Expectations structure in asset pricing experiments

Giulio Bottazzi[*], Giovanna Devetag[†]

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Abstract

Notwithstanding the recognized importance of traders' expectations in characterizing the observed market dynamics, for instance the formation of speculative bubbles and crashes on financial markets, little attention has been devoted so far by economists to a rigorous study of expectation formation in the laboratory.

In this work we describe a laboratory experiment on the emergence and coordination of expectations in a pure exchange framework. We largely base our study on previous experiments on expectation formation in a controlled laboratory environment by Cars Hommes, Joep Sonnemans, Ian Tuinstra and Henk van de Velden (2002a).

We consider a simple two asset economy with a riskless bond and a risky stock. Each market is composed of six experimental subjects who act as financial advisors of myopic risk-averse utility maximizing investors and are rewarded according to how well their forecasts perform in the market. The participants are asked to predict not only the price of the risky asset at time $t + 1$, as in Hommes et al. (2002a), but also the confidence interval of their prediction, knowing the past realizations of the price until time $t - 1$. The realized asset price is derived from a Walrasian market equilibrium equation, unknown to the subjects, with feedback from individual

[*]Sant'Anna School of Advanced Studies, Piazza Martiri della Libertà, 33 - I-56127 Pisa, Italy. E-mail: bottazzi@sssup.it.

[†]Department of Management and Computer Science, University of Trento, Via Inama, 5 - 38100 Trento, Italy. E-mail: devetag@cs.unitn.it

forecasts. Subjects' earnings are proportional to the increase in their wealth level. With respect to previous experiments that did not include an explicit evaluation of risk by participants, we observe a higher price volatility, a decreased likelihood of bubble dynamics and, in general, a higher heterogeneity of predictions.

1 Introduction

It is by now largely acknowledged that investors' expectations play a key role in the formation of speculative bubbles and crashes on financial markets. However, notwithstanding the recognized importance of trying to asses the dynamics that govern the formation of expectations and their response to information and experience, little attention has been devoted so far by economists to a rigorous study of expectation formation in the laboratory.

There are several experimental studies on asset markets (see, among others, King et al. (1993), Noussair et al. (2000), Porter and Smith (1995), Smith et al. (1988), Smith et al. (2000). However, most of these studies' main focus is the process of trading and the way in which trading activity itself may push prices far above or below the asset's fundamental value, although in several cases information about the participants' expectations is collected as well (see Sunder (1995) for a review).

In this work we describe a simple laboratory experiment on the emergence and coordination of expectations in a financial market, in which no trading takes place and in which subjects' only task is to form predictions about the future return of an asset and give a confidence range of their prediction. We largely base our study on a previous experiment of this type by Hommes et al. (2002a,b) on expectation formation in a controlled laboratory environment. In their experiment, each market is composed of six experimental subjects who are asked to predict the price of a risky asset at time t+1

knowing the past realizations of the price until time t-1, the mean dividend at each period and the risk-free interest rate. Subjects' earnings are a function of their forecasting errors, and the realized asset price is derived from an unknown market equilibrium equation with feedback from individual forecasts. The authors find out that in most markets prices diverge significantly from the (constant) fundamental value; moreover, speculative bubbles emerge endogenously due to *positive feedback expectations*. Finally, subjects belonging to the same market tend to coordinate on a common prediction strategy.

We replicate their experimental design but changing some important features. First and most importantly, we ask our subjects to predict not only the future price of the asset, but also the confidence interval of their prediction, which we use as an estimate of the forecasted variance of the returns. In this way subjects are asked to provide an estimation of the risk associated with their prediction and we are recreating a framework that is more similar to the ones really faced by financial advisors. We believe that adding information about the forecasted variance in the model may affect the dynamics observed in the experimental market compared to the baseline case of Hommes et al. (2002a,b).

Secondly, in our experiments a subject's earnings do not depend on his forecasting errors, but are proportional to the increase in the wealth level of a hypothetical investor (played by the computer program) who makes trading decisions according to a mean-variance approach taking as inputs the subjects' forecasts and acting with the time horizon of one step. In other words, experimental subjects act as financial advisors of myopic risk-averse utility maximizing investors and are rewarded according to how well their forecasts perform in the market. This experimental design allows us to focus exclusively on the dynamics of subjects' expectations, as in the original experiment by Hommes et al; in fact, our subjects are not engaged in any trading, which is done automatically by the computer program on the basis of the predictions they provide; however, the payoff assignment rule that we adopt is more correspondent to what happens in real financial markets, where prediction accuracy only matters inasmuch as it leads to 'correct' trading decisions.

Finally, we inform subjects of the positive feedback mechanism governing the dynam-

ics of price. In particular, subjects know that the price at time t is a positive function of all market participants' forecasted returns at time $t + 1$, and a negative function of the forecasted variability of the predicted returns. Subjects are also informed about the way in which the computer program calculates their personal demand functions for shares on the basis of their predictions, and on the nature of the asset pricing equation. In other words, subjects know that the price level at each time step - and the corresponding return - is generated by their own forecasting activity in a deterministic way. With such additional information, there is the possibility for groups to coordinate on a common expectation strategy. Section 2.1 and Section 3 respectively describe our model of asset pricing and our experimental design and implementation. Section 4 discusses the results and Section 5 offers some concluding remarks.

2　The Model

As previously said, participants in our experiment are asked to act as financial advisors for mean-variance utility maximizer speculators with a short (one time step) time horizon. We consider a simple economy with one risky stock paying constant dividend D at each trading round and a riskless bond with a constant return R. At each round of the experiment the participants are asked to provide prediction for the risky asset price return in the next round, i.e. for the relative price increase between the present and the next round, together with a confidence interval for their prediction. The participants prediction are then used as inputs to drive the investment decision of synthetic risk averse traders, played by the computer, that finally determine the asset price at each time step. In this section we describe the behavior of these synthetic traders in order to derive the explicit rules by which the participants' predictions about future returns do actually generate the present price. We begin by describing the traders' demand function following Bottazzi (2002) and, afterward, see how these different demand functions are merged to obtain the asset pricing equation.

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2.1 Personal demand function

Let $W(t)$ be the trader wealth at the beginning of time t and let x the fraction of wealth he wants to invest in the risky asset. If the price of the asset is $p(t)$ and $A(t)$ is the number of possessed shares then $W(t)\,x = p(t)\,A(t)$.

The future trader wealth (i.e. its wealth at the beginning of the next round) depends on the future return on the stock price $h(t) = p(t+1)/p(t) - 1$ and reads

$$W(t+1; h(t)) = x\,W(t)\,(h(t) - R + D/p(t)) + W(t)\,(1 + R) \tag{1}$$

where the dividends D are paid after the payment of the riskless interest R at the end of round t.

We choose as the expression of the agent utility the simplest function of the expected return and variance

$$U(t) = E_{t-1}[W(t+1)] - \frac{\beta}{2} V_{t-1}[W(t+1)] \tag{2}$$

where $E_{t-1}[.]$ and $V_{t-1}[.]$ stand respectively for the expected return and variance computed at the beginning of round t, i.e. with the information available at time $t-1$, and where β is the "risk-aversion" parameter.

Using the expression for W in (1) one obtains

$$E_{t-1}[W(t+1)] = x\,W(t)\,(E_{t-1}[h(t)] - R + D/p(t)) + W(t)\,(1 + R) \tag{3}$$

and

$$V_{t-1}[W(t+1)] = x^2\,W(t)^2\,V_{t-1}[h(t)] \quad . \tag{4}$$

Substituting (3) and (4) in (2) one obtains

$$U(t) = x\,W(t)\,(E_{t-1}[h(t)] - R + D/p(t)) - x^2\,\frac{\beta}{2}\,W(t)^2\,V_{t-1}[h(t)] + W(t)\,(1 + R) \tag{5}$$

whose maximum, remembering the definition of x provides the agent's demand of asset at times t, $A(t)$ that reads

$$A(t) = \frac{E_{t-1}[h(t)] - R + D/p(t)}{\beta\,V_{t-1}[h(t)]\,p(t)} \tag{6}$$

2.2 Aggregate demand and pricing equation

Consider a population of N heterogeneous traders. Let β_i (with $i \in \{1, \dots, N\}$) the risk aversion of the i-th trader and $E_{t-1,i}$ and $V_{t-1,i}$ respectively his forecasted return and variance. If the total amount of risky asset is A_{tot} its price can be determined under the condition of reducing the excess demand to zero. One has that the price $p(t)$ must solve

$$\sum_{i=1}^{N} \frac{E_{t-1,i} - R + D/p(t)}{\beta_i \, V_{t-1,i} \, p(t)} = A_{\text{tot}} \tag{7}$$

that reduces to a second order equation whose positive root reads

$$p(t) = \frac{\bar{E}_{t-1}}{2} + \sqrt{\left(\frac{\bar{E}_{t-1}}{2}\right)^2 + \bar{D}_{t-1}} \tag{8}$$

where

$$\bar{E}_{t-1} = \sum_{i=1}^{N} \frac{E_{t-1,i} - R}{A_{\text{tot}} \, \beta_i \, V_{t-1,i}} \tag{9}$$

is an average expected excess return weighted with respect to the inverse risk and

$$\bar{D}_{t-1} = \sum_{i=1}^{N} \frac{D}{A_{\text{tot}} \, \beta_i \, V_{t-1,i}} \tag{10}$$

is the analogously weighted expected dividend.

Notice that (8) provide a positive price for the risky asset even if the average expected excess return $\bar{E}_{t-1}$ is negative. Note that the above pricing equation has been obtained without considering any budget constraint for the agents. The A_{tot} can be reabsorbed in an overall rescaling of the parameter β_i.

2.3 The skeleton of the experiment

We conducted experiments with a given number of subjects acting as advisors for identical traders, in particular having an equal degree of risk aversion β. The experiment structure can be roughly described as follows:

- each participant is asked to provide a range within which she predicts, with a high

degree of probability[1], the future return will lay. Let a_i, b_i the range provided by participant $i \in \{1, \ldots, N\}$.

- for each participant range we compute the mid value and take it as an estimate of its forecasted return $E_i = (b_i + a_i)/2$. The forecasted variance of player i is set to $V_i = (b_i - a_i)^2/4$, i.e. the provided range is put equal to the $2 - \sigma$ range of an (assumed) underlying normal distribution.

- (8) is used to fix the present price $p(t)$, then (6) is used to determine the present market position of the synthetic trader, implied by the predictions of i-th participant, $A_i(t)$.

- once the present price is determined, from the trader's position in the previous time step $A_i(t-1)$ and from the past price $p(t-1)$ it is possible to determine the present value of her past position. The profit earned by the prediction of the i-th participant reads:

$$\pi_i(t) = A_i(t-1) \left(p(t) + D - p(t-1)(1+R) \right) \tag{11}$$

Notice that the total number of assets and the synthetic traders's degree of risk aversion (as measured by the parameter β) can be used to tune the impact of the forecasted variance on the price of the asset. At the end of the round t each participant receives information about: the new price $p(t)$, the new return $h(t)$, and the realized profit from the previous round π_t. In the next Section a detailed description of the experimental design is provided.

3   The experimental design and implementation

The experiment was entirely computerized and it took place in one of the computer rooms of the Computable and Experimental Economics Lab of the University of Trento on May 7, 2003. We conducted two sessions of the experiment, with three cohorts of 6

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[1]Roughly 95%, equivalent to the 2 standard deviation range of a normal distribution

subjects each participating in the first session and two cohorts of six participants in the second session, for a total of 30 subjects, which were recruited through ads posted at the various department buildings.

Subjects were mostly undergraduate students in economics and had never participated in experiments of this type before. Before the experiment began, subjects received paper copies of the instructions which were read aloud by the experimenter to make sure that the rules of the market were common knowledge among participants[2]. In addition, a handout with a summary of the market functioning together with the specification of the relevant parameters was also given to every subject. All subjects could see each other but were prevented from looking at each other's computer screens by wooden separators. They were told that they would participate in a financial market composed of six participants in which their task was to predict the expected price return of a hypothetical asset and its range of variability for a total of 50 periods. Their earnings would depend on the increase in the value of an initial endowment X that they would have at the beginning of every period. Instructions explained to subjects how their given forecasts of the expected price return at time $t + 1$ $E_i(t + 1)$ and the confidence interval $V_i(t + 1)$ would be utilized by the software to compute their personal demand function in every round, and how the sum of the personal demand functions of all six participants would determine the market price of the asset in period t. It was explained to subjects that the range V would be the interval of values that according to them would contain the forecasted return with a probability roughly equal to 95%.

Finally, instructions also explained that their earnings at the end of each period would consist of the capital gain achieved (which of course depended on the realized price return), the dividends paid and the fixed interest rate R gained on the residual of their endowment. It was made clear that there was no dependence between the investment choices made in different rounds, as a new, initial endowment X would be available to them at the beginning of every period. In other words, subjects acted as financial advisors of different investors, each of which acted as a mean-variance optimizer

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[2]A complete translation of the instructions given to subjects is available upon request.

with a time horizon of one step.

Subjects were told that their demand of shares could be negative or zero in some rounds, meaning that they could hold short positions or invest all of their endowment in the acquisition of bonds that would yield the riskless rate R. Their final earnings would be determined by the sum of their earnings in every round, and converted into cash as follows: the participant within the group that had achieved the highest cumulative payoff would receive an amount of €25, while the participant with the minimum cumulative payoff would receive an amount of €5. All other would get a payoff proportional to the maximum achieved. Subjects were informed of the payoff assignment rule but did not have any information throughout the experiment about other participants' earnings, therefore such payoff assignment rule gave them the highest incentive to maximize their earnings. Finally, although subjects knew that the market would be composed of six participants, they did not know the identity of the other five participants.

Sessions lasted one hour and a half each. The initial endowment X was set equal to 100 experimental schillings, the risk-less interest rate R was equal to 5%, the dividend was equal to 3 schillings. Finally, the parameter β and A_{tot} were fixed respectively to the value of 100 and 1.

4 Results

In Fig. 1 we report the observed asset prices for the 5 different groups together with the asset fundamental value. As can be seen from the plots, price volatility is very high but, expect for the final rounds of groups 3 and 5, it oscillates around the fundamental value. Moreover, notice that the price increase observed in group 3 and 5 is inconsistent with an idea of rational bubble, since it does not display the expected exponential growth. Hence, these can be plausibly interpreted as "speculative" bubbles. Their appearance toward the end of the experiment is probably due to a more 'extremist' behavior of some of the participants as the end of the experiment is approaching.

The behavior of the asset price in our experiment is remarkably different from the

one observed in Hommes et al. (2002a,b) with a higher volatility and a substantial lack of creation of relatively stable bubbles.

In Fig. 2 the autocorrelation structure of asset price returns for the 5 groups is shown (bold line) together with the autocorrelation of expected returns. The former is analogous in all groups except group 5, showing a tendency toward anti-correlation at 1 time lag. As far as the forecasted returns are concerned, one can notice that their autocorrelation structure is rather heterogeneous, with, however, a general tendency toward positive correlation, in contrast with the observed structure in price returns.

The heterogeneity in the participants' forecasts can be better judged from Fig. 3 and Fig. 4 that report the forecasted returns and forecasted variances of all the participants. We have eliminated the very beginning and end of the experiment in which some of the participants exhibit strange behaviors, probably due to lack of learning in the former case and end-of-experiment effects in the latter. As can be seen, not only predictions are quite heterogeneous, but they do no display any tendency to converge. Their volatility is group-specific, but it is in general very high and stationary. Forecasted variances seem to exhibit a higher persistence, in contrast to the forecasted returns. The more risk averse participants can be clearly perceived, and seem to behave consistently over time.

Finally in Fig. 5 we report the lagged cross correlation between the agents forecasted returns and the realized price returns. In this way one can analyze both how participants take the past returns into account when formulating their predictions, and how the participants' predictions themselves impact on the asset price. As expected, there is a strong correlation at lag 0. A high prediction of tomorrow returns formulated today generates a price increase and, consequently, a positive realized return today. Interestingly, the correlation between today's forecasts and tomorrow's prices is negative, suggesting a tendency to over-react to market fluctuations. This is plausibly the reason of the observed 1 lag negative autocorrelation in Fig. 2, i.e. of price "bouncing" dynamics. The correlation structure between the participants' predicted returns and past price returns is extremely heterogeneous and only a low degree of persistence can be observed in some cases.

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5 Conclusions

In this paper we have described a simple asset pricing experiment in which participants must forecast both the expected future price return of an asset and its variance. Our results show that, with respect to previous experiments in which subjects had to predict only the future price value, - and the pricing equation was linear with positive feedbacks from individual predictions - we find no evidence of coordination on common expectations, no evidence of persistent speculative bubbles, and a high volatility in the realized price around the asset's fundamental value. We suggest that it is the nonlinear structure of our pricing equation to determine such dynamics; in fact, the inclusion of the forecasted variance determines a dynamic by which small changes in the predicted confidence range determine large fluctuations in the realized price, which in turn makes it very difficult for subjects to coordinate on a common strategy. Note that in our model we adopted the simplifying assumption of an equal degree of risk aversion for our subjects. Future experiments should aim at introducing further heterogeneity by taking into account the - presumably - different risk attitudes of the participants in the experimental market. Taken together, our results confirm the importance of the market institutional details - and in particular the nature of the expectations feedback structure - in determining the observed market dynamics.

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Appendix: Instructions

The following is an English translation of the instructions given to subjects.

'You are about to participate in an experiment on decisions in market settings. Your

earnings will depend on your decision and on other participants' decisions. If you make appropriate decisions, you will be able to earn an appreciable sum of money that will be paid to you privately and in cash at the end of the experiment.

In this experiment you will participate in a financial market, and you will be asked to provide your estimates about the price variation of a financial asset. The market will last for a total of 50 periods. Your earnings will be based on the accuracy of your predictions in a way that will explained to you shortly.

All monetary quantities in the experiment will be expressed in experimental 'schillings'.

The Market

Each of you will participate in a market in which a hypothetical asset will be traded. Each market is composed of six participants (hence, yourself and other five participants). The division between groups of six participants will be made by the software randomly at the beginning of the experiment, and the group composition will remain the same throughout the experiment. The only information that you will have about the market will be the price of the asset over time, and its corresponding return (i.e., the price variation from one period to the next). This financial asset is such that at the end of every period a fixed dividend of 3 schillings is paid for each share owned (the dividends, for those of you who don't know it, represent the distribution of a firm's profits to the shareholders). In this market you will only have to make predictions. The trading decisions will be made for you by the computer program in the following way.

Predictions

At the beginning of period t - hence having information only up to period $t-1$ - you will be asked to provide two estimates:

1. your estimate of the asset's price variation in period $t+1$, or, in other words, its return, which we call E. This value can be positive or negative

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2. Your confidence range for such estimate, i.e., the range in which, according to you, the actual return E will fall with a probability roughly equal to 95%. We will label this confidence range with V

For example, you may predict that the asset return will be equal to 5%, with a confidence range of +-1%. This means that the most likely return for you will be 5%, and that such return may vary from a minimum of 4% to a maximum of 6% with a probability of roughly 95%.

The return is simply the price variation from round to round, defined as follows:

$$\frac{price(t+1) - price(t)}{price(t)} * 100 \tag{12}$$

Clearly, if the price rises the return will be positive, whereas if the price falls, the corresponding return will be negative.

Investment

At the beginning of each period you have an endowment of 100 schillings, given to you by a hypothetical bank, and which you can invest entirely or in part in purchasing shares of the asset. The amount that you do not use to buy shares remains in the bank and gives you a fixed (riskless) return of 5% in each period. On the basis of your estimates of the return of the asset at time t+1 and on the confidence range of your estimates (i.e., the two values of E(t+1) and V(t+1)), the software will compute the number of shares that you purchase at the beginning of period t according to the following equation:

$$D(t) = \frac{E(t+1) - 0.05 + 3/p(t)}{[V(t+1)/2]^2 p(t)} \tag{13}$$

where E(t+1) and V(T+1) are your forecasted return and its confidence range respectively, 0.05 is the riskless rate of interest that the bank applies to you, 3 is the dividend paid by each share in each period. In other words, D(t) is your individual demand of shares that the software calculates automatically for you in every period. The higher your estimated return for the next period (E(t+1)) the higher your demand for

shares in this period. On the contrary, the higher your confidence range (which reflects your degree of uncertainty about your own prediction of the future return), the lower will be your demand for shares. Please note that the variable p(t), which represents the price of the asset in period t, is an unknown in the equation, and it will be determined as follows:

Equilibrium between demand and supply and determination of the asset price

The price of the asset at time t is determined by equating the total demand for shares to the total supply of shares:

$$\sum_{i=1}^{6} \frac{E_i(t+1) - 0.05 + 3/p(t)}{[V(t+1)_i/2]^2 p(t)} = X \rightarrow p(t) \tag{14}$$

the term on the left-hand side of the equation is simply the sum of the individual demands of shares of all six participants, while X is the total supply of shares, which remains fixed throughout the experiment. Since the supply of shares is fixed, the higher the market demand for shares, the higher will be the price of the asset. The market demand for shares will be higher in general the higher the expected returns and the lower the uncertainty about such expectations (i.e., the lower the confidence range). After determining the price of the asset in period t, the software will substitute its real value in eq. 13 in order to determine the number of shares that each of you will buy.

Your Payoff

We assume for simplicity that everything you buy at the beginning of a period is sold in the following period. Your earnings will depend on how you have invested the endowment of 100 schillings that you have at the beginning of each period, and may derive from three sources: the increment of value of the shares you own, the payment of dividends at the end of each period, and the riskless interest that you earn on the remaining amount of money that you have not invested in shares. The earning related to your prediction at

the beginning of period t will be realized at the end of period t+1 and will be determined as follows:

$$\pi(t+1) = D(t)[p(t+1) - p(t)] + 3D(t) + [100 - D(t)p(t)]0.05 \qquad (15)$$

The first term expresses your capital gain, i.e., the profit you earn by reselling at price(t+1) the shares that you bought at price(t); the second term is the earning you get from payment of dividends (3 shillings for each share), and the third term is the riskless interest gained on the residual. Note that you are allowed to borrow money to buy shares or sell shares that you don't own in order to 'buy' money. Hence, D(t) may be negative in one period (in which case you will sell shares instead of buying them and will buy them back at the end of the subsequent period; you will earn a capital gain if the price has decreased); or, the value of D(t)*p(t) may be higher than 100 schillings. In this case the last term of the equation will be negative, reflecting the interest that you paid to the bank for the money that you borrowed beyond your endowment. Finally, if D(t) is zero in a period, your earnings will be given simply by the 5% interest on your entire endowment. In brief, your payoff will depend on the choices of investment that the software will make for you on the basis of your predictions.

Important: at the beginning of the next period, you again have a new endowment of 100 schillings. Everything you bought is resold before a new period starts. Therefore, there is no dependence between your investment plans in different periods.

A Numerical Example

At the beginning of period 4 - and knowing the asset price up to period 3 - you have to make a prediction on the asset return (and its confidence range) in period 5. Let's us assume that you predict a return of 12% with a confidence interval of +-5%. The software computes the optimal quantity of shares that you buy in period 4, as a function of price in period 4, which is still unknown. When all participants have entered their predictions, the individual demand for shares will be summed up and put equal to the supply of shares, which is constant. Solving the equation (demand=supply) will

determine the asset price in period 4, which let's us assume to be equal to 10.2. Now, the software substitutes the value of 10.2 to p(4) in your individual demand equation to find the number of shares that you buy. Let's us assume this number is 5; therefore, in period 4 you buy shares for a total value of 5*10.2 = 51 schillings. At the end of period 5, you can see the earnings that you obtained with this investment in period 4. Let's assume that the price at time 5 is 12.8, which is the price at which you will resell the shares. The corresponding return hence is equal to (12.8 - 10.2)/10.2 = 25%. Your earnings will be equal to:

$$G = 5 * [12.8 - 10.2] + [100 - (51)] * 0,05 = 13 + 2,45 = 15,45.$$

Now let's assume instead that the asset price has decreased in period 5 to value of 2; the corresponding return will be negative and equal to (2-10.2)/10.2 = -80%. You had mistakenly predicted a positive return and hence you had bought shares in period 4. Your earnings in this case are:

$$G = 5 * [2 - 10,2] + [100 - (51)] * 0,05 = -41 + 2,45 = -38,55.$$

A wrong prediction not necessarily means the you will suffer a loss; however, generally, the more accurate your prediction, the closer to optimal your investments will be, and higher your overall earnings. Your incentive is to provide predictions as accurate as possible. The confidence range reflects your degree of uncertainty on your own prediction; if you choose a wide confidence range, this implies you are very uncertain about the true value of the return, and hence you will buy a lower number of shares compared to the case in which you indicate a smaller confidence range. Your total earnings will be determined by the sum of the earnings you realize in each of the 50 periods and will be converted in euros as follows: whoever among the six participants to the market has achieved the highest earning will receive 25 euros. The participant with the lowest earnings will receive 7 euros. All the other participants will receive a sum proportional

to their payoff with respect to the maximum payoff. The same rule will be applied in case you all suffer losses.

5.1 Information

The information that you will have in each period concerns the past realizations of the price, the actual return, your predicted return, your payoff in each round with the indication of your cumulated payoff between parentheses. Besides, the values of the price and the corresponding return will be also displayed graphically (by two continuous lines of different colors) in the box on the left handside of your computer screen. Recall that the market will last for 50 periods. At the beginning of a period you will have to insert your values of E and V in the two pop-up windows that you see in the bottom part of the screen by using the numerical keyboard and pressing 'enter'. The values you enter are already interpreted by the software as percentages, therefore you do not need to use decimal values. You can choose values between -50,000 and +50,000 for the return and you can choose values from 1 to 100 for the confidence range (you can simply insert a number for V; for example, if you enter 2, the software will automatically interpret it as "+-2%". For the return, on the contrary, you also have to enter the sign (+ or -).

Please, do the experiment in silence and do not try to look at other participants' screens. Are there any questions?

Thank you for your collaboration!'

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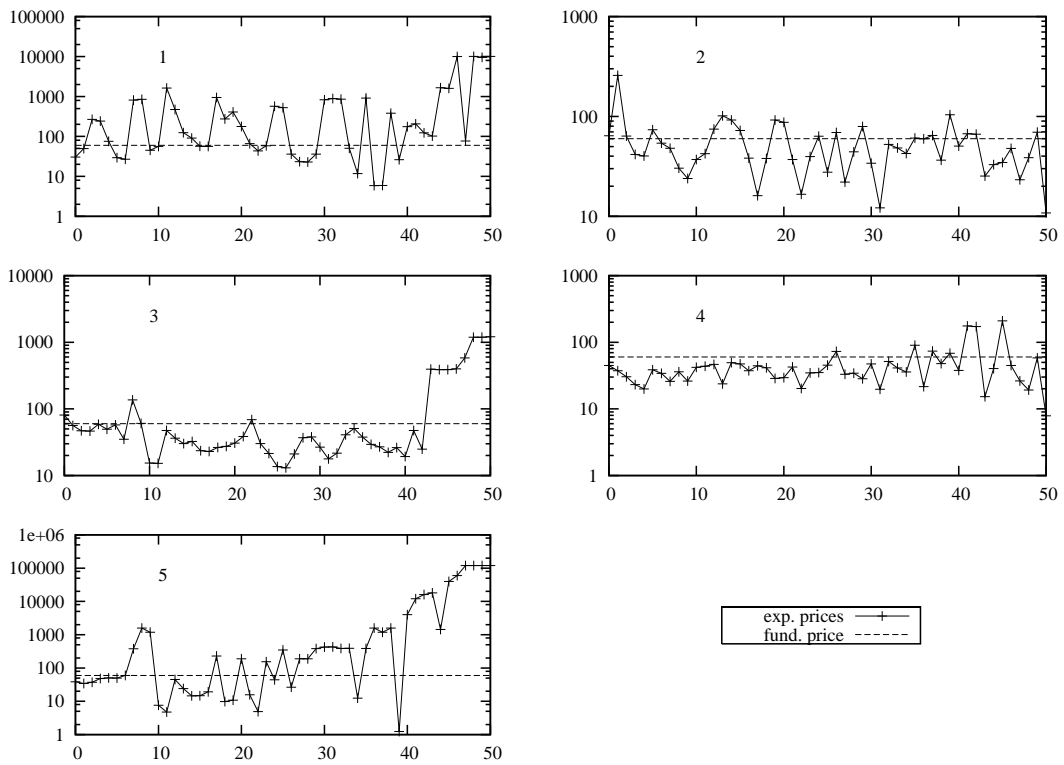
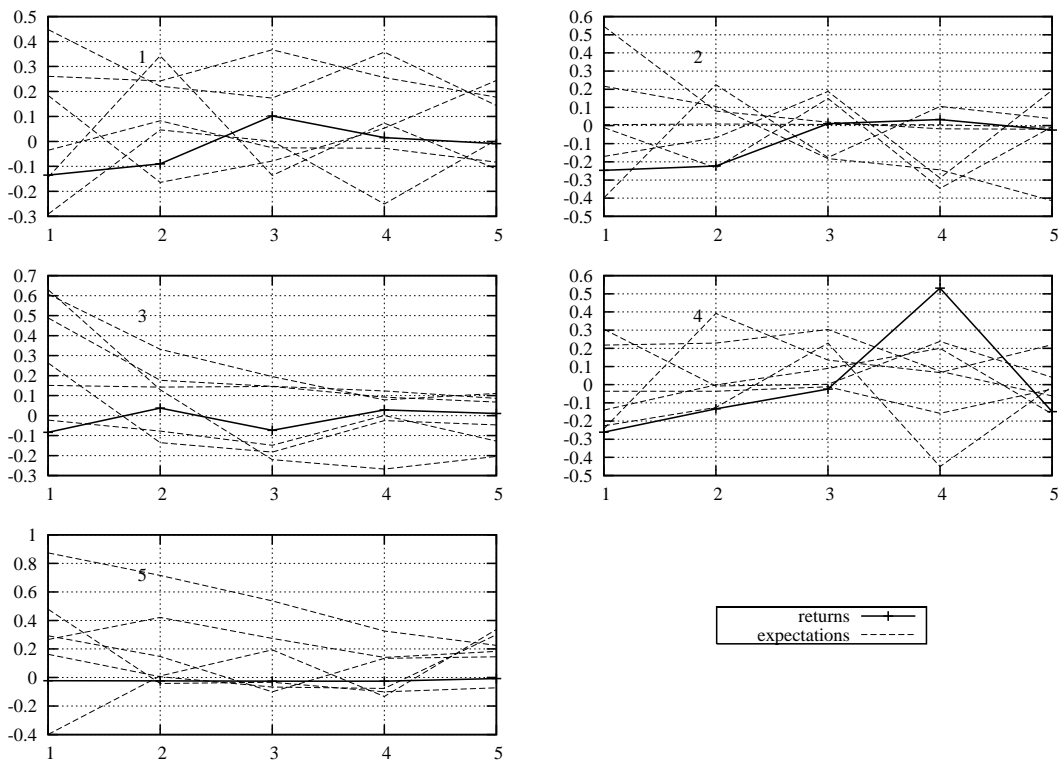Figure 1: Price history for the 5 groups.

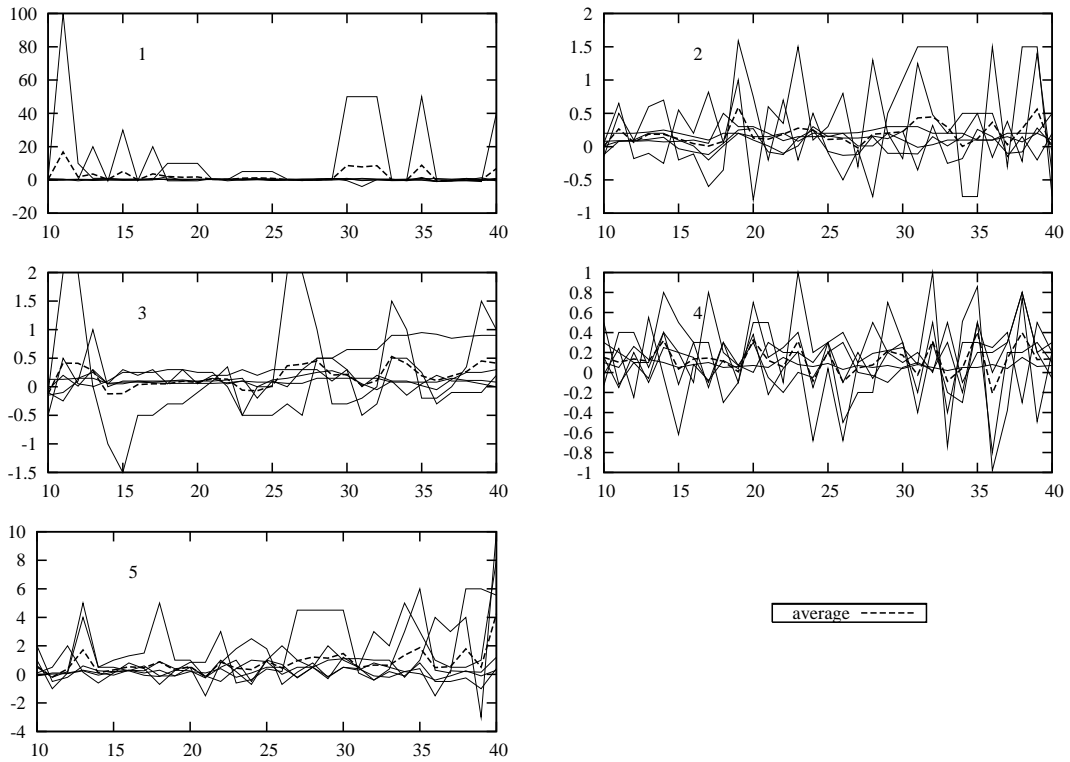Figure 2: Returns autocorrelogram for the 5 groups.

Figure 3: Forecasted returns for the 5 groups. Each line corresponds to the forecast of one agent.
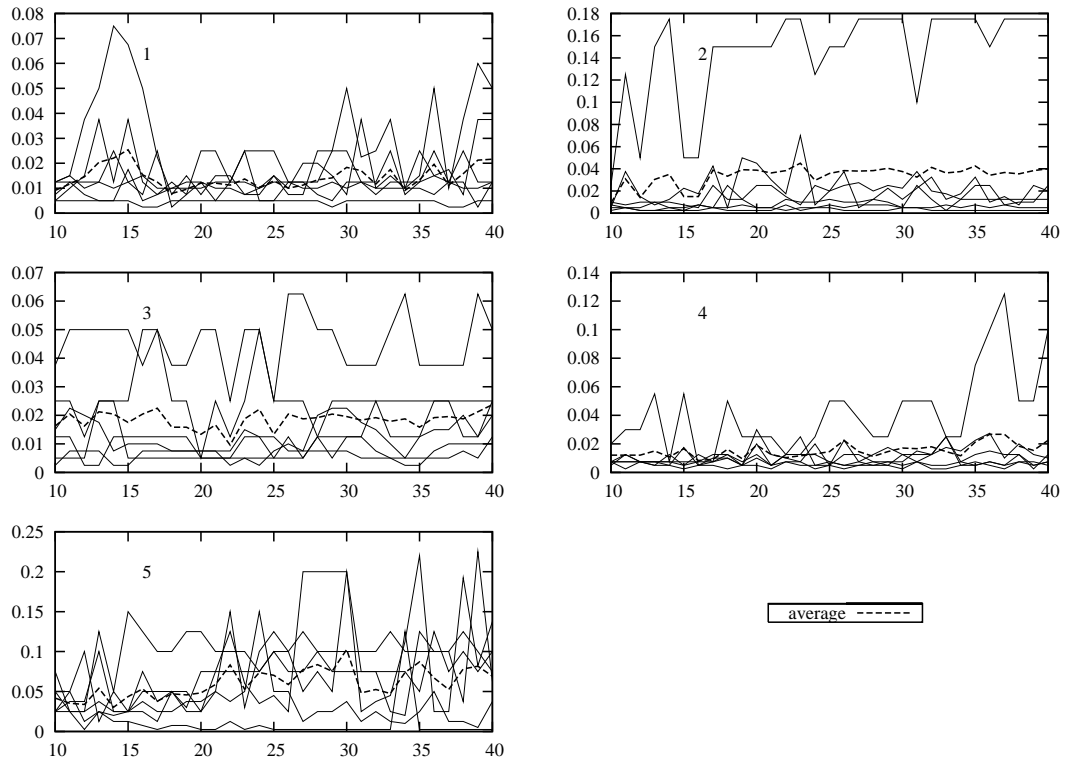
Figure 4: Forecasted variances for the 5 groups. Each line corresponds to the forecast of one agent.
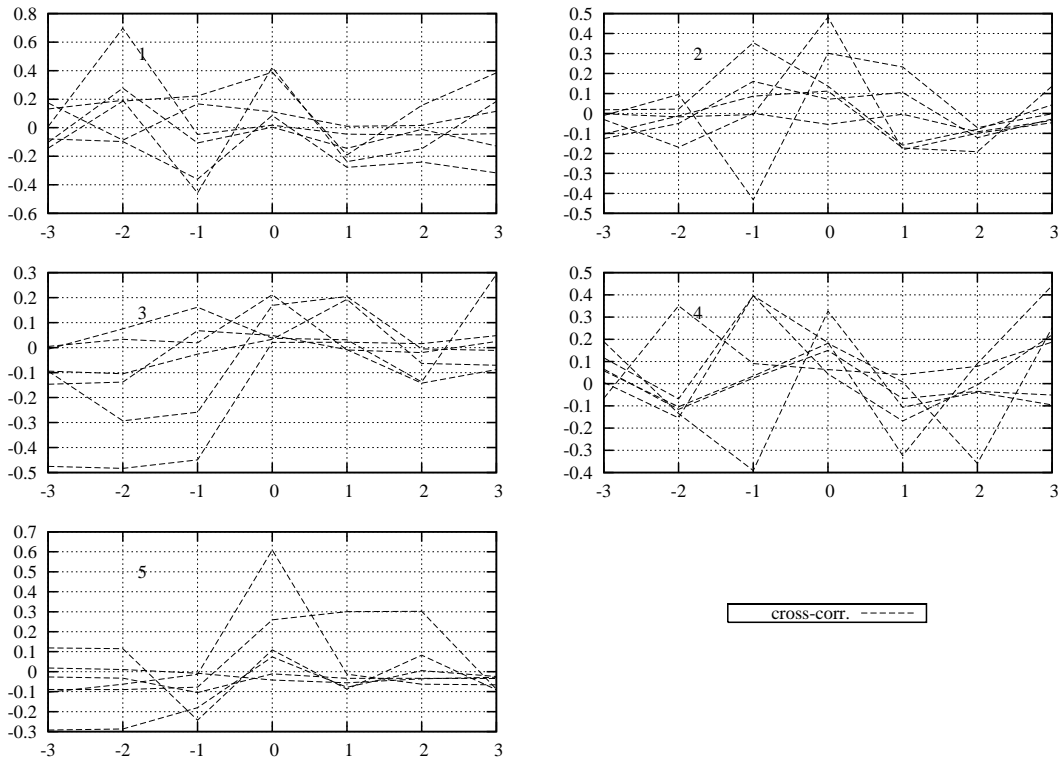
Figure 5: Cross-correlogram between agents forecasted returns and realized returns.