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A Bayesian approach to excess volatility, short-term underreaction and long-term overreaction during financial crises

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ABSTRACT

In this paper, we introduce a new Bayesian approach to explain some market anomalies during financial crises and subsequent recovery. We assume that the earnings shock of an asset follows a random walk model with and without drift to incorporate the impact of financial crises. We further assume the earning shock follows an exponential family distribution to accommodate symmetric as well as asymmetric information. By using this model setting, we develop some properties on the expected earnings shock and its volatility, and establish properties of investor behavior on the stock price and its volatility during financial crises and the subsequent recovery. Thereafter, we develop properties to explain excess volatility, short-term underreaction, long-term overreaction, and their magnitude effects during financial crises and the subsequent recovery. We also explain why behavioral finance theory could be used to explain many of the asset pricing anomalies, but traditional asset pricing models cannot achieve this aim.

1. Introduction

There are numerous papers that have modeled bubbles and crashes. Abreu and Brunnermeier (2003) use the idea of sequential awareness to develop a theory in which arbitrageurs compete with each other to beat the gun in a stock market.

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Matsushima (2013) extends their work and shows that rational arbitrageurs are willing to ride the bubble, even with incomplete information. He proves that the bubble can persist for a long period as the unique Nash equilibrium outcome. In this paper, we examine the problem of bubbles and crashes by using an alternative perspective, by modeling investor behavior to ride a bubble during bull and bear markets. The paper discusses the traditional and behavioral theories for investment.

There are two schools of asset pricing models, namely traditional asset pricing models and behavioral finance theory. It is well known that traditional asset pricing models (such as the CAPM and the Fama–French three factor model) do not explain many asset pricing anomalies, such as momentum. It is also well known that the market is not efficient (see, for example, Lim, Hooy, Chang, & Brooks (2016)), and that there are many market anomalies. Explaining market anomalies, such as market excess volatility, overreaction, and underreaction, is one of the most important issues in finance. Classical theorists of market rationality, for example, Fama and French (1996), hypothesize that overreaction and underreaction can be explained by the efficient market paradigm. On the other hand, behavioral finance theory, such as Barberis, Shleifer, and Vishny, 1998, BSV,Hong and Stein (1999), Daniel, Hirshleifer, and Subrahmanyam (1998), is able to better explain many financial anomalies, including overreaction and underreaction, based on assumptions of fundamental psychological biases of human beings.

BSV combine psychological phenomena with finance theories to explain market anomalies, such as the overreaction and underreaction phenomena, which are very important research topics in finance. This paper fits into the second school of work. Why can the traditional asset pricing models not be used to explain many asset pricing anomalies such as excess volatility, overreaction and underreaction phenomena, whereas behavioral finance theory can? Existing behavioral finance theory could be used to explain some of the asset pricing anomalies like excess volatility, overreaction and underreaction phenomena in normal market conditions but, as far as we know, no paper to date has studied whether excess volatility, overreaction and underreaction phenomena hold during financial crises and the subsequent recovery. In this paper, we bridge the gap in the literature to examine these two issues. We first discuss the assumptions used in the traditional asset pricing models and behavioral finance theory, and then we will provide an appropriate answer.

There are several basic assumptions for the traditional asset pricing model. Violating the assumptions could result in deviating from traditional asset pricing theory in a typical behavioral model. For example, BSV assume that investors adopt conservative and representative heuristics, and the earnings announcements satisfy a random walk following either a trending regime or a mean-reverting regime. This could be used to explain underreaction and overreaction phenomena. In addition, Gervais and Odean (2001) argue that insider traders place higher weights on a security's dividend if they successfully predict their past performance, and use the Bayes rule to update their prediction.

It has been observed that investors are too conservative and too slow to vary their prior beliefs when new information arrives. For example, assuming that conservative investors might not pay great attention to the latest earnings announcements, Edwards (1968) develops a Bayesian model that places a lower weight on useful statistical evidence, and greater weight on investors' priors. Nonetheless, Tversky and Kahneman (1971), Kahneman and Tversky (1973), and others use the concept of representative heuristics, namely the bias that individuals believe population parameters "represent" in the latest data, in their experimental studies. Many empirical studies (see, for example, Woodhousea, Singha, Bhattacharyaa, & Kumarb (2016)) find that psychology is an important factor in affecting stock prices.

Assuming that people overemphasize the strength of the evidence and de-emphasize its weight when they update their beliefs, Griffin and Tversky (1992) develop a model by combining both conservatism and representativeness. BSV further develop a Bayesian model to explain investors' behavioral biases by using both conservative and representative heuristics in making decisions. They assume that the earnings shock is independent, and follows a Bernoulli distribution with equal probability on e_0 or $-e_0$. Lam, Liu, and Wong (LLW) (2010, 2012) extend their work by introducing a pseudo-Bayesian approach, and relax the Bernoulli distribution assumption to allow the earnings shock to follow a normal distribution.

In this paper, we modify LLW's pseudo-Bayesian approach by assuming that the earnings shock of an asset follows a random walk model with and without drift to incorporate the impact of financial crises. We also relax LLW's normality assumption by assuming that the earnings shock follows an exponential family distribution. We note the advantage of using the exponential family distribution is that it is one of the most commonly used continuous distributions, including the normal, gamma, and other distributions, and can fit into situations with symmetric as well as asymmetric distributions. This relaxation is very important because it is well known (see, for example, Horváth & Šopov (2016)) that market information could be asymmetric. A bear market will be more sensitive to bad news, while a bull market is more sensitive to good news.

There are many findings and studies[2] in the literature supporting the use of the random walk model with drift for earnings announcement. By using this model setting, we establish some properties on the expected earnings shock and investor behavior during financial crises and the subsequent recovery. We find that as distinct from traditional asset pricing models, in which the expected value and its variance of the earning shock are constants, the *k*-step ahead expected value and its variance of the earning shock vary for each investor in our model setting. We also find that as distinct from the traditional asset pricing models in which the present value of the *k*-step ahead forecast future price is constant, the present value of the *k*-step ahead forecast future price varies for different expected market situations, including before stock price crashes, during stock price crashes, during subsequent recovery, and back to normal market condition in our approach. In addition, it depends on the predictive mean

[2] See, for example, Thompson and Wong (1991),Thompson and Wong, 1996, Chaudhuri and Wu (2003), Ayers, Li, and Yeung (2011), and the references cited therein.