Corporate efficiency in the UK: a stochastic frontier analysis

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Abstract

Purpose – Using a panel of 1,122 UK firms listed on the London Stock Exchange over the period of 1981-2009, corporate efficiencies are predicted in this paper as inverse proxies of agency cost and the agency cost hypotheses are tested. The paper aims to discuss this issue.

Design/methodology/approach – Stochastic frontier analysis is used to estimate corporate efficiency of firms, but from two different perspectives. The long-run and short-run corporate efficiencies are predicted focussing on modern approach of value maximization and traditional approach of profit maximization, respectively.

Findings – The estimation results reveal that, an average firm in the sample achieves 74.5 percent of its best performing peer's market value and 86.6 percent of its best performing peer's profit and both of them are highly significant in the analysis. The long-run market value efficiency supports the agency cost of outside equity and the short-run profit efficiency supports the agency cost of outside debt hypothesis. Also there is a positive rank correlation between these two efficiencies which confirms that an average firm in the UK suffers from inefficiency or agency conflicts to a certain extent, no matter whether the firm is driven by short-run or long-run growth perspectives.

Research limitations/implications – The predicted broad measures of agency costs in the paper have wider implications in enhancing the understanding of the UK firms' corporate performance especially when they operate under a relatively free and market based governance and financial system.

Originality/value – The work is distinguished by the large panel of UK firms and a long period of time that is considered. Emphasizing on the empirical implications of the distinctions between short-run and long-run efficiency is also novel.

Keywords Market imperfection, Agency cost, Asymmetric information, Corporate efficiency, Maximum likelihood, Stochastic frontier

Paper type Research paper

1. Introduction

The classical Modigliani and Miller (1958) approach to financial policy concluded that the financial structure of a firm is irrelevant to both its value and operating decisions. However, recent literature holds a number of market imperfections arising from asymmetric information and conflict of interests among various stakeholders responsible for invalidating this traditional view and henceforth financial structure of a firm and its investment decision becomes interdependent. The limited liability of owners-managers in a levered firm induce them to choose too risky projects expecting

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that their shareholders will get larger benefits if they turn out to be profitable and losses will be inflicted on to debt holders in case of failure (Jensen and Meckling, 1976). Anticipating such behavior, debt holders demand a premium on debt or bond covenants restricting the firm's future use of debt. Underinvestment may also be caused by a moral hazard problem when shareholders have an incentive to abandon profitable investment projects due to the wealth transfer from shareholders to debt holders that occurs whenever the net present value (NPV) of the project is lower than the amount of debt issued (Myers, 1977). Informational asymmetry in the credit market also does not allow lenders to price discriminate between good and bad borrowers in loan contracts, and as a result, a fraction of good investment projects which are not profitable enough to compensate for the excessively high cost of external financing face credit rationing (Stiglitz and Weiss, 1981). A firm's equity financing can also suffer from informational asymmetry problems when the prospective shareholders do not have enough information about the firm value and its projects (Myers and Majluf, 1984). To cover their potential losses from the adverse selection problem, the prospective shareholders demand a risk premium to purchase the shares of all firms considering the risk of an average investment project. The existing shareholders lose more if the investment projects are undertaken with this costly funding and hence prefer to abandon them. In short, the problems of asymmetric information in the capital market raises the cost of issuing new debt or equity limiting firms' ability or willingness to undertake good investment projects and leads to underinvestment.

Suboptimal investment can also occur due to agency costs between shareholders and management, which arises when the ownership and control of the firms are separated and as a consequence, shareholders' interests are not reflected by management's objective function. In the presence of informational asymmetries, neither the mechanisms devised to align the interests of these two parties may be fully functional nor the monitoring of managerial actions may be done efficiently or cost effectively. In such situations, the availability of cash flow in excess of that required to finance positive NPV projects may lead inefficient managers to increase investment spending instead of distributing the excess funds to shareholders. Such situations occur as the utility managers derive from managing firms has been shown to be an increasing function of the corporations' size because of the associated pecuniary and non-pecuniary benefits (Jensen, 1986, 2001; Bernanke and Gertler, 1989; Stulz, 1990) and therefore, management's corporate objective may be growth rather than value. As a consequence, investments with negative NPV could be undertaken and result in overinvestment.

Therefore, on one hand, shareholders take too risky projects and misrepresent the quality of the investment project due to their conflict of interest with debt holders and this requires the shareholders to pay higher cost of finance and face higher risk of financial distress, bankruptcy or liquidation as a result. On the other hand, managers misappropriate firm value due to their conflicts of interest with the shareholders which requires shareholders to bear the cost of providing incentives or monitoring to limit the opportunistic activities of the managers. The first of these two costs is termed as agency cost of outside debt and the latter one as agency cost of outside equity and Jensen and Meckling (1976) defines total agency cost as the sum of these two. In presence of all these market imperfection led inefficiencies, a firm's ability to achieve the best practice relative to its peers will be restricted. At times, firms can also be positively or negatively affected by some external factors which are completely beyond the control of managers or shareholders and a net measure of agency costs must leave out those factors. Moreover, according to the framework of Jensen and Meckling (1976), agency costs incurred by firms can be either zero or positive. Due to their multidimensional nature, it is difficult to measure agency cost in either absolute or relative terms and hence they are largely unquantifiable and the results are inconclusive as well.

Agency costs arising from the conflict of interests between different stakeholders prevent a firm to achieve the best practice relative to its peers. Considering that these best practice peers have minimized agency costs, recent developments consider efficiency measurement as closest to the concept of (inverse) agency cost (Berger and Bonaccorsi di Patti, 2006) which is basically how close an individual firm with similar technologies can reach to its benchmark. This benchmark represents a hypothetical value and the shortfall of the actual firm value from the hypothetical one gives an estimate of the level of inefficiency of the firm. Firms with lower degrees of shortfall, and hence lower inefficiencies, are the more efficient firms. For calculating efficiency in this fashion, stochastic frontier analysis (SFA) is in a number of respects superior to other alternative parametric and non-parametric methods. Several studies have analyzed data with both data envelopment analysis (DEA) and parametric, deterministic frontier estimators and have produced mixed evidence. The main disadvantage of DEA method is that there is no provision for statistical noise or measurement error in the model. Standard statistical tests to find the significance of the variables or hypothesis testing can also not be applied in this non-parametric technique. Under the deterministic frontier specification, random external events or error in the model specification or measurement of the component variables could also translate into increased inefficiency measures. But stochastic frontier is randomly placed by the whole collection of stochastic elements that might enter the model outside the control of the firm. Due to this attractive feature along with the internal consistency and ease of implementation, stochastic frontier is being considered as the standard and most widely accepted econometric technique for efficiency analysis (Bhaumik *et al.*, 2012; Greene, 2008; Kumbhakar *et al.*, 2012).

Therefore, in this paper, we rely on stochastic frontier approach to estimate the corporate efficiency of firms, but from two different perspectives considering that the focus has been shifted from traditional to modern approach in contemporary financial management[1]. The traditional approach focusses on short-term horizon and fulfills objective of earning profit. The modern approach focusses on wealth or value maximization rather than profit maximization which gives a longer term horizon for assessment, making way for sustainable performance by businesses. Giving priority to value creation, managers of modern corporations have now shifted to modern approach of financial management which leads to better and true evaluation of business. Using an unbalanced panel data on 1,122 UK firms listed on the London Stock Exchange during the period 1981-2009, we estimate two different frontiers considering both the approaches to predict firm efficiency following the technique pioneered by Battese and Coelli (1995), which allows to explain the inefficiency in terms of various firm related control factors simultaneously. Efficiency calculated from the market value frontier is termed as long-run efficiency and the one estimated from the profit frontier is called short run considering the different maximizing objectives and thus introduces dynamism in the manager shareholder conflicts or agency cost and facilitates comparison between the two. Our work is distinguished by the large and more complete set of firms that we consider. Our emphasis on the empirical implications of the distinction between short-run and long-run efficiency is also novel. Also, it has been reported in past studies that the corporate governance environment under which the UK companies operate is not disciplined by the market for corporate control (Short and Keasey, 1999; Franks *et al.*, 2001; Koke and Renneboog, 2005) and also the monitoring role of large shareholders, institutional investors and board of directors is limited (Faccio and Lasfer, 2000; Goergen and Renneboog, 2001; Ozkan and Ozkan, 2004). These cause a significant degree of managerial discretion to be present in these firms and for all these reasons, the UK is considered as an excellent choice for agency cost study. Therefore, we find it worthy doing further investigations on agency conflicts among firms in the UK aiming to make important contributions to the existing literatures.

This paper is structured into different sections as follows. Section 2 discusses relevant literature, Section 3 describes the methodology, Section 4 contains model specification, Section 5 introduces data and descriptive statistics, Section 6 presents the empirical results and analysis and finally Section 7 concludes the paper.

2. Literature Review

Tests of the agency costs hypothesis typically are based on regressions of measures of firm performance on the equity capital ratio or other indicators of leverage plus some control variables, but the results are inconclusive due to the difficulty in defining a measure of performance close to the theoretical definition of agency costs. For example, Himmelberg *et al.* (1999) use Tobin's *Q*, Mehran (1995) uses return on asset and Tobin's *Q* as well, Cole and Mehran (1998) use stock market price, Ang *et al.* (2000) use expense ratio and asset utilization ratio, Florackis and Ozkan (2009) use asset turnover ratio and selling, general and administrative expense ratio as proxies for firm performance. The tests using these traditional measures of firm performance based on financial ratios and stock market values may be confounded by factors that are unrelated to agency costs due to the measurement problem mentioned earlier. Also, the empirical strategies used in these studies do not allow calculating the extent of firms' performance shortfall due to agency costs by setting a separate benchmark for each of them. Ang *et al.* (2000) provide an estimate of such shortfall in small corporations where 100 percent manager-owned firms constitute the zero agency cost benchmark and any deviations of expense and efficiency ratios from this benchmark measures the agency cost. But there is no obvious benchmark like that for large firms against which a firm's actual value can be judged as 100 percent manager ownership is quite improbable in large corporations.

In these respects, efficiency measures are considered closer to the theoretical definition of agency costs as they have provision to control for firm-specific factors outside the control of management and to define a standard performance for the firms which they would be expected to achieve under minimum agency costs (Berger and Bonaccorsi di Patti, 2006). They examine the bi-directional relationship between capital structure and firm performance by using a parametric measure of profit efficiency as an indicator of (inverse) agency costs for evaluating US commercial banks' performance from 1990 through 1995. A similar study is conducted by Margaritis and Psillaki (2007) on a sample of 12,240 New Zealand firms to analyze the effect of leverage on firm performance as well as the reverse causality relationship with a two stage estimation procedure. But, they prefer to calculate technical efficiency and their frontier is based on non-parametric DEA. Ho and Zhu (2004) apply a two-stage DEA analysis to evaluate performance of 41 listed banking corporations of Taiwan. Their result shows that better efficiency of a company does not necessarily result in better effectiveness. Sufian (2007) also utilizes DEA to examine the long-term trends in the banking sectors' efficiency in Singapore which is found to exhibit a mean of 88.4 percent over the sample period.

SFA also provides a way to benchmark the relative value of each firm and allows for a distinction between random elements beyond the control of the firm and agency costs. Motivated by the above idea, Aigner *et al.* (1977) and Meeusen and van Den Broeck (1977) pioneered SFA. The literature on stochastic frontier estimation has grown vastly since then and has been widely used in economic studies of productivity and technical efficiency in hospital costs, airport, electric power, commercial fishing, farming, manufacturing of many sorts, public provision of transportation and sewerage services, education, labor markets and a huge array of other settings. An extensive survey of the underlying models, econometric techniques and empirical studies can be found in Kumbhakar and Lovell (2003) and Fried *et al.* (2008). A substantial research effort has also gone into measuring the efficiency of financial institutions, particularly commercial banks.

SFA is applied by Lensink and Meesters (2012) in investigating the impact of institutions on bank efficiency and technology using a data set of 7,959 banks across 136 countries over ten years, by Aysan *et al.* (2011) in investigating the cost and profit efficiencies of Turkish banking sector in the post-crisis era[2] during 2002-2007 using 32 banks and by Manlagñit (2011) in examining the cost efficiency of commercial banks in Philippine. However, the use of SFA in capital market studies is relatively new. SFA is utilized by Hunt-McCool *et al.* (1996) to analyze IPO under-pricing and also by Annaert *et al.* (2003) to judge mutual fund under performance. A new initiative in this field has been taken by Habib and Ljungqvist (2005), Pawlina and Renneboog (2005) and Nguyen and Swanson (2009) who use SFA to compute an estimate of the magnitude of agency costs by comparing a firm's actual Tobin's *Q* with its best performing benchmark *Q*. Using a panel of 1,307 US quoted firms in the S&P Super Composite Index from 1992 to 1997, Habib and Ljungqvist (2005) find that the average firm in their sample attains a value that is 16 percent below its benchmark value and they consider that as a measure of agency cost in US corporations. Simultaneously, they relate the shortfall from the benchmark to measures of managerial incentives, controlling for firm differences in the costs of solving the agency problem. Chung *et al.* (2012) also estimate average inefficiency of 45.5 percent of equity Real Estate Investment Trusts (REIT) with SFA in a similar fashion. Using data of 176 equity REITs from NYSE, AMEX and NASDAQ over the 1998-2005 period, they find that financially distressed firms and firms with higher information asymmetry exhibit greater extents of inefficiency. Institutional investors are found to reduce inefficiency more effectively for these sub-groups which are in line with Habib and Ljungqvist (2005) and Nguyen and Swanson (2009). The same approach is used by Pawlina and Renneboog (2005) on 985 firms listed on the London Stock Exchange from 1992 to 1998 and their finding is that the market value of an average firm could be increased by 18.2 percent (15.4 percent below the benchmark) if all its resources were used efficiently or agency cost can be minimized. They find positive effect of insider and outsider shareholding on inefficiency and their interpretation for this is that, firms subject to managerial entrenchment are on average less efficient and this problem is exacerbated by the presence of outside block shareholders (financial institutions, the government and industrial firms) at high levels of ownership[3]. And finally in the study by Nguyen and Swanson (2009) on 49 industries listed in NYSE, AMEX and NASDAQ from 1980 to 2002, the average efficiency for the entire sample is 70 percent (30 percent below the benchmark).

Besides Pawlina and Renneboog (2005), a few of the UK-based studies with particular interest in the capital market and agency costs can also be recalled here.

In contrast to using market value frontier to measure efficiency, Amess and Girma (2009) use an empirical model to evaluate the effect of efficiency on the market value. They use stochastic frontier production approach to estimate technical efficiency involving revenue, number of employees and fixed assets. Using an unbalanced panel of 706 public limited companies observed over the period 1996-2002, they estimate technical efficiency of 54 percent for the service sector and 51 percent for the manufacturing sector. However, they also use productive efficiency estimated by the DEA technique and labor productivity as alternative measures of firm efficiency and all these three measures are found to have positive effect on the market value of the manufacturing firms only. Amess (2003) finds positive transitory effect of management buyouts (MBOs) on firm level technical efficiency using the stochastic production frontier approach on a panel of UK manufacturing firms as well. Hardwick *et al.* (2011) compute profit efficiency using the SFA to examine the effects of corporate governance mechanisms on the profit efficiency of life insurance firms in the UK. Their results hint that evaluating the effectiveness of an individual governance mechanism on a firm's economic performance is quite problematic.

For this study, we stick to the SFA to measure net efficiency as a firm's relative position to its frontier can be affected by random luck irrespective of manager's effort. The variables exposed to the market volatility are expected to suffer from measurement error problem which is also not likely to have an effect upon the measure of efficiency by construction. We believe that our measures of corporate efficiency from two perspectives can be used as reasonable (inverse) proxies for all the market imperfections-related firm-specific problems, like agency conflict, technical or managerial inefficiencies, financial distress, etc. and their imposed costs on the firms.

3. Methodology

To estimate firm efficiency, a set of firms is considered each of which faces the same opportunity set. Obviously due to diverse firm-specific characteristics such as managerial strengths, technical efficiency and investment choices, different firms tend to avail this opportunity set in different ways and therefore create different firm values. The logic implies that firms with higher valuations are the ones generating more value per unit of assets and consequently, the market perceives them to be the more efficient firms and vice versa. By varying the opportunity set and firm characteristics in a sample of any combination of firms, an optimal value function or their frontier function can be estimated. The intuition behind the SFA is that a point on the frontier represents the maximum value that a given firm can obtain given its fundamentals and no inefficiencies and each firm's shortfall from the frontier is an approximate indicator of the perceived firm inefficiency by the market. The smaller the shortfall from the frontier, the higher will be the efficiency. Before estimating the optimal value or the frontier, three important points must be noted as suggested by Nguyen and Swanson (2009).

First, as the frontier function gives the optimal value achievable by the firms, it is only possible that firms can lie on or below the frontier, but not over it. Second, the benchmark optimal achievable value is hypothetically derived by an econometric estimation over the best performing companies facing a specific opportunity set, but the true optimal value for a particular firm remains unobserved. Third, a firm's shortfall from the optimal achievable value can be either simply due to random luck rather than superior management or foresight and so unrelated to any firm specific reasons.

Therefore, it is important to be able to distinguish between actual inefficiency and the random elements beyond the control of the firm's principals or agents. As explained earlier, determination of an efficiency score based on the technique of SFA can discriminate between both the inefficiency and luck asymmetry and enables us to estimate a measure of net inefficiency. To distinguish between the two, SFA assumes an error term composed of two components. One is a symmetric random component capturing measurement error, random shocks and omitted variables and the other is a non-symmetric component representing systematic shortfall from the frontier or inefficiency. Unfortunately, standard ordinary least squares (OLS) cannot distinguish between these two as the inefficiency component is incorporated into the intercept in OLS and is therefore unidentifiable. In contrast, the non-symmetric inefficiency in SFA appears as skewness in residuals, which can be computed for each firm and ranked accordingly. This is what makes this technique more appealing in the inefficiency or agency cost analysis.

Using conventional panel data notation, Y can be expressed as a function of a $(1 \times k)$ set of explanatory variables X which determines the location of the frontier, and the composite error term. Here Y represents the market value or profit to be maximized in this study:

$$Y_{it} = X_{it}\beta + \varepsilon_{it} \tag{1}$$

And:

$$\varepsilon_{it} = v_{it} - u_{it} \tag{2}$$

Where β is a $(k \times 1)$ vector of unknown coefficients to be estimated, $i = 1, \ldots, N$ firms and $t = 1, \ldots, T$ years. The location of the frontier is allowed to shift by virtue of the time dependence of the X variables. Here, v_{it} is a random variable which is assumed to be independently and identically distributed, $N(0, \sigma^2)$ and allows for estimation errors in locating the frontier itself, thus preventing the frontier from being set by outliers. The error term $u_{it} \geqslant 0$ permits the identification of the frontier, by making possible the distinction between firms that are on the frontier ($u_{it} = 0$) and firms that are strictly below the frontier ($u_{it} > 0$) and magnitude of this variable u_{it} corresponds to the shortfall in a firm's actual valuation from the potential. By assumption, this $u_{it} \geqslant 0$ measures the net inefficiency that the firm incurs as a result of misalignment of the stakeholders' objectives and can be related to factors explaining the inefficiency or agency cost. cov $(v_{it}, u_{it}) = 0$ restricts the stochastic error v_{it} around the frontier to be independent of the firm inefficiencies u_{it}. The main advantage of this econometric approach is that the symmetric random component v_{it} takes account of the effects of factors beyond the control of the managers, any measurement error or omitted variables by taking them away from the estimates of inefficiencies. The parameters of the stochastic frontier and the inefficiency models can either be estimated by using joint maximum likelihood or by a two-step approach, given appropriate distributional assumptions.

The two-stage estimation procedure, in which the first stage involves the specification and estimation of the stochastic frontier function and the prediction of the inefficiency effects, under the assumption that these inefficiency effects are identically distributed. The second stage involves the specification of a regression model for the predicted inefficiency effects, which contradicts the assumption of identically distributed inefficiency effects in the stochastic frontier. This procedure is unlikely to provide estimates which are as efficient as those that could be obtained using a single stage estimation procedure. Kumbhakar *et al.* (1991) and Reifschneider and Stevenson (1991) propose a stochastic frontier model for cross sectional data in which the inefficiency effects (ui) are expressed as an explicit function of a vector of firm specific variables and random error. The parameters of the stochastic frontier and the inefficiency model are estimated simultaneously, given appropriate distributional assumptions. Battese and Coelli (1995) propose a similar model for panel data and according to their model specification, u_{it} is assumed to be obtained by truncation at zero of $N(m_{it}, \sigma 2_u)$:

$$u_{it} = Z_{it}\delta + w_{it} \tag{3}$$

$$m_{it} = Z_{it}\delta \tag{4}$$

where, Z_{it} is a $(1 \times p)$ set of variables which may influence the inefficiency of the firms and w_{it} is obtained by truncation of $N(0, \sigma 2)$ such that the point of truncation is $-Z_{it}\,\delta$, i.e., $w_{it} \geqslant Z_{it}\,\delta$. δ is a $(p \times 1)$ vector of unknown coefficients to be estimated, and w_{it} denotes the unexplained component of u_{it}. Z_{it} may include some input variables in the stochastic frontier, provided the inefficiency effects are stochastic. The u_{it} and their determinants Z_{it} are allowed to vary over time, accommodating changes in a firm's position relative to the frontier over time and this captures the dynamics of the managers and shareholders conflicts. The time variant inefficiency effect is expressed as $u_{it} = \exp\{-\eta(t - Ti)\}ui$, where η is the decay parameter to be estimated and Ti is the last time period in the respective panel.

The Battese and Coelli (1995) model uses the parameterizations of Battese and Corra (1977) where $\sigma^2 = \sigma_u^2 + \sigma_v^2$ and $\gamma = \sigma_u^2/(\sigma_u^2 + \sigma_v^2)$. The method of maximum likelihood is proposed for simultaneous estimation of the parameters of the stochastic frontier and the model for the technical inefficiency effect. The likelihood function of the model is presented in the appendix in the working paper of Battese and Coelli (1993). It is evident from the earlier discussion that, firm i maximizes Y at time t if and only if it is on the frontier or in other words $u_{it} = 0$. If $u_{it} > 0$ for sufficiently many i and t, then SFA specification will lead to a likelihood gain because OLS wrongly restricts $\sigma^2 = 0$. Whether any form of stochastic frontier function is required at all can be checked by testing the significance of the γ parameter, which facilitates a comparison of random variables u_{it} and v_{it} and must lie between 0 and 1. If γ is zero then the variance of the inefficiency term σ^2 is zero which would indicate that the u_{it} term should be removed from the model. On the contrary, as γ approaches one, then the deviations from the frontier are characterized more so by inefficiency or agency costs rather than white noise. A likelihood ratio (LR) test can also be used to check the presence of inefficiency effect or the one sided error which basically corresponds to testing whether the OLS and the SFA functions are identical. LR statistic for this test follows a mixture of χ^2 distributions, critical values of which can be obtained from Table I of Kodde and Palm (1986). The degree of freedom of this statistic equals the number of parameters used to parameterize the distribution of u_{it}. The null hypothesis to be tested is $\gamma = \delta_0 = \delta_1 .... = \delta_k = 0$ and the rejection of the null hypothesis confirms that the inefficiency effects are stochastic and are related to the chosen explanatory variables in the Z_{it} vector.

Firm specific effect (f_i) and the aggregate time effect (τ_t) should also be included in the model. As the measure of u_{it} is based on the composite error term and the

	Mean	SD	Min	Q1	Median	Q3	Max
Market value	11.83	2.230	7.693	10.13	11.59	13.30	17.64
Size	10.92	3.243	4.301	9.448	11.28	12.97	16.74
Age	2.114	0.862	0	1.609	2.303	2.833	3.367
Leverage	0.1043	0.1352	0	0.0003	0.0524	0.1596	0.6539
Capital expenditure	0.0584	0.0610	0	0.0175	0.0405	0.0757	0.3306
Intangible asset	0.1406	0.2120	0	0	0.0131	0.2198	0.8148
Tangibility	0.2900	0.2386	0.0021	0.0873	0.2453	0.4253	0.9220
Dividend	0.0207	0.0240	0	0	0.0157	0.0312	0.1312
Firm risk	0.1354	0.1449	0.0028	0.0469	0.0808	0.1530	0.6598
Profit margin	0.0527	0.2766	−1.520	0.0357	0.1180	0.1813	0.4325
Tobin's Q	2.033	1.864	0.5193	1.072	1.464	2.178	12.69
Asset base	11.35	2.280	6.722	9.681	11.14	12.82	17.07

Table I.
Descriptive statistics

composite error term is in turn influenced by the parameter estimates of the frontier function, failure to include firm and time specific effects in a panel stochastic frontier model is likely to bias the estimate of u_{it} (Kumbhakar, 1991; Kumbhakar and Hjalmarsson, 1995). Because of the truncated error distribution, first difference or mean difference technique cannot be applied to eliminate the effects as differenced truncated normal distributions do not result in a known distribution (Wang, 2003). So, the composite error term in Equation (2) will actually be like the following:

$$\varepsilon_{it} = v_{it} - u_{it} + f_i + \tau_t \tag{5}$$

Once the parameters have been estimated and the location of the frontier is identified, computation of the efficiency score is straightforward. The efficiency score is a normalized measure between 0 and 1. A score of 0.85 means that the firm achieves 85 percent of its best-performing peer's market value or profit given other things constant. If a second firm achieves only 70 percent, then the market will consider the second firm as less efficient or suffering from higher agency cost compared to the first.

4. Model specification

4.1 Market value frontier

Tobin's Q represents the future investment growth opportunity in a firm and a firm which is trying to maximize the Tobin's Q or market value focussing on the modern approach of financial management, can be considered to be optimizing its growth prospect for a sustainable business performance and the market will perceive this firm as efficient considering its long-run growth objective. The efficiency estimated from this perspective can so be termed as long-run efficiency. To construct a theoretical benchmark value for each firm controlling for firm characteristics and opportunity set, a market value frontier can be estimated by the following equation, where the determinants of Q have been chosen based on underlying theory and the results established in prior literature. For example, Himmelberg *et al.* (1999) develop an empirical model where they regress Tobin's Q on a number of explanatory variables associated with the scope for managerial discretion or moral hazard, namely, size, capital intensity, profit margin, R&D intensity, advertising intensity and gross investment rates. We try to control for all these along with a few more variables:

$$\begin{aligned} \text{Tobins } Q_{it} =& \beta_0 + \beta_1\, Size_{it} + \beta_2\, Size^2_{it} + \beta_3\, Leverage_{it} \\ &+ \beta_4\, Capital\ expenditure_{it} + \beta_5\, Intangible\ assets_{it} \\ &+\beta_6\, Tangibility_{it} + \beta_7\, Tangibility^2_{it} + \beta_8\, Dividend_{it} \\ &+ \beta_9\, Firm\ risk_i + \beta_{10}\, Profit\ margin_{it} + v_{it} - u_{it} + f_i + \tau_t \end{aligned} \tag{6}$$

After log transformation, the above equation turns to the following, where market value, size and asset base are in natural logarithm form. The asset base or the log of book value of total assets is a control factor from the log transformation of Tobin's Q. The variables with many zero observations are scaled by total assets instead of log transformation to avoid losing observations following Nguyen and Swanson (2009). Log transformation is commonly used in SFA and is expected to reduce the skewness of the sample. As we have a total of 1,122 firms, so rather than including dummy for each individual firm to capture the firm fixed effect, the frontiers are estimated with sector dummies based on the assumption that firm characteristics will be similar within each of the 33 sectors classified by the FTSE/Dow Jones Industrial Classification Benchmark (ICB) codes. Year dummies are included to capture year specific effects:

$$\begin{aligned} Market\ value_{it} =& \beta_0 + \beta_1\, Size_{it} + \beta_2\, Size^2_{it} + \beta_3\, Leverage_{it} \\ &+ \beta_4\, Capital\ expenditure_{it} + \beta_5\, Intangible\ assets_{it} \\ &+\beta_6\, Tangibility_{it} + \beta_7\, Tangibility^2_{it} + \beta_8\, Dividend_{it} \\ &+ \beta_9\, Firm\ risk_i + \beta_{10}\, Profit\ margin_{it} + \beta_{11}\, Asset\ base_{it} \\ &+ v_{it} - u_{it} + f_i + \tau_t \end{aligned} \tag{7}$$

4.2 Profit frontier

On the other hand, profit efficiency evaluates how well managers raise revenues as well as control costs which settles how close a firm is to earning the profit that a best-practice firm would earn facing the same exogenous conditions. The reason why profit efficiency can be a reasonable (inverse) proxy for the agency cost is that the conflicts between debt holders and shareholders may raise the cost of funding for the firm and may also affect other input or output choices if the resources are misallocated due to aberrant managerial behavior. These may reduce profits relative to a best-practice firm and hence reduce profit efficiency. Efficiency estimated from this short-run profit-maximizing motive, can be termed as short-run efficiency. For the profit efficiency, the Equation (7) above is rearranged as follows:

$$\begin{aligned} Profit\ margin_{it} =& \beta_0 + \beta_1\, Size_{it} + \beta_2\, Size^2_{it} + \beta_3\, Leverage_{it} \\ &+ \beta_4\, Capital\ expenditure_{it} + \beta_5\, Intangible\ assets_{it} \\ &+\beta_6\, Tangibility_{it} + \beta_7\, Tangibility^2_{it} + \beta_8\, Dividend_{it} \\ &+ \beta_9\, Firm\ risk_i + \beta_{10}\, \text{Tobins } Q_{it} + v_{it} - u_{it} + f_i + \tau_t \end{aligned} \tag{8}$$

4.3 Inefficiency

As Battese and Coelli (1995) suggested, the explanatory variables in the inefficiency model may include some input variables in the stochastic frontier, provided the inefficiency effects are stochastic or the null hypothesis of $\gamma = 0$ is rejected. This implies that the inefficiency effects are significant and related to the chosen explanatory variables. As regards to the explanatory variables, Margaritis and Psillaki (2007) assume that leverage, risk, size, growth opportunities, market power and exposure to international trade are likely to influence firm efficiency. Berger and Bonaccorsi di Patti (2006) also use leverage, firm size, variance of earnings as firm risk along with regulatory environment, ownership structure and market concentration as control variables for efficiency. Relating the shortfall from the frontier to some monitoring and incentive variables could better explain the reasons for the failure to maximize value or profit, but we could not manage to collect any proxy for such variables for our sample firms from the chosen database. In this study, the following variables are rather included in the Z vector:

$$u_{it} = \delta_0 + \delta_1 \, Size_{it} + \delta_2 \, Size_{it}^2 + \delta_3 \, Leverage_{it} + \delta_4 \, Firm\,risk_i + \delta_5 \, Age_{it} + \delta_2 \, Age_{it}^2 + \delta_7 \, Year_{it} + w_{it} \quad (9)$$

5. Data

We have collected data from the Worldscope Database currently owned by Thomson Reuters which describes the database as the financial industry's premier resource of most comprehensive and accurate financial data on public companies resided outside of the USA[4]. Worldscope is available through a variety of Thomson Financial software products, including Thomson One products, Datastream and Quantitative Analytics. For this study, the data were collected through Datastream.

We excluded all banks, life and non-life insurance, real estate, general financial, equity and non-equity investment instrument companies according to the FTSE/Dow Jones ICB codes which are adopted by the database as its standard global classification tool as these firms follow different accounting practices. We also dropped all the observations with unexpected signs, like negative revenue, assets or investment. To avoid loss of firm years, we replaced missing values for intangible assets with zero and created a dummy variable for that considering the significant number of missing observations for intangible assets. Other than this, we dropped all the other observations with missing values for the required variables. Then we deleted all the firms with less than three consecutive years of observations for any of the required variables. Some firms operating for relatively longer period still have gaps in their panels, but have multiple three consecutive observations in them. Finally, the dataset we use in our estimations have an unbalanced panel of 1,122 firms from 33 different sectors with a minimum of three to a maximum of 29 consecutive years of observations and a total of 13,183 firm-years. As we allow both entry and exit of firms along the way, our estimations using this unbalanced panel data are expected to be free from any potential selection and survivor bias. All required financial variables are deflated with the GDP deflator and all regression variables are winsored at the 1 and 99 percent level to get rid of the extreme outliers. The latter rule is expected to eliminate observations reflecting very large mergers, extraordinary firm shocks, coding or severe measurement errors and is applied as a common procedure in contemporary finance literatures, e.g. Hovakimian and Titman (2006).

Table I reports means and distributional information for all the regression variables used in this paper. Tobin's Q is calculated as the ratio of market value of assets to the book value of assets. Market value is estimated as book value of total assets minus book value of equity plus market capitalization and book value of total asset is simply value of total assets. Natural logarithm of total sales and natural logarithm of the number of years a firm appears in the database are used as proxies for firm size and firm age, respectively. Leverage is calculated as ratio of long term debt to total assets; capital expenditure as ratio of capital expenditure or additions to fixed assets to total assets; intangible asset as ratio of intangible assets to total assets, tangibility as ratio of total tangible assets to total assets; dividend payout as ratio of total cash dividend paid to total assets; profit margin as ratio of operating profits or earnings before interest, tax and depreciation to total assets. Standard deviation of profit margin is used as a proxy for firm specific risk.

Firm size, mean of which is 10.92 and this gives an impression that average firm size is reasonably big. However, the standard deviation of firm size is 3.243 which hints on the diversity of firm size in the sample. An average firm in the sample has Tobin's Q of 2.033 and the maximum is 12.69. An average firm is highly capital intensive, with median investment in tangible assets is 24.53 percent of total assets, a bit lower than the mean of 29 percent. The leverage of an average firm is 10.43 percent which is almost exactly twice of the median value. The sample contains unlevered firms as well as highly levered firms with a maximum 65.39 percent of leverage. There are firms with a negative profit margin, but mean and median are both positive at 5.27 and 11.80 percent, respectively. The average rate of capital formation is 5.84 percent, the median of which is 4.05 percent. The risk is measured as the standard deviation of the operating profit margin of each of the firms over their respective panel years. This measure of risk is thus working as a static variable with a mean of 13.54 percent. This is driven up by the quartile of largest firms and thus may not be representative of the average firm risk. Intangible investment opportunity of an average firm is 14.06 percent, but again this is not representative of the sample as the 25th percentile has a value of zero and the last percentile has a value of 81.48 percent.

6. Empirical results

6.1 Market value frontier

In case of the market value frontier, the result of which is shown in panel A of Table II, most of the variables have the expected signs. In model 1, we have only controlled for the variables as in Himmelberg *et al.* (1999). Model 2 is our final one where we extend the set of explanatory variables and we explain the results of this model only[5]. The frontiers are estimated with sector and year dummies and also a missing dummy variable for the intangible asset. Market value of the firm changes negatively with firm size but positively with the square firm size with a turning point at 12.39, slightly less than the 75th percentile value. The initial negative relationship up to the turning point may be due to the diminishing returns after controlling for firms' asset base. It should be noted here that, multicollinearity tests between asset base and firm size did not expose any potential problems. The overall U-shaped relationship gives an impression that the market does not react positively to initial growth in sales, but relies on firms with a substantially higher level of sales or with persistently positive growth rate, which is quite logical considering that here the firm is relying on long-run value maximizing motive.

Similarly, tangibility or capital intensity shows a negative effect but square of them have the opposite effect on firm value. The turning point of tangibility is 1.75, which is

	Model 1			Model 2		
	Coeff	SE	*t*-ratio	Coeff	SE	*t*-ratio
A: frontier						
Size	−0.548	0.020	−27.23	−0.570	0.018	−31.83
$Size^2$	0.024	0.001	29.34	0.023	0.001	30.09
Leverage				0.348	0.045	7.789
Capital expenditure	2.375	0.090	26.26	2.273	0.089	25.64
Intangible asset	−0.497	0.029	−17.25	−0.454	0.029	−15.80
Tangibility	−0.930	0.077	−12.07	−1.096	0.074	−14.76
$Tangibility^2$	0.115	0.086	1.331	0.312	0.083	3.746
Dividend				0.065	0.002	32.07
Firm risk				0.710	0.070	10.21
Profit margin	0.201	0.022	9.343	0.096	0.023	4.236
Asset base	0.917	0.007	127.5	0.944	0.007	141.4
Constant	4.389	0.147	29.81	4.294	0.138	31.22
B: inefficiency						
Size	−0.347	0.021	−16.35	−0.380	0.022	−17.17
$Size^2$	−0.003	0.001	−2.614	−0.003	0.001	−2.714
Leverage	−1.539	0.196	−7.847	−0.714	0.193	−3.694
Firm risk	−1.291	0.112	−11.54	0.007	0.166	0.045
Age	−0.019	0.131	−0.147	−0.088	0.132	−0.671
Age^2	0.061	0.027	2.258	0.080	0.025	3.229
Year	0.054	0.006	9.879	0.053	0.006	9.104
Constant	1.886	0.271	6.962	1.873	0.274	6.824

Note: The frontier is estimated with sector and year dummies and also a missing dummy variable for the intangible asset

Table II.
Market value frontier

outside the range of the sample. As described earlier, the average firm in the sample is highly capital intensive and such dependence on fixed assets brings with it higher operating leverage or higher business risk which creates a negative impact among the risk averse investors. Both Habib and Ljungqvist (2005) and Nguyen and Swanson (2009) find such negative effects in their studies. Leverage is positively affecting the firm value because a rise of debt in the capital structure reins the discretionary managerial behavior and managers will be prompt to generate cash flows for servicing the debt to avoid liquidation which will drive up the value of the firm. Capital expenditure, dividend, risk and profit margin all have positive effects on firm value. So, the equity holders assess additions to fixed capital, higher dividend payment, firm risk caused by any of the diverse factors and profit margin as the outcome of firms' success or key to further growth and such prospects boost up the market value of the firm. The impact of intangible investment is negative on firm value and this can be related to the suboptimal and discretionary expenditure on intangibles which the shareholders may feel redundant.

The model also involves the specification of a regression model for the predicted mean inefficiency effects, the result of which is given in panel B of Table II. The predicted inefficiency is changing negatively with firm size and leverage. So, the general conception that larger firms are more efficient remains valid in this case. Larger firms benefit from better corporate governance, possess skilled and proficient workers, have closer tie with the legal and financial institutions, are more diversified and all these lead to better management and higher efficiency. Also the inverse relationship between inefficiency and leverage supports the agency cost of outside equity hypothesis which predicts that higher leverage puts more pressure on managers to maximize value, and thus mitigates agency problems between the shareholders and managers. Inefficiency decreases negatively with firm age initially which is expected, even though it is insignificant before it starts to increase significantly with age. This may be due to the speed of adjustment as very old firms may not be quick enough in reacting to news about future investment opportunities (Tobin's *Q*), possibly due to their different production technologies or because they suffer more from bureaucracy and divisional hierarchies (Gilchrist and Himmelberg, 1995). The level of inefficiency is also found to increase over time.

The value for the γ parameter is reported in Table III, which shows that 73 percent of total error variance is caused by the one sided inefficiency term or deviations from the frontier are characterized more so by inefficiency or agency costs rather than white noise and this is statistically significant as well. The null hypothesis of γ equals zero is rejected and this indicates that the inefficiency effects are stochastic and the SFA specification leads to a likelihood gain. The LR test also supports this by rejecting the null hypothesis that the inefficiency effects are absent and unrelated to the chosen explanatory variables.

The mean efficiency predicted from the second market value frontier model is 74.5 percent which means that an average firm has market value 25.5 percent below its best performing peer or an average firm fails to maximize value due to agency conflict. The statistical and distributional information of the efficiency term is presented in Table IV. Although the mean of the predicted efficiency is almost 10 percentage point lower than that estimated by Pawlina and Renneboog (2005) who considered period 1992-1998 only, our mean predicted efficiency turns to 80 percent over that period.

6.2 Profit frontier

In the second frontier where the dependent variable is operating profit which the firms are expected to maximize, the results presented in panel A of Table V are not quite similar to that of the market value frontier. Keeping similarity with market value

	Model 1			Model 2		
	Coeff	SE	*t*-ratio	Coeff	SE	*t*-ratio
σ^2	0.552	0.012	46.47	0.588	0.014	42.22
γ	0.663	0.011	58.26	0.734	0.010	73.66
No. of firms			1,122			1,122
No. of observations			13,183			13,183
Log likelihood value			−9,592.24			−8,997.12
LR test statistics of the one sided error			1,041.69			1,119.40

Notes: Here, $\sigma^2 = \sigma_u^2 + \sigma_v^2$ and $\gamma = \sigma^2{}_u/(\sigma_u^2 + \sigma_v^2)$. LR test statistics are reported for the likelihood ratio test for the null hypothesis of $\gamma = \delta_0 = \delta_1 .... = \delta_7 = 0$. The degrees of freedom of this test statistic is 9 which has a critical value of 20.97 at the 1 percent level of significance

Table III. Diagnostics for market value frontier

	Mean	SD	Skewness	Min	*Q*1	Median	*Q*3	Max
MVE_{Model1}	0.752	0.193	−2.087	0.007	0.704	0.822	0.877	1
MVE_{Model2}	0.745	0.201	−2.005	0.006	0.696	0.821	0.876	1

Table IV. Market value efficiency

	Model 1 Coeff	Model 1 SE	Model 1 t-ratio	Model 2 Coeff	Model 2 SE	Model 2 t-ratio
A: frontier						
Size	0.027	0.002	13.14	0.025	0.002	11.58
Size^2	−0.001	0.0001	−15.44	−0.001	0.0001	−13.89
Leverage				−0.015	0.007	−2.017
Capital expenditure	0.386	0.021	18.28	0.386	0.017	22.19
Intangible asset	−0.055	0.007	−8.543	−0.043	0.006	−7.196
Tangibility	0.099	0.016	6.083	0.064	0.014	4.485
Tangibility^2	−0.140	0.018	−8.007	−0.087	0.015	−5.666
Dividend				0.015	0.0004	33.50
Firm risk				0.249	0.011	21.93
Tobin's *Q*	0.040	0.001	49.35	0.025	0.001	32.28
Constant	0.001	0.015	0.069	−0.002	0.015	−0.133
B: inefficiency						
Size	0.076	0.004	21.94	0.081	0.004	20.95
Size^2	−0.015	0.0002	−79.38	−0.014	0.0002	−73.73
Leverage	0.387	0.032	12.24	0.275	0.030	9.116
Firm risk	2.544	0.068	37.55	2.759	0.043	64.14
Age	−0.188	0.032	−5.860	−0.234	0.031	−7.570
Age^2	−0.005	0.006	−0.822	0.016	0.006	2.707
Year	0.003	0.001	2.817	0.004	0.001	4.258
Constant	−0.097	0.069	−1.410	−0.219	0.050	−4.363

Note: The frontier is estimated with sector and year dummies and also a missing dummy variable for the intangible asset

Table V.
Profit frontier

frontier, here as well model 1 includes variables suggested by Himmelberg *et al.* (1999) only and model 2 is the extended one. Here, the relationship between profit margin and firm size is inverted U-shaped in contrast with the U-shaped relationship in the market value frontier. Similarly the contrasting inverted U-shaped relationship is present between profit margin and tangibility as well. However, capital expenditure, dividend and risk are still affecting the operating profit positively and so is Tobin's *Q*. Profit margin is found to have the same negative relationship with intangible investment, but the negative relationship between leverage and profit margin is again a disparity.

The operating profit responds positively with firm size and tangibility initially, but the relationship turns the other way after firm size of 12.50 and tangibility of 0.37. Here the managers are perhaps inclined to raise the profit at any cost to create a positive impression among the owner shareholders about their work effort or competence desiring to capture a better compensation package for them. This short-sighted strategy may raise the agents benefit and even inflate the principal's financial position for the time being, but most unlikely be sustainable for the company. This can be the reason behind the inverted U-shaped relationship between profit margin and firm size. Capital intensity and its related operating leverage was adversely affecting the market value earlier, but here initially the negative effect is compensated more by the positives of investment in tangible assets on firm's operation before inverting again. The negative relation of intangible investment opportunity and leverage with profit margin is again perhaps due to the agent's short-sighted growth motive due to which they might not feel the urge to reduce sub-optimal investments, take excess leverage and pay higher repayment for that and these push the profit down.

Turning to the regression on inefficiency presented in panel B of Table V, profit inefficiency is found to be negatively related to firm size and increasing over time, similar to that of market value inefficiency. However, the results differ in case of leverage. Even though the positive effect of leverage on profit inefficiency contradicts with the earlier findings, but it is in line with the managerial short-run growth perspective. Excess leverage brings with it the risk of bankruptcy and financial distress. These may prompt the limited liability shareholders or their managers to engage in deleterious activities and thus raise the agency cost of outside debt. Profit inefficiency remains negatively related with age throughout the whole sample.

Table VI reports the diagnostics test according to which the null hypothesis of $\gamma = 0$ and inefficiency effect is absent are rejected in this case as well. The estimate for the variance parameter, γ, is close to one (0.990), which indicates that the inefficiency effects are likely to be highly significant in this analysis as well and are clearly stochastic. Also they are significantly related to the chosen explanatory variables as suggested by the LR test. In this case, the predicted mean efficiency is 86.6 percent, detail information of which is given in Table VII.

Figure 1 shows the kernel density graphs of the predicted market value and profit efficiencies. The results suggest that long run or market value efficiency is consistently (in 11,537 out of the 13,183 firm years or 87.5 percent cases) smaller than the short run or profit efficiency. From the firm owner's perspective, profit maximization should not be the only objective; it should be coupled with capturing more market share, maintaining a stable earnings growth, insulating from financial crunch, diversifying operation, etc. So, even though profit maximization facilitates wealth creation, but when the managers give priority to value creation by shifting their focus to an array of objectives, it may not be possible for them to maintain a stable and high level of operational or managerial effectiveness, which might otherwise be possible and hence overall efficiency may fall down at the expense of longer term broader outlook.

Spearman correlation between the two predicted efficiency is also calculated and the null hypothesis that the two are independent is rejected and the correlation coefficient

	Model 1			Model 2		
	Coeff	SE	*t*-ratio	Coeff	SE	*t*-ratio
σ^2	0.196	0.005	39.90	0.167	0.003	58.52
γ	0.988	0.001	2,064.80	0.990	0.0004	2,726.99
No. of firms			1,122			1,122
No. of observations			13,183			13,183
Log likelihood value			9,540.31			10,512.23
LR test statistics of the one sided error			17,747.24			16,642.35

Notes: Here, $\sigma^2 = \sigma_u^2 + \sigma_v^2$ and $\gamma = \sigma^2{}_u/(\sigma_u^2 + \sigma_v^2)$. LR test statistics are reported for the likelihood ratio test for the null hypothesis of $\gamma = \delta_0 = \delta_1.... = \delta_7 = 0$. The degrees of freedom of this test statistic is 9 which has a critical value of 20.97 at the 1 percent level of significance

Table VI.
Diagnostics for profit frontier

	Mean	SD	Skewness	Min	*Q*1	Median	*Q*3	Max
PE_{Model1}	0.863	0.162	−2.438	0.099	0.853	0.928	0.955	1
PE_{Model2}	0.866	0.163	−2.426	0.099	0.853	0.933	0.960	1

Table VII.
Profit efficiency

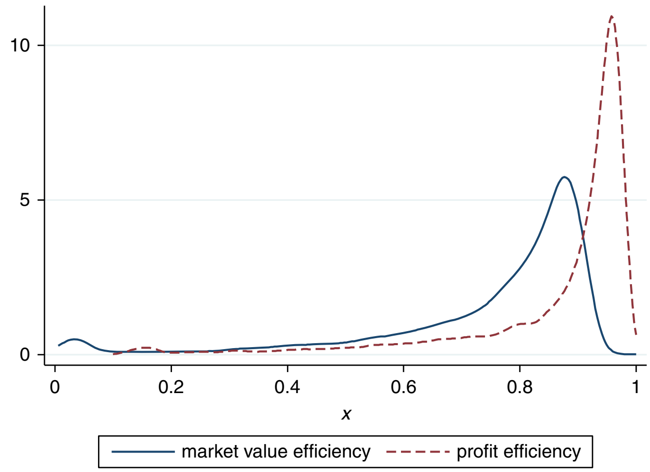

Figure 1.
Kernel density of profit and market value efficiency

between the two is found to be 0.5108. Even though maximizing accounting profit and maximizing shareholder value are not identical, this positive correlation hints that an average firm in the UK may always suffer from inherent inefficiencies or agency conflict to a certain extent, no matter whether the firm managers are driven by short-run or long-run growth perspective. This is in line with early suggestions that the corporate governance structure of the UK firms is generally poor and the UK financial system is not strong enough to monitor and control their discretionary power.

7. Conclusion

Although agency-theoretic models are usually formulated in terms of value rather than profit maximization, in this study both of the methods have been utilized considering that shortfall of firms' actual value from their potential due to agency costs can be proportional to the similar shortfall in their accounting profits or the other way round. Estimations of the two stochastic frontier models give quite interesting results and are in line with the theories and previous studies on agency cost as well. In this study, employing Battese and Coelli (1995) model, long-run corporate efficiency is predicted from the modern approach focussing on wealth or value maximization and the short-run corporate efficiency is predicted from the traditional approach focussing on earning maximum profit as inverse proxies of total agency cost to bring in the dynamics of the principal agent conflict.

The results of this paper have wider implications in the wake of heighten importance given on corporate governance issues after the 2007-2009 financial crisis (Ahrens *et al.*, 2011; Adams, 2012; Erkens *et al.*, 2012). Considering the relatively free and market-based governance and financial system in the UK, the governance issues have become more significant because of the agency costs. Our predictions indicate that an average firm in the UK suffers from performance shortfall due to inefficiency or agency conflicts, no matter which approach is adopted. However, these two different perspectives have important bearing on how the predicted efficiencies evolve. The short-run efficiency supports the agency cost of outside debt and the long-run efficiency supports the agency cost of outside equity hypothesis. Also, the long-run efficiency is found to be consistently lower than the short-run efficiency which may be considered as the cost of focussing on an array of objectives rather than on maximizing profit only.

Contrary to such costs, these longer term broader objectives can potentially ensure a healthy and sustainable firm performance. This is why managers of modern corporations are expected to follow this modern value maximization approach of financial management, which can lead to better and more accurate evaluation of business. We are also aware of some possible limitations of the empirical results we have presented in this paper. In the stochastic frontier model, relating the shortfall from the frontier to monitoring and incentive variables could explain the reasons for the failure to maximize value or profit. Even though, our explanatory variables for the inefficiency equation give reasonable explanations for the shortfall, a different set of variables like ownership and corporate governance structure could provide further insight about our measured corporate efficiency. But, unfortunately we could not get data for ownership structure for our sample firms and capital and product market regulatory factors from the chosen database. This can be a good avenue for future research.

Notes

1. For the purpose of brevity and consistency, we define inefficiencies as the agency costs due to conflicts between shareholders and managers or the agency costs due to conflicts between debt holders and shareholders; define corporate efficiency as an inverse proxy of these inefficiencies and we use these two words interchangeably in this paper.
2. November 2000 and February 2001 crises adversely affected Turkish economy and particularly Turkish banking sector.
3. Estimated coefficients of both these variables in their inefficiency equation are hardly significant, but the LR test indicates that they are overall significant in explaining the inefficiency effect.
4. The data definitions and other information about the contents of the Worldscope database are contained in http://extranet.datastream.com/Data/Worldscope/index.htm
5. Maximum-likelihood estimates of the parameters of the model are obtained using the computer program Frontier 4.1 written by Tim Coelli to provide maximum likelihood estimates of the parameters of a number of stochastic production and cost functions.

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