TOTAL FACTOR PRODUCTIVITY IN THE ETHIOPIAN MANUFACTURING SECTOR: EXTENT AND TREND

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ABSTRACT

Cognisant of the importance of total factor productivity growth in the process of industrialisation, examining its trend and extent in the Ethiopian manufacturing sector is essential. To this end, this paper employs different statistical and econometric models. Three main findings emerged from this exercise. Firstly, the Ethiopian manufacturing sector as a whole registered negative total factor productivity growth. Secondly, however, there were sub-sector differences: sectors that are light and had long production experience recorded positive total factor productivity growth, while others did not. Finally, the private sector, in general, appeared to be more efficient in resource use than the public ones. These results have relevant implications for industrialisation in Ethiopia. Not only should firms build the necessary technological and managerial capabilities, but should also introduce the necessary mechanisms for adapting, assimilating and modifying them with local conditions. In parallel, the government should create the necessary conducive environment by putting in place the appropriate, incentive structure and institutions.

1. INTRODUCTION

In Ethiopia, resources available for industrial growth are scarce and the prevailing economic conditions (saving rate, purchasing power, debt service ratio, investment confidence) suggest that accumulation of resources will not take place at a massive scale in the short to the medium terms. If there should be any industrial growth, it will come from more intensive use of resources (through increasing productivity) together with capital accumulation. However, efficiency in resource use would be attained only if efforts are made to attain some growth of total factor productivity, which includes the acquisition of technological capability and technical change (which come through accumulation of experience and learning by doing).

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In this regard, growth of total factor productivity is a decisive determinant of industrial growth (Solow 1957; Massell 1960). Solow (1957:316) showed that about one-eighth of the total increase in output (per man-hour) was traceable to increased capital per man-hour, while the remaining seven-eighth was attributed to total factor productivity growth. Massell's (1960:186) work indicated that roughly 90 per cent of the increase in output per man-hour was attributable to technical advance. Other estimates by Brown, Intriligator, Kendrick and Kennedy for the US economy and Aukrust for Norway (see Intriligator 1978) reflected the fact that growth of total factor productivity significantly contributes to improvements in resource utilisation.

On the Ethiopian manufacturing sector, such empirical works are scant. Most works are descriptive. An attempt was made, however, by the World Bank (1989) to measure the efficiency of the Ethiopian public manufacturing industries. The methodology was domestic resource cost (DRC). A survey made on 36 firms arrived at a DRC of 0.82, which, according to Eshetu, was more sanguine about the economic efficiency of Ethiopian public manufacturing enterprises (Eshetu 1992:2). Alemu (1992) measured efficiency by using financial rate of return and DRC (the DRC is based on the work of the World Bank in 1985 and 1989). He then concluded that firstly, public manufacturing industries are in general profitable; secondly, more than half are allocatively efficient. But, measuring the extent of allocative efficiency is not a substitute for measuring total factor productivity growth, since the latter focuses more on the extent of technological capability acquisition in order to catch up with the world frontier. This paper is an attempt to build on this line of argument and has the following specific objectives:

a) substantiating the link between growth of total factor productivity and industrialisation;
b) assess the extent of growth of total factor productivity in the manufacturing sector;
c) testing whether there is sector/ownership differences in rate of growth of total factor productivity; and
d) identifying those factors that cause variations for differences in TFP.

2. INDUSTRIALISATION AND TOTAL FACTOR PRODUCTIVITY: EMPIRICAL EVIDENCE

2.1. Industrialisation as a Learnt Process

Industrialisation is an evolutionary process that signifies the transition from a primitive, low productivity, low-income economy to one that is dynamic, sustained and diversified (Chenery et al., 1986). Such a structural shift of an economy is the cumulative result of piecemeal efforts of using ideas and eventually transcend to producing ideas.

Industrialisation as a learnt process can be visualised both historically and technologically. Historically, as late as 1750's, only one country was on the way towards a successful industrial revolution-England. Since then, the industrial revolution spread across the world: first towards Northern and Western Europe and Northern America, subsequently it moved towards Japan, Southern and Eastern Europe, and parts of Latin America and Oceania (Easterlin 1981). Thus, if countries in the South entered into the phase of industrial revolution at an increasing number with different paces and patterns, then industrialisation is a learnt process in which the latecomer accumulates knowledge on the successes and failures of the predecessors. Technologically, the process of acquiring technological capability is the process of industrial development and the costs of achieving international competitiveness are the costs of acquiring technological capability (Pack and Westphal 1986). The capacity to operate, assimilate, adapt and modify processes determines industrial development. Stewart (1984:833) argued that any successful industrial expansion is associated with some local technological activity since adaptation to local conditions is part of the process of successful industrial activity.

2.2. Linkages Between Industrialisation and Total Factor Productivity: Empirical Evidence

Empirical evidences justify the strong linkage between industrialisation and growth of total factor productivity. The first source of such evidence is the prevalence of high rate of total factor productivity growth in industrialised economies. From the work of Chenery, it is found that, on average, rate of total factor productivity growth (TFPG) in industrialised countries is much higher than that of developing countries. It was found to be 2.7% in the former and 2% in the latter (Chenery et al., 1986:20-22). Table 1 indicates the extent to which rate of TFPG varies across countries, specifically how significant the difference is between developed and developing economies. In addition, not only the growth rate but also the contribution of TFP to the aggregate economic growth is higher for industrialised economies than for developing economies. The same study reveals that developed economies are characterised by little growth of labour inputs (1.1%), moderate growth of capital (5.2%) and output (5.4%), and a relatively large contribution of TFP to aggregate growth (50%). The developing economies, in contrast, have high growth of labour inputs (3.3%), a higher total factor growth (4.3%) and a relatively small contribution of TFP to aggregate growth (30%). This implies that, at least as the stylised facts indicate, achieving higher growth of total factor productivity leads to higher stage of industrialisation.

Table 1. TFPG in Different Countries in Per Cent

Industrialised Countries		Developing Countries	
Canada (1947-60)	3.50	Argentina (1950-60)	1.05
France (1950-60)	2.90	Chile (1950-60)	0.85
Germany (1950-60)	3.60	Ecuador (1950-62)	2.18
Columbia (1950-60)	0.95	Greece (1951-65)	2.39
Italy (1952-60)	3.80	India (1950-60)	-0.18
Japan (1950-73)	4.50	Peru (1950-60)	-0.70
Holland (1951-60)	2.30	Mexico (1950-60)	1.60
Norway (1953-65)	2.90		

Source: Chenery et al. Industrialisation and growth: A comparative study, 1986:20-22.

Table 2. TFPG and its Share to Growth in Developing Countries

Country	Period	TFPG	Share to Growth
Chile	(1950-60)	0.85	24.3
	(1960-74)	1.2	27.3
Columbia	(1950-60)	0.95	20.7
	(1960-74)	2.1	37.5
Korea	(1955-60)	2	47.4
	(1960-73)	4.1	42.3
Mexico	(1950-60)	1.6	28.3
	(1960-74)	2.1	37.5
Peru	(1950-60)	-0.7	-15.6
	(1960-70)	1.5	28.3

Source: Chenery et al., Industrialisation and Growth: A comparative Study, 1986:20-22.

The second evidence for this linkage is the rise of rate of TFPG, on average, in developing economies with time as their level of industrialisation rises to higher levels. Cases in point are those for Chile, Columbia, Korea, Mexico and Peru, as observed in Table 2. For instance, the rate of TFPG in Korea was 2.10% for the period 1950-60, but grew to 4.10% for 1960-1974 when the Korean economy was considered as one of the newly industrialising economies. Thus, the rate of TFPG attained reflects where the level of industrialisation of an economy is.

3. MEASURING THE SIZE AND TREND OF TOTAL FACTOR PRODUCTIVITY

3.1. Models

In this paper, statistical and econometric models are applied to calculate the rate of growth of total factor productivity. However, no model is selected a priori. This enables us to choose the one that characterises the production process. The alternative models are the following:

1) Compute total factor productivity (TFP) using the expression:

$$A = \frac{Q}{aL + bK} \qquad [1]$$

Where Q is output, L is labour input, K is capital input, A is TFP, and a and b are output elasticities with respect to labour and capital, respectively. Then calculate the rate of growth of TFP. This was how Kendrick (1961) estimated total factor productivity growth for the US manufacturing industries for the period 1899-1953.

2) Solow's Geometric Index:

$$\frac{\Delta A}{A} = \frac{\Delta Q}{Q} - a\frac{\Delta L}{L} - b\frac{\Delta K}{K} \qquad [2]$$

An index of total factor productivity growth for each year can be derived from Equation [2] as:

$$A(t+1) = A(t)\,[\,1 + \frac{\Delta A(t)}{A(t)}\,] \qquad [3]$$

A series of A_t can be then constructed setting $A_0 = 1$. The rate of growth of total factor productivity (m) can then be arrived at from the expression $A_t = A_0(1 + m)^t$. The path-breaking work of Solow (1957) for the non-agricultural sector of the USA, Massell's (1960) work for the manufacturing sector of the USA, Mabro & Radwan's (1976) attempt for the manufacturing sector of Egypt and Krueger and Tuncer's (1980) work for the Turkish manufacturing sector followed this approach.

Two variants of Solow's geometric index have also been applied. First, there is Kendrick's arithmetic measure (Mabro et al., 1976:177), which takes the form:

$$\frac{A_2}{A_1} = \frac{Q_2 / Q_1}{a\frac{L_2}{L_1} + b\frac{K_2}{K_1}} \qquad [4]$$

and second we have, the expression utilised by Kazashi et al. (1983:4)

$$GA = a(GQ - GL) + b(GQ - GK) \qquad [5]$$

The shortcomings of these measures are their restrictive assumptions of constant returns to scale, neutrality of technical change, and perfect competition in both output and factor markets.

3) Econometric approaches: The most common technique utilised in this regard is to estimate a linear transformation of Cobb-Douglas production function:

$$LnQ = LnA_0 + mt + aLnL + bLnK + c[\mathrm{Ln}\,K - \mathrm{Ln}\,L]^2 + u \qquad [6]$$

Assuming a linearly homogenous Cobb-Douglas production function, equation 6 can be written as:

$$\mathrm{Log}\left(\frac{Q}{L}\right) = \mathrm{Ln}\ A_0 + mt + b\log\frac{K}{L} \qquad [7]$$

Where m measures the proportionate growth of total factor productivity and the constant term measures the initial efficiency parameter. Equation (7) increases the accuracy of the estimate since multicollinearity between L and K is minimised, though the assumption of constant returns to scale still holds. But, by adding (Ln L) to the right side of equation (7), returns to scale can be retained since the coefficient of L captures returns to scale. The CES production function specification of Equation [8] relaxes some of the assumptions imposed by the Cobb-Douglas specification. Arrow et al (1961) used this approach on the US economy. Since direct estimation by OLS is problematic, linear transformation is adopted in this paper:

$$LnQ = LnA_o + mt + aLnL + bLnK + c[\,\text{Ln}\,K - \text{Ln}\,L\,]^2 + u \qquad [8]$$

Where :

$$1)\ \ \gamma = antilog\ A_o,\ 2)\ \ \delta = \frac{b}{a+b},\ 3)\ \ \rho = \frac{-2c(a+b)}{ab};\ 4)\ v = a+b$$

To relax the assumptions imposed by the CES, and in case such a specification does not characterise the production process, a translog production function is also estimated.

3.2. Data

In this paper, the period under consideration in this study is 1976-1995. This is a twenty-year data set. The paper considers the manufacturing sector to the three digits ISIC classification. As a result, there are 19 manufacturing sub-sectors in the public manufacturing industries and 15 in the private manufacturing industries since there are sub-sectors where the private sector is not involved.

Output is measured by value-added at factor cost. Wage is used as a measure of labour input because it is the simplest means available to make labour homogenous. Net fixed asset represents capital input. Source of data is "the Results of Surveys of Manufacturing and Electricity Industries" published by CSA.

3.3. Results and Inferences

Assuming different factor elasticities of output, Equation [1] is applied on the Ethiopian manufacturing sector for the period 1976-1995. With the stringent assumptions of constant returns to scale, neutrality of technical change, perfect competition, factor elasticity of output is identical to factor shares. Four alternatives: arithmetic and geometric mean, and the initial and current factor shares are used[1]. The growth rate of TFP is computed using different formulae[2]. The results are reported in Table 3 and Table 4.

The inferences made from the results of the estimate are the following:

a) TFP calculated using Equation [1] revealed a non-increasing trend for the whole period (see Table 3). This holds regardless of types of factor shares considered. The rate, of course, varies depending on the formula used. Despite the general stagnation exhibited for the period under study, there were periods in which TFP showed an increasing trend (for example, 1976-1980). This fluctuation of TFPG went with the economic and political environment of the time. The base year of the period under study - 1976 - was a time of political upheaval; endogenizing management of enterprises that were nationalised was initiated around this period. Ethiopians took over the managerial and other key positions previously held by experienced managers and foreigners and these put the manufacturing sector, and hence TFP, in crisis. It took time for the 'new' Ethiopian managers to gain the lost skills (at least up to 1980). Gaining lost skills back combined with the "production campaign" put TFP at its climax in 1980. This indicates some sort of learning, in a sense that Ethiopians managed to run the nationalised industries. The majority of economic units ceased operation in 1992. Intense shortages of foreign exchange and hence shortage of raw material were encountered. This resulted in a decline in TFP further, the lowest that had ever reached in the period under study.

b) Technology index, assuming $A_{1976}=A_0$ and using different assumptions for factor share, reached about 1.6. Growth rate of total factor productivity (TFPG) exhibited positive growth rate (see Table 6). This, however, does not imply that growth of total factor productivity in the whole period had a positive trend. Moreover, both the technology index and the rate of growth of total factor productivity assumed a different trend when the 1991-1993 was omitted. For instance, if the years 1991-1992 were excluded, technology index in 1995 would be 1.0651 and if 1991-1993 is excluded, the technology index becomes 0.6919. At best this indicates no growth of total factor productivity. However, there were periods when no less than 10% growth rates were registered. For instance, growth of total factor productivity was increasing by 11.92 per cent for the period 1976-1980.

c) Econometric estimates produced quite puzzling results; some coefficients are theoretically meaningless and others are statistically insignificant. The Cobb-Douglas model gives the initial efficiency parameter a number almost close to zero, implying the whole expression is almost zero. Model (7) gives a negative coefficient for b implying that labour productivity is negatively affected by capital intensity, which is theoretically meaningless. The CES Model, as well, gives a negative capital share, which is unjustifiable. Generally, econometric estimates obtained from the above production functions[7] do not satisfy a priori expectations. Heterogeneity of aggregate data and small sample size (only 20 observations) might be the cause for such inconsistent outcomes.

The econometric models are re-estimated using panel data. The data is dis-aggregated by sub-sectors and this procedure enlarges the sample size. There are 19 sub-sectors, each with a 20-year data set. Enlarging the sample size has one clear advantage: it increases the degrees of freedom and reduces the impact of collinearity (Hsiao 1986:2). The results of this exercise are summarised in Table 8. Panel data set changes the natures of all the parameters. Coefficients are theoretically meaningful and statistically significant. Unlike the previous result, the coefficient for T is not different from zero; and the situation does not change after adjusting for heteroscedasticity using White's procedure. The results show that there has not been growth of total factor productivity in the Ethiopian manufacturing sector.

Table 8. Econometric Estimates of Different Models

Models	Coefficients	T-ratio
Model 6		
- Constant	1.3775	4.2085
- T	-0.0071	-0.9199
-Ln L	0.82819	14.0278
- Ln K	0.11537	2.5145
F-ratio	215.35	
R^2	62.92	
D.W	1.1168	
Model 7		
- Constant	0.9249	9.8371
- T	-0.01098	1.5056
- Ln k/L	0.11812	2.5728
F-ratio	4.548	
R^2	1.83	
D.W	1.1185	
Model 8		
- Constant	1.438	4.389
- T	-0.0036	-0.444
- Ln K	0.23385	2.5932
- Ln L	0.6977	6.7114
- Ln $(k-L)^2$	-0.05739	-1.5251
F-ratio	162.67	
R^2	63.05	
D.W	1.1368	
Translog		
- Constant	-2.0824	-1.0758
- T	-0.0035	-0.423
- Ln L	-0.0327	-0.074
- Ln K	1.6104	3.8126
- Ln L^2	0.0423	0.753
- Ln K^2	-0.0836	-2.176
- Ln K*L	0.014	0.171
F-ratio	112.34	
R^2	63.81	
D.W	1.1227	

Source: Own computation.

In a nutshell, two pictures emerge from the results in the manufacturing sector of Ethiopia for the period 1976-1995: stagnation and periodic variation. The TFPG is negative or zero. This result should, however, be seen critically, at least, with respect to learning. There were periods where TFP growth rate was substantial. Withstanding the tremendous disruption caused by the 1973 revolution and withdrawal of skills, generating a 10% rate of TFPG for the period 1976-1980 reflected acquisition of knowledge. But this was mainly due to attainment of existing capacity, which did not continue.

4. SECTORAL AND OWNERSHIP DIFFERENCES IN TOTAL FACTOR PRODUCTIVITY GROWTH

"... [L]earning does not occur in all firms.... Technical effort need not proceed in the same direction, even in firms within the same market " (Hebret-Copley 1990:1457-1460). This chapter attempts to examine the validity of this statement.

4.1. Sector Variation

To verify existence of sector differences, Equations [1] and [6] are employed. The TFP, using Equation [1], is estimated for each sub-sector. The results for selected years are provided in Table 9[4], which shows sizeable differences in the productive content of inputs among sub-sectors. For instance, a 29-fold difference was observed in 1976 between tanneries and paper sub-sectors. The same was true in 1995 between tobacco and rubber sub-sectors; the TFP for tobacco was 63-fold that of rubber. These facts reveal the prevalence of differences in total productivity across sectors.

More important is the rate of growth of total factor productivity registered between the period 1976-1995, which reveals the extent of learning or unlearning. A trend function is fitted using time as a regressor to identify such processes. Because some of the causes for excessive fluctuations in TFP were political that impeded full capacity utilisation, the model is estimated using time dummy variables for 1991, 1992 and 1993 to capture these political factors. The results are summarised in Table 10.

Moreover, an econometric model of Cobb-Douglas production function (Equation 6) was run using OLS in order to directly observe the rate of growth of total factor productivity for each sub-sector. But none of the coefficients of the model are significantly different from zero or theoretically justifiable.

A preferable and probably more reliable approach to show that sub-sector variation prevails in the data set is to use the methods of panel data analysis. In a panel data set setting, Equation 6 assumes that rate of growth of total factor productivity (m) is identical across sub-sectors over the period under study, i.e., $m_1 = m_2 = m_i = m$ where m_i represents rate of growth of total factor productivity of i's sub-sector. Time here assumes an identical pattern for each sub-sector and serves only as a variable whose coefficient is interpreted as a measure of autonomous growth. However, m_i differs across sub-sectors, since their respective internal and external environments (or strengths and potentials) differ. Testing the null hypothesis that $m_i = m$ in all i's against the alternative hypothesis that m_i is not equal to m will prove the case.

Table 9: Total Factor Productivity by Sub-Sector at Different Periods

Sub sectors	Years				
	1976	1980	1983	1992	1995
Food	0.7698	1.9334	0.9116	0.6616	2.0094
Beverages	1.4724	1.4221	1.1417	0.6744	1.5171
Tobacco	1.8515	3.8991	7.8517	1.4328	13.0447
Textiles	1.7383	2.5819	0.8942	0.2846	0.6061
Wearing app	1.4095	1.2982	1.7791	0.7600	1.2107
Tanneries	3.1516	1.077	2.0339	0.3153	2.7497
Footwear	1.9720	4.1626	1.1214	1.2642	1.3434
Wood	1.4740	1.5783	1.8875	0.9841	3.8295
Furniture	1.3081	1.8856	1.9519	1.7675	1.2871
Paper	0.1065	0.8908	2.6405	0.5050	1.7023
Printing	1.8587	2.4880	3.2098	2.6782	1.8768
Chemicals	1.0229	1.1910	1.0788	1.1796	2.3590
Other chem	2.7188	2.1766	3.6767	1.2541	1.9833
Rubber	0.5321	1.4279	2.0194	0.1572	0.2055
Plastic	0.5489	1.0421	2.9894	2.7049	2.0327
Glass	0.5565	0.8096	0.0964	0.2024	0.9100
Non-metal	0.4899	1.3228	0.1809	0.2871	0.7851
Iron and steel	1.7162	3.0203	3.3219	0.7946	8.1940
Fabricated	0.5989	1.7424	2.2198	0.0370	0.3354
Total	1.038	1.9916	1.4044	0.4645	1.0628

Source: Own computation.

Table 10. TFPG by Sub-Sector for 1968-1987 in %

Sub sectors	Trend function	
	Without dummy	With dummy
Food	No trend	No trend*
Beverages	-3.76	-3.09
Tobacco	8.20	8.77
Textiles	-9.09	-7.51
Wearing app	No trend	No trend
Tanneries	5.06	7.41
Footwear	-5.43	-5.42
Wood	No trend	No trend
Furniture	-1.19	-1.4
Paper	7.37	11.34
Printing	No trend	No trend
Chemicals	No trend	No trend
Other chem	No trend	No trend
Rubber	-10.1	-8.73
Plastic	5.09	5.26
Glass	No trend	No trend
Non-metal	No trend	No trend
Iron and steel	No trend	No trend
Fabricated metal	-11.8	-7.77
	-4.15	-2.68

* No trend means that the coefficient of T is either statistically insignificant or the overall model is unfit.
Source: Own computation

To do so, time has to assume two purposes - first, as a sector specific dummy and second, as a variable whose coefficient measures autonomous growth. This will give us 19 sector specific dummies whose values range from 1 for 1976 to 20 for 1995 and 0 otherwise. This, in turn, gives us the following equation:

$$LnY = LnA_0 + \sum m_i T_i + alnL + BlnK + u \qquad [9]$$

Where m_i represents sector specific rate of growth of total factor productivity (Hicks neutral type) and T_i represents sector specific dummy variable whose value ranges from 1 to 20 to that particular sector and 0 otherwise.

Fitting Equation [9] and checking the significance of the coefficient for the variables T_i and the general fitness of the model is one way of verifying the existence of growth of total factor productivity variation across sub-sectors. This is done using time specific dummies for 1983, 1984 and 1985 and without; and the result, adjusted for heteroscedasticity (using White's procedure), is reported in Table 11. The regression with time specific dummies did not prove itself better than without and hence is not reported here.

Table 11. Econometric Estimates of Equation 9

Regressor	Coefficients	T-ratio
LnL	0.8949	13.07
LnK	0.1762	2.94
Con	0.3369	0.61
T1	-0.02	-1.27
T2	-0.203	-1.4
T3	0.097	8.87
T4	-0.0766	-4.13
T5	-0.0325	-4.27
T6	-0.0169	-1.11
T7	-0.0351	-5.1
T8	-0.0377	-3.03
T9	-0.0259	-5.03
T10	-0.0113	-0.82
T11	-0.0067	-1.03
T12	-0.002	-0.22
T13	0.0176	1.77
T14	-0.0363	-3.05
T15	0.0117	1.76
T16	-0.0849	-1.96
T17	-0.053	-3.04
T18	-0.0069	-0.38
T19	-0.0493	-3.14
F-ratio	57.61	
R^2	75.82	
D.W	1.6673	

Source: Own computation.

The econometric estimate of Equation [9] shows that the model is generally fit. Besides, the majority of the coefficients for T, are statistically significant at 10% significance level. But the sizes and signs are not identical. This indicates that the rate of growth of total factor productivity is significantly different across sub-sectors.

Formally, the F-test is used to test such hypotheses. In this instance, Equation [9] is unrestricted while the equation without dummy is restricted since it implies that $m_1 = m_2 = m_i = m$. The calculated F-ratio[5] in this is case becomes 9.44, which is by far higher than the theoretical F-ratio at 1 per cent level (at 18 and 356 degrees of freedom). Hence, we reject the null hypothesis, which states that the m_i's are identical across sectors.

Hence, a difference in rate of growth of total factor productivity across sub-sectors is strong. Some sectors registered positive rate of growth of total factor productivity and others registered a decline over the period under study.

4.2. Ownership Matters

"While it may be true in theory that a properly managed public enterprise can be as productive and efficient as a private one, the reality is that politics, usually of a virulent nature, intrudes" (Summers 1992:8). Specially, "centralised decision making, lack of profit motive, and absence of competition, which typifies government operations, make government production always less efficient than private sector production" (Diamond 1990:34). To what extent are these statements valid in the Ethiopian context?

To test the existence of ownership differences, TFP and its growth rate are calculated as above for the public and private sector separately. The ratio of TFP of public sector to that of private for selected years is reported in Table 12.

Though the table does not reveal consistent patterns, on the average, the TFP in the private sector is higher than that of the public sector (since the geometric average of the ratio of TFP in the public sector to that of the private for the period 1976-1995 was 0.88). This implies then that the combined inputs in the private sector are more productive than that in the public. Of course, there were sub-sector and temporal variations. While in the late 1970's the public sector was more productive than the private, it was not so in the late 70's and 80's. The public sector was highly affected negatively during 1991 and 1992. In terms of sectors, public sector wearing apparel, tanneries and footwear, wood and furniture and the plastic manufacturing industries were more productive than the private ones. Recently, especially in 1995, the situation seems to have changed; it was only for 4 sub-sectors (textile, rubber, non-metallic mineral products and fabricated metal) that the private sector TFP is better than that of public.

Table 12. Ratio of Public TFP to Private TFP by Sector

Sub-sectors	1976	1980	1987	1992	1995	Average 1976-1995
Food	84.3%	134.0%	77.4%	76.6%	193.4%	89.9%
Beverages	66.9%	52.4%	76.3%	33.6%	1519.5%	85.1%
Textile	73.8%	202.9%	63.1%	28.9%	62.1%	87.6%
Wearing app.	118.6%	118.8%	137.2%	553.3%	491.7%	212.2%
Tanneries	871.2%	77.4%	256.4%	370.1%	252.2%	183.2%
Footwear	116.6%	230.2%	67.1%	111.6%	291.9%	135.2%
Wood	68.3%	79.2%	118.7%	114.6%	348.3%	124.6%
Furniture	115.8%	212.3%	145.5%	98.5%	289.6%	164.8%
Paper	52.2%	59.5%	92.7%	47.9%	669.1%	141.0%
Printing	216.6%	240.9%	231.0%	330.6%	231.8%	231.5%
Other-chem	178.8%	147.9%	150.7%	141.9%	258.2%	186.5%
Rubber	13.4%	36.8%	68.3%	8.2%	25.3%	29.9%
Plastic	129.9%	154.7%	217.6%	196.8%	1126.0%	334.9%
Non-metal	60.8%	131.6%	12.4%	16.5%	53.1%	33.5%
Fabric. Metal	59.2%	229.2%	201.2%	0.0%	28.6%	92.7%
Total	89.7%	142.1%	87.9%	43.4%	96.0%	88.0%

Source: Own computation.

Regarding the rate of growth of total factor productivity (measured by semi-log time trend), the difference between private and public (as can be seen in Table 13) becomes clearer than the picture discussed. While the public sector registered a decline of 4.35% per annum, the private sector assumes no progress or regress; its coefficient (-0.31%) is not significantly different from zero. Such ownership differences are observed across sub-sectors; in most cases, the private sector registering better performance. But the difference did not produce a systematic pattern, in a sense that the private sector did not produce consistently better results in all sub-sectors. For instance, while growth of total factor productivity is positive in the public tanneries and leather-finishing sector, the private sector produces rather no trend.

An econometric estimate of Equation (3) for each group (public and private) supports the above result–a good record of the private sector with respect to rate of growth of total factor productivity (see Table 14). Rate of decline in the public sector (-17.94%) is by far higher than that of the private sector (-1.6%).

Table 13. GTFP by Ownership and Sub-Sectors

Sub-sectors	Public	Private
Food	0.0070583*	0.0010894*
Beverages	-0.040628	-0.079167
Textile	-0.094499	-0.040168
Wearing app.	0.03542*	-0.08749
Tanneries	0.057048	0.019797*
Footwear	-0.039488	-0.065817
Wood	0.023646*	-0.0060548*
Furniture	-0.000507*	0.008423*
Paper	.080495*	0.016012*
Printing	.0065772*	-0.0073772*
Other-chemicals	0.0020798*	-0.015624*
Rubber	-0.10088	-0.10069
Plastic	0.058404	0.0015587*
Non-metal mineral	-0.051458	0.040705
Fabricated metal	-0.11655	0.019102*
Total	-0.043509	-0.0031156*

* Statistically insignificant even at 10% significance level.

Source: Own computation.

Table 14. Estimates of Cobb-Douglas function and Equation 9

Regressor	Coefficients	T-ratio
	Public sector enterprises	
LnL	2.5893	8.6342
LnK	0.59312	2.2127
Con	-24.5111	-4.8616
T	-0.17944	-5.4348
F-ratio	44.59	
R^2	87.3	
	Private sector enterprises	
LnL	1.2317	6.8405
LnK	0.35822	6.3677
Con	-5.2004	-3.433
T	-0.015983	-2.4637
F-ratio	78.12	
R^2	92.4	
DW	1.5339	
	Equation [9]-All enterprises	
LnL	1.0742	11.086
LnK	0.2624	3.3284
Con	-2.759	-5.7713
T_1	-0.06	-7.0066
T_2	-0.008	-1.5709
F-ratio	690.12	
R^2	99.26	
DW	1.9642	

Source: Own computation.

To verify ownership differences in the rate of growth of total factor productivity, panel data set and F-test are applied. Equation [9] is estimated by attaching ownership specific dummy variables that handle both ownership effects and autonomous growth. The result, adjusted for autocorrelation, is provided in Table 14.

The coefficient of T_1 represents the rate of growth of total factor productivity of the public sector while T_2 is that of the private sector. The result again implies that the decline is not identical in both groups (higher in the public sector, which is 6% per annum). The coefficient for T_2 is not statistically significant even at 10% level while that of T_1 is significant. F-ratio (the test for the hypothesis that rate of growth of total factor productivity is identical in both groups) is 28.9, which rejects the null hypothesis. This confirms that ownership influences the rate of growth of total factor productivity registered in the Ethiopian manufacturing sector.

4.3. Causes for Variation

Difference in the rate of growth of total factor productivity across sub-sectors has been demonstrated. Rate of growth of total factor productivity varies among sub-sectors, between ownership and across time in the Ethiopian manufacturing sector. The causes of this difference are examined in what follows.

Intuitively, sub-sectors are not supposed to have identical strengths, weaknesses, opportunities and threats since the technology, market, extent of import intensity, rate of protection, industrial structure (extent of concentration), incentive structure and accumulated experience they face are different. As a result, the productive content of inputs will differ across time, among sub-sectors and between ownership. How much do these variables explain the outcomes of the Ethiopian manufacturing sector, is a pertinent question. To shed some light on factors that causes differences, a model is formulated that specifies TFP as a function of these variables as follows:

$$A_{it} = a_0 + a_1 q_{it} + a_2 L_{it} + a_3 K_{it} + a_4 S_{it} + a_5 M_{it} + a_6 W_{it} + a_7 I_{it} + a_8 D + u_{it} \quad [10]$$

Where A is the TFP, q is the capital-labour ratio, L is the ratio of payment to production workers to non-production workers, K is the ratio of machinery and equipment to building and infrastructure, S is the ratio of number of enterprises with less than 50 employees (chosen arbitrarily) to the total in that particular sector, M is the ratio of imported raw materials to total raw material consumed, W is the average wage per annum, I is the average incentive payments per annum and D is a dummy variable for light and heavy industries.

Capital-labour ratio is included as a variable to represent production techniques, which has a strong correlation with level of technology. A modern production technique generally appears to be more productive and capital intensive. Hence, high K/L is associated with high TFP.

The ratio of equipment and machinery to building and other infrastructure is used as a variable to reflect the "intensity of technology" since change in the level of technology does not take place without being reflected in the change in the above ratio. It is assumed that the higher this ratio, the higher will be the "intensity of technology" and hence a higher factor productivity.

Size structure could be an important variable influencing TFP. The premise here is that large firms enjoy economies of scale whereas small-scale firms do not. A sub-sector with high composition of large enterprises might record a higher TFP. In this paper, the number of permanent workers each enterprise employs classifies its size.

Import intensity is an influential variable determining the size and rate of TFPG. A firm with high import intensity, because it cannot procure as much as it needs due to foreign exchange constraint, might frequently run below capacity, which as a result undermines value-added and thereby TFP. Import intensity, in this paper, is calculated using a simple ratio of imported raw materials to total raw materials consumed.

A favourable incentive structure influences the productive content of labour given its production technique; it pressures on each labour input to put as much effort as possible, thereby pushing the production frontier upwards. In this paper, average annual wage and average annual commission, bonuses, allowances, food and lodging are variables to capture the incentive mechanisms; high averages are supposed to lead to high TFP.

Experience in production could be important in influencing TFP. Learning will be higher in these activities which started earlier and whose technology is not complex. In this regard, Ethiopian industries are frequently claimed to be predominantly import-substitute, consumer type and light industries. And most of them were established in 1950's and 60's. Thus, because of the learning and spillover effects, these sectors might register high TFP. Thus, a dummy variable is included to differentiate these sectors; only chemicals, non-mineral product and metal sectors, mostly a recent phenomenon in the context of the Ethiopian manufacturing industries, are considered as heavy industries (which imply that these are less experienced in production).

The model is estimated using a pooled data set from 19 sub-sectors each having 17-year observations. All the above variables are included as explanatory variables to identify the influential variables that cause sub-sector differences in the productive content of combined factor inputs[6]. The data set suffered problems of serious serial correlation (fifth order) and it is corrected using the Cochrane-Orcutt iterative method. The result is summarised in Table 15.

According to the result, the coefficients for "intensity of technology" and average annual wage did not appear significantly different from zero. This implies, then, that these variables are not the cause for sub-sector differences and hence are excluded in the estimation (see Table 15).

The result, excluding the insignificant variables, becomes not only statistically significant (at 5% level) but also increases the over-all fitness of the model (according to the F-ratio test). Five variables are identified as causes for differences for the rate of growth of total factor productivity across sub-sectors; namely, capital intensity, size structure, import intensity, incentives and the nature of industries. Because these variables differ across sub-sectors, they cause differences in TFP.

Table 15. Econometric Estimates of Equation 9

Regressor	Coefficients	T-ratio
All variables in the model		
Q	-0.1153	-5.1687
L	-0.00273	-1.1386
K	-0.0209	-0.665
S	-1.2174	-2.3782
M	2.0630	4.1959
W	-0.00729	-0.1599
I	0.7675	3.0918
D	-0.60638	-2.7411
Con	1.3174	2.941
F-ratio	28.7005	
R^2	53.18	
D.W	1.9762	
Selected significant variables		
Q	-0.11477	-5.1627
S	-1.2182	-2.3869
M	2.0679	4.2267
I	0.69358	3.6751
D	-0.59376	-2.6927
Con	1.2102	2.9469
F-ratio	37.29	
R^2	53.38	
D.W	1.9743	

Source: Own computation.

An important point to notice is the sign of their coefficients since they indicate the direction of influences. Two outcomes are surprising. The first is the negative relationship between TFP and K/L. Sectors with high K/L appeared to be low in TFP.

The second is the positive relationship between import intensity and TFP; the more a sector is dependent on imports, the higher is its TFP. The latter one is more surprising in countries like Ethiopia where foreign exchange was a severe constraint causing enterprises to operate under capacity. The former can simply be understood to mean that growth of total factor productivity is not capital embodied whereby its cost outweighs its benefits.

The other variables have justifiable sign. The larger the share of small scale in the size structure, the lesser will be TFP in that sector since small scales are claimed to be less efficient than the larger ones. The same is true for incentives and experiences.

5. CONCLUSION

Resources available for industrial growth in Ethiopia are limited and the prevailing conditions (saving, investment, purchasing power, debt, stability, etc.) are not conducive for resources to be accumulated at extensive scale. Industrial growth therefore depends much more on improved productivity and efficiency in resource use. This would be possible, however, only if efforts are exerted to produce growth of total factor productivity.

Attaining high total factor productivity growth calls for building up the capacity to search for and select technologies for use in particular environments, operate assimilate, adapt and modify processes and products in light of the prevailing conditions and producing minor or more substantial innovations. In turn, the extent and intensity of building up these activities in any economy influences the magnitude and pace of its industrialisation. In a nutshell, the process of acquiring high total factor productivity growth is at the same time a process of industrial development.

Three stylised facts have already emerged on the link between growth of total factor productivity and industrialisation. The first is high contribution of growth of total factor productivity to output growth. Secondly, the rate of growth of total factor productivity is higher in industrialised economies than that of developing countries. Thirdly, rate of growth of total factor productivity increases as a developing economy enters into a higher stage of industrialisation. Thus, developing economies have to ensure that the capacity to generate high total factor productivity growth has taken place in their industrialisation process.

Given its importance in the process of industrialisation, a close scrutiny whether total factor productivity growth is built in the Ethiopian manufacturing sector becomes imperative. For this purpose, different statistical and econometric models are employed. Three points are clearly observed in this effort. First, the Ethiopian manufacturing sector, regardless of its state of allocative efficiency, registered a negative growth of total factor productivity for the period 1976-1995. This result indicates that there was no growth of total factor productivity generated in the sector. This, in turn, implies that the sector proved itself to be unlearning and the efficiency in resource use did not reveal improvements; rather it was deteriorating. Second, a sub-sector difference in the rate of growth of total factor productivity prevailed. Those sectors which are light, not technologically complex and with long production experience, though not all, produced a positive growth of total factor productivity while the others do not. Finally, the importance of ownership in determining the extent of growth of total factor productivity was clearly observed. The private sector, in general, appeared to be more effective in resource use than the public ones, though it was not across all sub-sectors and through all the years under study.

These results imply, for Ethiopia to industrialise, serious actions have to be taken by firms, and the government has to make conditions conducive for such efforts. Such actions should revolve around the capacity to generate growth of total factor productivity in every firm. Firms should build the necessary technological and managerial capabilities by making every effort to adapt and assimilate technologies to new conditions and to improve on them. This requires investment since technological knowledge cannot be easily imitated, transferred or modified. Parallel with this, the government should create a conducive environment by providing appropriate public goods, incentives and institutions. The government should give due attentions to those activities that are usually underinvested by the private sector, which include launching physical investment, developing human capital and undertaking technological efforts.

Since incentives determine the efficiency with which capabilities are used, affect the pace of accumulation of resources, influence the type of capital purchased and the kinds of learning, and determine the extent to which existing endowments are exploited in production, it should be given due consideration by the government. More importantly, as long as acquisition of technological capabilities requires inward-oriented trade policies, the government has to intervene by initiating these policies. But high level of intervention might frustrate or dissipate the development of healthy capabilities and prop up nonviable enterprises that should die out. Thus, there is a need to contain the costs of protection or subsidy by introducing limits and safeguards through selectivity and flexibility. Sectors must be selected, the appropriate duration of infant industry protection or promotion has to be specified and the means to evaluate performance should be defined. Erecting the right incentives are necessary, nevertheless without institutions, the ability to respond to incentives is bound to be very limited. Thus, building institutions that facilitate the working of the markets are necessary. There must be institutions to promote inter-firm linkages, to provide support to smaller enterprises, help firms to restructure them and overcome infrastructural, information and service deficiencies. Nevertheless, installing institutions alone is not sufficient, incentives and capabilities should also be built in; one without the other will not produce the required effect.

NOTES

1 Arithmetic mean of factor shares within the period assumes a constant factor elasticity of output, a Hicks neutral growth of total factor productivity and a non-variable elasticity of substitution among factors. The approach gives room for factor shares to vary overtime unsystematically (it implicitly assumes a zero mean and constant variance for the distribution) so that the average becomes a representative. Its drawback is that outliers easily influence the estimate (which could mostly be the case in the Ethiopian manufacturing industries in which the correlation between capacity utilisation and labour employed is insignificant due to lack of management power to fire-and-hire). The geometric mean of factor shares during the period has the same characteristic as that of the average with an advantage of reducing the influence of extreme values. The initial share, i.e. labour and capital shares to value-added at the initial period assumes a deterministic nature of factor shares which does not vary overtime whatever is the environment (the case of stationary process with a mean of its initial value). A year-by-year factor share is quite the opposite of the others; elasticities are variable and growth of total factor productivity is non-neutral and could be embodied, as well.

2 These formulae are:

$$i)\ r = \frac{1}{n-1}\sum\left(\frac{yt+1}{yt} - 1\right) x\ 100 \qquad [1]$$

This formula uses all information, but it is sensitive to extreme values.

$$ii)\ r = \frac{1}{n}\left(\frac{y_t}{y_o} - 1\right) x 100 \qquad [2]$$

This formula considers only two end values. It is not affected by whatever happened in between. As a result, it heavily depends on the two end values.

$$i)\ r = \frac{1}{n}\mathrm{Ln}\frac{y_n}{y_o}\ x\ 100 \qquad [3]$$

This considers two end values and it basically assumes a continuous process:

$$ii) r = anti\log\left[\frac{1}{n}\log\left(\frac{y_n}{y_o}\right)\right] - 1\ x\ 100 \qquad [4]$$

This considers only two end values, but is a discrete case.

$$i) \mathrm{Ln}\, Y = \mathrm{Ln}\, A_o + rt \qquad [5]$$

This is a trend function taking time as an explanatory variable and then computing the growth rate, for the continuous case and it uses all information. The following is for discrete case

$$ii) \log Y = \mathrm{Log}\, A_o + [\log(1+r)]t \qquad [6]$$

3 Estimating such production functions has problems, however. In the first place, existence of perfect competitive market, divisibility and homogeneity of output and inputs are assumed in the theoretical formulation of production functions while none of them are realistic. Given these assumptions, the data are assumed to represent points on the production function, i.e., the actual figures are the optimal ones, whereas huge discrepancies exist between them in time-series data like the one in this study due to variation in capacity utilisation at different times in point. Aggregation problems are also prevalent. As a result, estimates tend to be biased and inconsistent.

4. The years selected are those that are the initial or terminal or those years that represent unique characteristics in the history of the manufacturing industries. The climax year of production campaign, the beginning of the second phase of the ten-year perspective plan and the end of the socialist era, respectively, are those selected.

5 F-ratio can be computed using the following expression:

$$F = \frac{(\sum e_R^2 - \sum e_{UR}^2)/c}{\sum e_{UR}^2/(N-K)}$$

Where Σe_R^2 = restricted residual sum of squares, Σe_{UR}^2 = unrestricted residual sum of squares, N= number of observations, K= number of parameters estimated; and, c= number of restrictions.

6. The sources of ownership differences or the extent of these variables to influence the productive content of inputs across sub-sectors in public and private sector are not assessed. The premise for not to entertain the issue is that, once this done for sectors, it transcends to the other.

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