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Daily Stock Returns Characteristics and Forecastability

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Abstract

While stock prices and economic activity are interrelated in a nation, they "are not coincident" with each other. Stock prices are a leading economic indicator of the United States of America's (U.S.A.'s) economy. An economic variable that influences stock market prices is interest rates through an inverse relationship. The changes in stock prices (or stock returns) are generally caused by the demand for stocks. This paper reports on a study that investigates the underlying spectral and time-frequency characteristics of daily Standard and Poor's (S&P) 500, Dow Jones Industrial Average (DJIA), and National Association of Securities Dealers Automated Quotations (NASDAQ) composite stock returns, and changes in interest rate (namely, inverted 3-month Treasury bill). The study thereafter compared these findings with those obtained in a previous study by Joseph et al, which focused on monthly stock returns and interest rate data. Subsequent to studying stock returns and changes in interest rate that showed relatively similar spectral and frequency-time characteristics, this study investigated the forecastability of stock returns (in S&P 500, DJIA, and NASDAQ composite) by inverted interest rate (in 3-month Treasury bills) over prediction horizons of five and 30 days with the forecasting period covering the last 13 years. The measures of forecast accuracy used were root mean square error and correlation. The forecasts were favorable in all cases even with simpler neural network models.

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Keywords: Stock market returns; Treasury bill interest rate; Forecasting models; Forecastability; Nonparametric spectral analysis; Time-frequency analysis.

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1. Introduction

Stock prices and economic activity in a nation are interrelated. However, they "are not coincident" with each other [1]. Stock prices are a leading economic indicator of the United States' (U.S.') economy. One of the economic variables that influences stock prices is interest rates, but through an inverse relationship [1], [2], [3], [4], [5]. The changes in stock prices (or stock returns) are generally caused by the demand for stocks [3]. This paper investigated the underlying spectral and time-frequency characteristics of daily Standard and Poor's (S&P) 500, Dow Jones Industrial Average (DJIA), and National Association of Securities Dealers Automated Quotations (NASDAQ) composite stock returns as well as changes in interest rates (namely in inverted 3-month Treasury bill rate). Thereafter, the findings were compared with each other and those obtained in the study by Joseph et al [4], which focused on monthly stock returns and 3-month Treasury bill (T-bill) interest rate data. Subsequent to studying the stock market returns of the three prominent indices and changes in T-bill interest rate, this study proceeded to examine the forecastability of stock returns (in S&P 500, DJIA, and NASDAQ composite) using their past values and inverted 3-month T-bill interest rate as the predictor variables. Forecasting period covered almost 13 years out-of-sample stock return data, July/August 2004 to March 2017. The measures used to determine forecast accuracy were root mean square error and correlation, and the forecasted results were overall better than those obtained for the equivalent monthly data in [4] by Joseph et al.

Interest rates affect the economy through both short-term effects in the money market and the long-term effects in the loanable funds market [3]. The Federal government regulates the economy in the short-term with interest rates (namely, Federal funds rate) through the supply of and demand for money [3]. The rise and fall in the Federal funds rate correspondingly results in the rise and fall of all other interest rates including T-bill interest rate [2], [3]. The changes in interest rates are inversely related to the changes in stock prices, and consequentially stock returns [2], [3], [4], [5].

In [4], Joseph et al confirmed that monthly T-bill interest rate and stock returns time series data were nonGaussian, persistent, and time varying with smooth compact support over a very narrow band of low frequencies. They also showed that the correlation between pairs of S&P 500, DJIA, and NASDAQ were strong -- moderately high to high: lowest between DJIA and NASDAQ and highest between S&P 500 and DJIA with values of 0.73 and 0.95, respectively. Moreover, they said that the models used for forecasting were designed with a prediction horizon of one month (1-step ahead) and that the forecasts for S&P 500 stock returns were discernably the best of the three stock market returns forecasts. Fama in [6] stated that stock returns were examples of "stable" nonGaussian distributions, but that daily returns were more nonGaussian than monthly ones. Jondeau et al [7] provided further evidence to show that stock returns and interest rates were nonGaussian and time-varying with stock returns being negatively skewed and interest rates being positively skewed, and both stock returns and interest rates have excess kurtosis suggestive of fat tails, which are not present in Gaussian distributions that have skewness of 0 and kurtosis of 3. They further said that "correlation is not a valid measure for dependence" for non-Gaussian stock returns. Cont [8] discussed and elaborated further on the properties of financial asset returns including stock returns. In addition, Cont addressed the persistence and nonlinearity that are inherent in stock returns. Starica and Granger [9] stated that by acknowledging the nonstationarity inherent in stock returns and taking advantage of it in the design of the forecasting models yielded better forecasts than those produced by models designed for stationarity of stock returns.

In addition to stock returns being nonGaussian, time-varying with relatively low frequency spectral content on smooth compact support, negatively skewed with kurtosis exceeding 3, nonlinear, and persistent, they are noisy and volatile [5], [10], [11], [12], 13, 14]. Nonetheless, there is an abundance of evidence demonstrating that stock returns are forecastable with both conventional parametric statistical tools and more sophisticated nonparametric statistical learning tools (such as neural network, neuro-fuzzy, support vector machine models) [4], [9], [10], [12], [14], [15], [16], [17], [18], [19], [20], [21], [22] with statistical learning models performing generally better than classical statistical models [10]. In spite of this evidence, there is no consensus between academics and practitioners on the validity of stock returns forecasting on the basis of the efficient market hypothesis [14], [16], [18] [19], [23]. It may prove difficult to resolve the issue of stock returns' forecastability among academics and practitioners because as reported by Balvers et al [16], forecastability, within certain contexts, may necessarily be consistent with the efficient market hypothesis, Zhou [14] reported on the existent misalignment of financial practice and academic theory supporting stock returns' predictability, and Elliott and Timmermann [15] stated that economic models are "coarse