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Journal of Economic Behavior & Organization 68 (2008) 194–208

JOURNAL OF Economic Behavior & Organization

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Stochastic dominance and behavior towards risk: The market for Internet stocks

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Received 19 July 2004; accepted 19 March 2008
Available online 26 April 2008

Abstract

Internet stocks registered large gains in the late 1990s, followed by large losses from early 2000. Using stochastic dominance theory, we infer how investor risk preferences have changed over this cycle, and relate our findings to utility theory and behavioral finance. Our major findings are as follows. First, risk averters and risk seekers show a distinct difference in preference for Internet versus "old economy" stocks. This difference is most evident during the bull market period (1998–2000) where Internet stocks stochastically dominate old economy stocks for risk seekers but not risk averters. In the bear market, risk averters show an increased preference for old economy stocks, while risk seekers show a reduced preference for Internet stocks. These results are inconsistent with prospect theory and indicate that investors exhibit reverse S-shaped utility functions.

JEL classification: C14; G11; G14

Keywords: Stochastic dominance; Prospect theory; Utility functions; Gambles

1. Introduction

This paper uses stochastic dominance theory (Hadar and Russell, 1969; Hanoch and Levy, 1969) to identify dominant types of risk preferences over the Internet bull and bear market of the late 1990s. We argue that Internet stocks provide lottery-like payoffs which appeal to risk seekers or gamblers (Friedman and Savage, 1948; Markowitz, 1952; Hartley and Farrell, 2002). We also use the implied risk preferences to test two competing theories of choice under risk. The first is the prospect theory of Kahneman and Tversky (1979), which has been applied recently to behavioral finance (e.g., Barberis et al., 2001). The second theory, which stems from the experimental work of Thaler and Johnson (1990), indicates that contrary to prospect theory, investors may be risk seeking over gains and risk averse over losses (i.e., investors have reverse S-shaped utility functions). The Internet episode provides an ideal setting for such a test since the bull and bear market define regimes of gains and losses of a substantial magnitude. Furthermore, these market regimes reveal strong preferences by investors for Internet and non-Internet stocks, respectively.

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doi:10.1016/j.jebo.2008.03.013

Stochastic dominance theory is appealing because of its non-parametric orientation. Stochastic dominance criteria require minimal assumptions about returns distribution and preferences. For example, returns can display time series dependence and conform to any distribution. The underlying utility functions can be standard linear utility functions satisfying von-Neumann-Morgenstern axioms, or as Fishburn (1989) shows, they can include a variety of nonlinear utility functions based on substantially weaker axioms. Machina (1982) and Starmer (2000) show that stochastic dominance criteria are also meaningful for a range of non-expected utility theories of choice under uncertainty.

We apply a recent test of stochastic dominance developed by Davidson and Duclos (2000), hereafter, DD. The DD test allows for mutually dependent observations and has simple asymptotic properties. Like most traditional stochastic dominance tests, however, the DD test takes the viewpoint of risk averters. We show that it is straightforward to adapt the test for risk seekers since orderings for convex utility functions are simply the dual of orderings for concave utility functions (Li and Wong, 1999). Incorporating this result leads to a complete test framework that can be used to infer risk averse and risk seeking behavior. We apply this framework to test for the dominant type of risk preferences associated with different types of stocks during the Internet bubble and post-bubble period.

The rest of this paper is organized as follows. Section 2 revisits the Internet stock market episode of the late 1990s. Section 3 reviews theories of decision making under risk that incorporates risk aversion as well as risk seeking. Section 4 describes the dataset and presents descriptive statistics for our stock returns series. The theory of stochastic dominance for risk averters and risk seekers is discussed in Section 5. Section 6 introduces the DD (2000) test for stochastic dominance, and discusses test implementation issues. Section 7 reports the results of the DD test for the bull and bear market and what these results imply for prospect theory and the Thaler–Johnson hypothesis. In Section 8, we interpret our results by drawing on the utility analysis of gambling (Hartley and Farrell) and related results from behavioral finance. Section 9 concludes.

2. The Internet stock episode

From 1998 to early March 2000, prices of Internet stocks rose six-fold, outperforming the S&P 500 by a whopping 482 percent.[1] Technology stocks in general showed a similar trend, as evident from the NASDAQ 100 Index which quadrupled over the same period, and outperformed the S&P 500 index, by 268 percent. Following the peak of the bull market, prices of Internet stocks fell by more than 80 percent through the end of December 2003. This spectacular rise and fall of Internet stocks has spurred research into the causes of the Internet stock "bubble".

Ofek and Richardson (2003) provide circumstantial evidence that Internet stocks attract mostly retail investors who are more prone to be overconfident about their ability to predict future stock prices than institutional investors. They add that this investor clientele, along with short sale constraints and lockup agreements forced pessimistic investors out of the market, leaving only investors with most optimistic beliefs. Baker and Stein (2004) develop a model of market sentiment with irrationally overconfident investors and short sale constraints, showing that the model's predictions are consistent with the high trading volume and liquidity of Internet stocks during the boom period. Cochrane (2002) finds similar correlations between stock prices and turnover during the Internet bubble period and the 1929 stock market boom and crash. Hong et al. (2005) explain that the bubble was caused by a combination of factors such as investor overconfidence, short sale constraints and limited asset float. These papers all point to investor irrationality as the most probable cause of the Internet boom and crash.

Whether or not the bubble is due to investor irrationality is hard to resolve given our imperfect knowledge of correct asset pricing benchmarks. These models also assume that investors are globally risk averse, and that risk aversion is time-invariant. The first assumption is inconsistent with the possibility that people may be both risk averse and risk seeking as Friedman and Savage pointed out long ago. The second assumption is inconsistent with evidence that people's risk aversion changes with prior experience (Thaler and Johnson) and is conditional on contemporaneous market states (Shive and Shumway, 2006). The ability of standard asset pricing models to explain market "anomalies" is constrained by both assumptions.

[1] We use the Amex Inter@active index (more commonly known as the @Net index) as our proxy for stocks in the internet sector. The @Net index is a popular benchmark for internet-related firms. We also use the Nasdaq 100 Index as a broader proxy for "new economy" or technology-related firms. Our main proxy for "old economy" stocks is the S&P 500.