WP-2019-036

The Impact of Size and Group Affiliation in Emerging Markets: A Cost Efficiency Analysis of Indian Firms

Ramesh Jangili

Indira Gandhi Institute of Development Research, Mumbai
December 2019

The Impact of Size and Group Affiliation in Emerging Markets: A Cost Efficiency Analysis of Indian Firms

Ramesh Jangili

Email(corresponding author): ramesh@igidr.ac.in

Abstract

Despite strengthening market discipline and improving overall competition, emerging markets, like India, still have severe information problems. Large firms and group firms in these markets have the potential to gain differential advantage as well as destroy value. We analyse the cost efficiency performance of firms in India: the degree of cost efficiency with respect to firm size and the cost efficiency of firms affiliated to business groups with that of standalone firms. We find that as firm size increases the degree of cost efficiency decreases and standalone firms exhibit better cost efficiency scores when compared with that of group affiliated firms. This supports the view that firms having either market power or involved in explicit or implicit form collusion incur higher costs. Alternatively, firms which do not have market power minimises the cost in a better way.

Keywords: Cost Efficiency, Size, Group Affiliation, Stochastic Frontier Analysis

JEL Code: L25, D24, M21

Acknowledgements:

I would like to express my special gratitude and heartfelt thanks to Dr. Subrata Sarkar for his guidance and invaluable advice. I am also thankful Dr. Subal K Kumbhakar, Professor, Binghamton University, The State University of New York, Binghamton for his insightful discussion on the initial findings and shaping them into constructive ideas.

The Impact of Size and Group Affiliation in Emerging Markets: A Cost Efficiency Analysis of Indian Firms

Ramesh Jangili

Indira Gandhi Institute of Development Research (IGIDR)
General Arun Kumar Vaidya Marg
Goregaon (E), Mumbai- 400065, INDIA
Email(corresponding author): ramesh@igidr.ac.in

Abstract

Despite strengthening market discipline and improving overall competition, emerging markets, like India, still have severe information problems. Large firms and group firms in these markets have the potential to gain differential advantage as well as destroy value. We analyse the cost efficiency performance of firms in India: the degree of cost efficiency with respect to firm size and the cost efficiency of firms affiliated to business groups with that of standalone firms. We find that as firm size increases the degree of cost efficiency decreases and standalone firms exhibit better cost efficiency scores when compared with that of group affiliated firms. This supports the view that firms having either market power or involved in explicit or implicit form collusion incur higher costs. Alternatively, firms which do not have market power minimises the cost in a better way.

Key words: Cost Efficiency, Size, Group Affiliation, Stochastic Frontier Analysis
JEL Classification: L25, D24, M21

Acknowledgements:

I would like to express my special gratitude and heartfelt thanks to Dr. Subrata Sarkar for his guidance and invaluable advice. I am also thankful Dr. Subal K Kumbhakar, Professor, Binghamton University, The State University of New York, Binghamton for his insightful discussion on the initial findings and shaping them into constructive ideas.

1 Introduction

A large number of small firms present in most of the emerging market economies around the world, making the firm size distribution highly skewed. These firms, in general, engage in vast variety of private sector activities. However, few large firms dominate private sector activity by contributing most of the activities (in terms of quantum) in these markets. Similarly, diversified business groups dominate private sector activity in majority of the emerging markets around the world. We compare the degree of cost efficiency with respect to firm size and the cost efficiency of firms affiliated to business groups with that of standalone (unaffiliated) firms in India.

The economic growth of many emerging market economies has been staggering since the global financial crisis. The economic growth could not pick up to the desired pre-crisis levels. This has led to a resurgence of interest on economic growth across many countries. Though, economic policies for growth and development are concerned with both macroeconomic and micro economic aspects, much attention has been devoted to macroeconomic aspects. However, an economy could grow only when the micro economic agents that constitute the macro economy will grow. Corporates, being the producers in an economy, plays a major role in an economy for its growth and development. Corporates make use of available resources such as capital and labour (by generating employment) to produce goods and services, which have been demanded by the consumer. In the process they do generate profits while contributing to the economic growth and development.

However, contribution to growth and development need not be same from all the corporates, as it depends on their individual performance along with the policy environment in which they operate. There exist concerns that should policy makers emphasize on performance of small corporates or large corporates, corporates with business group affiliation or standalone corporates to achieve desired outcomes. There exist two con-

tradicting views, first being the small corporates generally show better performance with their innovations and competitiveness, and hence economy could grow. The second view, contradicting with the first view, is that large corporates have advantages of increasing returns to scale and have ability to organise in large scale; as a result, they can show better performance and therefore large corporates should be given importance than small ones in nation building. Similarly, firms[1] with business group affiliation and standalone firms have competing views on their performance.

The issue of whether performance of large firms is superior to that of small firms, or vice-versa, and whether the performance of group firms is superior to that of standalone firms, or vice-versa, has been a long standing theoretical and empirical debate in economics and management disciplines. Understanding the effect of size and group affiliation on firm performance is important for policy makers and would help them to initiate suitable actions at appropriate time.

The previous studies contributed to the existence of three well established theories which relate size and performance[2] (Storey, 1989). The first theory postulates that since all firms face the identical U-shaped average cost curve and small firms are far from the long run minimum point on their long run average cost, small firms exhibit superior performance than large firms. Second theory postulates that in imperfect markets, there may be a tendency for management in large firms to generate superior performance by exploiting the markets. The third being the Gibrat's law postulates that performance is independent of firm size. Empirical studies on the effect of firm size on performance have generated mixed results, supporting positive relation as well as negative relation. Further, depending on the performance measure, size range and time horizon, the relation changes. A positive relation of firm size with that of profitability was observed (Majumdar, 1997; Lee, 2009), and at the same time, negative relation

[1]Firms, companies and corporates are used to represent the same entity. For ease of reading flow, these terms have been used interchangeably.

[2]Firm performance is considered as firm growth.

was observed with that of productivity (Majumdar, 1997).

Besides, there do exist two alternative views on the effect of business group affiliation on firm performance.[3] The dominant being the transactions costs minimising perspective, wherein, groups play a significant role to overcome obstacles of inefficient markets and weak institutions. Consequently, affiliated firms display superior performance (Khanna and Palepu, 2000). Alternatively, business groups engage in coordinated lobbying for licences, subsidies and other resources in economies where many aspects of industrial and financial activities are controlled by Government (Majumdar and Sen, 2006). The power, thus gained could be used by group affiliated firms, as a rent seeking behaviour and would have diminishing effects on economic welfare in those economies. Though, extensive empirical research has been undertaken in this matter in addition to theoretical postulates, the nature of relationship appears to be inadequately addressed.

The relationship of firm performance with that of size and/or group affiliation appears to be country specific, time specific and moreover policy environment specific. Further, it is highly dependent on several institutional factors, directly or indirectly. The hypothesis that could be derived from existing theory with respect to the impact of firm size and/or group affiliation on firm's performance is generally mediated by the institutional environment that firm's face. Further, the existing literature broadly considered a measure of profit or firm value as performance. The major problem with this kind of measure is that though the firm is not operating at the maximum possible extent (by possibly wasting its resources), it can still generate superior profits or value by a kind of rent seeking behaviour, which is not observable. Therefore, the central issue of the empirical organisation literature[4] cannot be addressed with such measure

[3]Most of the existing empirical studies employ measure of performance as an accounting measure of market variables, such as, firm growth, firm value, profitability, etc. A detailed review on business groups and their effect on performance can be found in Khanna and Yafeh (2007)

[4]To what extent market outcomes reflect the exercise of market power

of performance.

Therefore, the equivocality in the literature raised because of institutional issues, which are country specific, and were not considered. Additionally, accounting measures of performance could not incorporate such factors. Hence an alternate measure should be considered for better understanding the empirical IO issue and suitable policy suggestions. Cost efficiency of a firm could be a better alternative performance measure, deviating from traditional measures. The literature on efficiency has been advanced extensively over the last two decades and proven to be a better alternative to traditional accounting measures in various empirical settings. Moreover, efficiency is a relative measure and institutional factors can also be incorporated. Furthermore, not enough attention is paid to estimate cost efficiency of firms. Therefore, an empirical attempt is made in this paper to understand the impact of size and group affiliation on firm performance (measured using cost efficiency) in a developing country, India.

However, there have been limited attempts to estimate the cost efficiency in Indian context (Kumbhakar and Sarkar, 2005; Ray and Das, 2010), and they are restricted to banking sector only. Though there exist few studies in Indian corporate sector (Bhandari and Maiti, 2012), they estimated only technical efficiency of specific industries. The inherent problem with the technical efficiency is that it can't address the question of optimal utilisation of resources. This issue can be addressed in the cost frontier framework, however, there is no such study available in Indian context that estimate cost efficiency of corporate sector or industry, at least to our knowledge.

Therefore, the objective of the study has become twofold; first to estimate the cost efficiency of firms operating in Indian corporate sector using stochastic cost frontier models. Second to determine the impact of size and business group affiliation on cost efficiency thus obtained. An unbalanced panel data spanning the period 1994-95 to 2013-14 is used to estimate cost efficiency of firms. The study empirically finds an evi-

dence for the view that small as well as standalone firms exhibit superior performance, in terms of cost efficiency, than their counterparts, large and group affiliated firms.

The rest of the paper is organised as follows: A snapshot of the operating environment for corporates since the economic reforms in 1991 along with legal and regulatory framework prior to 1991 are provided in Section 2. Theoretical understanding of efficiency with the stochastic frontier analysis is highlighted in Section 3. The section also deals with the specification of efficiency determinants. Section 4 discusses the data and empirical specification of the cost stochastic frontier used in this study. The factors that could affect cost efficiency are also discussed. Section 5 presents the empirical results, a snapshot of two digit industry wise cost efficiency also presented in this section. Finally, conclusions are in last section.

2 Indian Corporate sector - operating environment

As a response to severe balance of payments crisis, India announced a series of economic reforms in 1991. Many reform measures directly or indirectly led to a substantial liberalisation of the corporate sector and brought many changes to the environment in which Indian companies used to operate. The economic reforms primarily aimed at simplifying the restrictions on company activities, strengthening market discipline and improving overall competition by putting an end to the 'License Raj'. The existing Industries Development and Regulation Act was abolished, in addition to amendments to the Companies Act and other major laws.[5] Further, the foreign trade regime was liberalised by reducing tariff rates and nontariff barriers, import licensing was streamlined.

Foreign investment opportunities were increased by freeing of capital markets and

[5]A brief on the Legal and regulatory framework prior to the 1991 reforms is presented at Annex A.1

allowing foreign investors, which brought new financing and ownership opportunities. This led to significant raise in the volume of new equity issues. Further, domestic companies were allowed to enter into joint ventures with foreign enterprises. Indian companies were allowed to import new technologies and capital goods, increase productive capacity and introduce new products without obtaining industrial licenses. Moreover, competition law was enacted to focus more on anti-competitive practises that prevents abuse of market dominance.

Indian corporate sector is sustained by a well-established equity market. There are currently a total of 21 registered stock exchanges in India. The equity market is dominated by the Bombay Stock Exchange (BSE) and the National Stock Exchange (NSE). Both these exchanges offer stocks with volume and attract foreign investment. The other stock exchanges are regional in nature and generally have been traded in very small volumes but largely supported by listing requirements of publicly traded companies in that region.

3 Empirical Strategy - Measuring efficiency

Producer in an economy always assumed to operate efficiently, however, it need not be true in reality. Two identical firms never produce the same output, do not incur the same cost and do not get the same profit, even in identical markets. These differences can be explained in terms of a relative measure, which is popularly known as (in)efficiency. Efficiency is the most widely used performance measure, in micro level analysis, by which firms can be compared and assessed. In a competitive environment, not unlike the dominance of state owned enterprises, efficiency[6] is a necessary condition for firm survival (Lovell, 1993). Similarly, the concept of efficiency, in macro terms,

[6]can be defined in crude way as converting inputs, such as, physical capital and labour, into outputs, such as goods and services

broadly characterize the optimal utilisation of available resources.

Farrell (1957) laid foundation to empirically measure the efficiency and productivity at micro level. In his seminal work, the productive efficiency of a specific firm is defined as its relative success/failure against the best performing firm. This confirms the fundamental measure of a firm performance and had become the base for constructing a frontier. Subsequently, both parametric and non-parametric methods evolved to construct the frontier[7] considering the available 'best practice' firm that represents the optimal utilisation of resources. The efficiency of a given firm is measured in relative terms to the constructed frontier.

The non-parametric frontier method, known as data envelopment analysis (DEA), usually constructs a frontier through a piece wise linear combination of the actual input-output correspondence set that envelops data of all the firms. The primary advantage of this method is that, it does not assume any functional form for the production process, as it is based on linear programming technique. However, at the same time, it completely ignores the presence of statistical noise in the data. In contrast, parametric frontier method, known as stochastic frontier analysis (SFA), involves econometric estimation of a pre-specified stochastic function. The specification of an appropriate functional form in SFA is challenging and is considered as a stronger assumption. Sometimes, it is not easy to find an appropriate functional form representing the question under consideration and hence considered as its disadvantage. However, the efficiency measurement in SFA is not contaminated by statistical noise present in the data. A detailed comparison of two approaches with relative advantages and disadvantages can be found in Lampe and Hilgers (2015). Since, the data set considered in this study is firm level and possibly contains statistical noise, SFA is used considering its advantage over DEA in disentangling efficiency and statistical noise.

[7]Meeusen (1977) and Aigner et al (1977) were published their work almost at similar time in constructing parametric frontier, whereas, Charnes et al (1978) is the first study in constructing non-parametric frontier

3.1 Stochastic Frontier Analysis

The SFA framework was first developed to construct frontier models for the underlying production technology using econometric technique and has its roots in the way back 1977, when the production frontier models were simultaneously and independently introduced by Meeusen and Aigner et al. The models were augmented for panel data by Schmidt and Sickles (1984) and Khumbhakar (1990). Further, the models were extended to explain inefficiency by Battese and Coelli (1995) and Greene (2005) and are called technical inefficiency effects model. The later models help to explain the firm level inefficiency as a function of number of explanatory variables making them superior to simply estimating the average efficiency relative to 'best practice' firm.

3.1.1 The technical efficiency model

The basic underlying principle of all the stochastic frontier models is the unique characterisation of its noise term. The noise term in these models is characterised as the sum of a one sided technical inefficiency term and a two sided noise term. The stochastic frontier methodology begins with the production function $y_t = f(x_t; \beta)$ that converts inputs (x) into the resulting output (y) efficiently. However, the production process may involve certain degree of inefficiency. Therefore, the production function can be written in the following way (Kumbhakar and Lovell, 2000):

$$y_t = f(x_t; \beta) exp(v_t - u_t)$$

where v_t is a random noise component, an exogenous shock unknown to the producer and can be either positive or negative. And u_t is a non-negative term represents the inefficiency component. If a firm could not produce the maximum possible output, given its input levels and the technology then the firm is said to be technically inefficient.

Such inefficiency might arise due to poor quality of inputs, lack of managerial efforts, etc. Technically efficiency is defined as the ratio of observed output to maximum feasible output.

$$TE = \frac{y}{f(x_t;\beta)\, exp(v_t)} = exp(-u_t)$$

That is the firm's technical efficiency TE represents the ratio of observed output to the maximum feasible output and lies within the interval [0,1]. And the production function can be modified to $y_t = f(x_t;\beta) \times TE$. If a firm employs all its inputs efficiently, then it achieves an optimal output, and hence $TE = 1$. However, smaller values of TE indicate the presence of inefficiency in the firm's production. The production function, now can be written as $y_t = f(x_t;\beta)exp(-u_t)exp(v_t)$. Clearly, v_t is a pure noise component and is a two sided normally distributed variable, whereas, u_t is a non-negative technical inefficiency component that shows the distance from the frontier. Both these terms put together form a compound error term with an unknown distribution.

In the technical efficiency setup, it is assumed that inputs are given and the objective is to maximize output. The only inefficiency, if any, is technical in this setup. Further, it is not required to assume any behavioural assumptions on firms and also, the question of resource allocation is not addressed. However, in reality, behavioural assumptions need to be imposed on firms and input allocation decisions also need to be made. Thus, cost efficiency, which imposes a behavioural objective on firm and also addresses the resource allocation, is appropriate in many cases.

3.1.2 The cost efficiency model

Given the level of inputs, how far the actual output from what it should have been produced is the focal point in the technical efficiency analysis. However, under (over)

utilisation of inputs is not addressed. This question of optimal utilisation of resources can be addressed in cost efficiency analysis. Further, it provides information on the optimality of chosen mix of inputs and on possible wastes in the production process. Essentially, cost efficiency measures how close a firm's cost to a firm's optimal cost for producing the same bundle of outputs.

Similar to that of technical efficiency model, the basic cost efficiency model assumes that total cost deviates from the optimal cost by a random disturbance (v) and an inefficiency term (u). Thus, the cost frontier can be expressed as:

$$E = c(y_1, ..., y_N, w_1, ..., w_M; \gamma)\, exp(v - u)$$

where $E = \sum_{i=1}^{n} w_i x_i$ is the actual expenditure incurred, y is output, c(.) is minimum cost (which is common to all firms), $w_1, ..., w_M$ are prices of inputs $x_1, ..., x_M$ and γ is a vector of technology parameters associated with the cost frontier and needs to be estimated. The cost efficiency (CE) is defined as the ratio of minimum feasible cost to the actual expenditure incurred.

$$CE = \frac{c(y_1, ..., y_N, w_1, ..., w_M; \gamma)\, exp(v)}{E} = exp(u) \tag{1}$$

Since actual expenditure can be increased due to either technical or allocative or both inefficiencies, CE$\leq$1.

A technically inefficient firm produces a given level of output by using more of every input when compared to a technically efficient firm. Similarly, if a firm fails to produce at a point where iso-quant is tangent to the iso-cost line, then the firm is said to be allocatively inefficient (input oriented). In other words, some inputs are underused and some are overused. Both these cases, using more of every input and misallocation of inputs, lead to an increase in cost. This increase in cost due to technical and allocative inefficiency is termed as cost inefficiency and is captured by the CE term. The percent-

age of actual cost which exceeds the minimum possible cost can be measured using the reciprocal of CE. Since, cost efficiency is a broader measure of efficiency accounting for both technical and allocative efficiency, the same has been used in our analysis.

3.2 Size, business group affiliation and efficiency

To analyse the relationship of efficiency with that of size or business group affiliation, several techniques have been proposed in the literature. The more straight forward procedure is the so-called 'two-stage procedure', wherein, the stochastic frontier model is estimated in the first stage and obtained (in)efficiency scores are regressed on a set of explanatory variables in the second stage. Though, this is computationally easy and hence commonly used in the literature, this has two important econometric problems (Kumbhakar and Lovell, 2000). First being the assumption of efficiency term to be identically distributed in the first stage and in the second stage this assumption is contradicted by the fact that the regression of the (in)efficiency terms on the explanatory variables suggests that the (in)efficiency terms are not identically distributed. Second, the explanatory variables in the second stage must be uncorrelated with the variables of the frontier function, or else the maximum likelihood estimates of the parameters of the frontier function would be biased because of the omission of the explanatory variables in the first stage. Further, the estimated efficiency terms that are explained in the second stage are biased as they are estimated relative to a biased representation of the chosen frontier. Therefore, one has to use the 'one-stage procedure', that solves these econometric problems (Wang and Schmidt, 2002).

Therefore, one has to use cost efficiency models augmented to explain inefficiency, such as, by Battese and Coelli (1995) and Greene (2005) and they are usually referred to as inefficiency effects model. Battese and Coelli (1995) propose a model using panel data, wherein, the non-negative (in)efficiency term is assumed to have a truncated

distribution with different means for each term. Therefore, the distributions of the inefficiency term are not the same and are expressed as functions of explanatory variables. The (in)efficiency terms are then independently distributed but not identical. They are obtained by truncation at zero of the $N(\mu_{it}, \sigma_u^2)$ distribution with $\mu_{it} = z_{it}\delta$, where z_{it} is a vector of explanatory variables that may explain inefficiency, and δ a vector of parameters to be estimated. Thus, the estimated model includes two specifications: one for cost frontier function and the other for inefficiency, but they are estimated simultaneously unlike 'two-stage procedure'.

4 Data and Specification of empirical Model

4.1 Data

The data set used in this study is firm-level data from an electronic database called PROWESS, which is generated and maintained by the Centre for Monitoring Indian Economy (CMIE), Mumbai. This database contains information on financial performance, such as, income expenditure statement, balance sheet and other details from the annual report, of firms that are listed in various stock exchanges in India. The database also contains information on stock prices, ownership structure, industry classification, etc. The database covers most of the firms in various industries and the coverage is increasing over time. However, if particular industry is dominated by unorganised sector then the data base may not be representative of those industries.

The sample period considered for our study is from 1995 to 2014.[8] Though we have data from 1988-89 onwards in the database, we confined our analysis to the period 1995 to 2014, because the problem we address in this study is more interesting in the period of free entry and exit of firms in any industry. We could have considered from 1991

[8]The financial year in India is from April 1 to March 31 of the following year. Thus, the financial year 2014 covers the period from April 1, 2013 to March 31, 2014.

onwards, however, immediately after the liberalisation the firms could have been more sporadic. Therefore, we considered from 1995 onwards after four years of liberalisation. During our sample period, Indian economy witnessed large variation in inflation. In order to eliminate the effect of price changes, values in monetary terms are converted into real terms by dividing suitable GDP deflater of relevant industry.

Further, only those firms for which at least four consecutive year's data is available are considered in our analysis. Only non financial firms have been considered, restricting to have at least 50 percent income from non financial activities. Further, only those firms for which (i) total assets, (ii) sales/income from service activities and (iii) total expenses are reported in the database are considered. Over the entire sample period, new firms may enter into the market, some firms may exit the market and data of some firms may not be available in some year due to some unavoidable reason. Further, industry concentration would change only when we allow for free entry and exit in our sample. Our analysis of concentration, profits and efficiency will be more intriguing when we use unbalanced sample. Therefore, we used unbalanced sample of 125294 firm year observations of 11410 firms in our study.

4.2 Estimation issues - Cost frontier

The starting point of the cost frontier estimation is the dual cost function, $C(y, w, T)$, where C is the optimal cost, y is given level of output, w is the vector of input prices and T is the time trend introduced to capture technical change. It assumes that there do not exist technical and allocative inefficiency. The cost function is non-negative and non-decreasing in output and input prices, and also concave and continuous in input prices. The cost function can be estimated when the information on total cost, output and input prices are available.

It is assumed that one output and two inputs, capital and labour, form the production process. Therefore, total cost, output, price of capital and price of labour constitutes our cost function and hence cost frontier. The data base described above contains information on cost and output, however, they are in monetary value. Therefore, they have been converted into real terms by using appropriate industry specific GDP deflators. Prices of labour and capital are obtained as below.

Price of labour (w_L) is readily available, therefore, it is obtained by dividing total expenses on labour by total assets. Total assets have been used in absence of total employees as the relevant denominator owing to the lack of employee data in the corporate sector. However, as noted by Maudos et al (2002), this definition can be interpreted as labour cost per worker adjusted for differences in labour productivity and is a better measure of price of labour.

$$w_L = \frac{TEL}{TA} = \frac{TEL}{TL} \times \frac{TL}{TA}$$

where TEL is the total expenditure on labour, TL is the total number of employees and TA is the total assets. Therefore, this measure takes into account for the variation in capital labour ratio and hence considered as a better measure.

Price of capital (w_K) is obtained by dividing total operating cost less total expenses on labour by total fixed assets.

$$w_K = \frac{total\ operating\ cost - total\ expenses\ on\ labour}{total\ fixed\ assets}$$

Since we have input prices, the cost frontier can be estimated.

4.3 Specification of empirical model

Cost efficiency of the individual firms has been estimated by assuming a translog specification of the cost frontier. The translog function can be viewed as a second order approximation of any unknown cost function and is widely used in efficiency studies. The following translog function is used in our case by imposing the usual symmetry restriction.

$$\begin{aligned} lnE_{it} = {} & \beta_0 + \beta_y lny_{it} + \beta_L lnW_{L_{it}} + \beta_K lnW_{K_{it}} + \beta_t lnt \\ & + \beta_{yy}(lny_{it})^2 + \beta_{LL}(lnW_{L_{it}})^2 + \beta_{KK}(lnW_{K_{it}})^2 + \beta_{tt}(lnt)^2 \\ & + \beta_{yL}(lny_{it})(lnW_{L_{it}}) + \beta_{yK}(lny_{it})(lnW_{K_{it}}) + \beta_{yt}(lny_{it}lnt) \\ & + \beta_{LK}(lnW_{L_{it}})(lnW_{K_{it}}) + \beta_{Lt}(lnW_{L_{it}})(lnt) + \beta_{Kt}(lnW_{K_{it}})(lnt) \\ & + \mathrm{u}_{it} + v_{it} \end{aligned}$$

where $i = 1, ..., I$ represent firms and $t = 1, ..., T$ represent time.

E_{it} represent total expenditure incurred to produce the output y_{it} by the i^{th} firm at year t, W_L and W_K represent price of labour and capital, respectively, t is a time index that serves as a proxy for technical change. β is a vector of parameters to be estimated and $u_{it} + v_{it} = \varepsilon_{it}$(say) is a stochastic composite error term. The term v_{it} corresponds to statistical noise that is assumed to be independently and identically distributed, and the term u_{it} is a non-negative random variable associated with cost inefficiency. Further, it is assumed that u_{it} and v_{it} are independently distributed from each other.

It is clear that ε_{it} will have non-zero mean because u_{it} is non-negative. However, this non-zero mean problem can be avoided by rewriting $\varepsilon_{it} = v_{it} + (u_{it} - E(u_{it})) + E(u_{it}) \equiv \varepsilon^*_{it} + E(u_{it})$ where $E(\varepsilon^*_{it}) = 0$ by construction. We get an error term that has a zero mean but an extra term $E(u_{it})$ needs to be accounted in the regression. In the cost inefficiency effects model, $E(u_{it})$, could be replaced by a linear function of explanatory variables reflecting firm and time specific characteristics. Specifically,

$$E(u_{it}) = \delta_0 + \sum \delta_m z_{ml}$$

where z_{ml} represents firm and time specific explanatory variables associated with cost inefficiency, δ_0 and δ_m are parameters in the inefficiency model to be estimated and ω_{it} is an independently and identically distributed random variable with $N(0, \sigma_u^2)$ truncated from below at $-(\delta_0 + \sum \delta_m z_{ml})$. Which in turn implies that $u_{it} \backsim N(\delta_0 + \sum \delta_m z_{ml}, \sigma_u^2)$ truncated from below at zero.

Given the specification of a functional form for the deterministic cost frontier and assumption about the distribution of random variables u_{it} and v_{it}, the Maximum Likelihood (ML) method is used to estimate the unknown parameters, $\beta's$ and $\delta's$. The variance parameters of the likelihood function are estimated in terms of $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and $\gamma = \frac{\sigma_u^2}{\sigma^2}$, where σ_u^2 is the variance of the normal distribution that is truncated at zero to obtain the distribution of u_{it} and the γ parameter has a value between zero and one. Then, firm specific estimates of cost inefficiency can be obtained from the conditional expectation of $\exp(u_{it})$ given ε_{it}.

4.4 Factor affecting firm efficiency

Set of variables considered for explaining cost (in)efficiency are defined as follows: *Size* is measured as the natural log of total assets and *Business group affiliation* is defined as a dummy variable take 1 if the firm is affiliated with any of the business group otherwise zero. Further, *Age* is defined as the number of years since the inception of the firm in the year the data collected. *Liquidity* is measured as the ratio of current assets to current liabilities of the firm, when this ratio increases, current assets are more than desired and may have negative impact on efficiency, on the other hand, current liabilities are lower that provides a cushion and would have positive impact on efficiency. *Leverage* is measured as the ratio of total borrowings to total assets. Finally, *Capital labour ratio*

is measured as the ratio of capital to labour. All these are standard definitions used in the literature.

The size of a firm affects firm performance, such as, efficiency and profitability, in many ways. Large firms have capabilities of product diversification and have abilities to exploit the economies of scale and scope in addition to formalisation of procedures. These features of large firms allow them to generate superior performance by making the implementation of operations more effective. Alternatively, size is correlated with market power, extracting rents, and hence inefficiencies could develop, leading to inferior performance. Therefore, theory is equivocal on the precise relationship between firm size and performance.

With respect to business group affiliation, one stream of research suggests that firms with business group affiliation use the common resources such as technology, plants, brand names or distribution systems. As a result, they business group affiliated firms could generate superior performance compared to standalone firms. However, industrial organisation view suggests that group firms interacting in different product markets may use those interactions to support less rivalrous interaction, and therefore business group firms collude across the range of markets in which they meet. This would lead to rent seeking behaviour, making the firm inefficient, leading to inferior performance.

5 Empirical Analysis

5.1 Descriptive statistics

Prior to econometric analysis, we analyse the data based on descriptive statistics. Table 1 presents the descriptive statistics of the frontier variables for select years of our sam-

Table 1: Descriptive statistics of frontier variables

	N	Range	Min	Max	Mean	Median	Std	Small	Large	Standalone	Businessgroup
					1994-95						
Cost	4055	11.78	-2.22	9.56	2.64	2.53	1.79	0.92 (0.95)	4.69 (4.65)	1.92 (1.88)	3.57 (3.51)
Output	4055	15.31	-2.82	12.49	4.86	4.92	1.84	3.02 (3.23)	6.86 (6.80)	4.27 (4.39)	5.62 (5.76)
Price of labour	4055	9.80	-9.12	0.69	-3.26	-3.22	1.23	-3.16 (-3.20)	-3.27 (-3.11)	-3.43 (-3.43)	-3.05 (-2.94)
Price of capital	4055	10.23	-8.34	1.89	-2.47	-2.46	0.77	-2.49 (-2.47)	-2.41 (-2.40)	-2.54 (-2.53)	-2.38 (-2.37)
					1998-99						
Cost	5344	12.31	-1.96	10.34	3.24	3.15	1.77	1.47 (1.47)	5.30 (5.21)	2.63 (2.58)	4.17 (4.17)
Output	5344	16.13	-2.89	13.23	5.08	5.20	2.04	3.08 (3.35)	7.22 (7.20)	4.55 (4.78)	5.87 (6.05)
Price of labour	5344	11.40	-10.12	1.28	-3.09	-3.04	1.24	-2.99 (-3.04)	-3.22 (-3.07)	-3.22 (-3.17)	-2.89 (-2.81)
Price of capital	5344	10.96	-7.02	3.94	-2.32	-2.36	0.76	-2.29 (-2.35)	-2.35 (-2.37)	-2.33 (-2.37)	-2.30 (-2.35)
					2003-04						
Cost	7174	12.58	-1.69	10.89	3.39	3.31	1.90	1.43 (1.47)	5.61 (5.52)	2.82 (2.83)	4.53 (4.53)
Output	7174	16.44	-2.38	14.06	5.24	5.41	2.25	2.88 (3.15)	7.57 (7.56)	4.76 (5.01)	6.20 (6.40)
Price of labour	7174	10.69	-9.23	1.46	-3.02	-2.89	1.29	-2.76 (-2.72)	-3.22 (-3.02)	-3.10 (-3.00)	-2.87 (-2.70)
Price of capital	7174	10.41	-6.98	3.43	-2.30	-2.37	0.83	-2.24 (-2.35)	-2.33 (-2.38)	-2.30 (-2.36)	-2.29 (-2.39)
					2008-09						
Cost	8042	13.79	-1.65	12.14	4.09	4.08	2.06	1.90 (1.96)	6.46 (6.39)	3.54 (3.59)	5.18 (5.17)
Output	8042	17.47	-2.27	15.19	6.05	6.26	2.42	3.43 (3.74)	8.61 (8.61)	5.61 (5.86)	6.95 (7.13)
Price of labour	8042	11.42	-9.85	1.57	-3.06	-2.92	1.34	-2.70 (-2.62)	-3.42 (-3.24)	-3.12 (-3.00)	-2.95 (-2.75)
Price of capital	8042	14.99	-8.66	6.33	-2.33	-2.41	0.91	-2.36 (-2.46)	-2.29 (-2.37)	-2.37 (-2.42)	-2.25 (-2.39)
					2013-14						
Cost	4592	13.58	-1.22	12.37	5.38	5.44	2.10	3.08 (3.29)	7.72 (7.69)	4.76 (4.84)	6.24 (6.26)
Output	4592	18.86	-3.01	15.85	7.32	7.51	2.41	4.66 (5.03)	9.81 (9.82)	6.79 (7.09)	8.05 (8.20)
Price of labour	4592	11.79	-10.79	1.00	-3.07	-2.89	1.37	-2.79 (-2.60)	-3.49 (-3.32)	-3.12 (-2.95)	-3.01 (-2.81)
Price of capital	4592	16.08	-7.97	8.11	-2.39	-2.47	0.93	-2.51 (-2.58)	-2.31 (-2.41)	-2.45 (-2.50)	-2.31 (-2.43)

Summary statistics of all firms in the sample along with means (medians) of small and large firms, and group-affiliated and standalone firms are presented.

ple. Mean and median according to size class[9] and business group affiliation are also presented in Table 1. It is observed that average cost and output gradually increased[10] from 1994-95 to 2013-14, indicating improved economic activity in the country. However, it is observed that price of labour and capital remained stable during this 20 year period.

Table 1 shows that small firms perform better than that of large firms. In particular, large firms average cost is 3-5 times higher than that of small firms average cost. Whereas, their output is only 2 times higher than that of small firms. However, price of labour and capital paid by large and small firms appear to be not different. Further, it is observed that average cost for producing a unit of output by small firms is lower than that of large firms. This is in contradiction with the general convention of increasing returns to scale, might be due to suboptimal production process or misallocation of resources.

It is also evident from Table 1 that standalone firms perform better than that of firms affiliated to business groups. Average cost of firms affiliated business groups is 1.5 times higher than average cost of standalone firms, whereas, their output is 1.2 times higher. Again, not much difference is observed among prices of labour and capital paid by standalone and business group firms.

Further, descriptive statistics of the variable used to explain cost inefficiency are presented in Table 2. Average size of the corporate sector remained around 5.6 till 2004, has started increasing and rose to 7.3 in 2014. However, the size distribution appears to be symmetric across all the years. Similar pattern is observed for age of

[9]Since we wanted small firms to become medium and large during the sample period, the cutoff for size class is dynamic in nature and therefore is different for each year. We have defined the firms which are in first quartile as small and fourth quartile as large in each year's size distribution for presenting descriptive statistics. However, size is a continuous variable in regression models.

[10]It may be recalled that cost and output have been converted into real terms using GDP deflater of suitable industry.

Table 2: Summary statistics of key variables used to explain inefficiency

	Full sample							small	Large	t-stat	salone	broup	t-stat
Variable	N	range	min	max	mean	p50	sd	mean	mean		mean	mean	
	1994-95												
Size	4055	12.13	0.41	12.53	5.57	5.41	1.53	3.80	7.59	-98.77***	5.00	6.30	-29.78***
Age	4035	4.88	0.00	4.88	2.60	2.56	0.96	2.30	3.04	-18.01***	2.39	2.88	-16.75***
Liquidity	4055	422.00	0.00	422.00	4.11	2.53	9.53	4.77	3.20	5.41***	4.88	3.11	5.88***
Leverage	4055	28.79	0.00	28.79	0.41	0.33	0.86	0.40	0.38	0.45	0.35	0.48	-4.85***
Capital labour ratio	4055	23.44	0.00	23.44	0.25	0.10	0.75	0.22	0.29	-1.77*	0.26	0.22	1.68*
	1998-99												
Size	5344	13.30	-0.51	12.79	5.71	5.53	1.62	3.84	7.87	-120***	5.17	6.51	-32.52***
Age	5334	4.91	0.00	4.91	2.73	2.71	0.83	2.50	3.08	-18.23***	2.59	2.95	-16.01***
Liquidity	5344	460.00	0.00	460.00	3.98	2.21	12.47	5.39	3.25	3.81***	4.63	3.02	4.63***
Leverage	5344	45.43	0.00	45.43	0.50	0.37	1.30	0.49	0.44	1.1	0.43	0.61	-4.75***
Capital labour ratio	5344	126.20	0.00	126.20	0.30	0.11	1.94	0.24	0.41	-1.71*	0.29	0.30	-0.06
	2003-04												
Size	7174	14.69	-1.20	13.49	5.66	5.53	1.81	3.49	8.02	-140***	5.14	6.71	-37.82***
Age	7170	4.96	0.00	4.96	2.88	2.89	0.74	2.75	3.07	-12.71***	2.80	3.03	-12.73***
Liquidity	7174	831.50	0.00	831.50	4.65	2.03	21.25	5.92	3.46	4.07***	5.43	3.10	4.38***
Leverage	7174	72.79	0.00	72.79	0.51	0.31	1.72	0.59	0.42	2.79***	0.46	0.60	-3.11***
Capital labour ratio	7174	104.83	0.00	104.83	0.32	0.09	1.73	0.24	0.44	-2.82***	0.29	0.38	-1.98**
	2008-09												
Size	8042	15.07	-0.36	14.72	6.26	6.15	2.03	3.77	8.91	-160***	5.76	7.25	-32.89***
Age	8042	4.99	0.00	4.99	3.00	3.00	0.72	2.97	3.06	-4.07***	2.99	3.01	-1.22
Liquidity	8042	901.75	0.00	901.75	4.68	2.05	23.52	5.74	3.45	3.73***	5.15	3.75	2.53**
Leverage	8042	91.27	0.00	91.27	0.43	0.30	1.36	0.55	0.36	3.49***	0.41	0.45	-1.11
Capital labour ratio	8042	186.59	0.00	186.59	0.42	0.09	4.34	0.26	0.80	-3.07***	0.34	0.58	-2.28**
	2013-14												
Size	4592	15.81	-0.69	15.12	7.35	7.28	2.04	4.82	9.99	-120***	6.79	8.12	-23.14***
Age	4592	3.92	1.10	5.02	3.25	3.26	0.62	3.24	3.33	-3.75***	3.24	3.26	-0.92
Liquidity	4592	1566.00	0.00	1566.00	5.74	2.13	37.39	11.37	2.81	4.08***	7.30	3.58	3.34***
Leverage	4592	92.35	0.00	92.35	0.43	0.28	2.10	0.63	0.33	2.92***	0.40	0.48	-1.36
Capital labour ratio	4592	235.86	0.00	235.86	0.40	0.08	4.18	0.31	0.44	-1.39	0.28	0.56	-2.29**

Summary statistics of all firms in the sample along with means of small and large firms, and group-affiliated and standalone firms are presented.
** Significant at 1%, ** Significant at 5% and * Significant at 10%

the corporate sector. On the other hand, liquidity of the corporate sector is positively skewed, having few firms with very low liquidity and many firms with better liquidity management. Similarly, distribution of leverage and capital labour ratio are positively skewed.

Table 2 reveals that average age of small firms is significantly smaller than that of large firms across all the years. It is found that liquidity of small firms is higher than that of large firms for all the years presented and is statistically significant. The higher liquidity of small firms can be interpreted as they manage their liquidity in better way compared to large firms either because of their apprehension regarding availability of funds or in general they may have a better cash flow management. Further, large firms use more capital compared to small firms as observed from significantly higher capital labour ratio of large firms.

It is also observed that group affiliated firms are on the average, significantly larger than that of standalone firms. Further, group affiliated firms used to be older firms compared to standalone firms, however, the difference in age is not significant in recent past, suggesting group affiliated and standalone firms are of the same age, and hence have similar experience. Liquidity ratio of standalone firms is significantly larger than that of group affiliated firms. Leverage of the group affiliated firms has decreased over the sample period. Though significantly higher leverage for group affiliated firms in the initial years, has now decreased to the level of standalone firms. Further, it is observed that group affiliated firms have more capital compared to standalone firms.

5.2 Empirical results

The estimates of stochastic cost frontier model with fixed effects are presented in Table 3 and the estimates of inefficiency model are in Table 4. The models assume that cost

inefficiency u is i.i.d., $N(0, \sigma_u^2)$, $u_{it} \geq 0$. The results presented in column(1) captures the impact of firm size on inefficiency along with other firm characteristics. Results in column(2) captures the effect of business group affiliation on cost inefficiency controlling for other firm characteristics, but not the firm size. The effect of firm size along with business group affiliation is presented in column(3) and finally column(4) captures their interaction. It may be noted that these specifications are for inefficiency and hence cost frontier specification remains unchanged.

Since the main focus of our analysis is on cost efficiency, the estimated cost frontier parameters are not discussed in detail. However, it is mentioned that the estimated coefficients are theoretically consistent and twelve out of the fourteen parameters of the translog cost function are significant. It is observed that the coefficient associated with time variable and interaction of labour price and capital price are not significant in the model.

Coefficients associated with the cost inefficiency model (Table 4) for a specific variable should be interpreted in the following way. An efficient firm would be on the efficiency frontier and hence the distance from the efficiency frontier equal to zero. Hence, a positive and statistically significant coefficient associated with a variable indicates that this variable moves a firm away from the cost frontier. For example, a positive value associated with particular firm characteristic indicates that the specific firm characteristic is associated with a lower contribution to cost efficiency; the larger the coefficient, the greater distance and inefficiency it represents. On the other hand, a negative and statistically significant coefficient associated with a specific category indicates that the category helps to move a firm closer to the efficiency frontier, that is, the firm becomes more efficient as the coefficient becomes smaller. To sum it up, when interpreting the coefficient in the inefficiency model, we look at the value of the associated coefficient, the negative coefficient contributes the greater to a firm's efficiency and vice-versa.

Table 3: Maximum likelihood estimates (Stochastic Frontier Model)

	(1)	(2)	(3)	(4)
Output	0.0170**	0.5108***	0.0197**	0.0213**
	(0.0086)	(0.0168)	(0.0086)	(0.0088)
Price of labour	0.6627***	0.2268***	0.6552***	0.6562***
	(0.0208)	(0.0299)	(0.0206)	(0.0206)
Price of capital	0.1516***	0.0225	0.1443***	0.1446***
	(0.0243)	(0.0388)	(0.0247)	(0.0247)
Time	-0.0213	0.1625***	-0.0255	-0.0294
	(0.0210)	(0.0396)	(0.0210)	(0.0212)
Output^2	0.0035***	0.0396***	0.0034***	0.0032***
	(0.0005)	(0.0011)	(0.0005)	(0.0006)
Price of labour^2	0.0048*	0.0201***	0.0044*	0.0044*
	(0.0025)	(0.0033)	(0.0025)	(0.0025)
Price of capital^2	-0.0233***	-0.0067	-0.0242***	-0.0242***
	(0.0052)	(0.0059)	(0.0054)	(0.0054)
Time^2	0.0642***	0.0353**	0.0649***	0.0652***
	(0.0034)	(0.0057)	(0.0034)	(0.0034)
Output ×	0.0063***	0.0694***	0.0065***	0.0066***
Price of labour	(0.0017)	(0.0028)	(0.0017)	(0.0017)
Output ×	-0.0036*	-0.0227*	-0.0031	-0.0029
Price of capital	(0.0020)	(0.0136)	(0.0020)	(0.0020)
Output ×	-0.0052**	-0.0319***	-0.0041**	-0.0037*
Time	(0.0020)	(0.0087)	(0.0020)	(0.0021)
Price of labour ×	0.0017	-0.0026	0.0016	0.0017
Price of capital	(0.0046)	(0.0225)	(0.0046)	(0.0046)
Price of labour ×	0.0041	-0.0432***	0.0040	0.0037
Time	(0.0043)	(0.0056)	(0.0043)	(0.0043)
Price of capital ×	-0.0424***	0.0278**	-0.0424***	-0.0425***
Time	(0.0060)	(0.0118)	(0.0060)	(0.0060)
Constant	-0.3486*	-0.2844**	-0.3627**	-0.3560**
	(0.1802)	(0.1314)	(0.1797)	(0.1793)
N	125294	125294	125294	125294

Note: Values in parentheses are robust standard errors

*, ** and *** represents statistical significance at 10%, 5% and 1% level, respectively.

Table 4: Maximum likelihood estimates (Cost inefficiency effects Model)

	(1)	(2)	(3)	(4)
Size	0.9516***		0.9449***	0.9430***
	(0.0053)		(0.0054)	(0.0053)
Business group affiliation		0.4933***	0.0470***	0.0160
		(0.0250)	(0.0080)	(0.0276)
Size × Business group affiliation				0.0049
				(0.0043)
Age	-0.0362***	0.0076	-0.0368***	-0.0369***
	(0.0044)	(0.0099)	(0.0045)	(0.0045)
Liquidity	-0.0009***	-0.0039***	-0.0009***	-0.0009***
	(0.0001)	(0.0006)	(0.0001)	(0.0001)
Leverage	0.0299***	0.0532***	0.0295***	0.0296***
	(0.0098)	(0.0122)	(0.0097)	(0.0097)
Capital labour ratio	0.0004***	0.0004***	0.0004***	0.0004***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Constant	0.3023*	0.6115	0.3041*	0.3111*
	(0.1796)	(0.0902)	(0.1791)	(0.1782)
Usigma	-2.0191***	-12.2812	-2.0173***	-2.0151***
	(0.1651)	(5.9433)	(0.1646)	(0.1628)
Vsigma	-2.7372***	-0.2916***	-2.7473***	-2.7522***
	(0.3378)	(0.0096)	(0.3405)	(0.3393)
N	125294	125294	125294	125294

Note: Values in parentheses are robust standard errors

*, ** and *** represents statistical significance at 10%, 5% and 1% level, respectively.

5.2.1 Cost efficiency analysis

The cost efficiency scores are obtained from the estimated cost frontier using JLMS technique. Average efficiency scores of each two digit industry are presented in Table 5. Average cost efficiency of the corporate sector is also presented in the Table. It is observed that average cost efficiency has shown cyclical pattern. It started high at around 0.641 in 1994-95, it gradually declined to 0.612 in 2001-02. From there it gradually increased to 0.634 in 2005-06; again it gradually declined to 0.613 in 2009-10. Though it inched up to 0.614 in 2010-11, there after it declined to 0.586 in 2013-14. The declining trend in average cost efficiency, particularly since 2009-10, can be attributed to the Global Financial Crisis. It appears that there should have been turn around during 2009-10, however, it further decreased since then.

Further, it is observed that average cost has started decreased for many industries since 2010. Average efficiency is the lowest for firms operating in 'Electricity' industry during 2014, whereas, it was lowest for firms operating in 'Transport activities' during 1995. Further, it is observed that firms in 'Transport activities' continued to have lower cost efficiency over the entire sample period. Other industries for which lower cost efficiency observed is 'Storage activities'. Incidentally, average cost efficiency of firms in 'Storage activities' steadily declined over the sample period.

On the other hand, firms engaged in 'Trade activities' have better cost efficiency scores over the entire sample period. Firms operating in 'Diversified manufacturing' have better cost efficiency scores, indicating possible benefits of scope economies. Firms in 'Manufacture of Food' and 'Manufacture of Beverages' could register a decent score in terms of cost efficiency. Other industries for which cost efficiency is steady across sample period is 'Manufacture of chemicals' and 'Manufacture of basic metals'.

Table 5: Average cost efficiency scores of firms by two-digit Industry groups

Indsutry	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Agriculture	.645	.628	.598	.585	.598	.613	.611	.623	.615	.627	.625	.637	.624	.604	.613	.597	.602	.576	.565	.551
Mining	.570	.575	.564	.571	.574	.563	.572	.583	.592	.628	.631	.626	.606	.608	.612	.575	.555	.530	.528	.522
Food	.652	.656	.639	.638	.635	.633	.636	.641	.645	.640	.650	.653	.649	.648	.648	.646	.652	.646	.644	.638
Beverages	.627	.602	.576	.591	.599	.581	.575	.617	.612	.602	.621	.617	.637	.628	.601	.618	.626	.620	.615	.632
Textiles	.637	.633	.618	.609	.604	.605	.607	.604	.615	.614	.620	.621	.619	.616	.613	.617	.630	.632	.622	.625
Leather	.645	.656	.626	.599	.606	.642	.642	.616	.641	.639	.655	.663	.665	.665	.664	.649	.659	.668	.667	.662
Wood	.605	.599	.604	.622	.610	.617	.642	.608	.611	.625	.642	.630	.647	.647	.650	.636	.644	.637	.642	.616
Paper	.658	.650	.620	.618	.621	.616	.630	.626	.630	.636	.651	.664	.659	.647	.642	.634	.635	.621	.608	.616
Rubber Petro	.648	.631	.617	.609	.605	.611	.608	.611	.628	.646	.651	.658	.665	.666	.665	.657	.665	.659	.653	.655
Chemicals	.654	.643	.626	.623	.620	.618	.618	.617	.630	.640	.636	.634	.627	.623	.623	.619	.626	.624	.616	.613
Non-metallic	.591	.591	.568	.557	.560	.573	.566	.569	.576	.579	.590	.600	.605	.598	.597	.597	.579	.584	.571	.563
Basic Metals	.653	.648	.627	.627	.640	.647	.658	.654	.669	.674	.691	.685	.688	.689	.682	.661	.665	.661	.641	.630
Metal Prods	.637	.635	.618	.617	.612	.619	.621	.617	.626	.639	.652	.656	.655	.651	.639	.633	.637	.631	.610	.599
Electrical Mach	.647	.637	.620	.620	.621	.625	.621	.620	.624	.635	.658	.664	.675	.678	.666	.654	.654	.647	.630	.632
Other Manf	.669	.657	.665	.676	.694	.702	.697	.691	.697	.699	.688	.689	.705	.699	.696	.694	.701	.701	.699	.682
Trans Manf	.643	.636	.638	.618	.602	.619	.613	.611	.627	.638	.648	.649	.650	.640	.627	.628	.647	.647	.639	.623
Diversified	.640	.633	.612	.618	.598	.609	.615	.616	.610	.611	.617	.610	.612	.610	.609	.595	.610	.599	.585	.568
Electricity	.408	.431	.417	.381	.342	.354	.392	.410	.392	.403	.418	.411	.407	.429	.421	.398	.387	.389	.391	.342
Construction	.605	.608	.613	.603	.593	.604	.601	.595	.600	.605	.603	.608	.600	.589	.578	.571	.560	.546	.535	.502
Trade	.693	.678	.666	.666	.663	.658	.661	.665	.678	.679	.686	.683	.681	.673	.667	.665	.663	.648	.632	.625
Transport	.374	.339	.362	.392	.377	.414	.435	.433	.440	.490	.482	.456	.419	.400	.379	.357	.351	.326	.296	.345
Hotels	.521	.543	.522	.503	.509	.498	.497	.478	.489	.510	.512	.521	.519	.506	.477	.463	.467	.445	.412	.412
Storage	.626	.613	.596	.572	.570	.549	.536	.537	.543	.551	.528	.531	.521	.516	.498	.468	.453	.435	.435	.452
Communication	.571	.578	.565	.565	.573	.564	.548	.518	.531	.548	.574	.588	.591	.593	.588	.587	.589	.583	.560	.552
Real Estate	.633	.632	.604	.597	.577	.568	.571	.569	.575	.590	.587	.571	.564	.555	.524	.522	.524	.504	.471	.474
Other Services	.605	.606	.587	.572	.572	.547	.528	.547	.563	.588	.585	.596	.593	.573	.571	.552	.545	.531	.491	.500
Overall	.641	.635	.619	.615	.613	.614	.613	.612	.621	.627	.634	.634	.632	.627	.620	.613	.614	.606	.592	.586

Figure 1: Trends in average cost efficiency - Large vs Small firms

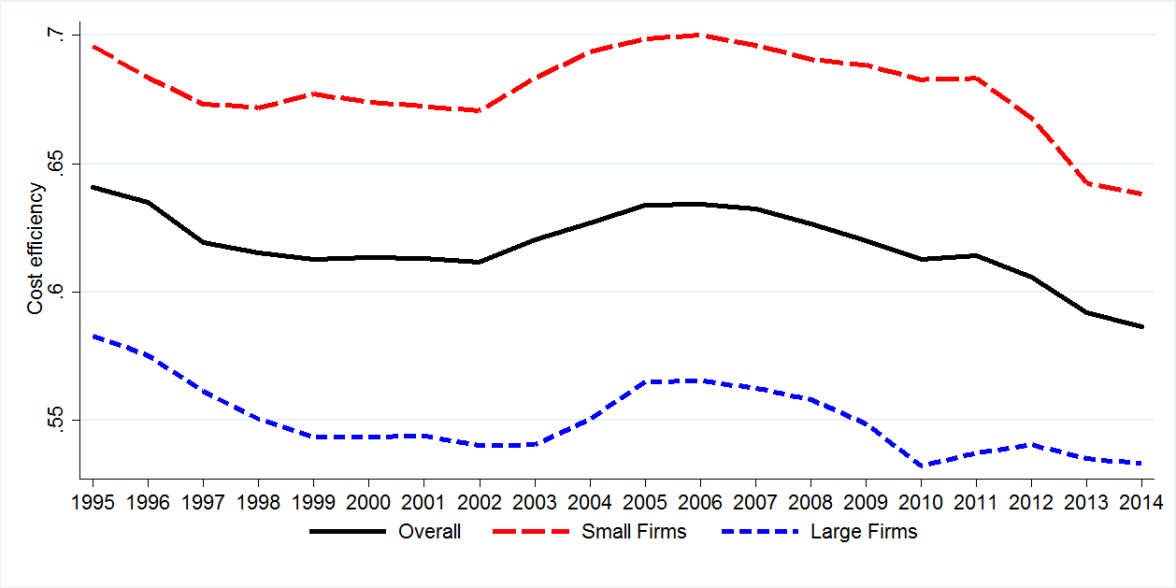
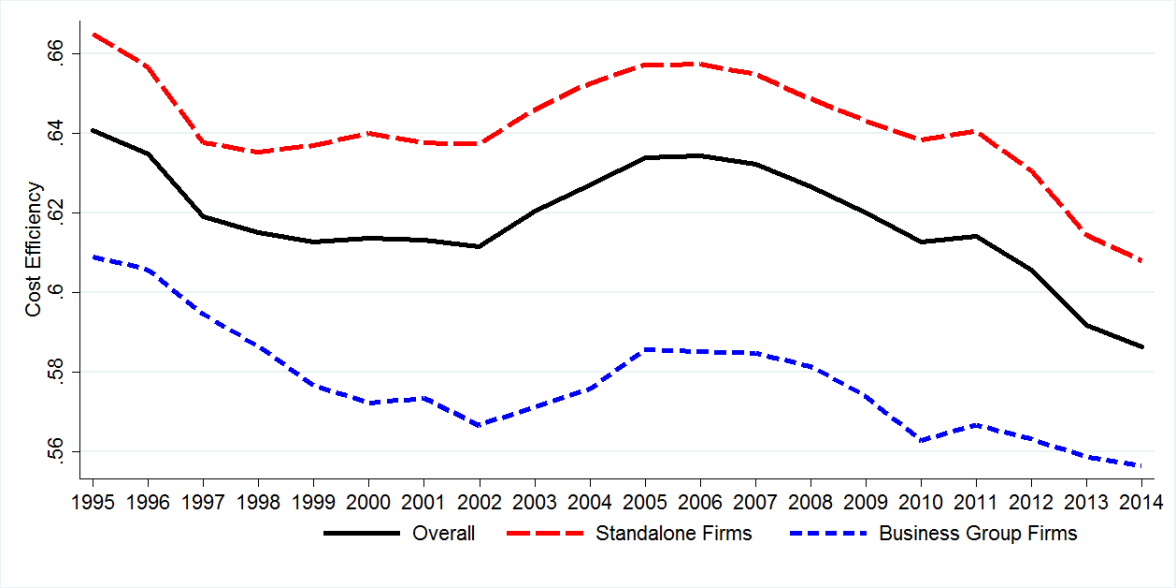


Figure 2: Trends in average cost efficiency - Business group vs Standalone firms



Average cost efficiency of small firms as well as large firms with that of overall efficiency across the sample period is presented in Figure 1. It is observed that average cost efficiency of small firms is consistently higher than that of large firms, irrespective of the year. Though small firms do not have advantage of economies of scale and scope, they are relatively easy to establish and generally do not have complex rules and procedures. As a result, they venture into niche markets and provide customised and specialist products/services. Further, the rise of micro-marketing wherein small group of potential customers act as marketing tool with their existing or predicted buying activities, might help small firms to understand the customer needs and work efficiently. Moreover, with the increased internet penetration, firms would be making use of web tracking cookies to exploit website and search engine visitors to track individual habits and interest, and then target them through emails. The strategy could increase their business potential without spending much on marketing expenses.

On the other hand, large firm's complex organisational structures don't allow them to shift easily to emerging business areas. In India too, large corporate and business group firms, in general, do not shift their core activities. Despite the unfavourable business situation, many a times they will continue to produce the same output as these firms might have already spent substantial amounts on capital requirements for such products and they cannot simply do away with these capital investments. Further, with the evolving innovations across the globe, small firms with young entrepreneurs will always be at forefront to adopt innovations in their business by discarding old machinery and technology. To that matter they need not be having capital investments in fixed assets, rather they may be having intangible assets.

Similarly, firms affiliated to business groups have registered lower cost efficiency levels compared to standalone firms (Figure 2). However, it is conventionally expected that firms with group affiliation add value by complementing other firms in the group, particularly, in the vertical integration of various stages of production process. How-

ever, the empirical results obtained in this chapter are contradicting this view and alternatively it is shown that these firms are cost inefficient compared to stand alone firms. These firms may be adding value by replicating the institutional and intermediary functions, that are missing in an emerging market like India, however, they may not be adding any value to become a firm to be cost efficient.

Further, the group affiliation could help them to get financing needs and may enable a firm to engage in various anti-competitive practices. However, the cost inefficiencies could be eliminated only by the firm's initiatives towards optimal utilisation of resources. The engagement in anti-competitive practices might pull these firms to be less efficient than their counterpart. Since the firm has already in advantageous (possibly because of group affiliation) position despite inefficient, it may not be trying out to be efficient.

5.2.2 Effects of firm characteristics on cost efficiency

The estimated coefficients of cost inefficiency model are of particular interest as they provide effects of firm specific characteristics on (in)efficiency. The coefficient for size and business group affiliation are of specific interest in this study. Further, the interaction effects of these variables with that of time provide us changing dynamics of these variable over the sample period. Further, the effect of all these variables putting together give us relative importance among them.

The coefficients for size, one of the interested variable in this study, is positive and significant in all the specifications, indicating that large firms are more inefficient. On the other hand, small firms are cost efficient and as firm becomes larger, they are becoming cost inefficient. This is in contradiction with the economic intuition that large firms' performance is superior to small firms having advantages of economies of scale and scope. But, in line with the industrial organisation literature that large firms would

be inefficient as they could extract rents from the market and hence do not have incentive to become efficient.

The other important variable in our analysis, business group affiliation, is also positive and significant. The implication of this positive coefficient is that the group affiliated firms are more inefficient than their counterpart stand-alone firms. This gives rise to a concern for the disruptive role of business group affiliations on the firm and the economy. A business group typically possess multiple resources, and able to internally utilise these resources to the advantage of its members. This internal utilisation of resources should result in significant economies of scale and scope. However, it is evident that firms with business group affiliation produce sub-par performance, that can be detrimental to both firm growth and overall social welfare. Further, when controlled for the firm size business group affiliation, though significant (model 3), its marginal contribution to firm inefficiency is drastically reduced. Moreover, when interaction term is included in the model (model 4), only size coefficient is significant. This result can be interpreted as firm size has the dominating role compared to business group affiliation, the entire inefficiency is driven by firm size. However, when firm size is not included in the model, the same is captured by the business group affiliation.

Based on our empirical results it is evident that small, standalone firms are more efficient and help in nation building. But the new small firms enter the market must be even more efficient to challenge the stiff competition from the existing rivals. Thus comes the role of dynamic efficiency. The existing firms may understand and tries to strategize their decisions; however, they must abide by their existing production process, which was efficient at that point in time but may not be efficient today. Since efficiency is a relative concept, the new small firm may appear to be more efficient than the existing firm. All the firms may be efficient in static sense but they may be finding it difficult to improve technology and innovation, which are necessary to improve dynamic efficiency.

The coefficient of age in inefficiency model is negative and significant indicating that older firms are more cost efficient than young firms. This is in line with the economic intuition that they learn as they grow older and their experience makes them to work efficiently. It is found that liquidity coefficient is negative and significant in all the specifications implying that firms that have higher liquidity, will have lower inefficiency.

The effect of leverage on cost efficiency of the firm is unswerving across various specifications. We find the firms with lower leverage are closer to the efficiency frontier. On the other hand, highly leveraged firms are less efficient. The evidence is consistent with general wisdom that highly leveraged firms may find it difficult to finance their operations. Moreover, taking cash out of a highly leveraged firm eliminates the freedom of management to service the debt, which further alleviates pressure and cost structure of a firm and creates a wedge between them with that of a best practice firm. The coefficient of capital labour ratio observed to be positive and significant, implying that firms operating with higher capital compared to labour are more inefficient. The positive effect of capital labour ratio on inefficiency may be due to the fact that capital is used more extensively when it is not required, leading to higher costs.

5.3 Robustness analysis

Since the time period considered in the analysis is 20 years and the economy as well as corporates experienced both boom and bust during this period, the model is further estimated for sub periods consisting of 5 years each, viz., 1995-1999, 2000-2004, 2005-2009 and 2010-2014. It may be noted that during the periods 1995-1999 and 2005-2009, the economy was in upswing, whereas, other periods it experienced busts or in downturn.

Since our focus is mainly on the coefficient of inefficiency effects model, only those

Table 6: Maximum likelihood estimates (Cost inefficiency effects Model) - various periods

Period→	(1) (1995-2014)	(2) (1995-1999)	(3) (2000-2004)	(4) (2005-2009)	(5) (2010-2014)
Size	0.9449***	0.9752***	1.0080***	0.9545***	0.8809***
	(0.0054)	(0.0092)	(0.0083)	(0.0060)	(0.0076)
Business group affiliation	0.0470***	0.0016	0.0036	0.0471***	0.1025***
	(0.0080)	(0.0110)	(0.0103)	(0.0102)	(0.0126)
Age	-0.0368***	-0.0583***	-0.0632***	-0.0198***	-0.0312***
	(0.0045)	(0.0070)	(0.0062)	(0.0054)	(0.0081)
Liquidity	-0.0009***	-0.0009**	-0.0013***	-0.0008***	-0.0010***
	(0.0001)	(0.0005)	(0.0003)	(0.0002)	(0.0003)
Leverage	0.0295***	0.0347***	0.0262***	0.0314*	0.0243**
	(0.0097)	(0.0056)	(0.0062)	(0.0161)	(0.0107)
Capital Labour ratio	0.0004***	0.0008**	0.0007**	0.0005***	0.0003***
	(0.0001)	(0.0004)	(0.0003)	(0.0001)	(0.0001)
Constant	0.3041*	1.2642***	0.4400	0.2185**	0.2896
	(0.1791)	(0.1797)	(0.5236)	(0.0859)	(0.4514)
Usigma	-2.0173***	-3.2402***	-2.3374***	-1.7820***	-2.0689***
	(0.1646)	(0.1597)	(0.3515)	(0.0740)	(0.6084)
Vsigma	-2.7473***	-2.1676***	-2.4617***	-4.0857***	-2.2206***
	(0.3405)	(0.0613)	(0.3891)	(0.6865)	(0.7097)
N	125294	22925	31384	39539	31446

Note: Values in parentheses are robust standard errors

*, ** and *** represents statistical significance at 10%, 5% and 1% level, respectively.

results are presented in Table 6 and frontier results are presented at Annex (Table A.1) for four sub-periods along with whole period. It is observed that the size coefficient is robust in all the sub periods. The result indicates that irrespective of the economic conditions, large firms are inefficient and they are continued to be inefficient since the beginning of the sample period.

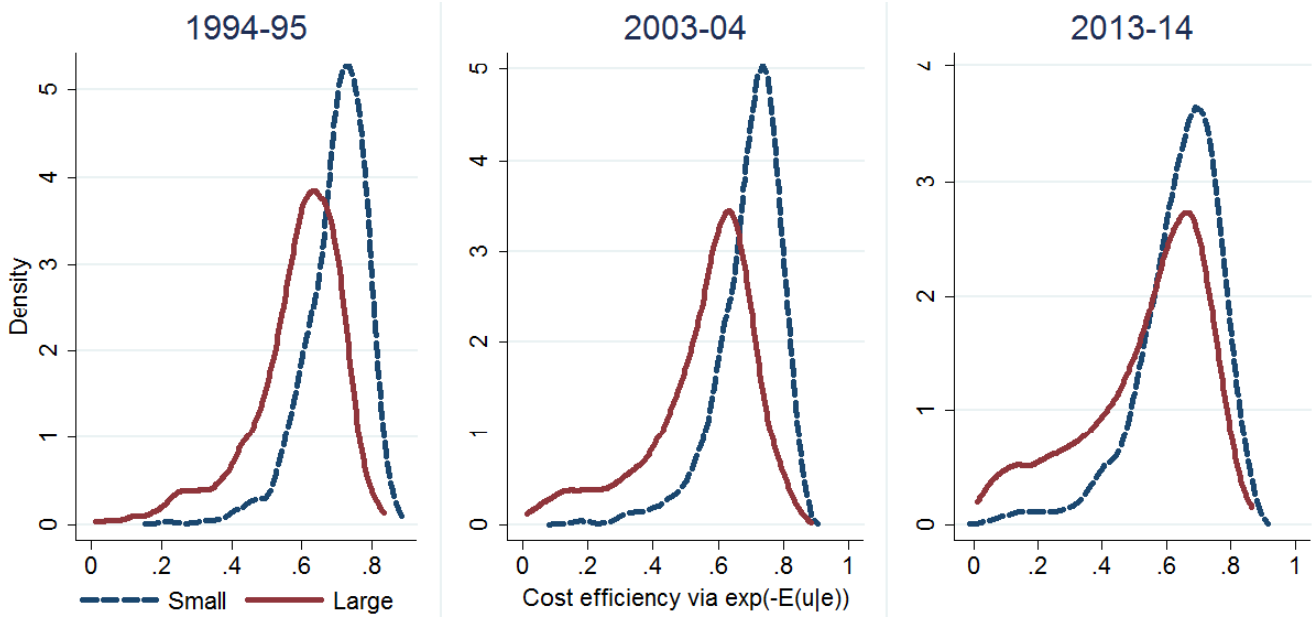
On the other hand, it is observed that the coefficient of business group affiliation is insignificant in first two sub-periods, i.e., 1995-99 and 2000-04, however, it has become significant thereafter. The results imply that until 2004, having business group affiliation do not contribute to cost (in)efficiency. However, it is the recent phenomena, which alleviated the cost inefficiency among business group firms. Further, it is observed that the inefficiency is increasing over the years as observed from the increased coefficient from sub-period 2005-09 to 2010-14. Hence, business group affiliation has become detrimental and is on rise in India.

Further, it observed that old firms continued to be more cost efficient in all sub-periods ans is robust. The coefficient of liquidity is robust across various sub-periods with high liquidity leads to more cost efficient. The coefficients of leverage and capital labour ratio are also robust across various sub-periods.

Next, we generate firm-specific and year specific measures of cost efficiency from the estimated stochastic cost frontier model. To recapitulate, the cost efficiency measure is bounded in (0,1), with values close to zero indicating low degree cost efficiency and values close to one indicating high degree of cost efficiency. Further, to check the robustness of firm size on cost efficiency, we report in Figure 3 the distribution of firm specific cost efficiency of size groups for 1995, 2004 and 2014.[11] It is evident from Figure 3 that the distribution of large firms cost efficiency is to the left of distribution of small

[11]Distribution of firm specific cost efficiency according size groups for all the years are presented at Annex (Figure A.1).

Figure 3: Distribution of cost efficiency - size group

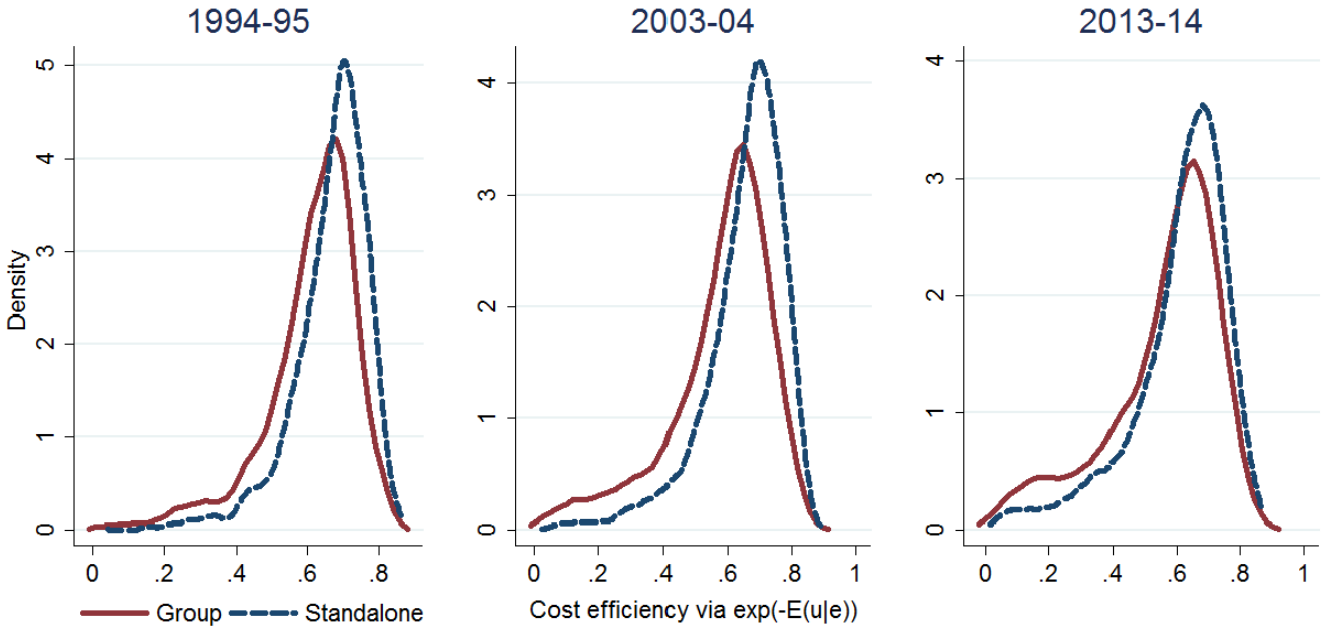


firms cost efficiency, suggesting small firms are more cost efficient than that of large firms, consistent with our results in previous section.

Similarly in Figure 4, we report the distribution of firm specific cost efficiency of business group affiliates and standalone firms.[12] Though, the distributions are not as wide as they were in size group classification, there is a discernible differentiation having standalone firms cost efficiency is more than that of group affiliated firms. Therefore, large firms as well as firms with business group affiliation, despite having advantages of increasing returns to scale and sharing of common resources, do not operate efficiently. On the other hand, small and standalone firms minimize their costs and operate close to the frontier.

[12]Distribution of firm specific cost efficiency according business group affiliation for all the years are presented at Annex (Figure A.2).

Figure 4: Distribution of cost efficiency - business group affiliation



6 Summary and Conclusions

Economic growth can be achieved only with the improved performance of their economic agents, such as firms. Generally, growth and profitability are used as measures of firm performance, however, the study makes use of a more comprehensive performance measure, cost efficiency. It is a relative measure and incorporates institutional factors unlike traditional performance measures. Cost efficiency can be estimated using either a nonparametric technique (Data Envelopment Analysis) or a parametric technique (Stochastic Frontier Analysis). Though nonparametric technique appears simple, it is not possible to find the factor effecting cost efficiency, in addition to other drawbacks. The Stochastic frontier technique requires strong statistical assumptions and rich data. Therefore, the measurement of cost efficiency for Indian corporate itself was considered to be challenging. The study eases out the challenge and estimated cost efficiency of the corporates, which provides a way forward for future research in this direction.

The study examines the effect of firm size and business group affiliation on cost efficiency of firms in Indian context using data for a long period of 20 years since economic reforms. Companies in India used to operate in a more controlled environment prior to economic reforms in 1991. With economic liberalisation, companies could find more opportunities in terms of their business, growth and financing requirements, and provide a level playing field for all the companies, irrespective of their size or business group affiliation, to compete for available resources and so as to become more efficient.

However, the study finds that cost efficiency is not uniform across all the firms. The empirical results suggest that the company size and business group affiliation plays a significant role in cost efficiency. Moreover, cost efficiency decreases as company size increases, and similarly, companies with business group affiliation are not efficient as that of standalone companies. Generally, large companies and companies with business group affiliation can reap the benefits of increasing returns to scale and hence their cost structure should be near optimal and should be more efficient. However, it is found empirically that large companies and companies with business group affiliation are more inefficient in terms of their cost. On the other hand, they spend more than that of their counter parts for the same level of output.

The findings have some implications for the Indian corporate sector and for the country. The results suggest that small and standalone companies are more efficient in terms of their cost. Therefore, they should be given preference and an environment needs to be created so that small and standalone companies' growth will not be hampered. It may be beneficial in the long run even for overall growth of the country. Since small and standalone companies are more cost efficient, and profits are the difference between revenue and cost, the profitability aspect of the Indian companies also needs to be examined.

References

[1] Aigner, D., Lovell, C. A. K., & Schmidt, P. (1977). Formulation and estimation of stochastic frontier production function models. *Journal of Econometrics*, 6(1), 21-37. https://doi.org/10.1016/0304-4076(77)90052-5

[2] Battese, G. E., & Coelli, T. J. (1995). A model for technical inefficiency effects in a stochastic frontier production function for panel data. *Empirical Economics*, 20(2), 325-332. https://doi.org/10.1007/BF01205442

[3] Bhandari, A. K., & Maiti, P. (2012). Efficiency of the Indian leather firms: some results obtained using the two conventional methods. *Journal of Productivity Analysis*. Springer. https://doi.org/10.2307/43548527

[4] Charnes, A., Cooper, W. ., & Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research*, 2(6), 429-444. https://doi.org/10.1016/0377-2217(78)90138-8

[5] Farrell, M. J. (1957). The Measurement of Productive Efficiency. *Journal of the Royal Statistical Society*. Series A (General), 120(3), 253. https://doi.org/10.2307/2343100

[6] Greene, W. (2005). Fixed and Random Effects in Stochastic Frontier Models. *Journal of Productivity Analysis*, 23(1), 7-32. https://doi.org/10.1007/s11123-004-8545-1

[7] Khanna, T., & Palepu, K. (2000). Is Group Affiliation Profitable in Emerging Markets? An Analysis of Diversified Indian Business Groups. *The Journal of Finance*, 55(2), 867-891. https://doi.org/10.1111/0022-1082.00229

[8] Khanna, T., & Yafeh, Y. (2007). Business Groups in Emerging Markets: Paragons or Parasites? *Journal of Economic Literature*. American Economic Association. https://doi.org/10.2307/27646796

[9] Kumbhakar, S. C. (1990). Production frontiers, panel data, and time-varying technical inefficiency. *Journal of Econometrics*, 46(1-2), 201-211. https://doi.org/10.1016/0304-4076(90)90055-X

[10] Kumbhakar, S., & Lovell, C. A. K. (2003). *Stochastic frontier analysis*. Cambridge University Press.

[11] Kumbhakar, S.,C. and Sarkar, S. (2005). 'Deregulation, Ownership, and Efficiency Change in Indian Banking: An Application of Stochastic Frontier Analysis', in Ranjan Chosh and Chiranjib Neogi, eds, *Theory and Application of Productivity and Efficiency: Econometric and DEA approach*, Macmillan India Ltd, pp. 125-156.

[12] Lampe, H. W., & Hilgers, D. (2015). Trajectories of efficiency measurement: A bibliometric analysis of DEA and SFA. *European Journal of Operational Research*, 240(1), 1-21. https://doi.org/10.1016/J.EJOR.2014.04.041

[13] Lee, J. (2009). Does Size Matter in Firm Performance? Evidence from US Public Firms. *International Journal of the Economics of Business*, 16(2), 189-203. https://doi.org/10.1080/13571510902917400

[14] Lovell, K (1993). 'Production Frontiers and Productive Efficiency', in *The measurement of productive efficiency : Techniques and applications*, ed. Fried, H.O., Knox Lovell, C.A., Schmidt, S. S., Oxford University Press, 1993, pp. 3-67.

[15] Majumdar, S. K. (1997). The Impact of Size and Age on Firm-Level Performance: Some Evidence from India. *Review of Industrial Organization*, 12(2), 231-241. https://doi.org/10.1023/A:1007766324749

[16] Majumdar, S. K., & Sen, K. (2007). The debt wish: Rent seeking by business groups and the structure of corporate borrowing in India. *Public Choice*, 130(1-2), 209-223. https://doi.org/10.1007/s11127-006-9080-6

[17] Maudos, J., Pastor, J. M., Preza, F., & Quesada, J. (2002). Cost and profit efficiency in European banks. *Journal of International Financial Markets, Institutions and Money*, 12(1), 33-58. https://doi.org/10.1016/S1042-4431(01)00051-8

[18] Meeusen, W., & van Den Broeck, J. (1977). Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error. *International Economic Review*, 18(2), 435. https://doi.org/10.2307/2525757

[19] Ray, S. C., & Das, A. (2010). Distribution of cost and profit efficiency: Evidence from Indian banking. *European Journal of Operational Research*, 201(1), 297-307. https://doi.org/10.1016/J.EJOR.2009.02.030

[20] Schmidt, P., & Sickles, R. C. (1984). Production Frontiers and Panel Data. *Journal of Business & Economic Statistics*, 2(4), 367-374. https://doi.org/10.1080/07350015.1984.10509410

[21] Storey, D. J. (1989). Firm performance and size: Explanations from the small firm sectors. *Small Business Economics*, 1(3), 175-180. https://doi.org/10.1007/BF00401855

[22] Wang, H., & Schmidt, P. (2002). One-Step and Two-Step Estimation of the Effects of Exogenous Variables on Technical Efficiency Levels. *Journal of Productivity Analysis*, 18(2), 129-144. https://doi.org/10.1023/A:1016565719882

Annex

A.1 Legal and regulatory framework prior to the 1991 reforms

The legal framework, prior to 1991 reforms, prevailed in India for regulating companies was largely evolved from the British Government. The main legislative acts under which Indian companies were controlled are listed below. However, these laws were not always been properly enforced leading to suboptimal performance of Indian companies.

The Capital Issues (Control) Act, 1947: Need to obtain approval from the Central Government to issue securities, this was to ensure that financial resources were channelled into those areas of goals and priorities of the Government.

The Industries Development and Regulation Act, 1951: Need to obtain a suitable license from the central government to expand its capacity, change product mix, introduce new processes, import machinery and equipment.

The Industrial Policy Resolution, 1956: Certain industries were reserved for the public sector so as to have a large state owned industrial and services sector.

The Companies Act, 1956: A modern legal and regulatory framework for the corporate sector, largely adopted from the British counterpart, vesting power to the central government to regulate, monitor and control the company affairs. Reporting, registration, type and structure of establishment also included in the act.

Monopolies and Restrictive Trade Practices Act, 1969: Introduced an asset based classification of monopoly but the act is applied only to the private sector.

Additionally, Government of India had other policies for the development of corporate sector:

Small scale industry were encouraged since 1967 and many product lines were reserved for the small scale industry.

Import substitution policy was implemented to shield domestic companies from foreign

competition with high import tariffs and multiple import licenses.

Three *development finance institutions*, the Industrial Development Bank of India (IDBI), the Industrial Finance Corporation of India (IFCI) and the Industrial Credit and Investment Corporation of India (ICICI) were set up by the government in order to promote industries. These institutions were to lend industrial enterprises at lower interest rates than prevailed in the market.

Table A.1: Maximum likelihood estimates (Stochastic Frontier Model) - various periods

Period →	(1) (1995-2014)	(2) (1995-1999)	(3) (2000-2004)	(4) (2005-2009)	(5) (2010-2014)
Output	0.0197**	0.0007	-0.0524**	-0.0452*	0.0127
	(0.0086)	(0.0175)	(0.0203)	(0.0266)	(0.0492)
Price of labour	0.6552***	0.7940***	0.6232***	0.3565***	0.7490***
	(0.0206)	(0.0386)	(0.0543)	(0.0727)	(0.1283)
Price of capital	0.1443***	-0.0490	0.2541***	0.3754***	-0.0151
	(0.0247)	(0.0478)	(0.0728)	(0.0912)	(0.1621)
Time	-0.0255	0.2283***	0.0105	-7.0611***	-1.5821
	(0.0210)	(0.0315)	(0.2632)	(0.6929)	(1.7890)
Output^2	0.0034***	0.0046***	0.0030***	0.0021***	0.0026***
	(0.0005)	(0.0011)	(0.0009)	(0.0007)	(0.0008)
Price of labour^2	0.0044*	0.0116**	0.0090	-0.0030	0.0029
	(0.0025)	(0.0047)	(0.0057)	(0.0031)	(0.0034)
Price of capital^2	-0.0242***	-0.0323***	-0.0400***	-0.0290***	-0.0167***
	(0.0054)	(0.0070)	(0.0072)	(0.0084)	(0.0060)
Time^2	0.0649***	0.0432***	0.0056	1.4436***	0.3957
	(0.0034)	(0.0065)	(0.0568)	(0.1337)	(0.3169)
Output × Price of labour	0.0065***	-0.0031	-0.0003	0.0048**	0.0104***
	(0.0017)	(0.0031)	(0.0027)	(0.0021)	(0.0024)
Output × Price of capital	-0.0031	0.0018	0.0020	-0.0031	-0.0027
	(0.0020)	(0.0041)	(0.0036)	(0.0028)	(0.0029)
Output × Time	-0.0041**	-0.0246***	0.0059	0.0183*	0.0231
	(0.0020)	(0.0029)	(0.0072)	(0.0101)	(0.0185)
Price of labour × Price of capital	0.0016	-0.0118	-0.0055	0.0152**	-0.0043
	(0.0046)	(0.0097)	(0.0071)	(0.0063)	(0.0060)
Price of labour × Time	0.0040	-0.0445***	0.0503***	0.1213***	-0.0544
	(0.0043)	(0.0063)	(0.0183)	(0.0278)	(0.0449)
Price of labour × Time	-0.0424***	0.0519***	-0.1333***	-0.1246***	0.0143
	(0.0060)	(0.0093)	(0.0313)	(0.0363)	(0.0591)
Constant	-0.3627**	-1.4457***	-0.2475	8.6606***	1.2680
	(0.1797)	(0.1323)	(0.6123)	(0.9256)	(2.5993)

Note: Values in parentheses are robust standard errors

*, ** and *** represents statistical significance at 10%, 5% and 1% level, respectively.

Figure A.1: Distribution of cost efficiency - Small vs Large firms

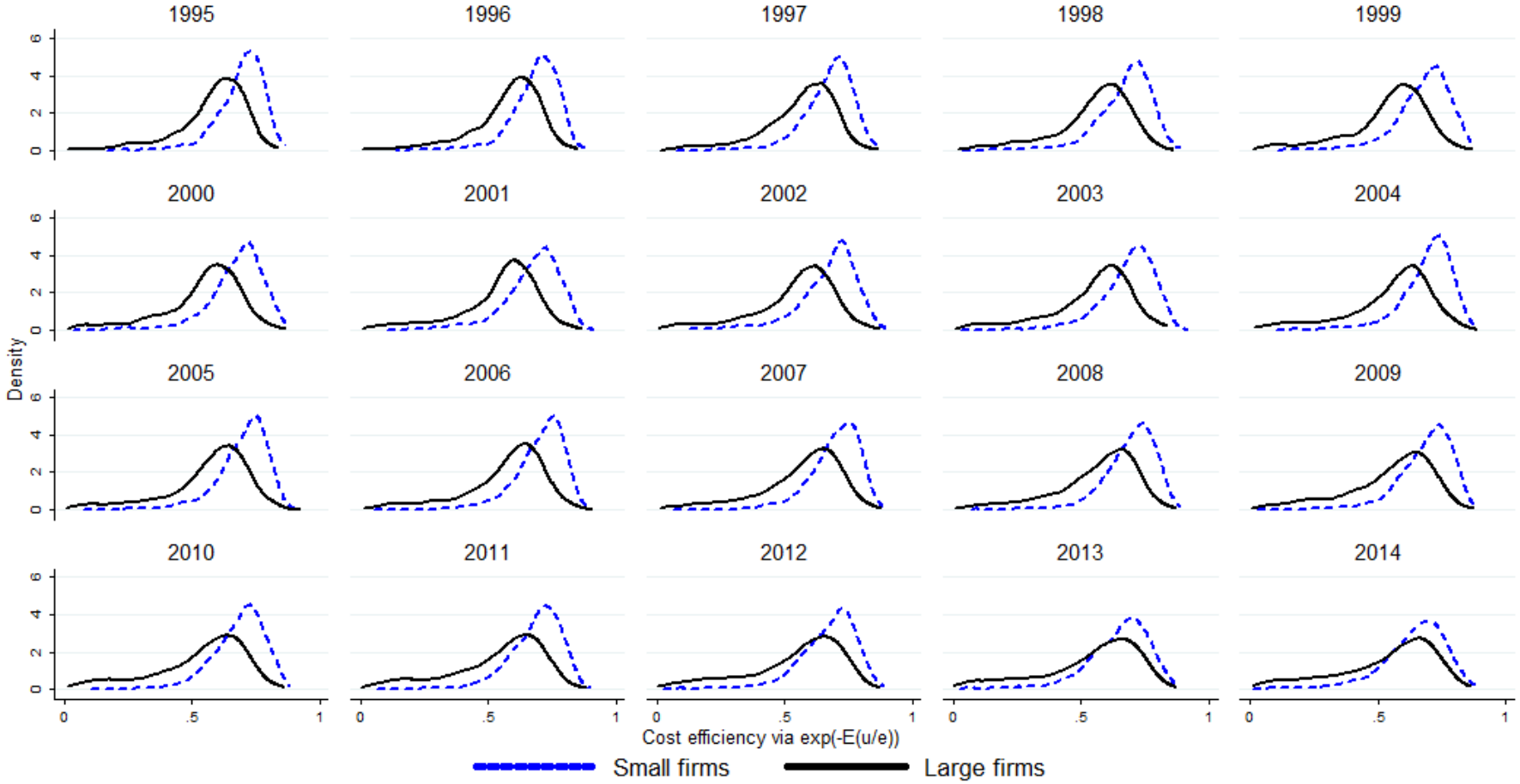


Figure A.2: Distribution of cost efficiency - Standalone vs Business group firms