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Labor productivity of Ethiopian large and Medium Scale Manufacturing Sector

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Abstract

Labor productivity growth is directly linked with living standard improvements of an economy. The objective of this paper is to examine the labor productivity growth and determining factors of large and medium manufacturing establishments in Ethiopia using a panel data set over the period 1996-2015 obtained central statistical agency annual survey. Using a model specification test (Hausman), fixed effects estimator is chosen and for the sake of addressing heteroscedasticity as well as serial correlation, variance covariance robust standard error estimation. Based on real value added, the mean labor productivity over the 20 year period is 1,565.33 having a large variability (standard error is 7875.26) showing the existence of high degree of heterogeneity among manufacturing firms whereas labor productivity at real gross sales value is 3,139.48 with standard deviation of about 9531. Labor productivity showed marginally growing trend in both gross output and value added terms. By value added measure, it lies below capital intensity. Among the determining factors of capital intensity, wage per worker, time dummy (2004-2010), firm age and size are statistically significant at 1%. The time dummy (2011-2015) is significant at 10%. Participation in the global market either by importing raw materials or exporting output doesn't significantly influence labor productivity. As capital intensity increases by 1%, labor productivity increases by 0.165% implying the complementary nature of capital and labor rather than being substitution. When average wage expenditure increases by 1%, labor productivity increases by 0.42%. The labor productivity in period II (2004-2010) is greater than period I (1996-2003) by 8.29% and period III (2011-2015) is greater by 34.94%. As firm age increases by 1 year, labor productivity increases by 0.6% and large firms are less productive than medium firms by 30.88%. Hence, in order to raise labor productivity at value added, firms should spend more on average wage which potentially attracts with more qualified labor and government should give more emphasis on the manufacturing sector as the result during the growth and transformation plan period is much higher than the other two periods. Rather than focusing on large firms which are expected to be more capital intensive more attention should be attracted to medium sized firms.

Key words

Labor productivity, productivity growth, manufacturing, value added per worker

JEL Codes: B22, L16

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1. Introduction

The ever increasing intensity of globalization brought about a cut throat competition in the business arena. The main factor to with stand such competition is labor productivity as it has an implication to profitability growth by means of lowering average cost of production and sell products at the prevailing price in the international market (Fallahi and Sojoodi, 2010).

Labor productivity, defined by ratio of output to labor unit (Hall and Jones, 1999) is a core determinant of sustained economic growth (Tiruneh *et al.*, 2016). Growth of labor productivity in the manufacturing sector is an indicator of the status of structural change in an economy over the target time period. It is also related with the level of capacity utilization by firms. If less of the full capacity of production is realized, then the labor productivity is expected to be lower as compared with firms which utilize more of their respective production capacity (Schreyer, 2001; Wubneh, 1990). Labor productivity has a direct link with firm profitability and growth as it has an implication to production at lower unit cost. It also has a direct effect on social welfare improvement since it is source of income from employment (Heshmati and Rashidghalam, 2018; Kumbhakar *et al.*, 2018; McCullough, 2015; Pilat, 1996). This leads to a renewed interest towards studying determinants of productivity (Fallahi *et al.*, 2010).

Yilmaz (2016) compared the labor productivity of two groups of countries those under middle income trap and those graduated from middle trap. The author's examination across sectors showed that the manufacturing sector contributed much of the within sector growth variation in labor productivity among the two groups of countries. The interest to study labor productivity emerges from three grounds viz: first, labor cost is high in the production process. Second, from simplicity point of view, labor can be measured relatively easily and third, it is linked with economic welfare and improvement in living standards (Heshmati and Rashidghalam, 2018; Papadogonas and Voulgaris, 2005).

According to Diewert (2016), if an economy has limited net factor income from abroad and limited change in labor force participation rate, labor productivity measures the level of living standard. In Ethiopia, labor force participation rate, based on international labor organization (ILO) estimate, has changed from 77.95% to 82.6% between 1990 and 2018 (World Bank WDI[1], 2019). This indicates that over the last 29 years there is no significant change in labor force participation rate in the country. On the other hand, net income from abroad showed negative average over last 41 year period (1977 to 2017) and it was positive only in one fourth of the years in which the most recent years with positive ones are from 2006 to 2008 (World Bank WDI, 2019). Thus, labor productivity can be taken as a measure of economic wellness in line with the literature in Ethiopia.

So far only few research works are conducted that investigate labor productivity in Ethiopia. For example, (Wubneh, 1990) compared labor productivity over the two regimes in Ethiopia viz: from 1960 to 1974 during Emperor Hailesilassie regime which followed a *feudo-capitalist* economic system and from 1975 to 1984 during the military regime where socialism was at the centre of policy design with the purpose of testing whether structural transformation has occurred or not. He concluded the marginal productivity of labor has declined significantly during the military regime. Abegaz (2013) has examined the labor productivity in his study on productivity and efficiency of large and medium scale manufacturing establishment in Ethiopia. His study covered from 1996-2009 and also he used value added per Birr spent on the wage bill. However, as far as our knowledge is concerned, there is no research on labor productivity growth and determining factors in Ethiopia after during the incumbent regime.

The main objective of this paper is to analyze growth and the determinants of labor productivity in Ethiopian large and medium scale manufacturing sector over the period 1996-2015.

2. Literature review

The sustenance of economic growth depends on structural transformation that an economy experiences which in turn relies on established industrial base. The manufacturing sector, because of its strong linkage (backward and forward) with other sectors as well as potential innovation, economies of scale and technological advancement that induces productivity, is the primary focus area in African policy debate (Mbate, 2016). The level of productivity shows to what extent a firm is able to maximize its revenue (value added) from a given input (set of inputs) and technology. In other words, it is a ratio reflecting how a production unit converts its factors of production in to output. It is measured by various indices such as productivity, multi-factor productivity, partial factor productivity (e.g. labor productivity and capital productivity). Labor is a key factor of production from productivity measurement stand point because labor related cost of production is large. Labor productivity enables to measure the competiveness of a firm (Heshmati and Rashidghalam, 2018).

Growth in labor productivity can originate either from technology sophistication and capital accumulation within each sector or from reallocation of labor from agriculture (low productive sector) to manufacturing which is assumed as higher productive sector. Ethiopia is peculiar among some African countries included in a study by McCullough (2015) in that labor productivity is higher in agriculture relative to the industrial counterpart. According to Krugman (1997), in the long run the fate of an economy is primarily determined by growth in labor productivity. He compared three alternative sources by which living standard measured by level of consumption can be raised namely: increasing labor productivity, employing larger proportion of the population and reducing saving that would be used for investment. He argued that the last two options will have only a short run welfare effect. For instance, consuming today reduces capital formation and hence investment which in turn reduces future consumption and creating more job opportunity to the unemployed can increases welfare as far as there is plenty of unemployment. However, one can't continue number of population employed indefinitely because it has a limit of 100%. Thus, the main source of long run improvement in economic wellness is brought about by growth in labor productivity.

2.1. Empirical findings on Determinants of Labor productivity

Zheng, Batuo and Shepherd (2017) categorized the covariates of labor productivity in to four groups such those related to the labor itself, those related to capital factor, those related to the market structure and those related to institutional set up.

Fallahi *et al.* (2010) conducted a research aiming to examine the determining factors of labor productivity on Iranian manufacturing firms. The finding shows that investment on research and development activities, labor quality (labor education), wage, participation in export and capital intensity significantly and positively affect labor productivity.

[1] World development Indicators

Efficiency wage

Higher wage rate, though has immediate cost increasing effect, increases labor productivity in a number of channels. First, it reduces worker turn over where stable workers are expected to produce more per unit of time arising from their expertise of learning by doing as well as more psychological attachment with the firm will enhance their production. Also efficiency wage is paid only to more productive workers which imply that workers increase their productivity by adding their effort in order to earn more (Sanchez and Toharia, 2000). Second, it helps the firm attract more educated and skilled workers (Elshennawy and Bouaddi, 2018).

Capital intensity

New capital investment made by the firm in such a way that increases the capital to labor ratio (capital intensity), increases productivity because new capital is expected to embody new technical sophistications which enhances productivity (Zheng *et al*., 2017). Heshmati and Rashidghalam (2018) examined the level of productivity and its determining factors on Kenyan manufacturing and service sectors and found that wage per worker and capital per worker (capital intensity) are significant factors that improve labor productivity.

Firm size

There are two theoretical arguments regarding the effect of firm size on labor productivity. The first argument is that large firms can increase labor productivity by using resource (labor and capital) more efficiently to exploit the scale economies which enables them reduce the average cost. In addition, they can invest on research and development activities which is a source of innovation and hence productivity growth (Fallahi *et al.*, 2010; Zheng, Batuo and Shepherd, 2017). The second argument states that large firms face coordination failure due to the bureaucratic system (Diaz and Sanchez, 2008). Empirical research showed mixed results.

Firm age

Yet there are arguments for and against firm age to have a positive effect on productivity. On one hand, young production units are presumed have high skill and new technology and their size is limited to be small or medium. Thus, they have higher productivity level (Papadogonas and Voulgaris, 2005). On the other hand, old units have better capacity in skill accumulated through learning by doing (Srithanpong 2016; Ding *et al.*, 2016).

Participation in the import export market

For units participating in the global market, productivity is a matter of survival because of the merciless competition that they face. Thus, they are initiated to utilize their resources as efficiently as possible in such a way that raises their level of productivity (Zheng *et al.*, 2017). International trade is a source of knowledge (learning) and innovation from the interaction with buyer of export item and sellers of imports. It also enables firms to import new technology embodied capital goods that enhance productivity (Wagner, 2002).

3. Methodology of research

3.1. Data type and source

The data used in this paper is a panel data of covering the period 1996-2015. It is obtained from central statistical agency annual survey on large and medium manufacturing establishments. For the sake of comparison across different time gaps, the 20 year is grouped in three namely: from 1996-2003 a period with no well-designed economic policy and small and in some years negative economic growth, from 2004-2010 with implementation of the policies and a higher economic growth rate and from 2011-2015, the rate of economic growth continued under the first growth and transformation plan.

4. Data analysis

4.1. Model specification

Heshmati and Rashidghalam (2018) state that labor productivity function is an inverted function for its demand function. These authors used a cross sectional data set which doesn't allow us to examine growth in labor productivity. Labor productivity growth can be analyzed using panel data set. The labor productivity function is derived from the production function as adopted from Heshmati and Rashidghalam (2018) and Papadogonas and Voulgaris (2005):

$$Y_{it} = f(K_{it}, L_{it}, M_{it}) \quad (1)$$

Where; i = 1, 2, 3... N number of firms and t = 1, 2, 3... T, Number of time periods

Y_{it} denotes value added; K_{it} is fixed capital stock; L_{it} represents the labor input; M_{it} raw material input.

$$\frac{Y_{it}}{L_{it}} = f\left(\frac{K_{it}}{L_{it}}, \frac{L_{it}}{L_{it}}, \frac{M_{it}}{L_{it}}, \right) \quad (2)$$

$$lnLP = f(lnW, \ln I,\ S,\ lnA, X, M, Period) \quad (3)$$

Where; W denotes wage per worker, I represents capital intensity measured by capital per worker; firm size dummy (1 for large and 0 for medium), A is firm age; X and M represent export of output and import of raw material respectively both being dummy variables 1 for yes and 0 for not and Period captures the effect of three period during 1996-2015 total time span. It is an indicator variable having three categories viz: period I (base) from 1996-2003, period II from 2004-2010 and period III from 2011-2015 (GTP I). *ln* is a notation for the natural logarithm in order to make the equation a growth one. The objective of equation 3 is to maximize output (value added) per unit of labor input. The Dependent variable LP refers to labor productivity. It is a ratio of two variables namely: real value added to full time equivalent number of workers. This means that labor productivity is measured as real value added to labor ratio. For the sake of comparison, real gross value to labor ratio, value added to capital ratio, capital to labor ratio. Real Value added, real gross sales value and real capital are obtained by deflating each year's respective value using GDP deflator from World Bank WDI data base taking 2011 as base year. By conducting Hausman model specification test, the fixed effects estimator is found to be consistent and hence equation (3) is estimated using fixed effects estimator.

5. Results

This section is concerned with the assessment of labor productivity in comparison with capital productivity in terms of total real sales value as well as in value added. It presents the cases by making comparisons across different industrial groups, policy break periods and other determinants.

Partial productivity with respect to an input is an average (per unit) measure. For instance, labor productivity measures value added per unit of full time equivalent labor (Hsu and Chen, 2000). As presented in table 1 below the mean real value added of Ethiopian large and medium scale manufacturing establishments is 157,360.5 Birr with a very significant variability (standard deviation is 889,648.2) and ranging from a negative value (-8,794,838) to very large positive value (36,400,000). The mean labor productivity based on the gross value is 3,043.44 with standard deviation of 9,334.96 whereas when the labor productivity is measured as value added to labor ratio; the mean value is 1,137.78 with variability of 8,857.09. This means o average one full time equivalent employee produces 1137.78 Birr real value added. The difference between the value added based and gross value based labor productivity indicates that the raw material and intermediate input has large contribution in the production of real sales value.

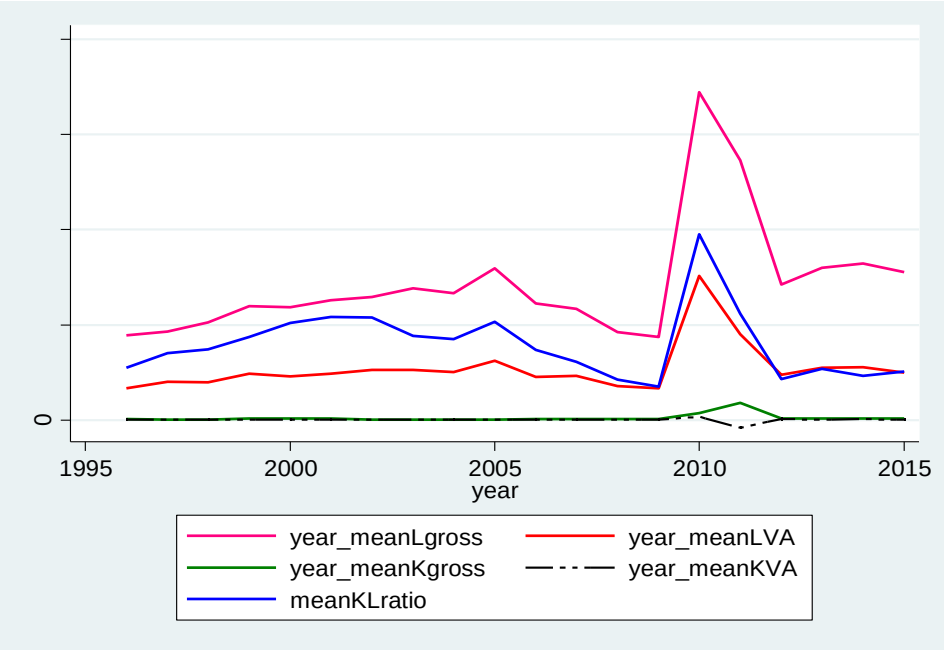
Table 1. Summary of key variables

Variable	Obs	Mean	Std.Dev.	Min	Max
Value Added	21005	180000	909000	0.012	3.64e+07
Labor productivity Based on gross real sales value	21005	3139.475	9530.995	0.205	449000
Labor productivity based on real value added	21005	1565.331	7875.262	0.001	449000
Capital productivity based on gross real sales value	21005	42.404	718.809	0.0009	60912.91
Capital productivity based on value added	21005	29.576	657.751	0.00013	60912.78
Capital intensity (capital to labor ratio)	21005	1451.172	6895.874	0.006	340000

Source: Own computation

On the other hand, capital productivity is 43.9 and 5.07 for gross sales and value added respectively. This indicates that, on the average, a 1 Birr fixed capital stock produces 43.9 Birr gross sales and 5.07 Value added in real terms. The average capital to labor ratio (capital intensity) is 1,512.58 implying that a labor unit supports 1,512.58 Birr fixed capital stock. Figure 1 below shows the trend of the partial productivities along with capital intensity across the 20 year period. The labor productivity and capital intensity variables follow similar pattern during the ups and downs of the period. The pink line which represents the mean yearly labor productivity t gross sales value falls above all followed by the capital intensity (the blue line). The red line shows the labor productivity on the basis of real value added. The capital productivity followed stable and lower pattern. Except during 2011 where the gross sales value per unit of fixed capital stock value (the green line) showed a peak in its trend. One peculiar pattern of the four of the trend lines is that all of reached their peak point in 2011 and returned down almost close to their respective initial values. The significance of this year is that it was the beginning year of

the first growth and transformation plan period in the country. It may be due to the policy coordination effort during the initial period but later the political commitment might have got loose.



Source: own sketch using CSA raw data

Figure 1. Trends of Partial Productivity and Capital Intensity

Determinants of Growth Labor productivity

There are various influencing factor of labor productivity such as size in literature. In addition to firm size a number of determining factors of labor productivity such as capital labor ratio which is expected to increase labor productivity since labor and capital complement each other (Hsu and Chen, 2000). Labor quality is another variable which is expected to positively influence labor productivity and it is proxied by mean wage because wage is expected to be correlated with labor quality. For analyzing the learning effect from international market, the participation in exporting as dummy variable is incorporated in the model as determinant. It is expected to influence positively (Fallahi *et al.*, 2010). Further, firm age is also included.

Table 2. Determinants of Labor productivity at Value added

lnL_productivity	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
lnK_intensity	0.165	0.014	11.44	0.000	0.136	0.193	***
lnwage_perworker	0.423	0.029	14.37	0.000	0.365	0.481	***
Period II	0.083	0.026	3.21	0.001	0.032	0.134	***
Period III	0.349	0.133	2.63	0.009	0.089	0.610	***
Firmage	0.006	0.002	3.70	0.000	0.003	0.009	***
Size_large	-0.309	0.076	-4.05	0.000	-0.458	-0.159	***
Import_status	0.023	0.039	0.58	0.558	-0.054	0.099	
Export_status	-0.014	0.041	-0.33	0.738	-0.095	0.067	
Constant	3.016	0.167	18.11	0.000	2.690	3.343	***
			Number of obs		21005.000		
F-test	63.788		Prob > F		0.000		
*** p<0.01, ** p<0.05, * p<0.1							

Source: Own computation

As presented in table 2 above, the coefficient of capital intensity, wage per worker, periods II and III, firm age and size are statistically significant and except firm age all are positive. Participating in the international trade either by importing raw material or exporting output has negligible effect on the growth of labor productivity. When capital to labor ratio (capital

intensity) increases by 1%, labor productivity grows by about 0.17% while per worker wage increases by a percent, labour productivity increases by 0.42% and age of the firm increases by same, labor productivity raises small but significant amount (0.006%). One the other hand, labour productivity of large firms is less than that of medium ones by 30.9%. Whereas Period II (2004-2010) has 8.3% more increasing effect on labor productivity than period I (1996-2003), the effect of period III (2011-2015) is greater by 34.9%.

The positive coefficient of capital intensity is an indicator of the complementary nature of capital and labour inputs. Average wage (wage per worker) is a proxy for labour quality; its positive coefficient is in line with a priori information. Also its magnitude is larger than the others. Firms learn from their respective past experience across their life cycle. Thus, the effect of age is positive but its small coefficient size indicates that learning effect is somewhat limited. Larger firms performed less than their medium counter parts perhaps due to the negative effect from coordination failure outweighs the gains of economies of scale from size. An increasing effect of the period is an indication that manufacturing labor productivity grows directly with economic growth and policy efforts on the sector. The quest that follows this discussion is that the pattern of factor productivity and value addition over time and across various time segments. Table 3 below provides the answer.

Table 3. Summary of Factor productivity and Value added by time period

Variable	Period I (1996-2003)		Period II (2004-2010)		Period III (2011-2015)	
	Mean	sd	Mean	Sd	Mean	sd
Value Added (000)	175	797	147	886	156	948
Labor productivity at gross sales value	2336.03	4843.79	3177.05	11531.05	3370.29	9082.62
Labor productivity at value added	918.10	2176.51	1297.49	11200.34	1121.58	8918.61
Capital productivity at gross sales value	17.26	368.33	40.87	579.6	64.23	992.45
Capital productivity at value added	4.39	53.83	17.46	569.00	6.83	2566.21

Source: Own summary using CSA raw data

Manufacturing value added (in thousands) has declined between the first and the second period from 175 to 147 though there is some improvement between the second and third periods from 147 to 156. Its standard deviation, however, increased successively showing the increment of heterogeneity among establishments in terms of value added generation. This is an indicator that even if aggregate economic growth was realized during the second period, it did not emerge from strong manufacturing base rather from infrastructure development efforts and from other sectors as confirmed by Shiferaw (2017). Labor productivity at gross value has increased significantly over the three the periods from 2336.03 to 3370.29 (i.e. by about 44.27%) and at value added though it increased between the first two periods (379.39 or 41.32%), it declined between the second and the third period (by 13.56%). This is an indicator of the fact that the growth in gross value added labor productivity comes more of from raw material input contribution. Capital productivity at gross sales value has increase over the whole period by about 2.72 fold. In case of capital productivity at value added, it increased between the first and third period almost by three fold (from 4.39 to 17.46) but it declined up to 6.83 (by 60.88%).

6. Conclusions and recommendations

Measured by real value added per unit of labour, the mean labour productivity is 1,565.33 Birr over the 20 year period (1996-2015). Its trend depicts a slight increment over time and a significant leap during 2011 which unfortunately dropped back to its trend just after this year. When the determinants of this growth are accounted, capital intensity, wage per worker, period II and period III, firm age and size have significant influence. The only negative significant effect is due to firm size. Participation international trade both by importing raw material input and exporting output has no significant influence on growth in labour productivity.

The policy implications to be drawn are first it is important to focus on firm size because larger firms have negative effect on labour productivity growth which requires to be made to reduce the coordination failure so that such firms exploit the advantage of economies of scale. Second, though there is a consensus among economic scholars about a positive effect of participation in the global market either by importing new technology embodied capital goods as well as learning from foreign buyers and sellers, it is found negligible in the Ethiopian case. Thus, a need arises to dissemination of information to the firms regarding what to learn engaging in it including how to improve competitiveness by which productivity will be enhanced. Moreover, the higher rate of labor productivity growth over the recent two periods implies that policy intervention in such a way that induces economic growth and a particular emphasis on the manufacturing sector is promising.

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