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Temporary price trends in the stock market with rational agents

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ABSTRACT

The paper contributes to the study of the features of temporary trends in stock indexes using an equilibrium approach with rational agents. It shows that the diffusion of significant fundamental information generates a Z-type aggregate demand function that leads to the occurrence of such a phenomenon as an imbalance (or disequilibrium). Pricing analysis under imbalance reveals that, with the exception of the independence of consecutive returns, there is a nonlinearity in mean that can be empirically detected using a threshold model or a regime switching model. The proposed model facilitates the convergence of the equilibrium approach with the methodology of evolutionary economics and can also be useful in studies of financial fragility.

1. Introduction

Discussion about nonlinearities in stock prices comes down to the following alternatives. First, nonlinearity inheres only to variance while changes in mean are lacking or characterized by the autoregression model (Cai, 1994; Dueker, 1997; Hamilton & Susmel, 1994; Hsieh, 1991; Kaufmann & Frühwirth-Schnatter, 2002; Klaassen, 2002; Marcucci, 2005; Schwert, 1989). Second, nonlinearity is associated with a mean reversion whereas the price behavior corresponds to trend-stationary fluctuations around the fundamental value (Chiang, Liu, & Okunev, 1995; Fama & French, 1988; Gropp, 2004; Kasa, 1992; Mukherji, 2011; Shiller, 1984; Shiller & Perron, 1985; Summers, 1986; Poterba & Summers, 1988). Third, nonlinearity in mean is described by regime switching depending on the external conditions; the following recent papers support this alternative (Brock, Lakonishok, & LeBaron, 1992; Hsu, Lin, Hung, & Huang, 2016; Liu, Jansen, & Li, 2005; Lunde & Timmermann, 2004; Rey, Rey, & Viala, 2014; Schaller & Van Norden, 1997; Turner, Startz, Nelson, 1989; Zhu & Zhu, 2013). Mathematically, this discussion comes down to the following model:

$$p(t) = p(0) + \sum_{i=1}^{t} \lambda \cdot \mu_i + \sum_{i=1}^{t} \omega^{t-i} \cdot \upsilon_i(0, \sigma) \quad (1)$$

where

$p(t)$ and $p(0)$ are logarithms of the stock price;

$\mu_i = \{-\mu_{i-1}, p;\ \ \mu_{i-1}, 1-p\}$, $\mu_0 = \{1,\ 0,5;\ \ -1,\ \ 0,5\}$ is the parameter characterizing the direction of temporary trend, with p denoting the probability of switching;

λ is trend speed (may be a variable);

ω is weight of the moving average characterizing mean reversion;

$\upsilon_i(0, \sigma)$ is white noise.

With $\lambda = 0$ and $\omega = 1$, there is a pure random walk, which is a traditional model to describe stock prices, starting from Bachelier (1900) and Osborne (1959). With $\lambda = 0$ and $0 < \omega < 1$, there is a model with a slowly decomposing stationary component or the process of mean reversion. Finally, with $|\lambda| > 0$ and $0 < \omega \leq 1$, there is a series containing temporary trends, which with $\omega = 1$ becomes the model of Markov switching proposed by Hamilton (1989); and with $0 < \omega < 1$ becomes the trend-stationary model, with a changeable trend that can be described, for example, as a centered moving average.

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Developing this discussion, the paper reveals the causes of temporary trends using microstructure models of the stock market. At the present time, the most common explanation for this phenomenon is related to works of scholars such as Barberis, Shleifer, and Vishny (1998), Hong and Stein (1999), and Frazzini (2006). As a source of temporary trends, these studies consider the irrational behavior of investors, in particular the underreaction that is followed by a subsequent overreaction from uninformed investors who follow simple trend-chasing strategies. In addition, some works try to rationally explain the temporary trends due to the variations of risk exposure and a dividend growth rate (e.g., Berk, Green, & Naik, 1999; Johnson, 2002). They, however, do not contribute to the discussion of the causes of nonlinearity in mean in stock prices, because they explain the momentum by a type 2 error rather than considering the market microstructure and the peculiarities of market equilibrium. Finally, the very recent papers by Albuquerque and Miao (2014) and Ottaviani and Sórensen (2015) provide a rational explanation for temporal trends using equilibrium models taking into account the asymmetry of information, heterogeneous expectations, and the limited funds available to informed investors.

In addition, this study contributes to the theoretical explanation not only of the momentum but also of the nonlinear effect in stock prices that includes the combination of a temporary trend with the independence of successive price increments. It shows that this effect can be explained in the framework of an equilibrium model with rational agents, in which the effects of bounded rationality can be added as secondary factors that just improve the model correspondence to the reality but are not a necessity for nonlinearity. An important element of the model is the function of the rational investor's optimal demand for a capital asset, including an area with a positive influence of the market price on the size of demand. In the equilibrium pricing model, it gives the aggregate Z-type demand function and causes such phenomenon as an imbalance. This is the key novelty of the model in comparison to other studies. Imbalance leads to significant stationary fluctuations in prices relative to the temporary trend, as well as to a sharp price movement in the opposite direction if the funds of professional investors are insufficient for the necessary price adjustment. It reduces the autocorrelation of returns and explains the nonlinearity in mean in stock prices. The paper also shows that a sufficient condition for the imbalance is the diffusion of essential fundamental information ignored by the majority of investors. This gives new insight because allows for associating nonlinearity in mean in stock prices directly with the phenomena of pattern recognition and focal attention (Neisser, 1967), and for making sure that the processes occurring at the macro level (particularly innovative development, inflation above a certain level, and the business cycles) are a source of trends.

The paper is organized as follows. The second section includes a literature review and the model framework. The third section proves the function of rational investor's optimal demand for stock, which is the ground for the Z-type aggregate demand function. The fourth section considers the equilibrium pricing model and discusses its properties, including the occurrence of imbalance and nonlinearity in mean in stock prices. The fifth section empirically demonstrates the main temporary trends in the dynamics of US stock indexes.

2. Framework and literature overview

To admit the possibility of the existence of temporary trends in the stock market with rational agents, it is necessary to examine the market microstructure and discuss the possibility of the occurrence of the phenomenon of imbalance (or disequilibrium). In the first approximation, imbalance means that an overwhelming majority of professional arbitrageurs are equally aware that some part of the available information has not yet been reflected in the price. This excludes any market efficiency in terms of Fama (1965, 1970), but does not disprove the relative definition of efficiency according to Timmermann and Granger (2004).[1] To a large extent, imbalance results from the effects of bounded rationality; in particular, Festinger (1957), Neisser (1967), Edwards, (1968), and Tversky and Kahneman (1974) have proved that some peculiarities of the human mind impede the perception of some fragments of information: the latter are either forced out of the perception or underestimated.[2] However, imbalance may also appear in a model where these effects are neglected; for this, it is necessary that the share of professional arbitrageurs, weighted by the wealth, be not high, and other (not professional) investors follow the index-based strategies, i.e., enter into transactions only in the case of need in (or excess of) liquidity. It is easy to see that in both cases (with and without considering the effects of bounded rationality), incoming information about a significant change in the fair value is necessary for the occurrence of imbalance.

Let us show this using a simple model of market equilibrium. Let us assume that the following groups of participants act in the market: 1) informed traders, i.e., those who correctly interpret the incoming information and act rationally; 2) uninformed traders who identify the signals of the informed traders through small changes in the market price and repeat their actions; 3) professionals whose trading strategies due to the effects of bounded rationality are not sensitive to the incoming information[3]; 4) non-professional investors who do not specialize in the permanent analysis of incoming information and use index-based strategies.[4] Roughly speaking, the first two groups of participants are open to the incoming information; that is why they increase the price adjustment; the second two groups, on the contrary, are in fact robust toward the incoming information; that is why they restrain price adjustment. Thus, in the model with homogeneous expectations, we can consider only two groups of participants, the first and the fourth. Given information asymmetry, the second group needs to be added, and finally, taking into account the effects of bounded rationality, the third group of participants will be included in the model.

For changes in market equilibrium, it is essential to identify what percentage of market participants increases price adjustment, and what percentage resists the same. In the case where the funds (including the possibility of borrowing) that are available to the first and second groups are insignificant compared to the reaction of the rest of the market (the third and fourth groups) to the price change, the price adjustment will be insufficient when professionals become aware of a significant change in the fair value.[5] In the model with information asymmetry (in the absence of the third group of participants), such a situation automatically implies

[1] Fama defines an efficient market as one where all available information is reflected in the prices, whereas Timmerman and Granger identify a market as efficient based on a set of available information, as well as the information retrieval technologies and forecasting models used. The second definition obviously does not contradict a situation of imbalance.

[2] This is about cognitive dissonance, the mechanism of pattern recognition and focal attention, the effect of conservatism, framing and disposition effect.

[3] They either fully ignore this information or perceive it partially, i.e., withdraw from a transaction before the required price adjustment takes place.

[4] "Noise" traders are not included in the model, because, depending on the situation, when the information about the changes in fair value becomes available, they will either increase the influence of informed traders on prices or resist this, i.e., act as either the second or the third group.

[5] This may be illustrated by the model where the demand function of the third and fourth groups has a positive price elasticity, and the increase in aggregate demand function on the part of the first and second groups of participants is insufficient for an immediate price adjustment.

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