The Determinants of Total Factor Productivity in Ethiopian Large and Medium Sized Manufacturing Firms

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Abstract: This paper examines the determinants of total factor productivity (TFP hereafter) using a panel of firms in Ethiopia. The data is obtained from the annual census data of medium and large scale manufacturing firms in Ethiopia which is collected by the Central Statistical Service (CSS). we use a classic model of Levinsohn and Petrin to recover an estimate of TFP and then run a separate regression using fixed effect, random effect and SYS-GMM models to assess the determinants of firm-level TFP. The results reveal that openness to the international market; skill intensity; private ownership and employee incentives have statistically significant and positive impact on firm-level TFP. On the other hand, bank loan has a significant and negative effect on firm-level TFP. Thus, policies that encourage openness and privatization enhance productivity. On the other hand, revising the bank lending approaches so as to reduce the effect of adverse selection is crucial.

Key words: Manufacturing Firms; TFP; Semi-parametric approaches; Ethiopia.

JEL Classification D24 . O14

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1. Introduction

Most empirical literature on firm-level productivity emphasizes the crucial role of total factor productivity (TFP) for firm survival, growth, expansion, and gaining competitive advantages. As such, productivity is regarded as the most important factor for long-run economic growth (Easterly and Levine, 2001; Klenow and Rodriguez-Clare, 1997). Ethiopia is an open economy in eastern Africa that strives to achieve industrialization. Within the framework of the successive country's five year development plans including Plan for Accelerated and Sustained Development to End Poverty (PASDEP), : Growth and Transformation Plan I (GTP I) and Growth and Transformation Plan II (GTP II), the expansion and development of the manufacturing sector has systematically been a key strategic priority. This urge for industrialization through the development of more labor and material intensive manufacturing sectors and pursuing export promotion policy is mainly driven by the ambition of achieving the goal of becoming a lower middle income country in 2025 (Tekleselassie et al., 2018).

Recent empirical findings show the existence of widespread variation in productivity across manufacturing firms (Bloom and Van Reenen, 2010; Syverson, 2011; Foster et al., 2016; Restuccia and Rogerson, 2017). Such large TFP variation is also observed in studies conducted on Ethiopian manufacturing firms. For example, (Abegaz, 2013) in his study of technical efficiency and TFP in the Ethiopian manufacturing firms using stochastic frontier model finds wide dispersion (at least 14 percent output variation) of efficiency and TFP levels among manufacturing firms. Other studies such as (Bigsten and Gebreeyesus, 2009; Siba and Gebreeye-sus, 2016; Tekleselassie et al., 2018; Abebe et al., 2018) confirm the existence of large variations in measured productivity of the manufacturing firms. Hence, the findings of the aforementioned authors further suggest a need for more comprehensive study of what explains such productivity differences among firms.

The aim of this paper is to examine the determinants of TFP in the large and medium manufacturing firms. To this end, this paper seeks answers to the question what determines firm-level productivity? In the quest for searching answers for the most pressing question above, this paper, unlike other studies on issue of productivity in the case of Ethiopian manufacturing firms, uses the state of the art methods for production function estimation and for the prediction of productivity developed by (Olley and Pakes, 1996) and further extended by (Levinsohn and Petrin, 2003).

For the analysis of the determinants of firm-level TFP in Ethiopian manufacturing sector, we use several firm level characteristics variables. Indeed, different studies use different variables as a determinant of firm level productivity which arguably indicates the absence of any accepted theory on the determinants of firm-level TFP. However, several studies on firm-level determinants of TFP and common sense suggest various variables which could influence firm TFP. Accordingly, in the context of Ethiopia, a few studies have been conducted in terms of explaining

the determinants of productivity of the manufacturing firms. These studies have focused on (i) ownership, firm size and export (Tekleselassie et al., 2018) using one year data and based on OLS estimation, (ii) educational status of workers and ownership (Abebe et al., 2018) using non parametric (index number approach) and regression residual parametric approach (trans log production function) on primary data in metal working industry and (iii) export (Bigsten and Gebreeyesus, 2009; Siba and Gebreeyesus, 2016) using system GMM, as the most crucial factors determining firms' TFP. While much has been learned from the previous literature, there is still a need for more comprehensive and dynamic analysis of the determinants of TFP of manufacturing firms in Ethiopia.

This study aims to contribute to bridge the existing gap in the literature by analyzing the determinants of productivity of the manufacturing firms in Ethiopia using 25 years long firm level data with the inclusion of some additional variables which are expected to impact the productivity of the firm such as liquidity (Credit), export status, ownership, employee incentives, quality of labor, foreign direct investments, etc. From a methodological point of view, this study, unlike other studies on the issue of Ethiopian manufacturing firms, uses the semi-parametric approach developed by (Olley and Pakes, 1996) and further extended by (Levinsohn and Petrin, 2003) that takes into account the simultaneity problem in the estimation of the production function. Besides, for additional robustness check in analyzing the determinants of productivity, we also use the SYSTEM-GMM approach side by side with the fixed effect and random effect methods. The results of the study revealed that privately owned firms are more productive compared to state owned firms. Currently, almost 77 percent of the manufacturing firms in Ethiopia are privately owned. With regard to openness, we find strong and positive correlation between firm-level TFP and exporting. However, only a few numbers of manufacturing firms in Ethiopia (6 percent) are currently engaging in exporting.

The structure of the paper is as follows. The next section presents a brief review of the empirical literature. In section 3, we present the data and briefly discuss the estimation strategy for the production function and the analysis of the determinants of TFP. In section 4, we present the result and discuss the main empirical findings. Section 5 concludes.

2. Empirical Literature

Recent empirical studies revealed that one of the significant findings in the productivity literature on manufacturing firms is the existence of widespread variations in productivity across firms (Bloom and Van Reenen, 2010; Syverson, 2011; Foster et al., 2016; Restuccia and Rogerson, 2017). (Abegaz, 2013) in his study of technical efficiency and TFP in the Ethiopian manufacturing firms, finds wide dispersion of efficiency and TFP levels among firms. (Bigsten and Gebreeyesus, 2009; Siba and Gebreeyesus, 2016; Tekleselassie et al., 2018; Abebe et al., 2018) find evidence

of substantial TFP variations among firms in the manufacturing sectors. This initiates the question of what explains such productivity differences among firms.

Moreover, most of the literature about TFP and its determinants first focuses on the methodological issues that arise when estimating TFP at firm level, particularly the simultaneity problem. This is because applying Ordinary Least Squares (OLS) to a panel of firm level datasets introduces the simultaneity bias as productivity (which is observed by the firm but not by the econometrician) and the level of input choices are likely to be correlated. This makes the error term correlated with the explanatory variables and the OLS estimates biased (Olley and Pakes, 1996; Levinsohn and Petrin, 2003; Van Beveren, 2012; Del Gatto et al., 2011).

A good estimation technique that overcomes the methodological issues when estimating productivity, a deeper understanding of its sources and determinants of productivity is therefore crucial to identify areas of intervention which could enhance the productivity of the manufacturing firms in Ethiopia.

In response to these methodological issues, several estimators have been proposed by scholars in the literature including fixed effects, instrumental variables, semi parametric estimators, SYSTEM-GMM, etc. However, the choice of one method over the others entirely depends on the availability of data, the aim of measuring productivity and the assumptions that the author is willing to make.

A fixed effect estimation approach reduces the firm specific and time variant unobserved effect (TFP) as a firm specific but time invariant unobserved effect in order to mitigate the simultaneity bias. This approach takes account of firm heterogeneity but neglects the temporal dimension. According to (Del Gatto et al., 2011) there are three circumstances that make the fixed effect approach not fully satisfactory as a measure of TFP. The first one is that the within estimator uses only the variations across time leaving a conspicuous part of the cross-sectional information unexploited. Second, the assumption that the unobserved TFP is constant overtime seems to be too strong a restriction. Finally, unlike the macro setting with typical micro data sets this estimator is consistent only under strict exogeneity assumption.

The solution to these problems relies on the identification of a proxy variable that reacts to the changes in the TFP observed by the firm and is therefore a function of it. Given the function is invertible; its inverse is calculated and plugged into the estimating equation before proceeding to estimate the production function parameters. The function of using a proxy variable method is to recover the productivity component by the traces it leaves in the observed behavior of the firm. This approach was first proposed by (Olley and Pakes, 1996) using investment as a proxy and has been extended by (Levinsohn and Petrin, 2003) to the use of the intermediate inputs.

Similarly, the literature focusing on the determinants of TFP over time provides various factors affecting the TFP of the firm using firm level data sets. Yet, few

previous studies pay attention to the methodological approach adopted and the compositions of variables used in the model to study the determinants of TFP, especially in the context of developing country. In what follows we discuss, based on previous works, the main factors affecting productivity.

(Javorcik, 2002) based on firm level analysis of the relationship between Foreign Direct Investment (FDI hereafter) and productivity using data from Lithuania produces evidence consistent with positive productivity spillovers from FDI taking place through contacts between foreign affiliates and their local suppliers in upstream sectors (that is through backward linkages). The results also indicate that spillovers are associated with projects with shared domestic and foreign ownership but not with fully owned foreign investments. The study reveals that a one standard deviation increase in the foreign presence in the sourcing sectors (that is an increase of 4 percentage points in the backward variable) is associated with a 15percent rise in output for each domestic firm in the supplying industry.

(Ding et al., 2016) examines TFP and its determinants in China using firm level data over the period 1998 to 2007. The results show that the average TFP growth in Chinese industries is 9.6 percent per year. The results indicate increasing returns to scale in a majority of industries and a large positive time trend representing technical changes. The results also confirm that younger firms, firm fixed costs, liquidity, agglomeration spillovers (for 18 out of 26 industries), diversification (except for tobacco industry and electronic power), private ownership (except for medical, electronic power and water production), foreign ownership, high working capital and firms with no political affiliation (except for gas and water production) are found to have higher TFP. Likewise, state ownership, R and D, and export (for 17 out of 26 sectors) are found to have adverse effect on TFP. However, based on a cross sectional sample of Chinese industrial sectors, (Liu and Wang, 2003) found that foreign presence, the level of R and D and firm size are the most important factors enhancing TFP in Chinese industries.

Recent literature argues on the causal relationship between international trade (export) and TFP (that is self-selection versus learning by exporting). The first strand of literature argues that due to the higher required productivity threshold to be able to enter the export market, only the most productive firms self-select into exporting. See for example (Roberts and Tybout, 1997; Bernard and Jensen, 1999). On the other hand, the learning by exporting literature claims that firms can improve their productivity because of entering the international market and exploit economies of scale by coping with the competitive pressures on them (Clerides et al., 1998; Delgado et al., 2002). Still some studies have found evidence of both self-selection and learning by exporting as determinants of TFP growth (Fernandes and Isgut, 2005) for Colombia and (Van Biesebroeck, 2005) for Sub Saharan Africa. (Bigsten and Gebreeyesus, 2009) studied the causal relationship between firm productivity and export for Ethiopian manufacturing sector using firm level panel data and find a strong relationship

between firm productivity and export. They concluded that export shifts the production function by 15 percent to 32 percent and exporting firms pay higher wages, have more workers and have more capital per worker. (De Loecker, 2007) studied the effect of exporting on productivity and finds that exporting firms received higher productivity gains than non-exporting firms.

Generally, the literature so far provides mixed evidence on the role of international trade (export and import) as a determinant of firm productivity growth. While the relationship between export and TFP is another potential research area that needs further investigation, in this paper we only focus on the relationship between firm participation in the international market and TFP.

(Tekleselassie et al., 2018) investigates the productivity determinants of medium and large firms in the textile and garment manufacturing sector in Ethiopia using census data. Their results reveal that while the elasticity of output to capital input is weak, labor and material inputs drive firm level outputs due to the labor and material intensive nature of the textile and garment manufacturing sectors. They also find that human capital, agglomeration effects and incentive systems are core drivers of productivity. However, their work is based on OLS estimates and focuses only on garment and textile manufacturing sectors.

The idea that credit promotes productivity is common sense among entrepreneurs and policy makers. Credit allows many productive firms to expand or make technological improvements and investments needed to increase their productivity beyond what their internal funds can support. In this regards, many empirical findings also suggest that a more efficient use of bank loan leads to higher returns and productivity levels (Gatti and Love, 2008; Nickell and Nicolitsas, 1999; Villalpando, 2014). (Gatti and Love, 2008), investigates whether access to credit improves productivity using data from Bulgarian firms and finds a significant and positive association between credit and TFP. Similarly, (Villalpando, 2014) studies the effect of bank loan on productivity based on a survey of Mexican firms and confirms the positive effect of bank loan on firms' productivity. The coefficient estimates for the bank loan is positive and statistically significant at the 1 percent level. The result also supports the hypothesis that bank credit enhances the productivity of the firms with investment opportunities. (Stiglitz and Weiss, 1981) analyses adverse selection and incentive effects in the credit market. Based on the assumptions that borrowers are subject to limited liability and lenders cannot distinguish borrowers of different risks, they show that a bank that raises its interest rate may suffer adverse selection due to the fact that only risky borrowers will be willing to borrow at the higher interest rate. They also indicate that a rise in collateral requirement leads to a decrease in the expected return on loans resulting in a credit rationing equilibrium.

3. Data and Empirical Methodology

3.1. Data

The data source for this study is the annual census data collected for the large and medium manufacturing firms by the Central Statistical Service of Ethiopia (CSS)[3] from 1996 to 2020. The manufacturing firm-level data covers large and medium establishments which have 10 and above employees and use power driven machines and of both public and private industries in the country. The data set provides basic information about the firm such as gross value of production, total sales value, export, total value of raw material, electricity, total wage paid and etc. It also provides beginning of the year capital and end year capital stock for each firm and year. Hence, for the sake of consistency in this study we constructed a new capital stock series for use throughout the analysis for each firm by taking the average of the beginning and the end year capital stock.

Appendix table A1 provides the summary statistics and a short description of the variables used in the estimation of the production function and thus the prediction of TFP which in turn is used to examine the determinants of TFP. The data set used in this analysis contains an unbalanced panel of manufacturing firms with a total of 23,331 firm-year observations. The average of the logarithm of the gross value of production is 15.04 and varies from a minimum of 6.8 to a maximum of 21.45. The variables used in the first stage of the estimation include total value of production, labor, capital, raw materials and energy (as well as investment used as a proxy in the (Olley and Pakes, 1996) estimation method) which is used to check the robustness of the (Levinsohn and Petrin, 2003) estimation method. Almost 77 percent of the manufacturing firms in Ethiopia are privately owned. Only 6 percent of the manufacturing firms in Ethiopia are exporters. The variables used in the estimation of the determinants of TFP include the following: FDI is a dummy variable that takes a value of 1 if there is foreign paid up capital in the firm, zero otherwise. Incentive is the sum of all benefits that the employee gets from the firm. Ownership is a dummy variable that takes the value one if the firm is privately owned; zero otherwise. Export and import capture the extent of foreign market participation. It is measured by a dummy variable which takes the value 1 if the firm is exporting, zero otherwise. Import represents the total value of imported raw materials. It takes the value of 1 if the firm imports, zero otherwise.

3.2. Empirical Methods for TFP Estimation and Its Determinants

The aim of this study is to estimate firm-level TFP using semi-parametric methods and to analyze the determinants of TFP in Ethiopian large and medium

[3] Because of the change in data coding system by Central Statistical Service (CSS) starting from 2011 on wards, the original data set does not have firm ID which the researcher corrected using establishment number of the firms and the 2-digit International Standard Industrial Classification (ISIC) as suggested by the statistical office of CSS

manufacturing firms. For this purpose, first, TFP is estimated using the (Levinsohn and Petrin, 2003) approaches. Next, the factors determining TFP are examined using alternative methods. Hence, the following production function in logs is used:

$y_{it} = \beta_o + \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_e e_{it} + \omega_{it} + \eta_{it}$ ..... (1)

In (1) y_{it} is the logarithm of the firm's output measured as the gross value of output, the three free variables l_{it}, m_{it} and e_{it} are the logarithms of the values of firm i's costs of labor, materials and energy in period t respectively. k_{it} is the value of firm i's costs of capital in period t and is a state variable in the model. β is a vector of input elasticity of firms. ω_{it} represents firm i's TFP in logs in period t while η_{it} denotes either a measurement error or a shock to productivity that is not forecast-able during the period in which labor and materials can be adjusted. Both ω_{it} and η_{it} are unobserved. The difference between ω_{it} and η_{it} is that ω_{it} is a state variable in the firm's decision problem and hence impacts the firm's decision rules concerning input demand, while η_{it} has no impact on the firm's decisions. The value of ω_{it} can be recovered by estimating the vector of coefficients, estimating the fitted value of firm i's output, and computing TFP as the difference between the actual and the fitted value of output.

Estimating equation (1) using OLS is biased due to the endogeneity that stems from the fact that information available on ω_{it}, although unknown to the econometrician, is commonly used by the firm in its decision about input choices. This is because OLS method requires that the inputs in the production function are exogenous in the sense that inputs are determined independently from the firms' efficiency level. According to (Griliches and Mairesse, 1995) and an earlier study by (Marschak and Andrews, 1944), inputs should be considered endogenous since they are chosen by the firm based on its productivity which is observed by the firm but not by the econometrician which in turn leads to a correlation between the level of input chosen and unobserved productivity shocks. This positive correlation between ω_{it} and inputs used in period t will cause an OLS estimation that does not take into account the unobserved productivity differences to provide upwardly biased estimates of the coefficients on variable inputs.

Because this paper focuses on firm level TFP and its determinants, the consistency of parameter estimates is very important. Keeping this in mind, this paper employs the semi parametric estimation procedure proposed by (Levinsohn and Petrin, 2003). This approach was first developed by (Olley and Pakes, 1996) using investment as a proxy variable for unobserved productivity and further extended by (Levinsohn and Petrin, 2003) using intermediate inputs as a proxy variable. These methods allow for firm specific productivity difference exhibiting idiosyncratic changes over time.

One of the main advantages of the (Levinsohn and Petrin, 2003) estimator over (Olley and Pakes, 1996) is that in the later case the investment proxy is only valid for plants reporting non-zero investment. This is because the monotonicity condition in (Olley and Pakes, 1996) requires that investment is strictly increasing in productivity.

However, practically, most firms in our sample report zero investment in their balance sheet. Thus, a large number of observations fall out of the estimation which treats the possibility of inverting the investment function. Besides, if the presence of those zeros is due to adjustment costs, the exclusion of the relevant observations leads to significant truncation bias (Levinsohn and Petrin, 2003; Van Beveren, 2012; Del Gatto et al., 2011). (Levinsohn and Petrin, 2003) used intermediate inputs rather than investment as a proxy since firms typically report positive use of materials and energy in each year. In this way, it is possible to retain most observations which also imply that the monotonicity condition is more likely to hold. Refer to (Levinsohn and Petrin, 2003) for the detailed theoretical framework of this approach.

Once equation (1) is estimated using (Levinsohn and Petrin, 2003) approach and having the coefficient estimates on hand, we predicted the log of firm-level TFP as follows.

$$\omega it = \hat{y}_{it} - \hat{\beta}_l l_{it} - \hat{\beta}_k k_{it} - \hat{\beta}_m m_{it} - \hat{\beta}_e e_{it} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (2)$$

In addition to the (Levinsohn and Petrin, 2003) approach, we estimate equation (1) using (Olley and Pakes, 1996; Wooldridge, 2009) and OLS to check the robustness of the (Levinsohn and Petrin, 2003) method using our data. Once TFP is predicted, the series of values constructed from the estimates can be used to further examine the determinants of TFP of the manufacturing firms using the following regression model:

$\omega_{it} = \alpha + \beta_1 Export_{it} + \beta_2 Import_{it} + \beta_3 FDI_{it} + \beta_4 lnSkill_{it} + \beta_5 wner_{it} + \beta_6 lnIncentive_{it} + \beta_7 Loan_{it} + \mu_i + U_{it}$ .....(3)

Where ω_{it} represents the log of firm-level TFP obtained from the (Levinsohn and Petrin, 2003) method, μ_i captures industry specific effects and U_{it} is the random error term and in all cases i denotes industry and t denotes time. It is obvious that in studies such as this, it is not possible to select variables for sure that determine firm-level TFP since there is not an accepted theory of what determine the TFP of the firm. As a result there is no generally accepted set of variables to include. However, previous literature and common sense suggest some variables such as exporting status, import and foreign direct investment (FDI) to be included to test the possible relationship with the TFP of manufacturing firms in Ethiopia. These variables can explain the degree of openness and foreign spillover towards the manufacturing firms in the country. Other variables like skill intensity, ownership, employee incentives and credit status of the firm are also included.

4. Results and Analysis

4.1. Production Function Estimation

Table 1 presents the estimated input elasticity using the (Levinsohn and Petrin, 2003; Olley and Pakes, 1996; Wooldridge, 2009), and OLS estimation methods. The average TFP predicted from the above methods are 3.42, 2.34, 3.73 and 0.052, respectively. Although comparison of different methods are not the main focus of this paper, checking the results of one chosen model against other competing models

provides confidence in interpreting and analyzing the estimation results. Appendix table A2 shows sector by sector estimation of production function and the variation at firm-level average TFP using the (Levinsohn and Petrin, 2003) method. Accordingly, textile and garment, tobacco, chemical and chemical products, non metalic minerals, paper and paper products, and furniture manufacturing are relatively the most productive sectors with the average productivity of 5, 4.5, 3.6, 3.4, 3.1 and 3, respectively. This indicates the existence of productivity variations in Ethiopian manufacturing firms. This variation in TFP estimates is more pronounced when we see across the different industries. For instance, the average TFP ranges from a low of 0.09 in manufacturing of motor vehicles to a high of 5 in textile and garment.

Table 1 reveals the elasticity of inputs obtained using the above mentioned alternative methods with their corresponding standard errors. As it is clearly shown, the values of the inputs elasticity obtained using different methods are not significantly different from one another except for the OLS regression which overstates the coefficient estimates of the variable inputs. The result indicates that by all measures the manufacturing firms in Ethiopia exhibit decreasing returns to scale, except for OLS approach. Indeed, our sector by sector estimation result (in Appendix table A2) confirm that most of the manufacturing firms exhibit decreasing returns to scale except for manufacturing of motor vehicles and manufacturing of rubber and rubber products which exhibit nearly increasing returns to scale.

The elasticity of total value of production to all the inputs is significant and positive which justifies that labor, capital, material and energy are crucial elements in the estimation of the production function. Using the (Levinsohn and Petrin, 2003) approach, the logarithm of Labor, capital, material and energy are significant at 1 percent significance level with positive coefficient of estimates. The estimates from alternative approaches also show the same pattern, which confirms the robustness of the result. Among the variables the coefficient estimates of total raw materials is higher followed by the coefficient estimates of labor. This is also true for sector by sector estimation (in Appendix table A2) except for manufacturing of basic iron and steel for which the coefficient estimates of capital is higher than both labor and material. Given the higher capital requirement for such large manufacturing firm the higher value of capital coefficient is not a surprise. On the other hand, for manufacture of tobacco only the material coefficient is significant. This might be because of the small number of firms in the sector.

The implication of the result for Ethiopia which is a labor abundant and capital scarce country (in this regard the implication could easily be extended to other countries with similar context) is that the highest contribution of the labor force is a very important news and indicates that the manufacturing sector still has the potential for absorbing more labor force by creating employment opportunities. As a result, manufacturing firms are part of the solution for the existing higher level of unemployment in the country.

Table 1: Production Function Estimation

	(LP)	(OP)	(WRDG)	(OLS)
Dep. Variable	lnGVP	lnGVP	lnGVP	lnGVP
lnWage	0.203***	0.218***	0.190***	0.317***
	(0.008)	(0.009)	(0.009)	(0.005)
lnEnergy	0.087***	0.086***	0.101***	0.064***
	(0.005)	(0.006)	(0.007)	(0.004)
lnK	0.074***	0.080***	0.111***	0.100***
	(0.018)	(0.016)	(0.012)	(0.004)
lnTVRM	0.499***	0.555***	0.443***	0.624***
	(0.019)	(0.009)	(0.023)	(0.004)
Avg. log TFP	3.42	2.34	3.73	0.052
RTS	0.86	0.94	0.85	1.11
N	21051	16133	7350	21051
R-squared				0.997

Source: Author's computation using CSS Medium and Large scale manufacturing data. Standard errors in parentheses. Asterisks indicate significance at*10%,**5%,***1% level. lnGVP represent log of gross value of production.

4.2. Determinants of Total Factor Productivity

The results from the estimation of the different versions of equation (3) are presented in table 2. Identifying the key factors that are responsible for TFP variation among manufacturing firms is a crucial goal that could be used as an input for policy purposes. Hence, this is a comprehensive analysis of the various determinant factors of firm-level TFP. In estimating equation (3) we use a bootstrap approach to construct valid standard error due to the fact that TFP is used as a dependent variable in the second stage. The estimated coefficients are the marginal effects of the explanatory variables on the log of TFP. The first column shows all the explanatory variables. The second column shows the result of the preferred (using a Hausman test of specification) fixed effect regression model with their respective t values in the parentheses. The third column shows the alternative panel regression result of the random effect model with their respective z values in the parentheses. To further check the robustness of the results obtained from the fixed effect and random effects models, we estimate a dynamic version of equation (3) using the SYSTEM - GMM approach and the result is presented in the fourth column.

The result shows that exporting dummy, importing dummy, being a private firm, employee incentives, skill intensity and the credit status of the firm are significant determinants of firm productivity. As it is supported by the international trade theory and backed by most empirical literature, openness to the international market is one of the most important factors affecting firms TFP. In this paper, openness to the international market is captured by two dummy variables expressing the exporting and importing status of the firm. The results of the study obtained from the fixed effect estimation shows that exporting firms are more productive than non-exporting firms, as the exporter dummy coefficient is statistically significant and positively related to firm-level TFP at 1 percent level of significant. The exporter dummy coefficient shows that exporting firms are 4 percent more productive than non-exporting firms. As indicated by literature in the field, (see for example (Fernandes and Isgut, 2005; Van Biesebroeck, 2005; Damijan et al., 2009; Damijan and Kostevc, 2006)) on the link between exporting and productivity, this variation can be explained either through self-selection or learning by exporting which needs further investigation as it is another potential topic worth studying. Figure 1 shows the distribution of TFP for exporting and non-exporting firms. As the figure shows a higher distribution of firm-level TFP is observed for exporting firms. It shows that exporting firms are more productive than their counterpart domestic, non-exporting firms as more concentration of firms is observed to the right of the distribution. However small in numbers (only 6 percent of firms in Ethiopia are exporters), exporting firms may indeed play a significant role in terms of absorbing the existing large number of unemployed people in the country. The average number of employees for the exporter firms (280 employees) is higher than for non-exporter firms (51 employees). They pay higher wages too. The average wage of exporting firms are almost 4 times higher than non- exporting firms which enables them to reduce the turnover of highly skilled employees in the firm.

Importer dummy is significantly and positively related with firm-level TFP at 1 percent significant level. Firms that use imported raw materials are more productive which might be an indication of the benefits of technological know-how and technical expertise (or knowledge spillover) and the quality of inputs associated with the imported raw materials. Yet, firms in Ethiopia are constrained by the shortage of foreign currency (like dollar and euro) which leads to foreign currency rationing based on among other things the importance of the sector for social and/or economic development.

In sum, the positive and significant relationship between greater trade openness and productivity can be explained by the fact that more open economies can benefit from the technological diffusion, international competition and economies of scale. This leads to a shift from domestic market dependency to production for international market which in turn encourages firms to increase their production capacity so as to reap the additional benefit of economies of scale that finally lead to

greater TFP gains. This result is in line with the empirical literature concerning the causal relationship between openness and productivity: (Bigsten and Gebreeyesus, 2009) for Ethiopian firms, (Fernandes and Isgut, 2005) for Colombia and Van Biesebroeck (2005) for Sub Saharan Africa found a positive and significant relationship between trade openness and TFP.

The result of the study on the relationship between ownership status and TFP revealed that privately owned firms are on average 3 percent more productive than publicly owned firms. The ownership dummy which represents the private ownership of the firm is significantly and positively related with TFP at 1 percent significant level. This shows that the private sector is an important potential driving force of TFP of the manufacturing firms in Ethiopia. As compared to state ownership, privately owned firms are highly profit oriented and usually take advantage of creative practices to run the firm more efficiently. Conversely, the low level of productivity in state owned manufacturing firms can be explained by the fact that most state owned firms have politically driven goals and hence performances while private firms have market driven goals and performances. Besides, the prevailing corruption chain of politicians and administrators and the low transparency make the firms' monitoring and evaluation almost impossible in state owned firms.

The results of the study on the relationship between firms' credit status and TFP shows statistically significant and negative correlation at 1 percent significant level for all model setups. The results reveal that the non-borrowing firms are more productive than the borrowing firms. We normally expects a positive sign for the loan dummy coefficient as it is natural to expect that additional money would be spent on more productive ways. This in turn depends on the firms' choice either for expansion, undertaking R and D, for technological improvements or investment needed to boost their productivity beyond what their internal funds can support. Some empirical studies also support the idea that bank credit enhances productivity (Gatti and Love, 2008; Nickell and Nicolitsas, 1999; Villalpando, 2014). Yet, contrary to our expectation, the coefficient for the loan dummy is statistically significant and negative which might explain the fact that in developing countries like Ethiopia, firms are credit constrained due to high interest rate requirements on borrowed money. As a result more productive firms use their own cash rather than borrowing and paying the high cost of loan (interest rate that range from 14 percent for public banks to 24 percent in private banks). In other words, due to the imperfect information in the loan market and adverse selection the cost of the loan is too high for the low risk borrowers to be willing and able to borrow and expand their investment. As a result the productivity of the firm could be adversely affected. According to (Stiglitz and Weiss, 1981), the interest rate a bank charges my affect the riskiness of the pool of loans due to either adverse selection or the incentive effects. The higher interest rate may attract higher risk borrowers while lower risk borrowers leave the credit market choosing to use probably their own fund. This in turn might cause for the high risk borrowers to divert

the loan for unintended purpose. This result is in line with the findings of (Edjigu et al., 2016) for Ethiopian firms.

Table 2: Determinants of Total Factor Productivity

Dep. Variable: lnTFP	FE	RE	SYSGMM
Exportdum	0.043***	0.105***	0.058***
	(0.011)	(0.011)	(0.016)
Importdum	0.019***	0.035***	0.029***
	(0.005)	(0.004)	(0.007)
FDIdum	0.002	0.076***	0.165
	(0.012)	(0.010)	(0.107)
Skill Intensity	0.025***	0.038***	0.019***
	(0.002)	(0.002)	(0.003)
Ownerdum	0.037***	-0.020*	0.080**
	(0.009)	(0.010)	(0.036)
lnIncentive	0.005***	0.012***	0.012***
	(0.001)	(0.001)	(0.001)
Loan	-0.015***	-0.007**	-0.012***
	(0.003)	(0.003)	(0.005)
prodLP_1			0.459***
			(0.059)
Constant	3.094***	2.929***	1.492***
	(0.016)	(0.013)	(0.168)
N	17977	17977	6313
Hausman Test	0.0000		
AR1			0.000
AR2			0.525
Hansen			0.587

Source: Author's computation using CSA medium and large scale manufacturing data. Standard errors in parentheses. lnTFP is obtained using LP method. Note: Asterisks indicate significance at*10%,**5%,***1% level.

To analyze the possible effects of employee incentives on TFP, we include the log of incentives in the model. The study result shows that employee incentives are

significantly and positively related with TFP at 1 percent significant level. As the theory of incentives suggests and most empirical works support (see for example (Bo-getoft, 1995; Nalbantian and Schotter, 1997)) incentives and productivity are inseparably linked. Incentives are a necessary part of inducing the employee to exert more effort towards the achievement of their task. Workers of any type (say it skilled or unskilled) need a pecuniary incentive to learn and attain new skills that can maximize the creativity of the employee, to agree to take additional responsibility and work towards the achievement of the firms development goals, to execute more difficult jobs with enthusiasm and hence to increase productivity. When firms provide incentives, employees who join those firms benefit from being provided incentives and develop sense of belongingness to the firm and hence willing to provide additional effort and/or adopt more efficient methods of production. Therefore, incentives are important motivational elements that help the firm to increase its productivity.

The findings on the link between TFP and skill intensity captured by the ratio of total wage to number of employees (i.e, average wages) shows that as the firm hires skilled personnel the productivity of the firm increases. The choice of proxy for labor quality is followed from the previous literature such as (Bahk and Gort, 1993)[4] as well as (Damijan et al., 2009) that used labor cost per employee as a measure of skill intensity. The study reveals that skill intensity is significantly and positively related with TFP at 1 percent significant level. This proves that, regardless of the measure of skill intensity, the quality of human resource in the manufacturing firm plays an important role in increasing firm's productivity. This result is in line with the empirical literature such as (Bahk and Gort, 1993; Damijan et al., 2009).

5. Conclusions and Policy Recommendations

The aim of the study is to estimate TFP using semi-parametric approaches and examine the determinants of TFP of the manufacturing firms in Ethiopia. To this end, a two stage analysis approach is followed in this study. First, TFP is estimated using the (Levinsohn and Petrin, 2003) method. Other alternative methods such as (Olley and Pakes, 1996), (Wooldridge, 2009) and OLS approach are also employed to check the robustness of the estimation results. Second, we used fixed effect and random effect methods to examine the determinants of firm-level TFP. We favor the (Levinsohn and Petrin, 2003) estimator over (Olley and Pakes, 1996) due to its advantage of using raw material as proxy in the estimation and as most firms in our data set report positive use of raw materials in all periods under investigation.

We find decreasing returns to scale production function. The results reveal that labor, raw materials, capital and Energy are the most important elements of the production function. The estimated coefficient of raw materials and labor are the

[4]Bahk and Gort (1993) use plant average wage as a measure of skill intensity on the grounds that variations in wages mainly measures differences in skills rather than differences in the prices of identical classes of labor (p565).

highest followed by the contribution of energy and capital. The implication is that for a labor abundant and capital scarce country like Ethiopia, the highest contribution of labor (next to raw materials) is a very important phenomenon as it indicates the existence of still vacant employment opportunities in the manufacturing sector as a whole. The estimated average TFP in manufacturing firms in Ethiopia is 3.42.

For the analysis of the determinants of TFP of manufacturing firms in Ethiopia, we employed the fixed effect and random effect methods. Based on the Hausman FE versus RE specification test the fixed effect is preferred over the alternative random effect model. Alternative specification of the model based on SYSTEM GMM approach is also used to check the robustness of the fixed effect model. Accordingly, firms' exporting and importing status, skill intensity, and employee incentives have significant and positive impact on firm-level TFP. Being a privately owned firm has a significant and positive impact on TFP whereas credit has a significant and negative impact on TFP. Foreign direct investment captured by the contribution made by non-Ethiopian citizens to total initial paid up capital of the firm is positive but insignificant.

Generally, the results show that export status, import status, skill intensity, employee incentives, being a private firm, and credit status of the firms are important determinants of TFP. Thus, based on the results so far it is possible to draw the following policy recommendations.

The statistically significant and positive effects of export and import on productivity suggest the importance of designing and appropriately implementing policies that encourage openness. Skill intensity and employee incentives are important factors to enhance TFP of the manufacturing firms. Thus, firms should promote human resource development through employee on the job training. They should also encourage employees and create enthusiasm of employees through employee incentives. This can be through career incentives (such as tenure and promotion) and/or financial incentives (such as higher wages, bonuses, commissions and other benefits). To do so, firms should set performance targets that help them for employee evaluation and make performance related bonuses and pay system. The government should take initiative to engage in policy dialogue with the private firms to encourage them to improve their human capital and to increase workers willingness and enthusiasm towards their job. Besides, the government has the role to play in terms of producing quality educated workers through vocational education and universities as most of education in Ethiopia is provided publicly. Creating a link between public educational sectors and private industries, as it is common in Europe, is also very important if such initiative will be taken by the government in order for the student to get practical skill of the work environment.

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Appendices
Table A1: Summary statistics

Variable	Description	Number	Mean	SD
lnProd	log of Total Value of Production	23,331	15.15	2.25
lnCapital	log of Capital	23,331	13.74	2.7
Lnwage	log of total wage	23,331	12.67	2
lnMaterial	log of Material	23,331	14.45	2.42
lnEnergy	Log of cost of energy	21,051	10.79	2.45
lnInvestment	log of investment	17,410	11.96	2.87
Exportdum	=1 if exporter, 0 otherwise	23,331	0.053	0.22
Importdum	= 1 if importer, 0 otherwise	23,331	0.61	0.49
FDIdum	= 1 if foreign paid up capital, 0 otherwise	19,289	0.05	0.23
Ownerdum	=1 if private, otherwise public	23,331	0.94	0.24
lnSkill intensity	Labor Quality	19,289	8.04	3.95
lnIncentives	Employee benefits	23,331	7.24	5.37
Loandum	= 1 if access credit, 0 otherwise	23,331	0.51	0.5

Source: Author computation using CSS medium and large manufacturing data

Table A2: TFP Variation by Industry (LP-Method)

	FB	Tb	TG	LP	WP	Pr	Ch	RP	NM	BM	MP	ME	Mo	FP
lnWage	0.200**	0.257	0.169**	0.194**	0.254**	0.215**	0.269**	0.305**	0.184**	0.077*	0.265**	0.223*	0.179*	0.199**
	(0.010)	(0.284)	(0.028)	(0.027)	(0.054)	(0.037)	(0.040)	(0.030)	(0.014)	(0.044)	(0.040)	(0.096)	(0.072)	(0.011)
lnEnergy	0.080**	-0.035	0.106**	0.040*	0.133*	0.094**	0.036	0.054**	0.143**	0.086**	0.005	0.025	0.011	0.065**
	(0.010)	(0.022)	(0.025)	(0.020)	(0.052)	(0.025)	(0.024)	(0.021)	(0.010)	(0.027)	(0.027)	(0.064)	(0.040)	(0.012)
lnCapital	0.033*	-0.003	0.048	0.095*	0.123*	0.045	0.100*	0.104*	0.093**	0.431**	0.119**	0.168*	0.160	0.046**
	(0.016)	(0.237)	(0.040)	(0.040)	(0.059)	(0.028)	(0.052)	(0.042)	(0.018)	(0.104)	(0.034)	(0.083)	(0.138)	(0.016)
lnTVRM	0.638**	0.627**	0.426**	0.623**	0.483**	0.527**	0.450**	0.558**	0.442**	0.392**	0.577**	0.578**	0.706**	0.653**
	(0.020)	(0.129)	(0.073)	(0.044)	(0.082)	(0.047)	(0.058)	(0.044)	(0.038)	(0.106)	(0.036)	(0.077)	(0.091)	(0.035)
RTS	0.95	0.85	0.75	0.95	0.99	0.88	0.86	1.02	0.86	0.99	0.97	0.99	1.05	0.96
N	9562	20	1254	1428	416	1488	1311	1723	4966	436	1593	350	169	4246
AVG lnTFP	2.03	4.5	4.9	1.8	1.8	3.1	3.6	1.1	3.44	1.8	1.7	1.07	0.09	3

Source: Author's computation using CSS medium and large scale manufacturing data. Standard errors in parentheses. Asterisks indicate significance at * 10%, ** 5%, *** 1% level. Dependent variable is log gross value of output. FB: Food and Beverage, TG: Textile and Garment, LP: Leather and Leather products, WP: Wood and products of Wood, Ch: Chemical and Chemical Products, Pr: Paper, paper products and printings, BM: Basic Iron and Steel, MP: Fabricated Metal products except machinery and equipment, FP: Furniture products, RP: Rubber and Plastic products, ME: Machinery and Equipment, NM: Other Non-metalic Minerals, MO: Motor Vehicles and Tb: Tobacco.

Figure 1: Export and TFP