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Sentiment approach to underestimation and overestimation pricing model

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ABSTRACT

Based on the underestimation model in bear markets and the overestimation model in bull markets, we propose two types of sentiment asset pricing models to study the effects of investor sentiment on stock prices and limit of arbitrage. The two sentiment asset pricing models demonstrate that investor sentiment has a systematic and significant impact on stock prices; furthermore, investor sentiment plays a significant role on the limit of arbitrage. We find that our framework can be helpful in understanding a range of financial anomalies: overreaction, underreaction, the fire sales and the limit of arbitrage.

1. Introduction

Whether on earth investor sentiment drives the changes of stock prices is a worthy question. Especially, a broad set of anomalies in the stock market strengthen doubts about the traditional financial theory and enhance the interest in investor sentiment in recent years. Many empirical studies have documented evidence of investor sentiment effects in asset prices (Lee et al., 2002; Baker and Wurgler, 2006; Baker and Wurgler, 2007; Berger and Turtle, 2012; Stambaugh et al., 2012; Fong and Toh, 2014; Kim et al., 2014; Greenwood and Shleifer, 2014 and Qian, 2014). Lee et al. (1991) reveal that investor sentiment affects smaller stock returns and leads to mispricing. Loewenstein (2000) demonstrates that the existence and importance of investor sentiment is correct, and investor sentiment affects the stock valuation. Brown and Cliff (2004) shed light on the effects of sentiment on market valuation and stock returns. Baker and Wurgler (2006, 2007) explain that stocks are likely to be most affected by sentiment and predict that investor sentiment has greater effects on stocks whose valuations are highly subjective and hard to arbitrage. In general, investor sentiment has an important impact on stock prices. In particular, this paper investigates the effects of investor sentiment on stock prices and limit of arbitrage, and further explains underreaction, overreaction and fire sales.

Many literatures prove that financial markets and financial industry are sentiment-driven domains, their interactions mainly occur at the investors' cognitive value and their available information. The key for making optimal investment decisions depends on available information and investor sentiment. De Long et al. (1990) explain that arbitrageurs observe fundamental value, so their demands are simple functions of the difference between fundamental value and price. Barberis et al. (1998) illustrate that investor's beliefs are reflecting the 'consensus', even if different investors have different beliefs and proved that cognitive biases are sufficient to simultaneously deliver both short-horizon continuation and long-horizon reversals. Daniel et al. (1998) also prove that cognitive biases are sufficient to simultaneously deliver both short-horizon continuation and long-horizon reversals. Stein (2009) interprets that 'newswatchers' who underreact to the news release form a biased expectation of fundamental value and arbitrageurs with uncertainty about total arbitrage capacity observe different fundamental values in different situations; the results show that the average absolute distance between price and fundamentals can be greater or smaller with infinite arbitrage. However, these literatures build asset pricing models without the effects of investor sentiment.

From the perspective of investor sentiment, investor sentiment affects the expected value of fundamental, and further affects the variance of fundamental. Mian and Srinivasan (2012) explore whether investor sentiment affects the stock price sensitivity to firm-specific earnings news, and find that the stock price sensitivity to good earnings news is higher in high sentiment periods than low sentiment periods, whereas the stock price sensitivity to bad earnings news is higher in low sentiment periods than high sentiment periods. So a large number of literatures build the sentiment asset pricing models including the biased cognitive value and variance. Yang and Zhang (2013a) demonstrate an asset pricing model to testify that the investor sentiment has a systematic and

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significant influence on the risky asset price. Yang and Zhang (2013b) further build a dynamic asset pricing model with heterogeneous sentiments, and demonstrate that the heterogeneous sentiment causes the mean reversion of stock returns. Yang and Li (2013) integrate sentiment and information to present a sentiment asset pricing model, and find that the information quality can enlarge the sentiment shocks on stock prices. Yang and Li (2014) also further integrate sentiment and information to raise a dynamic asset pricing model to provide an explanation to a few financial anomalies.

In general, the previous literatures all hypothesize that rational investors know the fundamental value when they construct sentiment asset pricing model. However, Stein (2009) proposes that a market in which there are both naïve investors with biased expectations and fully rational arbitrageurs can't explain market inefficiency with the increasing of arbitrageurs. And, the investors will form their minimum selling price or maximum buying price based on possible future prices, so the possible future price may be a certain value or in a certain interval. Arkes et al. (2008) find the investors' buying price is $30 and the stock price rise from $30 to $36, then their mental accounting will be equal or greater than $40.24, the investors feel satisfied only if the stock price up to $40.24. Stein (2009) assumed that the total arbitrage capacity is uniformly distributed on $[1-h, 1+h]$ or follows symmetric binomial distribution to calculate the gap between price and fundamental and verify that the market may be less efficient. Therefore, our model is also built on one key premise: arbitrageurs do not observe the fundamental and trade without being able to condition on a fundamental anchor.

Where our paper distinguishes from many of the previous literatures is in analyzing the combined effect of the value interval of cognitive value and the investor sentiment in bull and bear markets. Usually, the investors estimate the fundamental value and the cognitive value depends on the comprehension of available information and investor sentiment. In bear market, the investors underestimate the fundamental value, and the sentimental investors' cognitive value is affected by the investor sentiment. In short, their cognitive values are uncertain.

In this paper, we analyze the effect of investor sentiment and cognitive value in two kinds of circumstances. On the one hand, the investors may be more cautious with the investment in bear market or after prior loss, but it doesn't mean that they are rational (Barberis et al., 2001; Kahneman and Tversky, 1979; Tversky and Kahneman, 1992). In consideration of bounded rationality, we assume that all of the identical arbitrageurs will underestimate the fundamental value of information affected by the current investment climate in short horizons, and the sentimental investors will have a cognitive value of fundamental value of information including the underestimated value of information and the investor sentiment in bear market or after prior loss. So we construct the underestimated model to explore whether the investor sentiment causes the limit of arbitrage in bear market or after prior loss. On the other hand, the investors are less risk averse in bull market or after prior gains (Barberis et al., 2001; Kahneman and Tversky, 1979; Tversky and Kahneman, 1992). Similarly, we think all of the identical arbitrageurs will overestimate the fundamental value of information affected by the current investment climate in short horizons, and the sentimental investors will have a cognitive value of fundamental value of information including the overestimated value of information and the investor sentiment in bull market or after prior gains. So we construct the overestimated model to explore whether the investor sentiment causes the limit of arbitrage in bull market or after prior gains.

This paper contributes to the literature in the following areas. Firstly, investor sentiment has a systematic and significant impact on stock prices. Specifically, the equilibrium prices and the returns of arbitrageurs are time-varying with investor sentiment. However, the impacts of investor sentiment differ in bear and bull markets. Secondly, the model suggests a new source of limits to arbitrage, and demonstrates that investor sentiment has a significant on arbitrage. Thirdly, our framework can be helpful for understanding a range of financial phenomena: overreaction, underreaction, the fire sales and the limit of arbitrage.

The remainder of the paper is organized as follows. Section 2 describes the economy. Section 3 presents the sentiment asset pricing model when the investors' cognitive values are underestimated to the fundamental, and analyzes the returns of arbitrageurs. In Section 4, we build the sentiment asset pricing model when the investors' cognitive value is overestimated, and analyzes the returns of arbitrageurs. Section 5 concludes the results and provides a discussion of the limitations and future researches.

2. The economy

There are four time points, 0, 1, 2 and 3 in the economy. The economy contains a stock that has a terminal value at time-3 of $V = \theta + \varepsilon$, which represents the realized value of information, and ε is s normally distributed with a mean of zero and a variance of one. This stock is not in elastic supply: it is fixed at zero and unchangeable quantity in any period. Its terminal value V is normally distributed with a mean of θ and a variance of σ_θ^2, and it is realized at time-3, and the mean value θ represents the fundamental value of information. For $t = 0, 1, 2, 3$, we denoted the price at time t by P_t.

Table 1 describes the assumptions for the time-period. There are three types of agents participating in this market: arbitrageurs (denoted by a) who have rational expectations, the sentimental investors (denoted by s) and momentum traders (denoted by m). Here, D_t^a is the demand of arbitrageur at time t, D_t^s is the demand of sentimental investor at time t, and D_t^m is the demand of momentum trader at time t. Importantly, each type of agents makes full use of the available information. All of investors couldn't observe the terminal value V at time-1, but the arbitrageurs could observe the value interval of terminal value V at time-2, and they only know the terminal value V is uniformly distributed in a certain interval, and it is realized at time-3. In our model, the momentum traders enter the stock market at time-2; they won't enter the stock markets at time-1 for lack of the difference in prices. In order to hedge market risk and the ease of calculation, we assumed that arbitrageurs are present in the model in measure μ; the sentimental investors are present in measure $1-\mu$, where $0<\mu<1$, and the momentum traders are present in measure one, and that all agents of a given type are identical.

Arbitrageurs and sentimental investors have their own beliefs about the ex ante mean of the distribution of asset prices, and their demands of risky asset depend on the difference of cognitive value and the price, which is similar to the principle of momentum traders and Chen et al. (2002). However, arbitrageurs and sentimental investors have clear differences: arbitrageurs do not observe the news release and trade without being able to condition on a fundamental anchor, which is consistent with Stein (2009); and the sentimental investors can't observe the fundamental value completely, they incorporate investor sentiment and infer the arbitrageurs' value interval to form their cognitive value. In addition, momentum traders' demands are restricted to being a function of the price change over the prior period; it is clear that it must be an increasing function, which is similar to the principle of Hong and Stein (1999).

Table 1
The assumptions for the time-periods.

Periods	Arbitrageurs	Sentimental investors	Momentum traders
0	0	0	0
1	D_1^a	D_1^s	0
2	D_2^a	D_2^s	D_2^m
3	0	0	0