Interfaces with Other Disciplines

Estimation of firm performance from a MIMIC model[☆]

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A R T I C L E   I N F O

A B S T R A C T

In this paper we propose a new approach (based on the Multiple Indicator Multiple Cause (MIMIC) model of Joreskog and Goldberger (1975) to assess the performance of firms assuming that the 'true' firm performance is latent but there are many observable indicators of it. In our MIMIC model, the latent firm performance variable is linked with some observed explanatory variables (determinants) like age, size, advertising expenses, debt equity ratio, etc. Since there are many observed indicators (ROE, ROA, Tobin's Q, etc.) of the unobserved latent firm performance, the measurement equations in the MIMIC model link these observed indicators to the latent performance measure. We use firm level data from India during the period 2001 to 2008 to estimate the latent firm performance using the predicted factor scores and rank the firms according to the proposed measure. Finally, we estimate two stochastic frontier models and compute Pearson's correlation between pairs of performance measures. We find high rank correlation between the two measures of firm performance/efficiency, which justifies the use of the MIMIC model as a complementary method of performance measures.

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1. Introduction

In the efficiency and industrial organization literature the term firm performance is extensively used, although its meaning is not always made very clear. Quite often the term is used as a measure of a firm's overall financial health and is used to compare similar firms across the same industry or to compare industries or sectors. Since there are many ways to measure the financial health of a firm, the firm performance measure should be inclusive of various aspects of financial health such as firm value, return on assets, return on equity, resource use efficiency, etc. The problem lies in choosing a measure that captures more than one performance indicator. No single measure is in itself a comprehensive indicator of the 'true' firm performance.

Our objective, in this paper, is to estimate the 'true' firm performance which is viewed as a latent variable. First, we explain 'true' firm performance in terms of a vector of observed firm specific factors. Second, in estimating the 'true' firm performance we use

various indicators of firm performance.[1] Thus the framework fits in to the Multiple Indicator Multiple Cause (MIMIC) model developed by Joreskog and Goldberger (1975). The multiple cause part is where we explain 'true' performance, and the multiple indicators is where we relate the 'true' performance to various indicators[2] (popularly known as the structural equation, although it has no relationship with structural model in economics). Since there are many observed indicators (ROE, ROA, Tobin's Q, etc.) of the latent performance, the measurement equations (in the multiple indicator part of the model) link these observed indicators to the latent performance measure. Note that this modeling exercise is different from aggregating various observed performance indicators into a single aggregate measure which does not take into account possible measurement errors in the observed indicators. Also aggregation,

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[1] In the stochastic frontier (SF) and data envelopment analysis (DEA) literature no indicators of firm performance are used. Instead firm performance is estimated from the technology using input and output data. For example, see Ray (2015), Ray and Das (2010), Staub, Souza, & Tabak (2010), and Tzeremes (2015) for an application using DEA, and Sun, Kumbhakar, and, Tveterås (2015), Zhang, Xu, Feng, and Jiao (2015), and Dong, Firth, Hou, and Yang (2016) for an application using the SF approach. Lampe and Hilgers (2015) have provided an excellent survey on this issue.

[2] The MIMIC model is actually a variant of the linear independent structural relationships (LISREL) model of Joreskog and Sorbom (1999a, 1999b). In LISREL terminology, the multiple cause part is called the structural equation model (SEM), and the multiple indicators part is called the measurement model.

no matter how it is done, involves ad-hoc weighting of individual indicators which might not be even positively related (i.e., a higher value of one indicator might be associated with good performance while it might be opposite for another indicator). This MIMIC model is also different from the multiple-output-multiple-input stochastic frontier (SF) model in the efficiency literature (Kumbhakar, 1996, 2013). First, different indicators are unlikely to be similar to multiple outputs – the way economists model them in the production possibility function in which outputs are substitutable, given inputs. Second, our indicators are in fact performance measure themselves and estimating efficiency treating the indicators as outputs might go against the principle of the SF models. In spite of these differences, we compare and rank efficiency measures derived from various models to validate our proposed model, viz., the MIMIC model and the two SF models. In the empirical model we find that the performance scores of the SF models are highly correlated with those from the MIMIC model.

Our results (based on data from Indian listed firms) from the MIMIC model show that size has influenced firm performance negatively and significantly but the square of size exerts a positive and significant influence. This reflects a presence of a U-shaped relationship. Age of the firm shares a positive association with firm performance. The advertising expenditure shares a significant relationship with firm performance, but the same is not true with the R&D expenditure and leverage (captured by debt-equity) in our sample. We also find that different ownership structures influence firm performance differently.[3]

The rest of the paper is organized as follows. Section 2 provides a brief review of the literature that uses various indicators as measures of firm performance. Section 3 outlines our MIMIC model. The data and empirical results are presented in Section 4. Section 5 concludes the paper.

2. Indicators of firm performance and it determinants: a brief review

Several indicators, like return on asset (ROA) (Huang, Oua, Chena, & Lin, 2006; Khanna & Palepu, 2000), return on equity (ROE), Tobin's Q (Habib & Ljungqvist, 2005; Khanna & Palepu, 2000); market to book value ratio (MBVR) (Sarkar & Sarkar, 2000), return on employed capital, operating profit margin, etc., have been used in the existing literature to evaluate firm performance. Indicators like ROA and ROE are accounting-based measures of profitability, whereas indicators such as Tobin's Q and MBVR indicate stock-market based measures. The accounting-based measures reflect the past financial performance, whereas the market based measure the future performance. If ROA were chosen as an indicator of firm performance then it would only explain how effectively the firm has utilized the assets to generate earnings. This, however, is not the only determinant of firm's well-being. Other than utilizing assets, the firm also has to invest in the equity judiciously to generate higher earnings which will make the investors of the firm happy. This can promote the use of return on equity (ROE) as a measure of firm performance. The use of ROE can, however, be problematic. If investors are not careful, it can divert attention from business fundamentals and lead to unpleasant surprises. Companies can resort to financial strategies to artificially maintain a healthy ROE for a while and hide deteriorating performance in business fundamentals. Growing debt leverage and stock buybacks funded through accumulated cash can help to maintain a company's ROE even though operational profitability is eroding. Both ROA and ROE are calculated looking into the balance sheet and

other financial statements of the companies and hence, they do not account for the market oriented factors. Also, due to investors' expectations, the balance sheets announcements could influence stock market measures. Low dividends announcements are often depicted in the next day market price. This gets incorporated in market based measures like Tobin's Q, which is a measure of stock valuation. For example, a low Q means that the cost to replace a firm's assets is greater than the value of its stock. This implies that the stock is undervalued. Market to book value ratio (MBVR) is another measure used to find the value of a company by comparing the market value of a firm to its book value. This ratio attempts to identify if the securities are undervalued or overvalued.

Researchers in the early years used accounting based measures (Hoskisson, Hitt, Wan, & Yiu, 1999). In the early 1990s, with the rise of shareholder activism, shareholder value maximization became the stated objective of the firms and the use of market-based measures (Tobin's Q, MBVR) had been promoted. Although both accounting and market based indicators are widely accepted, there exists a debate regarding their relationship in the existing literature (Combs, Crook, & Shook, 2005; Richard, Devinney, Yip, & Johnson, 2009; Rowe & Morrow, 1999). According to Venkatraman and Ramanujam (1986), the accounting-based measures and the market-based measures can be unrelated due to the conflict between achieving short-run and long-run economic goals. Even if they are related, a question still remains, i.e., whether the relationship is high enough that the two measures (accounting and market based measures) can be used interchangeably (Richard, Devinney, Yip, & Johnson, 2009). This debate emphasizes that the use of single indicators may not precisely estimate firm's performance.

So far, as determinants of performance are concerned, there exist two schools of thoughts. The structure-conduct-performance (SCP) model emphasizes the degree of concentration in an industry determining firm performance. On the other hand, the firm effect models argue that differences in firm-level characteristics cause differences in performance. Firm specific factors could be the age of the firm, the leverage in a firm, size of the firm, selling expenses, investment in marketing and communication through advertising, investment in R&D, and the shareholding pattern in a firm.[4] The industrial organization literature suggests that older firms are more experienced, enjoy the benefits of learning, and hence turn out to be relatively superior performers compared to the newer firms. Firms' spending on innovation and marketing, as measured by research and development (R&D) and advertising expenses, respectively, is expected to yield positive returns in terms of share price performance. Given resource limitations, firms prioritize the quantum of their investments in R&D and advertising vis-à-vis other investments. Ho, Keh, and Ong (2005) finds that investment in advertising contributes positively to the one-year stock market

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[3] See Sueyoshi et al. (2010), García-Cestona and Surroca (2008), Gedajlovic and Shapiro (2002) and, for an excellent review on this, Short (1994).

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[4] We are also aware of factors like mergers and acquisitions (Bhaumik & Selarka, 2008), partial privatization (Gupta, 2005), busyness of the board members (Sarkar & Sarkar, 2009), capital structure (Berger and Bonaccorsi di Patti, 2006), affiliation to business group (Khanna & Palepu, 1999; Chacar & Vissa, 2005), as well as compensation to CEO (Core, Holthausen, & Larcker, 1999) can influence firm performance. On the other hand, diversification is often looked upon as an option to increase firm performance. Diversification can improve debt capacity, reduce the chances of bankruptcy by going into new products or markets (Higgins & Schall, 1975), and improve asset deployment and profitability (Teece, 1982; Williamson, 1975). Many researchers also argue that it is not the conduct of the management but rather industry structure that governs firm performance (Christensen & Montgomery, 1981; Montgomery, 1985). There are various studies that show empirically that the related diversifiers outperform the unrelated ones (Markides & Williamson, 1994). Simmonds (1990), on the other hand, examines the combined effects of breadth (related versus unrelated) and mode (internal R&D versus mergers and acquisitions) and finds that related diversified firms are better performers and R&D based product development is better than mergers and acquisitions. Although we do not have an explicit control of diversification in our framework, we still think that the use of unobserved heterogeneity at the industry level captures this to some extent.