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Manipulating market sentiment☆

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HIGHLIGHTS

- We analyze the interaction between a large rational trader and naïve speculators.
- Naïfs trade after a streak of price deviations from the asset's fundamental value.
- Naifs' trading rule does not follow a trend or respond to price trends.
- Nevertheless, the model gives rise to rich patterns of price fluctuations.
- The model synthesizes opposing views regarding the role of rational speculators.

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ABSTRACT

We analyze a simple model of an asset market, in which a large rational trader interacts with "noise speculators" who seek short-run speculative gains, and become active following a prolonged episode of mispricing relative to the asset's fundamental value. The model gives rise to price patterns such as bubble dynamics, positive short-run correlation and vanishing long-run correlation of price deviations from the fundamental value. We argue that this example model sheds light on the question as to whether rational speculators abet or curb price fluctuations.

1. Introduction

One of the main themes in the behavioral finance literature has been the effect that boundedly rational traders have on price fluctuations in financial markets. In seminal papers such as De Long et al. (1990a,b) and Hong and Stein (1999), conventionally rational traders coexist with "noise traders" (agents whose trading behavior follows some exogenous stochastic process), or with agents who follow trading rules, such as "fundamental trading" or "trend seeking", based on an incomplete understanding of the market.

A maintained assumption in this literature has been that the market is competitive in that rational traders are price takers and have no market power. In many markets, however, some rational traders have genuine market power: a large hedge fund acting in a (relatively thin) derivative market, for example, or a large oil producing country in a market for oil-related securities.

This short paper is a modest attempt to explore the effects of boundedly rational trading on price fluctuations when some rational traders have market power. We analyze a simple example of speculative trade between a large rational trader and boundedly rational speculators who follow a trading rule that conditions on the observed price history. We use this example to show how rich patterns of asset price fluctuations can emerge from very simple boundedly rational trading rules, as a result of their interaction with a large rational trader. Specifically, although the

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speculators' trading rule neither follows a trend nor responds to price trends, the expected asset price induced by the large trader's optimal strategy displays "bubble dynamics": during periods of low volume of speculative trade, the expected price strictly increases (decreases) when it is above (below) the fundamental value. This means that during these periods, price discrepancies are positively correlated in the short run and negatively correlated in the long run. The effects are suggestive of phenomena that have been documented in real-life financial markets (e.g., see Daniel et al., 1998).

2. The model

An asset is traded in a market in periods 0, 1, 2, ... This asset has a constant fundamental value equal to v. At the beginning of each period t, a long-lived large trader chooses a quantity x^t of the asset that he supplies to the market. Let p^t denote the price in period t and $\theta^t = p^t - v$ denote the deviation from the fundamental value. Demand for the asset is generated by two groups of agents:

Arbitrageurs. Their net demand in period t is $y^t = D(\theta^t)$. The function $D : \mathbb{R} \to \mathbb{R}$ thus represents the arbitrageurs' reactivity to current price discrepancies. We assume that D is continuous, strictly decreasing and odd (i.e., $D(\theta) = -D(-\theta)$). Let $\Theta(y) = D^{-1}(y)$ denote the inverse demand.

Noise speculators. Their net demand at period t, denoted z^t, is a stochastic function of the history of price deviations $(\theta^s)_{s=1}^{t-1}$. We will impose structure on this function below.[1]

The market price p^t is determined by a market clearing condition

$$x^t = D(\theta^t) + z^t.$$

The large trader's information set at period t consists of the entire history of price deviations $h^t = (\theta^1, \ldots, \theta^{t-1})$. His profit in period t is $x^t\theta^t$. He chooses a trading strategy – namely, a function that assigns a supply quantity to every information set – that maximizes his discounted expected profits. The discount factor is $0 < \delta < 1$.

The interpretation of the market structure is as follows. The large trader can access a large external competitive market and buy or sell any quantity at the fundamental price v, with no transaction cost. The implicit assumption behind the arbitrageurs' demand function is that they can also access the external market, albeit with increasing transaction costs that cause their net position to grow in absolute terms with the magnitude of the price discrepancy. Thus, one could view this market as a local marketplace set up by the large trader, who takes advantage of his privileged access to a global competitive market. The large trader may have an incentive to manipulate the local market price in anticipation of the noise speculators' reaction, but is mindful of the (limited) arbitrage activity that exploits deviations of the local market price from the fundamental value.

Let us turn to the description of the noise speculators' behavior. Fix $\alpha \geq 0$. For any given finite history $h^t = (\theta^1, \ldots, \theta^{t-1})$, if $\left|\theta^{t-1}\right| > \alpha$, let $B\left(h^t\right)$ be the largest integer s for which $\text{sign}(\theta^{t-k}) = \text{sign}(\theta^{t-1})$ and $\left|\theta^{t-k}\right| > \alpha$ for all $k = 1, \ldots, s$. That is, $B\left(h^t\right)$ is the duration of the most recent episode of persistent mispricing of magnitude greater than α in a given direction relative to the fundamental value. If $\left|\theta^{t-1}\right| \leq \alpha$ or $t = 0$, set $B\left(h^t\right) = 0$. We assume that at every period t,

$$z^t = \varepsilon^t + w^t - w^{t-1}$$

where ε^t is *i.i.d.* according to a density f that is symmetric around zero, $w^t = 0$ when $B(h^t) < L$, and $w^t = a \cdot \text{sign}(\theta^{t-1})$ when $B(h^t) \geq L$, where $L > 2$ is an integer and $a \in \{-1, 1\}$. Let F be the *cdf* induced by f, and assume $F(\alpha) < 1$.

The interpretation of the process governing z^t is as follows. Noise speculators consist of one conventional noise trader and one naive speculator. The former agent's net demand at period t is ε^t. The latter agent takes a buy or short position of one unit in each period; this position must be closed one period later. He takes a non-zero position only after a sufficiently long sequence of price discrepancies in the same direction and of sufficient magnitude. The naive speculator's net position at t is thus $w^t - w^{t-1}$. We say that a history h^{t-1} is *inactive* if $w^{t-2} = w^{t-1} = 0$ and $B(h^{t-1}) < L$. At an inactive history, the naive speculator is "waiting" for a critical streak of price discrepancies to form and does not take a non-zero position. Since we allow a to be either positive or negative, we can capture two types of "market sentiment". When $a = -1$, it is apt to refer to the noise speculator as a "fundamental trader", because he acts at period t as if the market is about to correct the mispricing. On the other hand, when $a = 1$, we may refer to the noise speculator as a "momentum trader". Our results can be extended to the case in which a is stochastic. The large trader's activity thus manipulates market sentiment in the sense that it helps activating the perception that the market is about to crash, or that it has gained momentum, etc.

If the large trader only faced arbitrageurs and conventional noise traders – i.e., if $w^t = 0$ for all t – he would be unable to make any speculative gain, and his optimal policy would be to supply a zero quantity in every period. Thanks to the naive speculator, the large trader has an incentive to manipulate the market price, in order to induce the naive speculator to become active, and then lean against him when he does.

3. The result

Our objective is to provide a qualitative characterization of the price fluctuations that emerge from the large trader's optimal net supply of the asset in each period. We first observe that the large trader faces a Markov decision problem. The naive speculator's net demand at period t following the history h^{t-1} is a deterministic function of the state defined by $q(h^{t-1}) = ((\text{sign}(\theta^{t-2}), B(h^{t-2})), (\text{sign}(\theta^{t-1}), B(h^{t-1})))$. Since the behavior of arbitrageurs and the conventional noise trader is entirely stationary, it follows that the large trader's dynamic optimization problem is Markovian w.r.t. to the set of states Q defined above. An inactive history h^{t-1} corresponds to a state with $B(h^{t-2}), B(h^{t-1}) < L$.

Let $V(q)$ be the value function given by a solution to this problem. Note that the arbitrageurs' demand function D, the density f and the naive speculators' trading rule are all symmetric w.r.t. the sign of price discrepancies. Therefore, V is symmetric in the following sense. Let $q = ((i, B), (j, B'))$ and $q' = ((-i, B), (-j, B'))$. Then, $V(q) = V(q')$.

The following notation will be useful. Consider an inactive history h^{t-1} with $B(h^{t-1}) = B < L$, and $\theta^{t-1} > 0$. We denote the state that corresponds to this history by ρ^B. We use F^q to denote the *cdf* of z^t conditional on a history h^{t-1} that corresponds to the state $q(h^{t-1})$. The expected price deviation at period t given x^t and a history h^{t-1} is thus

$$E\left(\theta^t \mid h^{t-1}, x^t\right) = \int \Theta\left(x^t - z^t\right) dF^{q(h^{t-1})}(z^t).$$

Note that this expression is decreasing in x^t.

Proposition 1 (*Bubble Dynamics*)**.** *Let x^* be a trading strategy that solves the large trader's problem. Consider two inactive histories h^t*

[1] Note that while the arbitrageurs' behavior at period t reacts instantaneously to θ^t, all other traders react to the price history up to period $t-1$.