Market Psychology, Animal Spirits and Reflexivity

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Neoclassical economics has abolished the role of psychology in decision making by assuming that all individuals are rational optimizers with rational expectations about future events. Even if one allows psychology and emotions to affect individual behavior, what is the aggregate effect of idiosyncratic individual psychological shocks to the economy? Neoclassical economics assumes that at the aggregate level all idiosyncratic shocks wash out and that individuals on average behave rationally. This view has, for example, already been expressed in Muth (1961; p321) seminal paper introducing rational expectations [emphasis added]:

Allowing for cross-sectional differences in expectations is a simple matter, because their aggregate affect is negligible *as long as the deviation from the rational forecast for an individual firm is* not strongly correlated with those of the others. *Modifications are necessary only if the correlation of the errors is large* $\cdots$

This quote also shows that Muth was aware of potential limitations of rational expectations, if individual forecasts and errors become it correlated. A key issue therefore is whether or not individual expectations are correlated and, if so, on what?

The financial-economic crisis has shown –once more– that markets are not 'rational', but may fluctuate wildly strongly amplified by investors' sentiment, emotions and market psychology. From a practitioners point of view, for example, George Soros (2009) stressed the role of expectations, or what he called 'reflexivity', in asset market fluctuations [emphasis added]:

That two-way connection–that you affect what you predict–*is what I call* 'reflexivity'. *That is how financial markets really work..... In short, the boom-bust sequences, the bubbles, are endemic to the financial system.*

And much earlier, the role of expectations and 'animal spirits' has already been pointed out by Keynes. As for predicting a beauty contest, for stock market investors it is much more important to predict what average opinion expects average opinion to be.

Laboratory experiments

Laboratory experiments with human subjects form an ideal tool to test in a controlled environment how individuals form expectations, how these individual expectations interact and which emergent structure they co-create at the aggregate macro level. In particular, in a controlled laboratory environment it can be tested under which circumstances individuals will be able to coordinate their expectations and whether coordination on a rational expectations equilibrium may arise or whether persistent market fluctuations with 'irrational exuberance' will occur.

Heemeijer et al. (2009) ran laboratory experiments with positive and negative expectations feedback to study how the feedback structure affects individual as well as aggregate behavior. The pricing rules are given by a simple linear feedback rule, with realized market price given as a function of average market expectations. They distinguished between a positive and a negative expectations pricing rule:

$$p_t = 60 - \frac{20}{21}[\sum_{h=1}^{6} \frac{1}{6} p_{ht}^e] - 60] + \epsilon_t \qquad \text{negative feedback} \tag{1}$$

$$p_t = 60 + \frac{20}{21}[\sum_{h=1}^{6} \frac{1}{6} p_{ht}^e - 60] + \epsilon_t \qquad \text{positive feedback} \tag{2}$$

Here ϵ_t is a small noise term to prevent that prices would become constant. Both pricing rules have a unique self-fulfilling rational expectations forecast $p^e = 60$. If individuals would coordinate on this rational forecast, realized prices would exhibit very small random oscillations around 60. The only difference between (1) and (2) is the slope coefficient, which is $-20/21$ in the negative feedback and $+20/21$ in the positive feedback treatment. Muth' classical hog cycle model is an example of a negative feedback system, with more optimistic expectations leading to increased production and lower market prices. Speculative asset markets typically exhibit strong positive expectations feedback, with more optimistic expectations leading to higher asset demand and thus higher asset prices.

Figure 1 shows that realized market prices in the positive versus negative feedback treatments are strikingly different. In the negative feedback case, the price relatively quickly settles down to the RE steady state price 60, while in the positive feedback case, the market price oscillates slowly around its fundamental value. These differences in aggregate price behavior are the result of differences in individual forecasting behavior. In the negative feedback case coordination of individual forecasts is relatively slow and takes about 10 periods. Due to persistence in heterogeneity of individual forecasts in the first 10 periods, the market price stabilizes and approaches the RE price 60, after which individuals coordinate their expectations on the RE benchmark 60. In contrast, in the case of positive feedback, coordination of individual forecasts is extremely quick: within 2-3 periods individuals coordinate their expectations on a price around 30. Hence, individual expectations coordinate on the 'wrong' price, i.e. on a price different from the homogeneous RE price 60; individual errors are strongly correlated. Note however that, although individual expectations are not perfect, they are almost self-fulfilling as the realized price is fairly close to what individuals predict.

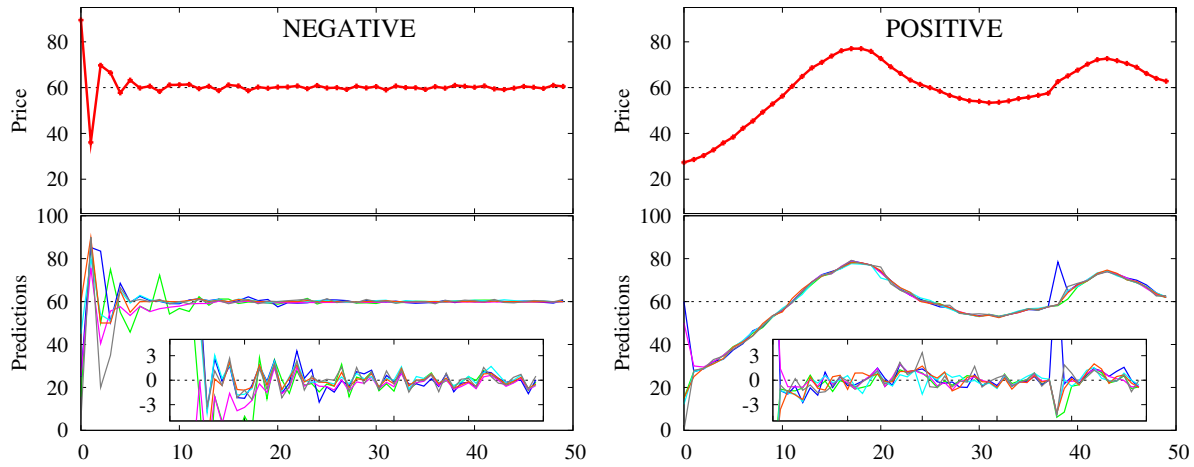

Figure 1: Negative (left panel) vs. positive (right panel) feedback experiments; prices (top panels), individual predictions (bottom panels) and forecast errors (small panels). In the negative expectations feedback market the realized price quickly converges to the RE benchmark 60. In the positive feedback market individuals coordinate on the 'wrong' price forecast and as a result the realized market price persistently fluctuates.

A behavioral heuristics switching model of expectations

Agreement that psychology can have an aggregate effect at the market level is one thing, writing down a model of animal spirits or reflexivity is another matter. If individuals make mistakes, which of the infinitely many possibilities should a model of bounded rationality allow? How to model the wilderness of bounded rationality? We use the heterogeneous expectations or heuristics switching model (Brock and Hommes, 1997; Anufriev and Hommes, 2012) to explain these different outcomes in individual and aggregate behavior in the laboratory experiments.

Agents can choose from a number of simple *forecasting heuristics*. Anufriev and Hommes (2012) focus on a simple model with 4 strategies similar to those obtained from estimations of linear models on individual forecasting data. The four strategies are: adaptive expectations, a weak and a strong trend-following rule (with a small resp. large trend-extrapolation coefficient) and an anchor-and-adjustment rule (similar to a trend-following strategy, but with a more flexible time varying anchor). Individuals choose among these forecasting heuristics based upon their relative performance. Hence there is reinforcement learning or survival of the fittest: individuals tend to switch to better performing rules, so that the impact of each of the rules is evolving over time.

Figure 2 shows realized market prices together with the simulated prices (top panels), and the corresponding evolution of the fractions of the four strategies (bottom panels) of the heuristics switching model. The model matches aggregate price behaviour in both the negative and positive feedback treatment surprisingly well. The time series of the fractions of the different forecasting heuristics (Figure 2, bottom panels) provide an intuitive

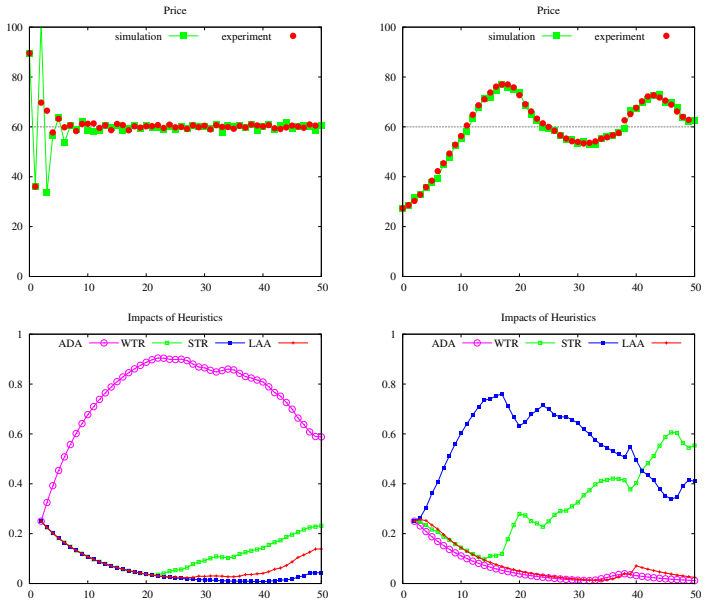

Figure 2: Negative feedback (left panels) and positive feedback (right panels) markets. Realized and simulated prices (top panels) and corresponding evolution of fractions of 4 strategies in heuristics switching model (bottom panels). In the negative feedback market the adaptive expectations (ADA) rule dominates and enforces quick convergence to the RE, fundamental price 60. In the positive expectations feedback market, the strong (STR) and the weak (WTR) trend following rules perform well and survive competition reinforcing price oscillations.

explanation of how individual learning leads to different aggregate price behavior. In the negative feedback treatment, the adaptive expectations strategy performs best and dominates the market, thus enforcing convergence towards the fundamental equilibrium price 60. In contrast, in the positive feedback treatment the strong and weak trend-following rules dominate the market and amplify price fluctuations.

The difference in aggregate behavior is thus explained by the fact that *trend following rules are successful in a positive feedback environment* reinforcing price oscillations and persistent deviations from the fundamental equilibrium benchmark price, while the trend-following rules are driven out by adaptive expectations in the case of negative feedback. Self-confirming coordination on trend following rules in a positive expectations feedback environment has an aggregate effect with realized market prices deviating significantly and persistently from the RE benchmark.

Concluding Remarks

Neoclassical economics leaves no room for market psychology, animal spirits and reflexivity. The financial-economic crisis, empirical asset market data and laboratory experiments however have shown that fluctuations in financial markets and the macro economy may be strongly amplified by expectations. Hommes (2013) discusses a behavioral theory of

heterogeneous expectations and animal spirits and its validation through empirical time series and laboratory experiments.

Perhaps the main finding of this behavioral theory is that positive feedback markets are 'irrational' in the sense that they do generally not settle down to efficient rational expectations prices. Rather (temporary) coordination of individuals on the 'wrong' price–i.e. a price different from a homogeneous rational expectations world–arises. A simple behavioral theory of heterogeneous expectations fits these empirical observations. Agents are *behaviorally rational* at the individual level. They use simple heuristics such as adaptive expectation, trend following rules and anchor and adjustment rules and switch between them based upon their relative performance. In positive feedback systems, (almost) self-fulfilling trend following strategies survive evolutionary selection and amplify market oscillations. Economic policy should take market psychology, animal spirits and reflexivity into account. A behavioral theory of heterogeneous expectations provides new tools for policy makers to manage expectations and 'market psychology' in complex economic systems.

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