RESEARCH ARTICLE

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Business and Economics Journal, Vol. 2012: BEJ-61

Ownership, Governance and Enterprise Efficiency: Evidence from Ghana

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Accepted: June 28, 2012; Published: July 21, 2012

Abstract
This study estimates the efficiency levels of firms in the manufacturing sector of Ghana using a single-stage stochastic frontier technique. A five-year panel data of 135 observations made between 2005 and 2009 are considered. The results show that the frontier model instead of the traditional average response (OLS) function is an adequate representation for the data. Findings reveal that employment, capital, corporate governance, ownership, and years of firm operation/experience have reasserting influence on the productivity of the firms. However, research and development and time which are used as a proxy for technological progress are found to have negative influence on the firm's output. The combined effects of factors involved in the technical inefficiency model are responsible in explaining the level and variations in the production of the firms in Ghana, although individual effects of some variables are not significant. Over all, private firms fared better. However, the predicted mean technical efficiency is estimated to be 38 percent. This finding indicates that there is high potential for increasing firm's output by an average of 62 percent in the short-run without any additional resource by adopting the practices of the best firm.

Keywords: Ownership; governance; enterprise efficiency; stochastic frontier; Ghana.

1. Introduction

In recent years, critics argue that most enterprises in Ghana operate no more efficiently than they had a decade ago despite years of structural adjustment policies, privatization, and sub vented agencies reforms intended to facilitate the country's transition to a fully matured market economy a decade ago [1]. Consequently, workers and the public contend that recent macro gains and success of the economy had not reflected at the market level, i.e., in enterprise performance and productivity. This is because enterprise efficiency has not recorded much change since the structural adjustment era with some enterprises even recording negative value added (input–output ratios). Blames for this situation are attributed to the government for not being bold enough to institute policies such as tax reforms, and market restructuring that affect the operations of industries [1, 2]. According to manufacturing literature in Ghana, the situation is particularly precarious at the supply side where privatized enterprises continue to shut down, lie idle and others threaten to relocate to other Economic Community of West African States (ECOWAS) countries because of low profitability and limited market, stemming from the of lack of support, resources, and unfavorable government policies.

A look at the State-Owned Enterprise (SOE) level is even more alarming. Despite having gone through a process of corporatization, whereby SOEs are legally transformed into joint-stock companies and limited liability companies, a sizable number of firms operate at a loss. In Ghana, corporatization, in many cases, had effectively increased management transparency and had strengthened enterprise oversight by the establishment of regulatory oversight commissions, and boards of directors for most SOEs all aimed at making the enterprises efficient [3]. Corporate control has become vested largely in management and board of directors, thereby increasing incentives for managers to position their companies to become more efficient and competitive. However, statistics available show that the changes in the structure of enterprise have not helped so much since enterprise productivity and output remained largely unchanged or, in some cases, had worsened [3].

Recent data from State Enterprises Commission (SEC) however show that productivity of enterprise correlates positively with good governance. As such, through its Performance Monitoring and Evaluation System (PME), SEC is now encouraging firms to adopt good governance practices. SEC [3] notes that improving governance within the enterprise sector requires fundamental transformation of incentives and attitude

among policy makers and stakeholders, as well as basic changes in the relationship between owners and enterprises.

Governance structures refer to type of ownership, management style and the depth of its corporate governance. Corporate governance is the 'level of self-regulation' in enterprises. Over the years, corporations are mandated to adopt practices aimed at improving the self-regulation of their enterprises. These systems and structures are critical to the functioning of modern private corporations and SOEs. The key elements of these systems and procedures include board structures, board operations, standards and specifications, reports of shareholders meetings and audited financial reports [4].

Another important governance structure addressed by recent reports is the correlation of ownership structure and productivity of enterprises. According to SEC, enterprises with lesser degree of government ownership performed better compared with enterprises with larger government ownership. In Ghana, ownership structure of enterprises are defined on a continuous scale ranging from 0% to 100%, where an enterprise starts as government owned, move to lease or contract, then to joint venture and eventually to outright sale or private.

The ownership concept, which describes the power of owners, was spearheaded by Hayek and Friedman in the late 1950s to bolster their arguments for private ownership. The concept stipulates that SOEs (public owned) are inherently less efficient than private firms [5] and that the inefficiency of SOEs, according to the authors, stems from two major factors: incentive and monitoring system and constraint optimization. First, the internal incentive and monitoring system of public enterprises are inferior to the one in private enterprises. Therefore, management is less interested in the efficient business practices of public enterprises, since most managers are politicians, who have their constituents far removed from the day-to-day activities of public enterprises. Second, public enterprises are not always subject to the market and sometimes pursue objectives other than profit maximization. Therefore, changes in the value of public assets, brought by decision-makers are dispersed throughout the community [6, 7].

The objective of this paper therefore is to addresses the question of whether technical efficiency differs under different ownership structures and to test for a causal link between ownership type and enterprise efficiency as per Galal *et al.* [8] who hypothesized that small public enterprises facing competitive output markets can do no better than private enterprises in the same circumstances, but can do considerably worse. This study will contribute to literature by considering the technical efficiency of SOEs and private firms in Ghana under their current governance structures. The remainder of this paper is organized as follows. Section 3 presents a theoretical discussion on stochastic production frontier analysis and enterprise efficiency. In section 3, data and model specification in the paper are discussed. Section 4 presents the estimated results and conclusions. Policy implications of the study follow in section 5.

2. Public-Private Efficiency Debate

Several studies and writings have followed since Hayek and Friedman and synthesizing empirical literature on the public–private efficiency debate, two sets of conclusions clearly emerge. The first finds private enterprises superior while the second draws a different conclusion (ambiguity or no difference). The first case shows that state enterprises and mixed enterprises are less profitable and efficient than private corporations and that privatization improves efficiency [9]. The second body of literature draws rather different conclusion: that no differences in efficiency exist between SOEs and private firms [10].

Other writers conclude with discerning results. Regarding firms productivity and efficiency, most of the empirical studies analyzed find that most firms do better and all firms at least do better after privatization in terms of productivity and efficiency [10-18].

As a result of the difficulty in apportioning blame for the dismal performance of public enterprises at the empirical level (whether ownership or size is the problem), a review of theoretical literature draw similar conclusions [8]. In reconciling the two set of conclusions, Galal *et al.* [8] made a subjective synthesis of the theoretical literature and came out with the following conclusion about the effects of private–public differences:

- Small private enterprises facing competitive output markets are unequivocally superior to large public enterprises facing monopoly markets.
- Small public enterprises facing competitive outputs markets can do no better than private enterprises in the same circumstances, but can do considerable worse.
- In large monopoly markets the predictions of theory are ambiguous, depending on the institutional details assumed (how the private sector is structured and regulated, and how the public sector is managed and motivated).

According to the authors, the first statement is clearly irrelevant for the policy purposes as it does not reflect a true choice [8]. The second proposition justifies mass privatization programs in social economies and the privatization drive in other developing countries where the public sector is overstretched.

In general, privatization has become highly controversial and politically charged, first, there are those who claim that privatization do not produce financial and operational benefits, or at least not enough to offset the social dislocation it causes. Second, there is an acute and pervasive fear that privatization leads to layoffs, first in the short-term when the firm divests, and then in the long-run in the economy at large. Third, there is a widespread belief that even if privatization enhances efficiency, the bulk of its benefits accrue to a privileged few – shareholders, managers, domestic or foreign business interest, and those connected to the political elite – while the costs are borne by the many, particularly consumers and workers [19, 20].

As Ghana moves to develop its infrastructure and industry through public–private partnership (PPP) initiatives, it is best to analyze some of the crucial issues that impact on the effectiveness and efficiency of enterprises. The urgency of this discussion comes on the heels of the contesting performances of several PPP initiatives undertaken by Ghana in recent years. The management issue of Aqua Vetens Rand Ltd., of the Ghana Water Company is major issue in Ghana. After years of private management of the sector by a private management firm, the overwhelming conclusion as per the performance of the sector is abysmal. Evidence has shown that the private management firm did not perform better than the original public servants in-charge of the management of the urban water supply of the country. In terms of improvement in services and the overall efficiency in the urban water supply system, data show that they performed below average [21]. Other examples of PPPs initiatives where the share of management is between private management firms and public servants in the country are returning inconclusive and controversial results [22]. These examples bring to the fore the importance of endogenous and exogenous factors that are crucial to enterprise productivity and efficiency. For instance, studies on the separation of the position of the chief executive and chairman of the board of directors on the performance of firms are inconclusive. Studies from both developed and developing countries are ambiguous regarding the Chief Executive Officer's duality role on the performance of enterprises [23-25].

Studies have also shown that government policy in the market place plays a crucial role in enterprise performance. Government policies that boost the growth potential of an economy, such as more flexible labor markets and other productivity-enhancing reforms such as tax rebates and proper business rules and regulations aid enterprise productivity. In addition to the above, research has shown that a business-friendly environment [26], skilled human capital and financial development [27], infrastructure development, and corrupt government officials resulting in undue advantages to certain enterprises [28] are all factor that affect productivity and efficiency of firms.

This paper therefore looks at the second proposition of Galal *et al.* [8] within the constraint of governance, degree of ownership and efficiency in Ghana and test the hypothesis:

> *'Small public enterprises facing competitive outputs markets can do no better than private enterprises in the same circumstances, but can do considerable worse'.*

The debate on the efficiency of SOEs versus private firms continues to generate great interest in Ghana as a result of good performance of recently privatized enterprises. Some privatized firms have performed creditably well over the past decade compared with corporate SOEs. A critical assessment of the SOE sector in Ghana, however, shows that most enterprises are producing far below their expected capacity. In contrast, new data emerging from the private sector portray a sector performing quite well. Nevertheless, companies listed on the Ghanaian Stock Exchange (GSE) have posted mixed performance over the years with most of them below value. These mixed results, have added to the political atmosphere that does not support further privatization in Ghana. The pendulum is gradually shifting to re-regulation or at worse retaining the status quo. Recent development in the world economy and its reverberations in Ghana regarding transparency, productivity, and efficiency of private enterprises have brought the issue of government re-regulating the private sector in the fore-front of policy debate in Ghana.

2.1. The conceptual definition of Small and Medium Enterprise (SME) sector in Ghana

The definition of small enterprise in Ghana is very ambiguous. There are huge variations as which enterprise is small in Ghana [29]. In certain literature, SME in Ghana is defined according to size, number of employees, annual turnover, and ownership of business and value of fixed assets [29]. Other authors also use the British Department of Trade and Industry (DTI) definition that describes a small firm as an independent business,

managed by owners and co-owners and having a small market share. This definition was the result of the Committee work in 1971 that studied the economic and market participation of various enterprises [30].

In Ghana, SMEs form a large part of businesses in both the formal and the informal sector but unlike their developed country counterparts, there is no accurate information on their contribution to GDP and national employment. The Ghana Statistical Service (GSS), for instance, considers firms with less than 10 employees as Small Scale Enterprises and their counterparts with more than 10 employees as Medium and Large-Sized Enterprises.

The characteristics of SMEs in Ghana are such that in certain literature, enterprises' employment cutoff point of 30 employees is used to indicate a Small-Scale Enterprises. A further disaggregation is sometimes done by categorizing enterprises into three categories: (i) micro-employing less than 6 people; (ii) very small, those employing 6–9 people; (iii) small – between 10 and 29 employees (see Osei *et al.* [31]).

Kayanula and Quartey [32], in their study, sub-divided SMEs into `organized' and `unorganized' enterprises. The organized ones tend to have paid employees with a registered office whereas the unorganized category is mainly made up of artisans who work in open spaces, temporary wooden structures, or at home and employ little or in some cases no salaried workers. They rely mostly on family members or apprentices. Rural enterprises are largely made up of family groups, individual artisans, women engaged in food production from local crops. The major activities within this sector include – soap and detergents, fabrics, clothing and tailoring, textile and leather, village blacksmiths, tinsmiths, ceramics, timber and mining, bricks and cement, beverages, food processing, bakeries, wood furniture, electronic assembly, agro processing, chemical-based products and mechanics [31, 33, 34].

In Africa, a continent-wide definition for small enterprise is one with permanent employees not exceeding 200. Adopting this definition for our small enterprises renders Galal *et al*. [8] assertion for the privatization drive in developing countries invalid. In Ghana, most of the privatized enterprises have employees exceeding 200. This study therefore adopts the widely accepted definition of Small Enterprise in the privatization literature as one with permanent employees not exceeding 5,000 and a Medium Enterprise as one with permanent employees not exceeding 10,000. Enterprises with permanent staff over 10,000 are considered large and significant enterprises [4]. In addition, the market share of each selected enterprise/firm is within 5% to 10% of total market thus qualifying them to be small enterprises in terms of contribution to national income.

Going back to the operational definition, there are several SMEs in Ghana both in the private and public sector competing in the open market in terms of sales/output, value added, employees, capital and management efficiency. There are enterprises described as limited liability companies but 100% owned by government and others a combination of public–private partnership arrangements. The paper looks at the Ghanaian business environment to capture enterprises from both spectrums: public and private.

3. Stochastic Production Frontier Analysis and Enterprise Efficiency

Literature on production frontier analysis shows that production possibility frontiers are estimated through either Data Envelopment Analysis (DEA) or Stochastic Frontier Analysis (SFA) [35]. The former is a non-parametric method with its inability to allow for stochastic shocks to the frontier as its main weakness. In SOE management where political interference constitutes a lot of noise in the management environment, such a method presents several challenges. The latter, SFA, as argued, is designed to incorporate stochastic disturbances if strong parametric specifications are implemented.

Efficiency studies in developed countries have documented the important effect of economies of scale. In the developing economies, studies have demonstrated the effects of firm size and age on technical efficiency [35] and a study by Chirwa [36] evaluated the impact of privatization on the technical efficiency of six privatized enterprises, three SOEs and six private enterprises competing in three oligopolistic manufacturing industries in which privatization took place between 1984 and 1991. Using panel data between 1970 and 1997 from the Malawian economy, it is found that evidence of privatization increasing the technical efficiency of all firms. Specifically, the efficiency of privatized enterprises, firm effect, was significant.

The present paper uses the SFA and follows the methodology used by Van der Vlist *et al.* [37] that employs a model based on Coelli [38] in which they assume a Cobb-Douglas technology, with (natural logarithms) output y_{it} and inputs X_{it} (a K-vector). The stochastic frontier model for panel data is specified as a linear function of output and inputs as:

$$Y_{it} = X_{it}\beta + v_{it} - u_{it} \; i = 1, 2, ..., N; t = 1, 2, ..., T \qquad (1)$$

v_{it} ~ *iid N* (0, σ_v^2),

where β is the unknown K-vector of production elasticity, assumed common to all producers. The model considers N firms indexed by $i = 1,2,...,N$ that are observed over T periods, with periods indexed by $t = 1,2,...,T.$ Each firm produces a single output using K inputs represented by the production frontier, $Y_{it} = f(X_{it};\beta)$. Firms are not necessarily efficient suggesting deviations from the production frontier [37].

The model allows for incorporation of variables considered exogenous to the technical production process, including ownership structures and management style, but nevertheless, affects technical efficiency [39, 40].

The variables v_{it} and u_{it} are error terms with the following properties. As shown in equation (1), the random shocks v_{it} are *iid N* (0, σ_u^2) and independent of the terms u_{it} . The u_{it} 's are non-negative random variables reflecting firm-specific and time-specific deviations from the frontier, associated with technical inefficiency of production. It is assumed that the u_{it} 's are independently distributed $N(Z_{it}\delta, \sigma_u{}^2)$. That is, the technical inefficiency effect u_{it} in equation (1) is specified as

$$u_{it} = Z_{it}\delta + \varepsilon_{it} \qquad (2)$$

where Z_{it} is an M -vector of firm-specific time-varying variables exogenous to the production process, δ is an unknown M -vector. The error term ε_{it} ~ N(0, σ_ε^2) is truncated from below by the variable truncation point $-Z_{it}\delta$. We define technical efficiency of producer i as:

$$TE_{it} = \exp\{-v_{it}\} = \exp\{-Z_{it}\delta - \varepsilon_{it}\} \qquad (3)$$

Therefore, the smaller u_{it} the closer the firm is to its production frontier. According to Van der Vlist *et al.* [37], such model serves two purposes: it gives us consistent parameter estimates and sheds light on policy changes affecting firm's output. For example, the model enables us to separate the effects of production variables on the production frontier from the effects of these variables on technical efficiency, and thereby ensuring that the parameter estimates are consistent. This is done by including in the Z variables; those production variables that enter the production frontier which we think may also affect technical efficiency. In addition, the model also enables us to see whether regulatory changes, such as mandatory internal audit functions in all private and public enterprises, have implications on technical efficiency of firms [37].

This framework is applied to private firms and firms under the Performance Monitoring and Evaluation System of SEC (PMES). Among the explanatory Z variables of the technical efficiency model (2) are indicators of corporate governance, managerial and enterprise characteristics of production such as value added.

Suppose that the coefficient corresponding to corporate governance (say δ_1) is negative and statistically significant, then increased corporate governance decreases the expected value of u_{it} and therefore brings the firm closer to its production frontier. This would then lead to a rejection of the null hypothesis of corporate governance having no effect on technical inefficiency in favour of the alternative hypothesis that corporate governance improves technical efficiency.

4. Data, Variables and Model Specification

Data and right variables pose a challenge in public-private efficiency debate. First, difficulty exists of like to like enterprises to compare. Second, the choice of variables that will be fair to both private and public enterprises because of constraints and objective differences are important [8]. Bearing this in mind, the data for this analysis are drawn from companies listed on the Ghana Stock Exchange and enterprises under the performance monitoring and evaluation of state enterprises system (PME) in Ghana for the period 2000–2006.

The sample of companies covers the manufacturing, utility, and service sectors of the economy. The combined cross-sectional time series data involving these enterprises constitute the panel data for this study.

The problems of correct variables to compare private and public enterprises have been discussed thoroughly in the public-private efficiency literature. Issues of performance, public profits not equal to private profits; productivity differences due to differences in constraints and objectives; differences in enterprise size; and enterprise efficiency as a result of differences in market conditions have all been discussed [4, 8, 13, 16]. This study adopts similar comparable variables used by Hu *et al.* [41] in their study, competition, ownership, corporate governance and enterprise performance in China. The variables used in the study are based on the variables used by the PME system in Ghana. These are production (input), performance (output) and dynamic (competition and governance variables) (see Table 1).

Table 1: Description of variables and their measurements.

Category	Variable	Unit
Production	Capital Labour Management Education	GH¢ Number Years
Performance	Value Added	GH¢
Corporate Governance Degree of ownership	Corporate Plan/Market Plan Public-Private	Index (1–4) (1–100)%
Level of Research and Development Years of firm operation	Research and Development Experience	Index (1–4) Years

Under production, the inputs are capital and labor and the level of education of management. Capital is measured by changes in stated capital of the enterprise and labor, and the number of employees. Performance is measured by value added. This variable considers output and intermediate inputs (value of output less cost of material and industrial services). In addition, we consider financial performance in two ways: *operating surplus to sales in current prices*, which measures the returns to all investors, owners and creditors; and *before-tax profits in current prices,* which measure both private and public profits. To allow for the incorporation of dynamic effects on output and efficiency, certain corporate governance variables are introduced. These are: corporate planning; size and membership of board of governors, standards and specifications, marketing plan, audited account and training programs. We distinguish four levels of effectiveness of this variable. We assigned the value of 4 to a firm if the entire items representing corporate governance are present. The value of 3 is assigned when a significant number of items (4) are present, 2 when about three items are present and 1 for a couple of the items. Research and development, another dynamic variable is also introduced such that the value of 4 is assigned to a firm when the level of research and development is very intense. The value of 3 is assigned when the level of research and development is intense. The value of 2 is assigned when the level of research and development is moderately intense and 1 is assigned when research and development is less intense. This categorization is consistent with Asiedu and Folmer [4]. Ownership, which measures the degree of privatization (1–100)%, is specified in the frontier model. At least all the sampled firm enjoyed some degree of privatization. Experience is measured in years of operation. Time is included in the production frontier to account for technical changes over the years.

4.1. Model specification

The stochastic frontier production function of first-order flexible Cobb-Douglas form is considered for this study. This functional form is widely used in frontier production studies [42, 43]. In this study, the Cobb-Douglas model (4) below is modified to include firm-specific factors.

$$LnVAD_{it} = \beta_0 + \beta_1 LnLABOUR_{it} + \beta_2 LnCAPITAL_{it} + \beta_3 LnCOPGOV_{it} + \beta_4 LnREDEV_{it} + \beta_5 LnOWNHOLD_{it} + \beta_6 LnEXPERIENCE_{it} + \beta_7 Time_{it} + v_{it} - u_{it}, \quad (4)$$

and the technical efficiency effects model as:

$$u_{it} = \delta_0 + \delta_1 COPGOV_{it} + \delta_2 REDEV_{it} + \delta_3 EdUMG_{it} + \delta_4 OWNHOLD_{it} + \delta_5 EXPERIENCE_{it} + \delta_6 TREND_{it} + \varepsilon_{it}, \quad (5)$$

The stochastic frontier production function (4) is specified in terms of production inputs and firm-specific factors: LABOUR, CAPITAL, COPGOV (Cooperate governance), REDEV (Research and Development), OWNHOLD (Owner holding), EXPERIENCE, TREND. The inefficiency model (5) is specified in terms of corporate governance, research & development, and education of management. Years of firm operations is included to account for experience of the firm. The variable TREND captures variation in inefficiency over time.

The maximum likelihood estimates of $\theta := (\beta, \gamma, \sigma_w, \sigma_v)$ are obtained by estimating equations (4) and (5) simultaneously using FRONTIER 4.1 software [77].

5. Results and Discussion

Discussion of the estimated parameters are based on a number of hypotheses tested to examine the adequacy of the specified models, presence of inefficiency and relevance of variables in explaining inefficiency (Table 2). Generalized likelihood ratio test which specifies that both the test for the absence of inefficiency effects and that inefficiency effects are not stochastic in the first and second null hypotheses, respectively are strongly rejected as confirmed by the high value of $\gamma = 0.90$ which is statistically different from zero. Hence, the traditional average response (OLS) function is not an adequate representation for the data.

Table 2: Hypotheses tests for model specification and statistical assumption.

Null hypothesis	Log-likelihood value	Test statistics (λ)	Critical value $\left(\lambda^2_{0.001}\right)$	Decision
1. $H_0 : \gamma = \delta_0 = \delta_1 = ... = \delta_6 = 0$	-	81.70[a]	25.37	Reject H_0
2. $H_0 : \gamma = 0$	-340.69	43.67[a]	9.50	Reject H_0
3. $H_0 : \delta_0 = \delta_1 = \delta_2 = ... = \delta_6 = 0$	-323.89	48.90	27.88	Reject H_0
4. $H_0 : \delta_1 = \delta_2 = ... = \delta_6 = 0$	-321.99	45.10	26.13	Reject H_0

[a]Values of test of one-sided error from the FRONTIER 4.1 output. The correct critical value for the hypotheses involving γ are obtained from Table 1 of Kodde and Palm (1986, p. 1246 [45]).

The third hypothesis that the intercept and the coefficients associated with the explanatory variables in the technical inefficiency model are zero (that the technical inefficiency effects have a traditional half-normal distribution with mean zero) is strongly rejected. Further, the fourth hypothesis which states that all coefficients, except the constant term of the inefficiency model are zero (hence the technical inefficiency effects have the same truncated-normal distribution with mean equal to δ_0) is also rejected. This reveals that the combined effects of factors involved in the technical inefficiency model are important in explaining the variation in the activities of the enterprises in Ghana, although individual effects of some variables may not be significant.

5.1. The frontier estimates

The parameter estimates of the stochastic production frontier model (1) are presented in Table 3. All the variables considered are significant except Years of experience of the firms. The coefficient of LABOUR CAPITAL, COPGOV (Corporate Governance), and OWNHOLD (Ownership) are positive meaning they have reasserting influence on the productivity of the enterprises in Ghana.

However, research and development (REDEV) and TREND which are used as a proxy for technological progress are found to have negative influence on the firm's output. These findings may indicate that the type of research and development programs adopted by firms in Ghana may not be relevant to increase productivity in the industry. This is also confirmed by the finding that there is no technological progress in the operations of the firms between 2005 and 2009. The estimated coefficient of TREND in the frontier model as 0.14 (0.04) means that since 2005, the output of firms decrease by 14% every year. Acquisition of innovative technology must be purpose driven and user friendly to achieve the target goal. Capital is interestingly found to have the highest elasticity of 0.62, indicating that a 1% increase of capital will increase production of the firms by 0.62%. This finding may indicate the over-reliance on the use of capital asset to achieve set goals instead of innovative ideas through research and development programs.

Table 3: Estimates for the stochastic frontier model.

Variables	Parameters	Coefficients	Standard error
Constant	β_0	0.18***	0.01
LnLABOUR	β_1	0.17**	0.11
LnCAPITAL	β_2	0.62***	0.06
LnCOPGOV	β_3	0.13**	0.06
LnREDEV	β_4	-0.26***	0.02
LnOWNHOLD	β_5	0.22***	0.07
LnEXPERIENCE	β_6	-0.39	0.55
TREND	β_7	-0.14***	0.04
Gamma	γ	0.90***	0.03
VAR(u)/VAR(total)	σ_u^2/σ^2	0.77	
log-likelihood	L	-299.84	

*, **, *** Statistically significant at levels of 0.10, 0.05, and 0.01, respectively.

The values of VAR (u)/VAR (total) estimated to be 0.941 and gamma $(\gamma = 90\%)$ mean that variance in the inefficiency error term is greater than variance in the stochastic error term. These results reveal that the one-sided inefficiency random component dominates the measurement error and other random disturbances.

5.2. Technical efficiency

The estimated technical efficiencies for firms in the study area are depicted in Figure 1 and follow a positively skewed distribution. It ranges between 10% and 77%.

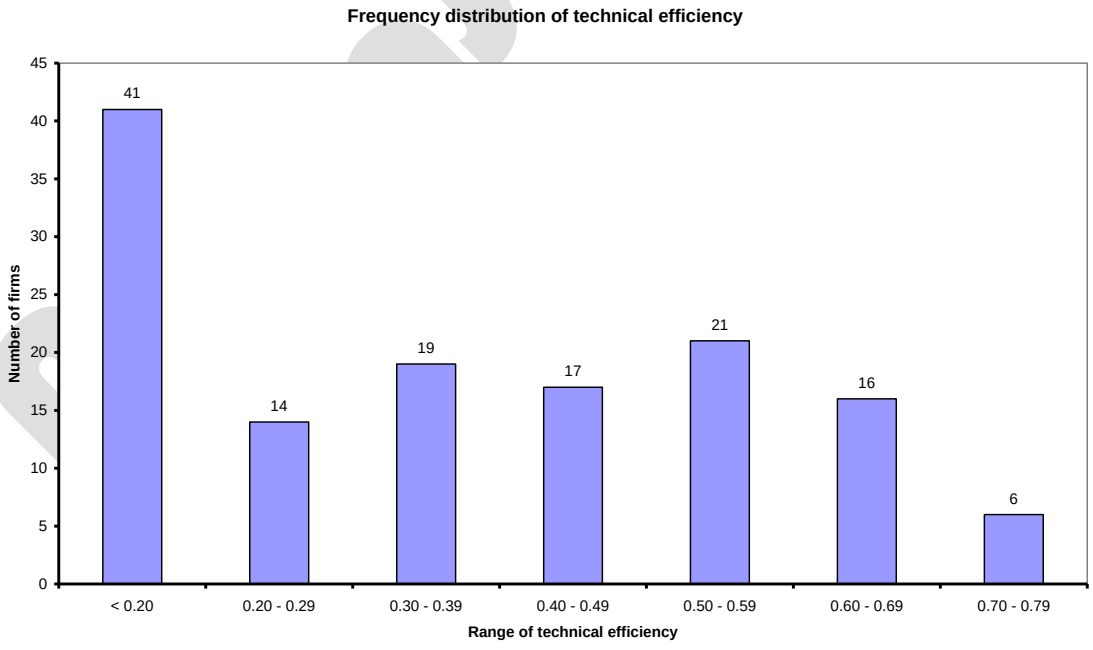

Figure 1: The estimated technical efficiencies for firms in the study area.

About 30.4% of the firms have technical efficiency index below 0.20 whilst 64.4% of the firms have efficiency indices between 0.20 and 0.69. Only few firms (4.4%) operate with technical efficiency index between 0.70 and 0.79. The predicted mean technical efficiency is estimated to be 0.38. This indicates that on

the average, firms are only able to produced 38% of the potential (stochastic) frontier output, given the present state of technology and input level. However, about 62% of technical potential output is not realized. This finding indicates that firms in the study area are operating way below the potential output. Therefore, there is the potential for increasing the firms output in the study area by an average of 62% in the short-run without any additional resource by adopting the practices of the best firm.

5.3. Inefficiency estimates

The estimates of the inefficiency model are presented in Table 4. The coefficient of the COPGOV (Corporate Governance) is estimated to be positive and significant. This means that cooperate governance has a negative influence on technical efficiency of operations by the firms. This finding is consistent with the observation by Asiedu and Folmer [4] who revealed that the lack of development and slow incorporation of corporate governance principle in the manufacturing sector of the economy affect operational efficiency.

Research and development coefficient is estimated to be negative and significant. This indicates that research and development programs adopted by the firms in the study area positively influence the efficiency of the firms although it did not enhance output of the firms as discussed above. Thus, research and development programs adopted by firms in the country should not only be directed towards efficient use of available resources but should also emphasize the need to increase output of firms.

Onumah *et al*. [46] observe a negative relationship between maximum level of formal education and technical efficiency. However, consistent with the results of Battese *et al*. [47], this study finds a positive relationship between years of formal education and technical efficiency, suggesting that firms with high level of formal education workers are more efficient, implying that it plays an important role in the productivity of firms in Ghana. Formal education enlightens workers about the ethics and production techniques of firms and also ensures easy adoption of innovative technology all of which bode to improve production.

Table 4: Inefficiency model estimates.

Variables	Parameters	Coefficients	Standard error
Constant	δ_0	3.14***	0.002
COPGOV	δ_1	0.23**	0.15
REDEV	δ_2	-0.29*	0.16
EDUMAG	δ_3	-0.68	0.41
OWNHOLD	δ_4	0.34***	0.10
EXPERIENCE	δ_5	0.28**	0.17
TREND	δ_6	-0.67***	0.06

*, **, *** Statistically significant at levels of 0.10, 0.05, and 0.01, respectively.

The coefficient of the firm ownership dummy is estimated to be significantly positive. This indicates that public firms are less technically efficient than private firms. The implication could mean that private firms tend to manage their business better to ensure higher profit and to meet high-rent obligations. Public firms do not employ rigorous supervision on workers and moreover, incentive packages for employees may be lacking. These factors do not enhance efficiency of production. Ahearn *et al*. [48] also note that large public firms do not perform better than small private firms.

The results reveal that the coefficients of experience is estimated to be significantly positive, indicating that more experienced firms are less technically efficient in their production than the less experienced firms who are progressive and willing to implement new production systems. This result is somewhat consistent with the findings of Coelli and Battese [42], who argued that older firms are likely to be more conservative and disinclined to adopt new innovations.

Using trend as a proxy to capture time varying technical efficiency was estimated to be negative and significant, meaning that efficiency of production by the firms improved over the period between 2005 and 2009 as the firms were now able to properly utilize their resources to achieve higher outcomes. However, the firms should ensure that attaining higher efficiency over the years should go hand in hand with increases in the output of the firms over the years through technological progress.

6. Conclusion

This study estimates efficiency levels of firms in the manufacturing sector of Ghana using a single stage Cobb-Douglas stochastic frontier technique. A five-year panel data of 135 observations between 2005 and 2009 is considered. The results show that the frontier model instead of the traditional average response (OLS) function is an adequate representation for the data. Findings reveal that LABOUR (Employment), CAPITAL, COPGOV (Corporate Governance), OWNHOLD (Ownership), and EXPERIENCE (years of firm operation) have positive influence on the productivity of the firms. However, research and development and TREND which is used as a proxy for technological progress are found to have negative influence on the firm's output. The combined effects of factors involved in the technical inefficiency model COPGOV (Corporate Governance), REDEV (Research and Development), EDUMAG (Education of workers), OWNHOLD (Ownership), EXPERIENCE, and TREND) are responsible in explaining the level and variations in production of the firms in Ghana, although individual effects of some variables may not be significant. The predicted mean technical efficiency is estimated to be 38%. This finding indicates that the firms are operating far below the frontier. Hence, there is high potential for increasing the firm's output by an average of 62% in the short-run without any additional resource by adopting the practices of the best firm.

In the light of these findings, the study provides evidence to increase the firms output through improvement in technical efficiency by considering education, research and development programs that ensures increase in both production and technical efficiency of operation. Firms, especially the experienced ones should be advised not to be complacent to increase the efficiency of operation with time. Management of public firms should be tasked to ensure discipline among workers and use of productive resources to enhance efficiency of operation as do their private counterparts. Above all, this study answers the question of whether technical efficiency differs under different ownership structures and provides positive conclusions that there is a causal link between ownership type and enterprise efficiency as hypothesized in the literature that small public enterprises facing competitive output markets can do no better than private enterprises in the same circumstances, but can do considerable worse. Therefore, this study provides a contribution to the public-private efficiency debate in the literature on privatization.

Competing Interests

None declared.

Authors' Contributions

All authors contributed equally to this work.

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Note:
The values for value added used in Table 1 represents changes in output or production over time. These are value-added per enterprise in a given year expressed in monetary value in the local currency [41, 49]. It is estimated using the log of capital and labour as in Cobb-Douglas specification.