Does Schooling Influence Productivity? The Case of Ethiopian Manufacturing Enterprises[1]

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Abstract

An empirical investigation was conducted to verify whether schooling influences productivity in the Ethiopian Public Manufacturing Industries. The results indicate that schooling influences the productivity of manufacturing enterprises significantly; viz, the higher the proportion of the labour force with a high level of schooling in an enterprise, the higher is productivity. This implies that increasing the proportion of social wealth expended on education is paying and that the education system in Ethiopia seems effective in translating skilled manpower into services. This, in turn, implies that not only broadening schooling in terms of quantity, but also deepening schooling by fostering quality could increase the productivity of manufacturing enterprises. Thus, government has to intervene in supplying skilled manpower since there is a serious risk of private under-investment in training at a firm level. However, for successful industrialisation to take place, any government move to supply these resources should involve the beneficiaries in order to balance demand and supply; give emphasis to tertiary education as strongly as basic education; and synchronise with other supportive schemes since human capital investment on its own cannot lead to the industrialisation of a country.

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1. Introduction

1.1 Background

Education is believed to create a productive citizen by inculcating important and useful knowledge into the minds of people, thereby speeding up economic development. Education "*transforms the raw human beings into production human capital by instilling the skills required by both the traditional sector and the modern sector of the economy, and makes the individuals more productive not only in the market place but also in the household*" [Tilak, 1992: 12].

Based on the above premise, a number of efforts have been made to quantify the impact of education in expediting economic development in different parts of the world since the 1950's. Some of the results of these efforts are summarised in Table 1.

These efforts have continued in other directions, as well in ways of seeking to quantify the importance of literacy in explaining differences in economic growth of countries; the correlation of enrolment ratios and GNP per capita; the cost-benefit ratio of investment in primary education vis-à-vis investment in infrastructure, etc.

Table 1: Role of Education on the Growth of Per Capita GNP or Income: Study Results

Researcher/Author	Year	Country	Contribution of Education
Denison	1909-29	USA	23%
	1929-57	USA	42%
	1948-73	USA	21%
Kendricks and Jorgenson	1945-76	USA	15-25%
Psacharopoulous	1950s and 1960s	Africa	17.2%
		Asia	11.2%
		Latin America	5.1%
		North America	20.0%
		Europe	6.5%

Source: Tilak, 1992:11-14

Regarding the relationship between literacy and economic growth, Bowman and Anderson [cited in Tilak, 1992:13-14] found out that:

- For a country to reach a GNP per capita level of US $200 (in 1950), a 40% adult literacy rate is necessary;
- GNP per capita crosses the US $500 only if literacy rate exceeds 80%; and
- Primary enrolment differences in the 1950s had substantial explanatory power for income level differences in 1980s.

Furthermore, Peasle's study (cited in Tilak, 1992:15]) on the 34 richest countries of the world since 1850 showed that no country has ever achieved significant economic growth without first attaining an enrolment ratio of 10% at primary level. The correlation coefficients between enrolment and economic growth were found to be strong: Curle found a 0.64 correlation coefficient between GNP per capita and post-primary enrolment and a coefficient of 0.53 between GNP per capita and proportion of GNP invested in education [Tilak, 1992:15]. Econometric methods produced similar results, namely the relationship between literacy and economic development is significant and strong.

For instance, according to Tilak (1992:16):

- Hicks found that a 20% increase in the literacy rate leads to a 0.5 percent increase in the growth rate;
- Wheeler found that an increase in literacy from 20 to 30 percent resulted in an increase in real GDP of 8 to 16 percent.
- Marris predicted that a one-percentage point difference in primary enrolment ratio was associated with 0.035 percent points in inter-country differences in per capita income growth rates.

Regarding the benefit-cost ratio of investment in education vis-à-vis investment in infrastructure, results favoured investment in the former. For instance, Marris's study (see Tilak, 1992:16) of 63 countries produced a benefit-cost ratio for primary schooling enrolment of not less that of 3.4 (for low income countries for the period 1981-87) while the equivalent ratio for infrastructure was found to be one or less than one.

All these empirical evidences strongly support the pivotal role played by education in economic development and suggest that a certain proportion of social wealth must be allotted for expanding education. A country that has failed to do so is liable to remain underdeveloped. In this regard, Lall stated that " *the operation of easy, low technology activities with which industrialisation generally starts requires literacy and schooling, a range of basic technical skills and some high level technological and*

managerial skills. To build upon a base of easy activities and enter more demanding activities calls for increasing level and technical specialisation in education" (Lall, 1992a: 117).

The low level of human capital invested in industry in Africa, including Ethiopia, suggests that this is one reason why the region presents a general picture of poor technological mastery and dynamism in industry. African countries with relatively high literacy rates and secondary schooling enrolment ratios like Kenya, Mauritius and Zimbabwe (Cornia et al, 1992:217) are also those with the best industrial record. Rodrik, in emphasising the importance of schooling and educational attainment as initial conditions for growth in East Asia, had said " *once initial levels of schooling is taken into account, there appears to be nothing miraculous about the high performing Asian Economies' growth experiences*" (Rodrik, 1994:8). All these are supportive of the contention that schooling is important in influencing productivity and growth.

But learning could be partly a matter of inherent intelligence, and partly of aptitudes and incentives. Education explosion and growth of enrolment may not necessarily bring about enhanced productivity and growth. How effectively those resources can be translated into services and how consistent the pattern of human resource development is with the pattern of economic growth is the central issues. In this respect, Easterlin says "I *think we can safely dismiss the view that the failure of modern technological knowledge to spread rapidly was due to significant differences among nations in the native intelligence of the populations. To my knowledge there are no studies that definitively establish differences, say, in basic IQ among the people of the world*" (Easterlin, 1981:5). Incentives for learning, education systems and quality of education matter more for productivity than any other variables.

A study carried out by Behrman and Birdsall in Brazil produced a much lower social rate of return to expanding primary years of schooling once quality is taken into account. They concluded that "*deepening schooling by increasing quality has a higher social rate of return than broadening schooling by increasing quantity*" (Berhman and Birdsall, 1983: 929).

There are other studies, which find weak or insignificant relationship between education and economic growth (Tilak, 1991:22). There are theories, as well, which consider education as a credential mechanism and screening apparatus. Schooling may not actually raise cognitive skills or productivity but may raise the private wage because it serves as a signal to employers of some positive characteristics like ambition or innate ability.

Study Objective

It is now generally accepted that a person with a high level of formal education is better prepared to adapt, understand, learn, use and create ideas. An enterprise staffed with personnel equipped with the proper skill and education has to appear at a higher production frontier to insure better resource utilisation and higher productivity. Ethiopia being cognisant of this fact has put every effort to hasten human resource development. This can be seen from the total public and education expenditure figures provided in Table 2.

As can be seen, total public expenditure on education increased continuously since 1990/91 at an annual average growth rate of 23.1 percent. Not only has the magnitude of public investment on education increased, but also its share in total public expenditure, the latter rising from 9.7% in 1990/91 to 13.8% in 1995/96.

Table 2: Public Education Expenditure in GDP 1990/91-2003/04

Year	Total Education Expenditure (000 Birr)	Share from Total Public Expenditure (%)	Share from GDP (%)
1990/91	489,654.8	9.7	2.4
1991/92	528,467.6	12.4	2.6
1992/93	694,400.0	11.3	2.6
1993/94	1,033,600.0	12.9	3.8
1994/95	1,145,200.0	13.3	3.6
1995/96	1,336,969.2	13.8	3.5
2000/01	2,178,400.0	13.7	4.0
2001/02	2,507,100.0	14.2	4.8
2002/03	3,293,100.0	16.1	5.8
2003/04	4,146,000.0	20.4	5.9

Source: PHRD. Education Sector Review: Synthesis and summary. Addis Ababa, Nov. 1996.
MoE. Education Statistics Annual Abstract 1996 E.C (2003/04). January 2005

However, the author could not come across empirical studies undertaken on Ethiopia to establish quantitatively whether schooling, in the Ethiopian context, has served as a screening and credential mechanism or as a condition of growth. Thus, this paper has yet to verify whether investment in schooling influences the productivity of the economy or whether it is unnecessary over-investment. Given this gap in knowledge,

the objective of this paper was to examine how significantly schooling has influenced productivity in Ethiopian manufacturing enterprises and generate some evidence on where schooling stands in the Ethiopian context.

During the writings of this paper, however, there were efforts towards the same end by Netsanet, Assefa and Abay (see Senait and Alemayehu, 1998). Netsanet measured the contribution of education to Ethiopia's economic growth using a growth equation (time series error correction model). He arrived at a result that education enters positively and significantly in explaining growth in aggregate real output (Netsanet, 1998). Assefa and Abay (1998) examined the impact of education on the technical and allocative efficiency of smallholder farmers in Ethiopia using the frontier profit function approach and arrived at a result that educated farmers are relatively and absolutely more efficient than illiterate farmers. These efforts nonetheless did not consider the impact of the level of schooling (primary, secondary and tertiary) on productivity, which is the focus of this paper.

There were efforts by Tesfayi and Krishnan (1998), Wolday (1998) Mengistu (1998) and others in estimating "returns to schooling" using earning function; but not reviewed since the focus here is analysing the impact of the different level of schooling on productivity.

2. Model

Two models are employed here to determine the importance of education in Ethiopian manufacturing enterprises. The first model is a version of Cobb-Douglas production function and the second is total factor productivity. The version of Cobb-Douglas production function is of the following form:

$$Q = AK^{\beta}L^{\alpha} \qquad (1)$$

Where Y =output; K =Capital; L = Labour; A = Efficiency parameter; β=Capital elasticity of output and α= Labour elasticity of output.

Labour is assumed to be heterogeneous so that the efficiency of the labour force differs by educational category. Four educational categories are considered, namely:

L_o = Number of workers with no formal schooling;

L_1= Primary schooling;
L_2= Secondary schooling and
L_3 = Tertiary schooling.

It is further assumed that the difference in efficiency between L_i and the base category L_o is ε_i. That is:

$$L_i = (1+\varepsilon_i)L_o \tag{2}$$

If ε_i is negative, schooling has a negative impact since the productivity of the L_i category is less than that of category L_o and the vice versa if $\varepsilon_i > 0$.

Under this scenario, labour in its efficiency unit becomes different from its mere number; that is, the labour input (Le) will be (see appendix):

$$L_e = L_o + \sum_{i=1}^{3}(\varepsilon_i + 1)L_i = L + \sum_{i=1}^{3}\varepsilon_i L_i \tag{3}$$

Here L is homogenous labour, with identical productive content as L_o.

If $\varepsilon_i>0$, labour in its efficiency unit is greater than its mere volume. In this case, schooling influences productivity positively. If $\varepsilon_i<0$, schooling is a cost.

Under this scenario, equation (1) will take the form of:

$$Y = AK^{\beta}[L_o + \Sigma(\varepsilon_i + 1)L_i]^{\alpha} \tag{4}$$

This can be transformed to another form by expanding equation (4):

$$Y = AK^{\beta}[L + \Sigma\varepsilon_i L_i]^{\alpha} \tag{5}$$

Since L= L_o+L_1+L_2+L_3, dividing the right hand side by L/L will turn the equation to:

$$Y = AK^{\beta}\left(L(1+\frac{\Sigma\varepsilon_i L_i}{L})\right)^{\alpha} \tag{6}$$

Assuming $\lambda_i = L_i/L$, equation (6) will take the form:

$$Y = AK^{\beta}[L(1+\Sigma\varepsilon_i\lambda_i)]^{\alpha} \tag{7}$$

If L is factored out, equation (7) will be:

$$Y = AK^{\beta}L^{\alpha}(1+\Sigma\varepsilon_i\lambda_i)]^{\alpha} \tag{8}$$

In this equation, the variable λ_i represents the proportion of each educational category and $\Sigma\lambda_i=1$. The coefficient of each λ_i represents the productivity differential between educational category i and the base category λ_o. By definition, if ε_i is greater than zero, then category λ_i is more productive than the base category λ_o. In this instance, schooling is paying.

Since it minimises the problem of multicollinearity and heteroscedasticity, it is better to divide both sides of equation (8) by L to give:

$$\frac{Y}{L} = \frac{AK^{\beta}L^{\alpha}(1+\Sigma\varepsilon_i\lambda_i)]^{\alpha}}{L} \tag{9}$$

Given that $L = L^{\beta} L^{1-\beta}$, equation (9) will be:

$$\frac{Y}{L} = A\left(\frac{K}{L}\right)^{\beta} L^{\alpha-(1-\beta)}\{1+\Sigma\varepsilon_i\lambda_i\}^{\alpha} \tag{10}$$

Taking its logarithms, equation (10) can be written as

$$Ln\left(\frac{Y}{L}\right) = LnA + \beta Ln\left(\frac{K}{L}\right) + \theta LnL + \alpha Ln(1+\Sigma\varepsilon_i\lambda_i) \tag{11}$$

where $\theta=\alpha+\beta-1$. θ indicates the extents of returns to scale. If $\theta<0$, there are decreasing returns to scale, if $\theta=0$ constant returns to scale are indicated, and if $\theta>0$ there are increasing returns to scale.

If we make use of the first-order Taylor series approximation that $Ln(1+x)\approx x$, then it is possible to rewrite equation (11) as:

$$Ln\left(\frac{Y}{L}\right) = LnA + \beta Ln\left(\frac{K}{L}\right) + \theta LnL + \alpha \sum \varepsilon_i \lambda_i \qquad (12)$$

The problem here is to identify singly ε_i from the coefficient of λ_i. $\theta=\alpha+\beta-1$ implies that $\alpha=1-\beta+\theta$. Since $\varepsilon_i=\alpha\varepsilon_i/\alpha$, we get $\varepsilon_i=\alpha\varepsilon_i/(1-\beta+\theta)$. Thus, εi can be determined from the coefficients of Ln(K/L), LnL and λ_i.

Another alternative to detect the importance of schooling in determining productivity is outlined below. First, the total factor productivity (A) of each firm is calculated using the expression:

$$A = \frac{Y}{aL + bK} \qquad (13)$$

Where a and b are Labour and Capital shares from value-added and Y, L and K are as specified in equation 1. The next step is to observe whether there are differences in total factor productivity (TFP) across firms and determine if these TFP differences exhibit a systematic pattern in relation to educational composition of the labour force in each firm using the following functional form:

$$A= f (K/L, W, \lambda_0, \lambda_1,\lambda_2,\lambda_3) \qquad (14)$$

Where:

K/L= Capital-labour ratio;
W =average wage rate;
λ_o = proportion of workers with no formal schooling;
λ_1 = proportion of primary schooling;
λ_2 = proportion of secondary schooling and
λ_3 = proportion of tertiary schooling.

If the coefficient for λ_i is positive, then i-category of schooling is important in determining productivity.

A panel data set, following a sample of individuals over time, is used in this paper, providing multiple observations on each individual included the sample (Hasiao, 1986:1). Panel data have advantages over conventional cross-sectional or time

series data in that they increase the degrees of freedom and reduce possible collinearity problems, thereby improving the efficiency of econometric estimates. Secondly, sequential observations for a number of individuals help to make inferences about the dynamics of change and help to construct and test more complicated behavioural models. Moreover, panel data help to reduce the effects of omitted variables over time or across individuals (Hsiao, 1986:1-4).

Nevertheless, panel data have their own limitations. Heterogeneity across units and over time leads to a variety of models, each based on assumptions made about the intercept, slope and characteristics of the disturbance term. The possible model specifications are presented in Table 3 where i and t represents enterprises and time.

Table 3: Taxonomy of Panel Data Models

	Assumptions about:		
Models	**Intercept**	**Slope**	**Disturbance Term**
1(a)	Common for all i,t	Common for all i,t	$E(UU') = \delta^2$
1(b)	Common for all i, t	Common for all i,t	E(UU')=V
2(a)	Varying over i or t	Common for all i, t	Fixed effect model
2(b)	Varying over i or t	Common for all i,t	Random effect model
3(a)	Varying over i, t	Common for all i,t	Fixed effect model
3(b)	Varying over i, t	Common for all i, t	Random effect model
4	Varying over i,t	Varying over i,t	Random Coefficient Model

Source: Johnston [6:397].

Model 1(a) assumes an identically, independently and normally distributed disturbance term. Model 1(b) assumes a heteroscedastic or serially correlated disturbance term, which requires a generalised least square (GLS) technique. Model 2 relaxes the assumption of a common intercept but retains the assumption of common slope coefficients for all decision units. Model 2(a) assumes an enterprise specific effect that reflects heterogeneous technologies and managerial skills or a time effect that reflects heterogeneous changes in capacity utilisation, technical progress (learning) or the general environment over time. Model 2(b), on the other hand, assumes a single intercept and the differential intercepts are merged with the disturbance term (which gives a random effect or error component model). Model 3 assumes the intercept to vary across individuals and over time simultaneously leading to a two fixed effects model (enterprise effect and time effect) or a three component error term- each component standing for enterprise effect, time effect and

the usual white noise. The specifications to be employed depend on the objectives of the study, the sampling technique, and the ease of the estimation techniques.

In this paper, model 2(a) is selected due to the strong conviction that the intercept for the current study might be different across enterprises. This is because of technological and managerial differences (which need to be captured so as not to confuse the impact with differences in schooling) but not over time, since the time is short and the years are nearly normal and identical. All possibilities will, however, be explored to arrive at reasonable inferences and implications.

3. Data and Limitations

As is obvious from the above, information required for the models relate to output (Y), capital (K) and labour (L), the latter by educational category.

Gross value-added at factor cost at current prices can represent output. Value-added is chosen in this analysis simply because it makes aggregation across enterprises possible and avoids double counting (inclusion of brought-in materials from other enterprises) and properly accounts for work done by each enterprise. The only problem in considering value-added as a measure of output in production is that it ignores the possibility of substitution between primary and intermediate inputs.

Capital input in production can be represented by net fixed assets of the enterprise in spite of the fact that:

- Net fixed assets constitute a stock (not a flow) concept, which is irrelevant to a production function.
- There is a direct relationship between changes in technology and gross fixed assets since innovations are embodied in capital goods, which replace existing equipment.
- Net fixed assets suffer from arbitrariness involved in the concept of depreciation.

In this paper, labour input in production is represented by permanent man-years excluding temporary and contract man-years. This has limitations in terms of not giving due consideration to the following questions:

- Which labour inputs are appropriate factors of production?
- What stock is available for use in production (man-years)?

- In what time periods are stocks available for production (man-hour)?
- Whether there is compensation for the flow of services (wages)?
- Does the productivity content of an hour of heterogeneous labour be identical thereby labour can be additive?
- Do relative earnings really match with relative marginal productivity and hence wage can serve as weighting mechanism?

As mentioned earlier, labour is classified by educational category. Initially, it was attempted to classify labour employed in the enterprises into four categories; namely, no formal schooling, primary schooling, secondary schooling and tertiary education levels. However, data constraints imposed restrictions and permanent man-years had to be partitioned into four: Labour with an educational background of less than grade 8 (L_1), of between grade 9 and 12 (L_2), of semi-professionals (L_3) meaning those with diploma, and of professionals (L_4) i.e. those with first degrees and above. Thus, the coefficients ε_i represent the difference in efficiency of labour between educational category i and the base educational category of below grade 8.

The sources of data used consist of audited financial reports and plan documents of each manufacturing enterprise included in the study. From plan documents permanent man-years broken down by educational category were obtained. All other information was obtained from the audit report of the enterprises. Information was gathered on 53 manufacturing enterprises for three consecutive years. These enterprises covered all ten sectors of the manufacturing (industrial) sector of the country. But, their selection can be said to be random since some sectors are represented disproportionately and some enterprises, which lacked data on one or more relevant variable, were excluded from the study. All the enterprises included in the study are public. Because the working environment, management and practical application of skills acquired through formal education are different in private and public enterprises, the results of the study might not be representative of realities in the private sector.

The years selected for the analyses are 1986/87, 1987/88 and 1988/89, which were relatively normal years, with no major upheavals like drought, war or political changes (including changes in the planning process). But, these years coincide with the period when there was a command economy, which stifled professionals' inspiration to apply their knowledge. Hence, the results obtained may not reflect the current situation where there has been a switch to more liberal practices.

4. Estimation Results

4.1 Summary Statistics

The schooling background of the labour force and the sample distribution of schooling of the selected manufacturing enterprises are summarised in Table 4. The average proportion of professionals in the total labour force of Ethiopian manufacturing enterprises was only 2.04 percent. The bulk of the labour force (almost 91.35 percent) consisted of non-professionals mostly grade 12 and below (of which 71% were grade 8 and below). Professional and semi-professional categories of labour force accounted for only 8.65 percent of the total labour force in the Ethiopian manufacturing enterprises under consideration.

But there were variations across enterprises with respect to the proportion of the labour force of professional and semi-professionals. While there were enterprises with no professional or semi-professional labour force, there are others with maximums of 8.45 and 31.11 percent professionals and semi-professionals respectively. The variance (or standard deviation) clearly shows this variation, although the variation of the proportion of professionals across enterprises was minimal compared to that of grade 8 and below category. Whether the variation in the proportion of professionals across enterprises showed a pattern in terms of relationship with productivity differences across enterprises is the main concern to be checked.

Table 4: Summary Statistics of Educational Background

	Educational Status			
Summary Statistics	**Professional**	**Semi Professional**	**Grades 9 - 12**	**Grades 8 and below**
Mean	0.0204	0.0661	0.2638	0.6497
Standard deviation	0.0147	0.0529	0.1188	0.1275
Median	0.0188	0.0505	0.2319	0.6656
Interquartile range	0.0182	0.0549	0.1329	0.1532
Minimum	0	0	0.0816	0.253
Maximum	0.0845	0.3111	0.7108	0.9031
IQR/1.35	0.0135	0.0407	0.0984	0.1135
Kurtosis	2.7566	5.4052	2.5319	0.5075

Skewness	1.2991	1.9806	1.3949	-0.7683

***Source**: Own Computation based on data from selected manufacturing enterprises.*

Regarding the sample distribution, all categories of educational status proved to be skewed. Given mean and median statistics, it can be shown that while the distribution of Grade 8 and below (L_1) category labour is negatively skewed, that of other categories are positively skewed. A skewed distribution is evidently not normal. In approximately normal distributions, the relationship between S.D and IQR is that S.D $\approx$ IQR/1.35 (Hamilton, 1992:8). In all cases in Table 4, however, the S.D is greater than IQR/1.35, confirming the non-normality of the sample distributions, with implications for the regression results.

4.2 Correlation between Productivity and Schooling

It has already been observed that there were variations in educational status of the labour force and in labour productivity across the enterprises. Whether the variation in the educational composition of the labour force corresponds to the variation in labour productivity has to be verified. The simplest mechanism to do this is to measure the strength of the linear association between these two variations through correlation coefficients. To this end, both Spearman and Pearson correlation coefficient between labour productivity (in its logarithmic form) and educational categories are computed and summarised in Table 5.

Since all the coefficients are statistically significant, they clearly indicate the association between educational category and labour productivity. The correlation between labour productivity and professional labour is 0.4188 - positive and significant - implying that enterprises with a higher number of professionals usually have higher labour productivity. The strength of the association, however, declines as educational level declines. While the correlation coefficient between LnY (the logarithm of labour productivity) and L_4 (proportion of professional man-years to total permanent man-years) is 0.4188, it is only 0.3891 for L_3 (proportion of semi-professionals), and 0.2485 for L_2 (proportion of labour force between Grades 9 and 12). The surprising outcome is the negative association between L_1 (proportion of labour force in grade 8 and below) and LnY implying that the higher the proportion of L_1, the lower is labour productivity.

Since the significance test for Pearson correlation coefficient depends on the assumption of bivariate normality which has already been proved to be wrong (distributions of L_4, L_3, L_2 and L_1 are non-normal), rank correlation coefficients are

estimated. These yield, however, similar results and only differ from the Pearson coefficient in terms of strength and importance. The rank correlation coefficients are lower in all cases except L_2 than the Pearson coefficients. Regarding relative importance of coefficients, the L_2 category replaces the L_4 category.

Table 5: Correlation between Productivity and Educational Category

Summary Statistics	Correlation Between productivity (LnY) and			
	L_4	L_3	L_2	L_1
Pearson				
● Coefficient	0.4188	0.3891	0.2485	-0.4384
● Significance*	0.0000	0.0000	0.0020	0.0000
Spearman (Rank)				
● Coefficient	0.3274	0.264	0.3341	-0.3968
● Significance	0.000	0.000	0.000	0.000

* Stands for p-value

Productivity is better revealed by total factor productivity than by simple average partial productivity (like average labour productivity). The association of the educational composition of the labour force and the productivity (or efficiency) of an enterprise may be clearly revealed if total factor productivity (TFP) is employed in stead of labour productivity. Thus, TFP is computed using equation 13. Labour is expressed in terms of permanent man-years; and factor shares are current wage to value added at factor cost ratios. The computed correlation coefficient between TFP and educational categories are reported in Table 6.

Table 6: Correlation between TFP and Educational Category

	Correlation Between TFP and			
	L_4	L_3	L_2	L_1
Pearson				
● Coefficient	-0.2146	-0.2789	0.0294	0.1120
● Significance	0.007	0.000	0.716	0.164
Spearman (Rank)				
● Coefficient	-0.2808	-0.2371	-0.0305	0.1236
● Significance	0.000	0.003	0.716	0.124

The results presented in Table 6 are unexpected. Either the correlation coefficients (both Pearson and Spearman) between educational category and TFP are statistically insignificant (for example L_2 and L_1) or of opposite signs where the actual coefficients are statistically significant (for example L_3 and L_4). These results show however partial effects and the combined effect of variables might change the picture.

Thus, the linear form of equation 14 is regressed and this completely changes the picture as revealed in Table 7.

Table 7: OLS Regression results of expression 14

Variables	Coefficients	P-Value	F-ratio	R^2
W	0.33394	0.002	49.17	0.608
LnK	-1.4831	0.000		
L_4	14.167	0.098		
L_3	6.2208	0.004		
L_2	5.2629	0.000		
L_1	3.3830	0.000		

Note: Standard errors are white heteroscedastic adjusted.

From Table 7, all the coefficients of L_i are positive and statistically significant at the 1-percent level except L_4, which even is significant at the 10 percent significance level. Furthermore, the signs of the coefficients for all L_i are positive and increase as the level of schooling increases. This fact reveals the importance of schooling in influencing the productivity (efficiency) of enterprises.

4.3. Econometric Results

The basic model estimated is

$$\text{Log}\,{}^{Y}\!/_{L} = \text{LnA} + \text{BLn}\,{}^{K}\!/_{L} + \theta\text{LnL} + \alpha\,\varepsilon_2\lambda_2 + \alpha\,\varepsilon_3\lambda_3 + \alpha\,\varepsilon_4\lambda_4 + \text{U} \qquad (15)$$

Where:

Y/L = Labour (Average) productivity
K/L = Capital- Labour ratio
L = Permanent man year
K = Net fixed asset
Y = Gross value added at factor cost, at market price
λ_2 = Proportion of labour force between grades 8 and 12 education
λ_3= Proportion of semi-professional permanent man-years from total
λ_4 = Proportion of Professional man-years from the total; and
U= Disturbance term.

What will be assumed about the intercept, disturbance term and returns to scale will vary the model specification. Based on these assumptions, there will be different cases, which could be grouped into two categories. The first category assumes non-varying intercept and the second category assumes varying intercept across enterprises and/or over time.

Category I

Case 1: The disturbance term is assumed to be independently, identically and normally distributed, i.e., $U_{i,t} \sim iid\ (0, \delta^2)$.

Case 2: Given case 1, outliers (both mild and extreme) are excluded and not adjusted for heteroscedasticity.

Case 3: Given case 2, regression is carried out without a constant.

Case 4: Given case 2, the production function is assumed to exhibit constant returns to scale and heteroscedasticity is adjusted using White's method.

Case 5: Outliers are excluded because of the heteroscedasticity problem and the OLS estimation is adjusted based on White's heteroscedasticity-consistent standard errors.

Category II

Case 6: Intercepts are supposed to vary across enterprises to reflect differences in managerial skills, experience and technology. Both fixed and random effect models are employed.

Case 7: Intercepts are supposed to vary over time to reflect the changing situation of demand and supply especially due to shortage of foreign exchange. Both fixed and random effect models are employed.

Case 8: Intercepts are supposed to vary across enterprises and over time simultaneously. Fixed and random effect model specification is applied.

Given these cases, regressions are estimated using different computer Econometric programmes, each specialised for specific purposes. "Microstat" is used to test for autocorrelation and heteroscedasticity problems; "SPSS" is used to identify outliers and symmetry of the disturbance terms; and “LIMDEP” is used to estimate fixed and

random effect model specifications. The results of this exercise are summarised in Table 8(a) for scenario cases 1 to 5 and in Table 8(b) for category II cases.

The setback here is how to choose a case explaining the actual situation of enterprises most aptly. Case 1 cannot be a candidate for selection since it contains extreme outliers (three cases) and exhibits problems of autocorrelation and heteroscedasticity. Case 2, also exhibits heteroscedasticity problems, which are adjusted in Case 5. Case 5 produces a statistically insignificant coefficient for L_4 implying that professionals do not influence productivity in any better way than other educational categories; i.e., regardless of the number of professionals employed, labour productivity will remain indifferent, contradicting the results of the correlation carried out in the previous section. Case 4 produces similar results as Case 5. On the contrary, Case 3 (regression without a constant and adjusted for heteroscedasticity using White's method) produces theoretically justifiable and statistically significant coefficients. The only problem with Case 3 is that it assumes a non-varying intercept implying differences in technology, management skills, production experience, external environment (shortage of raw materials, and foreign exchange), affecting labour productivity indifferently across enterprises and/or over time. This assumption is relaxed by including enterprise and time effects in Category II cases.

Table 8(a). Summary of Regression Results for Category I

Items	Case 1	Case 2	Case 3	Case 4	Case 5
Ln K/L	0.344*	0.209*	0.213*	0.209*	0.209*
LnL	-0.087	-0.009	0.161**	-	-0.009
λ_4	6.241	5.942***	8.625*	6.058	5.942
λ_3	0.704	1.824**	2.476**	1.844**	1.824
λ_2	0.199	0.989*	1.941*	1.025*	0.989*
Constant	1.902*	1.366*	-	1.301**	1.366*
D.W	1.583	1.820	1.810	1.821	1.820
R^2	34.4	37.7	32.2	38.1	37.7
F-Ratio	23.86	19.79	-	24.88	19.79

*Notes: *, ** and *** represent coefficients which are statistically significant at 1%, 5% and 10% levels respectively.*

Category II regressions are estimated with two steps or iterative GLS, allowing for group wise heteroscedasticity and cross group correlation (in built in LIMDEP). The setback is that it does not consider the problem of autocorrelation, but this problem

has already been dealt with through the exclusion of outliers from the data set. The Durbin-Watson statistic proves this, as is evidenced by the fact that D.W is 1.8.

For all of the category II cases, enterprise effect, time effect and the combined effect of both are estimated. But, the enterprise effect produces theoretically unjustifiable and statistically insignificant coefficients. The specification, which considers both time and enterprise effects simultaneously does not produce significant results, either. The time effect specification, however, produces theoretically meaningful and statistically significant coefficients. The Hausman test (large values in this test favour the fixed effect over the random effect model) suggests that the fixed effect specification is the appropriate one (the Hausman statistics is 34.9). The choice of the fixed effect specification can further be supported by the Lagrange multiplier (LM) test, which favours the fixed effect model over OLS without time effect (the LM statistics is 34.2 - large LM values favour the fixed effect model over OLS without group specific effects).

Table 8(b). Summary of Regression Results for Category II

Variables	Enterprise Effect		Time Effect		Both	
	Fixed	Random	Fixed	Random	Fixed	Random
Ln K/L	-.0.097	0.205*	0.199*	0.201*	-0.096	0.182*
LnL	-0.960*	-0.085	-0.008	-0.006	-0.658***	-0.040
λ_4	-9.782**	-1.359	7.508**	7.294**	-8.766**	1.291
λ_3	-0.708	0.896	1.848**	1.845**	-0.602	1.362
λ_2	0.646	0.459	1.115*	1.098*	0.703	1.026**
Con	-	2.100**	-	1.239*	6.250	1.709**

*Notes: *, ** and *** represent coefficients which are statistically significant at 1, 5 and 10% levels respectively.*

Once the fixed effect specification is chosen, what would remain is to obtain estimates of ε_i. The fact that the coefficient of LnL in the fixed time effects model is not significantly different from zero suggests constant returns to scale. Accordingly ε_i can be identified via $\varepsilon i=\alpha\varepsilon i/(1-\beta)$. In contrast, for case three (category I) the coefficient of lnL is significant at 5 percent. Thus, we used $\varepsilon i=\alpha\varepsilon i/(1-\beta+\theta)$. The results of ε_i for the fixed time effect model (category II) and case 3 (category I) are presented in Table 9.

Table 9: Values of ε_i

Coefficients	Fixed Time Effect	Case 3
ε_2	1.395	2.466

ε_3	2.309	3.146
ε_4	9.129	10.95

As is evident, all ε_i`s are positive, and their sizes increase as educational background improves or as tiers of schooling getting higher up.

5. Conclusion

As has been shown in this paper, the correlation between labour productivity and educational background is significant and positive. The regressions also yielded statistically significant relationship between total factor productivity and other variables including educational variables (excluding a constant term due to the problem of singularity of matrices) suggesting a positive impact of schooling on productivity. The basic econometric model used especially the time fixed effect specification produced similar results. Differences in labour productivity increase as the educational level increases. For instance, ε_2 is 1.395 while ε_3 is 2.309, 1.65 fold greater than ε_2 and ε_4 is 9.129 which respectively is 6.5 and 4 fold greater than ε_3 and ε_2. It shall be noted that ε_i represent the productivity differential between educational category λ_i and the base category λ_0.

Based on the above results, three conclusions can be drawn. First, schooling influences the productivity of manufacturing enterprises considered significantly. Second, the level of schooling is strongly associated with the level of productivity, i.e., the higher the proportion of the labour force with higher level of schooling in an enterprise, the higher the enterprise's productivity. Third, allotting an increasing proportion of social wealth to education is paying.

Thus, the results of the analysis provide empirical evidence that schooling in Ethiopia can serve as a condition for growth for it affects productivity significantly and positively. It is possible to infer from this that the education system in Ethiopia has, by and large, effectively translated skilled manpower training into productive services at least in the manufacturing sector. From the standpoint of the manufacturing enterprises, the education explosion and growth in college and university enrolment could have meant moving to a higher level of the productivity frontier. The results are telling and suggesting that in addition to broadening schooling and increasing

quantity, improving quality is also required to increase the productivity of manufacturing enterprises in Ethiopia.

The implications of this analysis to Ethiopian industrialisation are clear. Industrialisation is nothing but a sustained increment in productivity, a constant improvement in the efficient use of resources and an evolutionary process of acquiring technological capabilities. Successful industrialisation is associated with improvements in local technological know-how i.e. in the process of imitating, assimilating, transferring and adapting production techniques. These technological improvements are, in turn, person-to-person processes, the paces of which are influenced by the availability of skilled man power - the level of schooling.

Level of schooling has been proved to influence productivity in Ethiopian manufacturing enterprises substantially, implying that the technical competence of an industrial work force is improved through education imparted by the formal education system. Post employment and vocational training should improve this technical competence of the industrial work force even further, thereby increasing productivity and hastening industrialisation. In line with this, enterprises should undertake employee-training programs and institute in-firm training mechanisms. In Korea, companies spend at least 5-6% of their total budget on education and training programs (Lall, 1992:177) and this is one of the secrets of South Korea's rapid entry into new and demanding industries.

In the Ethiopian context, the problem is that there is a serious risk of private under-investment in training at the firm level because enterprises cannot appropriate all the returns on their investment to education. Enterprises will invest in their own training programs confidently, only if the extent of labour mobility is low and investment on employee-training yields appropriate benefits. But, in a free market governed system, labour is highly mobile and in-house trained workers leave. Nation-wide, mobility must not be restrained for it facilitates diffusion of knowledge. On the other hand, government has to adequately supply ever-increasing demands for skilled manpower. The modalities for supplying trained manpower will therefore need to be worked out according to prevailing conditions on the ground.

However, three areas where the government should take action are evident. First, government should involve the private sector and public enterprises (the prime beneficiaries) in its human capital development efforts for specific demand to match supply in both quantity and quality. Second, government should not only dwell on basic education but also consider tertiary education. The coefficients for semi-

professional and professionals proved that tertiary education influences overall productivity more strongly than basic education. Third, human capital expansion alone does not lead to the industrialisation of a country. For successful industrial development to take place, human capital should be combined with physical investment, infrastructure, technology, facilitative institutions and appropriate incentives. A proper balance is thus required; however, the nature of this balance depends on endowments, level of development, inherited structure and institutions. Efforts that stress only human capital run the risk of misunderstanding industrial development and misguiding industrial strategies.

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Appendix

One can easily arrive at equation 3 from equation 2 in the following way:

$$
\begin{aligned}
L_i &= L_o(1+\varepsilon_i) \\
&= (1+\varepsilon_i)\, L_0\left(\frac{L_i}{L_i}\right) \\
&= (1+\varepsilon_i)\left(\frac{L_0}{L_i}\right) L_i
\end{aligned}
$$

$$\Rightarrow \left(\frac{L_i}{L_0}\right) L_i = (1+\varepsilon_i)\, L_i$$

$$L_i^e = (1+\varepsilon_i)\, L_i$$

That is, L_i in efficiency units (relative to L_0).

$$
\begin{aligned}
L_T^e &= \sum_{i=0}^{3} L_i^e = \sum_{i=0}^{3} (1+\varepsilon_i)\, L_i \\
&= L_0 + \sum_{i=1}^{3} (1+\varepsilon_i)\, L_i, \sin ce\ \varepsilon_0 = 0 \\
&= L_0 + \sum_{i=1}^{3} L_i + \sum_{i=1}^{3} \varepsilon_i\, L_i \\
&= L_0 + L_1 + L_2 + L_3 + \sum_{i=1}^{3} \varepsilon_i\, L_i \\
&= L + \sum_{i=1}^{3} \varepsilon_i\, L_i
\end{aligned}
$$

This is total labour in efficiency units.