.1). Subjects are asked to submit their short- and long-run price predictions. This means that, at the beginning of period t, subject i submits her short-run prediction for the market price at the end of period t, denoted as ${}_ip^e_{t,t}$, as well as her set of long-run predictions for the price at the end of each one of the $20-t$ remaining periods. Long-run predictions are denoted as ${}_ip^e_{t,t+k}$with $1 \leq k \leq 20-t$.[2]

We implement the adjustment mechanism of prices proposed by Heemeijer et al. (2009) and employed by Colasante et al. (2018) in a LtFE eliciting long-run expectations. In the positive feedback treatment the realized price depends positively on the average short-run price forecasts. The adjustment mechanism is:

$$p_t = p_f + \frac{1}{1+r}(\bar{p}^e_{t,t} - p_f) + \epsilon_t \ . \tag{1}$$

In the negative feedback treatment the realized price each period depends negatively on the average subejects' short-run forecasts and it is computed as follows:

$$p_t = p_f - \frac{1}{1+r}(\bar{p}^e_{t,t} - p_f) + \epsilon_t \ , \tag{2}$$

where r= 0.05 in all sessions and d is equal to 3.5 or 3.25 depending on the session.[3] The constant fundamental price is computed as $p_f = \frac{d}{r}$. The term $\bar{p}^e_{t,t}$ in the pricing equation is the average of the six one-step-ahead predictions submitted at the beginning of period t, $\bar{p}^e_{t,t} = \frac{1}{6}\sum_{i=1}^{6} {}_ip^e_{t,t}$. Finally, the term $\epsilon_t \sim N(0, 0.25)$ is an iid Normal shock. The main difference between eq. (1)

[2] Although we collect from each subject 20 one-step-ahead predictions instead of 50 as in most LtFEs, within our experimental setting, we can monitor the entire time-spectrum of expectations and its evolution over time.

[3] The values of the interest rate and average dividend are constant through a given session. To avoid the effects of communication among subjects between sessions, we set two different values of the dividend, so that we have some markets with a fundamental price of 65 and others with 70.

and eq. (2) is how expectations affect the price: eq.(1) describes a positive feedback system where subjects predictions are self-fulfilling, i.e. the higher is the average forecast, the higher will be the price; eq. (2) describes, instead, a system in which there is a negative feedback between expectations and price.

Individual earnings each period are computed as ${}_i\pi_t = {}_i\pi_t^s + {}_i\pi_t^l$ and depend on the accuracy of the subject's short- and long-run forecasts. We denote as ${}_i\pi_t^s$ and ${}_i\pi_t^l$ the profit depending on the accuracy of short and long-run expectations, respectively. Subjects' gains from their short-run predictions depend on a hyperbolic function depending on the quadratic forecasting errors:

$$ {}_i\pi_t^s = \frac{250}{1+\zeta_{i,t}} \qquad \text{with} \qquad \zeta_{i,t} = \left(\frac{{}_ip^e_{t,t} - p_t}{2} \right)^2 . \tag{3} $$

We define ${}_i\pi_t^l = \sum_{j=1}^{t-1} {}_i\pi^l_{t-j,t}$, where ${}_i\pi^l_{t-j,t}$ represents the individual profit associated with the accuracy of the prediction submitted by subject i at the beginning of period $t-j$ about the asset price in period t, where $1 \leq j \leq t-1$. It is computed according to the following payment schedule:[4]

$$ {}_i\pi^l_{t-j,t} = \begin{cases} 25 & \text{if} \quad 0 \leq {}_i\delta_{t-j,t} \leq 5 \\ 12 & \text{if} \quad 5 < {}_i\delta_{t-j,t} \leq 10 \\ 5 & \text{if} \quad 10 < {}_i\delta_{t-j,t} \leq 15 \\ 0 & \text{otherwise} \end{cases} $$

where ${}_i\delta_{t-j,t} = |{}_ip^e_{t-j,t} - p_t|$. The total profit of each subject is the sum of profits across all periods.[5]

The information set available to the subjects when submitting their predictions is: the interest rate (r), the average dividend (d), the time series of asset prices up to period $t-1$ as well as all their own (short and long-run) past predictions. Profits are calculated at the end of each period and subjects receive information about the earnings of the last period together with the cumulative profit up to the current period. In the instructions, we also provide qualitative information about the feedback system implemented in the market, namely if there is a positive or negative relationship between subjects' one step-ahead predictions each period and the realized price (in Appendix B.2 a screen shot of the experiment is shown).

The experimental sessions were conducted in the Laboratory of Experimental Economics at University Jaume I. A total of 90 subjects[6] participated

[4] We used a payoff mechanism similar to Haruvy et al. (2007). Note that we implement a step-function instead of a smooth payoff function equal to eq. (3) for long-run predictions. We consider that a smooth payoff function for the long-run predictions could probably discourage subjects to provide accurate forecasts, since they would perceive it as too a difficult task to gain profits.

[5] We gave the same weight to short and long-run predictions in the subjects' final payoff by calibrating the parameters of the pay-off functions such that approximately $\max \sum_{t=1}^{20} {}_i\pi_t^s = \max \sum_{t=1}^{20} {}_i\pi_t^l$.

[6] Each subject participated only in one session.

and 15 markets were implemented: 7 with positive and 8 with negative feedback. Each session lasted approximatively 50 minutes and the average gain was of 20 Euros.

3 Working Hypotheses

Given the price adjustment rules in eqs. (1) and (2), the REE predicts that the realized price p_t converges to the fundamental value with fairly small fluctuations proportional to the idiosyncratic shock term ϵ_t. If we assume that all subjects follow rational expectations, their predictions in each period t and for each forecasting horizon k fluctuate around the constant fundamental value independently of the expectations feedback system, i.e. ${}_ip^e_{t,t+k} \approx p_f$. Plugging this condition into eqs. (1) and (2), we obtain $p_t = p_f + \epsilon_t$.

Hypothesis 1: Under the rational expectations hypothesis, short- and long-run predictions as well as prices converge to the REE, independently of the expectations feedback system.

In our experimental setting, the REE does not depend on the expectations feedback system. On the contrary, as routinely identified in the LtFE literature, the feedback system plays a crucial role on whether and how prices converge to the REE and, additionally, on the dynamics of the coordination of expectations, i.e. on the disagreement among forecasters. Following the general theoretical predictions of Haltiwanger and Waldman (1989), in markets with positive feedback, subjects' short-run expectations can be considered as strategic complements. In those markets, hence, subjects have a strong incentive to mutually coordinate their short-run predictions although not necessarily to the REE. The convergence to the REE is indeed difficult to achieve, since it requires that (almost) all subjects' expectations are coordinated around the fundamental value. In markets with negative feedback, subjects' expectations can be considered as strategic substitutes, so that subjects have an incentive to predict low (high) prices when they expect that the other subjects will predict high (low) prices. In those markets, therefore, we expect to observe a lower degree of coordination of subjects' short-run expectations. Moreover, the convergence to the REE is more likely to be observed, since it is sufficient that the average of the expectations is close to the fundamental value, instead of the more stringent condition of the positive feedback, where (almost) all expectations should coordinate around p_f.

Heemeijer et al. (2009) show, by means of LtFEs, that the dynamics of individual one-step-ahead price predictions, as well as of the market realized price largely depend on the particular nature of the expectations' feedback, confirming the general theoretical predictions of Haltiwanger and Waldman (1989). In particular, they find that, in markets with positive feedback, subjects coordinate their individual one-step-ahead predictions in a few periods, while the realized price needs a much longer number of periods to achieve some degree of convergence to the fundamental value. On the contrary, under negative feedback, the realized price exhibits a fast convergence to the fundamental value, whereas subjects' predictions need a slightly higher number of periods to coordinate. Differently from markets with positive feedback, the coordination of short-run predictions goes almost in parallel to their convergence to the fundamental value.

Our experimental setting shares the main characteristics of the experiment reported in Heemeijer et al. (2009) and, therefore, we expect to observe a similar time series properties for prices and short-run expectations depending on the feedback system.

Hypothesis 2: Markets with positive feedback are characterized by a fast coordination of short-run expectations and a slow convergence of the realized price to the fundamental value, whereas markets with negative expectations feedback are characterized by a faster convergence of the realized price to the fundamental value and a slower coordination of short-run expectations.

If Hypothesis 2 holds for our experimental data, we can argue that eliciting long-run expectations has no significant effect on the subjects' short-run predictions as well as on the realized price dynamics in the positive as well as in the negative feedback expectations system.[7] This allows us to directly compare the results of our experiment to the other LtFEs in the literature, even though we also elicit long-run expectations.

Concerning the dynamics of long-run expectations, when submitting their long-run predictions, subjects submit at the beginning of period t their price forecast for the end of period $t+k$, for all $k > 0$. According to eqs. (1) and (2), the price at the end of period $t + k$ depends on the other subjects' short-run predictions submitted at the beginning of period $t + k$. Therefore each subject should guesstimate, k-periods in advance, the short-run expectations of the other subjects. We expect that long-run expectations exhibit a lower degree of coordination the longer is the forecasting horizon, given the increasing uncertainty in guesstimating the future short-run behavior of other subjects. In other words, we should observe a higher dispersion of subjects' long-run expectations the longer is the forecasting horizon, independently of the underlying expectations feedback system.

Hypothesis 3: The term structure of the cross-sectional dispersion of expectations is positively sloped, independently of the expectations feedback system.

We expect, however, that the expectations feedback system exerts an impact on the subjects' formation of their long-run expectations and, in particular, on the value of the slope of the term structure of expectations. We can reasonably assume that subjects follow an anchor-and-adjustment rule,

[7] Colasante et al. (2017) show that Hypothesis 2 holds in the positive expectations feedback system.

anchoring their (short and long-run) expectations on past prices.[8] We infer therefore that the different price dynamics observed under the two feedback systems affects differently the dynamics of long-run expectations.

In a setting with a positive expectations feedback system, Colasante et al. (2017, 2018) show that subjects do anchor their short- and long-run expectations to the last realized price.[9] Anchoring expectations to the last realized price helps the subjects to persistently coordinate their short-run expectations. This anchor, however, turns out to be not stable over time because of the typical oscillatory pattern of realized prices in markets characterized by a positive feedback. In the LtFE literature it has been shown that subjects, within the positive expectations feedback system, often tend to linearly extrapolate the past observed trend of prices to predict the future price dynamics (see Hommes (2015)). The so-called extrapolative bias, indeed, is a general phenomenon observed in various markets; often economic agents tend to extrapolate or over-extrapolate the observed increasing (decreasing) trend of the market price (see for instance Barberis et al. (1998); Hirshleifer (2001)). We argue, therefore, that if subjects extrapolate linearly the past trend of prices to form their long-run expectations based on different priors, the term structure of dispersion of long-run expectations is convex, i.e. the level of disagreement across subjects increases more than proportionally with the forecasting horizon.

To illustrate more precisely our conjecture concerning the heterogeneity of expectations, let us assume that subjects anchor their long-run expectations to the last realized price and linearly extrapolate the past price change. We assume that each subject has an *ex-ante* different prior on the extrapolation coefficient m_i, and for simplicity we consider that all coefficients are independent of the period and the forecasting horizon. The coefficient m_i can be interpreted as the strength of the trend extrapolation.[10] The (short- and long-run) expectations formation rule can be written as follows:

$$ {}_ip^e_{t,t+k} = p_{t-1} + m_i \ (k+1)(p_{t-1} - p_{t-2}) \ , \tag{4} $$

where $0 \leq k \leq K$, and K is the maximum forecasting horizon.[11] Note that, according to eq. (4), the only source of heterogeneity across subjects in the formation of expectations is directly linked to their different priors on the strength of trend extrapolation m_i. The value of the variance of subjects' expectations for a given period and forecasting horizon is a direct measure

[8] As an example Anufriev and Hommes (2012) and Hommes (2015) introduce an heterogeneous expectations model showing that a set of different anchor-and-adjustment rules can successfully reproduce experimental data in a LtFE.

[9] Many contributions in the LtFEs literature have repetitively shown that the last realized price constitutes an anchor in the formation of expectations; however, they limit the forecasting horizon to one or two-steps ahead predictions.

[10] The Heuristic Switching Model, introduced by Anufriev and Hommes (2012), is an example of a model with heterogeneous in the trend extrapolation strengths.

[11] A cautionary note is in order here: eq. (4) does not intend to be a precise description of the behavior of the subjects when forming their expectations; instead it should be considered as a simple mathematical formulation helping us to better illustrate our conjecture.

of their degree of disagreement: a low value of the variance corresponds to a low degree of disagreement, while a high value of the variance signals a poor coordination of subjects' expectations. From eq. (4) it is possible to show that (see Appendix A for the details of the calculation):

$$\mathrm{Var}[{}_ip^e_{t,t+k}] = \mathrm{Var}[m_i]\ (k+1)^2(p_{t-1} - p_{t-2})^2 = (k+1)^2\ \mathrm{Var}[{}_ip^e_{t,t}]\ . \qquad (5)$$

The variance of the coefficients m_i does not vanish, since we have assumed heterogeneous priors among subjects. Eq. (5) is the term structure of cross-sectional dispersion of expectations given the forecasting rule of eq. (4). It shows that the dispersion of short-run predictions reflects the subjects' heterogeneity in their prior. An observed high degree of coordination of short-run predictions ($k = 0$) should not be directly interpreted as imprint of homogeneous expectations about future price dynamics. The linear extrapolation rule amplifies quadratically the heterogeneity of priors across subjects.

Hypothesis 4: Within a positive expectations feedback system, the term structure of expectations exhibits a parabolic shape.

We generalize eq. (5) in order to obtain a more flexible expression for describing the term structure of expectations in our experimental data, without necessarily assuming a linear forecasting rule:

$$\mathrm{Var}[{}_ip^e_{t,t+k}] = (k+1)^\alpha\ \mathrm{Var}[{}_ip^e_{t,t}]\ , \qquad (6)$$

where α is the shape parameter. The parameter α helps to characterize the heterogeneity of the whole spectrum of expectations. Homogeneous expectations are characterized by $\alpha = 0$, whereas $\alpha > 0$ implies that dispersion increases with the forecasting horizon. The higher is the value of α, the higher is the degree of heterogeneity of subjects' expectations. In particular, for values of the estimated parameter in the range $0 < \alpha < 1$, the term structure of expectations is concave, signalling a moderate degree of disagreement among subjects. For the case $\alpha = 1$, the scaling is linear. For values $\alpha > 1$, the term structure is convex, which indicates a high degree of disagreement among subjects about future price dynamics.[12]

In the negative feedback markets, Heemeijer et al. (2009) has shown that prices exhibit a fast and stable convergence to the fundamental value, despite the lower degree of coordination of short-run expectations as compared to the positive feedback system. Under the hypothesis that subjects form their expectations using an anchor-and-adjustment rule, we argue that a stable dynamics of the anchor (namely the fast convergence of the realized price to the fundamental value) helps subjects to reduce the uncertainty about the future short-run predictions of the others. In other words, it becomes easier for the subjects to guesstimate in period t the other subjects' short-run predictions at the beginning of period $t + k$. Subjects, then, learn to anchor their short-

[12] In Appendix A, we provide the reader with some simple illustrative examples of the connection between the forecasting rules and the resulting term structure.

as well as long-run predictions to the fundamental value and, therefore, we expect the degree of heterogeneity of long-run expectations to be rather stable for different forecasting horizons. This implies that the estimated value of the coefficient $\hat{\alpha}$ in eq. (6) is significantly lower than 1.

Hypothesis 5: Within a negative expectations feedback system, the term structure of expectations exhibits a concave shape.

The empirical analysis of the term structure of cross-sectional dispersion of expectations provides us with relevant information to better characterize the degree of disagreement among subjects on the evolution of future prices. In fact, if we do not consider a broader spectrum of expectations, we might end up underestimating or overestimating subjects' disagreement. As an example, let us consider a scenario where subjects exhibit a strong coordination of their short-run forecasts together with an increasing dispersion of their long-run expectations. Measuring subjects' disagreement as the variance of their short-run forecasts would lead us to underestimate the level of disagreement among subjects. On the contrary, we can think about a situation where a higher dispersion of short-run forecasts, compared to the first scenario, remains constant or decreases over different forecasting horizons (constant or decreasing term structure). In this case, we may overestimate subjects' disagreement. We take the position that, the term structure of expectations provides crucial information for characterizing the heterogeneity of expectations in LtFEs, and therefore long-run expectations cannot be ignored.

4 Results

Figures (1) and (2) show the dynamics of individual short-run predictions and realized prices for the 7 groups with positive feedback and the 8 groups with negative feedback. Figures (3) and (4) display, as examples, the evolution over time of the price together with individual long-run predictions in one of the groups in the positive and negative feedback treatment, respectively. The other groups exhibits very similar visual behavior.

Figures from 12 to 24 in Appendix A, describe individual long-run predictions as well as the evolution of the price for the 20 periods and for all remaining groups in the positive and negative feedback treatments (this material is not intended to be published, we include these figures for the convenience of the referees).

4.1 Analysis of short-run expectations

From a first inspection of Figures 1 and 2, it is evident that, when confronting the two expectations' feedback systems, the realized prices exhibit remarkable different patterns. In the positive feedback treatment prices do not show a clear convergence to the fundamental value. In some groups prices exhibit some kind of monotonic trend towards the fundamental value, in other groups we observe instead a diverging trend. Concerning individual short-run expectations we observe that, after some initial periods of volatility, individual expectations coordinate, although not necessarily around the fundamental value. On the contrary, in the negative feedback treatment, after few periods, realized prices convergence to the fundamental value, although it takes longer for subjects' short-run expectations to coordinate.

Differences in the convergence of prices to the fundamental value between the positive and negative feedback treatments are quantified in Figure 5, which displays the mean absolute difference between individual short-run predictions and the fundamental value (averaged across groups):

$$MAD_{t,t}^{p_f} = \left\langle \frac{\sum_{i=1}^{6} |_i p_{t,t}^e - p_f|}{6} \right\rangle_g . \tag{7}$$

The notation $< ... >_g$ denotes the average across groups. Note that $k = 0$ refers to short-run predictions. From Figure 5, it emerges that, although the mean difference reduces in the first 5 periods, in the markets with positive feedback subjects' expectations do not converge to the fundamental value. A Wilcoxon test shows that $MAD_{t,t}^{p_f}$ is significant for all periods, excluding the last period. Conversely, in those markets with negative feedback, subjects' expectations converge to the fundamental value. Nevertheless, it takes some time for the price to converge, since it is from period 8 that we find no statistically significant difference between expectations and the fundamental value.

Given our results concerning the convergence of short-run expectations we can reject Hypothesis 1 in the positive feedback treatment, since the REE is not a good benchmark to describe neither the subjects expectations nor the price dynamics. Our results in the negative feedback treatment show that the individual expectations and prices do converge to the REE, and therefore we cannot reject Hypothesis 1. Those results are in line with many LtFEs reported in the pertinent literature.

Figure 6 quantifies the coordination of subjects' individual short-run predictions measured as the mean absolute deviation between individual one-period-ahead forecasts and the (within-group) average of one-step-ahead expectations (averaged across groups):

$$MAD_{t,t}^{C} = \left\langle \frac{\sum_{i=1}^{6} |_i p_{t,t}^e - \bar{p}_{t,t}^e|}{6} \right\rangle_g \tag{8}$$

In the markets with positive feedback, we observe a fast coordination of subjects' short-run expectations. A similar dynamics is observed in the markets with negative feedback, although it takes longer for the expectations to coordinate.

Hypothesis 2 holds, since our results on coordination and convergence of short-run expectations are in line with the literature: fast convergence and slow coordination in the negative feedback treatment, whereas slow convergence and fast coordination in the positive feedback treatment. We can conclude therefore that eliciting long-run expectations does not affect the main properties of short-run expectations as well as the price dynamics.

We focus now on the analysis of individual forecasting behavior to further confirm that our results are in line with the literature. Following Heemeijer et al. (2009), we estimate the individual prediction strategies of subjects assuming that they use the following linear prediction rule:[13]

$$ {}_ip^e_{t,t} = {}_ic + \sum_{k=1}^{3} {}_i\alpha_k \; p_{t-k} + \sum_{k=1}^{3} {}_i\beta_k \; {}_ip^e_{t-k,t-k} + {}_i\varepsilon_t \; . \tag{9} $$

We obtain that regression (9) provides a good description for the forecasts of 78 out of 90 subjects.[14] The long-run equilibrium price level is computed as follows:

$$ {}_i\hat{p} = \frac{{}_i\hat{c}}{1 - \sum_{k=1}^{3} {}_i\hat{\alpha}_k - \sum_{k=1}^{3} {}_i\hat{\beta}_k} \tag{10} $$

where ${}_i\hat{c}$, ${}_i\hat{\alpha}_k$ and ${}_i\hat{\beta}_k$ denote the individual estimates obtained from eq. (9). Figure 7 shows the distribution of the difference between the long-run equilibrium price $\hat{p}$ and the fundamental value p_f[15] reproduce the main characteristics described in Heemeijer et al. (2009): (i) in markets with a negative feedback subjects are able to learn the REE, given the distribution is highly concentrated around zero. (ii) In markets with a positive feedback, long-run equilibrium prices are more dispersed around the fundamental value.

Following Heemeijer et al. (2009), since the linear prediction rule is a good descriptor of subjects' forecast, we estimate for each subject a simpler prediction rule based on the anchor-and-adjustment heuristic. We classify the subjects as naïve, adaptive, trend follower or fundamentalist depending on the individual parameter values. Our results are also in line with those reported by Heemeijer et al. (2009) (see the Appendix C for the details).

The empirical analysis considering the dynamics of expectations and prices generalize the results of Colasante et al. (2017, 2018) that eliciting long-run expectations has no significant effect on subjects' short-run expectations independently on the expectations' feedback systems.

[13] We use the same specification of Heemeijer et al. (2009) adapting it to our mathematical notation.

[14] We apply the Breusch-Godfrey test for small sample to check for the autocorrelation of the residuals.

[15] Since we have used two different fundamental values, in order to compare the the long-run equilibrium price convergence to the fundamental price across markets, we use the difference between the long-run equilibrium price computed using eq. (10) and the fundamental value.

k	Negative Feedback			Positive Feedback		
	All periods	period< 10	period≥ 10	All periods	period< 10	period≥ 10
$k=2$	-2.585	-2.950	-1.106	-14.835	-11.71	-8.985
	(0.01)	(0.003)	(0.269)	(0.000)	(0.000)	(0.000)
$k=4$	-3.252	-5.659	2.414	-14.435	-11.984	-8.141
	(0.001)	(0.000)	(0.020)	(0.000)	(0.000)	(0.000)
$k=6$	-7.578	-8.421	0.237	-12.382	-10.4	-6.69
	(0.000)	(0.000)	(0.813)	(0.000)	(0.000)	(0.000)

Table 1: Wilcoxon test on the convergence of k-steps-ahead expectations to the fundamental value in the positive and negative feedback treatment. We report the z-values and the p-values in brackets.

4.2 Analysis of long-run expectations

From a first inspection of Figures 3 and 4, we observe a clear difference in the dynamics of subjects' long-run expectations depending on the implemented expectations feedback system. In the positive feedback treatment, subjects' expectations, although highly coordinated in the short-run around the last realized price, exhibit linear trend extrapolation with different slopes, forming some sort of cone-shaped trajectory. On the contrary, in the negative feedback treatment, the fluctuations of short- as well as long-run expectations seem to be much more stable fluctuating around the fundamental value.

At first sight, the dynamics of long-run expectations seems to be strongly influenced by the underlying expectations feedback mechanism. In order to quantify this intuition, we extend to long-run expectations the analysis of short-run expectations concerning convergence to the fundamental value and coordination. Figure 8 reports the average convergence of long-run expectations to the fundamental value in the positive and negative feedback treatments, measured as the mean absolute difference between the fundamental value and the expectations submitted in period t for the price in period $t+k$ for different forecasting horizons k (averaged across groups):

$$MAD^{p_f}_{t,t+k} = \left\langle \frac{\sum_{i=1}^{6} |{}_i p^e_{t,t+k} - p_f|}{6} \right\rangle_g , \tag{11}$$

where $k = 0, 1, 2, 4, 6, 9$. Figure 8a confirms the lack of convergence to the fundamental value of long-run expectations, which we have reported also for short-run expectations. Concerning the negative feedback treatment Figure 8b shows that convergence significantly improves over time, reaching apparently almost fully convergence after period 10.

Table 1 shows that, for a given forecasting horizon k, the results of a Wilcoxon test for the convergence of the long-run expectations. Expectations do no convergence to the fundamental value in the positive feedback treatment, whereas, in the negative feedback treatment, long-run expectations converge after period 10. In early periods, the distance from the fundamental value is statistically significant. We can conclude therefore that Hypothesis 1 does not hold in the case of a positive feedback mechanism. Under a negative feedback mechanism, our results show that subjects *learn the REE* after some time, since they coordinate their short and long-run expectations to the fundamental value.

Figure 9 shows the coordination of subjects predictions measured as the mean absolute deviation between individual k-periods-ahead forecasts and their within-group average (averaged across groups):

$$MAD_{t+k}^{C} = \left\langle \frac{\sum_{i=1}^{6} |{}_ip_{t,t+k}^{e} - \bar{p}_{t,t+k}^{e}|}{6} \right\rangle_g \tag{12}$$

where $k = 0, 1, 2, 4, 6, 9$. Note that subjects *learn to coordinate* their short and long-run expectations over time. Importantly, for a given period, the cross-sectional dispersion of expectations systematically increases with the forecasting horizon, being this effect much more pronounced in the positive feedback treatment.

4.3 Heterogeneity of expectations

We have conjectured in Section 3 that the evolution of the dispersion of subjects' expectation over the forecasting horizon carries information on the degree of heterogeneity of expectations. We have, furthermore, conjectured that the heterogeneity of expectations depends on the feedback system. Figure 10 illustrates the evolution of the term structure of dispersion of expectations across periods and treatments. From a first look at Figure 10 it seems that in the positive feedback treatment the slope of the term structure is higher that in the negative feedback treatment.

In order to quantify what is apparent from Figure 10, Table 2 displays, for a given period, the ratio between the value of the long end and the short end of the term structure as a proxy for the heterogeneity of expectations:[16]

$$R_t(h) = \frac{< \mathrm{Var}[{}_ip_{t,t+h}^{e}] >_g + < \mathrm{Var}[{}_ip_{t,t+h-1}^{e}] >_g}{< \mathrm{Var}[{}_ip_{t,t}^{e}] >_g + < \mathrm{Var}[{}_ip_{t,t+1}^{e}] >_g}\ , \tag{13}$$

where h is the difference between the longest time forecasting horizon (in our analysis is 10-period-ahead).[17] In the positive feedback treatment, the value of $R_t(h)$ in most of periods is well above 10, signalling a remarkable disagreement of expectations about the future price dynamics. Conversely, in the negative feedback treatment $R_t(h)$ takes a value around 2, which signals a higher degree of homogeneity of expectations. If we measure the expectations'

[16] The long end of the term structure is estimated as the sum of average (across groups) variance of expectations in the last two forecasting horizons. The short end of the term structure is estimated as the sum of the average (across groups) variance of the expectations in the first two forecasting horizons.

[17] In periods 11, 12, and 13 the value of h is smaller, since the longest forecasting horizons are 9, 8 and 7 periods ahead, respectively.

heterogeneity considering the value of the variance of short-run expectations, we might end up with the misleading idea that in positive feedback markets subjects' expectations are less heterogeneous compared to those in negative feedback markets. Instead, taking into account a broader view of the evolution of the time-spectrum of expectations, we would revise our statement. This is an example of the importance of eliciting long-run expectations in order to precisely measure the level of disagreement among subjects.

Period	Negative feedback	Positive feedback
2	1.98	3.63
3	2.69	8.02
4	2.01	12.31
5	2.76	12.59
6	2.37	17.69
7	1.24	11.42
8	1.93	16.89
9	2.34	10.48
10	1.18	5.15
11	0.62	25.82
12	1.42	17.87
13	1.34	16.98

Table 2: $R_t(h)$ per period: Ratio between the value of the long end of the term structure and the short end of the term structure.

Let us now analyse the empirical properties of the term structure of expectations introduced in eq. (6) and the related hypotheses introduced in section 3. In order to test Hypotheses 3, 4 ad 5, we estimate the value of the shape coefficient α from a log-linearisation of eq. (6) with "normalized" variances, using a pooled panel regression:

$$\log\left(\frac{<\mathrm{Var}[{}_i p^e_{t,t+k}]>_g}{<\mathrm{Var}[{}_i p^e_{t,t}]>_g}\right) = \alpha\ \log(k+1)\ . \tag{14}$$

The normalization of the variances allows for a direct comparison of the shape of the term structure between the two treatments. Table (3) shows the estimated values of $\hat{\alpha}$ for the two treatments.

The values of $\hat{\alpha}$ are significantly different from zero in the two expectations feedback systems, confirming Hypothesis 3 which states that the term structure exhibit a positive slope. However, in the positive feedback treatment, the estimated value of the shape parameter $\hat{\alpha}$ is significantly higher than 1, indicating a convex term structure. We can talk about a high level of disagreement among subjects about the future dynamics of prices, despite the high level of coordination of their short-run expectations. Hypothesis 4, namely a parabolic shape of the term structure, does not hold, since the value of α is significantly smaller than 2. The case $\hat{\alpha} > 1$ mihgt indicate that subjects follow extrapolative rules, but those rules are more complex than just the simple

	Negative feedback	Positive feedback
$\log(k+1)$	0.36***	1.29***
SE	(0.03)	(0.03)
N	117	117
R^2	0.56	0.91

*** p-value < 0.01, ** p-value < 0.05, * p-value < 0.1

Table 3: Results of the pooled panel regression from eq. (14). Dependent variable: log of cross-sectional normalized variance of long-run expectation for a given period and forecasting horizon. We consider twelve periods $t = 2, ..., 13$ and ten horizons $k = 1, ..., 10$ (when possible).

linear extrapolation assumed in Hypothesis 4. In the negative feedback treatment, instead, the shape parameter turns out to be significantly smaller than 1, which indicates a concave term structure. Hypothesis 5, therefore, holds.

In section 3, we have conjectured that the concave shape of the term structure is related to the fact that subjects anchor their expectations to the past realized price, which exhibits a fast and persistent convergence to the fundamental value. Such stability of the anchor helps subjects to reduce the uncertainty in guestimating the future short-run predictions of the others. Subjects, therefore, learn to coordinate their long-run expectations to the fundamental value. In order to show that the convergence of expectations to the fundamental value smooths the heterogeneity of expectations, we introduce a similar functional form as in eq. (6) between the mean squared deviation of long-run expectations from the fundamental value and the forecasting horizon:

$$MSD^{p_f}_{t,t+k} = \left\langle \frac{\sum_{i=1}^{6} ({}_i p^e_{t,t+k} - p_f)^2}{6} \right\rangle_g , \tag{15}$$

$$\mathrm{MSD}^{\mathrm{p_f}}_{\mathrm{t,t+k}} = (k+1)^{\mu}\ \mathrm{MSD}^{\mathrm{p_f}}_{\mathrm{t,t}} . \tag{16}$$

We, then, estimate the corresponding parameter μ for the positive and negative feedback treatments.[18] Table 4 shows that the estimated value of the shape parameter $\hat{\mu}$ is not statistically different from the value of $\hat{\alpha}$ in the negative feedback treatment. This goes into the direction of confirming our conjecture that the convergence of expectations to the fundamental value and their mutual coordination are closely related. Conversely, in the positive feedback treatment, the estimated value of the shape parameter $\hat{\mu}$ and its difference with $\hat{\alpha}$ do not give us relevant information, since long-run expectations do not converge nor coordinate around the fundamental value.

[18] We use the same pooled panel regression of the normalized variances as in eq. (14).

	Negative feedback	Positive feedback
$\log(k+1)$	0.37^{***}	0.58^{***}
SE	(0.03)	(0.03)
N	117	117
R^2	0.49	0.78

*** p-value < 0.01, ** p-value < 0.05, * p-value < 0.1

Table 4: Results of the pooled panel regression from eq. (16). Dependent variable: log of average quadratic difference between individual long-run expectations $p^e_{t,t+k}$ and the fundamental value. We consider twelve periods $t = 2, ..., 13$ and ten forecasting horizons $k = 1, ..., 10$ (when possible).

5 Conclusion

We implement a LtFEs where we contemporaneously elicit short and long-run expectations about the evolution of the price in experimental markets characterized by different expectations feedback systems. In particular, we generalize the original contribution of Heemeijer et al. (2009) eliciting long-run expectations and extend the results of Colasante et al. (2017, 2018) to markets with a negative expectations feedback system. Our results reveal that eliciting long-run expectations does not influence subjects' short-run expectations. We observe, in fact, the same aggregate patterns of coordination and convergence of short-run expectations, as well as price dynamics, reported in the LtFEs literature. When enlarging the time spectrum of subjects' expectations, we observe that in the negative feedback markets, subjects learn the REE, since they coordinate their short and long-run expectations around the fundamental value. After a learning phase the REE turns out to be a good predictor for the dynamics of expectations independently of the forecasting horizon. Conversely, in the positive feedback markets, the REE does not predict the evolution of subjects' expectations, neither in the short- nor in the long-run. Instead, subjects learn to coordinate their short-run expectations around the last realized price, and tend to extrapolate past trend prices when forming their long-run expectations.

Concerning the disagreement of subjects' expectations, our empirical analysis suggests that, in order to characterize the heterogeneity of expectations it reveals to be extremely informative to measure not only the level of dispersion of subjects' expectations, but also how it evolves over different forecasting horizons. We propose a simple term structure model of cross-sectional dispersion of expectations, which is defined by one parameter only, i.e the shape coefficient. The estimated values of the shape coefficient in our experimental data turns out to provide important clues about how the feedback system affects the mechanism of formation of (long-run) expectations. In particular, in the markets with positive feedback the estimated value of the shape coefficient indicates a convex term structure signalling a high level of disagreement among forecasters. It is compatible with an (heterogeneous) extrapolative trend behavior of subjects when forming their expectations. A concave shape characterizes, instead, the term structure in the markets with negative feedback, pointing to a smoother evolution of forecasters disagreement. We argue that this behavior is a consequence of the stable convergence of the price to the fundamental value, which helps the subjects to predict more accurately the behavior of other subjects, and therefore, the dynamics of future prices.

From a more methodological perspective, we are firmly convinced that eliciting long-run expectations in the framework of the LtFEs complements the macroeconomic literature based on surveys on the origin of heterogeneity of expectations. Additionally, it can be successfully employed as test-bed for studying economic policy measures within diverse macroeconomic scenarios.

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A Term structure of cross-sectional dispersion of expectations

Let us introduce some simple examples of how a given the predictions rules for the long-run expectations affects the term structure of cross-sectional dispersion of expectations.

Let us assume that the subjects, when forming their long run expectations, linearly extrapolate the past price change with a coefficient m_i depending on each individual subject. Considering eq. (4), it is possible to compute the average expectation across subjects:

$$\mathrm{E}[{}_ip^e_{t,t+k}] = p_{t-1} + \mathrm{E}[m_i]\ (k+1)(p_{t-1} - p_{t-2})\ . \tag{17}$$

The variance of the expectations is therefore:

$$\mathrm{Var}[{}_ip^e_{t,t+k}] = \mathrm{Var}[m_i]\ (k+1)^2(p_{t-1} - p_{t-2})^2\ . \tag{18}$$

So, given that:

$$\mathrm{Var}[{}_ip^e_{t,t}] = \mathrm{Var}[m_i]\ (p_{t-1} - p_{t-2})^2\ , \tag{19}$$

and plugging it into eq. (18), the term structure is:

$$\mathrm{Var}[{}_ip^e_{t,t+h+1}] = (k+1)^2\ \mathrm{Var}[{}_ip^e_{t,t}]\ . \tag{20}$$

An alternative to the linear forecasting rule is a "random walk rule", whose starting value is the realized price in the previous period:

$${}_ip^e_{t,t+k} = p_{t-1} + \sum_{k=0}^{K} {}_i\eta_{t+k}\ , \tag{21}$$

where ${}_i\eta_{t+k}$ are iid random variables with $\mathrm{E}[{}_i\eta_{t+k}] = 0$ for each k and i. Under the rule of eq. (21), it is easy to show that the term structure of the variance is linear in the forecasting horizon:

$$\mathrm{Var}[{}_ip^e_{t,t+h+1}] = (k+1)\ \mathrm{Var}[{}_ip^e_{t,t}]\ . \tag{22}$$

An additional possible forecasting rule for long-run perditions is the following:

$${}_ip^e_{t,t+k} = p_{t-1} + {}_i\xi_{t+k}\ , \tag{23}$$

where ξ_t are iid random variable with $\mathrm{E}[{}_i\xi_t] = 0$ for each t and i. The variance of the predictions of the subjects will be independent of the forecasting horizon H:

$$\mathrm{Var}[{}_ip^e_{t,t+k+1}] = (k+1)^0\ \mathrm{Var}[{}_ip^e_{t,t}] = \mathrm{Var}[{}_ip^e_{t,t}]\ . \tag{24}$$

A more general term structure for the dispersion of the predictions shows a curvature depending on the shape parameter α.

$$\mathrm{Var}[{}_ip^e_{t,t+h+1}] = (k+1)^\alpha\ \mathrm{Var}[{}_ip^e_{t,t}]\ , \tag{25}$$

which nests all the previous specific cases.

Those simple calculations show that the term structire of the variance of the subjects' predictions can be extremely informative on possible underlying mechanism of long-run expectations formation.

B Instructions and Screenshot

B.1 Translated instructions

[General instructions]
Welcome to the Laboratory of Experimental Economics! You are participating in an experiment in which you will take decisions in a financial market. The instructions are very simple but, please, read them carefully.

During the whole experiment you will play with experimental money (ECU) and, at the end of the experiment, your final profit, summed to the 3 for the show-up fee, will be converted in Euro according to the following exchange rate: 1 Euro=500 ECU. The total amount will be paid at the end of the experiment by cash.

[Only in the positive feedback treatment]
You are a financial advisor to a pension fund that wants to invest an amount of money to buy an asset. The pension fund will allocate its money between a bank account which pays fix interest rate and a risky investment. The allocation depends on your forecast accuracy. In making your predictions remember that the market price is affected: positively by the dividend, negatively by the interest rate and positively by the investors predictions.

[Only in the negative feedback treatment]
You are an advisor to a firm that wants to buy a certain amount of a good. In each period, the entrepreneur decide how many units of that good he wants to buy with the aim to sell them in the next period. To take an optimal decision, the entrepreneur requires a good prediction of the market price in the next period. The price will be computed in the following way: if the demand for the good is higher than the supply, the price will rise. Conversely, if the supply will be higher than the demand, the price will decrease. The entrepreneur will take his decision based on your forecasting about the market price: the higher is the prediction, the higher will be the demand and, as a consequence, the market price will fall.

[General instructions]
Your task is to predict the price for 20 periods. In each period (t) you will predict the price for all the remaining $20-t$ periods, that is, in period 1 you will make 20 predictions starting from the prediction about the expected price for period 1, in period 2 you will make 19 predictions and so on. Your predictions must be between 0 and 100. In period 1 you will make predictions just looking at the interest rate and at the mean dividend. From period 2 on, you will have more information: besides the interest rate and the mean dividend, you will see a graph with the time series of your past prediction and the series of the realized price in the market. The green dots represent the series of the predicted price for the next period, while the blue dots represents the realized price in each period. Moreover, you will see the values of these series and the series of all your past predictions. Remember that in any period you will see the information about the market price of the previous period.

The interest rate will be equal to 5% and the mean dividend will be equal to 3.25 (or 3.5).

Once each player have made their prediction for the first period, the realized price will be computed and it will be shown at the beginning of period 2. The same mechanism holds for subsequent periods. After you insert the forecasting and the price computed, your profit will be computed according to the forecasting accuracy. Your profit depends on your forecast accuracy. The better your prediction, the higher the profit in each period. Besides the profit for the prediction for the subsequent period, you will receive a profit for the other predictions. This profit will be computed according to the following table:

Difference between market price of period t and your prediction for period t	ECU
± 5	25
± 10	12
± 15	5

At the beginning of each period you will see the profit for all the predictions and the cumulative gains.

B.2 Screenshot

C Individual prediction strategies

Following Heemeijer et al. (2009), we estimate for each subject the linear forecasting rule:

$$ {}_ip^e_{t,t} = \alpha_1 p_{t-1} + \alpha_2\ {}_ip^e_{t-1,t-1} + (1-\alpha_1-\alpha_2)p_f + \beta(p_{t-1}-p_{t-2}) + \epsilon_t \quad (26) $$

The heuristic described in eq. (26) can be successfully estimated for 72 out of 90 subjects. Using the estimates obtained we can classify subjects as:

(i) Fundamentalist in the negative feedback treatment: $\alpha_1 + \alpha_2 \approx 0$ and $\beta = 0$
(ii) Adaptive: $\alpha_1 + \alpha_2 \neq 0$ and $\beta = 0$
(iii) Naïve: $\alpha_1 \approx 1$ and $\alpha_2 = \beta = 0$;
(iv) Naïve and fundamentalist: $\alpha_1 < 1$ and $\alpha_2 = \beta = 0$
(v) Adaptive trend follower in the positive feedback treatment: $\alpha_1 \neq 0, \alpha_2 \neq 0$ and $\beta \neq 0$
(vi) Naïve trend follower in the positive feedback treatment: $\alpha_1 \neq 0, \alpha_2 = 0$ and $\beta \neq 0$
(vii) Trend follower in the positive feedback treatment: $\alpha_1 = 0, \alpha_2 = 0$

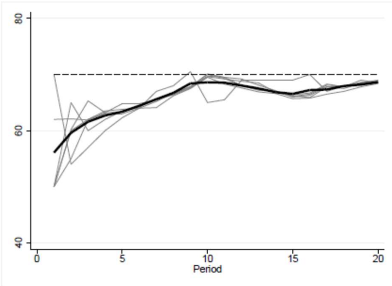
Tables 5 and 6 summarize our results confronting them with those reported in Heemeijer et al. (2009).

Prediction strategies	Our results	Heemeijer et al. (2009)
Naïve trend follower	34%	38%
Adaptive trend follower	21%	33%
Trend follower	16%	-
None	29%	29%
Observations	38 over 42	21 over 42

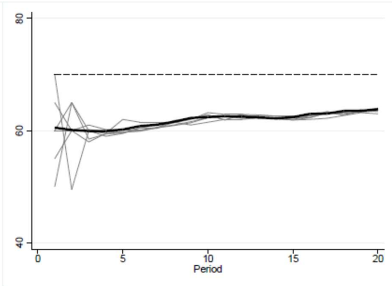
Table 5: Positive feedback treatment: individual prediction strategies according to the estimated parameters in eq.(26).

Prediction strategy	Our results	Heemeijer et al. (2009)
Fundamentalist	36%	37%
Nave fundamentalist	15%	32%
Adaptive	13%	-
Naïve	8%	5%
None	28%	26%
Observations	34 over 48	19 over 36

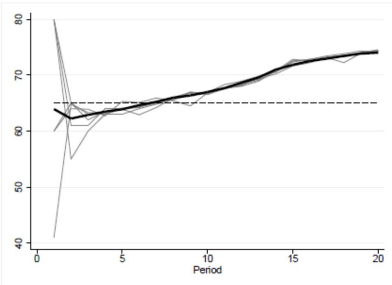
Table 6: Negative feedback treatment: individual prediction strategies according to the estimated parameters in eq.(26).



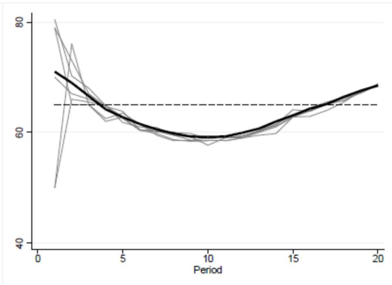
(a) Group 1



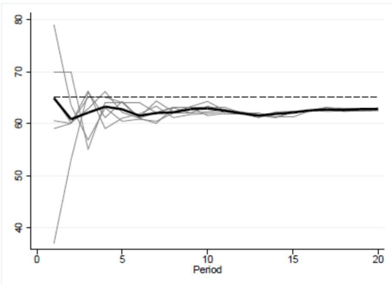
(b) Group 2



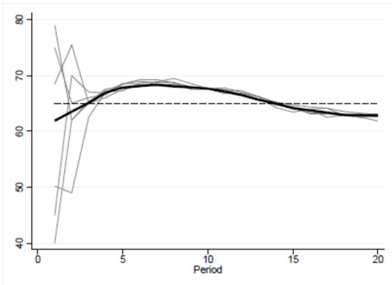
(c) Group 3



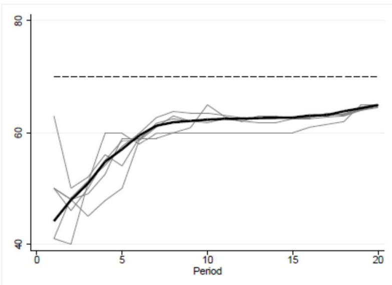
(d) Group 4



(e) Group 5

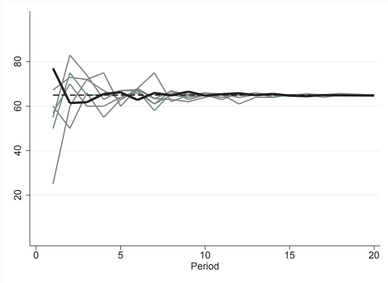


(f) Group 6

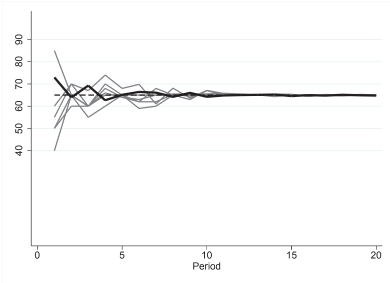


(g) Group 7

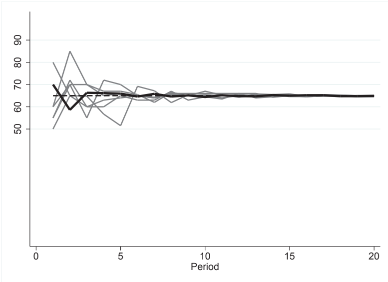
Fig. 1: Realized price and individual short-run predictions of all groups in the **positive feedback treatment**. The black solid line represents the realized price, the grey lines are the individual one-step-ahead predictions and the dashed line represents the fundamental value. In groups 1, 2 and 7 $p_f = 70$, while in groups 3, 4, 5 and 6 $p_f = 65$.



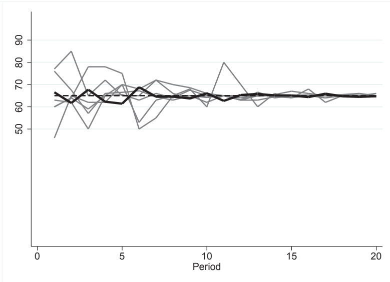
(a) Group 1



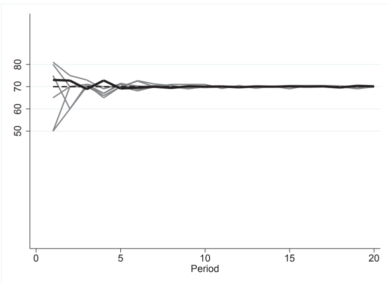
(b) Group 2



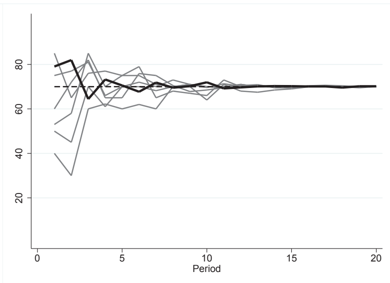
(c) Group 3



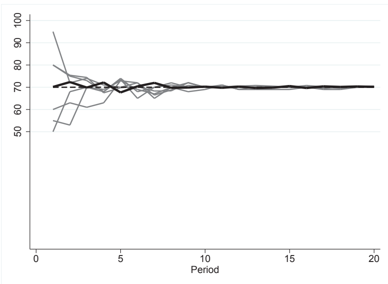
(d) Group 4



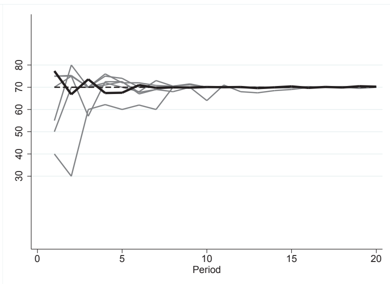
(e) Group 5



(f) Group 6

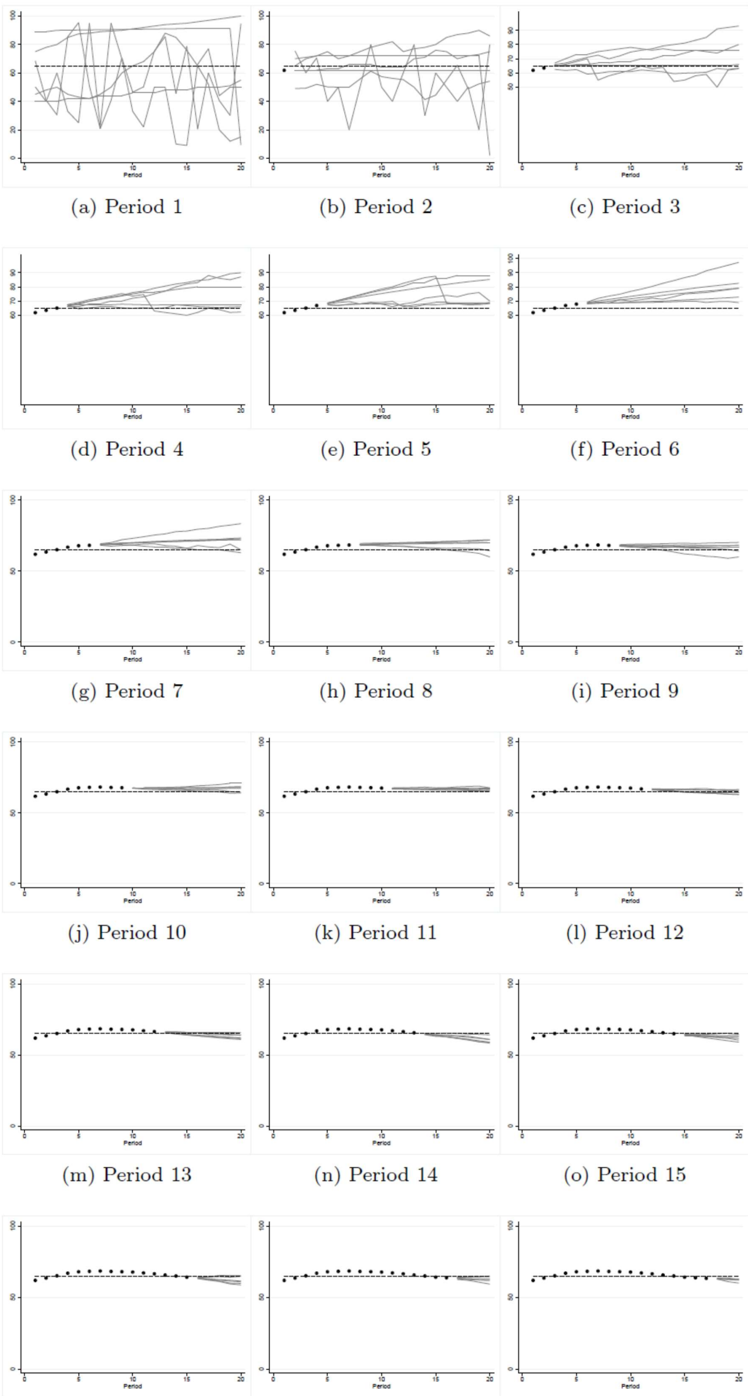


(g) Group 7



(h) Group 8

Fig. 2: Realized price and individual short-run predictions of all groups in the **negative feedback treatment**. The black solid line represents the realized price, the grey lines are the individual one-step-ahead predictions and the dashed line represents the fundamental value. In groups 1, 2, 3 and 4 $p_f = 65$, while in groups 4, 5, 6, 7 and 8 $p_f = 70$.



(a) Period 1 (b) Period 2 (c) Period 3

(d) Period 4 (e) Period 5 (f) Period 6

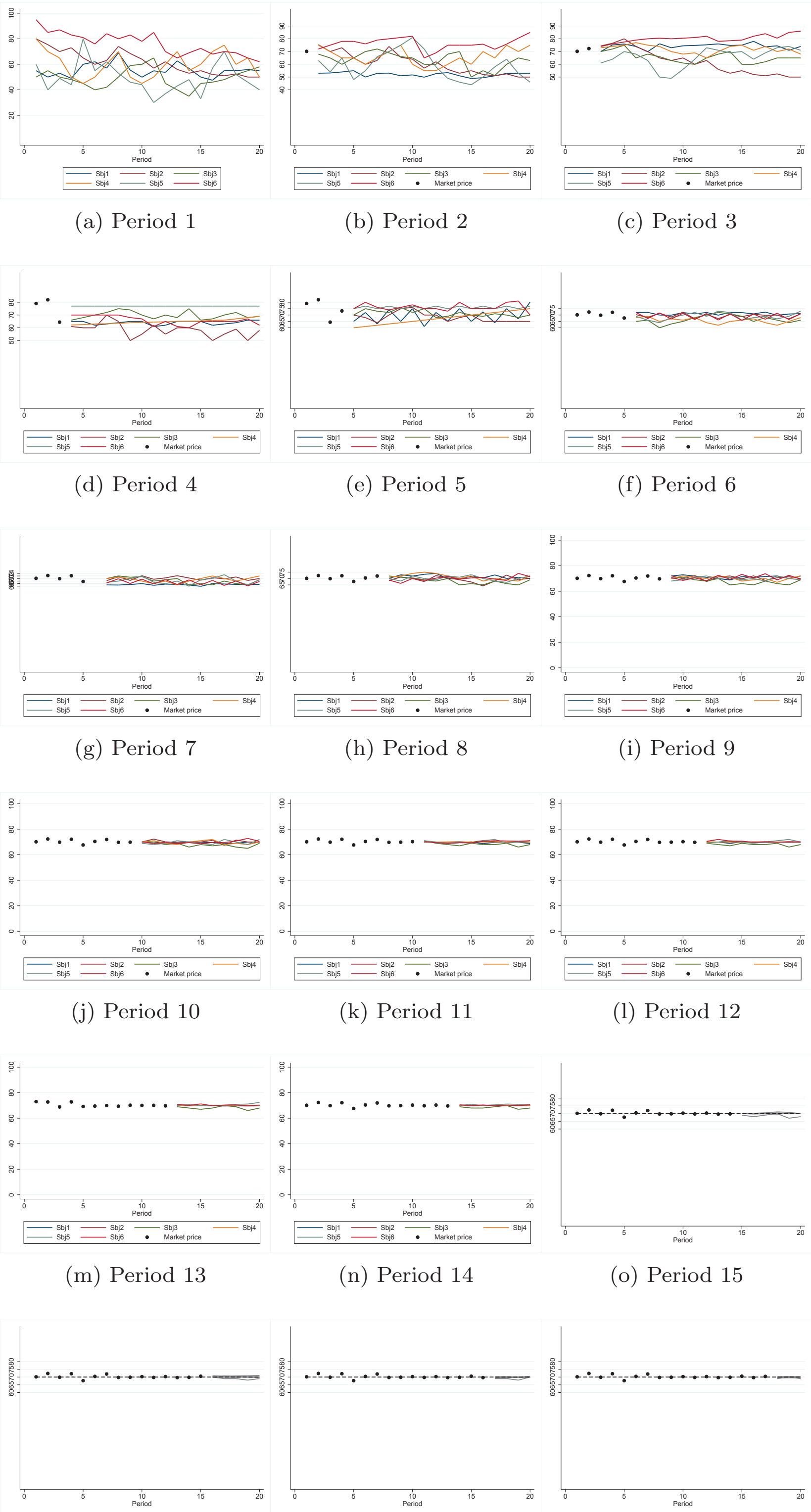
(g) Period 7 (h) Period 8 (i) Period 9

(j) Period 10 (k) Period 11 (l) Period 12

(m) Period 13 (n) Period 14 (o) Period 15

(p) Period 16 (q) Period 17 (r) Period 18

Fig. 3: Positive feedback:Individual long-run predictions of Group 4. The black dots indicate the realized price, the grey lines the individual forecasts and the dashed line the fundamental value.



(a) Period 1 (b) Period 2 (c) Period 3

(d) Period 4 (e) Period 5 (f) Period 6

(g) Period 7 (h) Period 8 (i) Period 9

(j) Period 10 (k) Period 11 (l) Period 12

(m) Period 13 (n) Period 14 (o) Period 15

(p) Period 16 (q) Period 17 (r) Period 18

Fig. 4: Negative feedback: Individual long-run predictions of Group 7. The black dots indicate the realized price, the grey lines the individual forecasts and the dashed line the fundamental value.

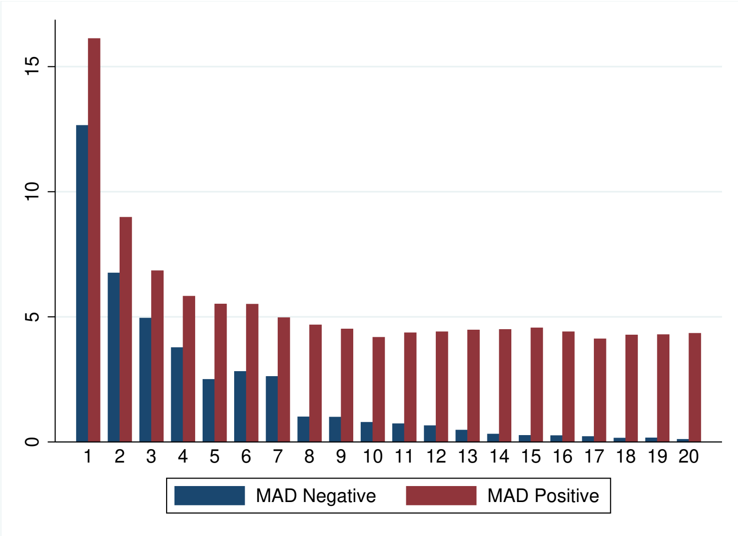


Fig. 5: Convergence of short-run expectations: $MAD_{t,t}^{pf}$ in the positive and negative feedback treatments.

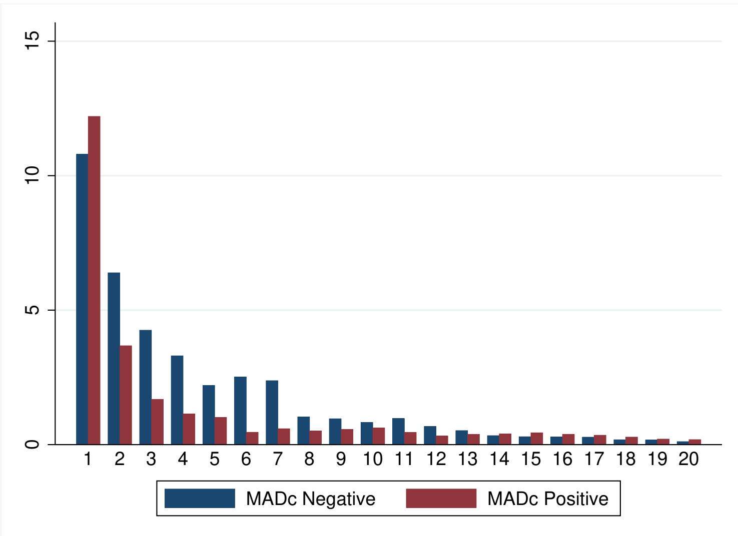


Fig. 6: Coordination of short-run expectations: $MAD_{t,t}^{C}$ in the positive and negative feedback treatments.

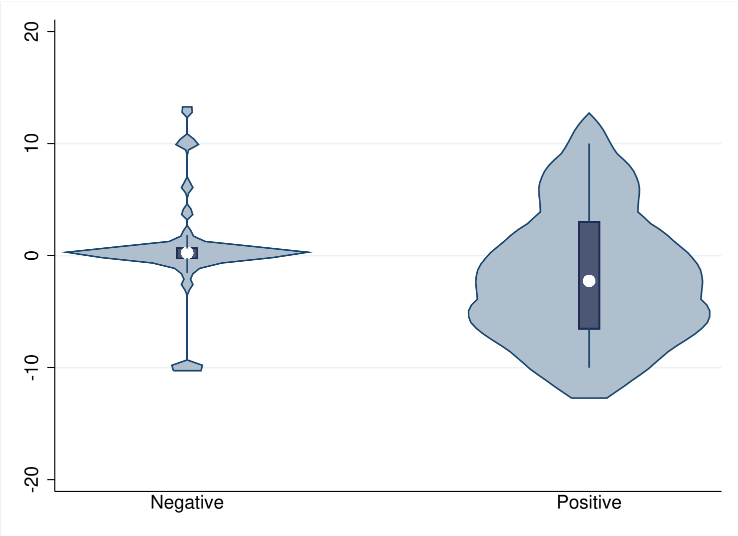
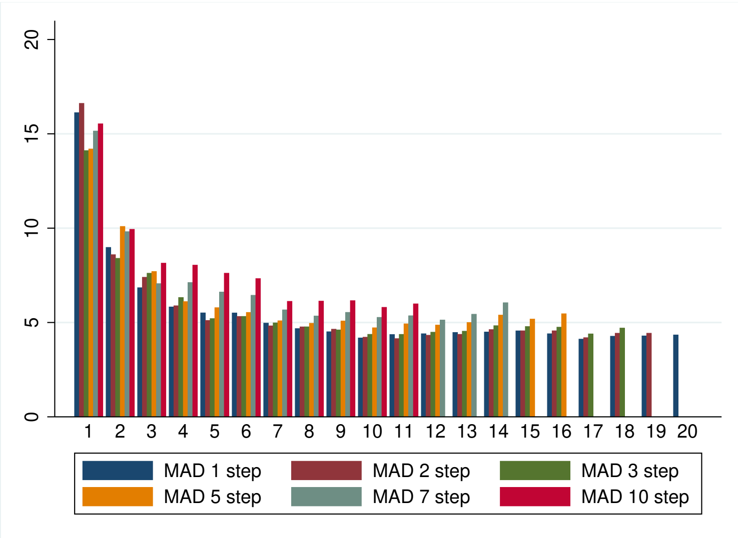
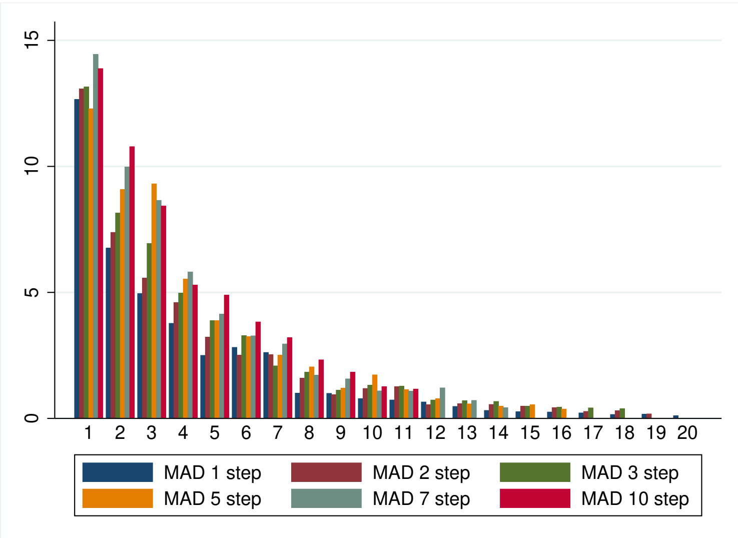


Fig. 7: Violin diagram of the distance between the long-run equilibrium price computed following eq. (10) and the fundamental value in the negative and positive feedback treatments. The white dot represents the median value equal to 0.26 and -2.25 for the negative and positive feedback treatment, respectively. In the two treatments a Wilcoxon test show no statistically significant difference from zero.

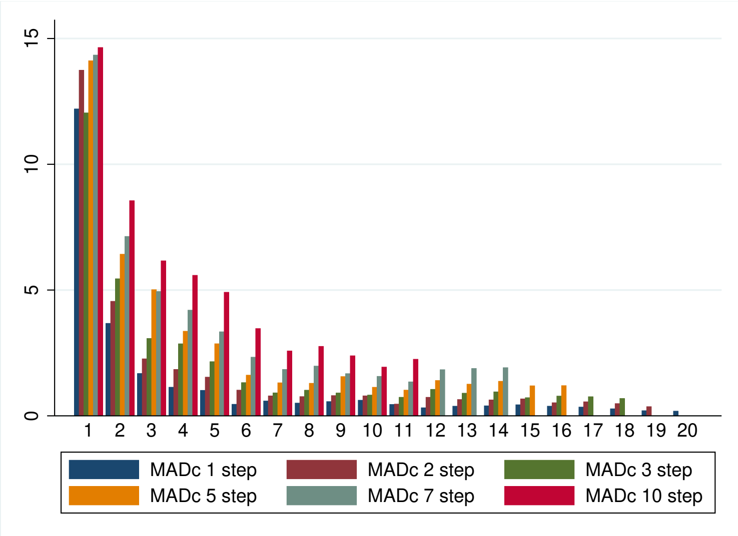


(a) Positive feedback treatment

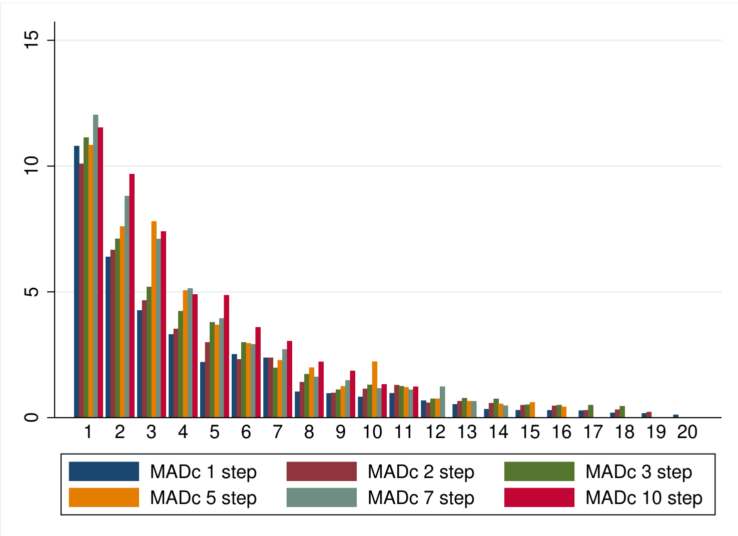


(b) Negative feedback treatment

Fig. 8: For each period $t = 1, ..., 20$, it is displayed the mean absolute deviations between the expectations and the fundamental value for different forecasting horizons $k = 0, 1, 2, 4, 6, 9$ ($MAD^{pf}_{t,t+k}$), averaged across groups.



(a) Positive feedback treatment



(b) Negative feedback treatment

Fig. 9: For each period $t = 1, ..., 20$ it is displayed the across groups average MAD_C of the subjects' forecasts submitted in period t for the price at the end of period $t + k$, where $k = 0, 1, 2, 4, 6, 9$.

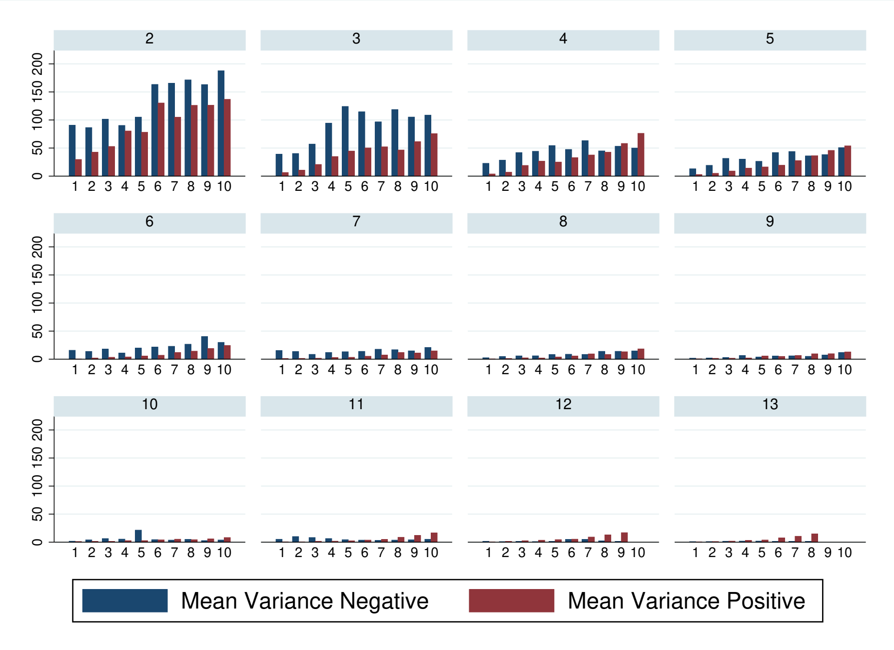


Fig. 10: Empirical term structure of the cross-sectional dispersion of expectations: Each histogram displays the variance of the expectations submitted in a given period for different forecasting horizons (in the horizontal axis) in the positive and negative feedback treatments. We consider twelve periods $t = 2, ..., 13$ and ten horizons $k = 1, ..., 10$ (when possible).

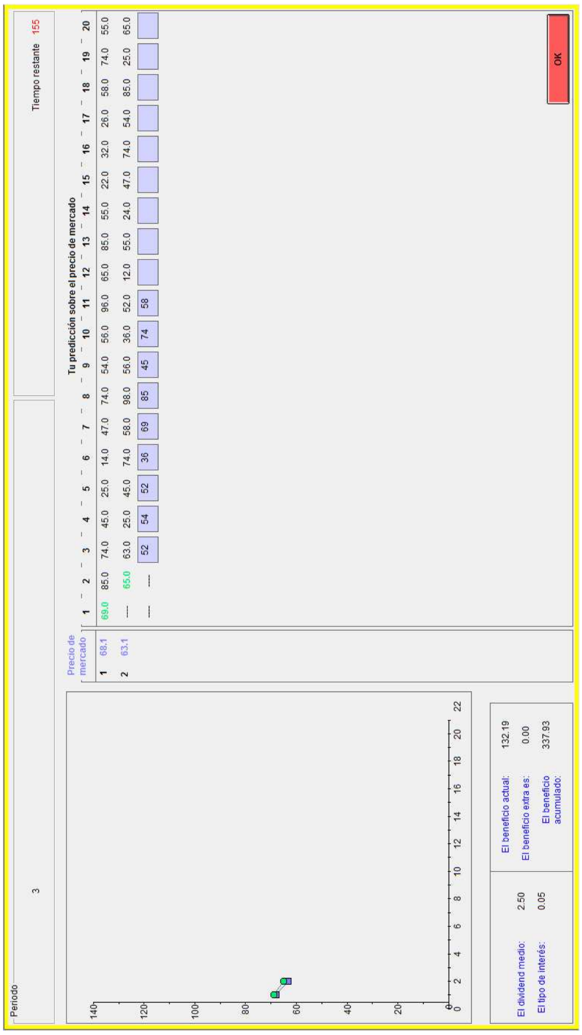
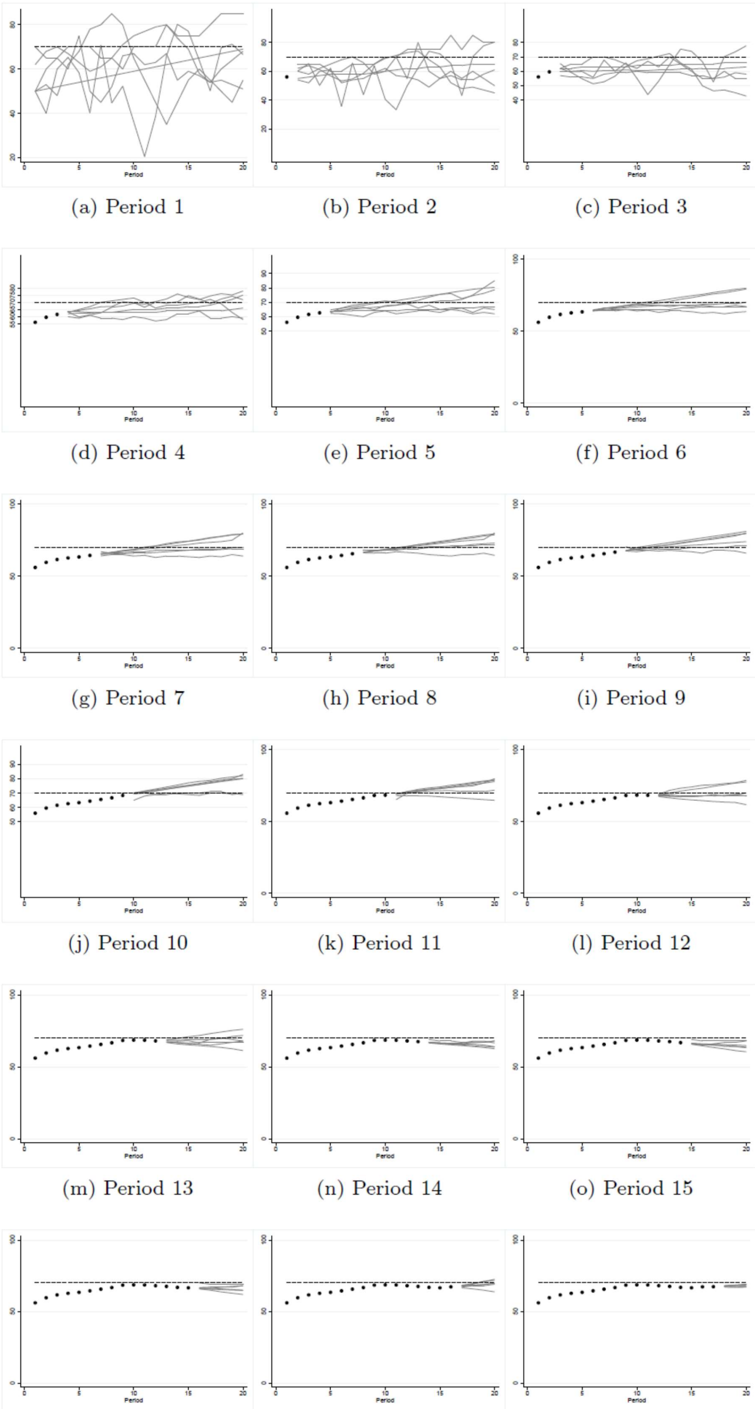


Fig. 11: Screen-shot of the experiment.

A Individual long-run predictions



(a) Period 1 (b) Period 2 (c) Period 3

(d) Period 4 (e) Period 5 (f) Period 6

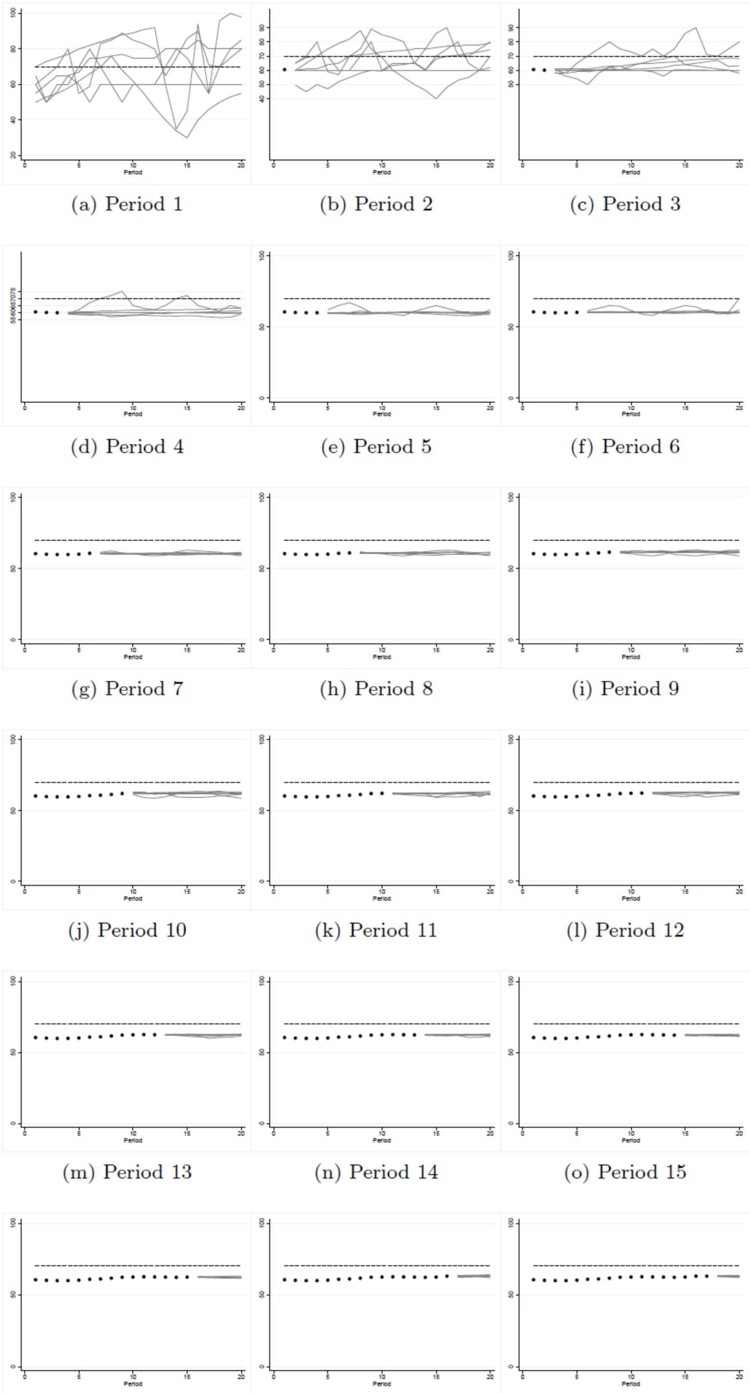
(g) Period 7 (h) Period 8 (i) Period 9

(j) Period 10 (k) Period 11 (l) Period 12

(m) Period 13 (n) Period 14 (o) Period 15

(p) Period 16 (q) Period 17 (r) Period 18

Fig. 12: Positive feedback: Individual long-run predictions of Group 1. The black dots indicate the realized price, the grey lines the individual forecasts and the dashed line the fundamental value.



(a) Period 1 (b) Period 2 (c) Period 3

(d) Period 4 (e) Period 5 (f) Period 6

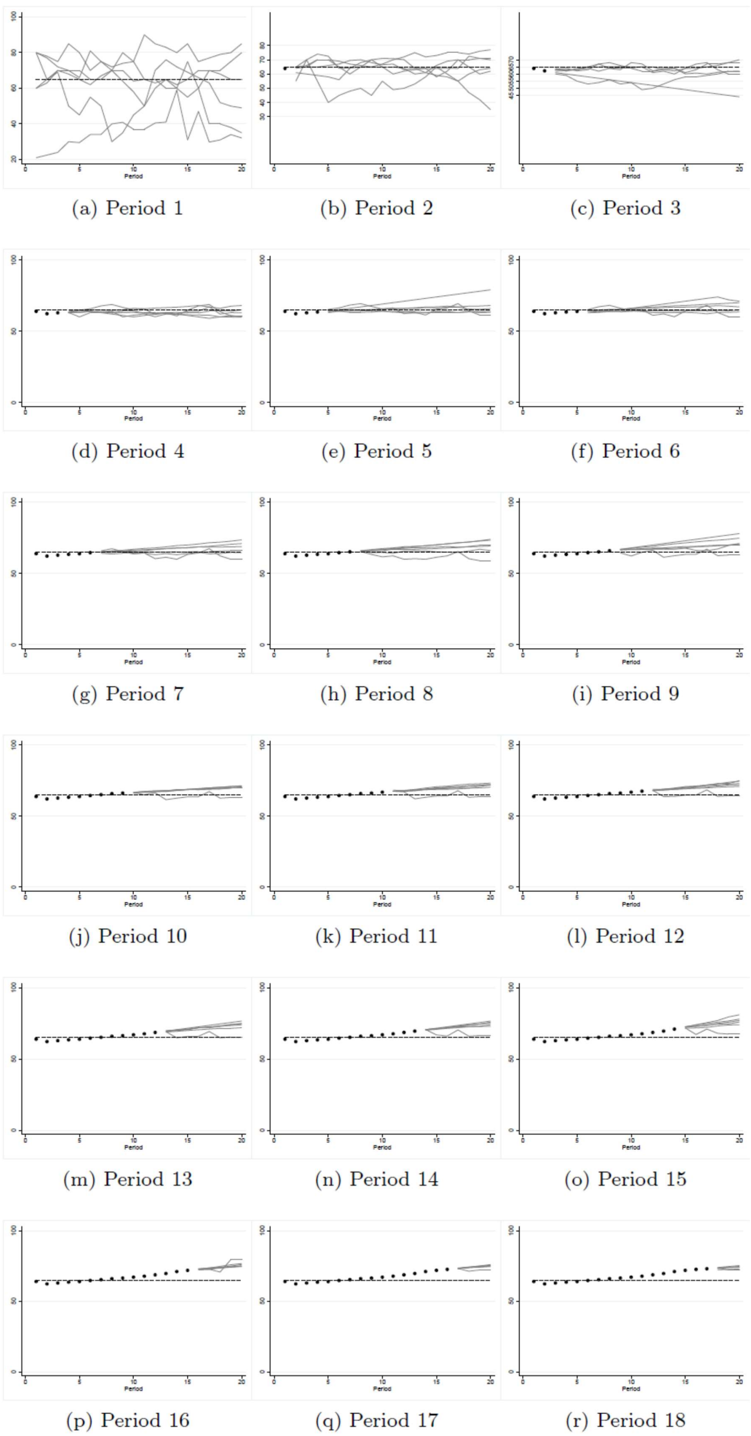
(g) Period 7 (h) Period 8 (i) Period 9

(j) Period 10 (k) Period 11 (l) Period 12

(m) Period 13 (n) Period 14 (o) Period 15

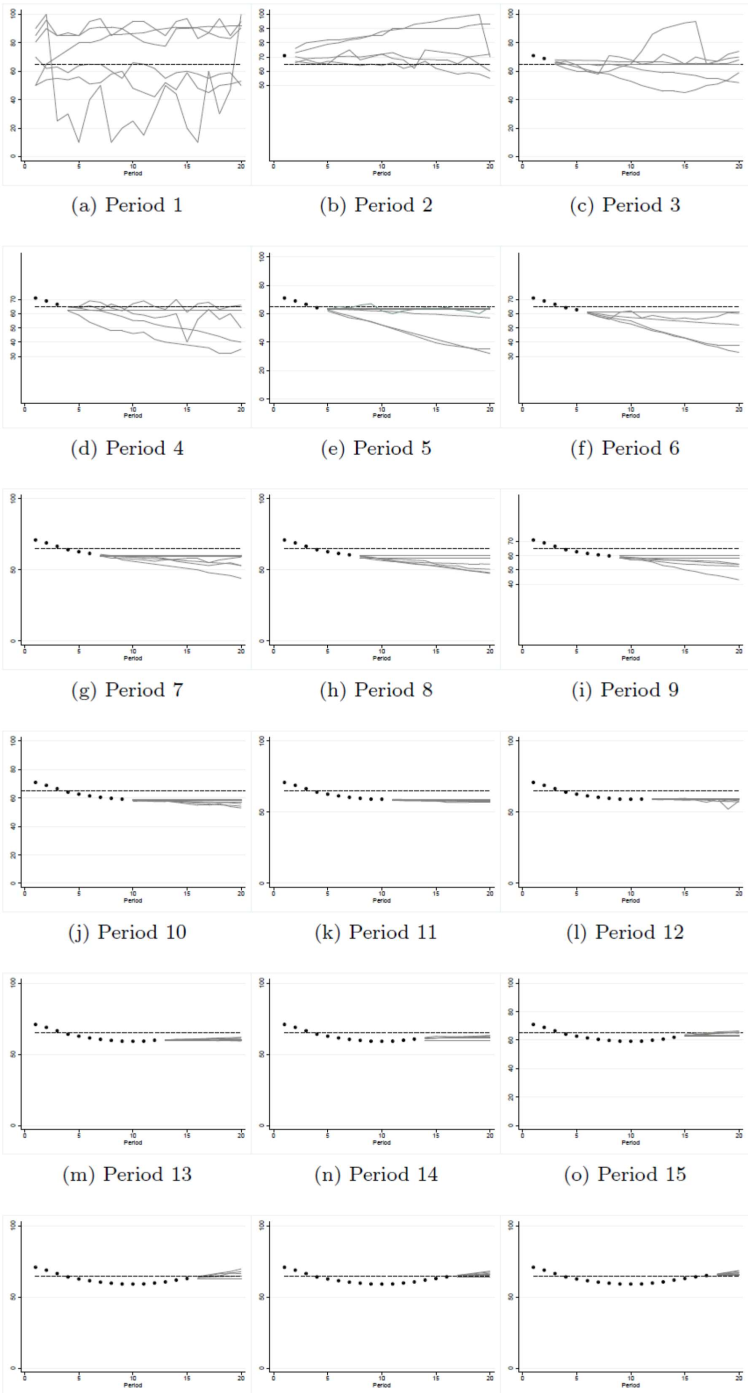
(p) Period 16 (q) Period 17 (r) Period 18

Fig. 13: Positive feedback: Individual long-run predictions of Group 2. The black dots indicate the realized price, the grey lines the individual forecasts and the dashed line the fundamental value.



(a) Period 1 (b) Period 2 (c) Period 3
(d) Period 4 (e) Period 5 (f) Period 6
(g) Period 7 (h) Period 8 (i) Period 9
(j) Period 10 (k) Period 11 (l) Period 12
(m) Period 13 (n) Period 14 (o) Period 15
(p) Period 16 (q) Period 17 (r) Period 18

Fig. 14: Positive feedback: Individual long-run predictions of Group 3. The black dots indicate the realized price, the grey lines the individual forecasts and the dashed line the fundamental value.



(a) Period 1 (b) Period 2 (c) Period 3

(d) Period 4 (e) Period 5 (f) Period 6

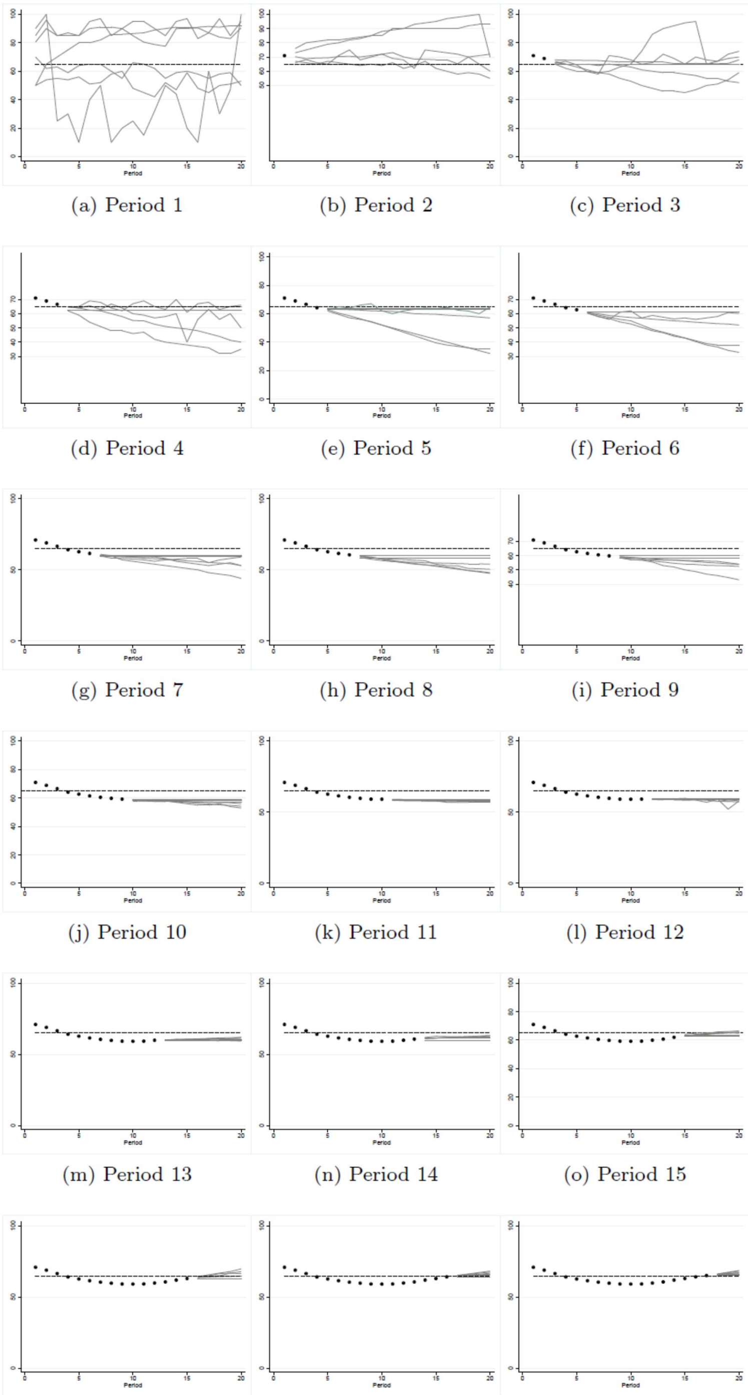
(g) Period 7 (h) Period 8 (i) Period 9

(j) Period 10 (k) Period 11 (l) Period 12

(m) Period 13 (n) Period 14 (o) Period 15

(p) Period 16 (q) Period 17 (r) Period 18

Fig. 15: Positive feedback: Individual long-run predictions of Group 4. The black dots indicate the realized price, the grey lines the individual forecasts and the dashed line the fundamental value.



(a) Period 1 (b) Period 2 (c) Period 3

(d) Period 4 (e) Period 5 (f) Period 6

(g) Period 7 (h) Period 8 (i) Period 9

(j) Period 10 (k) Period 11 (l) Period 12

(m) Period 13 (n) Period 14 (o) Period 15

(p) Period 16 (q) Period 17 (r) Period 18

Fig. 16: Positive feedback: Individual long-run predictions of Group 5. The black dots indicate the realized price, the grey lines the individual forecasts and the dashed line the fundamental value.

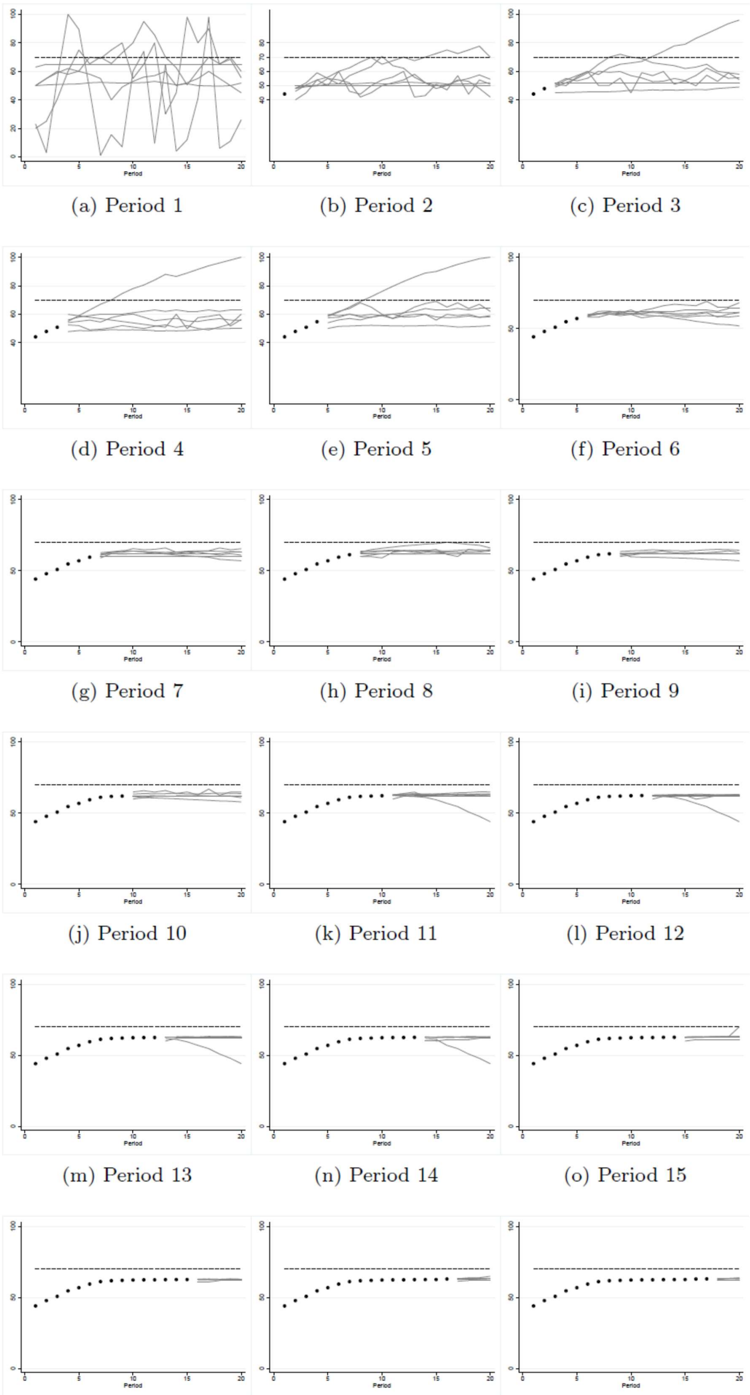
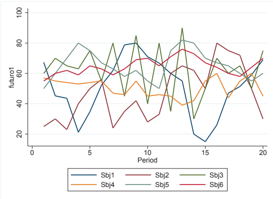
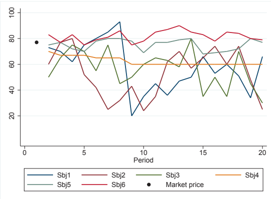
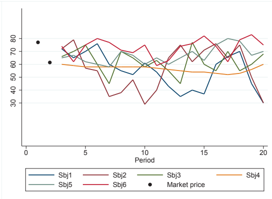
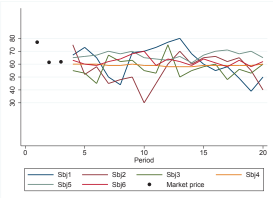

(a) Period 1 (b) Period 2 (c) Period 3
(d) Period 4 (e) Period 5 (f) Period 6
(g) Period 7 (h) Period 8 (i) Period 9
(j) Period 10 (k) Period 11 (l) Period 12
(m) Period 13 (n) Period 14 (o) Period 15
(p) Period 16 (q) Period 17 (r) Period 18

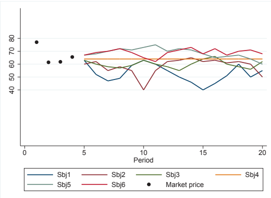
Fig. 17: Positive feedback: Individual long-run predictions of Group 7. The black dots indicate the realized price, the grey lines the individual forecasts and the dashed line the fundamental value.

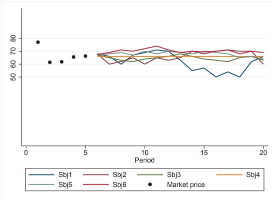

(a) Period 1

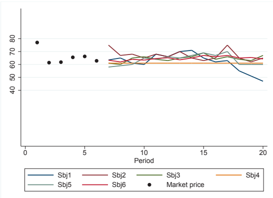

(b) Period 2

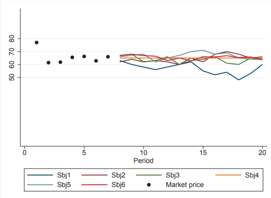

(c) Period 3

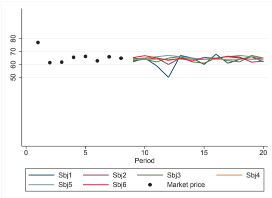

(d) Period 4

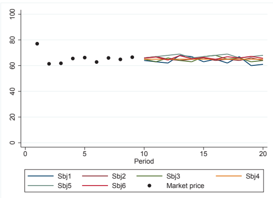

(e) Period 5

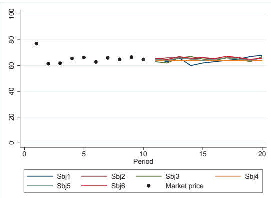

(f) Period 6

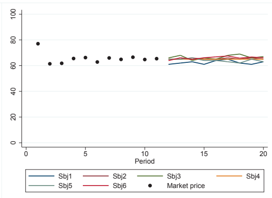

(g) Period 7

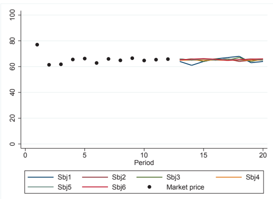

(h) Period 8

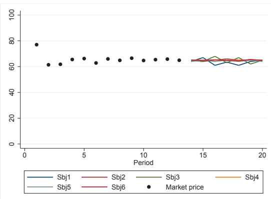

(i) Period 9

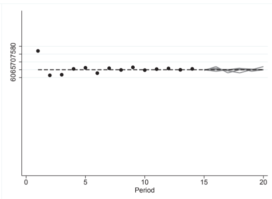

(j) Period 10

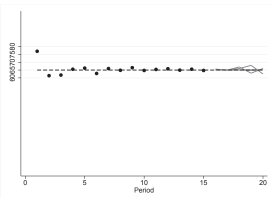

(k) Period 11

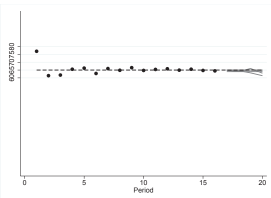

(l) Period 12


(m) Period 13


(n) Period 14


(o) Period 15


(p) Period 16


(q) Period 17

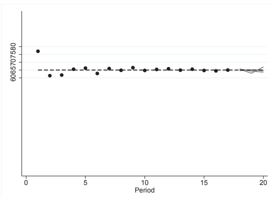
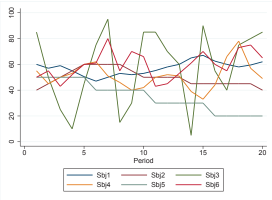
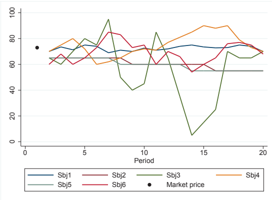

(r) Period 18

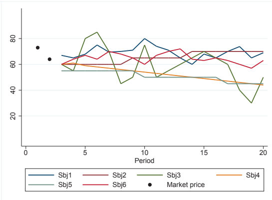
Fig. 18: Negative feedback: Individual long-run predictions of Group 1. The black dots indicate the realized price, the grey lines the individual forecasts and the dashed line the fundamental value.



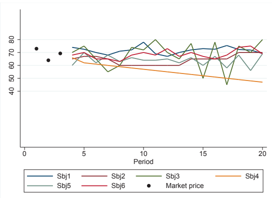
(a) Period 1



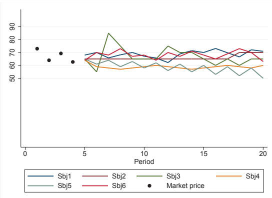
(b) Period 2



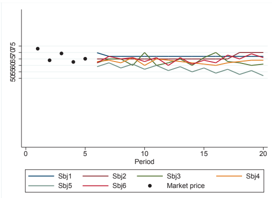
(c) Period 3



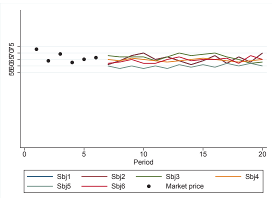
(d) Period 4



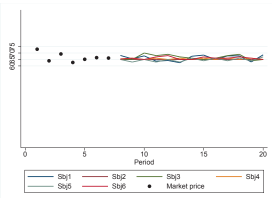
(e) Period 5



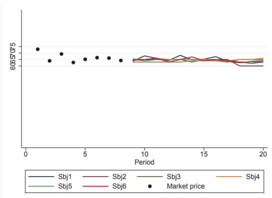
(f) Period 6



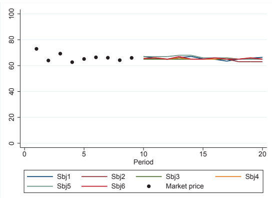
(g) Period 7



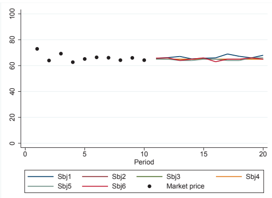
(h) Period 8



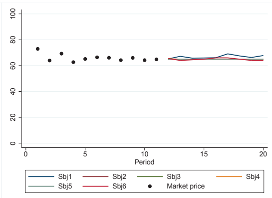
(i) Period 9



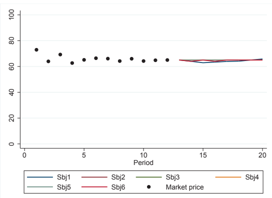
(j) Period 10



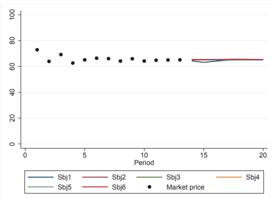
(k) Period 11



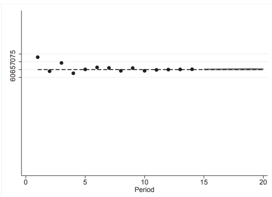
(l) Period 12



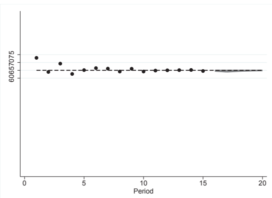
(m) Period 13



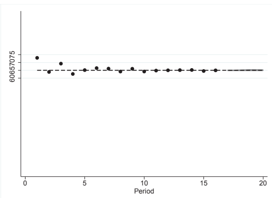
(n) Period 14



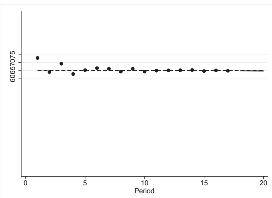
(o) Period 15



(p) Period 16

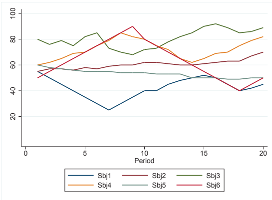


(q) Period 17

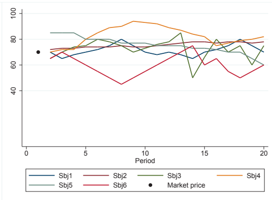


(r) Period 18

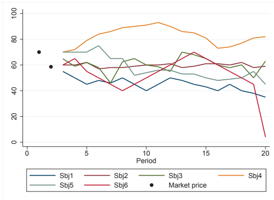
Fig. 19: Negative feedback: Individual long-run predictions of Group 2. The black dots indicate the realized price, the grey lines the individual forecasts and the dashed line the fundamental value.



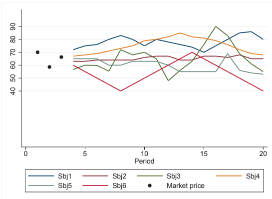
(a) Period 1



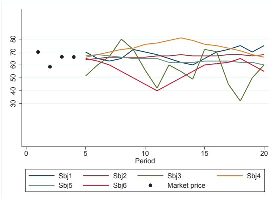
(b) Period 2



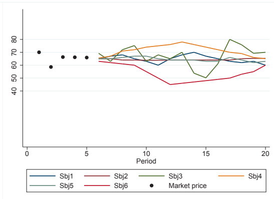
(c) Period 3



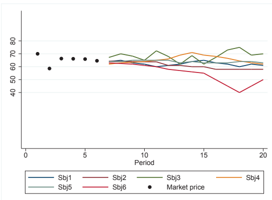
(d) Period 4



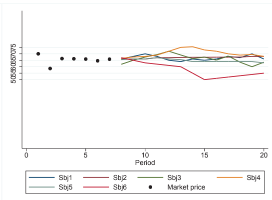
(e) Period 5



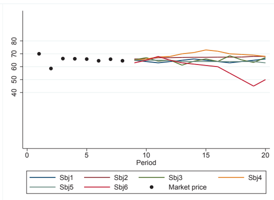
(f) Period 6



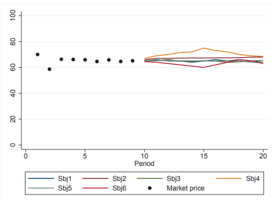
(g) Period 7



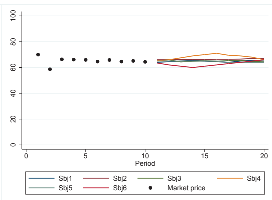
(h) Period 8



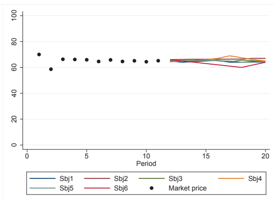
(i) Period 9



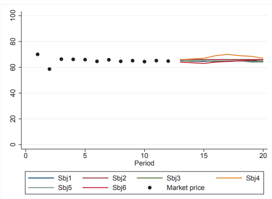
(j) Period 10



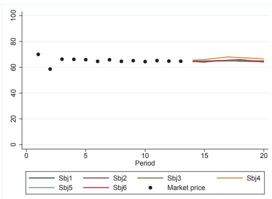
(k) Period 11



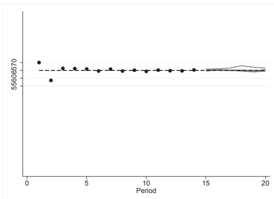
(l) Period 12



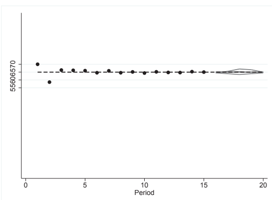
(m) Period 13



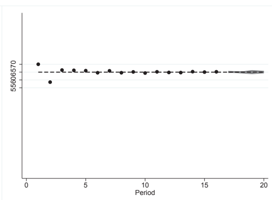
(n) Period 14



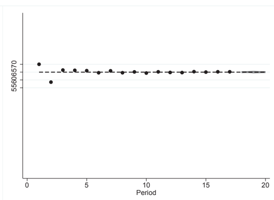
(o) Period 15



(p) Period 16

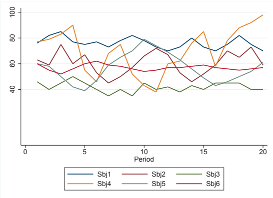


(q) Period 17

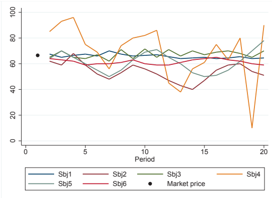


(r) Period 18

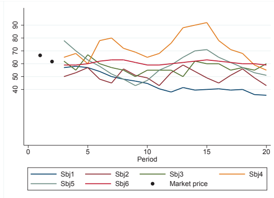
Fig. 20: Negative feedback: Individual long-run predictions of Group 3. The black dots indicate the realized price, the grey lines the individual forecasts and the dashed line the fundamental value.



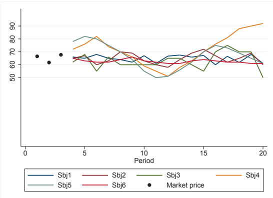
(a) Period 1



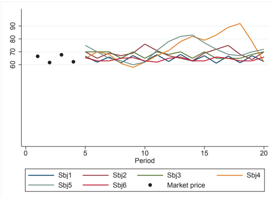
(b) Period 2



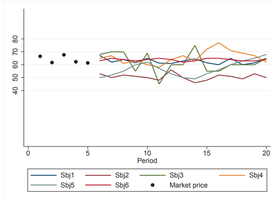
(c) Period 3



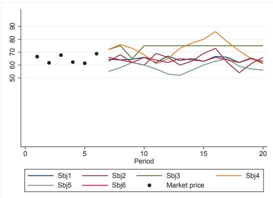
(d) Period 4



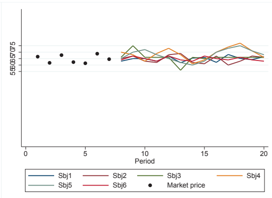
(e) Period 5



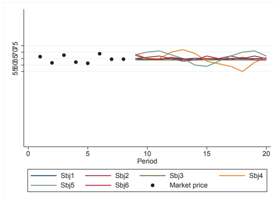
(f) Period 6



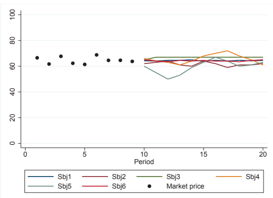
(g) Period 7



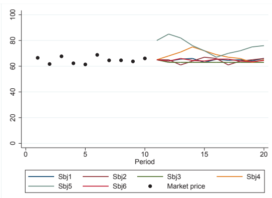
(h) Period 8



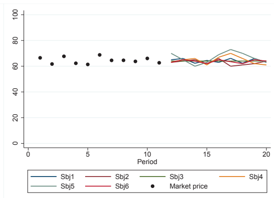
(i) Period 9



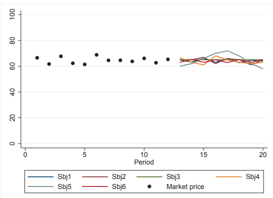
(j) Period 10



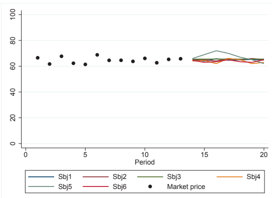
(k) Period 11



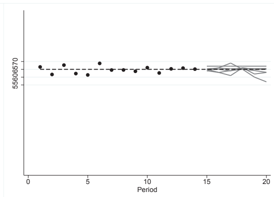
(l) Period 12



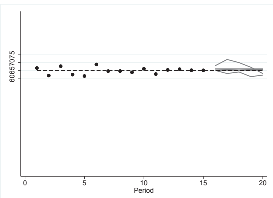
(m) Period 13



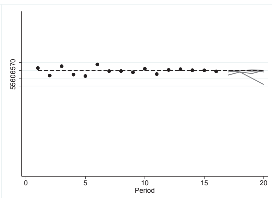
(n) Period 14



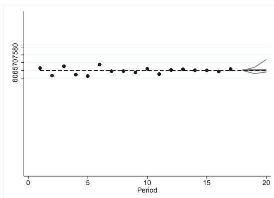
(o) Period 15



(p) Period 16

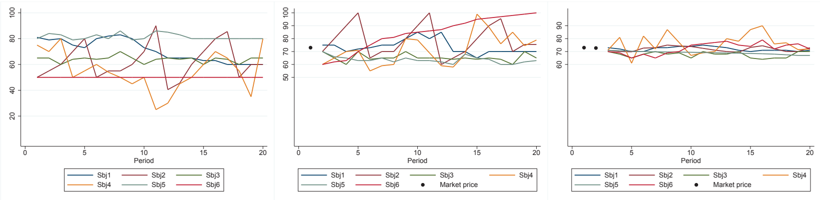


(q) Period 17

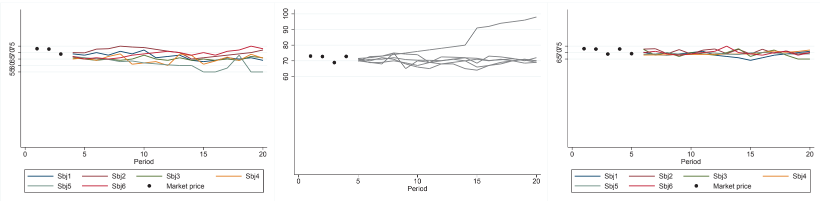


(r) Period 18

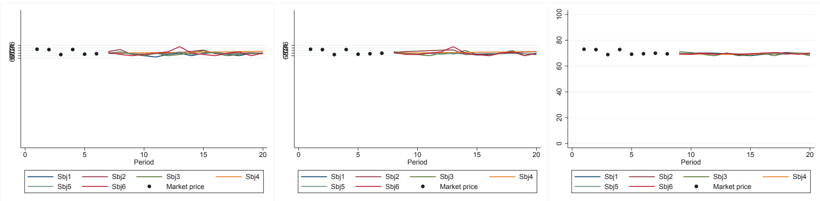
Fig. 21: Negative feedback: Individual long-run predictions of Group 4. The black dots indicate the realized price, the grey lines the individual forecasts and the dashed line the fundamental value.



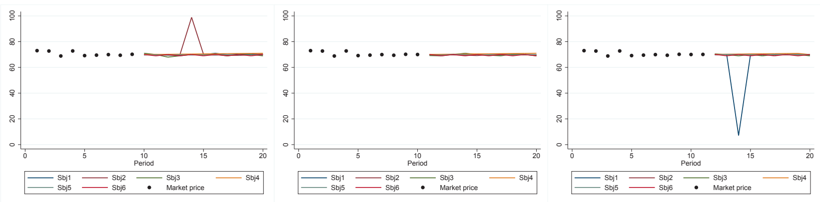
(a) Period 1 (b) Period 2 (c) Period 3



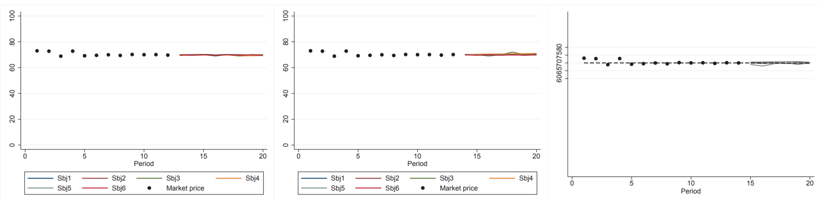
(d) Period 4 (e) Period 5 (f) Period 6



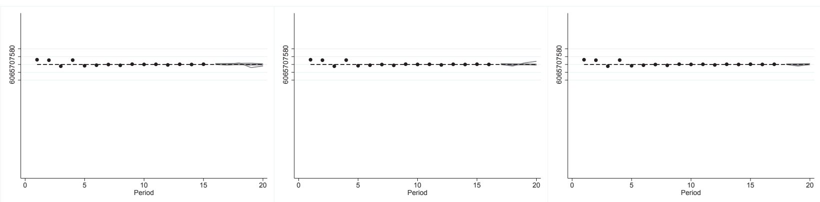
(g) Period 7 (h) Period 8 (i) Period 9



(j) Period 10 (k) Period 11 (l) Period 12

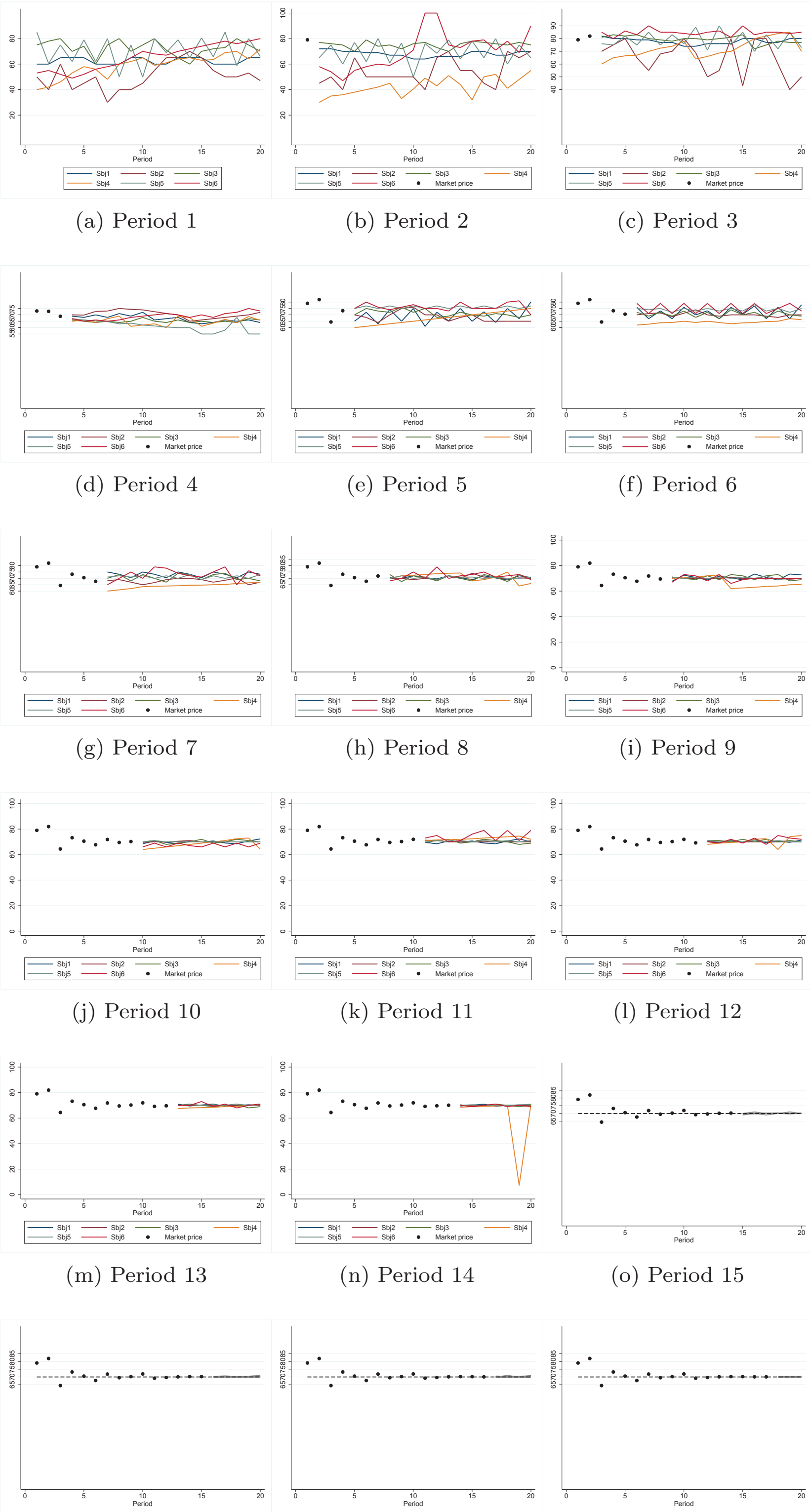


(m) Period 13 (n) Period 14 (o) Period 15



(p) Period 16 (q) Period 17 (r) Period 18

Fig. 22: Negative feedback: Individual long-run predictions of Group 5. The black dots indicate the realized price, the grey lines the individual forecasts and the dashed line the fundamental value.



(a) Period 1 (b) Period 2 (c) Period 3

(d) Period 4 (e) Period 5 (f) Period 6

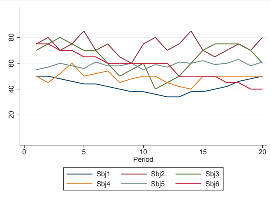
(g) Period 7 (h) Period 8 (i) Period 9

(j) Period 10 (k) Period 11 (l) Period 12

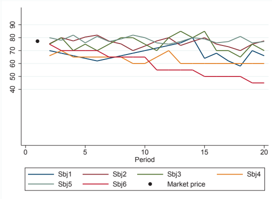
(m) Period 13 (n) Period 14 (o) Period 15

(p) Period 16 (q) Period 17 (r) Period 18

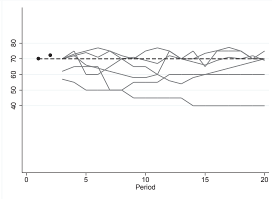
Fig. 23: Negative feedback: Individual long-run predictions of Group 6. The black dots indicate the realized price, the grey lines the individual forecasts and the dashed line the fundamental value.



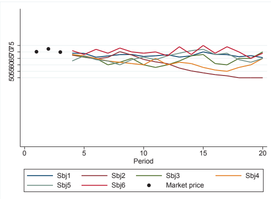
(a) Period 1



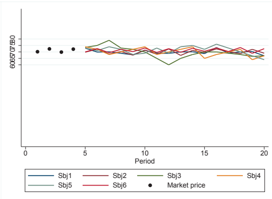
(b) Period 2



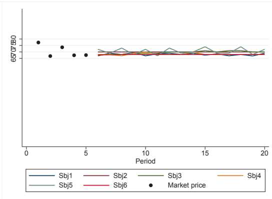
(c) Period 3



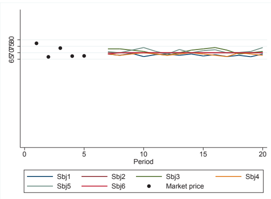
(d) Period 4



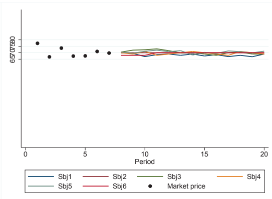
(e) Period 5



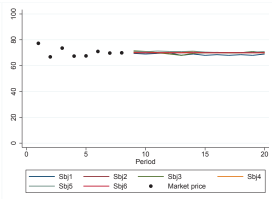
(f) Period 6



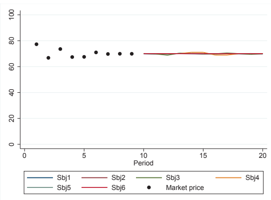
(g) Period 7



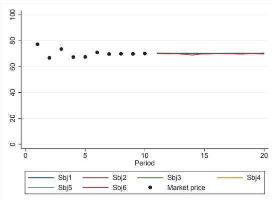
(h) Period 8



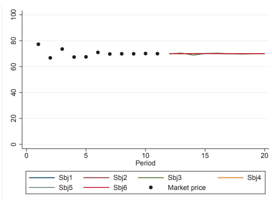
(i) Period 9



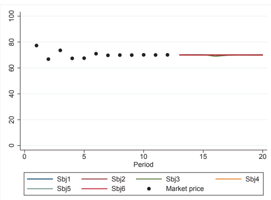
(j) Period 10



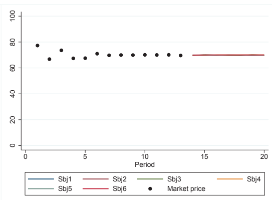
(k) Period 11



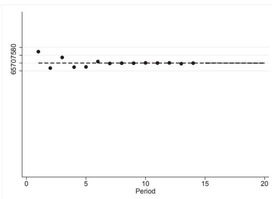
(l) Period 12



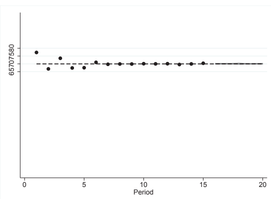
(m) Period 13



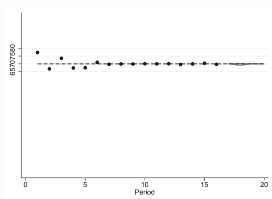
(n) Period 14



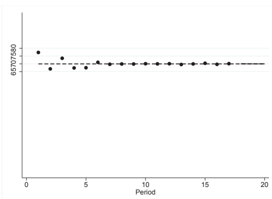
(o) Period 15



(p) Period 16



(q) Period 17



(r) Period 18

Fig. 24: Negative feedback: Individual long-run predictions of Group 8. The black dots indicate the realized price, the grey lines the individual forecasts and the dashed line the fundamental value.