

**DISTRIBUTIONS OF PUBLIC AND PRIVATE MANUFACTURING FIRMS
AND DETERMINANTS OF PRODUCTIVITY IN ETHIOPIA**

WODAJO, Tadesse*

SENBET, Dawit

Abstract

The aim of this paper is to assess the structure and distribution of large and medium (L&M) scale manufacturing industries in Ethiopia and to investigate the level of their productivities by disaggregating them into public and private firms using firm level panel data (from 2003 to 2005) for manufacturing industries. The paper employs Cobb-Douglas type production function estimated using three alternative techniques: Ordinary Least Squares (OLS), Fixed Effect (FE) and Generalized Method of Moments (GMM). The GMM results are found to be unbiased estimates for our dataset. Considerable regional variations are observed in the distribution of firms in Ethiopia, more so after 1991 than in the period before it. Significant regional variations are also observed in terms of production capacity and capital intensity. Compared to their counterparts, public firms employ substantially higher level of factors inputs and hence produce equivalently larger amount of output. Nevertheless, the GMM estimations reveal that despite public firms' substantial access to factor inputs, no statistically significant productivity differential is observed between the two sectors. Finally, while only indirect and material inputs are found to significantly influence publicly owned firms' productivities, all of the model variables (physical and human capital, indirect and material inputs, and workers' experience) are found to determine the productivities of private firm to a great extent.

Keywords: Public Firms, Private Firms, Manufacturing, Ethiopia

1. Introduction

Modern manufacturing had begun in Ethiopia in the early 20th century, mainly following the construction of the Ethio-Djibouti railways. Growing demand for manufactured imported goods on the one hand and rising cost of transportation for the imported goods on the other were believed to have necessitated domestic manufacturing. The expansion of manufacturing in Ethiopia is believed to have benefited from the entrepreneurial skills of foreigners (from Armenia, Italy, Greece and India) who had begun settling in the country at the time (Befekadu et. al., 2000).

During the Imperial regime (before 1974) private ownership was dominant (the majority of the firms being owned by foreigners either fully or partially as joint ventures) in the manufacturing sector. The role of the government was limited at the time as it owns (either fully or as a shareholder) a small proportion of the manufacturing firms (Befekadu et. al., 2000). During the Dergue regime (1974–1991), the manufacturing sector became under full control of the government as a result of the socialist ideology the government chose to pursue. Consequently, the government

* Tadesse Wodajo, St. Louis Community College, Department of Business and Economics, 11333 Big Bend Road, St. Louis, MO 63122, Email: twodajo@stlcc.edu. Dawit Senbet, University of Northern Colorado, Department of Economics, 501 20th St, Campus Box 101, , Greeley, CO 80639. Email: dawit.senbet@unco.edu

nationalized all privately owned large and medium scale manufacturing industries, prohibited ownership of private firms in some sectors (particularly in large scale manufacturing), imposed a ceiling on capital investment on others, and instituted various rules and regulations that discouraged private investment in the manufacturing sector (MEDaC, 1999). These had greatly constrained the development of the manufacturing sector during that period.

After it came to power in 1991, the current government lifted the restrictions (probably not all) imposed by its predecessor and took various reform measures as well, such as privatization of selected public industries and public enterprises reform program, which limit public ownership, encourage expansion of the private sector, and enhance efficiency and competitiveness (ICC, 2004). As a result, the number of large and medium (L&M) scale manufacturing industries has considerably increased in the country as revealed by a series of census surveys conducted by the Central Statistical Authority of Ethiopia (CSA).

Given the above synopsis, this paper attempts to assess the structure, distribution, size, and productivity of L&M scale manufacturing industries in Ethiopia by taking 1991 as a reference year in which a major shift in the country's political system has taken place. More specifically, this study has two major objectives. The first objective is assessing the structure, distribution and size of L&M scale manufacturing industries in the country. This can be done by exploring the composition (public vs. private), regional variations, and differences in the size (level of output, capital and employment) of manufacturing firms operating in the country. The second objective aims at investigating the differences in the levels of production between public and private manufacturing firms and the factors that influence their respective productivities. This objective can be achieved by examining whether there is any significant difference in productivity between publicly and privately owned firms and employing a regression analysis to identify and quantify the factors that determine the level of productivity in each sector. These would, therefore, be the major contributions of this study as there are no other studies we are aware of that addressed these issues focusing on Ethiopia's public and private L&M scale manufacturing industries. The remainder of the paper is divided as follows. In section 2 we present the review of literature and specify the model to be employed. In section 3 we briefly describe the source of data and present the descriptive analyses in detail. While section 4 focuses on the estimation results and the discussion, section 5 provides the conclusion of the study.

2. Review of literature and model specification

2.1 Review of literature

Productivity differentials among firms depend on many factors. Some of the factors include firm location (Rijkers et al., 2010), export orientation (Bigsten and Gebreyesus, 2009), access to producer service inputs (Arnold et. al., 2008), firm turnovers (Gebreyesus, 2007), and firm ownership (Cuaresma et. al., 2012; Zhang et. al., 2003; Brown et. al., 2004; Ehrlich et. al., 1994), to site a few. Rijkers et al. (2010) studied productivity differentials of firms in Ethiopia based on location; namely whether the firm is located in rural or urban areas. They used data from the 2007 Rural Investment Climate Survey-Amhara (RICS-Amhara) for the rural firms and the Ethiopian Enterprise Survey (2006) for the urban firms. Their findings show that location is important for firm growth and productivity. Specifically, they found that rural firms are

smaller than urban firms and they tend to remain small. On the other hand, urban firms exhibit a healthy dynamic growth. Bigsten and Gebreyesus (2009) examine the relationship between productivity and export of Ethiopian manufacturing firms using a panel data from Ethiopian Central Statistics Agency (1996–2004). They also investigate whether firms experience learning-by-exporting. Their findings show that, first, exporters perform much better than non-exports. They pay higher wages, have more workers, have more capital per worker and they are more productive. The same findings were reported by Biesebroeck (2005a) for Sub-Saharan Africa in general. Second, previous exporting experience (learning-by-exporting) has a significant positive impact on productivity.

Productivity differentials are also related to access to service inputs (communications, electricity and financial services). Using data from the World Bank Enterprise Survey for over 1000 firms in ten Sub-Saharan African countries, Arnold et. al. (2008) found a consistently positive and significant relationship between firm productivity and service performances of the three sectors named above. They conclude that inadequate access to essential services will undermine and hurt firm productivity.

Regarding firm size and productivity differential, Biesebroeck (2005b) documents the evolution of the size and productivity distribution among firms in nine Sub-Saharan African countries (including Ethiopia) and other advanced countries. In advanced countries, generally firms enter at a relatively smaller scale and lower productivity. Many could not survive and exit the market early on. Those who survived their early years converge to the industry average level of productivity. On the other hand, in Africa, small firms rarely reach the level of the biggest firms in the industry. The largest firms display higher level of productivity, growth rate and disproportionate contribution to economic growth. These create divergence at the top and bottom of the distribution. Gebreyesus (2008), based on Firm-Level Industrial Census Data from the Ethiopian manufacturing sector, reports that 60% of new firms that enter the market exit within 3 years. Those exiting firms are less productive than continuing and new firms.

A recent study by Crespo-Cuaresma et. al. (2012) compares productivity of state-owned versus private firms in the Belarusian machine building industries. They find that state-owned firms produce less efficiently and exhibit lower growth rate of productivity compared to their non-state-owned counterparts. They cite labor hoarding and inefficient over investment in the public firms as part of the reasons for the inefficiencies and productivity differentials. They find that a state-owned firm would employ about 46.7% more workers and uses about 100% more capital input than corresponding private firms.

Similarly, Zhang et. al. (2003) report on differences between the state and privately owned firms' R&D spending and productivity in China. Firms in the state sector have significantly lower R&D intensity and productive efficiency than their counterparts in the non-state (private) sector. Furthermore, within the non-state sector, foreign firms exhibit better R&D intensity and productive efficiency than domestically owned ones. Based on the data from Hungary, Romania, Ukraine and Russia, Brown et. al. (2004) find that privatization, on average, raises multifactor productivity by about 28% in Romania, 22% in Hungary and 3% in Ukraine. However, they also find that in Russia,

privatization reduces productivity by about 4%. In addition, privatization to foreign investors have more positive impact on productivity than to domestic investors.

Ehrlich et. al. (1994) investigate the effect of firm ownership (state versus private) on long run productivity growth or cost decline using panel data on 23 international airlines for the period of 1973-83. Their findings show that state ownership has a negative impact on the rate of productivity growth or cost decline in the long run. They report that a switch from state to private ownership significantly and unambiguously raises the long run productivity growth rates. However, the result tends to be inconclusive when it comes to the short run differences between the levels of productivity. In addition, partial privatization of state owned firms leads to a smaller improvement in productivity growth than complete privatization. Their results are consistent regardless of the size of the firms and the degree of competition they face.

This study focuses on the distribution and differences in characteristics of publicly and privately owned L&M scale manufacturing firms in Ethiopia. The study also examines the determinants of productivity in both sectors. As such, our study is the first attempt in addressing these issues emphasizing on public versus private firms in Ethiopia.

2.2 Model specification

Firms are engaged in the process of transforming inputs into outputs via certain production process (technology). This process is captured by the general functional form

$$Y_{it} = A_{it}f(Z_{it}) \quad (1)$$

where Y_{it} is level of output and Z_{it} is vector of inputs used in the production process. A_{it} denotes total factor productivity (TFP) which captures all those factors other than the measurable inputs such as labor and capital (e.g., level of technology and externalities) which are designated in most studies as major determinants of a firm's productivity (e.g., Soderbom and Teal, 2004; Selin, 2009) as well as a source of economic growth (e.g., Krugman, 1994; Luca, 2002; Chen 2002; Durlauf et al., 2005). This paper employs the Cobb-Douglas type production function in order to incorporate human capital-augmented labor on the one hand and make the results comparable to previous studies done in the area on the other. Hence, firm i 's production at time t is captured by:

$$Y_{it} = K_{it}^{\alpha}(A_{it}H_{it})^{\beta}e^{u_{it}} \quad (2)$$

where Y_{it} and A_{it} are as defined above, K_{it} is the stock of physical capital, H_{it} is human capital-augmented labor, and u_{it} is the error term. Some studies link human capital to years of schooling (e.g., Hall and Jones, 1999; Baptist and Teal, 2008), while others link it to both years of schooling and experience. We link human capital to workers' years of experience as shown below.¹

From Bils and Klenow (2000), the stock of human capital-augmented labor for firm i at time t (H_{it}) is the sum of individual worker's human capital stock

$$H_{it} = \sum_{l=1}^L h_{itl}L_{itl} \quad (3)$$

¹ The Ethiopian L&M scale manufacturing industries surveys do not collect data on workers' education. An average year of experience is imputed for each firm from wages and salaries each firm pays for different groups of workers.

where L_{it} and h_{it} denote, respectively, the number of workers and their level of human capital. Workers acquire their human capital through schooling and experience on the job. While the former is captured by years of schooling attained (S), the latter can be measured by workers' years of experience (E). This process of individual human capital accumulation can be expressed by the functional form (Bils and Klenow, 2000):

$$h_{it} = e^{f(S)+g(E)} \quad (4)$$

Then, equation (3) becomes

$$H_{it} = e^{f(S)+g(E)} L_{it} \quad (5)$$

The functions $f(S)$ and $g(E)$ capture the changes in the efficiency of a unit of labor due to S years of education and E years of experience, respectively, relative to one with no schooling and experience. Note that if $f(0) = 0$ and $g(0) = 0$, equation (5) reduces to the case where human capital is measured by 'undifferentiated' labor, resulting in the standard production function expressed only by capital and labor inputs.² In addition, $f'(S) > 0$ and $g'(E) > 0$ indicate the marginal gain in human capital from each year of education and experience, respectively. In empirical estimations, the education and experience functions are commonly expressed in linear and non-linear forms, respectively, as³

$$f(S) = \rho S_{it} \text{ and } g(E) = \delta_1 E_{it} + \delta_2 E_{it}^2$$

so that human-capital augmented labor becomes

$$H_{it} = e^{\rho S_{it} + \delta_1 E_{it} + \delta_2 E_{it}^2} L_{it} \quad (6)$$

and the production function in equation (2) becomes

$$Y_{it} = K_{it}^\alpha \left(A_{it} e^{\rho S_{it} + \delta_1 E_{it} + \delta_2 E_{it}^2} L_{it} \right)^\beta e^{\mu_i} e^{u_{it}} \quad (7)$$

To remove the effects arising from differences in firm specific, time-invariant unobservable variables (such as management capabilities, sophistication of the physical capital, working condition in the firm and quality of the workforce) we employ a fixed effects model. Denoting these unobserved disturbances by μ_i , the gross production function will then be

$$Y_{it} = K_{it}^\alpha \left(A_{it} e^{\rho S_{it} + \delta_1 E_{it} + \delta_2 E_{it}^2} L_{it} \right)^\beta e^{\mu_i} e^{u_{it}} \quad (8)$$

To calibrate the production function in (8) for estimation purposes based on variables available in the Ethiopian L&M scale manufacturing industries data, we incorporate such factor inputs as raw materials, M_{it} , and indirect inputs, I_{it} (e.g., fuel and lubricating oil, electricity, water, and rented structures and equipment),

$$Y_{it} = K_{it}^\alpha M_{it}^\gamma I_{it}^\varphi \left(A_{it} e^{\rho S_{it} + \delta_1 E_{it} + \delta_2 E_{it}^2} L_{it} \right)^\beta e^{\mu_i} e^{u_{it}}$$

Linearizing, collecting constant terms and rearranging give the final estimation equation,

$$\ln Y_{it} = \alpha \ln K_{it} + \gamma \ln M_{it} + \varphi \ln I_{it} + \beta \ln L_{it} + \beta (\ln A_{it} + \rho S_{it}) + \beta (\delta_1 E_{it} + \delta_2 E_{it}^2) + \mu_i + u_{it}$$

² See Hall and Jones (1999), pp. 87-88.

³ Bils and Klenow (2000) state that these specifications are similar to Mincerian wage equation which links log of individual wage to years of education, years of experience and years of experience squared.

$$\ln Y_{it} = C + \alpha \ln K_{it} + \gamma \ln M_{it} + \varphi \ln I_{it} + \beta \ln L_{it} + \theta E_{it} + \theta E_{it}^2 + \mu_i + u_{it} \quad (9)$$

Where the constant term $C = \beta(\ln A_{it} + \rho S_{it})$, and the parameters $\beta\theta_1 = \theta$ and $\beta\theta_2 = \theta$.

In equation (9) schooling is considered as a constant term since it acts in the same way as TFP (i.e., A_{it}) in governing the shift of the production function. To this effect, we assume that average years of workers' education vary across firms but the variations remain approximately constant over time. That is, there may be a variation in the average years of education between employees working in different firms in a given year, but the variation does not change from year to year. The latter amounts to assuming that workers turnover in a given firm has no or little impact on variability of average years of education over time since the differences in the levels of education among those leaving and joining the firm cancel out.

As documented in many studies, several biases arise when a production function such as equation (9) is estimated using simple ordinary least squares (OLS) method. The biases may result from omitted variables, simultaneity, measurement error, and autoregression. To overcome such endogeneity problems multiple estimation techniques have been proposed in the literature. Examples include fixed effects (FE) estimator (Mundlak, 1961), instrumental variables (IV) (Angrist and Krueger, 2001), semiparametric proxy estimator (Levinsohn and Petrin, 2003), structural identification (Ackeberg et al., 2005), and generalized method of moments (GMM) panel data estimator (Arellano and Bond, 1991). Although there is no consensus in the literature regarding the successfulness of these methods in solving the endogeneity problems, the GMM estimation is probably the most widely used method for dynamic panel models. However, the standard GMM (also known as difference GMM) estimators are found to suffer from weak instrument problem in dynamic panels with high autoregressive coefficient and small time period T . Consequently, an extended version of the standard GMM (known as system GMM) has been proposed to overcome the observed problem (e.g., Blundell and Bond, 1998; Griliches and Mairesse, 1998).

The system GMM appears to be the best alternative estimator in recent studies (e.g., Blundell et al, 2000; Wooldridge, 2001; Levinsohn and Petrin, 2003; Griffith et al., 2006) in providing more reasonable results for dynamic panels with small T and large N (i.e., few time periods and many firms in our case). These studies show that the system GMM improves the estimation results by adding extra moment conditions on the standard first-differenced GMM estimator as it uses the lagged differences of the endogenous variables as instruments. How the system GMM estimators become an improvement over the difference GMM estimators is discussed below.

The standard approach in difference GMM estimation is to first-difference the equation to remove the heterogeneity arising from firm-specific unobserved variables and then instrument the endogenous regressors with their own lagged values in first-differences. However, these lagged levels of the regressors have been found to be weak instruments for the first-differenced variables resulting in poor performance of the difference GMM estimators. The efficiency of these estimators can be increased by adding the levels equations to the first-differenced equations. Since the variables in the levels equations are instrumented with their own first-differences, the lagged first-differences of the levels equations become the additional instruments which result in improving the

performance of the system GMM estimators. This makes the system GMM an extended version of the difference GMM.

To exploit the additional efficiency gains from the extended GMM model, our study employs the system GMM as the main method of estimation. In addition, although the OLS and FE estimators' results are expected to be biased due to endogeneity and measurement errors, respectively, we present estimation results from both methodologies to serve as robustness checks and for comparison purposes.

3. Data and descriptive statistics

3.1 Source of data and definition of variables

The data used in this study are drawn from 2003–2005 Large and Medium (L&M) Scale Manufacturing Industries Surveys conducted by the Central Statistical Authority of Ethiopia (CSA). CSA (2005) defines L&M scale manufacturing industries as establishments, both public and private, which engage ten persons and above and use power-driven machinery and operate in all regions of the country under licenses issued by the Ministry of Trade and Industry and corresponding bureaus of the Regional States. CSA's annual surveys gather basic quantitative and qualitative information relating to the structure and performance of the country's L&M scale manufacturing industries. The variables collected include number of firms, type of ownership, number of proprietors engaged in the manufacturing sector and the main problems they encountered, number of employees, wages and salaries paid by major industrial groups and occupations, hours worked, volume of production and raw materials used, industrial and non-industrial costs, and sizes of fixed assets, paid-up capital, investment and production capacity.

The above three years data are selected for our analyses mainly because they are the latest datasets we have access to and for which we are able to generate the largest panel data. CSA surveyed 622, 635 and 589 manufacturing firms in 2003, 2004 and 2005, respectively.⁴ These constitute the unbalanced panel data, with an average of 615 firms, we use to address the first objective of the study; namely, assessing the structure, distribution and size of L&M scale manufacturing firms. In order to track the changes over the years, we focused on firms that were surveyed for three consecutive years, creating a balanced panel dataset that comprises 360 L&M scale manufacturing firms. This dataset is employed in the regression analyses which investigate the determinants of firms' productivities, the crux of the second objective of the study. We believe that the sizes of the two panel datasets are large enough to enable us generate valid statistical estimates on the distribution and productivity of L&M scale manufacturing firms and make inferences on the structure and performance of Ethiopia's L&M scale manufacturing sector as a whole.

The definitions of the major variables used in the description of the distribution of manufacturing firms in Ethiopia and those employed in the estimation of the production function are given in Appendix A1. To make the variables expressed in monetary terms comparable across time within the country and to those of other countries, we deflate and then convert them to international dollar. We first deflate all

⁴ The figures represent the final number of surveyed firms obtained after dropping those employing less than 10 workers (as per CSA's definition of L&M scale manufacturing firms) as well as those with missing observations.

the values using their respective deflators, which are taken from the World Bank Report and computed using 2000 as base year, to express them in 2005 local currency unit (LCU). Hence, while output, value-added and capital are deflated by the GDP deflator, private consumption deflator is used for material inputs, indirect inputs and wages. Finally, all the variables expressed in 2005 LCU are converted to their equivalent 2005 international dollar values using the 2005 purchasing power parity (PPP) conversion factor for GDP, PPP conversion factor for private consumption, and market exchange rate ratio for wages. Appendix A2 shows the deflators and conversion factors used together with the list of variables on which they are applied. Note that all monetary values in the following sections are expressed in PPP adjusted 2005 international dollar (denoted as 2005 PPP \$). An international dollar has the same purchasing power as the U.S. dollar has in the United States.

3.2 Public and private firms: Characteristics and distributions

Table 1 shows the variations in the distribution of manufacturing firms in Ethiopia viewed in terms of type of ownership, year of commencement and regional distribution of the population. As the country has been experiencing major political and economic changes since 1991, the year the current ruling party (Ethiopian People's Revolutionary Democratic Front, EPRDF) took power, we use 1991 as a reference year for before/after analyses. The survey contains firms that have commenced as early as 1912 and as recently as 2005, the same year the survey was conducted. Overall, nearly 61 percent of the surveyed firms have begun operation after 1991. While only a few public firms have been established after 1991, the number of private firms has more than doubled (123%) over the 15-year period (1991-2005), with an average growth rate of about 8 percent a year. The slow growth of public firms reduces the overall L&M scale manufacturing industry growth rate to an average of 53 percent in 15 years (or 3.5% a year).

The distribution of manufacturing firms is highly skewed when disaggregated by various regions of the country. It should be noted that the disparity in the regional distribution of firms is not a new phenomenon since it is observed both before and after 1991. However, the skewness has become more acute after 1991 as revealed by higher percentage increases in the number of newly established firms in some regions than others. For instance, the 550, 113 and 100 percent net increases in the number of manufacturing firms in Tigray, SNNP and Harari, respectively, in 15 years contrast with the 27 and 0 percent increases in Addis Ababa and Gambella, respectively, for the same time period. Whereas in Afar region only one private manufacturing firm has become operational after 1991, resulting in a 67 percent net decline compared to the number of firms before 1991.

Two important observations can be made based on Table 1. First, the four regions, which are commonly labeled as "under-developed regions" and were and still are the focal points of most political rhetoric, have remained either worse off (e.g., Benshangul-Gumuz and Gambella) or have become marginal beneficiaries (e.g., Somali and Afar) of the post 1991 political and economic environment. Second, the distribution of manufacturing firms does not seem to correspond to the regional distribution of the country's population, which in essence is the primary financier of

private firms as well as major consumer of the firms' products⁵. For instance, the increase in the number of L&M scale manufacturing firms after 1991 ranges from 61 to 113 percent in the three populous regions of the country, Oromia, Amhara and SNNP that constitute nearly 81 percent (i.e., 35, 26 and 20%, respectively) of the country's population. In contrast, in Tigray, a region with only nearly 6 percent of the country's population, the total number of manufacturing firms has dramatically increased from just 4 before 1991 by a sheer 26 after 1991, registering a staggering 550 percent rise within 15 years (or approximately a 37 percent rise per year). Given, the pre-1991 government policies which stifled private investment in the country in general and the 17-year war waged in Tigray region in particular, one may wonder as to what were the sources of private finances in this region to result in such unprecedented percentage change in the number of private manufacturing firms, which surpasses the net percentage increases in other regions of the country combined, except the government's favoritism for the region. It should also be noted that the growth rate of private manufacturing firms in Tigray is higher than the combined growth rates in Oromia, Amhara and SNNP.

On the other hand, relatively low levels of changes are registered in Addis Ababa and Dire Dawa, the two chartered cities categorized as special city administrations due to their metropolitan characteristics and uniquely diverse ethnic compositions.⁶ In both these cities the number of manufacturing firms has risen by 27 and 83 percent, respectively, after 1991 compared to the period before.

Table 1 also shows the density of manufacturing firms per 1 million population. This helps contrast the changes in the number of manufacturing firms to the growth of population in the country over time. Hence, taking into account the change in the size of the population between 1994 and 2005, we can observe that the percentage changes in the number of firms per 1 million populations are lower in the most populous regions. While the number of firms per a segment of population is either marginally rising or declining in a few regions (e.g., Afar and Gambella), it increases at an astonishing rate (457%) in Tigray, a rate approximately four times higher than in Amhara, Oromia or SNNP region.

To further study the regional variations in the distribution of manufacturing firms in Ethiopia, Table 2 disaggregates the L&M scale manufacturing sector by type of manufacturing industries (based on the International Standard Industrial Classification, ISIC). Accordingly, 50 percent of the country's industries constitute manufacturing of food products, beverage and tobacco (29%), furniture (12%), and publishing and printing services (9%). With a share of 8 percent each, manufacturing of tanning and dressing of leather and foot wear, basic metals and fabricated metal products, and non-metallic mineral products make up the second largest group of industries. While all the above manufacturing industries are located in many of the regions of the country, they rarely exist in parts of the country most commonly referred to as "under-developed

⁵ Both would not probably be unrealistic assumptions given the fact that the political system in Ethiopia is ethnic federalism, which was formed by dividing the country into regions delineated along ethno-linguistic lines, and the country's transportation infrastructure is poor. Whereas the former inhibits free inter-region flow of resources (particularly labor and capital) the latter reduces movement of products to major markets in various regions.

⁶ Addis Ababa is also the capital city of Ethiopia.

regions,” namely, Afar, Somalia and Gambella. In addition, excluding the two metropolitan cities, the capital city Addis Ababa and Dire Dawa (which together account for about 62% of the country’s manufacturing industries), the L&M scale manufacturing industries are unevenly distributed in various regions of the country. Notice also that such heavy industries as manufacturing of machinery and equipment, and batteries, motor vehicle bodies, parts and accessories account only for 2 percent of the country’s industries and are located only in selected regions of the country (i.e., Addis Ababa, Dire Dawa, Tigray or Oromia).

Table 2: Regional distribution of firms by type of manufacturing industry

Type of manufacturing industry	Ti gray	Af ar	Am hara	Oro mia	So malie	SN NP	Gam bela	Har ari	Addis Ababa	Dire Daw a	Total	%
Food products, beverages and tob.	8	0	17	45	2	9	0	4	82	9	176	29%
Textile and wearing apparel, ex. fur	2	2	4	0	0	5	1	0	31	1	45	7%
Tanning and dressing of leather and foot wear	1	0	6	9	0	0	0	0	34	0	50	8%
Wood&paper, wood&paper prod.	0	0	0	3	0	1	0	0	11	0	15	2%
Publishing and printing services	2	0	2	1	0	1	0	1	45	2	54	9%
Chemicals and chemical products	1	1	0	5	0	1	0	0	35	0	43	7%
Rubber and plastics products	0	0	0	6	0	0	0	0	34	0	40	6%
Other non-metallic mineral prod.	5	1	3	10	0	10	0	1	19	2	51	8%
Basic metals and fabricated metal products, except machinery & equip.	7	0	4	4	0	2	0	0	33	0	50	8%
Machinery and equipment	0	0	0	0	0	0	0	0	5	1	6	1%
Batteries, motor vehicle bodies, parts and accessories	1	0	0	1	0	0	0	0	5	0	7	1%
Furniture	3	0	10	6	1	18	0	3	33	2	76	12%
Total	30	4	47	90	3	47	1	9	367	17	615	
%	4.9	0.7	7.6	14.6	0.5	7.6	0.2	1.5	59.6	2.8	100	100

Sources: Authors’ computations using panel data constructed from Large and Medium Scale Manufacturing Industries Surveys, Central Statistical Authority of Ethiopia (CSA) 2003-2005. Note: No L&M scale manufacturing industries are reported for Benshangul-Gumuz.

Table 3 presents the distribution of manufacturing firms in the country in terms of the sizes of the firms, measured by their respective share of total output and level of employment. Overall, the manufacturing firms surveyed by CSA and included in this study account for about 86 – 95 percent of the total manufacturing industry output over the period of analysis (2003 – 2005). In this period, the percentage share of the surveyed firms’ output also seems to show a declining trend. Region-wise, only the outputs of firms in Addis Ababa show a significantly increasing trend over time. Focusing on regional variations, firms in Addis Ababa and Oromia account for both the largest number of firms in the survey (75%) and for over 70 percent of the total manufacturing output. Manufacturing firms in Amhara and Tigray regions account for 8 and 5 percent of the surveyed firms, respectively, but the firms in each region contribute 5 – 7 percent to the total industry’s output. The majority (74%) of the surveyed firms in Ethiopia have a very low employment capacity as they on average employ only 10 – 100 workers. It is only 6 percent of the country’s firms that provide employment opportunities for 501 – 3000 employees, the majority of which are located in Addis Ababa. Based on the panel of firms surveyed over the study period (2003 –

2005), the regional variations in capacity utilization and the possible reasons for underutilization are also investigated using Tables 4 and 5. Compared to firms in other regions of the country, those in Tigray appear to be highly capital intensive, followed by firms in Harari (see Table 4). Possible explanations for observing such high capital intensive firms in only these two regions could be that probably these firms are large in size and/or are relatively new as the majority of them have commenced after 1991. In contrast, the low level of capital per firm in the rest of the regions could be an indication of capital constraint resulting in a lower scale manufacturing, or the firms in these regions may be relatively older whose fixed assets have already depreciated over time. However, in terms of production capacity, measured by mean level of output over the survey period, manufacturing firms in Oromia region register the largest mean output, followed by firms in Tigray, Harari and Dire Dawa regions. The mean levels of manufacturing outputs in the rest of the regions (SNNP, Addis Ababa and Amhara) are observed to be very low, paralleling their respective low levels of capital.

Table 4 also presents the analyses conducted based on per unit of employee-hour which emphasize on the size of capital available per employee-hour, the value of output that can be produced by a worker in an hour, the additional value created by a worker in an hour, and the amount a worker receives as compensation for an hour's work.⁷ In this regard, variations are observed among the firms in different regions. Contrary to what is demonstrated above, the firms in Dire Dawa possess distinctively the highest value of capital, output and value-added per employee-hour. However, the firms in Oromia region, whose capital per employee-hour is nearly one-half of Dire Dawa's firms, are the ones that both produce the next highest level of output and create additional value per-employee hour. The firms in Addis Ababa take the third position in terms of the value of output produced and the new value created. The lowest values for these per employee-hour values are registered by firms in SNNP region. On the other hand, in terms of workers' compensation, the above high productivity firms (in Dire Dawa, Oromia and Addis Ababa) take the top ranks by paying in the range of \$1.30 – \$1.50 per hour. These relatively high hourly payments appear to correspond to the skill of the workers in these regions, as measured by their years of experience. Again, both the least paid and experienced workers are found in SNNP region. Furthermore, it should be noted that the highly capital intensive firms in Tigray and Harari are not among the top firms in productivity. The surveyed manufacturing firms reported their respective level of capacity utilization together with the rankings of the possible causes for their below full-capacity production (see Table 5). Taken together, all the surveyed L&M scale manufacturing firms in the country are operating only at about 59 percent of full-capacity production. Overall, the level of capacity underutilization appears to be worse among the private firms than the public ones. Particularly, the worst performers are the public firms in SNNP region and the private firms in Amhara region (at 41% and 49% below full-capacity production, respectively). In contrast, at nearly 89 and 84 percent of full-capacity production, the public firms in Tigray and private firms in Harari, respectively, are the best performers

⁷ For instance, an employee working for "one hour" in one of the firms in Tigray, on average, has \$32.51 worth of capital to work on, produces an output with a market value of \$36.48, creates a new value equal to \$16.47 in the process, and receives \$1.21 for the work performed.

in the L&M scale manufacturing industry. With regards to the causes of underutilization, about 60 percent of the firms (with nearly 15% more public than private firms) in the sample identified ‘shortage of raw materials, spare parts and working capital’ as the first major reason for their capacity underutilization. The proportion of firms that consider ‘difficulty in market competition and lack of market demand’ as the second major reason for operating below full-capacity are about 67 percent (the private firms being the ones most affected by it). Only nearly 20 percent of the firms (more private than public ones) ranked problems related to ‘government rules and regulations’ as the third possible reason for their underutilization. In general, while public firms seem to suffer most from shortage of inputs, spare parts and working capital, problems related to market competition and market demand appear to affect more private firms.

4. Estimation of production functions

The second objective of this study is to investigate if there is any difference in the amount of output produced per worker between publicly and privately owned L&M scale manufacturing firms in Ethiopia, and then identify the factors that influence their respective productivities. For such analyses, we employ a balanced panel dataset comprising 360 L&M scale manufacturing firms observed for three consecutive years (2003 – 2005). We start by showing the differences in productivities between public and private manufacturing firms together with some selected variables identified in the literature as major determinants of the level of production.

4.1. Descriptive statistics of estimation variables. Table 6 shows a stark difference both in the level of production and use of inputs between public and private firms in Ethiopia. Government owned firms seem to employ more inputs and produce more output compared to privately owned firms in Ethiopia. In absolute terms, the publicly owned manufacturing firms produce about \$22 million worth of output per year more than private firms. In terms of productivity (output per employee-hour), the observed differences between public and private firms are not statistically different. While public firms produce, on average, \$52.70 worth of output per employee-hour, private firms produce \$43.10 worth of output per employee-hour. However, this difference is not statistically significant at even 10% level. Statistically significant differences are observed in terms of use of inputs per employee-hour, workers’ years of experience and their remuneration. When it comes to the level of employment, public firms employ 314,000 more workers than private firms. That is more than 4 times the level of employment in the private manufacturing sector. The average wage in the public manufacturing sector is \$2.10 per hour and while the corresponding wage in the private sector is only \$1.21. The wage rate differential may not be surprising if we consider the substantial difference between public and private firms in terms of workers’ years of experience and value-added per employee-hour. In addition, public firms use about 3 and 6 times higher indirect inputs and raw materials, respectively, than private firms. Overall, public firms employ considerably more production resources (K, L, I and M) than private firms, revealing that public firms have more access to these inputs compared to their counterparts. The above discussion shows that public and private manufacturing firms produce different levels of output because they use different levels of factor inputs. Public firms are observed to employ substantially larger quantities of production resources (capital, labor, indirect inputs and raw materials) than private firms. In other words, the private manufacturing firms in Ethiopia can be

considered as starved of inputs. Despite such excessive use of resources by publicly owned firms, the difference in productivity between public and private firms is not considerably large. Statistically speaking, the productivity differential between public and private firms is not significant. This means that with less use of resources private firms are as much productive as public firms which have excessive levels of inputs at their disposal. The next question then focuses on whether the marginal contributions of the per-unit factors of production to the level of productivity are greater in the public or private firms. That is, where does a unit of additional resource produce more output per worker, in the public or private sector? This question can be answered by estimating separately the production functions of public and private firms.

4.2. Estimation results and discussion. This section attempts to identify which factor inputs contribute more to production per unit of labor (i.e., productivity). This can be done by estimating the production function in equation (9). This estimation equation quantifies the marginal contribution of each of the factor inputs to the productivity of public and private firms. In other words, the estimation shows by how much a unit increase in a given factor input raises the level of output produced by a firm per an employee-hour.

Table 7: Estimations of production functions. Dependent variable: Output per employee-hour (in log)

Variables	Public			Private		
	OLS	FE	GMM	OLS	FE	GMM
Capital per employee-hour (in log)	0.0536* (0.0320)	0.0011 (0.0421)	0.0375 (0.130)	0.0888*** (0.0162)	0.0942*** (0.0223)	0.119*** (0.0328)
Indirect inputs per employee-hour (in log)	0.196*** (0.0284)	0.105*** (0.0371)	0.137* (0.0716)	0.106*** (0.0206)	0.0692*** (0.0241)	0.0722** (0.0337)
Materials per employee-hour (in log)	0.450*** (0.0478)	0.436*** (0.0331)	0.603*** (0.121)	0.648*** (0.0245)	0.600*** (0.0244)	0.581*** (0.0532)
Human capital (in log)	0.300*** (0.044)	0.458*** (0.055)	0.223 (0.156)	0.157*** (0.020)	0.237*** (0.033)	0.229*** (0.065)
Experience (in years)	0.150*** (0.0512)	-0.0579* (0.0344)	0.103 (0.104)	0.108*** (0.0232)	0.0262 (0.0287)	0.115*** (0.0262)
Experience squared	-0.00363* (0.00192)	0.00234* (0.00127)	-0.00251 (0.00313)	-0.0036*** (0.00120)	-0.0014 (0.00146)	-0.0036*** (0.0013)
Year dummy (1 if year = 2004)	-0.184*** (0.0388)	-0.131*** (0.0332)	-0.17*** (0.0551)	-0.0195 (0.0257)	0.0121 (0.0260)	-0.00645 (0.0284)
Year dummy (1 if year = 2005)	-0.230*** (0.0542)	-0.0670 (0.0485)	-0.192 (0.130)	-0.00444 (0.0309)	0.0647* (0.0330)	-0.0196 (0.0367)
Constant	-0.522 (0.389)	-0.142 (0.385)	0.0714 (1.350)	0.126 (0.175)	0.0511 (0.235)	-0.376 (0.427)
R-squared	0.850	0.590	-	0.868	0.608	-
Number of firms	99	99	99	261	261	261
Observations	297	297	297	783	783	783
Specification Tests						
CRS test (p-value) ^{††}	0.0893	0.0161	0.0519	0.9087	0.0008	0.2564
Experience (p-value)	0.0000	0.1812	0.4035	0.0000	0.6215	0.0000
AR1			0.023			0.001
Sargan,			15.51			10.60
Sargan df			12			12
Sargan p-value			0.215			0.563

Robust standard errors in parentheses. Significant at *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$ level. All estimations using panel data from Large and Medium Scale Manufacturing Industries Surveys, Central Statistical Authority of Ethiopia (CSA) 2003-2005.

Table 7 presents the estimation results. Based on the discussion in section 2.2, the results from the system GMM estimation are considered as the basic results of this paper. The OLS and FE estimation results are also shown for robustness check and comparison purposes. According to Table 7, only indirect and materials inputs are found to be significant contributing factors to productivity in public owned manufacturing firms. For those public firms, while the use of raw materials substantially increases the level of productivity, the contributions of indirect inputs (fuel and lubricating oil, electricity, water, and rental structures and equipment) are significant only at 10% level. On the other hand, physical capital, human capital (i.e., human capital augmented labor) and workers experience are found to have no marginal contribution at all to the level of productivity of public firms. In addition, the level of productivity of public firms is declining over time between 2003 and 2005.

As discussed in section 4.1, the public manufacturing firms have already been employing higher level of factor inputs compared to private firms. The estimation results in Table 7 further substantiate this fact by showing that hiring more factor inputs (on the already large quantities being employed) would not substantially increase the level of productivity in public manufacturing enterprises. That is, the marginal increase in output resulting from the additional inputs (other than raw materials) would not be large enough to warrant additional investment. For instance, increasing the level of working capital in the existing public firms raises productivity by a very small amount that would not probably justify the investment.

On the other hand, when it comes to private manufacturing firms, all of the production resources (physical capital, indirect and material inputs, human capital and workers experience) are found to significantly increase the level of productivity (see Table 7). That is, using more of these factor inputs increases the per unit level of output at noticeably large amounts. As shown in Table 6, the private firms are employing significantly lower levels of factor inputs compared to the public firms. This has resulted in markedly lower level of production (in absolute terms) in the private L&M scale manufacturing sector. The estimation results in Table 7 reveal that the private firms can considerably increase the level of their productivities (i.e., produce more from a given input) if they employ more factor inputs. The implication of these results is that it is better to direct new investment and labor to the private firms than the public ones. This can be confirmed by calculating the marginal product of capital for both sectors. Following the approach by Göbela et. al., (2011), the marginal product of capital in the private sector is 16.5 percent, while it is 10.1 percent in the public sector during the period under study.⁸ In other words, the private manufacturing sector offers more ‘bang for the buck’ compared to public firms.

5. Conclusion

The number of Ethiopian L&M scale manufacturing sector is dominated by privately owned firms after 1991. However, the few government-owned firms produce most of the outputs. When it comes to regional distribution of these manufacturing firms, we observe considerable variations that are more pronounced after the current government

⁸ Göbela et. al., (2011) calculate the marginal product of capital using a formula $MP_k = \beta * Y/K$, where β is the parameter of capital obtained from the GMM estimation given in Table 7; Y and K are the mean values of output and capital, respectively, shown in Table 6.

took power in 1991. The distribution of manufacturing firms does not follow the distribution of the country's population, which in essence is the primary financier of private firms and consumer of their products. Moreover, the percentage changes in the number of firms per population are lower in most of the populous regions (e.g., Oromia and Amhara) and unjustifiably higher in a few less populous regions (e.g., Tigray). Significant regional variations are also observed in terms of production capacity and capital intensity. Firms in some regions are more capital intensive (e.g., Tigray) while others are starved of capital (e.g., Addis Ababa, SNNP and Dire Dawa). The majority (75%) of the Ethiopian L&M scale manufacturing firms have a low employment capacity as they employ only, on average, 10–100 workers. Only 6% of the country's firms provide employment opportunities for 501–3000 employees.

Categorizing the L&M scale manufacturing firms by ownership, we show that government and privately owned manufacturing firms produce at significantly different levels of output because they employ significantly different levels of factor inputs. Public firms employ more resources and produce higher level of output compared to private ones. However, despite the fact that public firms enjoy a substantial access to factors of production, no statistically significant productivity differential is observed between the two sectors. Finally, we find that publicly owned firms' productivities are affected only by indirect and material inputs. Additional capital, human capital, or experience did not show significant impact on productivity of public firms. On the other hand, all of the factor inputs (physical capital, indirect and material inputs, human capital and workers' experience) we include in our estimation model are found to have significant and positive impacts on the productivities of private firms.

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Table 1: Regional distribution of firms by ownership type, year of commencement, and share of population (2003 – 2005)

Region	Average number of firms by year of commencement						Number of firms per 1 million population			Share of firms (of total in 2005)	Share of population (using 2005 population)
	Before 1991		After 1991		% change (before/after 1991)		Before 1991 (using 1994 population)	After 1991 (using 2005 population)	% change (before/after 1991)		
	Public	Private	Public	Private							
1. Tigray	1	3	0	26	30	650	1.275	7.104	457	4.88%	5.78%
2. Afar	2	1	0	1	4	33	2.829	2.943	4	0.65%	1.86%
3. Amhara	6	12	0	29	47	161	1.301	2.523	94	7.64%	25.50%
4. Oromia	18	13	7	52	90	190	1.655	3.486	111	14.63%	35.34%
5. Somali	0	0	0	3	3	£	0	0.711	£	0.49%	5.77%
6. Benshangul-Gumiz [†]	-	-	-	-	-	-	-	-	-	-	0.84%
7. SNNP ^{††}	5	10	3	29	47	213	1.446	3.244	124	7.64%	19.84%
12. Gambella	1	0	0	0	1	0 [£]	5.499	4.098	-26	0.16%	0.33%
13. Harari	2	1	2	4	9	200	22.876	47.368	107	1.46%	0.26%
14. Addis Ababa	65	97	6	199	367	127	76.678	127.122	66	59.67%	3.95%
15. Dire Dawa	2	4	3	8	17	183	23.822	44.271	86	2.76%	0.53%
Total	102	141	21	351	615	153	4.544	8.419	85	100%	100%

Sources: Authors' computations using data extracted from Large and Medium Scale Manufacturing Industries Surveys, Central Statistical Authority of Ethiopia (CSA) 2003-2005. The 1994 population figures are taken from CSA, Population and Housing Census of 1994 Report, while the 2004 and 2005 population figures are drawn from CSA, 2005 National Statistics (Abstract), Table B. 5-6 and 5-7. [£] Computing percentage changes for Somali region will be misleading since there were no manufacturing firms in the region before 1991 and 3 new private firms were established after 1991. In Gambella region neither public nor private manufacturing firms were ever established. [†] No L&M scale manufacturing industries are reported for Benshangul-Gumiz. A total of 1, 3, and 4 firms are reported for Gambella, Somali, and Afar regions, respectively. These three regions are not included in later calculations due to missing and extreme values. ^{††} SNNP Region denotes Southern Nations, Nationalities and People's Region which was formed from the merge of former Regions 7-11 (i.e., Gurage-Hadiya, Sidama, Wolayita-Kembata, Omo, and Kafa). The region is believed to be composed of about 45 distinct ethno-linguistic groups.

Table 3: Size by share of surveyed firms' total output in total manufacturing output, and by level of employment

Region	% share of surveyed firms' output in total manufacturing industry [†] output			Number of firms employing _____ workers on average						
	2003	2004	2005	10-100	101-300	301-500	501-1000	1001-3000	Total	%
1. Tigray	5.4 %	7.4 %	4.1 %	24	2	1	2	1	30	4.9 %
2. Afar	1.9 %	1.4 %	1.0 %	2	1	1	0	0	4	0.7 %
3. Amhara	5.7 %	5.7 %	5.2 %	35	8	1	1	2	47	7.6 %
4. Oromia	31.0 %	30.1 %	23.1 %	61	18	2	7	2	90	14.6 %
5. Somali	0.02 %	0.01 %	0.1 %	3	0	0	0	0	3	0.5 %
7. SNNP	1.4 %	1.8 %	2.0 %	40	4	1	2	0	47	7.6 %
12. Gambella	0.02 %	-	-	1	0	0	0	0	1	0.2 %
13. Harari	1.8 %	1.5 %	1.3 %	6	2	0	1	0	9	1.5 %
14. Addis Ababa	39.0 %	43.7 %	47.2 %	271	54	24	14	4	367	59.6 %
15. Dire Dawa	2.0 %	2.8 %	1.9 %	13	3	0	0	1	17	2.8 %
Total ^{††}	88.2 %	94.5 %	85.7 %	456	92	30	27	10	615	100 %
				(74 %)	(15%)	(5%)	(4%)	(2%)	(100 %)	

Sources: Authors' computations using data extracted from Large and Medium Scale Manufacturing Industries Surveys, Central Statistical Authority of Ethiopia (CSA) 2003-2005. The 2003-2005 manufacturing industries' GDP data are taken from CSA, 2006 National Statistics (Abstract), Section F –Manufacturing and Electricity Industry, Tables F.2.a and b: Summary of Operations of Manufacturing Industry by Ownership, 2002/2003 - 2004/2005.[†]Manufacturing industry = L&M scale manufacturing + Small scale manufacturing and cottage industry.^{††}Indicates the proportions of total manufacturing output captured by the surveyed firms in the manufacturing industry.

Table 4: Mean values of selected variables disaggregated by region

Regions	Mean values (in 2005 PPP \$)			Per employee-hour values (in 2005 PPP \$)				Employees' experience (years)	Level of employment (L)	Number of firms
	Output (Y)	Capital (K)	Capital per firm	Output (Y)	Capital (K)	Value-added (V)	Wage (W)			
1. Tigray	11,607,990	18,381,750	612,725	36.48	32.51	16.47	1.21	6.4	171	30
3. Amhara	8,011,577	5,567,347	118,454	42.47	35.16	21.17	1.08	5.9	133	47
4. Oromia	20,141,970	7,084,130	78,422	49.48	22.27	25.83	1.30	6.8	160	90
7. SNNP	2,713,475	2,959,018	62,514	14.98	14.75	7.33	0.77	5.1	88	47
13. Harari	11,589,910	10,044,110	1,158,936	20.55	18.14	13.31	1.21	7.8	132	9
14. Addis Ababa	7,958,476	3,208,982	8,744	43.92	26.30	22.96	1.33	7.4	118	367
15. Dire Dawa	9,155,884	2,050,136	123,008	68.40	41.73	33.24	1.50	7.2	207	17

Sources: Authors' computations using panel data constructed from Large and Medium Scale Manufacturing Industries Surveys, Central Statistical Authority of Ethiopia (CSA) 2003-2005.

All computations are based on unbalanced panel data comprising 615 manufacturing firms.

Table 5: Rates of capacity utilization and reasons for underutilization

Regions				Three top reasons for capacity underutilization (% of firms)								
	Output as % of production at full-capacity			1. Shortage of raw materials, spare parts and working capital			2. Difficulty in market competition and lack of market demand			3. Government rules and regulations.		
	Public	Private	Both	Public	Private	Both	Public	Private	Both	Public	Private	Both
1. Tigray	88.5	55.8	57.2	50.0	29.2	30.1	25.0	78.7	76.3	50.0	29.2	30.1
3. Amhara	60.6	49.4	50.8	72.2	46.3	49.6	77.8	70.7	71.6	22.2	26.8	26.2
4. Oromia	66.2	56.2	58.9	70.3	67.5	68.3	45.9	70.6	63.8	24.3	24.9	24.7
7. SNNP	41.4	58.5	55.8	87.0	57.1	62.0	65.2	72.3	71.1	39.1	23.5	26.1
13. Harari	56.5	84.0	72.3	45.5	33.3	38.5	54.5	33.3	42.3	36.4	20.0	26.9
14. Addis Ababa	64.8	60.1	61.0	70.4	57.7	60.1	51.2	69.4	65.8	9.9	16.7	15.3
15. Dire Dawa	65.5	59.1	60.9	57.1	44.4	48.0	64.3	77.8	74.0	7.1	25.0	20.0
Total	62.7	58.5	59.4	70.7	56.0	58.9	52.3	70.1	66.6	17.0	20.3	19.7

Sources: Authors' computations using panel data constructed from Large and Medium Scale Manufacturing Industries Surveys, Central Statistical Authority of Ethiopia (CSA) 2003-2005. All computations are based on unbalanced panel data comprising 615 manufacturing firms.

Table 6: Descriptive statistics of estimation variables

Variables	Public				Private				Difference between means [†]
	Mean	Median	Min	Max	Mean	Median	Min	Max	
Output (Y)	28,971 (4,680)	12,613	95	309,216	7,330 (992.1)	1,581	49	155,295	21,642*** (4,782)
Capital (K)	10,804 (2,379)	2,945	10	277,659	5,278 (1,449)	986	2	384,590	5,526** (2,785)
Employment (L)	400.9 (44.71)	261	11	2,614	87.47 (10.83)	42	10	2,794	313.5*** (45.99)
Indirect inputs (I)	1,794 (745.2)	336	3	74,754	288.8 (127.3)	45	1	40,077	1,506** (756.0)
Materials (M)	6,674 (844.4)	3,425	14	56,840	2,375 (290.6)	483	12	38,820	4,299*** (892.4)
Wages (W)	1,270 (152.2)	716	17	11,520	224 (36.84)	71	3	8,625	1,045*** (156.6)
Output per unit of capital	4.246 (0.539)	2.311	0.078	37.918	4.102 (1.254)	1.018	0.029	643.308	0.144 (1.355)
Output per employee-hour	0.0527 (0.0052)	0.033	0.00021	0.333	0.0431 (0.0029)	0.023	0.002	0.345	0.0096 (0.00593)
Capital per employee-hour	0.0178 (0.0032)	0.007	0.00003	0.273	0.0288 (0.0027)	0.012	0.00002	0.583	-0.0110*** (0.00423)
Indirect inputs per employee-hour	0.00260 (0.0006)	0.00082	0.00004	0.050	0.00123 (0.0002)	0.001	0.00001	0.049	0.00137** (0.000631)
Materials per employee-hour	0.0150 (0.0018)	0.008	0.00003	0.147	0.0160 (0.0013)	0.008	0.00010	0.197	-0.001 (0.00225)
Value-added per employee-hour	0.0312 (0.0032)	0.018	0.00008	0.211	0.023 (0.0015)	0.012	0.0003	0.241	0.0087** (0.00348)
Wage per employee-hour	0.00210 (0.0001)	0.00180	0.00033	0.01118	0.00121 (0.0001)	0.00097	0.00014	0.00926	0.0009*** (0.000137)
Hours per week	40.20 (0.0924)	40	40	50	40.14 (0.134)	40	20	55	0.06 (0.162)
Experience (yrs)	10.2 (0.317)	9.7	2.8	22.5	7.0 (0.157)	6.5	1.1	19.7	3.2*** (0.354)
Number of firms	99				261				
Observations	297				783				

Sources: Authors' estimations using panel data constructed from Large and Medium Scale Manufacturing Industries Surveys, Central Statistical Authority of Ethiopia (CSA) 2003-2005. The monetary values are in '000 of 2005 international PPP. [†] t-test for differences between the means, public vs. private. Significant at *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$ level.

Appendix A1: Definition of variables

Variable	Definition
Output (Y)	Total sales value + difference in inventory of semi & finished goods (end minus beginning period) + difference in inventory of raw materials (end minus beginning period).
Capital (K)	Total book value of fixed assets at the end of the year.
Employment (L)	Total number of permanent employees, administrative and production workers.
Indirect inputs (I)	Value of fuel and lubricating oil + value of electricity + value of water consumed + rental values for structures and equipment.
Materials (M)	Total value of raw materials consumed, local and imported.
Wages (W)	Total wages + commission, bonuses, professional and hardship allowances + cost of the firm on food, lodging, medical and other benefits provided + firms' contribution on behalf of employees to pension, life and casualty insurance.
Valued-added (V)	Output minus materials and indirect inputs.
Hours per week	Number of hours worked per week, determined based on hours worked per day.
Employee-hours	Number of hours worked per year per employee, estimated using hours per week and number of months the firms are in operation per year.
Output per unit of capital	Output divided by capital.
Output per employee-hour	Output divided by employee-hours, gives the dollar value of output produced by a worker in an hour.
Capital per employee-hour	Capital divided by employee-hours, captures the size of capital available per worker in an hour.
Indirect inputs per employee-hour	Indirect inputs divided by employee-hours, captures the size of indirect inputs a worker can use in an hour.
Materials per employee-hour	Materials divided by employee-hours, captures the size of raw materials at the disposal of a worker in an hour.
Value-added per employee-hour	Value-added divided by employee-hours, gives the dollar value of additional value created by a worker in an hour.
Wage per employee-hour	Wages divided by employee-hours, captures the dollar amount a worker receives in an hour.
Experience (years)	Years of employees' experience in the manufacturing firms, imputed using the information on salaries paid to workers in different salary categories.

Appendix A2: Deflators and conversion factors

Deflators/Conversion factors	2003	2004	2005	Variables deflated or converted
GDP deflator	102.43	106.44	116.95	Y, V, K
Private consumption deflator (or CPI)	101.18	109.90	117.42	M, I, W
Market exchange rate (Birr per US\$, period average)	8.60	8.64	8.67	-
PPP conversion factor for GDP	2.10	2.12	2.25	Y, V, K
PPP conversion factor for private consumption	2.53	2.55	2.75	M, I
Market exchange rate ratio	0.24	0.25	0.26	W

Source: The World Bank, International Comparison Program database, 2000 – 2005.

Notes: The PPP conversion factor is the number of LCU (Ethiopian Birr) required to buy the same amounts of goods and services in the domestic market as a U.S. dollar would buy in the United States.

The PPP conversion factor for private consumption (i.e., household final consumption expenditure) is the expenditure in LCU (Ethiopian Birr) per international \$.

The market exchange rate ratio (or the national price level) is obtained by dividing the PPP conversion factor for GDP by the official market exchange rate.

Appendix A3: Justification for CRS restriction

Public firms: estimation coefficients. Dependent variable: *lypl*

Variables	OLS		FE		GMM	
	Restricted : CRS=1	Unrestricted	Restricted : CRS=1	Unrestricted	Restricted : CRS=1	Unrestricted
<i>lkpl</i>	0.054*	0.022	0.0011	-0.029	0.038	0.070
<i>lipl</i>	0.196***	0.132***	0.105***	0.054	0.137*	0.392
<i>lmpl</i>	0.450***	0.439***	0.436***	0.404***	0.603***	0.434***
<i>lhpl</i>	0.300***	0.589***	0.458***	0.380***	0.223	0.963***
Sum	1.000	1.182	1.000	0.808	1.001	1.507
CRS test (p-value)		0.0893		0.0161		0.0519
Decision		Reject CRS=1 at 10% level		Reject CRS=1 at 5% level		Reject CRS=1 at 10% level

Note: *lypl*, *lkpl*, *lipl*, *lmpl* and *lhpl*: log of output, capital, indirect inputs, materials and human capital per employee hour, respectively.

Private firms: estimation coefficients. Dependent variable: *lypl*

Variables	OLS		FE		GMM	
	Restrict d: CRS=1	Unrestricted	Restrict d: CRS=1	Unrestricted	Restrict d: CRS=1	Unrestricted
<i>lkpl</i>	0.089***	0.080***	0.094**	0.080***	0.199***	0.117***
<i>lipl</i>	0.106***	0.098***	0.069***	0.064***	0.072**	0.070*
<i>lmpl</i>	0.648***	0.637***	0.600***	0.587***	0.581***	0.577***
<i>lhpl</i>	0.157***	0.182***	0.237***	0.108**	0.229***	0.029
Sum	1.000	0.996	1.000	0.839	1.000	0.793
CRS test (p- valu e)		0.9087		0.0008		0.2564
Deci sion		Fail to reject CRS=1 at 10% level		Reject CRS=1 at <1% level		Fail to reject CRS=1 at 10% level

Note: lypl, lkpl, lipl, lmpl and lhpl: log of output, capital, indirect inputs, materials and human capital per employee hour, respectively.