



Generalized DEA model of fundamental analysis and its application to portfolio optimization

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Abstract

Fundamental analysis is used in asset selection for equity portfolio management. In this paper, a generalized data envelopment analysis (DEA) model is developed to analyze a firm's financial statements over time in order to determine a relative financial strength indicator (RFSI) that is predictive of firm's stock price returns. RFSI is based on maximizing the correlation between the DEA-based score of financial strength and the stock market performance. This maximization involves a difficult binary nonlinear program that requires iterative re-configuration of parameters of financial statements as inputs and outputs. We utilize a two-step heuristic algorithm that combines random sampling and local search optimization. The proposed approach is tested with 230 firms from various US technology-industries to determine optimized RFSI indicators for stock selection. Then, those selected stocks are used within portfolio optimization models to demonstrate the usefulness of the scheme for portfolio risk management.

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1. Introduction

Fundamental analysis (FA) is the process of evaluating a public firm for its investment-worthiness by looking at its business at the basic or fundamental financial level, see for example, Thomsett (1998). It involves examining a firm's financials and operations, especially sales, earnings, growth potential, assets, debt, management, products, and competition. FA may also include analyzing market behavior that stresses the study of underlying factors of supply and demand, see Doyle et al. (2003) and Piotroski (2000). The main goal is to enhance the ability to predict future security price movement and then use such predictions to design equity portfolios. On the other hand, technical analysis (TA) operates on the theory that market prices at any given point in time reflect all known factors affecting supply and demand, as well as a firm's relative financial strength. Thus, TA focuses on analyzing market prices themselves, rather than directly evaluating factors of fundamental strength or factors of supply and demand. Strategies based on TA generally utilize a series of calculations designed to detect when a price change is likely to occur so that an investor can manage market positions in the short-term, such as the case in highly leveraged derivative markets. In contrast, FA takes on a more long-term perspective in determining which firms are most likely to perform well in the future, based on their fundamental business strengths.

The work in this paper complements the approach of fundamental analysis. The objective of our research is to focus only on the publicly-available financial statements of a given firm and to use them to determine a measure of underlying business strength for the firm. In determining the underlying financial health of a company, the raw financial numbers of a firm do not provide the perspective required to differentiate between *healthy* and *unhealthy* stocks for investment. In other words, the context provided by a comparison of a given firm to its industry and to the market as a whole is essential. Therefore, the focus in this paper is not to evaluate a firm's business strength in isolation. Instead, a relative strength indicator is computed by comparing a given firm to many other firms which are in a similar business segment of the market, such as the industry to which the firm belongs. The central premise of this research is that market prices have factored in publicly-available information about the firm, but the future expectations of price performance are determined by the perceived business strength of the firm. Thus, this notion is consistent with the "efficient market theory", where the price of a stock is assumed to reflect the knowledge and expectations of all investors since everyone has the same information about the stock. The aim of this paper is to provide a measurable (objective) metric of that knowledge that is highly correlated with stock price performance. Then, such a metric can be used as a proxy for gauging a firm's expected financial performance, and hence the firm's future stock price performance. In this sense, a company's financial statements (income statement, balance sheet and cash flow statement) become indispensable resources for investment decision making. It must also be stated that this research is not focused on determining if a stock is undervalued, overvalued, or trading at fair market value, nor does it focus on qualitative market factors that are internal or external to the firm.

Many quantitative models have been proposed in the literature for stock price prediction using financial statements – regression models and artificial neural network (ANN) models have been applied, see for instance, Kanas (2001), Quah and Srinivasan (1999), and Thanassoulis (1993). In Kanas (2001), historical financial data is used as inputs and

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