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Investor sentiment, information and asset pricing model

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ABSTRACT

We present an asset pricing model with investor sentiment and information, which shows that the investor sentiment has a systematic and significant impact on the asset price. The equilibrium price's rational term drives the asset price to the rational, and the sentiment term leads to the asset price deviating from it. In our model, the proportion of sentiment investors and the information quality could amplify the sentiment shock on the asset price. Finally, the information is fully incorporated into prices when sentiment investors learn from prices. The model could offer a partial explanation of some financial anomalies: price bubbles, high volatility, asset prices' momentum effect and reversal effect.

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1. Introduction

The Efficient Market Hypothesis (EMH) of standard financial theory suggests that the financial market is "informationally efficient," and rational arbitrage would eliminate irrational effect on asset prices and necessarily brings prices closer to fundamentals. However, since the 1970s, many investor abnormal behavior and financial market's anomalies, which are thought as EMH paradoxes, have begun to emerge. At the same time, behavioral asset pricing theory gradually starts to form as a complement to the traditional asset pricing theory. 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. Black, 1986; De long et al., 1990; Grossman and Stiglitz, 1980; Kyle, 1985; Mendel and Shleifer, 2012); moreover, some psychology biases trader models are set up which argue 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 both types of models are that the noise and psychology biases are difficult to identify and can't be measured in the securities market; consequently, they can't be empirically testified. Compared with the noise term and bias factor in the securities market, investor sentiment could be quantitatively measured; furthermore, the corresponding empirical analysis can be made (Baker and Wurgler, 2006, 2007).

In recent years, the systematic role of investor sentiment has been investigated by many empirical analyses and theoretical studies. Some empirical results show that investor sentiment has an important and systematic effect on asset pricing (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). However, the sentiment-based asset pricing model is still in the exploratory stage. Some sentiment asset pricing models have been presented to emphasize the systematic role of investor sentiment in asset pricing. For instance, 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 and the result shows that different investor sentiments lead to different perceived prices, and Yang and Zhang (2013a, 2013b) consider a sentiment asset pricing model with consumption. Nevertheless, the related sentiment asset pricing models don't possess the generality of analysis, which only focus on investor sentiment and don't involve the important factors such as fundamental information.

Much different from the previous literature on sentiment asset pricing model, we present a generalized sentiment asset pricing model with information based on the framework of Grossman and Stiglitz (1980). We consider one class of uninformed sentiment investors who are vulnerable to sentiment and trade on it, so our model focuses on the interaction of rational investors and uninformed sentiment investors and shows how this interaction could sustain incorrect prices. Ultimately, we demonstrate how the financial asset is priced when sentiment investors learn from prices. The features of our model, which distinguish it from the previous sentiment asset pricing models, are the following terms. First, it gives an analytical solution to the sentiment equilibrium price which could be decomposed to the rational term and the

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sentiment term, the equilibrium price's rational term makes the asset price return to the rational expected value, and the sentiment term leads to the asset price deviating from the rational expected value which can generate price bubbles and high volatility. Second, when sentiment investors' proportion is less than a constant value, price move in reaction to the arrival of information is on average positively correlated with later price change and the changes of asset prices show short-term momentum effect; however, when sentiment investors' proportion is more than a constant value, price move resulting from information arrival is on average negatively correlated with later price change and the changes of asset prices show long-term reversal effect. Third, increasing the proportion of sentiment investors, and decreasing the quality of information would increase the sensitivity coefficient on sentiment; on the contrary, it is to the sensitivity coefficient on information. Fourth, adding more rational investors, increasing the information quality, and decreasing the sentiment expansion coefficient would increase the informativeness of the price system and the market efficiency. Finally, when uninformed sentiment investors learn from prices, all the information is incorporated into prices; increasing the proportion of rational investors, and decreasing sentiment expansion coefficient would increase the market efficiency, but the quality of information no longer has an effect in this case.

The rest of the paper is organized as follows. In Section 2, we spell out the economy for formal model. In Section 3, we consider the benchmark case in which investors are homogenous. In Section 4, we present a generalized sentiment asset pricing model with information. Section 5 concludes.

2. The economy

We propose a sentiment asset pricing model which extends the noisy rational expectation model of Grossman and Stiglitz (1980). Since we are interested in the role of irrational sentiment investors in the asset price, we add a class of sentiment investors to the model and obtain an analytical solution of equilibrium price. Therefore, we can focus on the interaction of rational investors and sentiment investors in an economy. Much different from the previous sentiment pricing models, we also consider the initial price so as to analyze the relationship between the equilibrium price and the initial price.

There are two tradable assets in the economy: a risky asset in supply M trading at price P_1, and a riskless asset in perfectly elastic supply with interest rate r_f so yielding a return $r = 1 + r_f$. There are two-periods (three dates) with $t = 0,1,2$, trading occurs at date 1, then the asset pays its terminal value V at $t = 2$. The terminal value is the sum of three terms. First is the unconditional expectation $P_0 + \mu$, where P_0 is the asset price at $t = 0$ and μ is the rational expected return. Second is a fundamental information release θ which is normally distributed with mean zero and variance σ_θ^2 and is realized at $t = 1$. Finally, there is a random disturbance term ε which is normally distributed with mean zero and variance σ^2 and independent of θ. So the terminal value is given by $V = P_0 + \mu + \theta + \varepsilon$.

In the economy, some investors who would perceive the asset terminal value with individual sentiment are called sentiment investors. Generally, sentiment investors overestimate the asset value with high sentiment, and underestimate the asset value with depressed sentiment. Baker and Wurgler (2006) employed principal component analysis to form a composite market sentiment index. The sentiment index is based on the common variation in six underlying proxies for sentiment: the closed-end fund discount, turnover rate, the number of IPOs, average first-day returns on IPOs, the equity share in new issues, and the dividend premium. Their results suggest that descriptively accurate models of prices need to incorporate a prominent role for investor sentiment in asset price.

Assume that there are two types of agents in the economy: a mass I of rational investors who observe valuable information θ about the terminal value of risky asset at date 1 and trade completely rationally, and a mass N of sentiment investors who are vulnerable to sentiment shock and involve their own sentiment S in the terminal value of the asset. High sentiment would improve the perceived value of risky asset and depressed sentiment would reduce it. S is also normally distributed with mean zero and variance σ_S^2. The two types of investors have known the numerical characteristics of θ and ε.

We assume that the two types of agents have the same Constant Absolute Risk-Aversion (CARA) utility function: $u(W) = -\exp(-\gamma W)$, where λ is the coefficient of absolute risk aversion and wealth W is normally distributed. Each type of investor begins with wealth W_{0i} and chooses demand X_i to maximize the expected utility at date 1, i.e.

$$\begin{aligned}&Max\, E\left[-\exp(-\gamma W_{1i})|\Omega_i\right]\\&\Leftrightarrow Max\left[E(W_{1i}|\Omega_i)-\frac{1}{2}\gamma Var(W_{1i}|\Omega_i)\right],\end{aligned}$$

where Ω_i is the information set available to investors.

$$\begin{aligned}&E(W_{1i}|\Omega_i)-\frac{1}{2}\gamma Var(W_{1i}|\Omega_i)\\&=E((V-p_1r)X_i+W_{0i}r|\Omega_i)\\&-\frac{1}{2}\gamma Var((V-p_1r)X_i+W_{0i}r|\Omega_i).\end{aligned} \tag{1}$$

Maximizing Eq. (1) with respect to X_i yields a demand function for risky asset

$$X_i=\frac{E(V|\Omega_i)-p_1(1+r_f)}{\gamma Var(V|\Omega_i).} \tag{2}$$

Furthermore, we consider some metrics for stability and efficiency of the market. The first is the information quality, $n=\frac{\sigma_\theta^2}{\sigma^2}$. The second is the informativeness of the pricing system, as defined by Grossman and Stiglitz (1980), $\rho_{p_1,\theta}^2=Corr^2(p_1,\theta)$. The third is an ex ante measure of the variance of the price, as defined by Mendel and Shleifer (2012), bad variance, $Var(p_1|\theta)$, and good variance, $Var(p_1|S)$. Therefore, when the information quality is higher, the bad variance is smaller and the informativeness of the pricing system is greater, the market becomes more effective.

3. The benchmark case: homogenous investors

Before we begin to solve the generalized model, let us first consider two special cases in which all investors are rational investors (i.e. $N = 0$) or sentiment investors (i.e. $I = 0$) in the economy. The former is similar in essence to that of Grossman and Stiglitz (1976, 1980). Let p_1^* be the equilibrium price under the former case. The conditional expectation and variance are given by

$$E(V|\theta)=p_0+\mu+\theta, Var(V|\theta)=\sigma^2. \tag{3}$$

Combining demand function of the risky asset and market clearing equation gives

$$X_I\times I=\frac{p_0+\mu+\theta-p_1\left(1+r_f\right)}{\gamma\sigma^2}\times I=M.$$

Solving for equilibrium price gives

$$p_1^*=\frac{p_0+\mu}{1+r_f}+\frac{\theta}{1+r_f}-\frac{\gamma M\sigma^2}{\left(1+r_f\right)I}. \tag{4}$$

In this case, $\rho_{p_1^*,\theta}^2=1$, all the information is factored into price, and the market is perfectly efficient. It is consistent with the argument of Fama (1970) "that a market in which prices always 'fully reflect' available information is called 'efficient.' …that is, a model that specifies

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