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Positive expectations feedback experiments and number guessing games as models of financial markets

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ABSTRACT

In repeated number guessing games choices typically converge quickly to the Nash equilibrium. In positive expectations feedback experiments, however, convergence to the equilibrium price tends to be very slow, if it occurs at all. Both types of experimental designs have been suggested as modeling essential aspects of financial markets. In order to isolate the source of the differences in outcomes we present several new experiments in this paper. We conclude that the feedback strength (i.e. the '*p*-value' in standard number guessing games) is essential for the results.

1. Motivation

In a famous quote Keynes (1936) describes financial investment as a game in which players try to predict average predictions:

> "professional investment may be likened to those newspaper competitions in which the competitors have to pick out the six prettiest faces from a hundred photographs, the prize being awarded to the competitor whose choice most nearly corresponds to the average preferences of the competitors as a whole".[1]

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[1] The quote continues with: "so that each competitor has to pick, not those faces which he himself finds prettiest, but those which he thinks likeliest to catch the fancy of the other competitors, all of whom are looking at the problem from the same point of view. It is not a case of choosing those which, to the best of one's judgment, are really the prettiest, nor even those which average opinion genuinely thinks the prettiest. We have reached the third degree where we devote our intelligences to anticipating what average opinion expects the average opinion to be. And there are some, I believe, who practise the fourth, fifth and higher degrees." See Keynes (1936), p. 156.

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This beauty contest analogy is often cited in papers on higher order beliefs[2] and has inspired an increasing number of theoretical and experimental contributions to economics and finance (for a recent theoretical study see e.g. Allen, Morris, & Shin, 2006). Most experiments focus on (variations of) the so-called number guessing game (see e.g. Nagel, 1995). In this game all players have to simultaneously submit a 'guess' from a certain interval (typically 0–100) and the winner is the player whose choice is closest to a given fraction (typically 2/3) of the average of these chosen numbers. This game has a unique Nash equilibrium and the distance between a specific guess and the equilibrium value can be considered a measure of the belief this player has about the rationality of the population of players, and about the distribution of the higher order beliefs about rationality in the population.

The general findings from the experimental literature on repeated number guessing games are that first period choices are not very close to the Nash equilibrium but convergence to that equilibrium is fast (typically within 4–5 periods) and stable. As a characterization of behavior of financial markets this fast convergence is surprising for at least two reasons.

First, empirical evidence suggests that asset markets are in fact not that stable. Shiller (1981), Shiller (2000), for example, shows that stock prices are excessively volatile: their variance is higher than that of the underlying fundamental value. Behavioral finance (for recent overviews see Shleifer, 2000; Barberis & Thaler, 2003) has shown that (1) many price movements are unrelated to news but are reactions to price changes (for example caused by investors using technical analyzes) and that (2) prices under-react to news, causing short-term trends. Mis-pricing cannot always be arbitraged away (Shleifer & Vishny, 1997) and market prices may therefore deviate substantially from their fundamental values for a longer period of time. Mis-pricing and over- and under-reaction has also been established experimentally. Smith, Suchanek, and Williams (1988) discuss experimental asset markets that feature bubbles and crashes in asset prices. Noussair, Robin, and Ruffieux (2001) show that these bubbles and crashes even emerge when the fundamental value is constant, instead of deterministically decreasing. Kirchler (2009) establishes under-reaction in an experimental asset market with a fluctuating fundamental value. Finally, in an expectation feedback experiment with some large permanent shocks to the fundamental value, Bao, Hommes, Sonnemans, and Tuinstra (2010) argue that there may be under-reaction of realized prices to these shocks in the short run, but over-reaction in the long run.

Second, evidence from expectations feedback experiments (see e.g. Hommes, Sonnemans, Tuinstra, & van de Velden, 2005; Hommes, Sonnemans, Tuinstra, & van de Velden, 2008; Heemeijer, Hommes, Sonnemans, & Tuinstra, 2009) does not seem to be consistent with the results from number guessing game experiments. Expectations feedback experiments are based upon the idea that asset markets (just like many other economic environments) are *expectations feedback systems*. Price expectations of traders determine their trading behavior which, in turn, determines the realized trading price. In an expectations feedback experiment participants have to submit their forecast of the future price of a certain asset and are paid according to their prediction accuracy. A computer program determines the optimal trades associated with the forecasts and the resulting realized trading price. The advantage of this design over traditional experimental asset markets is that it gives a clearer picture of how people form expectations in expectations feedback environments.[3] In prediction experiments with a positive expectations feedback (that is, where an increase in average predictions leads to an increase in the realized market price) there is a remarkable tendency for participants to coordinate on a common prediction strategy but no (or only slow) convergence to the equilibrium price.

These positive feedback prediction experiments are closely related to the number guessing game, but with very different results.[4] Nevertheless, the experimental designs do differ in a number of dimensions, particularly the *feedback strength* from expectations (guesses) to realized price (target number), the *information* given to the participants, and the *incentive structure*. It is, a priori, not evident which of these design differences is responsible for the differences in outcomes. This paper reports on a series of experiments that are designed to isolate the main determinants. Our main finding is that only feedback strength has a substantial impact upon convergence, although it does not seem to have a significant effect upon prediction accuracy or coordination of expectations. Providing more information to the participants, and/or introducing a winner-takes-all incentive scheme has no significant effect upon convergence, prediction accuracy or coordination, although the winner-takes-all incentive scheme does lead to a substantial increase in the number of "spoilers", i.e. sudden large and erratic deviations in individual predictions.

The remainder of this paper is organized as follows. In Section 2 we will briefly review the experimental literature on number guessing games and positive expectations feedback experiments and discuss the differences in design characteristics and outcomes between these two types of experiments. The design of five new experimental studies will be briefly discussed in Section 3 and the results of these new experimental studies will be analyzed in Section 4. Section 5 concludes.

[2] See for example, Biais and Bossaerts (1998), Ho, Camerer, and Weigelt (1998), Camerer, Ho, and Chong (2004) and Costa-Gomes and Crawford (2006). An alternative financial market interpretation of the guessing game is that it models the problem of leaving a market just before prices start going down, see Duffy and Nagel (1997) and Ho et al. (1998).

[3] In more traditional asset market experiments participants are also sometimes asked to submit price predictions, but it is difficult to give the appropriate incentives for providing these predictions and often they come about as a by-product to the experiment. For a more rigorous approach to expectation formation in experimental asset markets, see Haruvy, Lahav, and Nouissair (2007).

[4] When we started our experimental research on expectation feedback markets we were not fully aware of the close connection with guessing games. This connection only became apparent to us when we changed from using a market-clearing environment (Hommes et al., 2005), where participants had to predict two periods ahead, to a market-maker environment (Heemeijer et al., 2009) where participants only have to predict one period ahead (in Section 2.2 we will discuss the differences between these two types of expectations feedback experiments in more detail).