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Review

Stock Market Analysis: A Review and Taxonomy of Prediction Techniques

Dev Shah, Haruna Isah * and Farhana Zulkernine

School of Computing, Queen's University, Kingston, ON K7L 2N8, Canada; dshah@cs.queensu.ca (D.S.); farhana@cs.queensu.ca (F.Z.)
* Correspondence: isah@cs.queensu.ca

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Abstract: Stock market prediction has always caught the attention of many analysts and researchers. Popular theories suggest that stock markets are essentially a random walk and it is a fool's game to try and predict them. Predicting stock prices is a challenging problem in itself because of the number of variables which are involved. In the short term, the market behaves like a voting machine but in the longer term, it acts like a weighing machine and hence there is scope for predicting the market movements for a longer timeframe. Application of machine learning techniques and other algorithms for stock price analysis and forecasting is an area that shows great promise. In this paper, we first provide a concise review of stock markets and taxonomy of stock market prediction methods. We then focus on some of the research achievements in stock analysis and prediction. We discuss technical, fundamental, short- and long-term approaches used for stock analysis. Finally, we present some challenges and research opportunities in this field.

Keywords: stock exchanges; stock markets; analysis; prediction; statistics; machine learning; pattern recognition; sentiment analysis

JEL Classification: G10; G15; G17; D53

1. Introduction

Financial markets are one of the most fascinating inventions of our time. They have had a significant impact on many areas like business, education, jobs, technology and thus on the economy (Hiransha et al. 2018). Over the years, investors and researchers have been interested in developing and testing models of stock price behaviour (Fama 1995). However, analysing stock market movements and price behaviours is extremely challenging because of the markets dynamic, nonlinear, nonstationary, nonparametric, noisy, and chaotic nature (Abu-Mostafa and Atiya 1996). According to Zhong and Enke (2017), stock markets are affected by many highly interrelated factors that include economic, political, psychological, and company-specific variables. Technical and fundamental analysis are the two main approaches to analyse the financial markets (Park and Irwin 2007; Nguyen et al. 2015). To invest in stocks and achieve high profits with low risks, investors have used these two major approaches to make decisions in financial markets (Arévalo et al. 2017).

According to Hu et al. (2015), fundamental analysis is mainly based on three essential aspects (i) macroeconomic analysis such as Gross Domestic Product (GDP) and Consumer Price Index (CPI) which analyses the effect of the macroeconomic environment on the future profit of a company, (ii) industry analysis which estimates the value of the company based on industry status and prospect, and (iii) company analysis which analyses the current operation and financial status of a company to evaluate its internal value. Different valuation approaches exist for fundamental analysis. The average growth approximation technique compares Stock-A with other stocks in the same category to better

understand valuations, i.e., assuming two companies have the same growth rate, the one with the lower Price-to-Earnings (P/E) ratio is considered to be better. Hence the fair price is the earnings times target P/E. The P/E method is the most commonly used valuation method in the stock brokerage industry (Imam et al. 2008). The constant growth approximation technique such as Gordon's growth model (Gordon and Shapiro 1956; Gordon 1959) is one of the best-known classes of dividend discount models. It assumes that dividends of a company will increase at a constant growth rate forever but less than the discount rate. Dutta et al. (2012) demonstrated the utility of fundamental analysis through the use of financial ratios to separate good stocks from poor stocks. The authors compared their one-year return against the benchmark—i.e., Nifty—which gives an accuracy of 74.6%. This is one of the few papers which focus on using fundamental features (i.e., company-specific ratios) to identify stocks for investments.

Furthermore, Hu et al. (2015) grouped the domains of technical analysis into sentiment, flow-of-funds, raw data, trend, momentum, volume, cycle, and volatility. Sentiment represents the behaviours of various market participants. Flow-of-funds is a type of indicator used to investigate the financial status of various investors to pre-evaluate their strength in terms of buying and selling stocks, then, corresponding strategies, such as short squeeze, can be adopted. Raw data include stock price series and price patterns such as K-line diagrams and bar charts. Trend and momentum are examples of price-based indicators, trend is used for tracing the stock price trends while momentum is used to evaluate the velocity of the price change and judge whether a trend reversal in stock price is about to occur. Volume is an indicator that reflects the enthusiasm of both buyers and sellers for investing, it is also a basis for predicting stock price movements. The cycle is based on the theory that stock prices vary periodically in the form of a long cycle of more than 10 years containing short cycles of a few days or weeks. Finally, volatility is often used to investigate the fluctuation range of stock prices and to evaluate risk and identify the level of support and resistance.

Sentiments can drive short-term market fluctuations which in turn cause disconnects between the price and true value of a company's shares but over long periods of time, however, the weighing machine kicks in as a company's fundamentals ultimately cause the value and market price of its shares to converge. A prominent example comes from the Nobel Laureate Robert Shiller, who showed that stock prices are extremely volatile over the short term but somewhat predictable by their price-to-earnings over long periods (Shiller 1980). Diamond (2000) explained what returns to expect from the stock markets considering the economic scenario and suggested that in the future, returns could be substantially lower. Shiller (2000) also suggested that stocks are overvalued, and the bubble will burst anytime. In the year 2000, rightly so, we witnessed the dotcom bubble burst.

Stock market price prediction is a tricky thing. Several theories regarding stock markets have been conceptualized over the years. They either try to explain the nature of stock markets or try to explain whether the markets can be beaten. One such popular and most debated theory given by Fama (1970) is the Efficient Market Hypothesis (EMH) which states that at any point in time, the market price of a stock incorporates all information about that stock. In other words, the stock is accurately valued until something changes. There are three variants of EMH (i) the weak form which is consistent with the random walk hypothesis (Fama 1995), and that stock prices move randomly while price changes are independent of each other hence, it is not possible to beat the market by earning abnormal returns on the basis of technical analysis; (ii) the semi-strong form which states that prices adjusted rapidly according to market and public information such as dividend, earnings announcements, and political or economic events, hence it is not possible to earn abnormal returns on the basis of fundamental analysis; and, finally, (iii) the strong form which states that prices reflect market, public, and private information as such no investor has monopolistic access to information (Naseer and Tariq 2015).

According to EMH, price changes are unpredictable and forecasting a financial market is a hopeless effort. However, (Abu-Mostafa and Atiya 1996) argued that the existence of so many price trends in financial markets and the undiscounted serial correlations among fundamental events and economic figures affecting the markets are two of many pieces of evidence against the EMH. Researchers and