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Combined Factor Productivity in Ethiopian Manufacturing Firms

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Abstract
Combined Factor Productivity measures the rate of growth of output not accounted for by the rate of growth of combined factors of production viz-a-viz labour, capital, energy and material. So, CFP is one of the strong muscles of the economy. The aim of the paper is to estimate the CFP and its share of output determination in four selected Ethiopian manufacturing sub-sectors during 2006-2012. The standard primal (KL) and extended (KLEM) growth accounting CD production function by using the traditional Growth Accounting Method coupled with two alternative estimators-pooled OLS and fixed effects estimators of the panel data set. The findings indicated that CFP levels ranges from2.92 in leather to 8.01 in pharmaceuticals. The growth rate of CFP of almost all sub-sectors became negative in the post period compared to its pre-GTP version. Productivity and labour are found to be the main determinants of manufacturing output while capital is statistically insignificant to determine output particularly in KL model. The result suggests that in the industrialization process of the country, investment priority has to be given for those with higher productivity performances and having stronger inducing power. In addition, labour intensive manufacturing firms ought to be give due attention.
Keywords: CFP, KLEM, KL, Growth Accounting

1. Introduction

Combined Factor Productivity measures the rate of growth of output not accounted for by the rate of growth of combined factors of production viz-a-viz labour, capital, energy and material. It is a residual defined as the unexplained part of the variation of output after having taken the variation in inputs into account. To determine that how much output growth of the production unit is due to CFP and how much is due to factor accumulation(FA), estimation of productivity levels (difference in productivity among producers in the same time period) and productivity growth rates (variations in a given period of time could be indispensible. Conventionally, we find it in all literatures as either Total Factor Productivity (TFP) or Multifactor Productivity (MFP). Partial productivity, on the other hand, is the output measured per unit of a single input, mostly labour or capital. Since early in the beginning of the second half of the twentieth century, productivity has been proved to be one of the strong muscles of economic growth. Solow (1957) and Denison (1962, 1967).

Thus, this particular section has confined to the estimation of combined factor productivity of Ethiopian manufacturing firms-firms under industrial groups of food and beverage, textile, leather and chemical. The panel data set acquired from CSA annual survey of medium and large scale manufacturing for the years 2006-2012 where half of such periods cover the implementation of the first GTP of the country. This helped the researcher to examine the result in pre-post GTP horizon. The study used the standard primal (KL) growth accounting CD production function and standard extended (KLEM) growth accounting CD production function. Three types of unit root test of the major variables have been made prior to estimation. LLC unit root test, Hadri LM unit root test and Haris Tzavaris unit root tests were made and if the variable is stationary at least in two of the tests, we take it with no further manipulation. All are found to be stationary for Lenin Lin Chu and Haris Tzavaris. Pooled OLS estimator and fixed effect estimator have been used to estimate the production functions. The panel hausman test has been used to select the best consistent estimator from fixed and random effects. The hausman test assured the relevance of fixed effect model over random

2. GA Models for Estimating Combined factor productivity[1]

A Cobb-Douglas production function with four factors of production—capital, labour, energy and materials—are used to estimate CFP. Firm sales are used to measure output; the replacement value of machinery, vehicles and equipment is used to measure capital; labour is measured by the total hours of work of each firm while energy and materials are determined by the costs of energy consumed and costs of raw materials. CFP is estimated as the residual term of the production function. The CFP values used in this note are compared with the values obtained from additional production function specifications. The second variation of the Cobb-Douglas production function uses only labour and capital as inputs of production and the third uses value added as the dependent variable instead of gross output which is referred to as the standard primal growth accounting.

[1] For standard primal CD production function based growth accounting where only labour and capital inputs are included, TFP version is considered.

2.1 Standard Primal Growth Accounting

In the Standard Primal Growth Accounting, only the primary inputs, capital and labour are included in the control variable list. (Hulten, 2009) Here, as a base a Cobb-Douglas production function-type is assumed

$$Y_{it} = A_{it}\, K^{\alpha}_{it}\, L^{\beta}_{it}\ ;\ i = 1; \ldots; N;\ \text{and } t = 1; \ldots; T; \quad \ldots(3.6)$$

$$A_{it} = TFP_{it} = \frac{Y_{it}}{K^{\alpha}_{it} L^{\beta}_{it}} \quad \ldots(3.7)$$

$$\frac{Y'(it)}{Y(it)} = \frac{A'(it)}{A(it)} + \alpha * \frac{K'(it)}{K(it)} + \beta * \frac{L'(it)}{L(it)} \quad \ldots(3.8)$$

Where Y is a measure of output in terms of gross output of firms, A is a productivity parameter (technological progress), K is capital and L is labour hour, α and β are the output elasticities with respect to the corresponding factors, i is a manufacturing firm and t is time in years.

This framework dated back to the works of Abramovitz (1956) and Solow (1957).

$$Q_{it} = A_{it}\, K^{\alpha}_{it}\, L^{\beta}_{it}\ ;\ i = 1; \ldots; N;\ \text{and } t = 1; \ldots; T; \quad \ldots(3.9)$$

$$A_{it} = TFP_{it} = \frac{Q_{it}}{K^{\alpha}_{it} L^{\beta}_{it}} \quad \ldots(3.10)$$

$$\frac{Q'(it)}{Q(it)} = \frac{A'(it)}{A(it)} + \alpha * \frac{K'(it)}{K(it)} + \beta * \frac{L'(it)}{L(it)} \quad \ldots(3.11)$$

Where Q is a measure of output in terms of value added in this case, the rest are as defined before. In the first specification of CD production function appeared as a third here ,in addition to the traditional calculation of α and β, other factor elasticities are calculated and estimated where energy (E) and materials (M), are included. Hence, the more general production function of the given study is to be given by:

2.2 Standard Extended Growth Accounting

Here, in addition to the primary inputs, energy and material factors are incorporated in the independent variables list.

$$Y_{it} = A_{it} K^{\alpha}_{it} L^{\beta}_{it} E^{\delta}_{it} M^{\gamma}_{it}\ ;\ i = 1; \ldots; N;\ \text{and } t = 1; \ldots; T \ldots \quad (3.12)$$

$$A_{it} = CFP_{it} = \frac{Y_{it}}{K^{\alpha}_{it} L^{\beta}_{it} E^{\delta}_{it} M^{\gamma}_{it}} \quad \ldots (3.13)$$

$$CFP_{it} = \frac{Y_{it}}{K^{\alpha}_{it} L^{\beta}_{it} E^{\delta}_{it} M^{\gamma}_{it}} \quad \ldots (3.14)$$

The corresponding growth rate would be measured by

$$\%\Delta Yit = \Delta\%A_{it} + \alpha\Delta\%K_{it} + \beta\Delta\%L_{it} + \delta\Delta Є_{it}\% + \gamma\Delta M_{it}\% \quad \ldots (3.15)$$

$$\Delta\%A_{it} = \%\Delta Yit - \alpha\Delta\%K_{it} - \beta\Delta\%L_{it} - \delta\Delta Є_{it}\% - \gamma\Delta M_{it}\% \quad \ldots (3.16)$$

Where $\alpha, \beta, \delta\ and\ \gamma$ are the estimated factor elasticities of output for capital, labour hour, energy and materials. L_{it} , is constructed as the product of number of employment of each firm and the national working hour per day per individual. Thus,

$$L_{it} = l_{it} h_t$$ [1]

Where, l_{it} is the number of employees in each firm and h_t is total hours of work including holidays per year excluding weekends. The within estimator, GLS and MLE methods are applied to estimate the model assuming that the error term is random, with some specific distributions and uncorrelated with regressors.

Or in a simple logarithmic version of the same function,

$$\ln CFP_{it} = lnY_{it} - \alpha lnK_{it} - \beta lnL_{it} - \delta lnE_{it} - \gamma lnM_{it} \quad \ldots (3.17)$$

This might be defined as a fraction of rate of change in CFP which equal to the difference between the rate of change in aggregate output and the rate of change in aggregate inputs. In this particular study, the partial productivity measures of labour and capital each are estimated and also the factor productivities net of the combination of these two primary inputs from output is estimated as Total Factor Productivity. Lastly, the productivity measure mesh of the combination of all the four factors labour, capital, energy and material (KLEM) is estimated as Combined Factor Productivity (CFP). This approach is applied for the whole manufacturing firms included in this study.

3. Unit Root Test

Prior to the conduction of the body of analysis, the panel xt series properties of log values of Q, K, L, E and M of the major variables has to be investigated with unit root tests of various alternatives. If a variable is subjected

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[1] The data obtained from firms about labour is total employment; total labour hour is after certain manipulation of the total employment. Five working days per week and eight hours of work per day with thirteen national holidays in the country per year is prevailed in the Ethiopian labour market. Thus, 〖w_Dy*h_d-H_ty〗_ , where w_Dy is the total working day per year is, h_dis the working hour per day and H_ty is number of holidays per year. In this case if any holiday is coincided with weekends, underestimation of the labour hour may commonly be made in all firms. Of course, it could not bring a variation in labour hours as the large share of variation may come from the employment variation only.

to unit root problem with one type of test and not with the other, the results of the major tests would be taken. Hence, for this reason the researcher has conducted Levin Lin Chun, Hadri LM stationary and Harris T. tests at least for those which failed to reveal stationarity in the first test technique. These tests help us to avoid unauthentic regression and determine whether the variables have long run relationships or not.That is, the importance of investigating the stationarity properties of the data being studied. This is because, if the series are non-stationary (as many economic variables have been found to be), then coefficient estimates based on ordinary least squares (OLS) regressions may be biased and inconsistent; i.e. the regression results can be spurious. Thus, if the variables are non-stationary

Table 5.7 presented that all the four log variables are stationary at level as the p-value for each of them is much below 1% , the null hypothesis which states that there is panel unit root problem has been rejected leading to the acceptance of alternative hypothesis that clearly clearly put the stationarity of the variables.

All unit root tests strongly reject the null hypothesis of unit root for all of the series included in the study, which indicate that all the time series included in this study are stationary at the level. Absence of unit roots is in the variables assures that the variables are stationary at level.

Table 1: LLC, Hadri LM and Harris T unit-root test for lnQ ,lnL, lnK,lnE and lnM

```
Ho: Panels contain unit roots           Ho: All Panels contain unit roots
Ha: Panels are stationary               Ha: Some panels are stationary
Panel means:  Included                      Number of panels = 75
Time trend:   Included                      Number of periods = 7
ADF regressions: 1 lag                      Asymptotics: N/T -> 0
LR variance:     Bartlett kernel, 6.00 lags average (chosen by LLC)
```

	Levin-Lin-Chu		Hadri LM		Harris Tzavalis	
	Stat(t)	p-value	stat(z)	P-value	stat(Z-rho)	P-value
lnQ						
Unadjusted t	-30.4397				(-0.3034)	
Adjusted t*	-29.6660	0.0000*	-0.7071	0.7603	-9.0483	0.0000*
LnL						
Unadjusted t	-75.319				(-0.3542)	
Adjusted t*	-74.0209	0.0000*	-1.2918	0.9018	-10.0275	0.0000*
lnK						
Unadjusted t	-1.4e+02				(-0.3329)	
Adjusted t*	-1.4e+02	0.0000*	-1.3588	0.9129	-9.6177	0.0000*
lnE						
Unadjusted t	-1.3e+02				(-0.2532)	
Adjusted t*	-1.3e+02	0.0000*	0.1206	0.4520	-8.0825	0.0000*
lnM						
Unadjusted t	-62.9851				(-0.3116)	
Adjusted t*	-60.6799	0.0000*	-0.6987	0.7576	-9.2070	0.0000*

Source: Own computation, *,**,*** 1%,5% and 10% level of significance respectively.

Well for the right two unit root tests, the null and the alternative hypotheses are stated in a distinct form from that of the Levin-Lin-Chu test. Null and alternative hypotheses of them are;

H_0: All panels contain unit roots and

H_1; Some panels are stationary.

Of course, in this case rejecting the null doesn't imply the acceptance of the alternative for there is a defect in it. So further, scrutinization of the alternative has to be made. Hadri LM stationary test result entailed us that only some panels is stationary by rejecting the null. Hence, it has to be backed up by the other tests. Harris Tzavaris, consistent with the Levin Lin Chu test has shown the existence of stationarity in all the variables listed out. As it has been pointed out in the introduction of the chapter, the results of the majority test techniques has to be taken. The two test techniques LLC and Harris approved that there is no unit root problem in the log values of the variables,lnQ,lnL, lnK, lnE and lnM.

4. Fixed Versus Random Effects Estimator

Various estimators of panel data set are known in econometrics. Among others, Pooled OLS, fixed and random effect estimators are the common ones. The reliability of the study would be greater if the results of two or more estimators result the same output. So, in addition to pooled OLS, selecting either of the later two must be the preceding duty of estimation. The panel hausman test result portrayed with its low p-value at 1% level of significance that null hypothesis is to be rejected for the reason that random effects model estimator is inconsistent. Thus, we intend to accept the alternative hypothesis in which fixed effect estimator is the preferred.

Table 2: Model Selection between Fixed and Random Effect Models

```
                          ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-
V_B))
             |     fixed        random       Difference          S.E.
-------------+------------------------------------------------------------
-
         lnL |    .0817994     .1029868       -.0211874        .0089229
         lnK |    .2395285     .2530832       -.0135547        .0042322
         lnE |    .2315675     .2419039       -.0103365        .0041176
         lnM |    .2362513     .2378614       -.0016101        .0036907
     lnExper |     .342276     .1089155        .2333605        .1299163
      lnCFP1 |   -.2379199    -.2406039        .0026841        .0018261
--------------------------------------------------------------------------
-
          b = consistent under Ho and Ha; obtained from xtreg
          B = inconsistent under Ha, efficient under Ho; obtained from
xtreg
    Test:  Ho: difference in coefficients not systematic
                  chi2(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       20.69
                Prob>chi2 =      0.0021
```

5. CFP levels and Growth Rates

Table 5.10 presented the combined factor productivity levels and growth rates of LMSM firms for the period 2006 to 2012. Beverage has been found as the most performing firms persistently holding the rank of greater than or equal to three in the whole study period. Firms in the pharmaceutical industry have shown miraculous productivity improvement by doubling their average CFP levels in the post-GTP period than the pre-GTP counterpart from (4.00) to (8.01) even though, their CFP level is subjected to serious fluctuation problem. Foot wear (5.10), apparel (4.40) and food (4.04) producing firms are top in generating greater CFP level as an ingredient of their output source in the years 2006-2009 while the lead has been taken by pharmaceuticals (8.01), Detergents (4.49) and beverages(4.28) after the transformation plan. Leather producing firms appeared to be the least in the CFP levels in all the study period consistently with an average value of (2.92) and (2.99) respectively in the before –after GTP horizon.

In a nutshell, the CFP ranges on average from (2.92) to (8.01) where the heaver industries (pharmaceuticals and chemicals) are at the top of the ranking and leather products at the bottom leaving the food and textile firms in the middle. In a condensed average analysis of pre-post GTP, foot wear, apparel and food have shown a lower level in the post than in their pre-version. The remaining groups have shown betterment in the same time period.

Hence, due attention and priority has to be given for those manufacturing sub-sectors with better CFP. Chemical industry, where pharmaceutical is its subset, assured rising level of productivity. This group has also relatively stronger inducing power (multiplier effect) on other industries. It is for this reason that resource diversion has to be made towards such sub sectors from the other light industrial groups with low combined factor productivity.

The comparative results productivity growth rates of firms under industrial groups for each year during 2006-2012 are presented in table 5.11, which explains the combined factor productivity change for all sub-sectors on yearly basis and provide a comprehensive understanding about the performance of them. The industrial groups are a little bit more decomposed than the original frame. Leather industry has been crumbled in to leather and foot wear sub industries and chemical in to basic chemicals, pharmaceuticals and detergents. In the first year of analysis, foot wear sub-sector is the best performer among all the sub-sectors with CFP growth rate of 6.43 followed by detergents and apparel where the productivity increased by 6.05 and 5.59 respectively. Textile is the least performer (-0.74) proceeded by food (-0.39). In the following year of 2007-08, the combined factor productivity growth rates of each sub-sector fluctuated from its previous rates where food(5.26) and basic chemicals(4.64) are among the lead takers, foot wear(-0.21) and apparel(-0.09)-the previous year tops became the tail in their combined factor productivity growth rates.

The year 2008-09 is also the most flattering for apparel where it’s combined factor productivity growth rate increased by (12.91) which is the highest for the overall manufacturing sector during the year. This year is the worst for food (-0.64) and pharmaceuticals (-0.95) as their productivities are the lowest from the whole study periods. In the year 2009-10, the CFP growth rate declined and became negative for most sub-sectors except leather and chemical constituents (2411, 2422, 2423).In this year pharmaceutical sub-sector has the highest CFP growth rate (160.17) and also has the highest average growth rate during 2006-2012 with an average score of (13.10). In the year 2010-11, the face of high productivity turns towards foot wear and textile while detergents and apparels are from the least category with negative productivity growth rates. Except for basic chemicals, 2011-12 is remarked by negative growth rates for all sub-sectors (eight) where the previous negative CFP has been deteriorated. It is the poorest season in productivity growth.

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Except for basic chemicals, 2011-12 is remarked by negative growth rates for all sub-sectors (eight) where the previous negative CFP has been further deteriorated. It is the poorest season in productivity growth. When we examined the sub-period performance of before-after GTP oupled with the overall average, apparel (23.23), foot wear (12.32) and detergents (10.21) are among the best performers in the pre-GTP period (2006-2009) whereas post GTP (2010-12) average is a sign of poor performance for almost all sub sectors except for textile (1.23), foot wear (0.89) and food (0.16) for their little positive productivity growth. The remaining six manufacturing sub-sectors have negative productivity growth. The last right column of the growth rate table disclosed that on average of the study period, detergent (27.32) producing firms are the most productive sub sectors though fluctuation is their feature like others. Apparel (22.88) and foot wear (22.01) and pharmaceuticals (17.55) are the second, the third and the fourth in the average ranking position of productivity growth in the whole study period (2006-2012). Stability in the growth rate is hardly common and hence, negative and positive rates are switching in each sub sectors albeit the difference in the magnitude of variation. Leather and basic chemicals are relatively stable at the lower levels of growth rates of productivities since their range of variation is between -1 and 1 whereas apparel and pharmaceuticals are among the most instable category(-1and30) units of productivity growth rate variation.

Table 3: Estimates of levels and growth rates of combined factor productivity

Estimates of CFP Levels and Growth Rates

CFP Levels

ISIC	Industrial Group	2006	Rank	2007	Rank	2008	Rank	2009	Rank	2010	Rank	2011	Rank	2012	Rank	Pre-GTP	Post GTP
1511-49	Food	0.73	5	0.45	7	2.79	5	1.01	7	0.77	7	0.96	8	0.94	6	4.04	3.53
1551-54	Beverage	1.94	2	1.54	2	4.42	2	10.47	1	6.21	3	7.89	2	2.32	3	3.35	4.28
1710&23	Textile	3.00	1	0.78	5	1.44	7	1.91	4	0.73	8	2.62	5	1.51	4	3.02	3.57
1810-00	Apparel	0.04	9	0.26	8	0.24	8	3.30	2	1.81	6	0.72	9	0.25	8	4.40	3.56
1910-00	Leather	1.60	3	1.91	1	3.14	4	1.35	6	2.51	5	2.81	4	0.62	7	2.92	2.99
1920-00	Foot wear	0.02	8	0.18	9	0.14	9	0.74	8	0.50	9	2.19	7	0.12	9	5.01	3.76
2411&22	Basic Chemicals	1.33	4	0.90	4	5.06	1	2.84	3	4.86	4	2.22	6	2.87	2	2.97	3.99
2423-00	Pharmaceuticals	0.33	6	1.09	3	2.78	6	0.14	9	22.56	1	10.90	1	4.60	1	4.00	8.01
2424-00	Detergents	0.12	7	0.85	6	3.84	3	1.61	5	12.09	2	3.89	3	1.49	5	3.90	4.49

CFP Growth Rates

ISIC	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2006-09	2010-12	2006-12
1511-49	-0.39	5.26	-0.64	-0.24	0.24	-0.02	0.71	0.16	0.50
1551-54	-0.21	1.87	1.37	-0.41	0.27	-0.71	1.36	-0.12	1.56
1710&23	-0.74	0.85	0.33	-0.62	2.60	-0.42	-0.41	1.23	-0.43
1810-00	5.59	-0.09	12.91	-0.45	-0.60	-0.65	23.23	-0.49	22.88
1910-00	0.19	0.64	-0.57	0.85	0.12	-0.78	0.25	-0.21	0.24
1920-00	6.43	-0.21	4.20	-0.33	3.42	-0.95	10.21	0.89	22.01
2411&22	-0.32	4.64	-0.44	0.72	-0.54	0.29	0.90	-0.32	1.16
2423-00	2.33	1.55	-0.95	160.17	-0.52	-0.58	2.32	-0.44	17.55
2424-00	6.05	3.52	-0.58	6.49	-0.68	-0.62	12.32	-0.52	27.32

Source: Own Computation

In general, productivity levels and growth rates in medium and large scale manufacturing sub-sectors of Ethiopia swings up and down for each activity group along the periods and among the sub sectors. The year 2011-12 , among the periods of post GTP, is marked by the lowest productivity growth rates as eight out of nine sub-sectors revealed negative growth rates followed by the eve of the GTP (2009-10) with five activity groups having negative productivity growth rates. This implied that the post-GTP period is less productive than its pre-GTP horizons of the MLSM sub-sectors. The negative growth rate for the majority of the manufacturing sub-sectors entails us that the acquired productivity is perhaps on random bases and thus, sustaining it would be a difficult mandate.

5.1 Estimation Results

In this section, the estimation results of pooled OLS and fixed effect estimators would have been discussed with regard to the determinants of firm output. The estimation is made based on the equations 3.10 and 3.13 above for both standard primal growth accounting and standard extended growth accounting Cob-Douglas production function.

Accordingly, table 5.4 depicted the result where columns 2, 4 and 6 presented the coefficients of the prime Cob-Douglas production function in which only labour, capital and TFP are considered in the production function regression taking value added as dependent variable. The technological change –Solow residual, has been counted in this section as TFP while CFP is for the KLEM case. Capital is found to be statistically insignificant in all the three sub-pool regressions though positive. This, finding contradicts the neoclassical theory of capital accumulation as the main source of output. TFP and labour took the first and the second rank of leading the activity units' output level determination. However, the potency of labour deteriorated from effecting 0.254 to 0.182 units of output variation per unit of labour input in the pre-post GTP horizon of KL model. The first is statistically significant at 1% level of significance but the second is only at 5%. Hence, in the primary factor case of manufacturing production, technological change (TFP) and labour have taken the lion share of output determination while capital has negligible impact on output. Of course, in some regards , due to our ignorance, the influence of capital might be included in the total factor productivity.

The 1, 3 and 5 columns of the above table depicted the estimated coefficients of KLEM –the extended standard CD production function. The pooled regression result of the three categories pointed out that except energy and experience; the coefficients of other variables are positive and statistically significant at 1% level of significance. The effects of energy in determining the output of firms are positive and significant at 10% level of significance only in the first pooling category (2006-2012) while experience is only in the third (2010-2012). Capital in the KLEM model is found to be influential though not as powerful as labour. The decimal figures of coefficients have also signified that the power of determination of combined factor productivity (CFP) is the highest proceeded by labour inputs of the average activity units in the LMSM manufacturing sector of Ethiopia.

Table 4: Pooled regression results of variables

Variables	2006-2012		2006-2009		2010-2012	
lnQd, lnQv	Coefficients					
	1	2	3	4	5	6
lnK	.1369058*	0.062	.1410398*	0.036	.1318188*	0.017
lnL	.7364387*	0.308*	.7716375*	0.254*	.6791547*	0.182**
lnE	.0107476***		.0093063		.0164130	
lnM	.0711522*		.0467217*		.1029773*	
lnTFP, lnCFP	.9798035*	0.408*	.9816458*	0.411*	.9807441	0.446*
lnExper	.0585153		.0056625		.0056625***	
_cons	1.530428*	10.04*	1.399481*	9.87*	1.774044*	10.70*
R-squared	0.9628	0.4199	0.9714	0.3918	0.9507	0.4973
Adj R-squared	0.9624	0.4165	0.9714	0.3857	0.9493	0.4905
Prob > F	0.0000	0.0000		0.0000, N=300	N=225	0.0000,

Source: Computed from CSA data on LMSM annual survey reports (2006-12) using Stata12.version

*,**&*** refers to 1%, 5% and 10% level of significance respectively.

The finding has important policy relevance in such a way that labour intensive industrial investments are to be prioritised and productivity enhancement instruments such as trainings and employee incentives ought to be supplemented so as to sustain the benefit of productivity. Capital accumulation must be interpreted in the form of research and development or innovation which has augmenting effect of productivity than the direct physical capital accumulation. The finding related to production experience is inconsistent with what Gebreeyesus has found in (2009) for Ethiopian manufacturing firms. He reported that incumbent firms have better performance than newly entering counterparts. This bears the fact that experience has significant effect on production performance.

A unit change in combined factor productivity resulted in 0.97unit change in average output level of the activity units in the sector followed by labour and capital with 0.73 and 0.13 units of output variation per unit of labour and capital changes respectively. The rank of influence of the control variables has remained the same in the three sorts of pooling periods. The constant assumption of Cob-Douglas production function has been rejected in both cases of standard primal CD production function and extended [1]standard CD production functions. The sum of coefficients of major explanatory variables (K,L) and (KLEM) in the prime and extended

[1] Standard prime CD production function, Qv=F (L, K, A) where Q is Value added of the firm; L is labour hour, K is capital and A is Total Factor Productivity (TFP). Extended standard CD production function , Q=F(L,K,E,M,V) where Q is gross output, L,K as defined before ,E is energy , M is material and V is combined factor productivity(CFP) with implicit subscriptions of i and t for cross sectional and time variations of each variable.

production functions is less than one-implying a decreasing production function experienced by Ethiopian manufacturing firms. Thus, the empirical investigation result has shown that TFP and CFP followed by labour are found to be the dominant determiners of the variation in outputs of manufacturing firms in Ethiopia. This is so in both prime and extended CD production functions and in all the three data pooling sorts of Regression with respect to pre-post GTP. Therefore, firms should focus on augmenting the labour input and TFP/CFP through provision of relevant trainings, wakening of them by the instrument of bonus and via improving the working conditions as well as the managerial efficiencies which then , correct the paralyze of decreasing returns to scale of production in to the better increasing.

Table 5: Fixed effect Regression of panel data with prime (K, L) and extended (KLEM) CD prodn prodn

Fixed − effects (within) regression
$F(7,443) = 1074.12$
$Prob > F = 0.0000$

R − sq: within = 0.9644
between = 0.9471
overall = 0.9550
Corr(u_i, Xb) = 0.0000

lnQd	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnK	.1293071	.0092776	13.94	0.000	.1110736	.1475406
lnLh	.7185213	.0231805	31.00	0.000	.6729638	.7640787
lnE	.0116295	.0070958	1.64	0.102	-.002316	.0255751
lnM	.0764282	.0072075	10.60	0.000	.0622631	.0905932
lnCFP	.9486248	.0114912	82.55	0.000	.9260407	.9712089
lnExper	.0898503	.1618393	0.56	0.579	-.2282178	.4079185
_cons	1.467358	.4618459	3.18	0.002	.559677	2.375039
sigma_u	.28451336					
sigma_e	.41194514					
rho	.32295605	(fraction of variance due to u_i) (rho*=.1906872@)				

F test that all u_i=0: F(74, 443) = 1.65 Prob > F = 0.0013
F test that all u_i=0: F(20, 501) = 5.00 Prob > F = 0.0000@

R − sq: within = 0.4429
between = 0.3317
overall = 0.4127
Prime CD

cons = 8.872287 *
u = .61496128
e = 1.2669084

lnLh = .1912351 *
lnK = .0255087
lnTFP = .4373009 *
Prime CD

The second estimator as introduced in the beginning of the section is the fixed effect estimator. The two types of Cob-Douglas production have been considered in this case also. The estimated coefficient or parameters for the KLEM (extended standard CD) has been presented on the main body of table 5.5 while that for the prime standard CD (K, L) has been depicted at the bottom of the same table in half parenthesis. Now let us shift to examine the estimated coefficients of the regressors based on the fixed effect estimator. Similar to the above pooled OLS estimator, the fixed effect estimator could also take into account the prime and the extended standard CD production functions. The results presented in table 5.13 revealed that CFP/TFP is the significant factor that affects the output level of the firms positively as confirmed from the regression analysis of the two models. In KLEM CD model, the average magnitude of the coefficient of CFP in fixed effects panel data estimation is 0.95 leaving the second position to labour with a coefficient of 0.72. Thus, 100 percent change in CFP and labour would end up in 95 and 72 percents of output variation respectively. If we compare it with the magnitude of influence with that of the pooled OLS regression result of column 1 in table 5.4, the fixed effect coefficient has shown a reduction of 0.03 and 0.02 in CFP and labour respectively. However, despite this, the ranks of influence of the two variables are not overtaken by any other and each other. The effects of energy, experience on output has been statistically insignificant even at 10 percent level of significance in case of fixed effect regression analysis. Capital and material resulted 1.3 and 0. 9 percent of output change per 10 percent variation of the quantity of each of these resources.

The fixed effect estimation of the prime standard CD production function revealed that output is explained less than 41percent (R^2) by the controlled variables included in the model. This shows that omitted input variables have led to weak model specification. It is for this reason that alternative models of CD production function has been used in the study. Albeit the fact that their order of influence is remained constant with that in the pooled regression estimation result, their magnitude of effecting output declined in case of capital and labour. The coefficient of capital has reduced from 0.06 to 0.03 and that of labour is declined from 0.30 to 0.19. Unlike to capital and labour, TFP has shown 0.03 percent increment. However, despite the little bit variation in the coefficients estimated by the two methods, consistency in both models is ensured as the lead of output determination is taken by CFP/TFP and labour where capital is statistically insignificant to affect output in the prime model in both estimators.

If we link this result with factor intensity experience of Ethiopian manufacturing firms, it is capital – the less determiner of output, which has greater factor intensity (Amare, 2015a). So, our firms need to pick lessons up from here thereby to focus on labour which found to be the most persuading factor in the production processes of LMSM of Ethiopia. Thus, labour augmenting mechanisms such as training, incentives of various forms and improved working conditions would be given due attention.

6. Conclusion

The CFP measurement result confirmed that leather industry is the least productive (2.92) sub-sectors while pharmaceuticals and chemicals (relatively heaver industries) are at the top of the ranking (8.01) leaving the food and textile firms in the middle. In a condensed average analysis of pre-post GTP, foot wear, apparel and food have shown a lower level in the post than in their pre-version. The remaining groups have shown betterment in the same time period. Average combined productivity growth rate has declined from 5.7percent in the ex-ant period to 0.02percent of ex-post period of GTP. The rank of productivity level of industrial sub-groups revealed that leather and textile have shown deterioration while pharmaceuticals (9th in 2009) and (1st in 2010 onwards) and detergents–both in chemical industry have acquired a better position in the post GTP period. Hence, due attention and priority has to be given for those manufacturing sub-sectors with better CFP. Chemical industry assured a more rising level of productivity. This group has also relatively stronger inducing power (multiplier effect) than others on the rest of the economy. It is for this reason that resource diversion has to be made towards such sub sectors from the other light industrial groups with low combined factor productivity.

The estimation result of the parameters asserted that CFP and labour, in both KL and KLEM models, are found to be positive and statistically significant in determining firms' output while capital is significant only in the KLEM approach. In the KL function, in this study technological change –Solow residual, is deemed as TFP while CFP is for the KLEM. The statistical insignificancy of capital in all the three sub-pool regressions, contradicted the neoclassical theory of capital accumulation as the main source of output. TFP and labour took the first and the second rank of leading the activity units' output level determination. However, the potency of labour deteriorated from effecting 0.254 to 0.182 units of output variation per unit of labour input in the pre-post GTP horizon of KL model. A unit change in combined factor productivity resulted in 0.97unit variation in average output level of the activity units in the sectors followed by labour and capital with 0.73 and 0.13 units of output variation per unit of labour and capital changes respectively in KLEM of pooled OLS estimation while the fixed effect estimator resulted 0.95, 0.72 and 0.13 for CFP, labour and capital respectively. Fixed effect estimation of KL result is not so different from the above. The leading role of TFP and labour with parameter values of 0.44 and 0.19 are statistically significant to determine output. Material is positive and statistically significant at 1% level of significance in all four cases[1] but has weak potency of determination while energy and production experience have insignificant effect on output of firms.

The findings have important policy relevance in such a way that labour intensive industrial investments are to be prioritised and productivity enhancement instruments such as trainings and employee incentives ought to be supplemented so as to sustain the benefit of productivity. Capital accumulation must be interpreted in the form of research and development or innovation which has augmenting effect of productivity than the direct physical capital accumulation. The finding related to production experience is inconsistent with what Gebreeyesus has found in (2009) for Ethiopian manufacturing firms. He reported that incumbent firms have better performance than newly entering counterparts. This bears the fact that experience has significant effect on production performance. If the estimation result is linked with factor intensity experience of Ethiopian manufacturing firms, it is capital –the less determiner of output, which has greater factor intensity (Amare 2015a). So, our firms need to pick lessons up from here thereby to focus on labour which found to be the most persuading factor in the production processes of LMSM of Ethiopia. Thus, labour augmenting mechanisms such as training, incentives of various forms and improved working conditions would have to be given due attention.

Bibliography

Abramovitz, M. (1956): "Resource and Output Trends in the United States Since 1870," American Economic Review, 46, 5-23.

Baldwin, J.R., Harchauoui, T.M., Hosein, J., Maynard, J.-P. (2001). "Productivity: Concepts and trends". In: Baldwin, J.R., Beckstead, D., Dhaliwal, N., Durand, R., Gaudreault, V., Harchaoui, T.M., Hosein, J., Kaci, M., Maynard, J.-P. (Eds.) *Productivity Growth in Canada*. Statistics Canada, Ottawa, pp. 51–78.

Bigsten, A. / M. Gebreeyesus (2009). Productivity and exports: Evidence from Ethiopian manufacturing. *Journal of Development Studies*. No. 45, October, pp 1594−1614.

Chen and Feng, Y. (2000). "Determinants of economic growth in China: Private enterprise, education, and openness". China Economic Review, 11, 1-15.

[1] Pooled KL & KLEM and Fixed effect KL& KLEM

Central Statistical Agency (2012). “International Standard Industrial Classification of All Economic Activities of Ethiopia”, Revised No.4.

Denison, E. F. (1962): “The sources of economic growth in the U.S. and the alternatives before us," Supplementary Paper No 13, New York: Committee for Economic Development.

Ethiopian Economic Association/ Ethiopian Economic Policy Research Institute (2005) “Industrialization and Industrial Policy in Ethiopia”, Research Report, Addis Ababa

Greene (2008): “The Econometric Approach to Efficiency Analysis," in the Measurement of Productive Efficiency and Productivity Change, ed. by H. O. Fried, C. A. K. Lovell, and s. S. Schmidt, chap. 2, pp. 92 {250. Oxford University Press.

Gebreeyesus, M. (2008): “Firm turnover and productivity differentials in Ethiopian manufacturing, in”: *Journal of Productivity Analysis* 29, 113–129

Hsiao(2000). “Economic Panel Data Methodology,” in International Encyclopedia of the Social and Behavioral Sciences, edited by N.J. Snelser and P.B. Bates. Oxford: Elsevier (forthcoming)

Hulten, Charles R., and Sylaja Srinivasan. (1999).”Indian manufacturing industry”:Elephant or Tiger? NBER working Paper no. 5569. Cambridge,Mass.: National Bureau of Economic Research, October.

Hulten, Charles R. 2009. “Growth Accounting.” National Bureau of Economic - Research Working Paper 15341.

Jorgenson, D. W., and Z. Griliches (1967): “The Explanation of Productivity change," Review of Economic Studies, 34, 249-283.

Kim, Jong-Il, and Lawrence J. Lau. 1994. The sources of economic growth of the East Asian newly industrialized countries. Journal of Japanese and International Economies 8:235–71.

Kothari, C.R.(1990). *Quantitative Techniques,* 2nd ed., New Delhi: New Age International Publishers Pvt. Ltd., 1990.

MoFED(2010).Annual First year implementation performance report of GTP.

Nelson, R. R. (1981): “Research on Productivity Growth and Productivity Differences: Dead Ends and New Departures," *Journal of Economic Literature*, 19, 1029-1064.

OECD (2001). Measurement of aggregate and industry-level productivity growth. OECD manual. Paris.

Pieri, Fabio2010, *Essays on Productivity and Efficiency Analysis*. University of Trento.

Solow, R. (1957): “Technical Change and the Aggregate Production Function," The Review of Economics and Statistics, 39, 312-320.

World Bank (2006) Mexico’s competitiveness: reaching Its potential. World Bank report no. 35388-MX. Washington, DC

World Economic Forum (2006) The global competitiveness report 2006–2007

World Bank (2011). World development indicators. Ishington D.C.: the World Bank. Computer file.

Young, Alwyn. (1992). A tale of two cities: Factor accumulation and technical change in Hong Kong and Singapore. In *NBER macroeconomics annual 1992,* ed. Olivier Blanchard and Stanley Fischer, 13–36. Cambridge, Mass.: MIT Press.

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