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Stock return predictability and the adaptive markets hypothesis: Evidence from century-long U.S. data ☆

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ABSTRACT

This paper provides strong evidence of time-varying return predictability of the Dow Jones Industrial Average index from 1900 to 2009. Return predictability is found to be driven by changing market conditions, consistent with the implication of the adaptive markets hypothesis. During market crashes, no statistically significant return predictability is observed, but return predictability is associated with a high degree of uncertainty. In times of economic or political crises, stock returns have been highly predictable with a moderate degree of uncertainty in predictability. We find that return predictability has been smaller during economic bubbles than in normal times. We also find evidence that return predictability is associated with stock market volatility and economic fundamentals.

1. Introduction

The efficient market hypothesis (EMH) grew out of the University of Chicago's business school over 40 years ago. It swayed many academics and policy makers into believing that stock prices fully reflect all available information, and no market participant can systematically make abnormal profit (Fama, 1970). When the information set is limited to past prices, the market is said to be weak-form efficient, and asset return is purely unpredictable from past prices. While most finance academics believe that the market is weak-form efficient (see Doran et al., 2010), there are critics from behavioral finance who document irrational but predictable investor behavior such as overreaction and overconfidence (see, for example, De Bondt and Thaler, 1985; Barber and Odean, 2001) and the momentum effect (Jegadeesh and Titman, 1993). Many commentators even attribute some responsibility for the recent global financial crisis (GFC) to an enduring belief of financial economists and policy makers in the EMH and the self-correcting capacity of markets (see Fox, 2009; Nocera, 2009).

Grossman and Stiglitz (1980) provide a theoretically compelling argument that a perfectly efficient market is impossible because if prices fully reflect all available information, traders would not have any incentive to acquire costly information. Given the impossibility of perfect efficiency, Campbell et al. (1997) propose the notion of relative efficiency, which has led to a shift in research focus from testing the all-or-nothing notion of absolute market efficiency to measuring the degree of market efficiency. There is also a growing empirical literature suggesting that market efficiency varies over time (for a survey, see Lim and Brooks, 2011).

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Lo (2004) proposes a new framework in the form of the adaptive markets hypothesis (AMH), which can help explain the observed time variation in the degree of market efficiency. The AMH is developed by coupling the evolutionary principle with the notion of bounded rationality (Simon, 1955). A bounded rational investor is said to exhibit satisfying rather than optimal behavior. Optimization can be costly, and market participants with limited access to information or abilities to process information are merely engaged in attaining a satisfactory outcome. Lo (2004) argues that a satisfactory outcome is attained not analytically, but through an evolutionary process involving trial-and-error and natural selection. The process of natural selection ensures the *survival of the fittest* and determines the number and composition of market participants and trading strategies. Market participants adapt to the constantly changing environment and rely on heuristics to make investment choices. An important implication of the AMH is that return predictability can arise time to time due to changing market conditions. Therefore, market efficiency may not follow a secular trend toward greater efficiency as anticipated by proponents of the EMH, but instead can vary in a cyclical fashion being "highly context dependent and dynamic" (Lo, 2004). Though a number of recent studies proceed to explain time variation in the degree of return predictability (see Chuluun et al., 2011; Gu and Finnerty, 2002; Lagoarde-Segot, 2009), none of these previous studies explore the role of changing market conditions.

The testable implications of the AMH are twofold. First, the degree of market efficiency fluctuates over time. Second, the degree of market efficiency is governed by market conditions. This paper tests the first implication by tracking the evolution of return predictability of the U.S. stock market over the last century, and the second implication by examining whether the degree of return predictability in the U.S. is dependent upon market conditions as manifested by market crashes, fundamental economic or political crises, economic bubbles and regulatory regimes.[1] We measure the degree of return predictability using three alternative test statistics with superior statistical properties, namely, the automatic variance ratio test of Choi (1999), the automatic portmanteau test of Escanciano and Lobato (2009), and the generalized spectral test of Escanciano and Velasco (2006). In addition, the confidence interval is constructed to gauge the degree of uncertainty associated with return predictability. The above methodological advances provide a more rigorous analysis and results than our predecessors.[2]

We obtain monthly measures of the degree of return predictability from the Dow Jones Industrial Average index over the period from 1900 to 2009, and test whether they are related to different stock market conditions after controlling for macroeconomic fundamentals. Since 1900, the U.S. stock market has experienced a number of exceptional and unexpected events, such as market crashes, economic or political crises, economic bubbles and major regulatory changes. These events have strong implications on the psychology of market participants and the way they incorporate new information to prices, which in turn may generate time variation in the serial correlation of returns as suggested by the AMH.

This paper finds strong evidence in favor of time-varying return predictability of the U.S. stock market and dependence of return predictability on market conditions. Both findings are consistent with the implications of the AMH. In particular, during stock market crashes, no return predictability is observed and an extremely high degree of uncertainty is associated with measures of return predictability. In contrast, during economic or political crises, stock returns are found to be highly predictable with a moderate degree of uncertainty. In times of economic bubbles, the degree of return predictability is found to be lower than in normal times. We also find that return predictability is affected by market volatility and macroeconomic fundamentals such as inflation and interest rates. Contrary to the general findings of past studies, we find a higher degree of return predictability before 1980 and a strong tendency to non-predictability afterwards. The next section presents the details of the data. Section 3 presents the methodology, and Section 4 presents the empirical results and their implications. The conclusion is drawn in Section 5.

2. Data

We use the Dow Jones Industrial Average (DJIA) index, daily from January 1900 to June 2009. The index is a price-weighted average of 30 blue-chip stocks, accounting for 25–30% of the total value of U.S. stocks. The component stocks are regarded as the main drivers of the market. The index began with 12 component stocks in 1896, expanded to 20 stocks from 1926, and then to 30 stocks from 1928 to date. The composition changes only occasionally, at the discretion of the managing editor of the Wall Street Journal.[3] For weekly data, we take Wednesday values (if the market is closed on a Wednesday, the Tuesday value is taken). The data are available from the Dow Jones index web site (http://www.djindexes.com/).

Fig. 1 presents the time plots of daily index and log returns for four sub-periods chosen arbitrarily only for clarity of exposition. We observe that the market is heavily affected by a series of major events. The index suffers a sharp decline in 1914 due to World

[1] This study uses return predictability and market inefficiency interchangeably. It is worth noting that the presence of return predictability only alludes to potential market inefficiency because observed return predictability may not be economically exploited in a systematic way due to transaction costs and instability of the return prediction model. Moreover, evidence of return predictability may exist in a world of rational asset pricing with time-varying expected returns.

[2] There are three published papers in the area of time-varying efficiency of the U.S. market. All of these studies focus on first-order return autocorrelation. Gu and Finnerty (2002) employ the Lo and MacKinlay (1988) variance ratio test on the DJIA index with a single arbitrarily selected holding period; Lo (2004) draws evidence from rolling first-order autocorrelation coefficients of monthly returns of the S&P500 index; and Ito and Sugiyama (2009) provide time-varying AR coefficients of monthly returns of the S&P500 index. However, only Gu and Finnerty (2002) proceed to explore the factors associated with autocorrelation of DJIA index returns. Our paper differs from Gu and Finnerty (2002) in two significant ways. First, we use a fully data-dependent method to calculate the optimal holding period for the variance ratio test and estimate its confidence interval with wild bootstrapping. The automatic portmanteau test used in our paper also employs a data-dependent procedure to determine the optimal lag order. In addition to these two autocorrelation-based techniques, we employ the generalized spectral test that is capable of detecting nonlinear return dependence. Second, we examine whether U.S. stock return predictability is related to changing market conditions as hypothesized by the AMH.

[3] The current composition consists of 3M, Alcoa, American Express, AT&T, Bank of America, Boeing, Caterpillar, Chevron, Cisco Systems, Coca-Cola, DuPont, Exxon Mobil, General Electric, Hewlett–Packard, Home Depot, Intel, IBM, Johnson & Johnson, J P Morgan & Chase, Kraft Foods, MacDonald's, Merck, Microsoft, Pfizer, Proctor & Gamble, The Traveller Company, United Technologies, Verizon, Wal-Mart Stores, and Walt Disney.