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Two-period trading sentiment asset pricing model with information

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ABSTRACT

We present a dynamic asset pricing model with investor sentiment and information, which shows that the investor sentiment plays a systematic and important role in the asset prices and the information is gradually incorporated into prices. The model has an analytical solution to the sentiment equilibrium price. We find that sentiment trading quantity not only increases the market liquidity, but also causes the asset prices' overreaction if the intensity of sentiment demand is more than a constant value. Therefore, the continuing overreactions result in a short-term momentum and a long-term reversal. The model could offer a partial explanation to some financial anomalies such as price bubbles, high volatility, asset prices' overreaction and so on.

1. Introduction

Conventional wisdom suggests that the irrational trading should cancel each other out and has little impact on equilibrium prices at the aggregate level; even irrational investors follow a consistent pattern in the noise generating process, nevertheless, rational arbitrage would eliminate irrational effect on asset prices and necessarily brings prices closer to fundamentals (Fama, 1965; Friedman, 1953). However, emerging behavioral finance emphasizes the social property of irrational investors. It argues that irrational investors' actions are dependent on each other because of the information generating process, or the sentiment contagion. Thus, irrational investors create risk, and create their own space (De long et al., 1990, 1991). According to the irrational form, investors in the actual financial market may be affected by noise, cognitive biases, or investor sentiment.

Some noise trader models are proposed to illustrate the influence of noise trader on asset prices (see, e.g. Kyle, 1985; Black, 1986; De long et al., 1990; Mendel and Shleifer, 2012). Moreover, some psychological bias trader models are set up to show that investor cognitive biases have an important effect on asset prices (e.g. Barberis et al., 1998; Daniel et al., 1998; Hong and Stein, 1999; Yan, 2010). The shortcomings of the noise pricing model are that the noise is difficult to identify and can't be measured in the realistic securities market; consequently, it can't be empirically testified. The psychological biases pricing model can't be empirically testified, either; moreover, irrational investors have various psychological biases (e.g. overconfidence, confirmation bias, narrow framing) in the realistic financial market, but a single asset pricing model can't include all the biases.

Compared with the noise term and bias factor in the financial market, investor sentiment could be quantitatively measured; furthermore, the corresponding empirical analysis can be made (Baker and Wurgler, 2006, 2007). Baker and Wurgler (2006) employ principal component analysis to form a composite market sentiment index which is the proxies' first principal component. The sentiment index is based on the common variation in six underlying proxies for sentiment: closed-end fund discount, turnover rate, number of IPOs, average first-day returns on IPOs, equity share in new issues, and dividend premium. Their results suggest that descriptively accurate models of prices need to incorporate a prominent role for investor sentiment in asset pricing.

In recent years, the research on investor sentiment has become a hotspot in behavioral finance. Many empirical studies show that investor sentiment has a systematic and significant impact on the financial asset prices; furthermore, financial asset pricing is much higher with optimistic sentiment, and it is much lower with pessimistic sentiment (e.g. Baker and Wurgler, 2006, 2007; Baker et al., 2012; Brown and Cliff, 2004, 2005; Kumar and Lee, 2006; Lee et al., 2002; Seybert and Yang, 2012; Stambaugh et al., 2012; Yu and Yuan, 2011). In particular, the related empirical results are supported by financial experiments. Some financial experiments conclude that investors with high sentiment would make optimistic judgments and decisions that they would increase the perceived asset value, and vice versa (see e.g. Ganzach, 2000; Statman et al., 2008; Kempf et al., 2013).

In spite of this, the sentiment-based asset pricing model is still in the exploratory stage. Some static sentiment asset pricing models have been developed to emphasize the systematic role of investor sentiment

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in asset prices. For example, Yang and Yan (2011) set up a sentiment asset pricing model with representative sentiment investors, Yang et al. (2012) propose a sentiment capital asset pricing model whose result shows that different investor sentiments lead to different perceived prices, Yang and Zhang (2013a) consider a sentiment asset pricing model with consumption, Yang and Zhang (2013b) present a dynamic asset pricing model with heterogeneous sentiments, and Yang and Li (2013) set up a static asset pricing model with investor sentiment and information. Although these asset pricing models have shown that investor sentiment has a systematic and significant impact on the risky asset prices, almost all the related sentiment pricing models discuss a single trading equilibrium. Compared with one-shot trading, investors often make multiple transactions in the realistic financial market. Furthermore, some rational investors who make current trading strategies would take into account future trading opportunities, and some sentiment investors would change their sentiments over time. Ultimately, the equilibrium prices are multi-period game results among different types of investors. Moreover, the previous sentiment asset pricing models rarely involve some important factors such as fundamental information and the initial price.

Much different from the previous literature on the sentiment asset pricing model, we present a two-period trading asset pricing model with investor sentiment and information based on the framework of Kyle (1985). We consider a class of uninformed sentiment investors who are vulnerable to sentiment and trade on it, so our model focuses on the interaction between rational investors and uninformed sentiment investors and shows how this interaction could sustain incorrect prices. The unique features of our model are as follows: First, our model involves the initial price of the first period which can provide an anchoring point, thus we can describe a dynamic price path. Second, we consider the fundamental information released in the first period, and then a rational investor observes valuable information and makes a trading strategy to maximize his expected profit so that the information is gradually incorporated into prices. Third, a sentiment investor chooses his transaction according to his own sentiment which has a certain correlation with the information; when the intensity of sentiment demand is bigger, sentiment gets factored into price at a faster rate and causes asset prices' overreaction. Finally, based on the demands of rational investor and sentiment investor, we give an analytical formula of the sentiment equilibrium price, which could be decomposed to the rational term and the sentiment term. The rational term makes the asset price return to the rational expected value, and the sentiment term leads to the asset price deviating from it, which can generate price bubbles, high volatility and asset prices' overreaction.

The rest of the paper is organized as follows. In Section 2, we spell out the economy for the formal model. In Section 3, we investigate the equilibrium of the economy and discuss the properties of the equilibrium. Section 4 concludes.

2. The economy

We propose a two-period trading sentiment asset pricing model which extends the noisy rational expectation model of Kyle (1985). In our model, the uninformed sentiment investor, who is vulnerable to sentiment shocks and trade on sentiment as if it were information, is assumed not to update his trading rule in the dynamic setting because he is unsophisticated. The informed rational investor, who is risk neutral and sophisticated, is assumed to maximize expected profits and take into account explicitly the effect his trading has on the price at that transaction and the trading opportunities available at future transactions. Therefore, we can focus on the interaction of rational investors and sentiment investors in an economy.

There are two tradable assets in the economy: a risky asset (i.e. stock) and a riskless asset. For simplicity, we assume that the interest rate of the riskless asset is zero. There are three periods (four dates) with $t = 0, 1, 2$, and 3. Trading occurs in period 1 and period 2, then the asset pays its terminal value V at $t = 3$. The terminal value is the sum of three terms. First is the unconditional expectation p_0 which is the asset price at $t = 0$. Second is a fundamental information release θ which is normally distributed with mean zero and variance σ_θ^2 and is realized in period 1. Finally, there is a random disturbance term ε which is also normally distributed with mean zero and variance σ^2 and independent of θ so the terminal value is given by $V = p_0 + \theta + \varepsilon$.

There are three types of agents in the economy: a representative rational investor who possesses valuable information and trades completely rationally; a representative sentiment investor who is vulnerable to sentiment shocks and trades on sentiment; and market makers who make the market clear and set prices efficiently conditional on the quantities traded by others.

In the economy, the sentiment investor would perceive the asset terminal value with his own sentiment. Generally, the sentiment investor overestimates the asset value with optimistic sentiment, while underestimating the asset value with pessimistic sentiment (Kempf et al., 2013; Statman et al., 2008). Let us assume that the perceived terminal value V_S satisfies $V_S = p_0 + \theta + f(S) + \varepsilon$, where the sentiment function $f(S)$ is a monotonous increasing function of investor sentiment and satisfies the properties as follows: (1) $f(S) > 0$, if $S > \overline{S}$, i.e., $V_S > V$; (2) $f(S) < 0$, if $S < \overline{S}$, i.e., $V_S < V$; and (3) $f(S) = 0$, if $S = \overline{S}$, i.e., $V_S = V$. To this end, we focus on evaluating the demand for sentiment investor. In Appendix A, we prove the following lemma.

Lemma 1. In the static setting, given the linear pricing rule and profit maximization, the demand for sentiment investor is given by

$$X_S = b\left(S - \overline{S}\right), \tag{1}$$

where b is a constant measuring the intensity of sentiment demand and S is the level of sentiment. S is normally distributed with mean $\overline{S}$ and variance σ_S^2.

Obviously, the demand function for the sentiment investor is a monotonous increasing function of investor sentiment. It means that the demand is bigger with call sentiment, and the demand is smaller with put sentiment.

There are two transactions, and each transaction takes place in two steps. In period 1, the rational investor chooses the quantity X_1 that he will trade, and the sentiment investor simultaneously chooses the quantity[1] $b\left(S_1 - \overline{S}\right)$ that he will trade, where S_1 is the level of sentiment in period 1. S_1 is normally distributed with mean $\overline{S}$ and variance σ_S^2, and the correlation coefficient between S_1 and θ is ρ_1. Then, the market makers set the price p_1, and trade the quantity which makes the market clear. In period 2, the rational investor chooses the trading quantity X_2, and the sentiment investor simultaneously chooses the trading quantity $b\left(S_2 - \overline{S}\right)$, where S_2 is the level of sentiment in period 2. S_2 is also normally distributed with mean $\overline{S}$ and variance σ_S^2, and the correlation coefficient between S_2 and θ is ρ_2. Then, the market makers make the market clear and set the price p_2. Fig. 1 illustrates the timing of events.

Equilibrium is defined such that the following three conditions hold:

(1) The sentiment investor's trading rule is $b\left(S - \overline{S}\right)$, in which the sentiment investor's demand is more with optimistic sentiment and sentiment investor's demand is less with pessimistic sentiment.

[1] Here, the sentiment investor sometimes trades on sentiment as if it were information. In the static setting, we have verified that the sentiment investor's demand function is just the proposed form of the text. Since the sentiment investor is unsophisticated (see, Ling et al., 2010; Victoravich, 2010), we assume that sentiment investor wouldn't update his trading rule in the dynamic setting.