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Comparative Analyses of Stock Returns Properties and Predictability

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Abstract

This study investigates the stock returns of the Dow Jones Industrial Average (DJIA), Standard and Poor's (S&P) 500, and the National Association of Securities Dealers Automated Quotations (NASDAQ) to analyze and compare their properties and to determine their relative predictability. While it is commonly accepted that price per earnings ratio and corporate earnings are the main determinants of stock market returns, this assertion may not hold equally for monthly and daily stock returns. In addition, does this assertion hold equally for stock returns regardless of the stock market index? This work uses nonparametric spectral estimation to study the underlying properties of stock returns and uses monthly corporate earnings (corporate profits after tax) and 3-month Treasury bill interest rate (proxy for price per earnings ratio) to forecast the monthly stock returns of S&P 500, DJIA, and NASDAQ indices. Since corporate earnings are issued quarterly, this data set had to be interpolated to produce the monthly corporate earnings. Overall, the analyses and forecasting were facilitated with both statistical and digital signal processing techniques. Some examples of the techniques used include Hurst exponent to determine predictability, nonparametric spectral estimation to determine the underlying properties of the stock returns, and correlation and root mean square error to determine the forecasting accuracy. The results of this study provide evidence to support that economic and financial time series such as interest rates, corporate earnings, and stock market returns are time varying and nonGaussian with smooth compactly supported and essentially bandlimited power spectral density estimates. It further shows that the forecasts of the different stock market returns align well with the desired values and the S&P 500 forecasted stock returns were the best.

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Keywords: Stock Returns; Forecasting; Power Spectral Density Estimate; Spectrogram; Stock Price Indices; Interest Rate; Corporate Earnings

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1. Introduction

This paper investigates stock returns' properties and predictability relative to each other. Price per earnings (P/E) ratios and real corporate earnings (corporate profits after tax) have been found to influence stock market returns through stock prices[1, 2, 3]. Since interest rates and P/E ratios are inversely related to each other and interest rates are used "as a proxy for the P/E ratio"[1], inverted interest rates and corporate earnings also strongly impact stock market prices and returns. These two determinants of stock prices are directly affected by the changes in real money, changes in the price level, and changes in total spending, which are ultimately affected by the corporate tax rate, potential output, changes in nominal money, and changes in government spending as described in the Keran stock price determination model[1]. Lorie and Hamilton[2] and AL- Shubiri[4] added other influencing factors of stock returns in dividend yield and the general economy's evolution. Major stock market indices such as the Dow Jones Industrial Average (DJIA), Standard and Poor's (S&P) 500, and the National Association of Securities Dealers Automated Quotations (NASDAQ) are descriptively very similar to each other – their fluctuations typically coincide[1, 2], suggesting moderately high to very high correlations between pairs of them. In fact, for stock price samples under study, the Pearson correlations between S&P 500 and DJIA, S&P 500 and NASDAQ, and DJIA and NASDAQ were found to be 0.952, 0.824, and 0.729 respectively over the period where their durations coincide: January 1986 to May 2015. Moreover, according to Levy and Sarnat[5] and Wong et al[6] stock returns in different industries within the typical economy tend to move together with sufficiently high positive correlations.

Stock market returns reflect a relatively cheap alternative to loans for obtaining capital to finance a business[4]. Under the efficient market hypothesis, stock returns are an example of a random walk process[2]. However, some researchers have produced evidence to the contrary. For example, Lo and MacKinlay[7] used a volatility-based specification test to reject the notion that stock returns follow the random walk model at least for weekly stock returns. Their conclusion was supported by the evidence of amply high "positive serial correlation" in weekly and monthly stock market data. Furthermore, Officer[8] found that stock market returns are described by 'fat tailed' distributions with some level of stability that appears more consistently in monthly returns. In addition, Biswal[9] provided an overview of the applications of spectral analyses and wavelets used to uncover the inherent hidden periodicities, nonstationarities, nonlinearity, and complex dynamics and relationships in the behavior of stock price changes (returns). Spectral analysis was also used to argue against the randomness of stock returns by demonstrating that their spectra vary in important ways and were therefore not flat[10]. Moreover, stock markets in developing countries may produce stock returns with attributes different from stock market returns in developed countries. For example, Bhandari and Kamaiah[11] used cross-spectral analysis to study the relationships between returns yielded on India's BSE 30 and those generated on well-established stock markets in the United States of America (DJIA and NASDAQ), United Kingdom (FTSE 100), and Japan (Nikkei 225) and discovered "some evidence" showing that the relationships are nonlinear with short-term synchrony, and that the BSE 30 was lagging in the long-run. Finally, to capture the spectra of business cycles as they evolve through time, Turhan-Sayan and Sayan[12] used both linear (Gabor Transform and short-time Fourier Transform) and nonlinear (Page distribution and Wigner distribution) time-frequency methods to compare their relative effectiveness in detecting cycles in stock market data, and found the Page distribution to be the most effective on both synthetic and real stock market data.

Before applying a forecasting regime to time series data such as stock market returns, a desirable precursor is to determine the predictability of the time series[13]. An effective way to accomplish this task is to estimate the Hurst exponent[13, 14, 15, 16, 17] of the time series data. The Hurst exponent provides a reasonable estimate of the relative persistence inherent in a time series[14, 15, 16, 17]. A persistent time series has Hurst exponent in the half-open interval of (0.5, 1] and consequently has long-term memory (correlations)[16, 17], and is therefore predictable over the discernable trends, at least, in the short-run[15]. These time series data that include stock market returns have a fractal dimension (2 – Hurst exponent) in the half-open interval of [1, 1.5), implying that the fractal dimension of a time series decreases as its Hurst exponent increases suggesting less jaggedness in the time series. Mandelbrot and Hudson[16] reported an average Hurst exponent of about 0.635 for S&P 500 stock returns from their examination of several studies. More specifically, Lobato and Savin[18] reported that their findings support the existence of meaningful long-term memory in stock returns.

Stock market returns are inherently noisy, volatile, multivariate, complex time series with nonlinear, nonstationary, and non-Gaussian features[14, 16, 19]. They also possess uncertain and intricate relationships[16, 20]. Of the