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Exploring the Persistent Behavior of Financial Markets

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ABSTRACT

This paper presents the persistent behavior hypothesis for financial markets, which is tested statistically on five stock indices from 2001 to 2014. We find significant results in all five stock markets for the full sample period as well as subperiods. A persistent behavior strategy (PBS) on index futures is also presented, the net annual returns of which are significantly higher than 15% in all futures markets including transaction costs. The best performance, about 27%, occurs in the E-mini NASDAQ 100 and TAIEX futures. We also present studies on the impact of investor behavior over market price of TAIEX futures.

1. Introduction

It has been shown that information asymmetry declines within the trading period of a day. (Wood et al., 1985; Jain and Joh, 1988) use NYSE stock data to reveal the U-shaped intraday patterns of transaction volume and price volatility. (Admati and Pfleiderer, 1988; Foster and Viswanathan, 1990; 1993) provide models to explain these time-dependent patterns in security trading. They consider how information is impounded in prices, and show that the information asymmetry declines from the beginning of the trading time. A natural economic interpretation of such a market is thus as follows. Although dynamics vibrate in the early stage of a market's trading period owing to diversity in investor decisions about their investment positions for the day, momentum moves market dynamics towards a common direction after the opening period. In this paper, we define such market behavior as the persistent behavior of financial markets; it is worth noting that the notion of "persistent" here is different from the sense generally adopted in the literature on fractional and multifractional Brownian motion (see Bianchi et al., 2013; Matos et al., 2008). The hypothesis of persistent behavior of market price is then formulated as follows. When the price goes up (down) from the opening of the market to the probe time, the hind price – that is, the price at the closing of the market – tends to be greater (less) than the price at the probe time. In this paper, the persistent behavior hypothesis is tested statistically on the Standard & Poor's (S&P) 500, the Dow Jones Industrial Average Index (DJIA), the NASDAQ 100, the Hang Seng Index (HSI), and the Taiwan Stock Exchange Capitalization Weighted Stock Index (TAIEX) from 2001 to 2014. We find significant results in all these stock markets for full sample and subperiods. Based on the findings, we also present a trading strategy on index futures.

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Technical analysis is one of the most popular methods for developing trading strategies (Park and Irwin, 2007). In contrast to fundamental analysis, which uses macroeconomics and corporate information such as corresponding assets, including earnings per share (EPS), sales margin, dividend yield, and so on, technical analysis forecasts the movement of prices in the future by modeling market behavior. The profitability of the technical analysis strategy has been studied extensively in the literature. For example, (Brock et al., 1992) test two of the most popular trading rules, that is, moving average (MA) and trading range break (TRB), using 90 years of Dow Jones Index data; they find significant results in profitability tests using both standard statistical analysis and bootstrap techniques. However, some literature shows that the performance of technical analysis is falling. (Neely et al., 2009) use previously studied trading rules, such as MA, to test the intertemporal stability of excess returns in the foreign exchange market. Although they find positive excess returns of MA during the 1970s and 1980s, the profit opportunities of MA rules disappear in the early 1990s. They conclude that these irregularities are consistent with the adaptive markets hypothesis (Lo, 2004). In addition, (Cheung et al., 2011) investigate MA and TRB in HSI by daily data, and they find significant results pre-1986 and insignificant results post-1986. (Schulmeister, 2009) investigates how technical trading systems exploit the momentum and reversal effects in Standard & Poors (S&P) 500 spot and futures markets. By using daily data, the performance of technical models has declined steadily since 1960, and has been unprofitable since the early 1990s. Although by using 30-minute data, the same models produce an average gross return of 7.2% per year between 1983 and 2007, the performance between 2001 and 2007 of the models is worse than that between the 1980s and 1990s. They conclude that there is more information in more high frequency data. The literature does still show significant profits for technical analysis by observing market behavior. (Szakmary et al., 2010) investigate commodity futures markets using a monthly dataset spanning 48 years and 28 markets and find trend-following trading strategies yield positive mean excess returns net of transactions costs in at least 22 of the 28 markets. By observing the correlation of stocks prices and their option implied volatilities, (An et al., 2014) find that the stocks achieve high (low) future returns if there are large increases in their call (put) implied volatilities over the previous month. When they sort stocks into decile portfolios based on past first differences in call volatilities, there is significant 1% spread per month between first and tenth portfolios.

It is also important to study investor behavior and their impact on financial markets, and much literature has been conducted on this topic. (Hirshleifer, 2001) suggests that investor psychology is a determinant of asset prices, and Barberis and Thaler (2003) presents an application of behavioral finance to the aggregate stock market, the cross-section of average returns, individual trading behavior, and corporate finance. (Menkhoff, 2010) conducts a survey of 692 fund managers, and finds a significant relation between technical analysis and the view that prices are heavily determined by psychological influences; he concludes that technicians apply trend-following behavior. On the other hand, (Hoffmann and Shefrin, 2014) investigate the trading behavior of individual investors and find that individual investors frequently make poor portfolio decisions on option trading by using technical analysis. In addition, (Nofsinger and Sias, 1999) investigate the relationship between changes in institutional ownership and stock returns; they find a positive correlation and indicate that institutional investors tend to engage in positive-feedback trading. Moreover, their results suggest that institutional herding impacts prices more than does herding by individual investors.

However, to the best of our knowledge, none of the previous literature has conducted the study on the aforestated persistent behavior of financial markets, and this article is the first to study this topic. There are three parts to our findings. First, we use data from the S&P 500, the Dow Jones Industrial Average Index (DJIA), the NASDAQ 100, the Hang Seng Index (HSI), and the Taiwan Stock Exchange Capitalization Weighted Stock Index (TAIEX) from 2001 to 2014 to test the persistent behavior hypothesis statistically. We show significant results in all these stock markets in both full sample and subperiod tests. These results are robust, because the results of all these stock markets before and after the financial crisis of 2007 and 2008 are consistently significant. Second, based on the findings of persistent behavior in stock markets, we also present the persistent behavior strategy (PBS), a trading strategy for index futures. Since there is no real-world index trading, we use the PBS to engage in index futures trading for real-world trading. In the experiments, transaction costs are taken into account; since index futures are very liquid products, the slippage cost of transactions is very low. We thus follow the estimation of Schulmeister (2009) and assume overall transaction costs to be 0.01% (per trade). From the results of back-testing from 2001 to 2013, the PBS achieves more than 15% net annual returns with p-values no greater than 0.2% in each futures market. The best performance, about 27% net annual returns with p-value less than 1×10^{-5}, occurs in the E-mini NASDAQ 100 and TAIEX futures. Finally, by using TAIEX futures transaction data, we also investigate investor behavior for TAIEX futures by grouping investors into subtypes, that is, foreign investment institutions, domestic institutions, dealers, and individuals. We find that the four types of investors all display persistent behavior in their net buy positions (buy positions minus sell positions). However, although institutional investors' persistent behavior for net buy positions is consistent with the persistent behavior of market prices, that of individual investors is not. Additionally, we observe a positive relationship between the net buy positions of institutional investors in the probe period and hind returns. In (Nofsinger and Sias, 1999), monthly data are used to illustrate investor herding behavior; in contrast to their study, we use intra-day data to demonstrate the herding behavior of institutional investors. Specifically, herding behavior is observed quite quickly after market opening.

The rest of the paper is organized as follows: In Section 2, we present our methodologies, including a definition of persistent behavior and the trading rules for persistent behavior strategies. In Section 3, we introduce the empirical data. The experimental results and discussion are given in Section 4. We conclude in Section 5.

2. Methodology

In this section, we give a formal definition of the persistent behavior of the stock market and the method we adopt to statistically test for the existence of the persistent behavior. The definition of PBS is also given for index futures trading.