ESSAYS ON THE STATUS AND DETERMINANTS OF EFFICIENCY AND INFORMALITY IN MANUFACTURING FIRMS OF BANGLADESH

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Abstract

The manufacturing firms in Bangladesh are surging with impressive growth for past few decades and are powering the nation to become a middle income country through industrialization. The firms have survived financial crisis in recent past but are now facing a new era of competition both domestically and internationally. Under this circumstance, chapter-2 explores technical efficiency and its determinants for these firms. At the same time, the manufacturing sector is dominated by informal firms similar to other developing countries under industrialization. But surprisingly, informal manufacturing firms are mostly overlooked in literature mainly for data unavailability. Chapter-3 utilizes a focused survey data to investigate the determinants and impact of informality among manufacturing firms. First study uniquely used heteroscedastic 'true' random effect model of stochastic frontier analysis to estimate exogenous determinants of efficiency in a robust single-step estimation process. The discussion of marginal impact of determinants in this advanced model is a valuable contribution to related literature. This study has found that human capital of top manager and access to financial services are the most influential factors in attaining higher efficiency. Export and innovation are found to affect the production frontier significantly. High average efficiency score measured from the true random effect model, while compared to competing models, reveals the extent of heterogeneity among sample firms and the role of firm specific effect in efficiency analysis. The informality study argues and statistically shows that formalization (or informality) is a continuous phenomenon and firms range from very informal to very formal. Principal component analysis (PCA) is used to define this continuous spectrum of formalization. A very rich set of variables is used to find the impact and determinants

of formalization. This study has found that formal firms are more productive than informal firms and degree of informality has impact on marginal productivity. Owner's human capital and family background, firm's age, number of paid worker, distance from registration authority, inspection rate and location effect are found as the main determinants of formalization. It is discussed that the existence of informality in sample firms can be explained partially by dual economy model and partially by rational exit model. Formal firms are found to have higher usage of intermediate inputs, especially machinery and ICT and have better access to utility services and wider customer segments.

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Chapter 1: Introduction

1.1 General Background

Manufacturing industry is the key route for many developing countries in fostering growth and achieving higher per-capita income. Following the example of industrialized Japan and Germany after second world-war, many nations systematically tried to increase national income and alleviate poverty through industrialization. The agriculture sector, even after materializing a production evolution, already has shown its limitation in creating adequate employment opportunities for the populous developing countries, especially in Asia. While comparing with trade or service sectors, manufacturing industry shows higher absorption capacity in employment generation. The emergence of trade or service sectors is dependent on certain economic development and favorable infrastructure which are inadequate in most developing economies. Also, success of these sectors is not associated with the expansion of human engagement. So, it is industrial sector, represented by manufacturing, that materialized the phenomenal economic growth and employment creation in the 'Asian Tigers'-Singapore, South Korea, Hong Kong and Taiwan and in 'the factory of the world' China. The same is applicable to a number of Asian economies who are coming out of poverty trap by creating huge employment through industrialization (Sonobe & Otsuka, 2011). Despite recent economic development, more than 1.6 billion people in Asia were living below 2 USD a day in 2010 (Wan and Sebastian, 2011). At the same time, open market economy has opened up the opportunity of enormous growth for manufacturing sector. In spite of the argument of ineffectiveness of industrial policy by a section of researchers, the role of government and policymakers in promoting successful industrialization is a proven fact where carefully

adopted industrial policies address market failure (Sonobe and Otsuka, 2011). So, policymakers have been keen in developing proper policy framework for sustainable socio-economic development of their nations (Ohno, 2006).

As a representative developing country in Asia, Bangladesh was traditionally an agriculture based-economy. But now, it is trying to become an industrialized nation riding on a fast growing manufacturing sector. Under the leading role of its world-top garment industry, contribution of manufacturing to national income is increasing for years. The operational condition of the manufacturing firms is diverse and this diversity is required to be addressed while setting policy for them. And to sustain the growth trend in the sector, the factors affecting firms' operational efficiency are needed to be explored. For example, to support the growth of the firms, top manager or owner should possess entrepreneurial ability. Proper application of manager's human capital can ensure innovation in the firm and thus its expansion and survival. So, investment in developing human capital of managers is a precondition for the survival of the firms in long run. At the same time, even highly capable mangers can do little when there is not enough finance to support their expansion plan. The policymakers have room to address the market failure in credit market to support firms with enough finance. Also, firms that are innovative are required to be identified so that such financial services are properly utilized. Even when firms have enough to invest, they may not know where to invest effectively and what will be the possible benefit from alternative investment plans; this is a fact that firms learn through their operational experience. So, the role of human capital of manager, financial service and firm age, among other factors, are needed to be investigated robustly in building an effective industrial policy and to invest in required factors to sustain under emerging competition.

A significant attribute of the manufacturing sector of developing countries is the presence of large informal firms. Sonobe and Otsuka (2011) found that these firms dominate the developing economies and often stay in cluster. But their impact is mostly underestimated due to unregistered status and institutional low-visibility. The way economic transition and growth in developing nations have occurred through industrial expansion, similarly the growth in industrial sector is boosted by the emergence of huge informal firms. Alike other countries primed in agriculture previously, the economic activities in Bangladesh are still dominated by informality. This is a perspective that is recognized in most of the emerging economies during their transition phase. Till now, majority of the workforce in Bangladesh is found to be engaged in informal sector and they face lower benefit, less social protection, and higher vulnerability to poverty (Bangladesh Bureau of Statistics, 2013). A number of theories have been discussed as the possible reason for the existence of informal firms including regulatory failure, unfavorable tax rule and business environment, and underdeveloped socio-economic status; but their role in transition economy is more complex and interesting than these arguments. The ability of employment creation, income generation for marginal economic class and supporting power for economic transition make informal firms an inseparable part in the study of manufacturing sector in developing countries.

1.2 Motivation

Recently, the manufacturing sector in developing countries are facing a new era of challenges. Gradual integration into open market economy has removed the protection-shield that has been safeguarding the sector from immense international competition. For example, Bangladeshi garment firms enjoyed a long spell of overwhelming success with

special quota facility in USA market and also in Europe and under the protection of trade policy that hindered fabrics from abroad to move inside Bangladesh. But both of these facilities are under threat. Fabrics are pouring in from abroad at much higher rate than before, especially from China and special export facility to USA market has been terminated. Similar uncertainty is likely for the European market as well, especially moving up in the national income level will gradually remove these special treatments. So, with a limited basket of export items, political uncertainty and changed international scenario, firms can no longer sit back with their inherent capacity rather are required to enhance efficiency and competency not only to grow, but to survive as well. In this respect, studying the efficiency status and its determinants would be beneficial for Bangladeshi manufacturing firms.

Stochastic frontier analysis (SFA), the most popular parametric technique for production frontier and efficiency estimation, has been widely used with two considerable shortcomings. The assumption of time-invariant efficiency is not applicable to panel data and is a very restrictive assumption for a dynamic industry like manufacturing. In addition, considering all the time-invariant effects as firm inefficiency is a big exclusion of reality where firms have inherent attributes that are not inefficiency. These assumptions create strong bias in efficiency estimation. On the other hand, many SFA models, used for investigating performance determinants, adopted flawed and incorrectly specified two-step methods. In the first step, efficiency or productivity is being estimated with an independent assumption of inefficiency. In the second step, this assumption is violated by explaining estimated inefficiency scores through a set of explanatory variables. Excluding the dependency on these exogenous determinants in the first step or violating the independent assumption of inefficiency in the second step makes two-step methods

statistically unacceptable. An advanced SFA model developed by Greene (2005a, b) addresses both issues with a heteroscedastic assumption and can be argued to be one of the best SFA model with robust model specification. But surprisingly, we do not have any large scale application of Green's heteroscedastic model so far, especially not for the performance analysis of manufacturing firms. All these facts motivate to undertake a study that will look into the efficiency of Bangladeshi manufacturing firms and would find the exogenous factors affecting firm performance using a robust and heteroscedastic SFA model which considers time-varying efficiency and firm specific effects effectively.

By the year 2021, Bangladesh is planning to achieve the status of a middle income nation. This goal can be attained with the fulfillment of two prerequisites. First, to eliminate poverty by ensuring proper employment and income. Second, to increase productivity in the nation under industrialization to ensure efficient allocation of resources. In Bangladesh, transition from agricultural based economy to industrialization is drawing a large number of unskilled labor. The formal sector, with its limited capacity, cannot incorporate majority of these labors. Hence, informal sector has thrived by appointing majority of the total work-force. Informal manufacturing firms are offering employment opportunity to women, unskilled and low-skilled workers and thus is leading economic inclusion. Small and micro firms are the center of interest for both productivity improvement and employment generating programs of the government. Additionally, to develop a better social framework, sustainable infrastructure for industrial expansion, citizen welfare and to improve citizen's quality of life, the government is under demand of increasingly higher public spending. With a move for more economic freedom, reliance on foreign grants is being reduced and dependency on tax revenue is heavily increasing. One of the strategy of increasing tax collection is to bring informal firms under formal

framework. All these issues ask for a rigorous exploration of the development, transition and operational process of informal firms to set proper industrial and tax policy. In spite of massive contribution, conventional surveys mostly excluded informal firms due to their unregistered, mobile and small nature. Another significant weakness related to informality studies is in its definition. Most researchers considered informality through a single and discrete indicator. But when we look into the business registration, business practices, marketing standards, affiliation, innovation, customer access and financial inclusion of firms, we find a range of formalization parameters based on which firms span from very informal to very formal. So, any quantitative study for informal firms should consider this continuity trait while defining them. Therefore, to develop an effective industrial policy, to ensure proper transition in economic activities, to boost productivity, and to expand the size of formal sector with industrialization, informal manufacturing firms of Bangladesh must have to be studied with deeper understanding of their background incentive, transition process, strength and weakness. Because Bangladesh represents an ideal example of developing country under industrialization and economic transition, findings for the manufacturing industry of this country have greater policy implication for other developing economies as well.

1.3 Objective

The objective of this dissertation is therefore two folds. In the first part, we want to investigate the efficiency status of manufacturing firms of Bangladesh. For this, we would use a random effect SFA model which considers inefficiency as time-varying and separates firm effects from inefficiency. It will provide us the opportunity to see the impact of separating firm effects on estimated efficiency scores and thus to investigate

unobserved heterogeneity among firms. At the same time, we would introduce the exogenous influence on inefficiency by heteroscedastic consideration so that we can estimate efficiency determinants in a single-step estimation process. Given the dominance of informal firms in Bangladesh manufacturing sector, we want to find whether formal firms have higher productivity than informal firms. For this purpose, we would use a new and 'continuous informality' definition and want to show statistically that it represents informality phenomenon better than any discrete definition. Aiming at policy recommendation, we want to explore the determinants of firms' formalization process. We also want to discuss the reason behind the existence of informal firms and the route through which formal firms perform better.

1.4 Contribution

In our first study, we have showed that separating firm specific effects from inefficiency heavily increases estimated efficiency score by successfully applying true random effect SFA model. At the same time, we have found the determinants of efficiency, which includes top manager's human capital, firm age and financial services, using a heteroscedastic specification of true random effect model. To the best of our knowledge, this is the first large-scale application of heteroscedastic true random effect model to investigate efficiency and its determinants in a single-step estimation process.

Our second study is one of the first academic studies, as far as we know, to show that informality is better defined as a continuous process rather than discrete and we used principal component analysis in this respect. With this new definition of informality, we have showed higher productivity for more formalized firms. We have pointed out determinants of formalization indicators. Especially, discussion of the role of detail

family background and personal attributes of owner, distance from registration authority and inspection rate are highly valued contribution to informality studies.

1.5 Organization

After this introductory chapter, we present the first study on efficiency and its determinants in manufacturing firms in 2nd chapter. In 3rd chapter, study on the informality is documented. In each of these chapters, we first discuss the general background of the study with motivational aspect. Then we present the status of current literatures on the selected study topic, gaps in current knowledge and corresponding research questions to address the gaps. It is followed by a brief portrayal of current industrial status. Then we discuss research methodology, variables and data used in these studies. After that, result of the study is discussed followed by a brief conclusion. Each of chapter-2 and chapter-3 is followed by analytical tables and figures for corresponding studies. In chapter 4, we discuss the policy implications of studies from chapter-2 and chapter-3. At the end, we present a brief summary of the dissertation.

Chapter 2: Efficiency and its Determinants in Manufacturing Firms - An Application of True Random Effect Model

2.1 Introduction

Efficiency study of manufacturing firms has become an interesting topic for researcher for last few decades, especially for developing countries. Liberalization of the markets, flow of foreign investment and regulatory reforms have drawn the attention of academics to investigate the impact of these changes on firms' performance. Promoting industries has been suggested as a strong pathway to reduce poverty and to support economic development in developing nations. Their ability to create employment, generation of income and provision of expansion have made industrial development one of the most viable option for policymakers to promote socioeconomic growth of these countries (Lin and Chang, 2009; Hayami, 1998; Otsuka et al., 2009; Sonobe and Otsuka, 2006). The manufacturing sector of Bangladesh is growing fast and in terms of export value and contribution to GDP, it has become dominant since 1990s when garments firms emerged as a major producer in the world. Manufacturing has become the leading sector among industries to contribute increasingly to national income and growth of GDP. Figure-A1.6 shows the contribution of manufacturing sector in GDP since independence of the country and it can be observed that it increases steadily with varying growth rate. In 1990s, the average contribution was around 10% and became 15%in 2000s. The contribution has reached to 18% in 2014-15 and even higher in real GDP. Contribution to real GDP in fiscal year 2010-11 to 2015-16 were 17.75, 18.28, 19, 19.45, 20.17, and 21.01 respectively. The growth rate of the industry was varying around 8% to 10% by this time. Considering the uncertainty and economic crisis in the last decade, the steady growth of

the industry is encouraging. The combined index of manufacturing production, Quantum Index of Production (QIP) has reached 285 in 2015. After few years of stagnation, the recovery started couple of years ago and peak is being reached recently (figure-A1.7). But the weakness of the export oriented manufacturing industry is its high concentration around few products. In 2013-14, only six of the products were summed up to 86% of the export. Within these six products, only garment products constituted more than 81% in 2015. This is a considerable weak-point of the industry being subjected to higher risk. Also, the sector experienced uncertain growth in recent years revealed from the fluctuating growth rate and decelerating growth in GDP contribution. Exclusion from GSP (Generalized System of Preferences) facility in USA market has been a big shock for readymade garments. It constitutes almost 95% of the export to the USA market and USA is the single most important destination for Bangladeshi export items constituting more than 16% of the export market share. The removal from GSP did not only affect garment sector, but other manufacturing industries as well. European countries rank as the next major destination for export items and this region receives around 45% of Bangladeshi export. EU is also closely observing production and labor standards and the exclusion from special treatment under 'multi fiber agreement' cannot be ruled out. Limited basket of export items, political uncertainty and the possibility of removal from preferential treatments have exposed the sector towards an uncertain future. So, it has become imperative for the firms to allocate their resources more efficiently than any time before and the overall performance of the sector needs to be scrutinized.

Stochastic frontier analysis (SFA) has become a popular tool for efficiency and performance analysis. Its use in the manufacturing industry is particularly supported by the development of production theories which promote specific functional relation

between input and output (Coelli et al., 2005; Le & Harvie, 2010; Major, 2008). Kumbhakar and Lovell (2000) and Fried, Lovell, and Schmidt (2008) have presented comprehensive reviews of literatures using SFA for efficiency and productivity study. One of the reason for the popularity of SFA is its more pragmatic approach to economic problems; for example, it does not consider all the firms to be fully efficient unlike neo-classical models. Non-parametric data envelopment analysis (DEA) is also popular, but its application is questionable when particular functional form is established. Additionally, the incorporation of measurement errors and individual effects are the features of SFA that cannot be attributed to DEA. Earlier SFA models focused either on time-invariant inefficiency or time-varying inefficiency. The assumption of time-invariant efficiency is weak for panel data, especially for manufacturing industry where technical, marketing and organizational dynamics are high. Similarly, considering all the time-invariant effects as firm inefficiency is a big exclusion of reality where firms are supposed to have natural or long-term attributes not related to inefficiency. Griliches and Mairesse (1995, p.23) argued that it is required to consider heterogeneity among firms from the same industry similar to the firms from a different industry. On the other hand, forcing all the time-invariant effects into error term in time-varying models is also unacceptable. These shortcomings have been addressed by Greene (2005a, b) with a SFA model which considers time-varying inefficiency and firm specific time invariant effect. Greene's model has been accepted favorably for its logical structure and distinction between firm effect and inefficiency effect. The most striking attribute of Greene's model is that is allows the incorporation of measurable effects that capture firm specific heterogeneity.

The inspiring growth of the manufacturing sector in Bangladesh has drawn attention of researchers to investigate the growth phenomenon of the sector (Rhee, 1990; Easterly, 2002; World Bank, 2013; Mottaleb and Sonobe, 2011). But statistical consideration of heterogeneity among firms has always been weak in these studies creating biased estimate of performance indicators. The firms in Bangladesh work under diverse operational and business conditions and possess high degree of heterogeneity. So, analyzing manufacturing firms' efficiency using an advanced model that considers heterogeneity properly will be worthy. It is also required to find the determinants of technical efficiency to support firms in building competency under uncertain growth period. The outcome of the study is supposed to have valued implication to industrial leaders and respective policymakers in ensuring sustainable and healthy growth of manufacturing sector.

2.2 Literature Review

2.2.1 Literature Review on Methodology

Technical efficiency has become an interest in development economics being a strong source of productivity growth. Also, its role has been widely discussed in the growth process of enterprises and in relation to the success or failure of firms (Leibenstein, 1966; Jovanovic, 1982 etc.). The study of manufacturing firms' performance has become popular in light of the successful development of industrial nations like Japan and Germany and their followers such as South Korea, Singapore, Taiwan, Hong Kong and recently China. As many countries failed to follow their footsteps, it became an interesting case to find the reason of the possible success or failure. Analyzing determinants of efficiency has become a key point of discussion, especially the role of asset, labor, human

capital, technology, human capital of managers, marketing, competition, innovation, international orientation etc. In one of the pioneer studies in this field, Pitt and Lee (1981) introduced a random effect model to measure the inefficiency of Indonesian weaving industry and found their model best suited for the data, given the methodological development till that time. They found efficiency between 60 to 70 percent and age, size and ownership to be the significant sources of inefficiency difference. Recently, Chapelle and Plane (2005) have investigated the technical efficiency of Ivorian manufacturing sector using four-step DEA method to find the impact of size, operational environment, and technology. They found smaller firms to be more efficient due to simpler managerial structure, incentive for labor and favorable environment. Aggrey, Eliab and Joseph (2010) explored the relation between firm size and technical efficiency using two-step method and found a U-shaped relation between technical efficiency and size for Uganda and Tanzania. Sonobe, Akoten, and Otsuka (2009), Mottaleb and Sonobe (2011) and Nam, Sonobe and Otsuka (2009) showed the strong relation of entrepreneur and top manager's education and experience with performance improvement and expansion in firms in knitwear (Bangladesh, Vietnam) and shoe (Ethiopia) industry. Lundvall and Battese (2000) discussed the effect of firm size and age on manufacturing firms in Kenya. They found size to be positively associated with efficiency and marginal effect of size was positive for older firms. Age was negatively correlated for small textile firms and opposite for larger firms. Sonobe, Akoten, and Otsuka (2011) found strong evidence of the importance of education, experience and firm size for growth and marketing expansion. Oh, Heshmati, and Loof (2014) found capital intensity negatively associated with productivity and pointed to unused capital stock during economic recession. They found firm age positively associated with productivity growth in Korean manufacturing sector.

Fernandes and Isgut (2006) and Blalock and Gertler (2004) studied the impact of export on firm performance. Tan and Lopez-Acevedo (2002) and Aw et al. (2005) tried to explain the effect of human capital development programs. Business environment and research orientation were also the interest of several studies (Dollar et al., 2005; Hallward-Driemeier et al., 2003; Griliches, 1998). Charoenrat and Harvie (2014) recently discussed the impact of firm size, age, ICT adoption, and export on firms' technical efficiency for Thai manufacturing SMEs. While other factors were found positive, impact of firm size was found different in different time periods.

In the most recent study on Bangladesh manufacturing firms, Fernandes (2008) analyzed the impact of human capital, integration into world market, technology, finance, business environment, firm size and age on total factor productivity (TFP). This study used data for period the 1999-2003. It found that smaller firms are more efficient, and age shows a U-shaped relation with TFP. Firms with higher human capital, especially with more experienced managers are supposed to be more productive. Also, export, foreign ownership, R&D activities, and quality certification are found to be positively associated with efficiency. Bank loan was found negatively related while overdraft facility showed positive relation with TFP measure. This study used the data of firms having more than 50 workers, so it is biased towards bigger firms.

Most of the studies investigating the determinants of performance indicators used hugely flawed two-stage models; measuring productivity or efficiency in first stage and regressing efficiency scores against explanatory variable in second stage. The number of studies using single-stage approach, where efficiency score estimation and identification of determinants are carried out together, is rather moderate in number. The pioneer models proposing single-step models are Kumbhakar, Ghosh, & McGukin (1991),

Reifschneider and Stevenson (1991), Huang and Liu (1994), Battese (1992) and Battese and Coelli (1992, 1995). Later, Greene (2005a, b), Kumbhakar and Heshmati (1995) and Wang and Ho (2010) have taken single-stage models to a different level. But till now, we do not have noteworthy application of the newly developed heteroscedastic models for a manufacturing industry. Among studies done so far in Bangladesh, the only study that measures the impact of explanatory variables on firm performance is that of Fernandes (2008). She used TFP as the measure of firm performance. Even considering endogenous growth theory, TFP does not stand for the best indicator of firm's performance. She also used two-step process to find determinants of TFP by estimating TFP in the first step and then running OLS in the second step against explanatory variables. Such assumption results into misspecification of the model. Wang and Schmidt (2002) showed that ignoring explanatory variables in the first step regression would create strong bias in the estimated inefficiency score if frontier parameters and explanatory variables are interrelated. And when they are not interrelated, the dependency of inefficiency score on explanatory variables would cause the estimated scores to be underdispersed in first step and thus would make second step regression biased downward.

Review of literature shows that very few studies systematically addressed heterogeneity among firms while investigating exogenous determinants of efficiency. So, it is required to apply a robust single-step SFA model for manufacturing firms to figure out efficiency determinants and their impact. In this respect, our study proposes the application of Green's 'true' random effect model in the manufacturing sector of Bangladesh. The study sheds light on the relation of exogenous determinants with efficiency while controlling for firm effects effectively.

2.2.2 Literature Review on Bangladeshi Manufacturing Industry

The number of studies that have analyzed emerging Bangladeshi manufacturing industry is not rare, though very few studied the industry as a whole. The manufacturing sector has been helping the country to maintain consistently high GDP growth rate close to 7% for past two decades. It has changed the socio-economic structure of the country and is encouraging to become a middle income nation. Hossain & Karunaratnen (2004) discussed the efficiency change in manufacturing firms using stochastic frontier model for the years of 1978-94. Using 'inefficiency effect' model of Battese and Coelli (1995), they tried to focus on the impact of trade liberalization on technical efficiency of industrial sectors constructed on three digit level. They found technical efficiency to grow from 0.34 in 1978 to 0.68 in 1994. They concluded that both the export oriented and domestically focused sectors were gaining high efficiency after the introduction of liberalized industrial policy. Their generalized likelihood ratio test showed that Cobb Douglas production function is inadequate in describing the manufacturing sector of Bangladesh and translog is the better option. Export orientation was found to be strongly contributing to the improvement of efficiency by reducing X-inefficiency resulted from enhanced international competitiveness. The exchange rate depreciation is argued to reduce anti-export bias over time and thus brought greater export orientation. But they considered the industry at three-digit aggregated level and it is impossible to deduce the impact of explanatory variables on firm level. Their study was supposedly affected by the heterogeneity within aggregated firms and would produce biased result. Krishna and Sahota (1991) studied thirty manufacturing sub-sectors (four-digit) of Bangladesh for the period 1974-1986. In most of these industries, average efficiency was below 50% while 13 industries were above 50% and only 2 industries above 90%. They found the

correlation between technical efficiency and productivity change to be weak. The study lacks proper control of firm effects. With the strong possibility of omitted variable bias and absence of proper control variables, it is hard to conclude on the outcome of this study.

In the most rigorous study on Bangladeshi manufacturing industry, Fernandes (2008) measured productivity and estimated exogenous factors affecting firms' TFP. Though she formulated a panel structure, big part of the study is cross-sectional and is supposed to suffer from endogeneity issue. She used Ackerberg, Caves, and Frazer (2007) method asserting investment as the proxy for missing variables. In a heterogeneous and highly diverse sector, it is difficult to argue that investment can control for all or most of the unobserved shocks. It is a weak assumption especially where investment data is not well documented. Also, this study used recalled information for past years making the data highly vulnerable to biased information. The assumption of invariance of productivity determinants, such as human capital variables, innovation, export orientation and international integration over past years is also a big weakness of this study.

2.3 Brief Outline and Statistics of Manufacturing Industry

The latest survey of manufacturing industry was done in 2012 by Bangladesh Bureau of Statistics (BBS). This survey covered all types of manufacturing firms with at least 10 employees. Our sample mostly consists of firms with more than 10 employee (except 10 firms). The survey estimated that the total number of registered manufacturing firms would be around 42,792. Micro firms (up to 25 worker), having 41% of the share, is the biggest group and large enterprises (more than 100 worker) are the smallest (8%). Textile

industry has the maximum share with 25% of total firms, followed by food industry (20%) and readymade garments (16%). More than five million people are estimated to be engaged in these firms. Large firms engage 59.1% of the total person engaged (TPE) and this figure is only 5.4% for micro firms. More than 61% of the wage and financial benefits are provided by the large firms which is only 4.9% for micro firms. Female employment is highest in large firms being 48% on average. On the other hand, micro industries are mainly dominated by male employee with 84% share. Majority of the labor force is production worker with average 82% share in TPE.

The strength of the sector is heavily skewed towards the large firms in all aspects except firm number. In terms of raw material usage, micro firms are mainly dependent on local sources (86%) followed by small firms (25 to 50 worker). On the contrary, large and medium enterprises (51 to 100 worker) are primarily dependent on foreign raw materials using 59% and 62% foreign material respectively. In terms of gross output, large type firms produce around 47% of the total industrial output followed by medium industries (47%). Micro firms produce only 5% gross output. Following similar trend, value added by large firms is 47% which is more than double from medium firms. Value added per worker is also strictly increasing from micro towards large firms. Readymade garment industry is the single most dominant sub-sector with 35% share in value added, followed by textile (14%), basic metal (13%) and food (11%). Large type firms pay the highest amount of indirect tax (58%) collected from manufacturing sector. This figure is 20% for medium, 19% for small and only 3% for micro industries. The distribution of fixed asset of the sector is presented in table-A1.11. Large enterprises hold majority of total asset with 48% share. Machinery and equipment constitute the largest share of fixed asset in the sector with 45% share followed by building (resident and factory) with 21%

share. Most of the firms (59%) have capacity utilization over 75%. Within the estimated population of firms, only 103 firms are government owned and 35 are jointly owned by government and private enterprises. All other firms are owned by private enterprises. Out of them, 263 are foreign owned and 160 are joint venture. All the firms with government or foreign ownership are either medium or large enterprise. Intermediate cost is the major component in total cost table for all firm groups.

2.4 Methodology

2.4.1 Development of True Random Effect Model

SFA considers an optimal level of output, cost or input to be efficient and any shortfall from that level is attributed to inefficiency. But all the shortfall should not be attributed to inefficiency and in the advanced models, it is addressed by random shocks and firm effects. There have been a number of extensions of SFA used in different literatures with different objectives. The fixed effect model proposed by Schmidt and Sickles (1984) belongs to the first group of successful applications. Their initial model was,

$y_{it} = \alpha + f(x_{it}, \boldsymbol{\beta}) + v_{it} - u_i$ (1)

where α is a common intercept, $f(x_{it}, \boldsymbol{\beta})$ is the production technology, x_{it} is the vector of inputs, $\boldsymbol{\beta}$ is the vector of technology parameters to be estimated, v_{it} is the random two-sided error term, and u_i is the non-negative inefficiency term which is always one-sided. u_i parameters are considered fixed; so, α_i (= $\alpha - u_i$) can be estimated from coefficient of firm dummies. Inefficiency is represented by $\hat{u}_i = max\{\acute{\alpha}_i\} - \acute{\alpha}_i \geq 0;\ i = 1,\ldots,N.$ (2)

Though this model does not requires distributional assumption, it excludes the possibility of including time-invariant variables as u_i is allowed to be correlated with such regressors.

They later proposed the random effect version considering u_i to be a random variable but maintaining the same assumption about v_{it}. Elaborate relation of this model can be shown as:

$$y_{it} = \alpha^* + f(x_{it}, \boldsymbol{\beta}) + v_{it} - u_i^* \quad (3)$$

where $E(u_i) = \mu > 0$, $\alpha^* = \beta_0 - \mu$, $u_i^* = u_i - \mu$

Feasible least square (FGLS) method can easily estimate this model for panel data and inefficiency estimate is obtained from $\hat{u}_i = \max\{u_i^*\} - u_i^*$. In this random version, the inefficiency is uncorrelated with fixed regressors though no assumption is made for the distribution of u_i.

Another set of studies, including Pitt and Lee (1981), Kumbhakar (1987), and Battese and Coelli (1988), proposed a different version of random effect model where half-normal or truncated-normal distribution is assumed for u_i and maximum likelihood (ML) method is used for the estimation. Jondrow et al. (1982) showed that the distributional assumption is required to distinguish between inefficiency and noise terms. At this phase of development, Battese & Coelli (1995) model is the most famous. This model, widely known as inefficiency effect model, received its recognition due to distinctive features that generalized previous models and made it suitable for wider range of applications. The core structure of the model is as follow:

$$lny_{it} = \beta_o + f(x_{it}, \boldsymbol{\beta}) + v_{it} - u_{it} \quad (4)$$

where $u_{it} = \boldsymbol{\delta z_{it}} + \varepsilon_{it}$

Here, v_{it} is the random error term and u_{it} is the inefficiency obtained by the truncation of a normal distribution with mean $\boldsymbol{\delta z_{it}}$ and variance σ_u^2. Modeling of inefficiency is more general and flexible in this model compared to previous models. In another group, Kumbhakar (1991), Kumbhakar and Heshmati (1995), and Kumbhakar and Hjalmarsson

(1993, 1995) proposed advanced models which identify time-invariant and time-varying inefficiency.

But the main criticism of these models is either they force all unobserved time invariants effects into error term (in time-varying inefficiency) or include them all into inefficiency effect (time-invariant inefficiency). Thus they produce biased result, especially in a manufacturing sector suffering from variety of latent heterogeneity. Production frontier in these models is only capable of handling observable fixed effects and thus overemphasize their influence having no control and consideration for unobserved firm effects. Greene (2005a, b) was the first to address this problem in controlling latent heterogeneity by true random effect (TRE) model. TRE treats firm specific unobserved heterogeneity separately from inefficiency. The correlation between exogenous variables with firm effects as well as other hidden correlations are unraveled from inefficiency estimate in this model. The basic structure of Greene's random effect model is -

$$lny_{it} = \beta_o + f(x_{it}, \boldsymbol{\beta}) + \alpha_i + v_{it} - u_{it} \qquad (5)$$

where-

β_o - is the fixed intercept term

α_i - is a random variable that represent random firm effects or time invariant heterogeneity and is free of any distributional assumption;

v_{it} - is the random two-sided error component assumed to be independently and identically distributed with normal distribution $N(0, \sigma_v^2)$

u_{it} – is the time-varying inefficiency effect with either half-normal, truncated-normal or exponential distribution and is always non-negative ($u_{it} \geq 0$).

Kumbhakar and Lovell (2000) referred from Greene (1990) that rank-correlation between different distributional assumptions (half-normal, exponential, truncated-normal, gamma) is quite high. Though mean efficiency is sensitive to the choice of distributional assumption, ranking of the producers based on their efficiency scores and the composition of the upper or lower efficiency groups are not sensitive to the choice of distribution. Kumbhakar and Lovell (2000) suggests that the use of relatively simpler distributional assumption, such as half-normal or exponential, is preferred to more general ones such as truncated-normal and gamma. They also said that the choice between these two assumption, both in which only a single parameter is used to define density, is of without significant consequence. So, we have chosen the simplest and most consistent (in terms of estimation) half-normal distribution for u_{it} in TRE model. Distribution of u_{it} is then defined as-

$u_{it} \sim N^{+}(0, \sigma^2_{uit})$

This model can be estimated with ML method. The likelihood function is defined with the variance parameter-

$\sigma_s^2 \equiv \sigma_u^2 + \sigma_v^2$, where σ_u^2 and σ_v^2 are the variance of u_{it} and v_{it} respectively.

We have used Jondrow et al. (1982) method to calculate inefficiency (known as JLMS) by taking expected value of the distribution of u_{it} conditional on its random component part-

$\hat{u}_{it} = E(u_{it}|\varepsilon_{it})$ (6)

where $\varepsilon_{it} = v_{it} - u_{it}$

Technical efficiency is calculated as: $TE_{it} = \exp(\hat{u}_{it})$

All the firms in our sample have panel (from 2 to 3 years) observations. A panel model is more efficient in estimating technical inefficiency, in disentangling inefficiency

from random noise component and is more flexible and robust with distributional assumption. With comparatively large number of firms but smaller time dimension and in the presence of time invariant regressor, we preferred random effect model to fixed effect model.

Though the application of Greene's model has become popular, nature of the application is quite limited in the sense that most of the studies used limited parameter and data. Some recent application of Greene's model can be found in Drine and Nabi (2010), Berta et al. (2010), Abid and Drine (2011), Hailu and Tanaka (2015) etc. Most of them have used the model to estimate efficiency without considering exogenous determinants of efficiency. We have not come across any literature that has introduced heteroscedasticity in *u* and *v* explicitly to find efficiency determinants using TRE. The reasons are, firstly, unavailability of proper explanatory variables in survey data and secondly, difficulty in applying TRE model with heteroscedastic assumption. With the recent development in programming tools and availability of rich micro-data, we are able to overcome these drawbacks.

2.4.2 Heterogeneity and Exogenous Determinants of Efficiency

Initial development of SFA models disregarded heteroscedasticity and also did not provide any platform to introduce the influence of exogenous determinants of (in)efficiency. Kumbhakar and Lovell (2000, page 115) discussed that the consequence of ignoring heteroscedasticity in SFA is more severe compared to linear models. If v_i is heteroscedastic, ignoring it would create bias in estimating efficiency score and intercept term though frontier estimate would be consistent. But ignoring heteroscedasticity in

inefficiency term u_i creates bias both in frontier estimate and (in)efficiency score estimation.

Caudill and Ford (1993), Caudill, Ford, and Gropper (1995) and Hadri (1999) have particularly shown the way (we will refer to this approach as het-1) how to incorporate heteroscedasticity in variance. Their common approach was to consider half-normal distribution of the inefficiency term with a variance defined by exogenous variables -

$u_i \sim N^+(0, \sigma_{ui}^2)$ (7)

where, $\sigma_{ui}^2 = exp(\acute{z}_i \boldsymbol{w})$ (8)

Here, z_i is the vector of exogenous explanatory variables including a constant term and $\boldsymbol{w}$ represents corresponding coefficient vector. These heterogeneity in u_i are not related to production process directly but capture firm effects. Following the same method, heteroscedasticity is introduced to idiosyncratic error term v_i by Hardi (1999) as:

$v_i \sim N(0, \sigma_{vi}^2)$ (9)

where $\sigma_{vi}^2 = exp(\check{h}_i \boldsymbol{\gamma})$ (10)

The exogenous set $\boldsymbol{z}$ and $\boldsymbol{h}$ may or may not be same though for simplicity it is suggested to consider the same set of variables. Interestingly, these variables may include some $\boldsymbol{x}$ variables as well including time or technology trend.

Though het-1 model was initially proposed for addressing heteroscedasticity, it can be used as a way to observe the relationship between inefficiency measure and its explanatory variables. It is one of the two ways exogenous determinants can influence inefficiency in a single-step method by scaling the distribution of inefficiency. Being free from all the flaws of two-step procedure, this single-step procedure estimate the relationship between inefficiency and its determinants together with all frontier

parameters. In a half-normal model, distribution of u_i is defined as (7) and σ_{ui}^2 is the only parameter of the model that can be parameterized with exogenous determinants. For het-1 specification, the unconditional mean of inefficiency is a function of σ_u^2 (Kumbhakar, Wang, & Horncastle, 2015, page 72)-

$$E(u_i) = \sigma_u \left(\frac{\varphi(0)}{\Phi(0)}\right) = exp\ \{\frac{1}{2}(\ln(2/\pi) + \acute{z}_i \boldsymbol{w})\} \qquad (11)$$

Here, φ and Φ are the probability and cumulative density functions of a standard normal distribution, respectively. Now, the relation between $E(u_i)$ and z_i is non-linear and ML estimate of $\boldsymbol{w}$ would not provide much information about the true relational form. The marginal impact of n-th variable of z_i on $E(u_i)$ is expressed as -

$$\frac{\partial E(u_i)}{\partial z[n]} = w[n]\ \sigma_{ui}\ \varphi(0) \qquad (12)$$

This relationship also shows that,

$$\text{sign}\left(\frac{\partial E(u_i)}{\partial z[n]}\right) = \text{sign}\ (w[n]) \qquad (13)$$

So, the sign, and significance of the coefficients of exogenous determinants estimated from ML estimation shows the direction of their relationship with unconditional mean of inefficiency term.

Deriving the relations in (12) and (13) are the best that we can do for a half-normal model. Our TRE model uses heteroscedastic $\boldsymbol{u}$ and $\boldsymbol{v}$ and JLMS estimation technique uses conditional mean of inefficiency $E(u_i|\varepsilon_i)$. There is no study to our knowledge that has derived the marginal effect of exogenous determinants on conditional mean, whether with half-normal or any other distributional assumption. Wang (2002) argued that such derivation is almost intractable especially with heteroscedastic $\boldsymbol{u}$ and $\boldsymbol{v}$. Though Sun & Kumbhakar (2013) tried to derive it, their model is limited to semi-parametric set-up. Homoscedastic assumption for $\boldsymbol{u}$ and $\boldsymbol{v}$ gives us an opportunity to derive monotonous

marginal impact of exogenous determinants on unconditional mean E(u_i); marginal impact on conditional mean E($u_i|\varepsilon_i$) (and variance) can also be inferred from it. But unfortunately, this derivation is available only for truncated-normal distribution of u_i. As one of our main objective with TRE model is to estimate efficiency score and to find significant determinants in this advanced framework, we are content with the discussion of unconditional mean and would focus only on the significance of exogenous variables in explaining inefficiency variance in TRE analysis.

The second way to introduce the influence of inefficiency explanatory variables into SFA model is in the location of the distribution i.e. parameterizing the truncated mean of the distribution. So, it is possible only with the assumption of truncated-normal distribution of inefficiency. Stevenson (1980) first proposed a truncated normal-model (for cross-sectional data) where u_i is defined as-

$$u_i \sim N^{+}(\mu_i, \sigma_{ui}^2) \qquad (14)$$

where μ_i is the truncation mean of the distribution. The first group of models to incorporate exogenous effects in inefficiency was truncated-normal models proposed by Kumbhakar et al. (1991) and Reifschneider and Stevenson (1991). Later, Huang and Liu (1994) and Battese and Coelli (1995) followed up similar model. These models (we will refer to as het-2) considered the distribution mean μ_i as a linear function of explanatory variables as follows-

$$\mu_i = z_i'\delta \qquad (15)$$

here $\boldsymbol{\delta}$ is the coefficient vector of determinants. This model offers better flexibility than half-normal model as we have unit-specific mean of the pre-truncated distribution. In het-2 model, u_i and v_i are considered homoscedastic.

In the argument of the superiority between het-1 and het-2 to explain exogenous influence in inefficiency, Wang (2002) says that none of them have clear advantage over the other and combining them would definitely provide a more reasonable structure compared to the individuals. The conditional and unconditional mean and variance of u_i include both of μ_i and σ_{ui} and thus jusdtifies the parameterization of both components. Wang (2002) showed the way to combine het-1 and het-2 and proved that it accommodates the non-monotonic relationship between inefficiency and its determinants. Considering Wang's (2002) approach i.e. with the assumptions,

$\mu_i = \acute{z}_i\delta$ and $\sigma_{ui}^2 = exp(\acute{z}_i w)$ (16)

the marginal effect of n-th element of z_i on unconditional mean and variance is as follows (Kumbhakar et al., 2015, section 3.4.4.5)-

$$\frac{\partial \mathrm{E}(u_i)}{\partial \mathrm{z[n]}} = \delta[\mathrm{n}]\,[1- \Lambda_\mathrm{i}\,[\varphi(\Lambda_\mathrm{i})/\Phi(\Lambda_\mathrm{i})] - [\varphi(\Lambda_\mathrm{i})/\Phi(\Lambda_\mathrm{i})]^2] + w[\mathrm{n}]\,(\sigma_{\mathrm{ui}}/2)[(1+ \Lambda_i^2)\,[\varphi(\Lambda_\mathrm{i})/\Phi(\Lambda_\mathrm{i})] + \Lambda_\mathrm{i}\,[\varphi(\Lambda_\mathrm{i})/\Phi(\Lambda_\mathrm{i})]^2] \quad (17)$$

$$\frac{\partial \mathrm{V}(u_i)}{\partial \mathrm{z[n]}} = \delta[\mathrm{n}]/\,\sigma_{ui}\,[\varphi(\Lambda_\mathrm{i})/\Phi(\Lambda_\mathrm{i})]\,(\mathrm{E(u_i)} - \mathrm{V(u_i)}) + w[\mathrm{n}]\,\sigma_{ui}^2\,\{1- \frac{1}{2}\,[\varphi(\Lambda_\mathrm{i})/\Phi(\Lambda_\mathrm{i})]\,(\Lambda_\mathrm{i} + \Lambda_i^3 + (2+ 3\Lambda_i^2)\,[\varphi(\Lambda_\mathrm{i})/\Phi(\Lambda_\mathrm{i})] +2\,\Lambda_\mathrm{i}\,[\varphi(\Lambda_\mathrm{i})/\Phi(\Lambda_\mathrm{i})]^2)\} \quad (18)$$

where $\Lambda_\mathrm{i} = \mu_i/\sigma_{ui}$ and w[n] and δ[n] are corresponding coefficient.

If we consider homoscedastic u_i, then w[n]=0 and $\sigma_{ui} = \sigma_u$, and these reduce to het-2 model (which is homoscedastic). Then equation (17) becomes-

$$\frac{\partial \mathrm{E}(u_i)}{\partial \mathrm{z[n]}} = \delta[\mathrm{n}]\,[1- \Lambda_\mathrm{i}\,[\varphi(\Lambda_\mathrm{i})/\Phi(\Lambda_\mathrm{i})] - [\varphi(\Lambda_\mathrm{i})/\Phi(\Lambda_\mathrm{i})]^2] \quad (19)$$

Here, $[1- \Lambda_\mathrm{i}\,[\varphi(\Lambda_\mathrm{i})/\Phi(\Lambda_\mathrm{i})] - [\varphi(\Lambda_\mathrm{i})/\Phi(\Lambda_\mathrm{i})]^2] = \mathrm{m_2}/\sigma_u^2$ (now, $\sigma_{ui} = \sigma_u$ = constant) (20)

$\mathrm{m_2}$ is the second moment of u_i (variance) and is positive. Thus, $(\mathrm{m_2}/\sigma_u^2)$ is also positive.

So, $\frac{\partial \mathrm{E}(u)}{\partial \mathrm{z[n]}} = \delta$[n] x ($m_2/\sigma_u^2$) (21)

Equation (21) shows that the marginal effect is the slope coefficient multiplied by a positive adjustment term. Hence,

sign $(\frac{\partial \mathrm{E}(u)}{\partial \mathrm{z[n]}})$ = sign (δ[n]) (22)

So, the marginal effect has the same sign of the slope coefficient δ[n]. From equation (18), it can be shown that the same argument is applicable to the marginal impact of determiants on unconditional variance V(u_i). Hence, the relation of exogenous determinants with unconditional inefficiency mean and variance is monotonic i.e. same sign for all the obeservations of the sample with het-2 assumption and the direction of relation is represented by the sign of coefficient $\boldsymbol{\delta}$. But for heteroscedastic consideration, parameterized σ_{ui} would make the derivation comlex and the relation becomes non-monotonic depending on the value of the determinants and thus may change its sign within sample firms. The same discussion is applicable to marginal effect on variance. Similar to half-normal distribution, it is almost intractable to derive the marginal impacts on conditionals mean E($u_i|\varepsilon_i$) and conditional variance V($u_i|\varepsilon_i$), especially for heteroscedastic assumption (Wang, 2002). But the advantage of truncated-normal model is that for homoscedastic u_i and v_i (het-2), marginal impact on E($u_i|\varepsilon_i$) is the same as the first term of right hand side of equation (17). In this case, we need to replace μ_i and σ_{ui} as follows-

$\mu_* = \sigma_v^2 \mu_i - \sigma_u^2(y_i - x_i\beta)/(\sigma_v^2 + \sigma_u^2)$ (23)

$\sigma_* = \sigma_v \sigma_u/\surd(\sigma_v^2 + \sigma_u^2)$ (24)

We see from equation (21) and (22) that the marginal effect is monotonic and represented by the coefficient $\delta[n]$ for conditional mean $E(u_i|\varepsilon_i)$ as well. Similar argument is applicable to conditional variance $V(u_i|\varepsilon_i)$ in model het-2.

Inspired by the advantage of truncated-normal model in explaining relationship between inefficiency and exogenous variables and to support findings from TRE analysis, a model with Wang's (2002) specification (equation 15-16) will be worthy to apply. It will bring significant virtue in another way. We tried panel TRE model with truncated-normal distributional assumption of u_{it}, but it failed to converge in STATA. The difficulty in converging this more complex specification of TRE is acknowledged by Belotti and Ilardi (2012) as well who pointed to the ultra-sensitive nature of the model. So, we have considered all the pooled cross-sectional observations to run a cross-sectional analysis with truncated-normal distributional assumption of inefficiency. This analysis would supplement findings from panel TRE study and would help in commenting more vigorously on the relations between exogenous determinants and (in)efficiency. The model is a cross-sectional adaptation of Wang's (2002) model and stands as-

$$lny_i = \beta_o + f(x_i, \boldsymbol{\beta}) + v_i - u_i, \qquad (25)$$

where u_i is defined by (14-16) and for v_i is defined as-

$$v_i \sim N(0, \sigma_{vi}^2) \qquad (26)$$

and $$\sigma_{vi}^2 = exp(\check{h}_i\gamma), \qquad (27)$$

2.4.3 Model Specification

Though Cobb-Douglas (CD) production function is simpler, translog function has some advantage over CD. It is more flexible in incorporating second order terms and thus

provides opportunity to measure marginal impact of input variables more accurately. Also, the elasticity of substitution is not restricted to unity unlike CD model. Christensen, Jorgenson and Lau (1973) has found the assumption of CD production function to be unrealistic especially in complex and multiproduct production process and showed the applicability of translog function. Detail functional form of our panel TRE model is as follows-

$$lny_{it} = \alpha_i + \beta_l\, lnL_{it} + \beta_k\, lnK_{it} + \beta_m\, lnM_{it} + \tfrac{1}{2}\beta_{ll}(lnL_{it})^2 + \tfrac{1}{2}\beta_{kk}(lnK_{it})^2 + \tfrac{1}{2}\beta_{mm}(lnM_{it})^2 + \beta_{lk}(lnL_{it})(lnK_{it}) + \beta_{lm}(lnL_{it})(lnM_{it}) + \beta_{km}(lnK_{it})(lnM_{it}) + \beta_t Year_t + \tfrac{1}{2}\beta_{tt}Year_t^2 + \beta_{c1}Innovation_{it} + \beta_{c2}Export_{it} + v_{it} - u_{it} \quad (28)$$

where y_{it} is the output, L_{it} is labor input, M_{it} is intermediate input, K_{it} is capital, *Year* is year effect, *Innovation* is innovation status of the firm, *Export* is the export percentage in annual sale and $\boldsymbol{\beta}s$ are corresponding coefficients to be estimated. As exogenous determinants (we assumed same variable set for z_{it} and h_{it}), to explain heteroscedasticity in u_{it} and v_{it} (as in 16), we used firm age, top manager's experience and education, and access to short term (overdraft) and long term (bank loan or line of credit) financial services.

The pooled cross-sectional analysis with (25)-(27) specification is-

$$lny_i = \beta_o + \beta_l\, lnL_i + \beta_k\, lnK_i + \beta_m\, lnM_i + \tfrac{1}{2}\beta_{ll}(lnL_i)^2 + \tfrac{1}{2}\beta_{kk}(lnK_i)^2 + \tfrac{1}{2}\beta_{mm}(lnM_i)^2 + \beta_{lk}(lnL_i)(lnK_i) + \beta_{lm}(lnL_i)(lnM_i) + \beta_{km}(lnK_i)(lnM_i) + \beta_t Year_t + \tfrac{1}{2}\beta_{tt}Year_t^2 + \beta_{c1}Innovation_i + \beta_{c2}Export_i + \beta_{id}IDs + v_i - u_i \quad (29)$$

Here, *IDs* are the industrial dummies for garment, textile, leather, foods, chemical and electronics sectors (default is other sectors). To define heterogeneity in inefficiency mean (μ_i) and variances (σ_{ui}^2, σ_{vi}^2), the same set of determinants as TRE model is applied.

We have used STATA to estimate model (28) and (29). Other competing SFA models are also estimated to check robustness of our result, especially to observe the effect of considering firm specific effects while calculating efficiency score. Among the weaknesses in SFA, the most restrictive fact is the distributional assumption of inefficiency *(u)* and error term (*v)*. The shapes of *u* and *v* may be similar but this problem arises primarily in small cross-section of normal-gamma model. For our normal-half normal TRE model, the most severe problem may occur when one of *u* and *v* is responsible for most of the assumed distribution for error term ε, and in such case, the model fails to produce effective estimation result. But our estimation is free from this problem as the gamma (γ) value of the regression is not too high nor not too low rather within an acceptable range.

2.4.4 Variables

2.4.4.1 Inputs

In production theory, capital and labor are considered as the most basic inputs. With the development of industrial sector, conventional theory accommodated three more inputs- material inputs, purchased services, and energy (Coelli, Rao, O'Donnell, & Battese, 2005). These three are termed together as intermediate input. While few literatures considered them distinctively, most studies used the aggregated value of intermediate inputs in production function. We also used the aggregated value. In addition to inputs, we will discuss below other variables used in production frontier.

Labor: In the production process, labor is a basic and mandatory input and one of the main items of firm's expense. Though apparently it seems simple to measure the unit of labor engaged in production process, there are different aspects to consider to

make an accurate measure through a single aggregated variable. It is generally measured by either number of person employed, number of working hours of labor, number of full time equivalent employee or with total wage and salary bills. While considering the number of employee, it is required to address the issue of part-time and full-time worker due to their difference in contribution to production process. Without the information on the contribution of these employee types, the number of employee does not effectively represent labor. In our dataset, the number of full-time permanent worker is mentioned explicitly. But the number of full-time temporary worker is mentioned only for the year-end and no information on temporary worker's contribution is available. So, we cannot consider number of employee to represent labor input. Hailu and Tanaka (2015) mentioned that a number of literature including Hossain and Karunaratne (2004), Keramidou and Mimis (2011), Kim (2003), and Sehgal and Sharma (2011) used the sum of permanent and temporary labor as labor input, but it is not clear how they have accounted for the vast difference in the respective contribution of labor categories. They acknowledged that their choice may led to biased result. Total labor hour is a much better indicator for true labor input, except the fact that it does not consider labor input quality. In a labor market like Bangladesh, where the number of temporary worker is high in the industry and the documentation of used labor is poor, working hour is not available for many of the firms. So, we have used another option following the guideline in Coelli et al (2005), total wage and salaried bill to represent labor input. It was successfully used in a number of literature including Aggrey, Eliab, and Josep (2010). Most of the manufacturing firms in Bangladesh follow close wage structure inspired by the minimum wage guideline for garments sector. Though the minimum wage rule is applicable to low level production worker (either temporary or permanent), they are majority in number

and form the core of labor input. It may be argued that the wage and benefit of administrative staff and managers are much higher than the production worker; but in the highly competitive labor market, such benefit is mostly based on experience and skill level of employees. Aggregated total wage and financial benefit is supposed to represent both the working hour and the labor quality in a better way compared to the number of employee. Most of the sample firms are either located in export processing zone or near the capital and low-skilled production worker in available in the country. So, the difference of industry or area would not affect salary range significantly in our sample. The value has been deflated using fixed price deflator for year 1996 to accommodate the effect of price change across years.

Capital (Total Asset): Coelli et al. (2005) discussed that proper measurement of the capital input is a considerable challenge. The core difference of capital from the other two inputs, labor and intermediate input, is that capital is a durable input that is being used across years. But labor and intermediate inputs are used within a particular period of time. Several issues are to be considered while using any particular method of capital measurement. All these issues led to a wide range of choice and methodology. In the OECD manual of Measuring Productivity (2001) and Measuring Capital (2^{nd} edition, 2009), the standard methods are referred in detail. A number of alternative measures for capital input have been used for manufacturing industry, such as book values of fixed assets (Hossain and Karunaratne, 2004), amount of tangible fixed asset (Kim, 2003), replacement cost for machinery and equipment (Lundvall and Battese, 2000; Ngui-Muchai and Muniu, 2012; Aggrey et al. (2010), fixed capita stock (Sehgal and Sharma, 2011) etc. Though replacement cost is considered as a good candidate for capital measure, this is missing for many firms in our data. Also, the validity of replacement cost data is

questionable in many cases as it is highly subjected to the judgment and knowledge of respondent. So, we have chosen net book values of fixed asset as the capital input. The accounting definition of net book value is the original cost of an asset, adjusted with accumulated depreciation, accumulated depletion, or accumulated amortization, and with accumulated impairment. It consists of land, buildings, machinery, vehicle and equipment values. Similar to labor, this value has been deflated against fixed price of year 1996.

Intermediate Input: We have used intermediate consumption as the third input variable. Coelli et al. (2005) discussed that this input is of much importance in some sectors including manufacturing. Sometimes it is termed as production cost. It includes the cost of raw material, purchased service, electricity and fuel. We have used aggregated cost of these items. Recently, it has been successfully used by Hailu and Tanaka (2015), Aggrey et al. (2010), and Lundvall and Battese (2000). The value is deflated with fixed price index.

Technology Trend: We have used year indicators to represent Hicksian technological change. Battese and Coelli (1995) used similar approach in their landmark study. Additionally, we have used the square term as well to see the rate of technological change.

Innovation: Innovation has become a crucial factor related to firm performance for its widely recognized role in the growth and quality up-gradation process. Kline and Rosenberg (1986) and Edquist (1997) are pioneer in focusing on the role of innovation. Kleinknecht and Mohnen (2002) discussed how various resources, including the European Community Innovative Survey, have paved the way to look into the role of innovation in production process. Crepon et al. (1998) and Baldwin et al. (2002) explored the role of research activities and innovation. Hartono (2015) surveyed a good number of

literatures that explored the role of innovation in positively influencing firm's growth, efficiency and profit. However, the definition of innovation differs among scholars. Without going into detail of the definition, we have considered the innovative aspects that are more applicable to developing industries. In these markers, innovation is defined by re-engineering effort, adaptation of new product and production process and setting-up new marketing channels rather than creation of new knowledge and technology. This approach was successfully tested by many studies as mentioned in Sonobe and Otsuka (2011, 2014). In our dataset, introduction of new product, production process or marketing channel is used to define innovation. Previous literatures placed innovation either in the production frontier or as an efficiency determinant. The reason behind our decision to include it in the frontier comes from the definition of innovation. The introduction of any new product or marketing channel should have a direct impact on sale. Process innovation, when effective, is supposed to shift the production frontier. So, our model structure and definition suggest innovation to be included in the production frontier.

Export percentage: Export orientation has become a key discussion point in trade and industrial economics in post liberalization era. Almost every study on industrial performance have considered this variable. Especially, Granér and Isaksson (2009), Kim (2003), Rankin (2001) and Charoenrat et al., (2013) discussed the relation between export and firm performance and all of the study found positive relation. It has been obvious from the findings of trade related studies that export has direct positive impact on the profitability and sale of firms. Firms that are more export oriented have higher sale for a number of reasons including access to wider and more profitable market. So, we have used ratio of export to annual sale as a control variable in production frontier.

The input variables used in our model are standard inputs used and established in almost all recent SFA literatures and robustly discussed in Coelli et al. (2005). But the placement of innovation and export in the frontier may draw some arguments of endogeneity, especially in the cross-sectional model. Though we cannot totally rule-out the possibility of endogeneity for these two variables, we have taken analytical measures to ensure that any possible endogeneity does not affect our result significantly in (28) and (29). We have run alternative regression without these variables. It does not change the overall results of the frontier or the efficiency determinants. Also, we have included them as efficiency determinants with other z-variables and it also does not alter our results of frontier or efficiency determinants. Additionally, both are insignificant as z-variables.

Though ownership structure is considered in some studies as explanatory variable, almost all the firms in our sample are totally owned by domestic private entities. There are only 17 observations from fully or partially foreign owned firm. The policy restriction and regulatory environment were almost unchanged during the study period. So, we have not considered any ownership or policy effects in our model.

2.4.4.2 Output

Most of the firms in our sample are multiple-product firm. So, it is not reasonable to use output quantity to measure output. It is more realistic to use total value of sale with appropriate price deflator (Coelli et al., 2005). Another popular measure of industrial output is the value added. But there is a strong arguments that it is unable to estimate growth rate accurately (Cobbold, 2003). In OECD manual (2001), it is discussed that the choice between value added and gross-output depends on production function, the effect of technical change on inputs and the focus on labor productivity. Other points of

consideration are the dependency on intermediate inputs in the production process and growth of the sector. If the dependency is too high or important, value added measure would no longer represent true growth as it does not accommodate intermediate goods in the production frontier (Cobbold, 2003). For our sample firms, intermediate goods are key factor in the production process and inventory level is low compared to sale. So, the value of gross annual sale has been used as a reasonable output measure. It has also been deflated with fixed price deflator.

We have used net profit in simple panel regression to test our model specification. Profit is better than value added as it incorporate intermediate goods along with labor cost. Net profit is also a strong performance indicator and directly related to firm's sustainability. It is calculated by deducting total annual production cost from total annual sale. Our input and output choices are supported by a good number of literature including Scully (1999), Lundvall (1999), Chapelle and Plane (2005), Brada et al., (1997), Little et al., (1987), Page (1984) (as mentioned in Aggrey, Eliab, and Josep, 2010). All the input variables in the frontier have been normalized with their geometric mean and are transferred to natural logarithmic value. It helps us in explaining the coefficient as elasticity of output which is calculated at the geometric mean of variables. Similar modification has been suggested by Coelli et al. (2005).

2.4.4.3 Exogenous Determinants of Efficiency

We tried to distinguish variables that may affect inefficiency from growth theories, established literatures, and practical knowledge of the sector under study. Greene (2003) discusses the placement of these variables either in production frontier or as (in)efficiency

explanatory variable. His conclusion was to judge adopted production function and the nature of the industry under study and then to decide with best intuition. We have chosen the following variables as efficiency determinants-

Firm Age: The role of firm age was investigated in Admassie and Matambalya (2002), Batra and Tan (2003), Charoenrat and Harvie (2013), Charoenrat et al. (2013), Lundvall and Battese (2000), Park et al. (2009), and Tran et al. (2008) (as surveyed by Charoenrat and Harvie, 2014). The age of firm, from theoretical viewpoint, may have positive association with performance because it helps firms from their experience (Stinchcombe, 1965). It may have negative impact as well due to inflexibility, bureaucracy and rigidity in response to market change in older firms. Reference studies found both types of impact of firm age and show that it may vary based on location, industry, time and type and development phase of the industry. The impact may also be non-monotonous within a sample industry. It is measured by the number of operational years of the firm.

Top manager's human capital: The human capital of top manager has been discussed as the most crucial factor in materializing multidimensional innovation within manufacturing firms. Its role is a proven fact in the industrial studies on Japan, Taiwan and China (Sonobe and Otsuka, 2011). Human capital is successfully represented by experience and schooling year or education in most existing studies. These have been popularly used in growth theory as key inputs to firms' growth mechanism. Fernandes (2008) has found that experience of top manager is more important than education in Bangladesh garment industry. Nam, Sonobe, Otsuka (2009) also studied the impact of proprietor's experience on firm's performance and found it very positive. We have measured experience by the number of years the top manager is serving in the particular

industry. Working in the same industry would enhance production, marketing and organizational knowledge of the manager that can effectively benefits his current firm. On the other hand, education is the attribute that enables firms' managers to learn technology and an effective mean to absorb foreign knowledge. It also makes sure that accumulated knowledge is appropriately used in current operational system of the firm. Mottaleb and Sonobe (2009) and Amin and Sonobe (2013) showed that educational qualification of the top managers assisted in gaining from technology transfer from abroad, from innovative system of multinational firms and in integrating those knowledge with comparative advantage in Bangladeshi garment and pharmaceutical firms. The absence of this parameter mainly failed many African countries in gaining more success compared to Bangladeshi garments and pharmaceutical industry. We have used total schooling years of the top manager as a measure of educational qualification. This data is absent for the year 2013 and we have generated these missing data by extending 2011 data. Because 2013 panel observations is a sub-set of 2011 observations, time difference is short (2 years) and education has apathetic nature, the assumption should not create big distraction in the result. Robustness is checked by running pooled cross-sectional analysis and simple panel regressions with only 2007-11 data including education and with three years' data excluding education. Results from these robustness checks argue against the possibility of any serious problem for the assumption.

Access to financial services: The impact of financial services on firms' performance has been discussed in recent literatures including Charoenrat and Harvie (2014), Fernandes (2008), Tran et al. (2008), Batra and Tan (2003), Admassie and Matambalya (2002), and Li and Hu (2002). Most studies discussed access to bank loan, overdraft facility or line of credit facility as the parameter to measure the impact of

financial services. Though they are combined into a single variable in some studies, many reasonably separate them for having different attributes. For example, line of credits or bank loans are, in general, disseminated under long term contract and the repay period is also longer. The credited amount is higher compared to other forms of lending services. It is exploited to cover infrastructure development, capital machinery purchase, labor development, setting up marketing channel and also for input procurement. On the other hand, overdraft facility is offered to address short term credit requirement of the firms, primarily to support their purchase or sale over a short period. The amount is lower compared to loan. So, we have used two types of financial services in our model: long term financial service *fin2*, representing whether or not the firm has access to bank loan or line of credit; and short term financial service *fin1*, representing whether or not the firm has access to overdraft facility during the study period.

Though we have included firm size, international certification and training in our discussion, we argue against their inclusion either in frontier or as efficiency determinants. Growth theory says that whether a firm would follow current production path or would expand depends on the entrepreneur (Penrose, 1995). Firm size affect performance by bringing in technological economies. More specialization of labor, higher usage of machinery and installation of larger production units help in producing larger quantities with lower unit cost (Penrose, 1995). In most cases these advantage offset additional managerial and transport cost for larger operation. Firms who can take advantage of this technological economies, become larger and dominate other firms. While we discuss the effect of firm size, we cannot included it in the frontier for its possible correlation with asset or labor. Training program is supposedly related to either manager's human capital or the financial ability of the firm. Also, export orientation is

related to specific training programs. Similarly, international and quality certification is related to manager's human capital and export orientation. So, we have not include them in our core SFA models.

2.5 Data

We have used World Bank Enterprise Survey (WB-ES) data in this study. This survey collects data on firm performance, organizational structure, business perception, challenge for growth, business environment etc. The data is collected using highly standardized and robust survey methodology. For Bangladesh, the sample firms were selected by stratified random sampling. The detail of survey methodology for WB-ES can be found at http://www.enterprisesurveys.org/Methodology. From survey population, sample firms were stratified through three levels: industry, establishment and region. This survey covered both manufacturing and service sector and we have selected the manufacturing subset. In manufacturing, food, garments, textile, leather, chemicals, electronics, transport, furniture, and others were the selected sub-sectors. The business register of Bangladesh Bureau of Statistics was used as the sample frame. The last three ES survey rounds were conducted in 2013, 2011 and 2007 and we can develop panel dataset from these three rounds. Our study is the first systematic and big scale analysis of the ES data of Bangladesh. Survey round of year 2007 covered 1202 manufacturing firms. Within these, 235 were surveyed in the year 2011 for collecting panel data. In year 2013, 1063 fresh firm were surveyed in addition to 116 firms for panel survey. To keep the panel structure of the data, we have selected firms having at least two years' of observation. After required cleaning, we ended up with data from 186 firms with 447

observation. We have constructed a separate cross-sectional dataset by pooling observations from all three years. This cross-sectional dataset has higher number of firms and observations across all sub-sectors. The data summary is presented in table-2.1.

Selected sample of our study is heavily dominated by garments and textile firms. As manufacturing sector of Bangladesh is highly dominated by garments firms in terms of GDP contribution, export and employment generation, the demography of our sample is acceptable. Summary statistics of the sample firms are show in table-A1.1. Capacity utilization of the sample firms is quite high with 85% of the firms have 75% or higher capacity utilization. Firms' payment for security purposes increased across years. It shows the requirement of building safer business environment. Sample firms have generally high level of skilled production worker; almost 80% of the firms have more than 75% skilled production worker. Almost 72% firms own a generator individually or shared with others. On average, 25% of the electricity is produced by the generators owner by firms privately. Average export is 61%, 55% and 62% of annual sale for 2007, 2011 and 2013 respectively. Though panel TRE model with normal-half normal distribution offers the best consistency and reliability, the sample size has become limited to keep panel structure. But the cross-sectional dataset is one of the most enriched data used in SFA analysis for manufacturing sector.

2.6 Results

2.6.1 Simple Panel Regression

With the panel data of the sample, firm profit (logarithmic value) is regressed against possible performance determinants using different set of control variables and firm effects. It will give us clue about the influence of determinants and would also validate model specification. Table-2.3 shows the results for panel regressions. We used random effect model (column-1 to column-11) due to its flexibility. Fixed effect model is used in column-12 and 13 for robustness check and to see the impact of excluding fixed firm effects. In column-1, we tried to explain firm performance by top manager's human capital. In column-2, we have added firm age as a control. Column-3 adds access to short term and long term financial services. In column-4, export percentage (of total sale) and innovation are added. Training and R&D activities are added in column-5. And in column-6, garments and textile (together) dummy is added to control sub-sector effect. We have checked robustness by excluding experience and education in column 7, 8 and 9 (to check against endogeneity argument).

The result shows that education of top manager is significantly positive in all columns. This is highly expected and is supported by a number previous literature. Because we have generated 2013 education data by extending 2011 data, column-10 runs the regression for 2007 and 2011 data and education is significantly positive here. So, top manager's schooling year is positively related to firm profit. Surprisingly, experience show no significant impact on profit. It shows that experience of top manager do not have any direct impact on annual profit. If there is any impact on firm performance, it would be through the influence on firm efficiency and we would measure it in SFA models. Firms' age, which is one of the mostly discussed determinants of firm performance, has positive and significant coefficient in all alternative regressions. Colum-6 (with all controls) shows the highest coefficient value for firm age (0.7) among random effect

regressions. Exclusion of fixed effects in column-12 and 13 increases the magnitude to 1.67.

Short term financial service (*fin1*- overdraft facility) is significantly and positively associated with profit. The effect is higher when we remove manager's human capital variables from the regression in column 7-9. In fixed effect regressions (industry fixed effects and education are excluded for time-invariant nature, experience is excluded due to non-significance), the impact of *fin1* becomes stronger. Statistical summary shows that *fin1* is not correlated with manager's experience, but firms having access to *fin1* have managers with higher schooling year. So, some effects of excluded education may be absorbed by *fin1* in fixed effect regression. Access to bank loan or line of credit (*fin2*) is either insignificant or marginally significant (at 10% level) in the random effect regressions and has a negative coefficient. But it is highly significant with greater magnitude in the fixed effect regressions. The statistical summary in table-A1.22 shows that access to loan or LOC increases with higher managerial education. So, we need to consider the effect of *fin2* on profit carefully and can say that bank loan or LOC weakly and negatively affects profit.

Export percentage and innovation are found to be highly significant and positively associated with profit in all the regressions. Innovation has high coefficient value which is consistent across all RE and FE regressions. Export percentage has high and positive coefficient value and it reduces almost to half when we add industry control for garments and textile. This is reasonable and expected as these two are the most export oriented sectors. Training program and research and development activities show no significant effect on profit. Impact of these highly endogenous variables are supposedly absorbed in managers' human capital and other controls. Table-A1.7, table-A1.21 and table-A1.22

show the apparent correlation between these variables and manager's human capital. Industry dummy for garments and textile has significantly positive coefficient indicating that firms in these two sectors yield more profit on average than similar firms from other sectors. This result holds almost the same if we consider garments and textile firms separately.

To observe the effect of firm size on performance, a number of variables have been discussed in literature as the proxy of size. Among them, number of worker is mostly used. But there is a strong criticism against using current employee number due to its possible endogeneity problem. In such case, number of worker at the start of firm's operation offers a good proxy which is highly correlated to current employee size but exogenous in nature. Column-11 in table-2.3 shows the regression result with the addition of firm size and the result is positive and significant. It means that firm size has a strong positive effect on sample firm's profit.

This simple panel analysis shows that chosen variables are highly related to firm performance. Within these variables, we have selected firm age, manager's education and experience and financial services as the exogenous determinants of (in)efficiency with the argument that affect firm performance by influencing (in)efficiency . On the other hand, export directly affects sale revenue and product or process innovation changes production technology and thus shifts the frontier. So, they are more justified to be added to the frontier. But there is no ultimate exactness in this placement as discussed by Greene (2003). We have set up the best model based on basic statistical analysis and knowledge for this specific industry.

2.6.2 Stochastic Frontier Analysis

The regression result for true random effect model with normal-half normal distributional assumption is presented in table-2.4. Due to data availability, an unbalanced panel is used where the observation from a particular firm is at least 2 to keep the panel nature of the data, with average and maximum observation per firm are 2.4 and 3 respectively. The chi-square test and Wald statistics prove that the chosen model is fitted well with the sample data and the model is reliable. We have shown the frontier coefficients and determinants of the variances (*Usigma* and *Vsigma*) in table-2.4 for different specifications of true random effect model to comment on the robustness of the result. Our core model includes basic input parameters for the translog production function along with innovation (*inno*) and export percentage (*export*) in the frontier and firms' age, top manager's experience, top manager's schooling year, access to long-term financial services (*fin2*) and short-term financial service (*fin1*) are included to explain the change in distribution of inefficiency variance (*Usigma*) and random error variance (*Vsigma*). All these variables, along with our preferred normal-half normal distributional assumption, produce the result in column-1 (HN). Subsequent columns show the result for homogenous *Vsigma*, TRE models with exponential distribution for inefficiency and regression without innovation and export. Regression result excluding education is shown in column-9 to check for any possible bias for our assumption regarding 2013 data on education. For same reason, regression result with data for 2007 and 2011 is shown in column-10 (including education). All these range of alternative models offer good robustness check for the frontier estimates and significance of the determinants of inefficiency. The sign and significance of all the primary inputs, frontier controls and efficiency determinants show that our chosen model and variables are highly consistent,

effective and robust. This is one of the first large scale application of heteroscedastic TRE model. Considering its sensitivity, the consistency and robustness of our model is very encouraging and it puts a strong argument for the acceptance of our model. The result of cross-sectional models is presented in table-2.5. The result of core model is shown in column-1. Column-2 shows the homogenous version of the main model. Analysis with only 2007 and 2011 data is shown in next two columns with the inclusion of education. Column-6 to 8 show the regression results with the addition of firm size as determinants.

The value of $E(\sigma_u) / E(\sigma_v)$, which often is called the signal to noise ratio, is within the range of 0.20-0.81 in TRE models (2.27-7.30 for cross-sectional models). This ratio for regression models are shown in table-A1.24. As discussed in Belotti, Daidone, Ilardi, & Atella (2012), if this value is too small, the model definition is not justified as the noise becomes dominant in the distribution of disturbance term. On the other hand, if the value is too high, we cannot identify inefficiency and noise term properly from the distribution of disturbance. The values for our models fits in the acceptable range and shows acceptance of model definition. The value of Akaike Information Criteria (AIC), a popular criteria for model comparison, is also shown in table-A1.24. We find that TRE models are more stable in this respect and heteroscedastic models have slightly better score than homoscedastic models. Most notably, TRE models have better AIC scores compared to the half-normal random effect model of Pitt and Lee (1981) despite their complex structure.

2.6.3 Frontier Estimates

The regression results in table-2.4 show that all the first order inputs are highly significant and expectedly positive. Labor, intermediate input (IC) and time trend are significant at

1% significance level across all alternative models. Coefficient of asset is significant with varying degree and is insignificant in column-3 (though close to significant with a positive standard error). All these coefficients are strongly positive. The coefficient's magnitude for IC and labor are much greater than that of asset. It shows that labor and intermediate input are stronger in affecting the sale compared to asset. We have normalized the variables before taking their natural logarithmic values for regression. So, the first order coefficients represent elasticity of the output for respective input. Coefficient estimation of 0.55 for *IC* shows that one percent increment in intermediate consumption would result into 0.55% increment in annual sale for an average firm of this sample. Similarly, one percent increase in total asset would result into 0.07% increment in annual sale and for one percent more labor expense, 0.30% hike in annual sale is supposed to occur on average. Among all the primary inputs, the intermediate input is the most dominant in terms of elasticity and shows comparatively higher impact on output for any percentile increment or decrement. This finding is supported by previous studies, including Hailu and Tanaka (2015) who found similar impact of intermediate inputs. It also supports the choice of intermediate input and rejection of value-added as the output (which disregards intermediate input) showing the role of intermediate inputs in sample manufacturing firms. Frontier estimates from cross-sectional models in table-2.5 support these findings from TRE analysis. Additionally, year1 is significant and highly positive indicating firms were enjoying higher sale (more than 4%) in year 2011 compared to 2007. Textile and leather dummies show lower sale and chemical dummy shows higher sale. Because we are controlling for export percentage and it has highly significant and positive coefficient estimate, findings from sector dummies reveal further information on firms' sale.

Two frontier variables, export percentage (*export*) and innovation (*innovation*), are found highly significant and have positive coefficient. Their impact on annual sale in TRE model is similar to the impact on annual profit in simple panel regressions. Innovative firms (performing any sort of innovation in last three years) are supposed to have 0.23% higher annual sale than the non-innovative firms. This is a strong finding from a panel data analysis and it supports the theory that innovation helps firms to achieve higher productivity. Chudnovsky, Lopez, and Pupatong (2006) found similar impact of innovation on the productivity of manufacturing firms in Argentina under a long period of time. Crepon et al. (1998) and Jefferson et al. (2006) found positive relation between innovation and productivity while Benavente (2002) found no effective impact. Our study shows that not only in the long run, but advantage from innovation can be achieved even under a short period of time. The export percentage has higher impact than innovation with a positive coefficient value of 0.46. It means, firms having 1% more export share in sale are supposed to have 0.46% higher sale. Also it is notable that the coefficient of export is higher than that of asset and labor. It supports previous findings that export enhances productivity of manufacturing firms. This is in line with the trade theory that export increases sale with broader access to customer and markets with higher demand, reduces risk with more marketing options, helps in attaining economies of scale, encourages innovation and promotes productivity under greater competition and international integration. Newman, Rand, Tarp and Nguyen (2014) found similar effect of export for Vietnamese firms. Nishimizu and Robinson (1984) found that export orientation improves efficiency by encouraging firms to utilize their capacity with better precision and by adopting new technology. The significant role of export and innovation is an exploratory finding of this study in explaining key factors affecting sales in

manufacturing firms. The technology trend *t* and its square term are highly significant (at 1% level) but has opposite sign. It reveals that the industry shows a highly positive technological development. But the negative sign of the coefficient of square term indicates detrimental rate in the improvement. It can be said that the market is under technological development and the rate of change was decreasing during study period.

From the summarized value of estimated coefficients of first order input parameters, the return to scale status can be calculated. In main TRE model, it is 0.92 which indicates that the sample firms were operating in decreasing return to scale, but is close to constant return to scale. The intercept term is -2.06 and shows a normal and justified value for random effect model.

Unlike their first order counterparts, the second order coefficients are significant in varying degree and show both positive and negative estimates. Except the asset-labor mix, other two second order parameters of asset are insignificant. This, along with comparatively lower value of first order coefficient shows that among the three primary inputs of production, total asset offers lowest elasticity to annual sale. It makes the selection of intermediate inputs or labor size more important irrespective of the asset level. Additionally, the marginal impact of total asset on annual sale varies only with the level of labor and not with the level of total asset or intermediate consumption. The asset-labor mix parameter has a significant coefficient value of -0.06. It means the marginal impact of total asset on sale is:

$$M_{asset} = 0.07 - 0.06 * lnlabor.$$

So, as the labor force grow, the marginal impact of asset diminishes. Square term of labor has highly positive coefficient and significant negative coefficient for the mixed parameters with asset and IC. So, the marginal impact of labor on sale is as follows:

$$M_{labor} = 0.30 + 0.12*lnlabor - 0.06*lnasset - 0.07*lnIC.$$

It shows that with everything else being unchanged, the marginal impact of labor on annual sale decrease with the increase of asset or intermediate consumption (IC) and the impact of IC and total asset are almost the same. But the marginal impact of labor depends much more on the level of labor compared to the level of asset or IC.

Intermediate consumption has highly positive coefficient of first order estimate and shows highest coefficient amongst the second order inputs as well. The second order coefficient estimate is 0.21. The marginal impact of IC additionally depends on the level of labor but its relation with total asset is not significant. So, the change in sale for the marginal change in IC stands as:

$$M_{IC} = 0.55 + 0.21*lnIC - 0.07*lnlabor$$

The marginal positive impact of IC on annual sale increases significantly as IC increases. And because of having a low dependency on the level of labor, IC impacts the change in annual the most among all inputs.

2.6.4 Efficiency Determinants

Now, we turn our attention to the core part of the study- finding the exogenous factors which influence (in)efficiency of manufacturing firms. In the TRE model with half-normal inefficiency distribution, the marginal impacts of inefficiency determinants are intractable for conditional mean $E(u_{it}|\varepsilon_{it})$ or for heteroscedastic v_{it} assumption (regarding both $E(u_{it}|\varepsilon_{it})$ and $E(u_{it})$). Thus, we will discuss only the significance of z variables in half-normal TRE model in table-2.4. In contrast, we have a monotonic relationship between the marginal effects regarding conditional mean $E(u_i|\varepsilon_i)$ and unconditional mean $E(u_i)$ in truncated-normal cross-sectional analysis. Equations (21) and (22) along with (23) and

(24) show that the relation of marginal impacts regarding both conditional and unconditional mean is monotonic for homoscedastic truncated-normal model (referred as het-2 model) and the sign is represented by δ[n] coefficients (coefficients of determinants explaining inefficiency mean μ_i). Column-2, column-4 and column-5 in table-2.5 (homoscedastic *u* and *v*) present δ[n] values for het-2 models. The sign of these coefficients thus show the direction of monotonous marginal impacts on $E(u_i|\varepsilon_i)$. In addition, we can numerically calculate marginal impact of *z*- variables on unconditional mean $E(u_i)$ for individual firms using STATA although $E(u_i|\varepsilon_i)$ is not available within that code. The sample averages of coefficients δ[n] in table-A1.19 reveals both the direction (thus supplement the discussion for table-2.5 results) and magnitude of marginal impact on $E(u_i)$. The heteroscedastic models in table-2.5 are presented as reference and robustness check for our TRE models (which is also heteroscedastic). Due to the complex relation between inefficiency mean and variance and the intractable nature of the derivation for marginal impacts, we would discuss only the significance of coefficient estimates of *z*-variables in these heteroscedastic models.

Firm age is significantly related to inefficiency (both with mean and variance) in all regressions in table-2.4 and table-2.5. All homoscedastic models in table-2.5 show negative δ[n] values indicating that firm age is negatively associated with conditional mean of inefficiency $E(u_i|\varepsilon_i)$. It is further enhanced by looking into the average marginal impacts of firm age on $E(u_i)$ shown in table-A.19. All the average marginal impacts are negative in this table with the value of -0.10, -0.05 and -0.05 for model-1-homo, model-2-homo and model-3 respectively. So, we can strongly suggest that older firms are less inefficient or more efficient than newer firms. As mentioned in Charoenrat and Harvie (2014), Alvarez and Crespi (2003), Audretsch, Horst, Kwaak, and Thurik (2009) and

Biggs (2002) found firm age positive to technical efficiency, supporting our finding. Fernandes (2008) found inverse U-shaped relation between age and TFP for Bangladeshi manufacturing firms similar to the finding of Van Biesebroeck (2005) for African countries and Jensen et al. (2001) for US firms. To look deeper, we have classified sample firms into 5 different age groups and have calculated mean efficiency for each of the group as shown in table-A1.2. Corresponding graph (figure-A1.1) suggests that the youngest group of firm (less than five years in operation) are clearly less efficient compared to older groups and has a mean efficiency of 0.84. Efficiency score of other groups are almost indifferent. If we disregard the highest aged group from our analysis, the shape of the graph almost becomes like an inverse U-shape, similar to Fernandes (2008). Additionally the graph shows that in long term, the shape becomes flat (saturated) rather than moving downwards. The initial low efficiency may result from long term investment at initial periods and other cost to set up operation, production, marketing channel, initial training of personnel etc. After recovering set-up cost, there is no apparent role of firm age on efficiency in later years. The long-term trend is more obvious from our simple panel regressions which indicates a positive linear relation between firm age and firm profit. So, we can say that the impact of firm age on output is incremental with diminishing return in long run.

Manager's year of experience is found to be highly significant in affecting inefficiency both in table-2.4 and table-2.5 indicating strong influence of managers' experience on firm's efficiency. The homogenous models in table-2.5 show that experience negatively affects $E(u_i|\varepsilon_i)$. So, higher efficiency of manager is related to reduced inefficiency and in turn enhanced efficiency of firms. From table-A1.19, we find that the average marginal impact of experience on $E(u_i)$ is -0.011 for model-1-homo, -

0.007 for model-2-homo and -0.007 for model-3. It confirms overall negative impact of experience on inefficiency both at individual and industry level. Now, to find out more, we have plotted the mean efficiency scores of four firm groups with ascending managerial experience (*exp*). The first group with *exp* less than 8 years, second group 8-15, third group from 16-25 and the rest having more than 25 years of experience. The resulted plot (figure-A1.2) is interesting and clear. With the increment of manager's experience, averaged efficiency score increases steadily. This is a certain indication of the role of manager's experience on technical efficiency of firms. It further proves our argument that top manager's experience affects the performance of firm not by directly scaling-up the output, but by improving firms' ability to produce better with given constraints. Mottaleb and Sonobe (2011) found the role of manager's experience in improving performance of knitwear manufacturers of Bangladesh. The impact was shown through the ability of re-design and in exploring export markets. Fernandes (2008) also found that firms with more experienced manager have comparatively higher productivity. Our finding says that manager's experience plays role in improving firm performance through efficient operation.

Education of top manager is strongly significant in most of the models in table-2.4 and table-2.5. The negative δ[n] values in homoscedastic models of table-2.5 says that higher schooling year of manager reduces conditional mean of inefficiency $E(u_i|\varepsilon_i)$ and thus enhances efficiency. The average marginal impact of education on unconditional mean $E(u_i)$ is strongly negative as well in table-A1.19, with a value of -0.097 for model-2-homo and -0.10 for model-3. Also, the magnitude of marginal impact of education is higher in table-A1.19 compared to experience. This proves that education of top manager is highly influential in promoting efficiency among manufacturing firms and its

comparative impact is similar or greater than experience. Simple panel analysis also showed that top manager's schooling year enhances firm profit. To look deep into TRE analysis, we have plotted mean efficiency scores against five educational groups. The resulting graph (figure-A1.4) shows that firms with higher level of manager's education consistently have higher efficiency compared to the lower level. Fernandes (2008) found similar result in her study that higher managerial education helps firms to attain higher productivity. It supports the role higher education in manufacturing firms of developing countries. Amin and Sonobe (2013) explained the role of higher education and higher educational institutes in the development and improvement phase of Bangladesh pharmaceutical firms. Nam, Sonobe and Otsuka (2009) found the significance of human capital and managerial experience in improving firm performance in Vietnam and Mottaleb and Sonobe (2011) found similar result for Bangladesh knitwear industry. Our study strengthens this theory and explores that highly educated and experienced managers influence firm's operation through technically efficient operation. It facilitates the idea that developing countries, who are in the expansionary phase of their industrial development, should keep investing in higher education and should keep it affordable. It would act as a long term investment for industrial development.

Access to overdraft facility (*fin1)* is not significant to explain variance in u_{it} but is highly significant (at 1% level) in all variances of v_{it} in table-2.4. It suggests the role of overdraft facility in firm performance but says that the way of impact is through other way rather than affecting inefficiency variance. Table-2.5 results confirm this argument that *fin1* is highly significant to explain heterogeneity of μ_i in all models. Its relation to *Usigma* and *Vsigma* in table-2.5 is similar to TRE model (table-2.4). Negative coefficients (δ[n]) of *fin1* in homoscedastic models in table-2.5 confirms that it is negatively related

to conditional mean of inefficiency E($u_i|\varepsilon_i$). Table-A1.19 shows that average marginal impact of *fin1* on unconditional mean E(u_i) is -0.07, -0.065 and -0.067 respectively. So, having access to overdraft facility significantly improves efficiency (reducing inefficiency) of manufacturing firms. **Access to bank loan or LOC (*fin2*)** shows almost similar trend as *fin1* but is less significant both in table-2.4 and table-2.5. For *Usigma* in table-2.4, it is significant only in one model (with exponential distribution of u_{it}) and weakly significant with *Vsigma* in most models. In cross-sectional results, *fin2* has consistent and negative coefficients for μ_i and is also significant related to *Usigma.* Similar to *fin1*, negative coefficients of *fin2* (δ[n]) in homoscedastic models show that it is negatively related to E($u_i|\varepsilon_i$). Average marginal impact in table-A1.19 confirms similar relation to E(u_i) with values -0.01, -0.02 and -0.025 for model-1-homo, model-2-homo and model-3 respectively. It is to be noted that these average impacts are lower in magnitude than those for overdraft facility. So, bank loan or line of credit (LOC) access enhances efficiency in firms but its impact is apparently weaker than overdraft facility. Van Biesebroeck (2005) found a positive relation between TFP and overdraft facility and a negative one between loan and TFP. Fernandes (2008) found similar effect in Bangladesh. Our simple panel analysis also shows that overdraft facility is positively associated with profit but bank loan or LOC is weakly and negatively related to profit. Overdraft facility is a short term service and shows positive impact on both profit which is a short-term performance indicator and on time-invariant efficiency which is a long-term performance indicator. But bank loan or line of credit, which is long-term service in nature, shows negative impact on short term performance (profit) and positive to long term performance (time-invariant efficiency). This finding is quite revealing and shows different mechanism of different financial services in influencing firm performance.

We have also calculated the marginal impact of determinants for heteroscedastic models (not shown but similar to results in table-A1.19). According to equation (17), the marginal impacts should be non-monotonous. We observe both positive and negative marginal impact of determinants on the unconditional mean of inefficiency for heteroscedastic model. For example, marginal impact of top manager's experience on efficiency is positive below 40 years of experience, though the magnitude is decreasing with the increment of experience. But above 40 years, the marginal impact is negative and it increases with the increment of experience. It indicates that experience has an overall positive impact on efficiency, but highly experienced managers, who are very old as well, negatively affect firm performance. Similar non-monotonic trend is found for other determinants. We do not show the sample average of marginal impact for heteroscedastic model as the average value would not represent any meaningful result in this case.

Literatures have discussed the impact of **firm size** on efficiency (including Bartelsman and Doms, 2000; Jovanovic, 1982 etc.) and found positive impact on performance, especially in the initial growth period. Fernandes (2008), on the other hand, found smaller firms to be more productive in Bangladesh. We have divided sample firms into four categories according to their permanent employee size. Though permanent employee is not a good proxy for labor cost in our sample, it does represent operational size of the firms. Most of the previous studies used employee size as the firm size indicator. Our grouping of size is shown in table-A1.4. This stratification follows the definition of Bangladesh business registration (BR). From figure-A1.3, we find that large firms are the most productive while micro firms are the least. Our analysis is biased towards large sized firms as they contains 60% of the observations and the large and very

large group contains 77% of the observations. Yet it is interesting to find that bigger firms are more efficient on average and there is a general incremental trend with firms' size. To look deeper, we have included firm size in z-variables in both TRE and pooled-cross sectional analysis. We also used starting employee as a proxy for firm's current employee to offset possible reverse causality effect. Results in table-2.4 and table-2.5 shows that labor size is significantly and negatively associated with inefficiency. It is supported by simple panel regression result as well. Including size-group dummies in simple panel analysis shows that bigger groups have higher average profit. This finding is consistent across all size groups. So, larger firm size is expected to bring higher efficiency. It is opposite to the findings of Fernandes (2008) but is supported by most existing literature. We attribute this contradiction to the weak modeling aspects of Fernandes (2008) and prefer our result in this respect. Large firms in Bangladesh are intuitive to be more efficient as they move to larger scale of operation only with better return. The summary statistics in table-A1.12 shows that the sector is dominated by micro and small firms. Table-A1.18 shows that very large firms started with comparatively much smaller worker. So, firms go larger only when they enjoy certain success in their current operation. They grow and sustain before moving up in operational scale and thus towards economies of scale in most cases. The mean efficiency in figure-A1.3 grows with decreasing rate and gradually becomes saturated above 0.88. It says that firm size helps to achieve higher efficiency and the marginal impact decreases and fades away once firms become large beyond certain size. Training programs are arranged for general and specific human resource development for the firms. Though some literature have included training program as a determinant of productivity or efficiency, we do not support the idea because of the possibility of multicollinearity. Training program is highly related to financial

ability and thus in turn with sale, export (as a requirement) or with top manager's ability (of developing firm's human capital). Close to 30% of the firms arranged off-the-job training program for employees in our sample. Firms those arranged any formal training program have higher average efficiency (0.90) than the firms not arranging such (0.86). It shows that more efficient firms are more supposed to arrange training program. Probably such decision is influenced by exogenous factors that are directly affecting efficiency, for example, manager's ability or export orientation. Table-A1.7 shows that groups of firms with higher level of managerial experience have higher probability of arranging training program. An overwhelming majority (78%) of the training programs were arranged for developing technical knowledge of the workers. 81% of these training were performed in-house and within rest, 5.6% training was conducted by related industrial association and 5.3% by a governmental agency. Firms who did not arranged any training program, 68% cited the reason of no requirement. Others pointed to the lack of competent institution or program (13%). Research and development activities is another determinants discussed in some literature but is highly correlated with firm size, export orientation, manager's ability and finance. The simple panel regression also shows that training and R&D do not have any direct impact on firm profit when we control for other variables. Same argument is applicable to international certification.

Interestingly, year dummies are significant but show opposite sign as the determinants of μ_i in homoscedastic models of table-2.5. It tells that firms are generally more efficient in 2013 and less efficient in 2011 compared to 2007. Most of the firms in our study are located in the capital city. We have averaged the efficiency scores of firms from the capital city and outside but no significant difference is found.

2.6.5 Efficiency Scores

Another key objective of the study is to estimate technical efficiency scores. The average efficiency of the sampled manufacturing firms are expectedly high in true random effect model with an average value of 0.87. Compared to some recent studies for manufacturing firms, our result shows highest average efficiency. We have calculated efficiency score using other SFA specifications, namely LSDV (least square dummy variable) fixed effect model, FGLS (feasible generalized least square) random effect model and normal-half normal time-invariant random effect model (pl81). The LSDV-FE model shows as average efficiency of 0.18 which is the lowest. This model consider all the time-invariant and fixed effects as inefficiency and thus should show highest inefficiency and lowest efficiency score. FGLS-RE model shows an average score of 0.55. Because of the incorporation of only random components of the unobserved effects as inefficiency, inefficiency score should be lower in RE model. For time-invariant random effect model of Pitt & Lee (1981), the score is 0.66 on average. We take this model as reference because it assumes half-normal distribution for inefficiency and uses ML estimation similar to our TRE specification. As the 'true random-effect' model separates firm specific effects and considers only time-varying random effects as inefficiency, the inefficiency in TRE model should be much lower than pl81 model and thus should have higher efficiency score. Table-2.2 shows the correlation between efficiency scores and reveals that TRE is the most weakly correlated to other models. If we look into the density function of the efficiency scores, both *pl81* and TRE efficiency distributions are clearly skewed to the left. The negative skewness results from the assumption and modeling structure of the stochastic frontier model regarding. Time-invariant efficiency score from cross-sectional SFA model (model-1-hetero in table-2.5) is found to be 0.77 and thus completely fits in

above discussion revealing efficiency improvement from time-invariant model to time-varying TRE model. Efficiency distribution (figure-2.2, for TRE model) shows that most of the firms are highly efficient having efficiency above 0.8. The density of firms is low below 0.8 efficiency level indicating few firms operating with low technical efficiency. These firms can improve efficiency by investing more in competent management, human resource development and by adjusting operational size.

We conclude that the manufacturing firms in Bangladesh are operating with high technical efficiency for the study period. Hailu and Tanaka (2015) found the efficiency of manufacturing firms in Ethiopia close to our range. Most of the industrial sectors they analyzed had TRE efficiency in the range of 0.80 - 0.88. But they did not considered heteroscedasticity nor used explanatory variables as the determinants of efficiency. Kumbhakar et al. (2014), Farsi et al. (2005) and Farsi and Filippini (2006) also have found the efficiency of TRE model higher than that of basic FE & RE models. But they have not controlled for the heterogeneity in inefficiency distribution and our study is unique in this respect.

The yearly trend of mean efficiency is also interesting. The mean efficiency drops from the average 0.87 in 2007 to .82 in 2011, but then increases to 0.93 in 2013. In 2011, a lot of firms are found with efficiency lower than 0.6 while it is applicable to very few firm in 2007 and almost zero for 2013. The cross-sectional analysis also reveals that in year 2011, firms suffered lower efficiency. The apparent reason for this lower efficiency may be referred to the export scenario caused by worldwide financial crisis from 2008 onwards. Though Bangladesh was not directly affected by the financial crisis (as visible from the GDP trend), its export oriented industry suffered uncertainty. The average export percentage is 61-62% in 2013 and 2007 but 55% in 2011. We find that the average annual

sale is not lower in 2011 compared to other years. So, possibly the challenge faced in export caused lower efficiency in 2011.

In terms of ownership, the average efficiency of firms having domestic or foreign ownership is almost similar and we cannot make any further comment as the number of foreign owned entity is limited in our sample. In terms of legal or registration status (at the starting of firm operation), registered firms have slightly higher average efficiency, but the difference is not statistically significant. Firms that use basic ICT services, specially having a website have slightly higher average efficiency than firms do not have such facility. Email usage is rather a common practice among firms and thus does not show any significant relation to efficiency. Though sample firms work with high capacity utilization, we find no particular pattern of relationship between the capacity utilization and efficiency score.

2.6.6 Sector Specific Analysis

Due to limited number of observations, only garments and textile firms (together) are analyzed separately with panel TRE model (292 observations from 120 firms). The regression coefficients and statistics are shown in table-A1.25. But with pooled-cross-sectional analysis, we can run regression for garment, leather, textile, chemical and food sectors separately. Regressions results of SFA model with truncated-normal inefficiency for all these sectors are shown in table-2.6. The frontier coefficients are almost close to our main TRE model in table-2.4. In table-2.6, asset is not significant for leather and food sectors indicating that these two sectors have low dependency on physical asset. Within the mix variables, labor-intermediate consumption mix is the strongest variable across all sectors. The most important finding from frontier estimates of table-2.6 is the non-

significance of export for textile and chemical firms. While it is significant in other sectors, the marginal impact is much lower compared to the results in table-2.5. So, inter-sectorial impact of export on annual sale is lower compared to the whole sector. Similarly, innovation is not significant across sectors. It can be said that within same industry, impact of innovation is less visible.

In analyzing the determinants of inefficiency, though the significance of determinants vary among different sectors, their sign is same as our core analysis when they are significant. So, we would not discuss the direction or sign of marginal impact rather would focus on the significance only. Experience of top manager is consistently significant for garment and textile firms both in TRE and cross-sectional regressions. Mottaleb and Sonobe (2011) and Amin and Sonobe (2013) found for garments and pharmaceutical industry in Bangladesh that experience of top manager supports firm's growth and enhance export. Experience is not significantly related to efficiency of chemical and food firms. Interestingly, education of top manager is also insignificant for chemical firms. Chemical sector is dominated by pharmaceutical firms and they have highly experienced and educated manager. This homogeneity in manager's human capital among chemical firms makes them insignificant in intra-sectorial analysis. Education of top manager is significant in all sectors except textile and chemical. Overdraft facility is positively and strongly associated with efficiency in chemical, textile and leather sectors. Bank loan or LOC is positively affecting firms' efficiency in garment and chemical sectors. Garment and chemical are the most capital intensive and grown-up sectors and their access to bank loan is expected to be a significant factor. Firm size (starting employee number used as proxy) shows significant positive impact on efficiency in all sectors except textile. For food firms, only manager's experience and firm size are

positively and significantly related to efficiency. This sector has low capital intensity, low investment and smaller average firm size compared to other sectors. According to a number of studies including those of Sonobe and Otsuka (2006), performance of low capital-intensive and smaller firms is strongly influenced by the experience of top manager and operational size of firm. All sectors generally show low efficiency in 2011 compared to 2007.

2.6.7 Additional Findings

We have summarized the group means of human capital variables for different size groups in table-A1.17. The statistics is presented for both panel data and extended pooled cross-sectional data. It shows possible correlation between firm's employee size and manager's education and export percentage. It justifies the decision to leave firm size outside core regressions.

For 20% of the firms, women have share in ownership. Firms with female ownership show no significant difference in performance. 17% of the firms were not registered at the starting of their operation. It means almost one fifth of the firms started their operation as informal firm and then moved to formal sector. More than 61% of the firm recognized competition from informal firms as an obstacle to their business while more than 40% mentioned it as moderate to severe problem. Very few of them are located in special industrial zone (15%). 57% of the firms have own generator for electricity supply, referring to the power shortage issue during study period. More than 50% of the firms use email to contact their client and 35% of them have own website. It shows an increasing trend in ICT awareness of the firms compared with previous studies. The biggest challenge for operation is found to be the lack of proper power supply (electricity).

90% of the firms cited it as a moderate to severe problem. Political instability and corruption are referred as the most severe obstacles regarding business environment by majority of the firms. 44% of the firms acknowledged to be approached for informal payment during regulatory meeting with government agencies or during tax inspection. More than 50% of them gave any form of informal payment in the last year of operation. Almost 50% of the firms cited inadequately educated workforce as an important obstacle in their current operation. In addition to electricity supply, other obstacles adversely affecting operation are access to finance and political instability.

Technical assistance in production and quality management is cited as the most important business service required to promote export, closely followed by training for workers. Getting proper information about foreign market is the second most important service sought for export promotion. These issues are also important for enhancing domestic sale. Garment industry observed the highest expansion in terms of employee during this time (84% expansion over three years), interestingly followed by food industry (43%). It is a sign of the recent development of food firms in the country. The average share of female labor is 20% in sample firms and garment firms have the highest ratio of female workforce where majority of workers are women. The average schooling year of production worker is just over six for the whole industry. Chemical firms have the highest average schooling year for production worker with 8.8 years, indicating the requirement for more educated worker in this capital intensive sector.

2.7 Conclusion

This study analyzes the efficiency of manufacturing firms in Bangladesh and explores efficiency determinants using one of the most robust SFA model. This is an enriched analysis of manufacturing sector for a developing country. This study shows that the effect of heterogeneity in measuring efficiency is very high and ignoring such results into heavily biased estimation. Sample firms are found to be operating with high time-varying technical efficiency. Intermediate consumption is the most important and dominant input factor in the production process having highest coefficient of elasticity among primary inputs. Export and innovation are both found positively associated with higher sale. The effect of export remains strong in the intra-sectorial study, except for the textile and chemical firms. On the other hand, innovation loses its significance in intra-sectorial regressions. Firms' age, top manager's experience and schooling year and access to financial services have been found to significantly and positively affecting efficiency. Effect of firm age becomes saturated once the age increases beyond certain limit, but it's clear and positive influence on firm performance tells that Bangladeshi manufacturing firms improve over time and they are benefitted from experience. Overdraft facility, which is a short-term financial support in nature, is found to affect both of profit and efficiency positively. Bank loan or line of credit (LOC), on the other hand, have positive impact on efficiency, especially time-invariant (long-term) efficiency but shows negative and weak impact on profit (short-term performance indicator). Within sectors, the effect of bank loan and LOC is positive in garment and chemical firms which are the most capital intensive and fastest growing sectors. Firm size shows positive relation with profit and efficiency. Training programs shows weakly positive correlation with firm performance, but it was revealed to be associated with manager's human capital. Research

activities are found non-significant in improving firm performance. Among industrial sectors, chemical firms shows better performance than others, followed by leather and textile firms. Chemical and textile firms also show greater dependency on asset and lower on export. Food firms' performance is dependent on manager's human capital and firm size and not on any other factors. Firms generally improved efficiency from 2007 to 2013. The sector operates in decreasing return to scale and though technological trend is positive, its rate of change was decelerating. The sector, as a whole, was growing during the study period and proper policy support can further this trend.

Tables and Figures - Chapter 2

Table 2.1
Summary Statistics

Variables	Observation	Mean	STD	Min	Max
Firm Age (years)	2,337	18.47882	13.61829	0	176
Total Asset (BDT)	2,237	1.49E+08	6.18E+08	1000	1.41E+10
Total Full-time Labor	2,340	298	683.5796	1	11000
Labor Cost (BDT)	2,302	2.30E+07	9.04E+07	39000	2.32E+09
Production Cost (BDT)	2,310	1.47E+08	4.81E+08	5000	7.01E+09
Land & Building (BDT)	1,538	1.2E+08	4.72E+08	10000	8.89E+09
Machine & Equipment	2,225	67083642	3.23E+08	1000	6.4E+09
Experience (years)	2,329	17.11164	9.900514	0	60
Education (schooling	1,275	14.19059	3.286752	0	18
Sale (BDT)	2,282	3.62E+08	4.26E+09	133000	2.00E+11
Starting Employee	2,207	108	247.4178	1	4500
Export Percent	2,340	31.1772	44.96422	0	100
Fuel Cost (BDT)	1,578	4709594	26308416	440	5E+08
Capacity Utilization %	2,332	80.65	15.91	1	100
Net Profit (BDT)	2,313	1.76e+08	4.07e+09	-7.00e+09	1.95e+11

Note: BDT- Bangladeshi Taka

Table 2.2
Kendal's rank order correlation

	TRE	PL81	FGLS-RE	FE
TRE	1			
PL81	0.18	1		
FGLS-RE	0.15	0.94	1	
FE	0.11	0.79	0.91	1

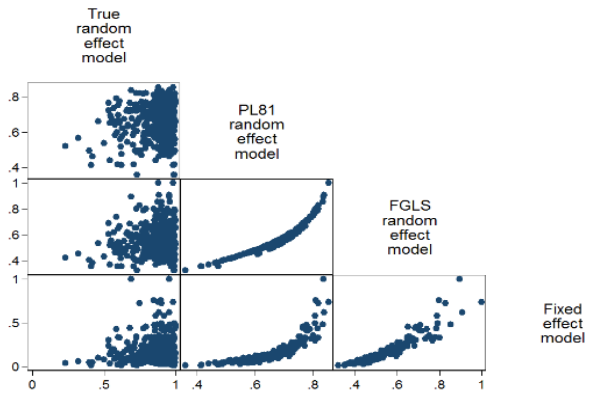


Figure 2.1
Distribution of efficiency-PL81

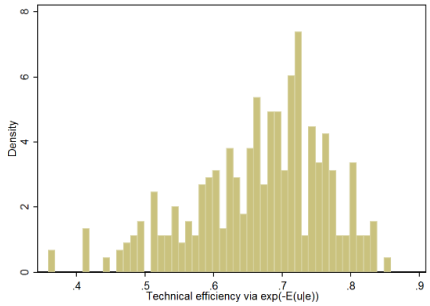


Figure 2.2
Distribution of efficiency-TRE

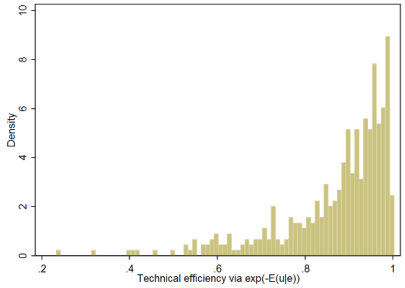


Table 2.3
Simple panes regression results

Variables	*1* *lnprofit*	*2* *lnprofit*	*3* *lnprofit*	*4* *lnprofit*	*5* *lnprofit*	*6* *lnprofit*	*7* *lnprofit*	*8* *lnprofit*	*9* *lnprofit*	*10* *lnprofit-re-2007-11*	*11* *lnprofit-isize*	*12* *lnprofit-fe*	*13* *lnprofit-fe*
exp	-0.01	-0.02	-0.01	-0.01	-0.01	-0.01				0.001	-0.01		
	-0.57	-1.17	-1	-1.13	-0.81	-0.71				-0.1	-0.51		
edu	0.19	0.18	0.17	0.11	0.11	0.11				0.09	0.09		
	(4.01)***	(3.74)***	(3.62)***	(2.32)**	(2.35)**	(2.46)**				(1.79)*	(1.96)**		
lnage		0.4	0.39	0.47	0.47	0.71	0.71	0.43	0.38	0.98	0.72	1.67	1.63
		(1.96)*	(1.91)*	(2.32)**	(2.36)**	(3.58)***	(3.73)***	(2.26)**	(1.92)*	(4.27)***	(3.76)***	(4.09)***	(3.99)***
fin1			0.49	0.45	0.46	0.46	0.48	0.47	0.52	0.3	0.42	0.68	0.7
			(2.91)***	(2.84)***	(2.93)***	(3.01)***	(3.11)***	(2.98)***	(3.07)***	(1.72)*	(2.74)***	(3.46)***	(3.55)***
fin2			-0.13	-0.15	-0.15	-0.12	-0.13	-0.17	-0.15	-0.13	-0.11	-0.31	-0.34
			-1.41	(1.75)*	(1.71)*	-1.41	-1.53	(1.92)*	-1.56	-1.37	-1.3	(2.90)***	(3.19)***
inno				1.25	1.29	1.2	1.22	1.28		1.48	1.11	1.38	1.35
				(5.53)***	(5.60)***	(5.34)***	(5.43)***	(5.65)***		(5.69)***	(5.02)***	(4.83)***	(4.80)***
exprt				1.04	1.06	0.45	0.57	1.15		0.6	0.27	1.43	1.43
				(4.29)***	(4.34)***	(1.76)*	(2.22)**	(4.79)***		(1.96)*	-1.08	(3.32)***	(3.29)***
tra					-0.35	-0.32	-0.34			-0.19	-0.44	-0.55	
					-1.55	-1.48	-1.59			-0.67	(2.02)**	(1.93)*	
rnd					-0.1	-0.04	0			-0.02	-0.01	-0.23	
					-0.47	-0.17	-0.01			-0.06	-0.04	-0.83	
GarT						1.35	1.38			1.52	0.85		
						(5.11)***	(5.11)***			(4.79)***	(2.98)***		
lnisize											0.38		
											(3.93)***		
_cons	13.82	12.96	12.87	12.19	12.21	10.99	12.38	13.61	15.3	-6.52	10.12	10.1	9.93
	(18.62)***	(14.33)***	(14.28)***	(14.07)***	(14.07)***	(12.81)***	(19.43)***	(22.46)***	(25.91)***	(6.47)***	(11.80)***	(8.55)***	(8.48)***
N	424	424	424	424	424	424	424	424	424	**323**	424	424	424
R^2												0.27	0.25

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

Table 2.4

True Random Effect regression results with different distributional & heterogeneity assumption

		1	2	3	4	5	6	7	8	9	10	11	12
	Variables	HN	HN-hom	HN-NC	Exp	Exp-homo	pl-81	re-gls	FE	Without education	2007-11	Size effect	Initial size effect
Frontier	T.Asset (K)	0.07	0.08	0.04	0.07	0.09	0.07	0.07	0.09	0.06	0.07	0.09	0.07
		(2.09)**	(2.40)**	(1.37)	(2.28)**	(2.83)***	(2.26)**	(2.42)**	(2.06)**	(2.04)**	(1.81)*	(3.28)***	(2.06)**
	Int.Input (M)	0.55	0.52	0.56	0.56	0.51	0.52	0.52	0.47	0.55	0.35	0.52	0.55
		(14.37)***	(12.86)***	(14.27)***	(14.38)***	(13.03)***	(13.98)***	(14.66)***	(10.99)***	(13.91)***	(9.88)***	(14.69)***	(13.91)***
	Labor (L)	0.30	0.28	0.38	0.29	0.26	0.29	0.29	0.14	0.32	0.33	0.22	0.29
		(6.29)***	(5.57)***	(7.98)***	(5.98)***	(5.18)***	(4.82)***	(5.44)***	(1.82)*	(6.73)***	(6.29)***	(4.96)***	(5.75)***
	Time.Trend	1.37	1.41	1.40	1.37	1.45	1.18	1.18	1.04	1.33	1.29	1.50	1.37
		(11.19)***	(11.39)***	(10.58)***	(10.73)***	(10.90)***	(8.99)***	(8.67)***	(8.02)***	(10.92)***	(9.17)***	(11.93)***	(11.25)***
	T.Asset2	0.01	0.01	0.01	0.01	0.00	0.02	0.02	0.03	0.02	0.03	-0.001	0.02
		(0.61)	(0.53)	(0.35)	(0.55)	(0.17)	(0.83)	(0.80)	(0.88)	(0.72)	(0.85)	(0.04)	(0.66)
	Int.Input2	0.21	0.18	0.21	0.21	0.20	0.18	0.18	0.17	0.20	0.18	0.19	0.20
		(9.16)***	(7.88)***	(9.13)***	(9.16)***	(8.25)***	(5.43)***	(5.43)***	(5.17)***	(8.79)***	(6.91)***	(8.93)***	(8.65)***
	Labor2	0.12	0.13	0.12	0.12	0.15	0.15	0.15	0.24	0.10	0.20	0.13	0.12
		(2.76)***	(2.78)***	(2.74)***	(2.81)***	(2.90)***	(1.90)*	(2.11)**	(3.18)***	(2.53)**	(3.49)***	(3.07)***	(2.79)***
	K*M	-0.01	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	-0.01	-0.02	-0.00	-0.01
		(0.65)	(0.20)	(0.65)	(0.71)	(0.28)	(0.06)	(0.12)	(0.06)	(0.71)	(0.94)	(0.06)	(0.57)
	L*M	-0.07	-0.06	-0.08	-0.07	-0.07	-0.07	-0.07	-0.09	-0.07	-0.06	-0.06	-0.07
		(3.36)***	(2.61)***	(3.26)***	(2.79)***	(2.69)***	(1.83)*	(1.86)*	(2.31)**	(3.14)***	(1.99)**	(2.60)***	(3.11)***
	L*K	-0.06	-0.07	-0.07	-0.06	-0.08	-0.08	-0.08	-0.08	-0.06	-0.09	-0.06	-0.06
		(2.92)***	(3.26)***	(3.41)***	(2.78)***	(3.30)***	(2.51)**	(2.61)***	(2.79)***	(2.87)***	(3.01)***	(3.06)***	(2.93)***
	Time.Trend2	-0.34	-0.35	-0.35	-0.34	-0.36	-0.29	-0.29	-0.26	-0.33		-0.37	-0.34
		(10.94)***	(11.00)***	(10.30)***	(10.48)***	(10.63)***	(8.88)***	(8.53)***	(7.72)***	(10.65)***		(11.64)***	(10.94)***
	Export	0.46	0.54		0.41	0.51	0.56	0.57	0.70	0.46	0.61	0.25	0.42
		(4.85)***	(5.08)***		(4.36)***	(4.94)***	(4.39)***	(4.69)***	(4.29)***	(4.66)***	(4.81)***	(3.05)***	(4.21)***
	Innovation	0.23	0.22		0.26	0.26	0.21	0.21	0.23	0.21	0.21	0.24	0.23
		(2.36)**	(2.18)**		(2.71)***	(2.71)***	(2.21)**	(2.21)**	(1.71)*	(2.20)**	(1.73)*	(2.88)***	(2.39)**
	_cons	-2.06	-1.88	-1.68	-1.93	-1.92	-1.65	-2.06	-2.10	-2.03	16.80	-1.94	-2.07
		(13.26)***	(10.07)***	(11.43)***	(12.71)***	(12.51)***	(10.90)***	(10.58)***	(10.24)***	(13.28)***	(93.73)***	(13.87)***	(12.96)***
Usigma	Experience	-0.29	-0.09	-0.27	-0.04	-0.07				-0.35	-0.22	-0.00	-0.28
		(1.99)**	(1.79)*	(1.72)*	(1.39)	(3.10)***				(2.64)***	(1.75)*	(0.06)	(1.65)*

	Education	-0.19	-0.13	-0.20	-0.25	-0.16					-0.15	0.11	-0.11
		(1.54)	(2.16)**	(1.85)*	(3.50)***	(3.37)***					(1.38)	(1.49)	(0.84)
	Overdraft- *fin1*	0.35	0.55	0.39	0.48	0.46				0.50	0.25	0.56	0.79
		(0.36)	(1.32)	(0.39)	(1.28)	(1.49)				(0.63)	(0.36)	(1.73)*	(0.82)
	Loan-*fin2*	0.38	-0.17	0.32	-0.17	-0.23				0.02	0.12	-0.14	0.80
		(0.28)	(1.46)	(0.27)	(0.75)	(2.16)**				(0.04)	(0.19)	(0.56)	(0.78)
	Firm age	0.97	0.67	0.93	0.73	0.75				0.12	0.87	1.05	1.50
		(1.65)*	(2.31)**	(1.69)*	(2.06)**	(2.92)***				(0.36)	(1.62)	(3.21)***	(1.93)*
	Firm size											-1.35	-0.85
												(5.47)***	(2.01)**
Vsigma	Experience	-0.03		-0.03	-0.04					-0.03	0.01	-0.08	-0.03
		(2.78)***		(2.96)***	(2.90)***					(2.89)***	(0.36)	(5.36)***	(2.32)**
	Education	-0.03		-0.00	-0.02						-0.08	-0.04	-0.02
		(1.22)		(0.10)	(0.91)						(2.51)**	(1.04)	(0.85)
	Overdraft- *fin1*	0.71		0.74	0.78					0.64	0.50	0.77	0.63
		(4.57)***		(4.66)***	(4.80)***					(4.56)***	(2.94)***	(4.76)***	(4.37)***
	Loan-*fin2*	-0.22		-0.29	-0.17					-0.25	-0.15	-0.14	-0.22
		(1.98)**		(2.16)**	(1.55)					(2.28)**	(1.42)	(1.73)*	(2.16)**
	Firm age	0.17		0.06	0.14					0.02	0.28	0.15	0.12
		(1.21)		(0.40)	(0.86)					(0.28)	(1.66)*	(0.96)	(0.84)
Vsigma	_cons		-0.45			-0.76	0.80						
			(3.03)***			(3.60)***	(9.47)***						
Usigma	_cons						0.28						
							(1.27)						
Theta	_cons	-0.02	-0.31	-0.04	-0.01	-0.30				-0.16	0.26	-0.004	-0.14
		(0.15)	(3.60)***	(0.20)	(0.13)	(3.69)***				(0.96)	(1.47)	(0.10)	(0.76)
		447	447	447	447	447	447	447	447	447	342	445	447

Note: Dependent Variable: *ln(annual sale)* * $p<0.1$; ** $p<0.05$; *** $p<0.01$

Table 2.5

Pooled Cross-Sectional (truncated-normal) analysis

		1	2	3	4	5	6	7	8
	Variables	Model-1-hetero	Model-1-homo	Model-2 edu-07-11	Model-2 - homo	Model-3 with 2013 edu	Model-4 size + edu	Model-5-isize+edu	Model-6 isize
Frontier	T.Asset (K)	0.08	0.06	0.04	0.03	0.03	0.03	0.03	0.03
		(10.38)***	(8.41)***	(6.09)***	(4.40)***	(4.74)***	(5.18)***	(4.67)***	(4.96)***
	Int.Input (M)	0.63	0.61	0.70	0.71	0.68	0.70	0.69	0.68
		(66.31)***	(64.86)***	(81.92)***	(80.02)***	(74.11)***	(79.67)***	(68.39)***	(62.67)***
	Labor (L)	0.24	0.30	0.26	0.24	0.26	0.25	0.26	0.26
		(19.75)***	(24.38)***	(23.23)***	(20.66)***	(21.85)***	(21.50)***	(19.75)***	(19.08)***
	year1	4.19	7.93	8.13	8.26	8.28	8.12	8.21	8.03
		(27.44)***	(2.72)***	(17.09)***	(5.74)***	(4.49)***	(8.78)***	(5.60)***	(7.44)***
	year2	0.03	-0.07			-0.04	-0.02	-0.04	-0.07
		(0.81)	(1.93)*			(0.94)	(0.52)	(0.96)	(1.56)
	T.Asset2	0.03	0.02	0.01	0.01	0.00	0.01	0.00	0.00
		(6.37)***	(4.39)***	(1.24)	(1.40)	(0.55)	(1.27)	(0.50)	(0.55)
	Int.Input2	0.18	0.18	0.17	0.15	0.16	0.17	0.16	0.17
		(20.59)***	(20.56)***	(18.18)***	(16.79)***	(17.19)***	(17.14)***	(15.49)***	(14.86)***
	Labor2	0.11	0.15	0.14	0.12	0.13	0.13	0.13	0.13
		(8.88)***	(12.35)***	(9.84)***	(8.31)***	(9.22)***	(9.02)***	(8.36)***	(8.16)***
	K*M	-0.04	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
		(8.08)***	(5.68)***	(3.95)***	(3.66)***	(3.23)***	(3.55)***	(3.05)***	(3.34)***
	L*M	-0.13	-0.16	-0.15	-0.13	-0.15	-0.14	-0.15	-0.15
		(15.66)***	(19.60)***	(15.73)***	(12.86)***	(14.27)***	(14.16)***	(12.80)***	(12.65)***
	L*K	0.01	0.01	0.02	0.01	0.02	0.01	0.02	0.02
		(2.28)**	(1.71)*	(2.71)***	(1.17)	(2.34)**	(1.99)**	(2.16)**	(2.39)**
	Garment	-0.03	-0.06	0.04	0.01	0.02	-0.001	0.001	-0.01
		(0.73)	(1.39)	(1.04)	(0.21)	(0.45)	(0.10)	(0.02)	(0.31)
	Textile	-0.11	-0.13	-0.04	-0.03	0.01	-0.00	-0.00	-0.02
		(2.82)***	(3.32)***	(1.20)	(0.84)	(0.32)	(0.05)	(0.08)	(0.37)
	Chemical	0.12	0.09	0.01	0.04	0.06	0.07	0.06	0.07
		(3.00)***	(2.15)**	(0.43)	(1.06)	(1.71)*	(1.92)*	(1.69)*	(1.61)

	Leather	-0.08	-0.07	-0.02	-0.04	-0.03	-0.04	-0.03	-0.05
		(1.97)**	(1.73)*	(0.54)	(1.01)	(0.86)	(1.02)	(0.90)	(1.31)
	Food	0.02	0.02	-0.02	-0.05	-0.04	-0.02	-0.04	-0.06
		(0.65)	(0.45)	(0.76)	(1.47)	(1.09)	(0.69)	(1.25)	(1.66)*
	Export	0.00	0.00	-0.001	-0.001	0.00	0.001	0.00	0.00
		(7.06)***	(6.82)***	(1.00)	(0.05)	(1.11)	(1.21)	(0.97)	(1.31)
	Innovation	0.05	0.04	0.02	0.03	0.04	0.03	0.04	0.05
		(2.09)**	(1.69)*	(1.10)	(1.93)*	(2.28)**	(1.91)*	(2.23)**	(2.36)**
	_cons	-0.29	-0.21	16.35	16.38	16.48	16.50	16.49	16.52
		(8.56)***	(5.89)***	(620.36)***	(575.91)***	(565.24)***	(582.67)***	(524.25)***	(490.92)***
Mu	Experience	-0.10	-0.08	-0.07	-0.04	-0.04	-0.04	-0.03	-0.07
		(5.44)***	(5.71)***	(4.09)***	(2.40)**	(2.38)**	(2.07)**	(1.97)**	(4.53)***
	Overdraft-*fin1*	-1.04	-0.55	-0.80	-0.35	-0.34	-0.61	-0.27	-0.43
		(4.79)***	(6.00)***	(3.42)***	(3.48)***	(3.40)***	(1.66)*	(2.75)***	(4.63)***
	Loan- *fin2*	-0.24	-0.08	-1.68	-0.13	-0.13	-0.10	-0.14	-0.11
		(1.74)*	(1.44)	(6.36)***	(2.00)**	(2.06)**	(2.51)**	(2.35)**	(1.93)*
	Firm age	-0.76	-0.80	-0.25	-0.28	-0.25	0.25	-0.10	-0.67
		(4.03)***	(6.37)***	(1.52)	(1.93)*	(1.75)*	(1.25)	(0.62)	(4.71)***
	year1	7.70	10.79	18.39	16.50	16.26	16.38	16.10	13.16
		(13.38)***	(3.69)***	(18.50)***	(10.38)***	(8.30)***	(14.24)***	(9.98)***	(11.22)***
	year2	-9.33	-21.83			-17.35	-21.53	-18.06	-17.38
		(2.39)**	(2.14)**			(1.50)	(1.86)*	(1.39)	(1.43)
	Education			-0.44	-0.52	-0.51	-0.43	-0.40	
				(8.79)***	(12.65)***	(12.36)***	(7.99)***	(9.65)***	
	Firm size						-0.48	-0.46	-0.71
							(6.10)***	(6.33)***	(10.90)***
Usigma	Experience	0.02		0.02			0.02		
		(4.53)***		(4.33)***			(3.30)***		
	Overdraft-*fin1*	-0.06		-0.14			-0.17		
		(1.37)		(1.61)			(1.50)		
	Loan- *fin2*	0.25		0.59			0.10		
		(3.36)***		(6.78)***			(1.92)*		
	Firm age	0.05		0.20			0.30		

		(0.90)		(3.44)***			(3.83)***		
	Education			-0.04			-0.03		
				(4.12)***			(2.27)**		
Vsigma	Experience	0.01		-0.03					
		(3.90)***		(3.92)***					
	Overdraft-*fin1*	-0.24		-0.64					
		(5.01)***		(6.06)***					
	Loan- *fin2*	-0.34		-0.84					
		(6.48)***		(13.73)***					
	Firm age	-0.37		-0.20					
		(11.59)***		(2.72)***					
	Education			-0.02					
				(1.63)					
Usigma	_cons		0.68		0.89	0.88		0.84	0.72
			(8.71)***		(12.88)***	(12.52)***		(11.56)***	(10.27)***
Vsigma	_cons		-1.56		-3.38	-3.10	-3.11	-3.07	-3.05
			(43.84)***		(55.86)***	(55.96)***	(57.57)***	(53.38)***	(50.97)***
N		2,193	2,193	1,109	1,109	1,217	1,215	1,149	1,149

Note: Dependent Variable: *ln(annual sale)* * $p<0.1$; ** $p<0.05$; *** $p<0.01$

Table 2.6
Sector-wise Pooled Cross-sectional (truncated-normal) analysis

	Variables	Chemical	Food	Garment	GarText	Leather	Textile
Frontier	T.Asset (K)	0.05	-0.01	0.08	0.08	-0.00	0.05
		(2.14)**	(0.58)	(4.73)***	(6.21)***	(0.11)	(2.61)***
	Int.Input (M)	0.70	0.76	0.53	0.57	0.70	0.67
		(21.52)***	(45.42)***	(24.47)***	(32.11)***	(37.10)***	(25.35)***
	Labor (L)	0.24	0.23	0.23	0.26	0.31	0.25
		(6.69)***	(10.15)***	(8.36)***	(11.69)***	(12.22)***	(8.29)***
	year1	3.23	5.97	5.59	7.11	0.60	4.99
		(4.79)***	(24.48)***	(7.46)***	(3.11)***	(3.88)***	(9.41)***
	year2	-0.05	-0.02	0.03	0.06	0.02	0.19
		(0.51)	(0.28)	(0.42)	(1.00)	(0.20)	(1.86)*
	T.Asset2	0.01	0.00	0.01	0.01	-0.00	-0.00
		(0.40)	(0.22)	(0.64)	(0.89)	(0.62)	(0.19)
	Int.Input2	0.15	0.11	0.24	0.22	0.19	0.16
		(3.74)***	(5.67)***	(11.26)***	(12.38)***	(12.56)***	(5.72)***
	Labor2	0.17	0.09	0.14	0.11	0.27	0.10
		(3.10)***	(3.70)***	(3.45)***	(3.55)***	(8.33)***	(2.15)**
	K*M	-0.01	0.02	-0.03	-0.03	-0.00	-0.03
		(0.35)	(1.19)	(2.54)**	(3.07)***	(0.63)	(1.18)
	L*M	-0.14	-0.11	-0.10	-0.12	-0.22	-0.12
		(3.32)***	(5.95)***	(4.14)***	(5.83)***	(10.17)***	(4.07)***
	L*K	-0.01	-0.01	-0.03	-0.01	0.001	0.02
		(0.29)	(0.77)	(1.62)	(0.51)	(0.32)	(0.76)
	Export	0.001	-0.001	0.01	0.001	0.001	0.001
		(0.38)	(2.31)**	(5.12)***	(3.43)***	(1.67)*	(1.06)
	Innovation	0.07	-0.02	0.03	0.04	-0.02	0.04
		(1.11)	(0.82)	(0.71)	(1.17)	(0.64)	(0.84)
	_cons	17.03	15.47	17.04	17.34	15.32	17.50
		(233.31)***	(575.70)***	(174.75)***	(357.44)***	(438.10)***	(339.98)***
Mu	Experience	-0.06	-0.19	-0.04	-0.07	0.74	-0.13
		(1.58)	(1.28)	(2.14)**	(3.72)***	(3.97)***	(3.40)***
	Schooling	-0.18	-0.65	-0.18	-0.21	-1.07	-0.08
		(1.21)	(2.55)**	(3.96)***	(5.13)***	(1.83)*	(1.02)
	Overdraft	1.14	-1.03	0.10	-0.06	-1.12	-0.94
		(2.46)**	(0.57)	(0.73)	(0.47)	(2.15)**	(2.07)**
	Loan/LOC	-1.21	0.85	-0.17	-0.13	0.18	-0.06
		(2.09)**	(0.59)	(2.06)**	(2.17)**	(0.30)	(0.79)
	Firm age	-0.11	-0.97	0.25	0.22	-3.68	-0.77
		(0.31)	(1.04)	(1.40)	(1.31)	(2.17)**	(1.71)*
	Firm Size	-0.44	-1.51	-0.47	-0.44	-7.32	0.01
		(2.40)**	(2.07)**	(4.53)***	(4.59)***	(2.59)***	(0.02)
	year1	8.60	23.27	9.28	11.49	28.01	9.51
		(3.31)***	(4.66)***	(8.50)***	(4.81)***	(4.04)***	(5.99)***
	year2	-16.17	-57.14	-2.40	-3.50	-26.49	2.60
		(0.29)	(0.97)	(0.86)	(0.90)	(0.56)	(0.71)
Usigma	_cons	-0.70	1.61	0.38	0.42	1.75	-0.03
		(1.59)	(5.69)***	(3.03)***	(4.03)***	(8.26)***	(0.12)
Vsigma	_cons	-2.62	-4.46	-3.04	-2.93	-3.93	-3.17
		(18.26)***	(23.49)***	(23.96)***	(29.48)***	(22.71)***	(18.25)***
N		134	197	331	473	216	142

Chapter 3: Measuring the Impact and Determinants of Formalization in Manufacturing Firms of Bangladesh

3.1 Introduction

3.1.1 General Background

Informal firms have become a driving force for the economic transition in most economies under industrial development. The definition and significance of informal firms in developing countries are totally different from the general perception in developed countries. While informal firms are conceptually close to unauthorized or illegal in developed economies, it is quite different for lower-middle income and low income developing countries which are dominated by informal economy. Studies tried to explain the presence of large informal sector through different arguments including extreme tax rule and regulatory burden, unfavorable and uncertain business environment, corruption and institutional dysfunction and weak economic development (Amin & Islam, 2015). But the condition in developing countries, where informal economy has huge role in economic transition, should be analyzed with more elaborate understanding. In these countries, informal firms are not illegal but simply lack in business registration, proper organizational structure and standard business practices. Their existence and contribution are undeniable reality and seek attention for deeper analysis. The mobility of operation and unregistered status as well as the size of the informal firms make them less visible and exclude them from the mainstream enterprise surveys. But their contribution to national GDP, employment and economic transition is too big to ignore if the wellbeing of the whole economy is concerned. So, it is imperative to get a clearer picture about the operational status of informal firms as well as their transition process towards the formal sector. At the same time, different attributes of the informal firms including their

background incentive for being informal and choice to transform should be considered while investigating their performance and growth process. It would help in developing a more applicable and sustainable industrial policy for the economy as a whole.

3.1.2 Motivation

The government of Bangladesh is committed to poverty reduction and bring Bangladesh out of poverty trap by 2021. Reduction of unemployment and promoting productivity are two of the main tools to attain this goal. Poverty rate decreased in the country from 40% in 2005 to 31.5% in 2010 and this reduction is followed by a huge migration to urban centers. The formal sector, having limited absorption capacity due to higher skill, education and capital requirement, is less capable in accepting these economic migrants and that's why informal sector has flourished in the country. Informal sector appoints majority of the workforce and with the development of non-farm economy, its proportional contribution to GDP is increasing over past decade. In the latest labor force survey, informal sector is found to employ 88.5% of the total work-force (agriculture included). Women participation in informal sector compared to formal sector is higher and it is higher in rural area compared to urban area. The size of informal sector is larger not only in Bangladesh, but in other developing country as well. In OECD countries, 17% of the workforce is in informal sector while it is about 60% in developing countries according to Dessy & Pallage (2003) and Ihrig & Moe (2004). As the government is emphasizing in boosting non-agro economic activities, the focus is to promote micro and small firms and it has become imperious to explore their strength, weakness and transition process. Additionally, the government is increasingly trying to bring informal firms under formal framework to expand tax revenue to cope up with the growing demand of public

spending. A better understanding of the incentive and operational status of informal firms can only ensure the undertaking of proper policy measures to enhance this transition. But for the difficulty in data collection for informal firms, informal sector related studies are not adequate. So, studying the informal sector is required to support smooth and effective industrialization in Bangladesh.

3.1.3 Definition of Informality

International Labor Organization (ILO) defines informal enterprise conceptually as production unit engaged in production of goods with the primary objective of generating employment and income for the persons concerned in order to earn a living. These entities are supposed to operate at lower organizational level, with little or no division between capital and labor. Labor relations are based on casual employment, kingship or personal and social relation rather than formal contract. The operational definition of informal firms is, according to ILO, household unincorporated enterprise owned and operated by own-account workers, either alone or in partnership with members of the same or other households which may employ unpaid family worker as well as occasionally hired workers (informal own-account enterprise) or which employ one or more employee on a continuous basis (enterprise of informal employers). It excludes corporations and quasi corporations and units with ten or more employees. But in academic studies, more practical definition is used though we can argue that very few of them considered respective industrial attributes while using different definitions. Most of the studies considered one particular aspect of informality. The most notable formalization indicators used in academic studies are firm's labor size and business registration. Within business registrations, tax registration is used in most studies and trade license in few. Rothenberg,

et al. (2016), Siba (2015), Demenet, Razafindrakoto and Roubaud (2015), Amin and Islam (2015), and De Mel, McKenzie and Woodruff (2013) used tax registration to define informality. Amin and Islam (2015), Rothenberg et al. (2016), and Siba (2015) used employee size. Among studies using employee size, having ten workers is used as the most popular threshold to define formal-informal transition. This number is drawn from ILO and some country specific definitions. Firms' legal status (for example, Rothenberg et al., 2016 used sole-proprietorship for Indonesian firms) and written business record (Siba, 2015) are also used as informality indicator in some studies. All these studies have considered binary or discrete definition of formalization. It can be argued that informality or the formalization process is not simply related to a single variable, rather formalization is a process connected with reforms and up-gradation in organization structure, business practice, affiliation, external and internal contracts etc. For example, if we define informality by the possession of trade license, is a firm merely having trade license equal in formality to a firm also having tax registration? Or is a firm having tax registration equal to a firm also having membership in chambers of commerce and exports as well? Similarly, it is difficult to argue that a firm having all business registration but with less than ten workers is an informal firm. With this understanding of the flaw regarding single variable based definition, some studies used combinations of informality indicators. Siba (2015) used business registration and employee size together. Benjamin and Mbaye (2012) used five binary variables, namely employee size, business registration, record-keeping, mobility of workplace and access to bank loan and formed five formality groups. When we argue that a single variable cannot represent the true formalization status of a firm, same argument can be used to say that a combination of handful binary variables cannot properly show the process of formalization. This is related to a number of firm

attributes and business process and a credible definition can only be formed when we incorporate all or most of them to define a continuous spectrum of formalization for a given sample of firms.

3.2 Literature Review

The importance of studying informal firms, separated from traditional formal industries, has become evident during past two decades with the rise of developing industrial nations, transition of previously agro-based economies and governments' increasing focus on tax revenue to improve public goods provisions in developing nations. Rothenberg et al. (2016) argued that this study is required because informal firms may evade a huge amount of tax revenue and thus limit government's capacity to deliver public services. The existence of informal sector creates discrepancy in production cost between formal and informal firms resulting in inefficient allocation of resource (Hsieh & Klenow, 2009; Levy, 2007). So, informal firm study would help in adopting a policy to bring level playing field in the industry. It would also address productivity issue, if there is any, in informal sector; otherwise productivity gap forces the whole sector to perform low and it is not solved by normal market mechanism due to market failure. At the same time, the contributory role of informal sector cannot be denied especially for accommodating laid-out workers from formal sector during economic crisis and offering flexible work opportunity to women at their home (Rothenberg et al., 2016; Alatas & Newhouse, 2010; Loayza & Rigolini, 2011).

Some studies found that informal firms are less productive, managed by managers with low competency, and many have little intensive to move to formal sector. Benjamin and Mbaye (2012) also found significant productivity gap between formal and informal

firms. But at the same time, they argued for the heterogeneity among informal firms by showing similar productivity for large informal and formal firms. Reasons for the better performance of formal firms are discussed in very few studies. Low productivity in informal firms is attributed to low production level by many (Levy, 2007; Benjamin & Mbaye, 2012; Grimm, Knorringa, & Lay, 2012; Grimm, Kruger, & Lay, 2011; De Mel et al, 2008; McKenzie & Woodruff, 2006; Siba, 2015). The firms, after being formal, enjoy some benefits including greater access to financial and credit services, better infrastructure, utility access and legal protection in addition to better market access. Formal firms see themselves less exposed to corruption but they need confirmation and confidence of a sound regulatory environment (Cling, Razafindrakoto, & Roubaud, 2012; Malesky & Taussig, 2009). On the other hand, informal firms have lower labor cost and flexibility in adjusting production scale. Better performance makes them more visible to authority. So, the operational level of an informal firm is influenced to a significant extent by the perceived benefit of being formal (Lenvenson & Maloney, 1998). McKenzie and Sakho (2010) showed a contradictory impact of formalization on large and smaller firms and pointed to other firm effects. Productivity gain and performance improvement by formalization depend also on the cost of formalization and that's why not all firms gain from formalization (De Mel, McKenzie, & Woodruff, 2012; McKenzie & Sakho, 2010; Rand & Torm, 2012; Bigsten, Kimuyu, & Lundvall, 2004). Cunningham & Maloney (2001), Maloney (2004), and De Mel et al. (2010) also discussed the importance of considering heterogeneity among informal firms.

Amin and Islam (2015) have analyzed the impact of firm size on the performance of informal firms. Interestingly, they found smaller informal firms to be more productive. This finding was contradictory to the findings of Benjamin and Mbaye (2012) from West

Africa who found that large informal firms are more productive. In a rare panel study for informal firms, Demenet et al. (2015) discussed the attributes of firms who choose to formalize from informal status, who choose to remain informal and firms who became informal from being formal. Due to the panel nature of their data, they could also discuss the difference in intermediate goods' consumption to explain the channel through which formal firms perform better. They found that firm's operational age is not a significant factor in formalization, rather it is entrepreneurs' ability that plays the major role. Their finding supports the study of McKenzie and Woodruff (2006). They argued that a certain firm size is to be achieved by the informal firms to get benefitted from their formal transition. They mentioned in line with the findings of Levy (2007) that better access to intermediate goods, especially to utility services, helps formal firms to increase their productivity. They discussed that formalization is supposed to help firms grow in size and thus attain the optimal level. Giorgi and Rahman (2013) showed that it is the indirect cost like taxation and compliance that play key role in firm's decision to move to formal sector when they grow. De Mel et al. (2013) also found in their Sri Lankan experiment that one-time cost is not the main barrier to enter formal sector, rather perceived future cost of taxation is the key. They found modest effect of registration on performance with few firms performing better after registration.

All these studies, except Benjamin and Mbaye (2012), used binary definition of informality either in terms of size or business registration. After looking into the distribution of size, productivity or any other specific criteria of our sample, such sharp distinction can hardly be considered. This approach fails to shed light on the development and transition process of informal firms and heterogeneity among them. Rothenberg et al. (2016) argues that informality should not have binary definition, rather formalization is a

continuous process that covers a wide range of parameters and business practices. Also, we have not found any significant study focused on informality in manufacturing industry exclusively. This is a big gap because manufacturing firms are totally different in nature and have better possibility of expansion and to move to formal sector compared to other industries. For example, many trade or retail firms operate locally and have limited customer segment which exclude them from the issue of moving to formal level. Demenet et al. (2015) found that manufacturing firms are lowly registered in their Vietnam study. Though they have not placed any reason, it points to the special circumstances faced by manufacturing firms.

To find the determinants of formalization, most of the current studies used very limited set of variables due to data availability issue. Though owner's background information is used, it is limited to age, education and sex in most cases. Support from family (or liquidity available to invest in business) and cognitive processing power of the owner are strongly related to owner's human capital and are needed to check against firm's formalization status. Distance (proxy for convenience and information access) and inspection intensity (proxy for regulatory enforcement) are also rarely used as possible determinants of formalization. These is no clear result about the role of firm age on formalization process as well. Another significant weakness of many recent studies on informality is that they used data from surveys conducted to collect data either for formal or informal firms. Using data from separate surveys is supposed to create substantial bias in the combined analysis and comparisons thus would be less credible.

Hence, it will be worthy to consider formalization as a continual process and observe the impact of different formality level on firm's productivity. In addition to that, the role of owner's attributes, especially education, experience, intelligence and family

background as well as distance and regulatory enforcement are to be checked regarding formalization. We want to address these gaps to look into the informality phenomenon in manufacturing sector which is mostly untouched till now.

3.3 Industry Background

The labor force survey 2010 (Bangladesh Bureau of Statistics, 2010) included informal sector and became the most enriched data on informal sector. Though it does not include any firm specific data, it captures all the industry level data for formal and informal sector. Bangladesh is shifting towards industry and service oriented economy from traditional agro-based economy. Figure-A2.5 shows sectorial contribution to GDP since the independence of the country. In 2009-10, gross value added of industry was 1,201 billion BDT (17 billion USD) compared to 1,006 billion BDT (14.5 billion USD) from agriculture. Share of agriculture in GDP (current price) was 18.6%, while industry had 28.5% and service 52.9% share. Manufacturing alone contributed 17.9% to GDP in this year (figure-A2.6), where 11.1% was from formal and 6.8% from informal sector enterprises. Informal sector activities accounted for 43% of the GDP in 2009-10. Informal enterprises were accounted for 34% of the total GVA in industrial sectors and 33% in service sector.

Table-A2.5 shows detail of informal sector contribution to GDP and employment creation. Informal enterprises were holding 42 million jobs out of 54 million total jobs in the labor market in 2010. So, 77% of the employed population was engaged in informal sector enterprises. On a sectorial level, gross value added per job is six times in formal sector compared to informal sector. It raises the issue of productivity in informal sector enterprises and the importance to solve it in promoting industrial development. 76% of

the informal firm owners choose this job due to family tradition or better knowledge of the job (table-A2.6). More than 60% started the business with their own saving or loan from family or friends. More than 88% of the informal firms have less than 10 workers and thus show that they are mostly small and micro in nature (table- A2.7).

Affiliation with financial institutions reveals financial challenges faced by firms. Only 7.5% of the manufacturing informal firms applied for any bank loan which is much lower than agriculture and financial groups who have average 23% application rate. A huge proportion of informal firms do not even apply for loan. 87% of the loan receiver revealed positive impact of the loan on their business (table-A2.8). Among firms whose applications were rejected, 92.3% cited that their request was deemed unconvincing. Access to financial support or loan is the single most important assistant sought by majority of the informal firms (48%). It is followed by technical training (28%), access to modern machines (27%), access to market information (26%) and support in raw material supply (25%). 10% of the informal enterprises were associated with any business association. Among supports that informal firms received from respective association, access to loan is the major (52%). Financial difficulty is cited as the most severe challenge faced by informal firms (table-A2.9). It shows the credit constraint faced by informal firms. Despite low access to bank loan, informal firms have an excellent opportunity to get credit support from the micro-credit institutions to support expansion. In our sample, we find that unlike bank loan, informal firms have higher subscription to financial services of micro-credit institutions.

3.4 Business Registration System in Bangladesh

Business registrations are the most customary and arguably most important aspect of formalization. In Bangladesh, main registration authorities are local municipality offices for trade license and national bureau of revenue (NBR) for tax registration (circle offices) and value added tax (divisional offices). Trade license is the most basic, cheapest and most convenient business registration. The local city corporation, Zila Parishad (district council) and Union Parishad (municipality counterpart in rural area) issue it and it is required to conduct business activity within respective administrative area. For defaulters, the fine is five percent of the annual fee for each defaulting month. The amount is very minimal for a manufacturing firm even with very small scale of operation and the license fee is annual and fixed. The local administrative unit can inspect and identify the defaulters more easily than tax authority. So, getting a trade license by paying a cheap annual fee with full authorization to conduct business is an easy choice for firms. Traditionally it is the most known registration system and there is no further commitment or burden related to it. In that sense, merely having a trade license probably does not represent a business's true formal status or their perception about it in manufacturing industry. But the case is totally different for tax or VAT registration.

There are two ways for starting a manufacturing firm with a business registration. The first is by setting up a joint stock company or firm. Businesses who start as medium or big enterprise or who are export oriented normally start with this very formal way. In this case, businesses go through following steps: first, they need to get trade license from local municipality. Then they go to the Registrar of Joint Stock Companies & Firms (RJSC) with article of incorporation of the company and relevant documents to register as a company or firm. Once they get registration certificate, they are required to go to

local circle office of NBR for tax registration (TIN). At the same time, they are required to visit divisional value added tax (VAT) office for VAT registration (BIN). For a joint stock company or firm, TIN and VAT registrations are mandatory irrespective of their operational level or turnover. Practically, there are many firms who are registered with RJSC but operating without TIN and BIN or are not submitting tax return. Though it shows a lack of enforcement, it is much lower in number compared to the number of firms not registering (after being eligible) for TIN or BIN. On the other hand, when firms want to start in small scale, they register for trade license first. If the proprietors have taxable income (annual income more than 250 thousand BDT), they need to register for TIN. And if the business exceeds annual turnover of six million BDT, it is required for VAT registration. So, there is a provision for very small manufacturers to legally stay out of tax or VAT registration if they are operating on low level.

There are two types of avoidance that manufacturers possibly adopt regarding tax and VAT. One is not to register for tax or VAT and the other is not submitting tax return or submitting false income statement. NBR would be able to impose fine and demand all due taxes for any detected avoidance if the individual or firm is not registered. There is no time limit for this action. Detection at any time would impose penalty and due charge for any previous period. But for registered firms, authority would only be able to address any possible avoidance within last six years and not before that. In normal procedure, a notice is issued to pay all due amount with a certain fine imposed for the avoidance. At the same time, for false statement and other major fraudulent irregularities, NBR may suggest to prosecute defaulters under certain laws which may bear up to 3-5 years (depending on the nature and applied provision) of jail sentence.

In Bangladesh, where tax registration is very low compared to working population, the enforcement is enacted using incentive bases strategic scheme. Direct inspection or policing is almost impossible in the economy dominated by informal sector. For example, there are more than 90 million voters in the country of 160 million population. But NBR has less than three million tax registration (by April 2017). It indicates a general lack of perception and education about the requirement and importance of tax registration. The extent of population outside tax system indicates the importance of encouragement and educational campaign as well as indirectly binding regulation to expand tax arena gradually. NBR is doing this by setting up a framework of indirect enforcement. For example, TIN is mandatory to buy properties like land, apartment and car, to participate in any tender, for any contract with government agencies, for export and import permission, for association membership etc. Even TIN is now required to have a bank account with business name and specifically for bank loan. When the government introduced national ID for all Bangladeshi nationals in 2008, the subscription rate was very low in initial phase. But gradually, the whole adult population came under the ID system and it was made possible within a reasonable timeframe using indirect enforcement or incentive based method. For example, national ID is required to avail many public services, to get passport, for renting properties etc. The success in national ID project is being followed by NBR in expanding tax registration.

To encourage small businesses to come inside tax framework, a progressive tax rule is implemented. With an exemption level of 300 thousand BDT, the rate spans from 5% to 25%. VAT rate is rather flat, with export items have zero rate and all other taxable items have 15% rate (these are for manufacturing firms; for specific service oriented industry, a lower rate exists). As discussed earlier, there is a threshold of annual turnover

to become eligible to pay VAT. Any business having six million BDT or more annual turnover must register for VAT. For small businesses having turnover less than the threshold, there is provision of paying 4% turnover tax on their approved annual income (income tax included). In 2010, around 44,000 manufacturing firms were registered with VAT. The overall return submission rate was 16% in that year (NBR 2011). In this year, manufacturing firms provided 56,475 million BDT revenue through VAT which was 25% of the indirect tax.

There is a big difference in approach and view of the authority towards unregistered firms in Bangladesh and most developed countries. Firms that are not paying tax or VAT (after registration) or are not even registered (even being eligible), are not termed as illegal business in legal term in Bangladesh. Rather, the authority use the term 'defaulter' in their enforcement process, not 'illegal'. Similarly, for hiding income and other related issues, they use 'convicted taxpayer' rather than 'criminal' and regarding undeclared income, use 'untaxed income' rather than 'illegal income'. NBR explicitly differentiate these firms and income from illegal business and illegal income like drug-dealing and smuggling. Though it does not project the complete legal procedure of the tax system, it gives fairly enough idea about the perception and view of authority towards unregistered economic activities and that is reflected in their enforcement process.

3.5 Methodology

3.5.1 Principal Component Analysis

The formalization of firms is a process rather than a simple registration or passing a threshold of employee number. As we have discussed above, such sharp or discrete definition undermines the gradual transformation process of the firms and thus limit the

scope for policy application. So, we argue that formalization is a continuous process ranging from firms which are very informal to firms which are most formal within a given sample. Now, as there is no standard set of parameters which guides this process, we have selected all the conventional indicators which may be related to firms' formalization and have been discussed in recent studies. The indicators are: 1) trade license, 2) tax registration (TIN), 3) value added tax (VAT) registration, 4) business association membership, 5) chamber of commerce membership, 6) sole-proprietorship, 7) using written employment contract, 8) use computer, 9) bank account of business, 10) bank loan, 11) paying taxes, 12) buying practice, 13) stock control, 14) marketing practice (combined score), 15) record-keeping (combined score), and 16) financial planning (combined score).

Within these variables, the first thirteen are binary variable formulated from the response of firm owners. Exclusively those variables are chosen which have the applicability to all sample firms. Sole-proprietorship is included as it is the most common ownership-status in informal sector. Within the equipment and ICT usage, computer is the most common tool applicable to manufacturers while fax, website etc. are not commonly related. 'Paying taxes' says whether the firm pay any form of tax to any of the authority irrespective of having TIN or VAT registration. It mainly includes holding tax and other municipality taxes in addition to income tax and VAT payment. So, the positive response for tax payment (75%) is higher than the TIN possession (49.6%). Whether the firm checks price from alternative suppliers is used to represent buying practice which should be applicable to all firms. Firms that frequently use-up their stock of raw materials and other input supplies are assumed to be more dynamic in stock management and thus are given higher score. Firms who systematically uses-up their stock within one month,

within 3 month and within 6 months are given scores of 3, 2 and 1 respectively while firms that always have enough raw materials in their stock (thus do not show good stock management) are given zero. Marketing practice is a combined score calculated from the response to following questions: 1) visited competitors' business to see their prices, 2) visited competitors' business to see their products, 3) asked existing customers about new products, 4) talked with former customer about reason for leaving, 5) asked supplier about best-selling product, 6) used special offer to attract customer, and 7) advertising (flyer, paid community advertisement, phonebook, newspaper, billboard away from business, attending meeting). Positive response for any of these questions would yield 1 and 0 for negative. So, a firm can have highest 7 to lowest 0 marketing score. Similarly, record-keeping score is calculated from: 1) keep written business record, 2) record every purchase and sale, 3) use record to examine current liquidity status of business, 4) check record to analyze the sale trend of product, 5) work-out cost of main product, 6) know the most profitable product for per unit sale, 7) has written budget for utility and indirect business cost, 8) has written record of customer's debt, and 9) can present each months' profit to receive bank loan. So, a firm may have highest 9 and lowest 0 record-keeping score. Financial planning score is measured from: 1) frequency of checking financial strength of business and analyze improvement (score from 3 to 0 for monthly, yearly, 'less frequent than yearly' and 'never' responses), 2) frequency to compare actual performance to target (same as 1), 3) prepare budget for possible cost of next year, 4) prepare profit and loss statement, 5) prepare cash flow statement, 6) prepare income and expenditure statement, and 7) prepare balance sheet. Firms range from 11 to 0 in planning score.

We have used Principal Component Analysis (PCA), as used in McKenzie (2015) and originally proposed by Galpin (2006) in their business sophistication model, to formulate continuous informality groups with the consideration of all these variables. First the correlation matrix of these variables are constructed. From this correlation matrix, corresponding eigenvectors are estimated including their individual eigenvalues. The eigenvectors are sorted in descending order according to their eigenvalues. The eigenvalues represents the extent to which corresponding eigenvector accounts for the variation in the sample data. These eigenvectors represent the principal components after their components are being put in multiplicative relation with related variables and then in summarized form.

The main objective of performing principal component analysis is to reduce the dimensionality of a large number of possibly interrelated variables without losing the power to explain variation across the data (Jolliffe, 2002). All sixteen variables, as mentioned above, are strongly argued as the indicator of firms' formalization. But to incorporate them in a systematic study, we need to overcome two disadvantages. First, they are too many in number to present any comprehensive indicator of formalization for individual firms. Second, many of them are possibly correlated to each other and it is statistically impossible to generate an aggregated score or indicator using any conventional statistical tool. So, we develop principal components from corresponding eigenvectors which overcome these challenges. The correlation matrix, eigenvectors and eigenvalues are shown in table-A2.11 and table-3.9. The first principal component accounts for 28.5% variation in the data which is the highest among all components according to the structure of PCA. The second component accounts for only 9% of the variation. Being enough for our purpose, we choose only the first component and

calculate individual score for each firm by putting respective value of variables in following equation:

*PC1= 0.21*trade-license + 0.35*TIN + 0.32*VAT + 0.14*business-association + 0.23*chamber-of-commerce – 0.17*sole-proprietorship + 0.22*employment-contract + 0.31*business-bank-account + 0.28*bank-loan + 0.29*pay-tax + 0.26*use-computer + 0.13*marketing-score + 0.29*record-score + 0.32*planning-score + 0.11*check-price + 0.12*stock-control* (1)

Notably, all the coefficients in first component are in the range from 0.11 to 0.34 and eleven coefficients are in between 0.21 to 0.34. So, our data and the PC formulation process exclude the fear of providing too much weight on few parameters while understating the effect of others. It also justifies the choice of first component in addition to its high explanatory power for variation in the data compared to any other component.

We have calculated individual PC1 score for firms from equation (1) and divided them into five groups with equal percentile distribution according to PC1 score. For example, firms having PC1 score up to the score of 20^{th} percentile are included into group-1 and so on. So, group-1 is the least formal and group-5 is the most formal in this informality range. The summary of build-up parameters for these five groups are shown in table- A2.3. It is observed that all the parameters are strictly improving from group-1 to group-5 indicating higher formal attributes. To check the robustness of our group formation, we have divided firms into 20 groups with equal percentile distribution of their PC1 score in a separate set-up. Summary statistics of the variables used to form PCs were prepared for these groups and visibly similar groups were merged. We ended up with seven reformed groups and used them instead of the five initial groups. The results were similar. With the same intension, we have used covariance matrix of the variables to calculate eigenvectors instead of correlation matrix. Because we need to make sure all

variables are in the same scale of measurement while using covariance matrix (Jolliffe 2002, page 22), we have broken-up planning score, record score and marketing score into their binary components so that we have only 0 or 1 for all the variables. Principal component groups formed from this covariance matrix also showed similar result to our initial five groups and thus argue for the universality and robustness of the group formation. We have used the group dummies (with group-1 or the most informal group as reference group) as the indicator of formalization status.

3.5.2 Impact of Formalization

To measure the impact of formalization, we have used a simple OLS regression model for a Cobb-Douglas (CD) production function. The basic CD function is represented as-

$y = AL^{\alpha}K^{\beta}$

where y is the output; L is labor input and K is capital; A is total factor productivity (constant); α and β are output elasticity (constants). If we divide both side of above equation with labor input L, we receive-

$\frac{y}{L} = AL^{\alpha-1}K^{\beta}$

$\ln(\frac{y}{L}) = \ln(AL^{\alpha-1}K^{\beta})$

$\ln y_l = \ln A + (\alpha\text{-}1)\ln L + \beta \ln K \quad (2)$

where y_l is output per labor or labor productivity. For constant return to scale assumption, $\alpha + \beta = 1$. Almost all the studies using CD have found the value of α and β to be less than unity even under increasing return to scale ($\alpha + \beta > 1$). Unless the sector is operating at extremely high increasing return to scale (which is unlikely) and labor fully dominates capital usage (very unlikely as well), α will be less than unity and thus the coefficient of

labor term in equation (2), (α-1) would be negative. In regression analysis, this phenomenon will additionally test the validity of our model definition. Detail specification of the regression model is-

$\ln y_l = \beta_o + \boldsymbol{\beta_1}\textit{Inputs} + \boldsymbol{\beta_2}\textit{Status} + \boldsymbol{\beta_3}\textit{Owner} + \boldsymbol{\beta_4}\textit{Others} + \varepsilon_i$ (3)

$\mathbf{y_l}$ = labor productivity- annual sale divided by total worker

Inputs = total asset, total worker (log values)

Status= Formalization status, represented by PCA group dummies or alternative definitions (discussed later)

Owner = Owner's characteristics, represented by owner's age, schooling year, digit-span recall ability

Others = firm's age, innovation, location effects

$\boldsymbol{\beta}$s = coefficients vectors

ε_i = random error term

We have used labor productivity, measured by annual sale per labor, as the dependent variable in our model. The sample firms are mainly labor intensive similar to all other manufacturing firms in Bangladesh (except for pharmaceuticals firms which are almost absent in our sample). So, labor productivity is a simple but good measure of sample firms' performance. Capital and labor are used as inputs for the production function. Capital is defined by the total asset of the firm (current value). It is the summarized value of all land, buildings, machinery and equipment. Total number of worker is used to represent labor. It is the most favorable representation of labor for the labor intensive firms. At the same time, it effectively controls for firm size which is represented by labor size in labor intensive industries. To measure the impact of formalization, we have used PCA group dummies with group-1, which is the least formal,

as the reference group. In addition, using PCA groups would allow us to check our argument for continuous formality. So, the hypothesis that we want to test from this model are-

Hypothesis 1: Formalization is a continuous process and firms range from very informal to very formal status.

Hypothesis 2: More formal firms perform better than firms that are less formal.

As a robustness check for the effect of formalization and to compare with previous studies that used discrete definition of formalization, we used two alternative definitions. In the first case, firms registered with either tax or VAT are considered as formal (we would refer as formal-1 group) and others as informal (having neither tax nor VAT registration). Though trade license is the most basic registration applied to all manufacturing firms, it does not present a good definition of formalization due to very low cost of having the license and low cost of avoidance. On the other hand, initial cost, yearly commitment, recognition to tax regulators, cost of avoidance, role of tax registration in financial agreements, eligibility for export and access to wider customer segment including government make tax or VAT registration the most viable formalization indicator if we use business registration to define discrete formality. At the same time, a number of studies, including ILO definition, considered employee number as an indicator of formalization. They mostly used (including ILO) ten paid workers as the threshold to define formal status. So, together with business registration, we consider firms with ten or more employee as formal (even they have no business registration) in our second discrete definition (would be referred as formal-2).

One of the unique characteristics of our study is that we use a rich set of control variables. It increases the robustness of our model and reduce the possibility of endogeneity in cross-

sectional regression. Most importantly, we use owner's characteristics which are representative of the owner's human capital. Though in conventional literature, top manager's human capital is used to explain firm performance, using owner's attributes in our model is justified for two reasons. Firstly, owners act as the top manager in most of the manufacturing firms and in all the informal firms (unregistered and/or small) in Bangladesh. When they do not, even then they are relevant to all policy level decisions of the firm. So, using owner's attributes is more practical for our purpose, especially when we are dealing with informal firms. Secondly, if top manager is other than the owner, there is a big possibility of reverse causality. Highly capable managers may improve firm performance but at the same time, highly performing firms may hire more competent manager and we cannot conclude the exact direction from cross-sectional data. But owner's attributes are totally exogenous and exclude any reverse causality argument. We used owner's age, schooling year and digit-span recall ability to represent the owner's capability to influence business performance. In the survey, respondents were asked to recall a number, starting from three digit, after showing it to them for ten seconds on a paper-board. If they were successful, another number with higher digit was shown and the process advanced until the respondent was unable to recall any higher digit. Digit-span recall entries in our data show the highest digit recalled by corresponding owner. Higher digit-span recall ability indicates higher cognitive processing ability. Digit-span recall is a proxy for the short-term cognitive processing power of the owner and has been used by De Mel et al. (2008, 2010) and McKenzie (2015). These studies found it significantly related to better performance and larger firm size. Owner's age is the proxy for experience and has been used credibly in recent literatures (including Amin and Islam,

2015; Demenet et al., 2015). Schooling year is the most popular measure of individual education in related studies (Amin and Islam, 2015; Demenet et al., 2015; Siba, 2015).

Firm age is the most popularly used exogenous variable in performance analysis and it is argued to control for a lot of hidden factors (Amin and Islam, 2015; Demenet et al., 2015; Siba, 2015). Innovation is used because innovative product or process shifts the production frontier and thus affects output directly. As we are dealing with many firms with informal characteristics, it will be interesting to observe the effect of innovation compared to the positive effect found in some recent studies. The survey data is collected from 19 district headquarters and they have different attributes including business environment and regulatory enforcement. To control for the location effect, we used location dummies. Instead of putting 18 districts as dummies (with one as reference), we used Dhaka, Chittagong and Lowregist as the dummies and all other districts as default. Dhaka is the capital and Chittagong is the second largest city and commercial capital. Regulatory environment is these two cities are different from others including the presence of concerned governmental agencies. While summarizing the registration rate in 19 districts, two of the districts, Tangail and Cox's-Bazar, stand out with their low registration rate (considering tax, VAT and trade license). So, we referred these two districts together as Lowregist. There is no particular difference among other districts and they are the reference districts in our model. Robustness of the result is checked by using 18 district dummies in the regression. The result supports the usage of three location dummies as we proposed.

3.5.3 Determinants of Formalization

To find the determinants of firm's formalization, we have used a Probit regression model. The model is specified as-

$$F_i = \beta_o + \boldsymbol{\beta_1} Owner + \boldsymbol{\beta_2} Employee + \beta_3 Inspection + \boldsymbol{\beta_4} Distance + \boldsymbol{\beta_5} Others + \varepsilon_i \quad (4)$$

$\mathbf{F_i}$ = Formality indicator- individual business registration (tax, VAT, trade license), formal-1, formal-2, business practices

Owner= owner's age, schooling year, parents' schooling year, digit-span recall, poverty during childhood

Inspection= average inspection rate in the district (for tax, VAT, trade license)

Distance= closeness to authority (dummy) (for tax, VAT, trade license)

Employee= number of total employee (group dummies)

Others= Firm age and location effects

We used indicators of formalization status as the dependent variables in this model. Using an aggregated variable or attachment to PCA group as F_i would be useless because we cannot relate the result to any fruitful policy recommendation. For example, if we use attachment to PCA groups as F_i in (4) and find that owner's education is positively related to it, we cannot draw any practical implication from this finding. Membership of PCA group is a statistical condition and cannot be understood practically by general stakeholders. So, we need to focus on the individual aspects of formalization process and show the role of possible determinants in achieving them. We primarily used business registration (tax and VAT) as the dependent variable as this is understood generally better by the stakeholders and is a strong, if not the most important, indicator of formalization. At the same time, we analyze determinants for two discrete definitions formal-1 and

formal 2. We use an OLS set-up of model (4) to use business practices of the firms (planning and record-keeping practice scores) as dependent variable.

We have used detail of owner's characteristics as the determinants of formalization. In addition to age, education and digit-span recall, we used father and mother's schooling year and status of poverty during childhood of the owner. Parent's education is argued to represent the awareness, ethical learning and non-institutional learning of the entrepreneur. In the survey, firm owners were asked whether their families were doing well in meeting food requirement of the family members during owner's childhood (at 12 years of age). Negative response is documented as an indication of poverty during childhood. Owners who had poverty during childhood are less probable to get financial support from their family to invest in their business. So, this variable represents (when positive) the unavailability of liquidity to invest in business and is a good proxy to represent family support in business (McKenzie, 2015). A significant number of sample firms' initial capital and operating capital are supported by family and friends. It further justifies the inclusion of a variable representing poverty in the family of the owner. Firms with highly competent owner are supposed to grow further and become more formal.

Another important aspect of firm's formalization process is the size of the firms. It has several dimensions of influence in changing a firm's status. When a firm grows in size, it is generally associated with higher production and possibly larger profit. So, the firm can evolve or attain greater capacity, can reach greater customer segment, moves towards export and tries to expand its business. Ultimately they become more and more formal by registration and improved business practices. When a firm grows in size, it becomes more visible to the relevant authority and hiding proper production level and

turnover becomes increasingly difficult. Then the firm faces more risk of inspection, higher cost of avoidance and it becomes more economical for many of them to turn formal. Though some studies used firm asset as the measure of size, we have discussed that sample manufacturing firms are labor intensive and the number of total employee is the best representative for firm size. The only problem of using current employee number is the possibility of reverse causality and endogeneity. More formalized firms may employ more worker due to their higher production. Also, there may be some unobserved operational factors affecting current employee size. So, we used the number of total worker at the beginning of firm operation, which is highly correlated with current employee number, to represent firm size. It is totally exogenous and free from reverse causality argument. It may be argued that firms set their starting employee size based on future expansion plan, but that is quite unusual in Bangladesh where the availability and easy recruitment of labor exclude such theory. Amin and Islam, (2015) used initial employee as an instrument for current employee.

To represent enforcement effect, we have used the average rate of inspection in respective district. It is calculated from the survey response whether the firm has been visited by the inspector of relevant registration authority (tax, VAT or municipal). This is a vital issue while investigating factors influencing business registration process but is rarely discussed in literatures. We used another variable representing the distance of the firm from relevant authority which is also rarely used. It is a proxy for convenience and information access. McKenzie and Sakho (2010) found in their study for Bolivia that closeness to tax office is positively associated with higher registration. We have used a dummy variable indicating whether the firm is located within 2.5 kilometers of the respective authority. This threshold distance is based on personal intuition considering

the span of district headquarters and transportation time. Additionally, we have used firm age and location effects to observe their impact and to control for endogeneity. Especially, older firms enjoy more growth prospect, have better visibility and have more experience of the market. Their operational age is supposed to affect their formalization status. So, we will test the following hypothesis using model (4):

Hypothesis 3: Owners with higher human capital help firms to achieve formal status;

Hypothesis 4: Firms which are closer to registration authorities and are more frequently inspected will have higher business registration rate.

Hypothesis 5: Older and bigger firms are more probable to become formal and having business registration.

3.6 Data

Data for this study has been derived from the World Bank Informality Survey 2010 conducted in Bangladesh. The population of the survey was all business entities situated outside household in 19 district headquarters across Bangladesh. So, the sample is urban in nature. It is also biased towards more formalized firms as it excluded all household establishments which are huge in number. From the survey data, we have taken the manufacturing sub-set to exclusively look into the informality inside these firms. The summary of the sample data is represented in table-3.1 and table-A2.1.

In addition to our definition of continuous informality using PCA groups, we used two separate discrete measures of informality to compare our result with previous studies. Firms having either tax or VAT registration are termed as formal-1 and others as informal in the first definition. The second is a combination of registration and firm size. Firms

having tax or VAT registration or more than ten worker are assumed formal and are termed as formal-2. Within sample firms, only fourteen firms export and we find them all to be included in group-5 in the PCA formation and are at the highest level in formalization spectrum. Most of the firms have trade license from local municipality and thus have the least condition to move to more formal level. So, our sample is not dominated by very informal firms unlike real situation. But it offers us an opportunity to look into the continuous formalization spectrum more effectively using PCA analysis.

The summary statistics in table-A2.1 shows that sample firms are quite heterogeneous in nature. Number of workers spans from one (only owner) to more than two thousand. The distribution of the employee number is heavily skewed to right with 90% of the firms have employee not higher than 55. Also, 50% of the firms have less than ten employee which is often discussed as a threshold for formality. Observing total number of workers at starting, we see a significant expansion in employee size among sample firms. 145 firms have up to six unpaid workers and almost half of them belong to formal-1 group. So, formal firms also do possess significant number of unpaid workers though the ratio to total worker is much lower for them. Average operational year of the firms is just over 13 years. 50% of the firms are aged 10 years or less, 80% within 21 years and 90% within 30 years. 30% of the firms have been found to be engaged in any type of product or process innovation within last three years. The share of land and building in total asset is lower than machinery and equipment. It refers to the practice of renting working facility. We have used logarithmic value for sales per worker, total asset and total employee in the regressions. Average age of the owners is 43 years with an average schooling year of 9.4. As we discussed above, the sample is leaned towards more formal firms and urban in nature and these are reflected in the high schooling years of owner. The schooling years

of parents of the owners are much lower compared to their own education. Digit-span recall is 5.5 digit on average and 41% of the owner faced poverty during their childhood.

3.7 Results and Analysis

3.7.1 Impact of Formalization

Table-3.2 shows the regression results to estimate the impact of formalization on firm performance. We find all the PCA groups to have significant and positive coefficient indicating their higher productivity compared to group-1 which is the least formal (most informal). Coefficient of group-2, which is just one group above the most informal group in our scale, is comparatively less (at 10% level) significant (all other group coefficients are significant at 1% level) and lowest in magnitude. The magnitude of the coefficients goes strictly higher when we move to higher formality groups. The Wald-test shows that the difference between consecutive group coefficients are also significant (expect for group-2). The development of these PCA groups is totally based on their formality parameters and they do not have any other hidden relation according to principal component analysis algorithm. In table-3.2, we have checked robustness of the regression by using only location dummies with PCA groups and then added asset and employee size before running full regression. All results show significant and increasingly positive coefficient of more formal groups. In table-A2.3, we show the combination of formality parameters for different PCA groups. In figure-A2.1, sophistication score based on first PCA component (PC1 score from equation-1) shows approximately a normal distribution. These shows that constructed PCA groups are continuous in formalization aspect. So, the significant positive nature of higher formality groups, the increment of coefficient values

towards higher order groups and significance of the difference between consecutive groups' coefficients suggest that formalization (or informality) is a continuous process rather than a discrete phenomenon and thus supports hypothesis-1.

In addition to the argument for gradual formalization process, PCA group coefficients show that firms belonged to higher formality group are more productive. We have checked robustness of this result with alternative and discrete definitions of formality. Results for formal-1 and formal-2 definitions of formality are shown in table-3.3. The coefficients of formalization dummies are highly significant and positive. So, all alternative definitions of formalization show significant positive impact of formalization on firm's productivity. It suggests hypotheis-2 that firms who are more formal are more productive. Our result are supported by many of the recent studies including Demenet et al (2015), Rothenberg et al. (2016) and Benjamin and Mbaye (2012) who have found favorable impact of formalization on productivity. But at the same time, in line with the discussion in section-3.2, we should be careful about the reason behind better performance of more formal firms.

Although we have tried to include exogenous controls, we cannot totally rule out the possibility of endogeneity due to missing variables. Moreover, reverse-causality is to be taken care of while explaining the result. Whether formalization affects productivity or higher productivity promotes formalization is a fact that is tricky to be addressed fully using cross-sectional data. This argument is more applicable to discrete definition of formalization. But usage of PCA groups (formed from 16 different variables) and control for firms' size give us more confident that there is at least significant positive role of formalization in improving productivity irrespective of the status of reverse-causality.

We have shown individual influence of business registration systems on productivity in table-3.4. The coefficients for trade license and tax registration are higher than that of VAT, though all are significantly related to productivity. This approach is more practical to observe the impact of individual business registration systems to avoid their possible correlation issue. But to check their relative influence, we have used them together in the regressions shown in table-3.3 (column 3a-3c). Here we see that trade license and tax registration remain significantly and positively related to productivity but VAT registration's influence is absorbed by the other two, making it insignificant. We can say that for our sample firms, trade license and tax registration are the forms of business registration that affect firm's productivity more and tax registration has the greatest impact on productivity among business registration systems (having highest coefficients in table-3.3). Similar to our finding, Demenet, et al. (2015) discussed the relative importance of tax registration compared to trade license.

Inputs of the production function, asset and labor are highly significant (at 1% level) and have the expected sign as we discussed for equation (2). While asset is positively related to productivity, coefficient of labor has negative sign indicating that α in equation (2) is less than unity. Coefficient of asset (β) has a value around 0.15 and α is around 0.75. So, the output elasticity for labor is much higher than for capital. This is a highly expected result for this labor intensive industry and it further supports our model specification. In turn, it reveals another important feature. Firms which are more capital intensive have higher labor productivity. From summary statistics we have found that the main component of capital is machinery and equipment. So, it can be said that usage of machinery and equipment is related to gaining higher labor productivity in manufacturing firms, irrespective of their formalization status. Another variable which is highly

significant (at 1% level) in all the regressions in table-3.2 is owner's age. We use it as a proxy for experience of the owner. Owner who are older and thus have more experience, significantly help the firms to improve their productivity. But its coefficient is lower than other two attributes of the owner. According to our expectation, owner's digit-span recall ability is positively and significantly related to firms' productivity. It has the highest coefficient among owner's attributes and thus reveals its importance in expressing the cognitive processing ability of the owner and in influencing firm performance. Surprisingly, schooling year of owner is negatively related to productivity but the relation is weak (significant at 5% level in PCA model, at 10% level in formal-1 but insignificant in formal-2). The reason for such negative coefficient is difficult to explain but it is clear that the impact of education on productivity is much weaker compared to the influence of owner's age and digit-span recall. Firm age shows a negative but weakly significant relation with productivity. It has the lowest coefficient among all significant variables. It reveals that older firms in the sample are less productive. Product or process innovation shows no significant relation with productivity. It says that either sample firms have no productivity gain from their innovation process or their innovation is of very low end which is covered by standard business practices of other firms. Within location effects, firms in Chittagong district are significantly more productive than firms in reference districts.

3.7.2 Determinants of Formalization

Probit regression results to estimate determinants of different formality indicator are shown in table-3.5 and table-3.6. In table-3.5, we have shown determinants for business registrations and discrete formality definitions fortmal-1 and formal-2. To represent labor

size, we have used group dummies (no paid-employee is the reference group) instead of total worker number to observe the impact of the increment in labor size on the formalization process. Within owner's attributes, schooling year is proved to be the most important through its positive and significant coefficient in most of the regressions in table-3.5 (except for trade license). Owner's age is highly significant and positively related to tax registration and formal-1. Digit-span recall ability shows similar impact and additionally shows influence on trade license. Interestingly but intuitively, poverty during childhood of the owner shows a strong negative relation with tax registration and its coefficient is highest in magnitude among owner's attributes. Between parents' education, only mother's schooling year shows significant positive relation with VAT registration. These results supports hypothesis-3 that owners with higher human capital help firms to achieve formal status. Operational year of firms is one of the two variables significant for all the business registration systems. The other one is 'having more than ten employee' and it is the only variable to be highly significant (at 1% level) in all regressions and has the highest coefficient value. Other labor size groups show significance compared to reference group mainly for trade license. Having higher number of paid employee is increasingly more relevant to possess a trade license. So, hypothesis-5 is supported by our findings stating that older and bigger (in terms of labor size) firms are more probable to become formal.

We have included distance (closeness to authority) and inspection variables in the second column for each type of business registration in table-3.5. Closeness to authority is marginally important for tax and VAT (at 10% level) and inspection rate is highly significant for VAT registration only. It supports hypothesis-4 for VAT and tax registration exploring the positive role of inspection and distance on registration. This

finding is supported by the study of McKenzie and Sakho (2010) who found similar impact of distance on tax registration. Interestingly, inspection and distant variables show no significance to trade license. All the sample firms are situated in the district headquarters and thus should be in close proximity of the municipal offices. Compared to tax authority, municipalities are more visible and trade license provides enough legality for most businesses in exchange of a very low fee. That is why we find very high possession rate for trade license and it is intuitive that distance or inspection should not show any additional impact. Being in the low registration districts is negatively related to VAT registration.

From above discussion, it can be summarized that firm age, owner's schooling year and bigger firm size (more than ten workers) are the most significant factors to influence firms' formalization process. For tax registration, owner's age, poverty in childhood, higher digit-span recall and closeness to tax office are additionally important. But for VAT registration, only mother's education, closeness to VAT office and VAT inspection rate are important. It shows the perceived difference between these two tax registration systems. For trade license, which is the most basic business registration, only firms' age and worker size are important.

Regression results for other formality indicators including individual PCA score are shown in table-3.6. Having higher employee is significantly related to all indicators of formality except for marketing practice. Except location effects, nothing else is related to the membership of business associations. Firm age and digit-span recall positively and poverty in childhood negatively affect firm's possession of bank account with business name. Schooling year of the owner, mother's education and digit-span recall are positively related to firm's computer usage and this is a highly expected result. Keeping

written business record is positively related to schooling year, mother education and negatively with poverty in childhood and firm age. So, older firms are less supposed to keep written business records. Schooling year is also found significant for keeping accounting statement. Only labor size is significantly related to advertisement practice of the firms. For integrated PCA score, owner age, schooling year, mother's education, digit-span recall, and higher employee size are positively and poverty in childhood is negatively related. Schooling year and mother's education are significantly related to record and planning practices in addition to labor size. Similar to advertisement, mainly labor size is related to marketing score.

So, education of the owner and labor size are the two most important determinants for different formality indicators. Digit-span recall ability and mother's education are in the next level in helping firms in formalization. It is an interesting finding that mother's education is clearly more important than father's education in gaining more formalized status and indicates a wider implication of women education. Firm age shows significant positive relation to business registration, but opposite impact to business practices. Probably that is why it became insignificant while using PC1 score as dependent variable. We can say that firms which are older are more probable to register their business, but they do not possess good business practices and it hinders further development across formality spectrum. Poverty in childhood shows a consistent and negative relation to formalization process.

3.7.3 Why Informal Firms Exist

In recent literatures, different models have been discussed to explain the existence of informal firms in industry. They can be broadly classified into three groups arguing for

three different models. The first one is 'exclusion model' which says that unfavorable regulatory burden hinders firms' inclusion into formal sector. It also argues that formal firms sometimes play key role in keeping the entry barrier high. They do it to get benefitted from lower competition in formal sector and to out-source part of their production process to informal firms at cheap cost. 'Rational exit model' (Parry, et al., 2008) says that firms take their formalization decision by comparing perceived cost of registration and benefits from registration. And 'dual economy model' (Harris & Todaro, 1970; Lewis, 1954) argues the existence of informal firms as a byproduct of overall economic condition of the society and they exist as long as the demand for their products exists.

Some studies say that the size of informal sector is negatively related to economic growth, GDP per capita, tax revenue and public good provisions. Their argument points to dual economy theory. We have found that formal firms are clearly more productive than informal firms. Dual theory also says that the economy is divided into two broad categories of firms- formal firms with higher productivity and informal firms with low productivity. So, our finding related to productivity points to the existence of dual model. Informal and formal firms produce products with different qualities and their growth or decline depends on the demand for their respective products. Economic development increases purchasing power of the customers, increases demand for quality products from formal firms and gradually push the informal firms towards formal. This is not related to any regulatory burden or cost-benefit issue. If the overall productivity of the sector improves, the informal firms gradually disappear. So, the productivity gap shows the possibility of the existence of dual model. Now we look into the owner's attributes of sample firms based on their formality status. The summary is presented in table-A2.2 for

different formality groups. It is observed that more formal firms have owners with higher age (more experienced), more education and more digit-span recall ability. Poverty in youth is less likely faced by owners of more formal firms and they have clearly more educated parents. So, this gap in ability and family support may additionally point to the existence of dual model based on the argument that firms with highly capable owner operate into formal sector while those with less competent owner remain informal. According to dual model, the salary of formal firms should be strictly higher than that of informal. Though we find higher average salary per worker for formal firms in our sample, the difference with informal firms is not significant.

Now if we look into the history of the registered firms, we find a lot of firms registered after being in operation for few years. Only 36% of the firms having tax ID started their operation with it and the figure is 41% for VAT. Average year of registration is 1.3, 1.7 and 3.3 for trade license, tax and VAT respectively. This finding indicates possible existence of rational exit model. It can be said that firms gradually moves to formal sector when they gain higher ability after being in operation for sometimes. It helps them to attain higher production and profit level and they can offset direct registration cost, future cost (regular tax payment, compliance cost) and uncertainty of the new regime and can benefit from formalization through export, loan or greater market access. This argument also rules out exclusion model because the entry barrier and regulatory burden should keep most firms out of the formal sector after starting as informal. This discussion is further enhanced by observing the distribution of firms' labor size. The distribution is heavily skewed to right and there is no missing middle sized firms. To get clearer picture, we have presented the distribution up to one hundred employee and additionally presented the distribution of a much larger sample of more than 8000

countrywide firms (Bangladesh Bureau of Statistics, Manufacturing Sector Survey 2012,). Within formal-1 firms, 33% have less than ten workers and this figure is 27% for upper two PCA groups (most formal). The condition of exclusion model that small and micro firms remain informal and formal firms grow in size creating a gap in the middle of the distribution (Hsieh & Olken, 2014; Tybout, 2000; Rothenberg et al., 2016) is absent in our analysis.

Within firms not having TIN, 35% ever wanted to register for TIN but an impressive 57.7% expressed their desire for TIN registration if the upfront cost becomes zero. The real cost of business registration (both official and unofficial) is not very different from the perceived cost of registration for unregistered firms (table-A2.10). And these costs are well within the capacity of the firms when we compare with their monthly profit. Average time required for registration seems reasonable and thus proves that uncertainty is the main reason for many willing firms not to register. The same tendency is found for trade license. 50% of the sample firms (46% of registered, 56% of the unregistered) say that there is no disadvantage of tax registration while only 18% mention no advantage (8% of registered, 27% of the unregistered). Among possible disadvantages, tax payment and burdensome process are the main reasons mentioned by firms. These replies, along with above discussion totally rule out 'exclusion model' and show inclination towards 'rational exit theory'. Another evidence against exclusion model is the study of Giorgi and Rahman (2013) who studied the effect of reduced entry cost on the registration of informal firms in Bangladesh and found no effect. Though their experiment was related to joint stock companies and firms, similar mechanism is applied to tax and VAT registration.

Based on above arguments, we can say that informality in Bangladesh manufacturing sector is explained partially by rational exit model and partially by dual economy model. The basic principal of rational exit model is that firms move to formal sector when perceived benefit is higher than cost. So, in addition to reduced cost of registration, benefit for formal firms also needs to be increased by supporting them with better business environment, especially by supporting smaller formal firms who are primarily newcomer from informal sector or new entrant (Levy, 2007; Maloney, 2004). Dual economy theory asks for overall socio-economic development to gradually shift informal firms to formal. It argues that there is no quick fix of the issue but is related to choice and ability of producers and customers. Higher national income will enhance demand for formal goods, will help the sector expand and would pull labor from informal sector and thus would gradually erode informality (Rothenberg et al, 2016).

3.7.4 Why Formal Firms Perform Better

From our cross-sectional data, it is difficult to project on the real cause of the better productivity of formal firms. But we can get an insight into the process of gaining better performance by analyzing the type and extent of intermediate goods consumption of different formality groups. Benjamin and Mbaye (2012) found that the productivity difference is mainly due to the difference in business environment and law enforcement. They also found formal firms having better access to banking service and offer better compensation for workers. But Demenet et al. (2015) found no such difference for formal firms. They found usage of accounting methods significantly higher among formal firms. Amin and Islam (2015) and Demenet et al. (2015) found that formal firms gain significantly from the better access to utilities and higher usage of machine and equipment.

Table-3.8 shows the statistics for intermediate inputs. More formal firms have clearly higher consumption of utilities per worker, higher usage of machine and equipment per worker and higher ICT usage. Formal status helps firms to access water, electricity and gas services as a commercial entity and can support production expansion easily. But informal firms face difficulty in this respect which in turn affects their production process. Formal firms have higher access to bank loan and it strongly supports their credit requirement and expansion plan to achieve more economies of scale. Formal firms have greater access to customer segments, both geographically and by type. They reach customers outside their own sub-districts in greater portion and can sale to government almost exclusively. So, we can say that formal status helps firms in better access to utility services, to use ICT and equipment efficiently, to avail bank loan and advanced credit services, and to reach new market segments. All these are supposed to contribute to the achievement of higher productivity by formal firms.

We find another interesting result regarding profit and asset ratio. We have profit data of only one month and it may be far away from normal monthly profit for many firms. But we have taken group average and thus the bias should not create a serious problem. Figure-A2.4 and table-3.8 show that return to capital (profit to asset ratio) is higher for informal firms compared to formal ones. It supports the finding of Siba (2015) who showed that the return to capital is decreasing with the increment of capital for both formal and informal firms. Though it is difficult to explore more on this issue, at least it can be said that informal firms have their own strength and there is a possibility of their transition to more formal and productive level by proper policy incentive. Additionally, it exclude exclusion model, weakens dual model and supports rational exit model in above discussion of informality existence.

3.8 Conclusion

The existence of the informal economy is the most practical phenomenon in the manufacturing sector of developing countries. Their contribution to national GDP, employment of majority workforce, providence of platform for economic migrants and women and their role in turning agro-based economy into industry based economy have drawn attention of researchers, especially with the emergence of newly industrialized nations. Though some studies tried to find the impact of informality on firm performance, the methodologies have been weak due to the weak definition of informality. So far, informality has been defined as a discrete phenomenon and the impact and factors related to formalization have been discussed based on such definition. Also, limited number of variables have been tested in finding the determinants of formalization process. Our study contributes to the literature by assuming a continuous formalization spectrum measured from principal component analysis and by using a rich set of relevant variables to define formalization status. To compare with existing literature, alternative definitions of formalization are also used. The study statistically supports the idea that formalization is a continuous process and firms span from very informal to very formal groups. Firms in the more formal groups are found to be more productive than less formal firms. This finding is robust for both continuous and discrete definition of formality. Firms with higher capital intensity are found to have higher labor productivity. Owner's human capital, especially experience, education and cognitive processing ability improve firm performance significantly. Firm age is weakly related to productivity and show negative influence. Owners who have more experience, higher education, higher cognitive processing power and more educated mother significantly increase the possibility of formalization for their firms. Liquidity support from family, represented by poverty

during childhood of the owner, is found significant for some aspect of formalization. In addition to owners' experience (represented by age), two other determinants that affect the formalization status most are firm age and larger labor size. Older firms with more than ten workers are significantly more registered than newer and smaller firm. Older firms have higher business registration rate but lack in business practice. Location effects are also found significant in most regression models. Detail discussion of productivity, registration history, firm size, actual and perceptual cost of registration and the incentive for formalization show that informality in sample manufacturing firms can be explained partially by 'dual economy model' and partially by 'rational exit model'. Dual economy model says that informality exist as a side-effect of economic under-development. The low-income segment of the economy has demand for low-quality goods and can supply cheap labor resulting into the creation and survival of informal sector. Transition economy expands the informal sector by accepting migrant labors at cheap cost. Formal sector, due to its limited capacity, cannot provide enough support in the developing economies. According to this model, informality only can be eroded with the development of the economy as a whole. 'Rational exit model' says that firms decides their status based on the cost and possible benefit of formalization. The discussion excludes the possibility of 'exclusion model' which says that informality is resulted from high entry barrier and excessive regulatory burden. Through the analytical discussion of intermediate inputs, this study showed that formal firms have better access to utility facilities, banking services and use ICT at higher rate. They have access to wider customer segments including governmental agencies and have much higher rate of equipment and machinery usage. This study clearly shows the policy actions required to promote formalization in the huge informal sector. Many firms lack basic business practices and

this can be easily addressed by arranging standard training sessions following ILO guideline. Entrepreneurial education to be incorporated in the educational system to create more confident and knowledgeable owner in the micro and small firms. The network of micro-credit institutions should be utilized effectively to support informal firms to grow. Diversified regulatory conditions across different districts point to the possibility of inter-district learning and its importance in promoting a countrywide campaign to enhance formalization. In addition to support formalization, incentives for formalized firms must be ensured by improving business environment. Especially, security and corruption free business procedures to be ensured for firms to attract them towards formal sector.

Tables and Figures- Chapter 3

Table 3.1
Data

Data Type	Total firms	Tax ID	VAT registration	Trade License	Export
Cross-section	462	229	148	419	14
Formal-1: Firm has either Tax or VAT registration (242 firms) Formal-2: Firm has either Tax or VAT registration or total employee>10 (284 firms)					

Table 3.2
Impact of formalization-1

VARIABLES	Labor productivity: ln(sale per worker)		
	1	2	3
group2	0.258*	0.261**	0.257*
	(0.133)	(0.130)	(0.131)
group3	0.566***	0.530***	0.529***
	(0.146)	(0.144)	(0.143)
group4	0.949***	0.767***	0.760***
	(0.142)	(0.165)	(0.166)
group5	1.424***	1.225***	1.290***
	(0.149)	(0.200)	(0.205)
Dhaka	-0.240**	-0.213**	-0.175*
	(0.104)	(0.104)	(0.100)
Chittagong	0.651***	0.607***	0.648***
	(0.169)	(0.162)	(0.165)
Lowregist	-0.210	-0.242	-0.180
	(0.189)	(0.188)	(0.191)
Tot.Employee		-0.209***	-0.229***
		(0.0628)	(0.0603)
Assets		0.149***	0.152***
		(0.0268)	(0.0266)
Owner age			0.0147***
			(0.00454)
Schooling			-0.0336**
			(0.0131)
Digits-pan			0.102**
			(0.0434)
Firm age			-0.00712*
			(0.00371)
Innovation			0.0182
			(0.0976)
Constant	11.72***	10.40***	9.600***
	(0.109)	(0.286)	(0.390)
Observations	461	461	458
R-squared	0.248	0.304	0.338

Note: annual sales per worker is the dependent variable (log value). Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1)

Table 3.3
Impact of formalization-2

VARIABLES	Labor productivity: ln(sale per worker)				
	1	2	3a	3b	3c
formal_1	0.479***				
	(0.115)				
formal_2		0.351***			
		(0.119)			
Tax ID			0.678***	0.446***	0.427***
			(0.120)	(0.124)	(0.126)
VAT			0.220*	0.0864	0.120
			(0.129)	(0.128)	(0.126)
Trade-license			0.467**	0.428**	0.415**
		(0.119)	(0.186)	(0.182)	(0.175)
Assets	0.175***	0.190***	0.149***	0.152***	
	(0.0262)	(0.0258)	(0.0268)	(0.0266)	
Tot.Employee	-0.130**	-0.147**	-0.209***	-0.229***	
	(0.0576)	(0.0609)	(0.0628)	(0.0603)	
Owner age	0.0129***	0.0147***	0.0147***		
	(0.00459)	(0.00460)	(0.00454)		
Schooling	-0.0235*	-0.0196	-0.0336**		
	(0.0137)	(0.0137)	(0.0131)		
Digit-span	0.117***	0.126***	0.102**		
	(0.0438)	(0.0441)	(0.0434)		
Firm age	-0.00749**	-0.00721*	-0.00712*		
	(0.00378)	(0.00373)	(0.00371)		
Innovation	0.0544	0.0483	0.0182		
	(0.0985)	(0.0994)	(0.0976)		
Dhaka	-0.205**	-0.181*	-0.226**	-0.235**	-0.202**
	(0.102)	(0.103)	(0.108)	(0.103)	(0.102)
Chittagong	0.575***	0.577***	0.538***	0.504***	0.530***
	(0.177)	(0.181)	(0.168)	(0.169)	(0.173)
Lowregist	-0.309	-0.336*	-0.274	-0.307	-0.241
	(0.189)	(0.186)	(0.194)	(0.189)	(0.194)
Constant	9.301***	9.011***	11.54***	9.960***	9.163***
	(0.368)	(0.355)	(0.183)	(0.297)	(0.380)
Observations	458	458	461	461	458
R-squared	0.303	0.289	0.220	0.287	0.317

Note: annual sales per worker is the dependent variable (log value). Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1)

Table 3.4
Impact of formalization-3

VARIABLES	Labor productivity: ln(sale per worker)								
	1a	1b	1c	2a	2b	2c	3a	3b	3c
Trade license	0.893***	0.541***	0.505***						
	(0.185)	(0.182)	(0.174)						
Tax ID				0.873***	0.526***	0.509***			
				(0.0953)	(0.111)	(0.114)			
VAT							0.687***	0.269**	0.278**
							(0.106)	(0.117)	(0.117)
Tot.Employee		-0.0815	-0.112*		-0.114*	-0.135**		-0.0754	-0.106*
		(0.0594)	(0.0597)		(0.0593)	(0.0576)		(0.0614)	(0.0602)
Assets		0.203***	0.201***		0.169***	0.173***		0.192***	0.190***
		(0.0252)	(0.0255)		(0.0258)	(0.0257)		(0.0268)	(0.0269)
Owner age			0.0136***			0.0125***			0.0143***
			(0.00476)			(0.00460)			(0.00468)
Schooling			-0.0174			-0.0233*			-0.0227
			(0.0138)			(0.0137)			(0.0141)
Digit-span			0.121***			0.111**			0.129***
			(0.0449)			(0.0436)			(0.0453)
Firm age			-0.00695*			-0.00747**			-0.00682*
			(0.00377)			(0.00376)			(0.00379)
Innovation			0.0579			0.0711			0.0664
			(0.100)			(0.0980)			(0.0995)
Dhaka	-0.189	-0.264**	-0.216**	-0.228**	-0.251**	-0.211**	-0.218*	-0.273**	-0.218**
	(0.117)	(0.106)	(0.104)	(0.110)	(0.105)	(0.102)	(0.115)	(0.109)	(0.105)
Chittagong	0.591***	0.503***	0.533***	0.601***	0.541***	0.573***	0.548***	0.507***	0.545***
	(0.189)	(0.178)	(0.185)	(0.171)	(0.172)	(0.177)	(0.169)	(0.173)	(0.181)
Lowregist	-0.399**	-0.370**	-0.299	-0.361*	-0.377**	-0.306	-0.415**	-0.415**	-0.329*
	(0.191)	(0.184)	(0.190)	(0.188)	(0.180)	(0.187)	(0.185)	(0.179)	(0.184)
Constant	11.56***	9.504***	8.607***	11.94***	10.24***	9.375***	12.16***	10.03***	9.067***
	(0.184)	(0.280)	(0.355)	(0.0746)	(0.263)	(0.370)	(0.0750)	(0.273)	(0.372)
Observations	461	461	458	461	461	458	461	461	458
R-squared	0.102	0.259	0.290	0.201	0.276	0.306	0.131	0.251	0.285

Note: annual sales per worker is the dependent variable (log value). Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1)

Table 3.5
Determinants of Formality indicators-1

VARIABLES	Tax ID	Tax ID	VAT	VAT	Formal-1	Formal-2	Trade license	Trade license
Owner age	0.00870***	0.00890***	0.00320	0.00356	0.00763***	6.02e-05	0.000818	0.000787
	(0.00281)	(0.00285)	(0.00235)	(0.00243)	(0.00288)	(0.00232)	(0.000715)	(0.000720)
Schooling year	0.0213**	0.0237**	0.0204***	0.0225***	0.0260***	0.0159**	0.00115	0.00107
	(0.00979)	(0.00978)	(0.00789)	(0.00787)	(0.00970)	(0.00696)	(0.00222)	(0.00220)
Poor when	-0.137**	-0.155**	-0.0542	-0.0793	-0.0954	-0.0496	-0.0206	-0.0212
-young	(0.0624)	(0.0628)	(0.0515)	(0.0511)	(0.0634)	(0.0485)	(0.0184)	(0.0181)
Father	-0.00789	-0.00995	-0.000929	-0.00337	-0.00738	-0.00231	-0.000751	-0.000652
-education	(0.0103)	(0.0103)	(0.00869)	(0.00817)	(0.0101)	(0.00784)	(0.00225)	(0.00227)
Mother	0.0141	0.0145	0.0186*	0.0177*	0.0119	-0.000520	0.00215	0.00204
-education	(0.0123)	(0.0123)	(0.0104)	(0.0104)	(0.0126)	(0.00971)	(0.00308)	(0.00310)
Digit span recall	0.0731***	0.0655**	0.0221	0.0144	0.0516**	0.00893	0.0115*	0.0111
	(0.0258)	(0.0262)	(0.0210)	(0.0209)	(0.0262)	(0.0202)	(0.00688)	(0.00686)
Firm age	0.00587**	0.00540*	0.00382**	0.00349*	0.00610**	0.00555***	0.00199**	0.00203**
	(0.00278)	(0.00284)	(0.00189)	(0.00200)	(0.00300)	(0.00212)	(0.000914)	(0.000905)
Dhaka	0.0358	0.0509	-0.0194	-0.00410	0.0171	-0.0894		
	(0.0653)	(0.0693)	(0.0502)	(0.0540)	(0.0693)	(0.0658)		
Chittagong	0.124	0.159	0.172*	0.116	0.110	0.108*		
	(0.105)	(0.104)	(0.102)	(0.106)	(0.115)	(0.0580)		
Lowregist	-0.124	-0.103	-0.180***	-0.188***	-0.130	-0.0991		
	(0.130)	(0.133)	(0.0692)	(0.0620)	(0.135)	(0.113)		
One-two	0.0639	0.0723	0.0158	0.0849	0.0694		0.0361**	0.0365**
	(0.205)	(0.204)	(0.202)	(0.216)	(0.200)		(0.0149)	(0.0150)
Three-five	0.216	0.247	0.255	0.386**	0.311**		0.0473**	0.0487**
	(0.178)	(0.174)	(0.198)	(0.188)	(0.157)		(0.0200)	(0.0203)
Six-ten	0.239	0.263	0.209	0.300	0.278*		0.0664***	0.0673***
	(0.175)	(0.171)	(0.201)	(0.198)	(0.161)		(0.0243)	(0.0245)
More than ten	0.623***	0.650***	0.458***	0.573***	0.663***		0.143***	0.147***
	(0.120)	(0.114)	(0.170)	(0.150)	(0.108)		(0.0367)	(0.0386)
Close to tax		0.118*						
-office		(0.0611)						
Tax inspection		0.239			0.113	0.180		
-rate		(0.245)			(0.305)	(0.222)		
Close to VAT				0.0919*				
-office				(0.0511)				
VAT inspection				0.590***	0.274	-0.0920		
-rate				(0.189)	(0.299)	(0.230)		
Close to tax or					0.0633	0.0578		
-VAT office					(0.0617)	(0.0466)		
Total labor						0.423***		
						(0.0389)		
Close to								0.00659
municipal office								(0.0137)
Municipal								-0.00128
-inspection rate								(0.0393)
Observations	459	459	459	459	459	459	459	459
Pseudo R^2	0.36	0.37	0.26	0.28	0.36	0.47	0.29	0.29

(*** p<0.01, ** p<0.05, * p<0.1)

Table 3.6
Determinants of Formality indicators-2

VARIABLES	Probit Regression							OLS Regression			
	Business-associatn	chamber of commerce	Business bank account	Computer use	advertise	Busness records	Accounting statements	sophisscore_1_corr	Marketing score	Record score	Planning score
Owner age	0.000382	-0.000428	0.00334	0.000249	0.000301	0.00177	0.00102	0.0211***	-0.0129	0.0179*	0.0138
	(0.00242)	(0.00113)	(0.00266)	(0.000353)	(0.000394)	(0.00189)	(0.00247)	(0.00624)	(0.00822)	(0.00945)	(0.00950)
Schooling year	-0.00987	0.00476	0.00891	0.00520**	0.00119	0.0209***	0.0160**	0.0935***	0.0162	0.142***	0.0974***
	(0.00773)	(0.00370)	(0.00832)	(0.00212)	(0.00127)	(0.00637)	(0.00744)	(0.0238)	(0.0255)	(0.0359)	(0.0324)
Poor when young	-0.0872	-0.00288	-0.0980*	-0.00256	-0.0181	-0.140***	-0.0280	-0.332**	0.194	-0.427*	-0.183
	(0.0555)	(0.0274)	(0.0577)	(0.0101)	(0.0114)	(0.0447)	(0.0557)	(0.155)	(0.194)	(0.253)	(0.231)
Father education	-0.00763	0.00432	0.00624	-0.000547	0.000216	-0.00896	-0.00806	-0.00219	0.0716**	-0.0270	-0.0583*
	(0.00847)	(0.00448)	(0.00909)	(0.00145)	(0.00162)	(0.00653)	(0.00832)	(0.0229)	(0.0289)	(0.0367)	(0.0333)
Mother education	0.00612	0.00591	0.00504	0.00313*	0.00283	0.0224***	-0.0103	0.0762***	-0.0156	0.102**	0.157***
	(0.0107)	(0.00517)	(0.0115)	(0.00163)	(0.00206)	(0.00806)	(0.0103)	(0.0280)	(0.0365)	(0.0447)	(0.0419)
Digit span recall	0.00744	0.00936	0.0648***	0.00726*	0.00177	-0.00629	-0.0286	0.177***	0.0676	0.0837	0.122
	(0.0215)	(0.00986)	(0.0225)	(0.00418)	(0.00365)	(0.0172)	(0.0221)	(0.0613)	(0.0709)	(0.0992)	(0.0937)
Firm age	-0.000698	0.00129	0.00450**	0.000260	-0.000351	-0.00446***	0.00185	0.00868	-0.000148	-0.0151*	-0.0128*
	(0.00205)	(0.000794)	(0.00215)	(0.000301)	(0.000351)	(0.00162)	(0.00204)	(0.00558)	(0.00693)	(0.00878)	(0.00752)
Dhaka	-0.0445		-0.0203	0.0375*	-0.0104	-0.0882*	0.313***	0.0850	0.243	-0.352	0.0692
	(0.0585)		(0.0618)	(0.0193)	(0.00972)	(0.0499)	(0.0542)	(0.153)	(0.206)	(0.245)	(0.240)
Chittagong	-0.197**		0.0526	0.0286	0.0316	0.0893*	0.224***	0.320	-1.015***	0.328	0.434
	(0.0879)		(0.106)	(0.0306)	(0.0311)	(0.0524)	(0.0856)	(0.309)	(0.310)	(0.388)	(0.434)
Lowincidence	-0.123		-0.0821			0.0802	-0.0453	-0.900***	-0.749***	0.0850	-1.605***
	(0.0998)		(0.114)			(0.0638)	(0.106)	(0.256)	(0.262)	(0.462)	(0.266)
One-two	0.355***		0.213	0.984***	0.949***	0.149***	0.00318	0.794**	0.321	1.252*	0.200
	(0.100)		(0.211)	(0.0260)	(0.0635)	(0.0507)	(0.150)	(0.345)	(0.426)	(0.745)	(0.440)
Three-five	0.346***		0.410**	0.907***	0.857***	0.218***	0.167	1.306***	0.141	1.888***	0.715*
	(0.115)		(0.172)	(0.128)	(0.134)	(0.0571)	(0.140)	(0.324)	(0.401)	(0.698)	(0.412)
Six-ten	0.411***		0.498***	0.891***	0.943***	0.236***	0.0864	1.735***	0.292	2.333***	1.095**
	(0.100)		(0.145)	(0.135)	(0.0659)	(0.0487)	(0.143)	(0.329)	(0.408)	(0.696)	(0.427)
More than ten	0.540***		0.637***	0.869***	0.816***	0.383***	0.200	3.069***	0.350	2.878***	2.369***
	(0.101)		(0.136)	(0.123)	(0.131)	(0.0704)	(0.137)	(0.336)	(0.407)	(0.697)	(0.434)
Total Employee		0.0483***									
		(0.0108)									
Constant								-4.945***	1.374**	0.847	-0.0903
								(0.482)	(0.620)	(0.905)	(0.724)
Observations	459	459	459	459	459	459	459	459	459	459	459
R-squared	0.06	0.25	0.23	0.40	0.16	0.25	0.10	0.571	0.082	0.287	0.332

(*** p<0.01, ** p<0.05, * p<0.1)

Table 3.7
Summary statistics according to formality status

Type of firm	Owner age	Schooling year	owner: graduate or higher	Father's education	Mother's education	poor when young	Digit span	Paid worker	salary/ worker	Starting from scratch	Expected employee after 5 years
Informal-2	40	7	2%	4.6	3.1	57	5.02	3.6	3146	84%	10
Formal-2	45	10	23%	6.6	4.6	30	5.7	49	3480	92%	94
Informal-1	40	7.2	3%	4.7	3.1	56	5	5.6	3303	81%	12
Formal-1	46	10.8	24%	6.8	4.8	27	5.8	55	3752	93%	105
PCA1	40.1	6.7	2%	3	1.8	63	4.7	3.5	3500	93%	231
PCA2	41.9	7.3	1%	3.7	2.4	58	5.1	6.5	3381	91%	251
PCA3	42.3	8.6	4%	4.3	3	38	5.4	10.5	3423	89%	207
PCA4	45.3	10.1	21%	5.7	3.8	29	5.7	15.8	3454	86%	168
PCA5	47.1	12.9	43%	7.7	5.7	15	6.2	122.4	3963	76%	315

Table 3.8
Summary statistics of intermediate inputs

Type of firm	utility usage per worker, BDT	Equipment value/worker, BDT	Computer use	Bank loan %	Sale%-within Upazilla	Sale%-within District	% sales to government	capital return
Informal-2	355	18244	0.56%	14.6	68	33	1.7	0.54
Formal-2	1161	56794	15%	50.7	43	40	11.3	0.31
Informal-1	338	16121	0.45%	15	64	33	1.3	0.52
Formal-1	1300	65415	18%	56	46	41	13.22	0.29
PCA1	217	11532	0.00%	1	65	34	2	49
PCA2	466	21759	0%	11	60	36	2	43
PCA3	1077	21241	1%	30	62	35	1	64
PCA4	934	39919	4%	60	46	38	9	27
PCA5	1560	115813	42%	80	38	43	22	16

Note: BDT- Bangladeshi Taka

Table 3.9
Eigenvectors and Eigenvalues

	Comp1	Comp2	Comp3	Comp4	Comp5	Comp6	Comp7	Comp8	Comp9	Comp10	Comp11	Comp12	Comp13	Comp14	Comp15	Comp16
Trade license	0.218	0.458	-0.0227	-0.171	0.0655	-0.0389	-0.126	0.500	0.266	-0.295	0.177	-0.234	0.0604	-0.131	0.395	0.145
Tax ID	0.352	0.124	-0.230	0.0710	0.134	-0.171	0.0928	-0.0594	-0.223	0.137	-0.0582	0.368	-0.0507	0.122	0.0246	0.720
VAT	0.322	-0.0375	-0.132	0.0942	0.264	-0.146	-0.0864	-0.0888	-0.355	0.413	0.366	-0.125	0.126	-0.414	0.190	-0.305
Business association	0.148	0.343	0.215	-0.246	-0.461	0.320	0.0345	-0.308	-0.388	-0.112	0.348	0.0357	-0.195	0.120	0.0584	-0.0316
Chamber of commerce	0.237	-0.179	-0.0550	0.0755	0.478	0.250	-0.116	-0.255	-0.180	-0.696	-0.0309	0.00222	0.0999	0.0322	-0.0248	-0.0704
Sole proprietor	-0.170	0.257	0.224	0.306	0.356	0.589	-0.0867	0.00763	0.166	0.331	0.214	0.0215	0.202	0.167	-0.0745	0.148
Employment contract	0.224	-0.396	-0.0388	-0.222	-0.204	0.412	-0.101	0.318	0.0862	0.0711	-0.0205	0.558	0.192	-0.127	0.178	-0.101
Business bank account	0.311	0.108	-0.117	0.0916	0.153	0.255	0.366	-0.0774	0.290	0.122	-0.246	0.0103	-0.637	-0.0796	0.118	-0.233
Bank loan	0.287	0.0489	-0.138	-0.0646	-0.178	0.0142	0.511	-0.313	0.354	-0.00339	0.0418	-0.146	0.587	0.00742	-0.0917	-0.0098
Pay taxes	0.295	0.400	0.0456	-0.181	0.136	-0.138	-0.119	0.238	-0.0966	0.0699	-0.203	0.208	0.118	0.217	-0.554	-0.379
Use computer	0.265	-0.434	-0.0545	-0.241	0.0644	0.0872	0.0239	0.244	-0.0334	0.156	0.235	-0.466	-0.145	0.510	-0.141	0.103
Marketing score	0.134	-0.0490	0.608	-0.310	0.144	0.0360	0.0311	-0.0858	-0.162	0.170	-0.528	-0.220	0.136	-0.132	0.205	0.151
Record score	0.290	-0.0062	0.100	0.352	-0.196	-0.192	-0.440	-0.240	0.210	0.0742	-0.128	0.0356	0.0633	0.456	0.380	-0.179
Planning score	0.320	-0.0829	0.0960	0.218	-0.287	0.112	-0.391	-0.0524	0.200	-0.0238	-0.0234	-0.216	-0.118	-0.444	-0.471	0.252
Buying score	0.109	-0.162	0.595	0.00207	0.173	-0.350	0.183	-0.0234	0.282	-0.108	0.449	0.313	-0.149	-0.0271	-0.0877	0.00605
Stock control	0.128	-0.0470	0.217	0.614	-0.223	0.0312	0.382	0.435	-0.353	-0.144	-0.0842	-0.0779	0.0909	0.0336	0.0123	-0.0588
Eigenvalues	4.483	1.483	1.417	1.110	1.037	0.881	0.836	0.800	0.694	0.632	0.562	0.501	0.477	0.392	0.378	0.316

Chapter 4: Policy Implication

4.1 Enhancing Efficiency of Manufacturing Sector

Our study in chapter-2 indicates that educated and experienced managers play crucial role in improving firms' performance. Thus investment in higher education is important for technical efficiency of firms. Sonobe and Otsuka (2011) showed that such investment in manager's human capital development would bring innovation inside the firms, would help in absorbing foreign technology and managerial knowledge in export oriented industry and in optimal utilization of firm resources. Lack of properly educated workforce is cited as a problem by many firms and it is required to promote more secondary and vocational education for worker level as well.

Firm size is another key factor found to be related with higher efficiency status. It is also evident from our study that financial services affect firm performance positively both in short-term and long-term, and access to finance is cited as a severe problem by many firms. So, banking services as public infrastructure should be made more accessible to firms to enhance efficiency.

Innovation and export should be promoted through institutional support due to their direct and positive impact on production process. As evident from the survey responses, firms need support in gaining proper knowledge of foreign markets and government can intervene in this respect. .

Another key finding of the study is the different attributes of different manufacturing sub-sectors. Food and leather sectors show promising performance with higher efficiency and may need more support and incentive compared to other established sectors. The role of efficiency determinants varies widely among sub-sectors and clearly

points to the heterogeneity among them. So, while addressing growth issue, sector specific attributes found in this study would be a good input to sector specific policy measures.

4.2 Improving Productivity and Supporting Transition of Informal Firms

A key policy suggestion from the findings of chapter-3 is that informal firms should move to formal sector which will help them in attaining higher productivity through better access to intermediate inputs, financial services, wider customer segment etc. The actual one-time cost is lower than perceived cost and significant proportion of formal firms indicated the benefit of formalization. So, these should be considered by existing informal firms which have ambition to grow.

Human capital of firms' owner has been found robustly related to firms' performance and formalization process. The policymakers have a lot of room to improve and contribute at this point. The current educational system should incorporate entrepreneurial education which will enhance the knowledge of future entrepreneurs and will result into higher productivity and formal sector inclusion.

Location effects are found significantly related to productivity and formalization. Table-A2.4 shows the difference in regulatory environment related indicators for 19 districts. We observe a variation in cost and time related to business registration and different registration rate across districts. It refers to an opportunity for inter-district learning regarding effective registration and regulatory measures.

Chapter 5: Conclusion

This dissertation addresses two demanding issues in manufacturing firms of developing countries: efficiency and informality. The first study explores efficiency of manufacturing firms using a robust and advanced model. The consideration of firm specific effect, introduction of exogenous determinants to explain heterogeneity in inefficiency and the analysis of conditional and unconditional mean and variance of inefficiency have made this study an valued contribution to existing literature. This dissertation has quantitatively shown the extent of influence firm specific effects have on efficiency estimation process and explored the risk of ignoring them. Finding of this thesis supports the long-standing theory that international trade and innovation are key in firms' growth process by presenting their significant role in improving annual sale. The finding of significant positive role of manager's human capital and financial services in improving technical efficiency is a complement for relevant studies, but we do it more robustly and our quantitative findings of marginal effect of exogenous determinants on efficiency are more credible than existing studies. Inter-sectorial difference of the role of performance determinants shows the scope for inter-sectorial learning in manufacturing industry and points to the requirement of sector-specific policy adoption. But any industrial policy formulation has to recognize the fact that industries in Bangladesh, as in other developing economies, are dominated by informal firms. Firms in enterprise survey also mentioned competition from informal firms as one of the main challenge for their operation. Informal firms are associated with most of the advantages manufacturing industry brings to developing nations, spanning from employment generation to increased contribution to national income. In this study, we defined formalization as a continuous process and argue

that firms range from very informal to very formal groups. And firms in the higher level of formalization spectrum perform better than less formalized firms. It is a significant finding in understanding manufacturing industry properly and in promoting any policy for productivity improvement in the sector. With an aim of proper policy advocacy, we explored the determinants of the formalization process. Similar to the efficiency determinants, owner's human capital is proved to be the most significant factor in driving formalization. We exclusively have identified the role of family background of the owner, closeness to registration office and inspection rate in firm's formalization process. It is discussed that informality exits in Bangladesh because firms think it to be more economical to stay informal or because demand for informal sector's product and supply for labor are available. This argument contributes to the current policy measures of the government in drawing firms towards formal sector. Both of the studies in chapter-2 and chapter-3 have pointed to the importance of investing in human capital development in Bangladesh. The primary step would be to invest more in education and incorporating entrepreneurial knowledge into current educational system. Access to financial services is proved to enhance efficiency among formal firms and required for the expansion and transition of informal firms. So, government's systematic intervention to address any possible failure in the credit market would boost productivity and efficiency in the manufacturing sector.

Appendix 1

Tables & Figures of Chapter-2

Table A1.1
Summary of used data

Panel Data		
Sector	Firm	Observation
Food	33	14
Textile	38	92
Garment	85	200
Leather	15	35
Chemicals	18	42
Electronics	13	30
Others	6	15

Cross Sectional (pooled) Data		
Sector	Firm	Observation
Food	341	371
Textile	262	294
Garment	401	512
Leather	309	338
Chemicals	237	271
Electronics	69	89
Others	385	468

Table A1.2
Age & Efficiency

Age group	Mean efficiency	observation
<5 years	0.844	13
5-10	0.872	64
10-20	0.875	191
20-30	0.868	115
>30	0.874	64

Figure A1.1
Age vs efficiency

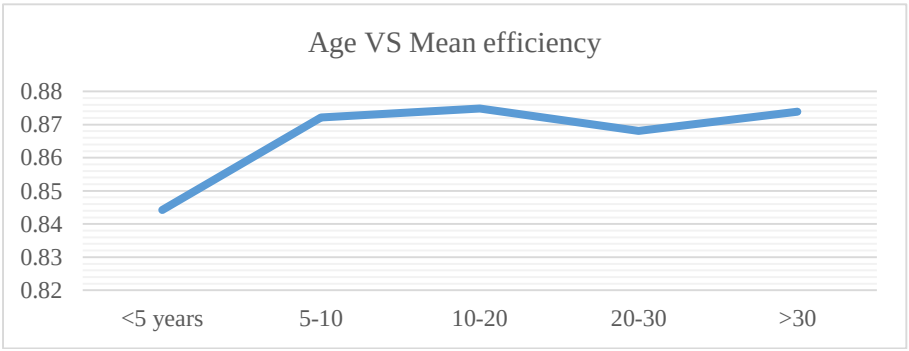


Table A1.3
Manager's Experience vs Efficiency

Manager Experience in years	Mean efficiency	obs
<8	0.671	69
8-15	0.848	171
16-25	0.947	144
>25	0.985	63

Figure A1.2
Manager's Experience vs Efficiency

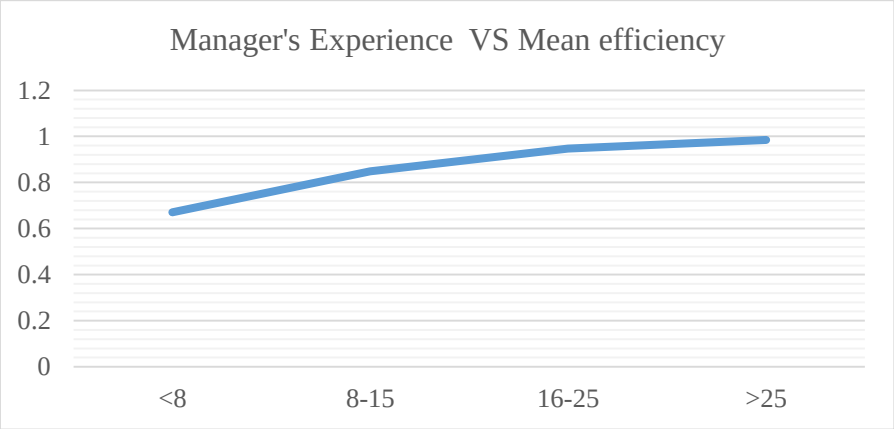


Table A1.4
Size vs efficiency (TRE)

Size (by labor)	Mean efficiency	obs
<=25	0.804	33
26-100	0.855	66
101-250	0.881	79
>250	0.881	269

Figure A1.3
Size vs efficiency (TRE)

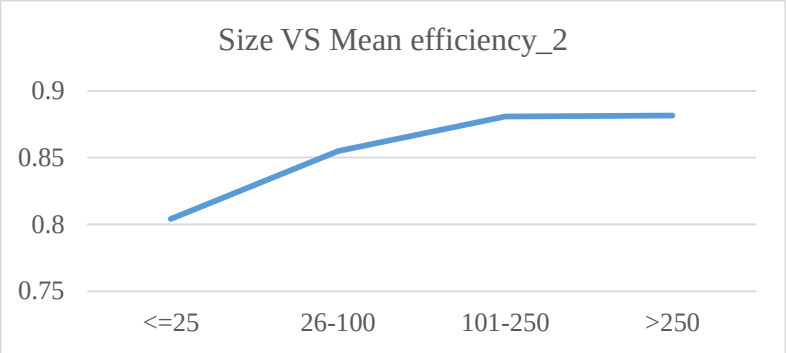


Table A1.5
Manager's Schooling vs Efficiency

Manager's schooling year	Mean Efficiency	obs
0-5	0.625	6
10	0.776	12
12	0.806	42
16	0.880	355
18-20	0.944	32

Figure A1.4
Manager's Schooling vs Efficiency

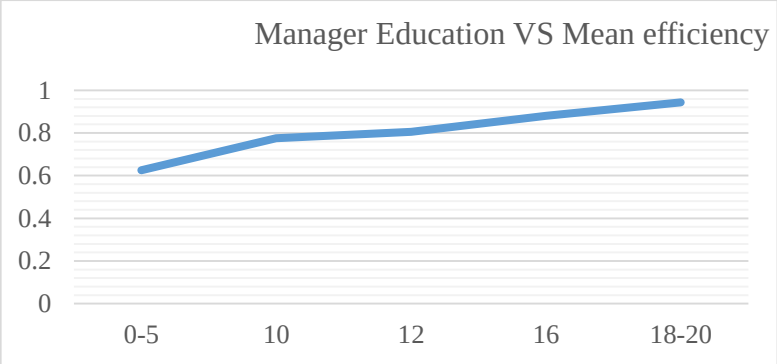


Table A1.6
Financial Services vs Efficiency (TRE)

Overdraft Facility	Loan/LOC	obs	Mean efficiency
Yes	No	76	0.846
Yes	……	238	0.856
Yes	Yes	159	0.859
……	Yes	268	0.870
…….	No	173	0.871
No	Yes	109	0.886
No	……	208	0.889
No	No	97	0.891

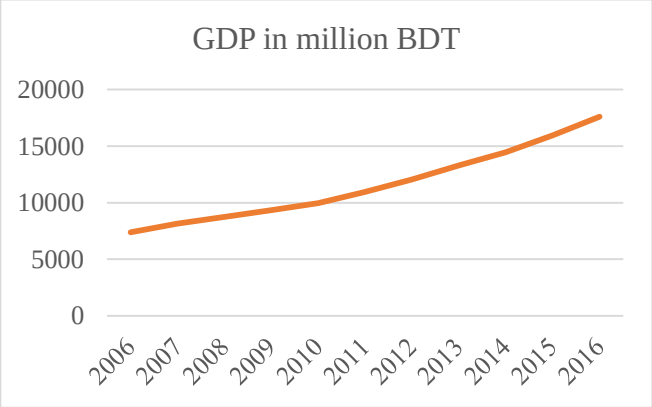
Table A1.7
Manager's Experience vs Training

Manager Experience groups	Training		Ratio
	Yes	No	
1	15	54	0.278
2	50	121	0.413
3	55	89	0.618
4	30	33	0.909

Table A1.8
Average Efficiency-other results

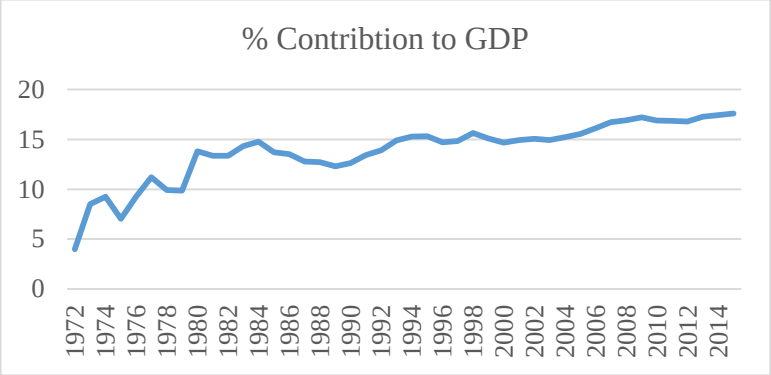
Criteria	Type	Obser vation	Average Efficiency Score
Ownership	Foreign	8	0.88
	Domestic	430	0.87
Initial Registered	Yes	332	0.88
	No	114	0.83
Email	No	77	0.84
	Yes	368	0.87
Website	Yes	262	0.88
	No	183	0.85
R &D Activity	Yes	250	87
	No	197	87
Import of input materials	<50	187	87
	>50	232	87

Figure A1.5
GDP of manufacturing sector



Source: BBS, 2012

Figure A1.6
GDP contribution of manufacturing sector



Source: BBS, 2012

Figure A1.7
Quantum Index of Productivity

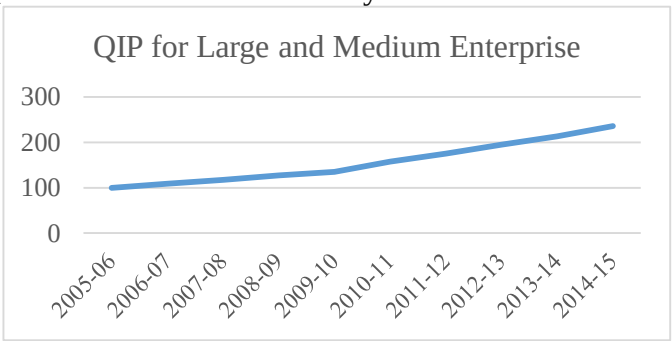


Figure A1.8
Growth rate of manufacturing sector

Table A1.9
Raw material usage & source

Size	Source of raw materials	Value of raw materials (In million Tk.)
Micro	Local	141999
	Foreign	21543
Small	Local	480663
	Foreign	254824
Medium	Local	347399
	Foreign	583049
Large	Local	655853
	Foreign	959743

Table A1.10
Operational Cost

Size	No of establishments	Non-industrial cost	Industrial cost	Intermediate cost
		Million taka	Million taka	Million taka
Micro	17384	4679	179396	183726
Small	15666	24215	810602	833293
Medium	6103	21788	1028606	1044696
Large	3639	53745	1744118	1770244

Table A1.11
Asset

	Total (mil Taka)	Micro	Small	Medium	Large
Total	1188105	46527	283335	286900	571341
Land	238872	16883	68144	63376	90469
Land development	8889	188	2323	1575	4803
Building (residence & factory)	250356	8531	50640	58194	132991
Machinery and equipment's	533889	16259	128438	129021	260171
Transport	44112	1398	9680	11118	21915
Computer and software	11007	274	2625	1647	6461
Other fixed assets	100980	2994	21485	21969	54531

Source: BBS 2012

Table A1.12
Gross Output

Category	Number of firms	Gross Output	Grass Value Added
		Million taka	Million taka
Total	42,792	5,394,905 (100%)	1,562,947
Micro	17,384	275,818 (5.1%)	92,092
Small	15,666	1,203,267 (22.3%)	369,974
Medium	6,103	1,408,342 (26.1%)	363,646
Large	3,639	2,507,478 (46.5%)	737,235

Table A1.13
Growth of Total person engaged, gross output, gross value added

Period	No of firms	Total Person Engaged	Gross Output	Gross Value Added
			In million taka	In million taka
2001-02	27971	2465697	901937	290911
2005-06	34710	3705884	1912048	718239
2010-11	42792	5015936	5394906	1562947

Table A1.14
Total person engaged

Type	No of firms	both sex	male	female
Total	42,792	5015936	3062009	1953928
Micro	17,384	271644	229407	42237
Small	15,666	738801	615426	123374
Medium	6,103	1041220	673821	367399
Large	3,639	2964272	1543355	1420918

Table A1.15
Ownership status

Type	Total	Micro	Small	Medium	Large
Total	42,792	17,384	15,666	6,103	3,639
Government	103	0	0	48	55
Private	42,231	17,384	15,666	5,877	3,305
Government & private jointly	35	0	0	14	21
Joint venture(local & foreign)	160	0	0	75	85
Foreign	263	0	0	89	174

Table A1.16
Distribution of person engaged, salary and benefits

	Employed Persons	Number	Salary & Wages	Cash-non cash benefits	Social Security	Total salary, wages and benefit
Type	Sex	thousand	mil. BDT	mil. BDT	mil. BDT	mil. BDT
Total		5,016	517,517	49,033	2,515	569,065
Administrative & managerial	Male	192	27,712	2,589	292	30,593
	Female	12	1,674	186	16	1,876
Clerical & sales workers	Male	214	25,021	2,211	244	27,475
	Female	20	2,077	424	50	2,551
Production & related worker	Male	1,996	202,412	12,872	707	215,991
	Female	2,102	217,507	13,510	861	231,878
Working owner / proprietor/partner	Male	41	0	15,005	289	15,294
	Female	2	0	993	15	1,010
Temporary labor	Male	353	34,039	610	28	34,677,621
	Female	77	7,075	194	9	7,278,870
Family helper	Male	2,676	0	182	2	183,648
	Female	3,785	0	257	2	258,524

Table A1.17
Firm size, manager's human capital, export

Panel Data					
	micro	small	medium	large	Very large
Experience	15.7	16.7	16	15.9	19.5
Schooling	12.9	14.9	15.7	15.5	16.1
Export %	3	34	55	72	76
Pooled Cross-section Data					
	micro	small	medium	large	Very large
Experience	13.3	15	15.6	15	18.4
Schooling	11	13.8	15.4	15.7	16.2
Export %	3	19	42	74	71
Firm number	765	604	323	492	159

Table A1.18
Current employee vs starting employee

Current Employee	Starting Employee
<25	13
26-100	25
101-250	75
251-1000	220
>1000	504

Table A1.19
Average Marginal Impacts (referred to models in Table-2.5)

Determinants	Model-1-homo	Model-2-homo	Model-3
Experience	-0.010723	-0.0070863	-0.0074841
Education	-	-0.097198	-0.1009982
Age	-0.103642	-0.0512466	-0.0494645
Fin1	-0.07166	-0.0651529	-0.0679363
Fin2	-0.010873	-0.0233287	-0.0257038

Table A1.20
Sector-wise statistics

Sector	Export %	Innovation %	Experience - Top manager	Schooling - Top manager	Full Time Labor	% of foreign inputs	labor growth rate %	Schooling year-Production worker
Leather	38	0.524	16.5	11.6	156	16	36	5.5
Food	11	0.499	16.6	12.8	117	8	43	5.7
Chemical	4	0.638	18.9	15.6	384	44	39	8.8
Textile	34	0.565	17	14.9	405	35	34	6.1
Garment	55	0.617	15.4	15.5	645	46	84	6.5
Others	5	0.417	17.8	14.3	84	33	32	6.2

Table A1.21
Relation with manager's experience

	Manager Experience Group			
	1	2	3	4
Overdraft				
No	31	75	69	33
Yes	38	95	75	30
Ratio	1.22	1.26	1.08	0.90
Loan/LOC				
No	27	71	49	26
Yes	40	98	93	37
Ratio	1.48	1.38	1.89	1.42
R&D				
No	26	87	60	24
Yes	43	84	84	39
Ratio	1.65	0.96	1.4	1.62

Table A1.22
Manager's schooling, overdraft, loan/LOC, training & R&D

	Manager Education Level		
Overdraft	Foreign	Local Grad	HSC-SSC
No	9	167	29
Yes	23	187	25
Ratio	2.55	1.11	0.86
Loan/LOC	Foreign	Local Grad	HSC-SSC
No	9	136	24
Yes	23	213	30
Ratio	2.55	1.56	1.25
Training	Foreign	Local Grad	HSC-SSC
Yes	13	121	14
No	19	234	40
ratio	0.68	0.51	0.35
RND			
Yes	22	202	24
No	10	153	30
ratio	2.2	1.32	0.8

Table A1.23
Additional survey findings

Issue	Yes	No	Ratio (Yes/Total)
Initial Registration	1150	243	0.17
Female Ownership	473	1883	0.20
Compete against Informal firms	504	893	0.36
Obstacle in business: informal firms	1371	847	0.62
Obstacle in business: informal firms – high	888	1330	0.40
EPZ/Ind. Park	180	998	0.15
Generator Ownership	1343	1015	0.57
Email to contact clients	1186	1168	0.50
Own Website	808	1544	0.34
Electricity as Obstacle-high	2115	238	0.90
Tax Inspection	1505	819	0.65
Informal payment request from meeting or inspection	607	772	0.44
Informal payment	661	642	0.51

Table A1.24
Model validation parameters

	model	E(σu) / E(σv) or σu/σv	AIC	BIC
Panel Models	TRE-HN_Hetero	0.20	1219	1321
	TRE-HN_Homo	0.68	1238	1324
	TRE-HN_NC	0.19	1243	1338
	TRE-Exp_Homo	0.81	1233	1319
	TRE-Exp_Hetero	0.41	1219	1321
	Pl81	0.58	1247	1313
	FGLS RE	0.41		
	LSDV FE	0.89		
Cross-Sectional Models	Cross-sectional model-1	2.90	4062	4250
	Cross-sectional model-1-Homo	3.10	3855	4009
	Cross-sectional model-2	2.27	969	1139
	Cross-sectional model-2-Homo	8.40	1142	1273
	Cross-sectional model-3-Homo	7.30	1290	1433

Note: AIC- Akaike Information Criteria, BIC- Bayesian Information Criteria

Table A1.25

TRE Regression results - Garments & Textile

		1	2	3	4	5	6	7	8	9	10
	Variables	HN-1	HN-homo	EXP-1	EXP-homos	PL81	RE-fgls	FE	without education	TRE-2007-11	With size
Frontier	T.Asset (K)	0.08	0.09	0.09	0.09	0.07	0.07	0.04	0.09	0.05	0.07
		(2.42)**	(2.80)***	(2.55)**	(2.94)***	(1.94)*	(1.81)*	(0.96)	(2.89)***	(1.19)	(2.09)**
	Int.Input (M)	0.37	0.34	0.34	0.33	0.37	0.37	0.30	0.37	0.32	0.34
		(10.56)***	(9.87)***	(8.53)***	(10.16)***	(11.46)***	(12.50)***	(7.66)***	(10.25)***	(8.43)***	(9.71)***
	Labor (L)	0.29	0.27	0.27	0.26	0.28	0.28	0.31	0.31	0.27	0.17
		(6.18)***	(5.66)***	(5.73)***	(5.69)***	(4.27)***	(4.17)***	(3.88)***	(6.63)***	(4.57)***	(3.65)***
	Time.Trend	1.72	1.86	1.80	1.84	1.35	1.35	1.25	1.75	1.50	1.56
		(10.44)***	(10.97)***	(11.61)***	(11.44)***	(7.86)***	(7.71)***	(7.41)***	(11.21)***	(7.80)***	(10.55)***
	T.Asset2	-0.02	-0.02	-0.03	-0.02	-0.02	-0.02	-0.07	-0.01	-0.03	-0.04
		(0.69)	(0.79)	(0.84)	(0.77)	(0.46)	(0.52)	(1.71)*	(0.38)	(0.70)	(1.57)
	Int.Input2	0.15	0.15	0.15	0.15	0.16	0.16	0.14	0.15	0.16	0.16
		(5.67)***	(5.80)***	(5.84)***	(6.14)***	(4.03)***	(4.02)***	(3.91)***	(5.42)***	(4.98)***	(5.79)***
	Labor2	0.15	0.21	0.18	0.23	0.23	0.23	0.24	0.12	0.23	0.21
		(2.53)**	(3.59)***	(2.18)**	(3.57)***	(2.18)**	(2.14)**	(2.30)**	(1.93)*	(3.55)***	(3.51)***
	K*M	0.03	0.03	0.03	0.04	0.03	0.03	0.04	0.02	0.02	0.03
		(1.46)	(1.97)**	(1.80)*	(2.16)**	(1.77)*	(1.80)*	(2.08)**	(1.25)	(1.07)	(1.89)*
	L*M	-0.02	-0.04	-0.03	-0.05	-0.06	-0.06	-0.07	-0.01	-0.04	-0.04
		(0.71)	(1.52)	(0.70)	(1.57)	(1.46)	(1.46)	(1.68)*	(0.32)	(1.03)	(1.37)
	L*K	-0.08	-0.07	-0.08	-0.08	-0.10	-0.10	-0.10	-0.08	-0.09	-0.08
		(3.28)***	(2.81)***	(3.21)***	(3.11)***	(2.32)**	(2.29)**	(2.54)**	(3.14)***	(2.80)***	(3.43)***
	Time.Trend2	-0.43	-0.47	-0.45	-0.46	-0.34	-0.33	-0.31	-0.44		-0.39
		(10.37)***	(10.95)***	(11.55)***	(11.42)***	(7.85)***	(7.69)***	(7.28)***	(11.09)***		(10.43)***
	Export	0.43	0.46	0.47	0.47	0.62	0.63	0.81	0.35	0.64	0.45
		(3.15)***	(3.47)***	(3.46)***	(3.70)***	(4.07)***	(4.07)***	(4.41)***	(2.65)***	(3.96)***	(3.33)***
	Innovation	0.34	0.29	0.29	0.26	0.26	0.25	0.33	0.37	0.21	0.19
		(3.17)***	(2.70)***	(2.76)***	(2.46)**	(2.24)**	(2.17)**	(2.09)**	(3.41)***	(1.44)	(1.76)*
	_cons	-2.83	-2.53	-2.76	-2.69	-2.41			-2.87	17.17	-2.41
		(14.09)***	(12.69)***	(13.74)***	(13.78)***	(11.89)***			(14.70)***	(66.22)***	(10.72)***

Usigma	Experience	-0.21	-0.09	-0.15	-0.11				-0.24	-0.18	-0.07
		(2.12)**	(4.10)***	(2.44)**	(3.34)***				(2.51)**	(1.77)*	(2.89)***
	Education	0.06	-0.00	-0.03	-0.03					0.14	0.47
		(0.49)	(0.03)	(0.55)	(0.73)					(1.39)	(3.61)***
	Overdraft- *fin1*	0.10	0.24	0.16	0.21				0.20	0.04	-0.04
		(0.36)	(1.39)	(0.62)	(0.88)				(0.56)	(0.14)	(0.10)
	Loan-*fin2*	-0.03	-0.11	-0.07	-0.18				-0.01	-0.06	-0.26
		(0.18)	(1.55)	(0.43)	(1.74)*				(0.06)	(0.44)	(2.73)***
	Firm age	0.03	0.49	0.40	0.40				0.34	-0.52	-0.11
		(0.04)	(2.49)**	(1.23)	(1.48)				(1.24)	(0.79)	(0.27)
	Firm size										-1.19
											(3.73)***
Vsigma	Experience	-0.04		-0.00					-0.06	0.01	-0.06
		(2.02)**		(0.03)					(3.40)***	(0.37)	(2.91)***
	Education	-0.10		-0.12						-0.20	-0.19
		(1.92)*		(2.22)**						(2.37)**	(2.54)**
	Overdraft- *fin1*	0.81		0.53					0.71	0.58	0.87
		(3.19)***		(0.85)					(3.32)***	(1.88)*	(3.00)***
	Loan-*fin2*	-0.07		-0.14					-0.08	0.01	0.58
		(0.67)		(0.86)					(0.86)	(0.06)	(1.73)*
	Firm age	0.41		0.14					0.03	0.80	0.69
		(1.64)		(0.39)					(0.19)	(2.53)**	(2.22)**
	Firm size										0.05
											(0.39)
Vsigma	_cons		-1.64		-1.58	0.68					
			(4.19)***		(5.48)***	(7.66)***					
Usigma	_cons					0.30					
						(2.34)**					
Theta	_cons	0.26	0.33	0.32	0.32		-2.85	-2.84	-0.19	0.24	0.22
		(2.41)**	(4.24)***	(4.21)***	(4.44)***		(13.68)***	(13.07)***	(1.03)	(1.62)	(2.05)**
N		292	292	292	292	292	292	292	292	227	290

Note: Dependent Variable: *ln(annual sale)*

Appendix 2
Tables & Figures of Chapter-3

Table A2.1
Summary Statistics

Variable	Mean	Std.Dev.	Min	Max
Current total employee	33.21	139.0	1	2331
Starting total employee	20.62	57.37	1	631
Current paid employee	26.24	134.5	0	2300
Current temporary worker	5.429	26.51	0	450
Current unpaid worker	0.450	0.815	0	6
Total assets (BDT)	8.599e+06	5.250e+07	2200	9.420e+08
Machine, equipment, working capital (BDT)	4.993e+06	2.440e+07	5000	3.000e+08
Land and building (BDT)	4.569e+06	4.370e+07	0	9.000e+08
Machine & equipment in use (BDT)	2.893e+06	1.680e+07	0	2.300e+08
Yearly sales (2009) (BDT)	2.000e+07	9.910e+07	6000	1.860e+09
Sales per worker (BDT)	465363	901162	6000	1.080e+07
Profits in last month (BDT)	245886	1.786e+06	1200	3.500e+07
Firm age (year)	13.71	12.90	1	100
Innovation (%)	0.301	0.459	0	1

Note: BDT- Bangladeshi Taka

Table A2.2
Summary of Owners' Attributes

Owner Attributes	Mean	Std.Dev.	Min	Max
Owner age	43.35	10.70	21	80
Owner's schooling year	9.139	4.320	0	18
Mother's schooling year	4.076	3.568	0	16
Father's schooling year	5.844	4.642	0	18
Digit-span recall (digit)	5.457	1.285	3	11
Poverty during youth %	0.411	0.493	0	1

Figure A2.1
Density of individual score based on 1st PCA component

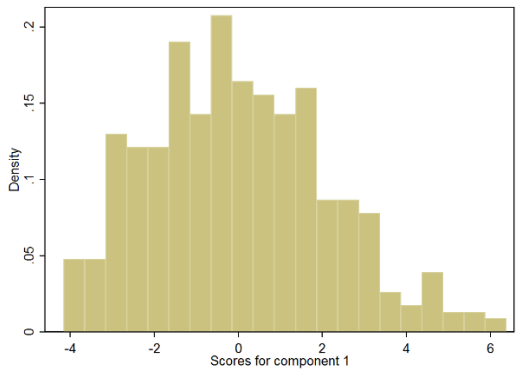


Figure A2. 2
Density of labor size

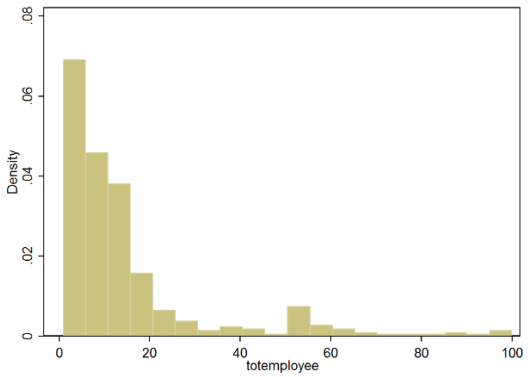
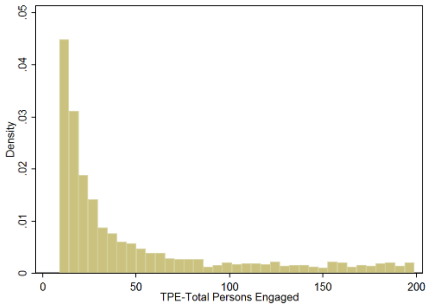


Figure A2.3
Density of labor size (BBS countrywide data)



Source: BBS, 2012

Figure A2.4
Capital Return vs Total Asset

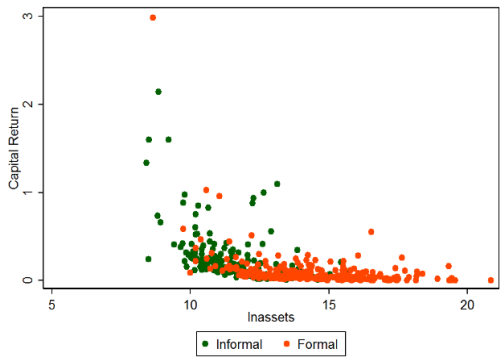


Table A2.3
Summary (mean value) of variables used to estimate PCA groups

Variable	**PCA1**	**PCA2**	**PCA3**	**PCA4**	**PCA5**
Assets (BDT)	170325	514629	1.209e+06	3.935e+06	3.730e+07
Employee	4.914	8.120	12.05	17.40	124.1
Annual sales (BDT)	783450	2.272e+06	5.689e+06	8.630e+06	8.280e+07
Trade license	0.570	0.967	1	1	1
Tax ID	0	0.120	0.473	0.891	1
VAT	0	0.0217	0.204	0.489	0.891
Business association	0.183	0.565	0.559	0.707	0.663
Chamber of commerce	0	0	0.0215	0.109	0.478
Sole-proprietorship	0.957	0.935	0.882	0.772	0.641
Employment contract	0	0	0	0	0.239
Business bank account	0.0323	0.261	0.452	0.696	0.978
Bank loan	0.0108	0.120	0.301	0.609	0.804
Pay taxes	0.183	0.707	0.914	0.989	1
Use-computer	0	0	0.0108	0.0435	0.424
Run out stock	2.075	2.337	2.473	2.543	2.870
Marketing score	1.086	1.913	1.989	2.185	2.641
Check price	0.376	0.565	0.677	0.630	0.707
Record-keeping score	2.892	4.261	5.935	6.565	7.261
Planning score	1.312	2.370	3.118	4.043	6.054
Schooling years	6.7	7.3	8.6	10.2	13

Note: BDT- Bangladeshi Taka

Table A2.4
District-wise summary of regulatory variables

Districts	Trade license	Municipal cost, BDT	Municipal time, days	Municipal bribe (%)	Tax cost, BDT	Tax time, days	Tax bribe, %	Tax ID	VAT
KUSHTIA	0.95	253	3.00	0.05	269	8.97	0.07	0.71	0.37
KHULNA	1.00	489	3.94	0.16	1415	8.54	0.23	0.68	0.37
MYMENSINGH	0.95	661	4.32	0.11	908	18.25	0.08	0.60	0.25
PATUAKHALI	0.90	375	2.67	0.22	667	7.67	0.17	0.60	0.60

CHITTAGONG	1.00	1074	8.40	0.46	2785	15.30	0.65	0.57	0.49
DINAJPUR	0.85	600	5.18	0.09	593	9.29	0.00	0.54	0.46
DHAKA	0.90	1663	9.92	0.50	3565	15.47	0.65	0.53	0.35
JESSORE	0.89	573	4.13	0.25	578	7.44	0.00	0.50	0.33
RANGPUR	0.86	310	10.08	0.08	1014	15.29	0.14	0.50	0.36
NOAKHALI	0.85	373	4.00	0.18	2750	20.83	0.83	0.46	0.46
BARISAL	0.89	1066	6.38	0.75	2444	12.13	0.63	0.44	0.39
SYLHET	1.00	534	5.06	0.00	1171	10.00	0.00	0.44	0.38
BOGRA	0.83	406	5.21	0.00	1735	17.40	0.00	0.43	0.22
COMILLA	0.95	404	3.50	0.17	1671	19.00	0.71	0.37	0.16
PABNA	0.93	289	4.85	0.14	900	11.00	0.45	0.37	0.20
RAJSHAHI	0.85	642	3.82	0.45	2500	8.75	0.75	0.31	0.23
FARIDPUR	0.94	227	2.67	0.13	500	3.60	0.00	0.29	0.18
COX'S BAZAR	0.79	618	3.91	0.36	4000	19.00	0.75	0.29	0.00
TANGAIL	0.69	300	2.909091	0.00	1375	25.25	0.00	0.25	0.19
Average	*0.89*	*571.41*	*4.94*	*0.22*	*1623.20*	*13.32*	*0.32*	*0.47*	*0.31*

Note: BDT Bangladeshi Taka

Table A2.5
Gross value-added and employment in formal and informal industrial sectors, 2009-10

Industry	Gross value added (million BDT)		Number of jobs		Gross value added per job (thousand BDT)		
	Formal Sector**	Informal sector	Formal Sector**	Informal sector	Total	Formal Sector**	Informal sector
Agriculture , Fishing, forestry	196,150	1,051,959	5,016,345	21,452,762	47.2	39.1	49
Mining and quarrying	80,812	329	24,734	79,233	780.4	3,267.30	4.1
Manufacturing	743,588	457,493	1,322,879	5,170,042	185	562.1	88.5
Electricity, gas, and water	70,780	1,165	47,266	70,179	612.6	1,497.50	16.6
Construction	373,455	183,126	363,067	2,243,364	213.5	1,028.60	81.6
Trade, motor vehicle repair	333,233	669,713	2,225,275	4,934,800	140.1	149.7	135.7
Hotel & restaurant	30,011	21,490	178,676	626,444	64	168	34.3
Transport, storage, and communication	536,073	182,723	904,475	3,041,626	182.2	592.7	60.1
Financial intermediation	119,084	3,914	172,749	194,395	335	689.3	20.1
Real estate and business activities	341,448	115,382	305,781	349,104	697.6	1,116.60	330.5
Public administration	181,665	5,904	387,195	156,779	344.8	469.2	37.7
Education	161,679	17,405	695,458	553,025	143.4	232.5	31.5
Health	147,509	3,915	207,759	196,619	374.5	710	19.9
Community and other private services	528,661	155,994	643,403	2,925,657	191.8	821.7	53.3
Total	3,844,148	2,870,512	12,495,062	41,994,029	4,312	11,344	963

Note: ** household and agriculture is included here in formal sector to separate them from informal enterprises. Source: Labor Force Survey 2010, BBS.

Table A2.6
Reason for choosing current business activity by informal firms (%)

Reason	National	Urban	Rural
Family tradition	39	20	46
Knowledge of the profession	37	47	33
Better income/higher profit	18	21	17
More stable return than other jobs	1	2	1
Others	5	9	4

Source: Labor Force Survey 2010, BBS

Table A2.7
Employment Size of Establishment and Type of Production Unit (%)

Employment Size	Formal Enterprise	Informal Enterprise	Household
Less than 10 workers	37.1	88.4	95.1
10-49	26.4	5.6	3.7
50-149	12.9	2.8	0
150-more	23.6	3.3	0
all	100	100	100

Source: Labor Force Survey 2010, BBS

Table A2.8
Impact of Loan on Business Operation (%) of informal firms

Impact	Response %
Increase production	67
Increase volume of sales	48
Diversification of production	37
Improvement of competitiveness	35
Working less time	23
Recruitment of additional staff	21
Financial difficulties	19
Utilization of less staff	18
Others	14

Source: Labor Force Survey 2010, BBS

Table A2.9
Problem faced by informal firms %

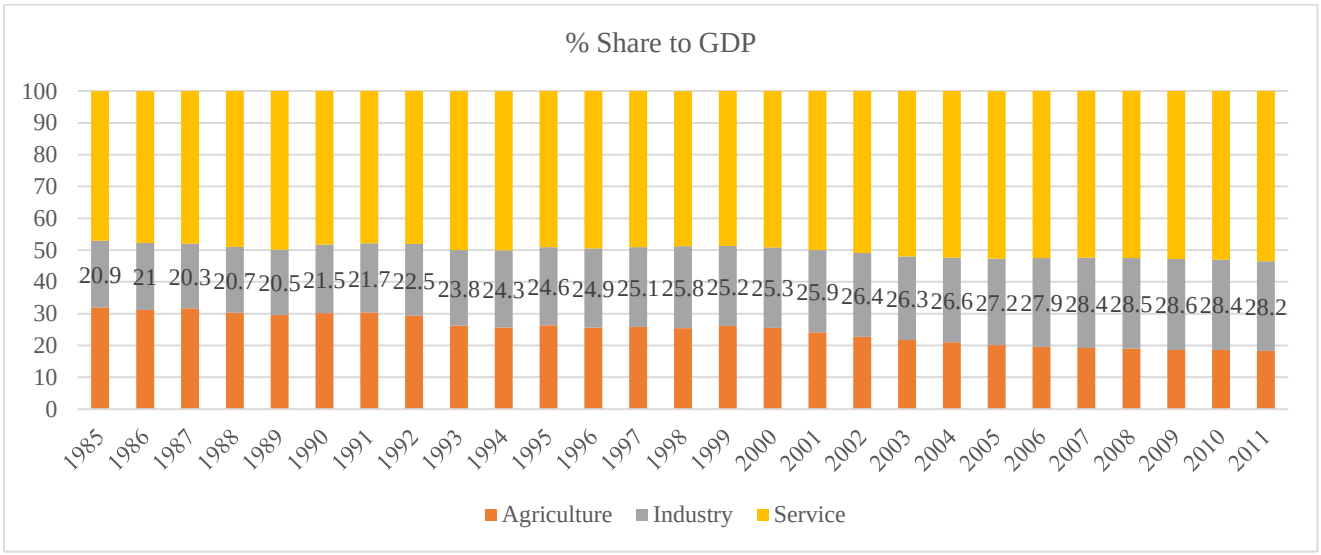
Problem	Response
Financial difficulties	38
Supply of raw materials	32
Lack of space, adapted premises	23
Lack of machine or equipment	19
Sale of products-lack of customers	17
Sale of products-too much competition	17
Organization, management difficulty	13
Too much control, taxes	7
Others	6.5

Table A2.10
Business registration cost and perception

Status	Registration type	% of firm having	Mean one-off cost	Median one-off cost	Avg years in operation before having	Avg days to get	% paid bribe		
Registered	Trade license	90	800	500	1.3 (2.1)	6	27		
	Tax	49.5	1940	1000	1.7 (3.3)	10	37.5		
	Registration type	% Ever thought of registering	Perception of official cost	Perception unofficial cost	Expected annual tax	Perception time required	average monthly profit	% wish to register with zero cost	
Unregistered	Trade license	70	1000	850		16	11860	85	
	Tax	35	2000	725	2400	4.3	18710	57	
	Registration type	Disadvantage-1	Disadvantage-2	Disadvantage-3	No disadvantage	Advantage-1	Advantage-2	Advantage-3	No advantage
Combined	Trade license	initial cost	process is burdensome	paying tax	76%	less risk of fine	operate more visibly, no worry	bank account with own name	17%

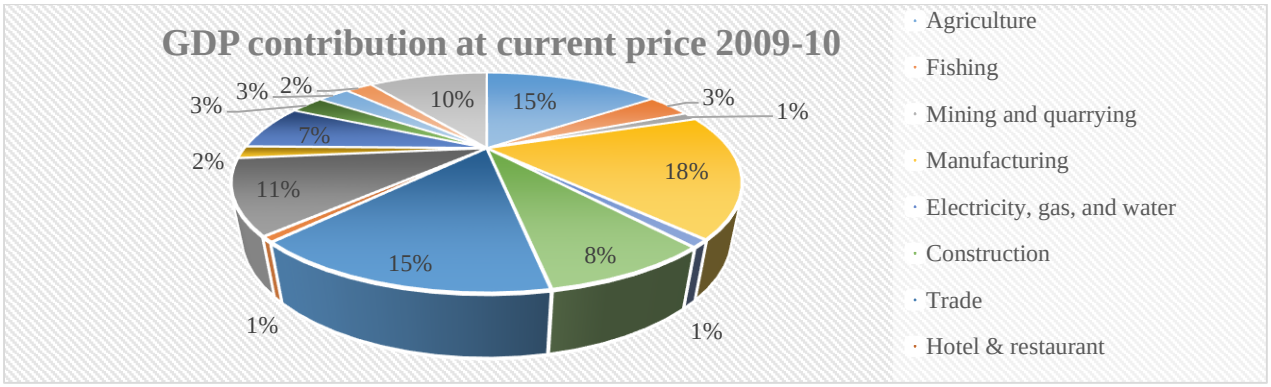
	Tax	paying taxes	process burdensome	process time consuming	50%	bank account in business name	bank loan	lower risk of fine	18%

Figure A2.5
Sectorial contribution to GDP over time



Source: Labor Force Survey 2010, BBS

Figure A2.6
Sectorial contribution to GDP for 2009-10



Source: Labor Force Survey 2010, BBS

Table A2.11
Correlation matrix of PCA variables

	Trade license	Tax ID	VAT	Business association	Chamber of commerce	Sole-proprietor	Employment contract	Business bank-account	Bank loan	Pay taxes	Use computer	Marketing score	Record score	Planning score	Buying score	Stock control
Trade license	1															
Tax ID	0.318	1														
VAT	0.220	0.572	1													
Business association	0.224	0.161	0.0918	1												
Chamber of commerce	0.119	0.348	0.356	0.0141	1											
Sole proprietor	-0.0602	-0.280	-0.188	-0.0459	-0.0883	1										
Employment contract	0.0716	0.226	0.217	0.0864	0.228	-0.232	1									
Business bank account	0.295	0.507	0.377	0.154	0.318	-0.0916	0.231	1								
Bank loan	0.229	0.429	0.323	0.226	0.212	-0.260	0.230	0.458	1							
Pay taxes	0.532	0.510	0.378	0.272	0.195	-0.126	0.126	0.364	0.285	1						
Use computer	0.104	0.298	0.394	0.00704	0.309	-0.317	0.481	0.292	0.272	0.166	1					
Marketing score	0.0673	0.0430	0.107	0.206	0.129	-0.00625	0.134	0.105	0.0736	0.237	0.183	1				
Record score	0.188	0.397	0.369	0.148	0.235	-0.172	0.191	0.291	0.286	0.300	0.201	0.128	1			
Planning score	0.234	0.352	0.369	0.226	0.276	-0.193	0.354	0.353	0.318	0.300	0.332	0.156	0.568	1		
Buying score	0.0365	0.0324	0.0995	0.0357	0.107	-0.0320	0.0620	0.0637	0.0780	0.094	0.150	0.384	0.176	0.143	1	
Stock control	0.0506	0.161	0.131	0.0597	0.0689	-0.00346	0.0912	0.164	0.113	0.073	0.0803	0.0631	0.214	0.239	0.159	1

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