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Does Higher Education Influence Productivity of Graduates? Evidence from Tanzanian Manufacturing Enterprises[1]

Godius Kahyarara[*]

Abstract

This paper examines the effects of higher education on worker's performance in the labour market. It does so by estimating firm level productivity effects of higher education in Tanzania manufacturing enterprises. The estimates are obtained from a Cobb-Douglas production function that treats higher education as one of the determining variables of productivity. The analysis drawn from such estimates contributes knowledge to two empirical questions: i) Are there gains from investment in higher education to employers? ii) What is the influence of productivity in explaining higher wages to graduates? Data used is employer-employee matched data from Tanzania enterprises from 1994 till 2008. Time dimension of the data allows controls for time invariant individual characteristics that are potential sources omitted variable bias in micro analysis like the one provided in this article. The findings strongly support the hypothesis of positive correlation between higher education and worker productivity. The ordinary least square estimate on the proportion of higher education is 0.027, suggesting that 1% increase in the proportion of the workforce with higher education increases observed productivity by 0.27%. But generalized method of moments coefficient estimates are 0.0009 and statistically significant, showing that our ordinary least square estimates were biased. The results also confirm a positive correlation between productivity and a graduate manager. Using such results, the article concludes that there is robust evidence that productivity is affected by higher education, in the data. Hence, employers gain from utilizing higher education graduates through increased firm performance especially productivity. There is therefore a justification for employers to support higher education.

1.0 Introduction

The purpose of this article is to analyze the effects of higher education on worker productivity. The study justification is that addressing the link between education and productivity is critical because of the mixed conclusions on the effects of education in the labour market on the one hand, and the general low level of productivity in Tanzanian labour market, on the other. It will be recalled that the theoretical explanations of the role of education in the labour market have so far provided conflicting conclusions on the role of education in the labour market. The first suggests that education has positive effects in productivity such that higher educated workers will be more productive than lower educated workers. The second conclusion is that there is no direct effect of education on productivity except that education signals ability. The study was motivated by the fact that as

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[*] Department of Economics, University of Dar es Salaam

Tanzania strives to boost productivity and growth, larger investment should be made in education and training. The human capital theory (see for example Becker, 1993) predicts that learning increases employee's productivity that in turn raises the firm's profit. Furthermore, Becker (1962) pointed out that investment in education is a process that raises future productivity, and that employees can raise their productivity by learning new skills and by perfecting old ones.

However, alternative theories such as 'Signalling' and 'Matching' conclude that education does not act as a source of productivity. These models, first developed by Spence (1973) and Stiglitz (1975), suggest that schooling acts as a signal or a filter for ability differences among workers that firms would wish to reward but cannot reward directly. In this model workers choose education not to increase their productivity, as in the human capital model, but to *signal* to employers their productivity. Ability, screening costs and equilibrium determine wages. Ability differences may be positively correlated with length of schooling because, for example, more able persons: i) receive higher benefit from a given amount of schooling; ii) value future earnings more highly; and iii) enjoy learning. From the firm's perspective these attributes are likely to be unobserved but valuable nonetheless, because they may enhance the return to on-the-job training within the firm, and reduce the likelihood that such a worker quits or is absent (Weiss, 1988), or simply reduce monitoring costs. Hence, this study aimed at contributing knowledge to the empirical question – What is the role of higher education in the labour market? The answer to this question can shed light on the link between investment in education such as higher education and observed performance of production in the labour market and the economy at large.

The study policy contribution is on the area of long-term relationship between graduate's outcome in the labour market that can reflect employer's benefits of employing graduates on the one hand, and social benefit of investment in higher education, on the other. Thus, to understand the long-term perspectives for the linkage between education and labour outcome such as productivity is critical for periodic review and formulation of development policies. Most significantly, the questions related to funding of education come back in different forms. The first form of such questions is related to who should pay for higher education. The human capital theory argues that investments in general education increase an employee's productivity at other work places than the work place of the employee. In his seminal work, Becker (1964) argues that employers will not be willing to invest in general training when labour markets are competitive. However, they are willing to invest in specific training because it cannot be transferred to outside firms. Therefore, by exploring the gains productivity has on higher education on firm level productivity, the article provides evidence of potential gains to employers from higher education. The analysis of the article makes use of employer-employee matched data from Tanzania enterprise surveys. The available measures of education in the data are the number of years the manager has spent in school, weighted average of years of education of the workers in an enterprise and a proportion of workers with higher education in a given enterprise. The data has a long span of time dimension from 1995 up to 2008. This forms a rich source of information that allows estimates that control for omitted variable bias problem 'endogeneity, when estimating the effects of higher education on productivity. The estimation strategy of the article undertakes both value added and gross output production functions using ordinary least square [OLS], fixed effects [FE], and generalized method of moments [GMM]. After this introduction, Section 2.0 discusses salient features of trends in Tanzania higher education and productivity; while Section 3.0 presents theoretical a framework of the study. Section 4.0 discusses the methodology and data available for the study; and Section 5.0 presents empirical findings. The last section (Section 6.0) draws a conclusion of the article.

2.0 Tanzania Higher Education and Productivity

The role of higher education in the development, enhancement of productivity and poverty eradication, in developing countries has been a central topic on the recent development agenda. In particular, Tanzania has embarked on comprehensive social, economic and political reforms that have resulted into new national level plans and programmes. Whether changes in education following economic and social reforms have impacted on productivity change, is a critical question that can assist policy makers to understand the role of education and training in poverty reduction. Tanzania has recently witnessed changes in both quality and quantity of the new entrants from all levels of education. Higher income to parents has resulted to greater numbers of individuals accessing higher education. The question that needs a precise response is: To what extent does change in supply of graduates influence observed productivity? To this end, the article first describes trends in higher education and then presents trends in productivity.

2.1 *Trends in Higher Education Enrolment*

From early 1970s till end of 1980s Tanzania had a single university with the overall enrolment capacity not exceeding 3,000 students. From the early 1990s the total enrolment in higher education increased from 4,594 in 1993 to 13,442 in the year 2000. Overall political, economic and social changes resulted in the increase in enrolment of higher education graduates to around 100,000 by the year 2008 (see Table 1). The rise in enrolment during recent years is partly a reflection of the reforms in higher education and abolition of the manpower planning system introduced in 1992. In sum, the labour market conditions and demand for education are likely to be influenced by the trends in enrolment rates in various levels of education described in this section. The rise of enrolment rates has the effect of inducing a shift in supply of workers with more education. This shift may lower the rate of returns to schooling of more educated workers.

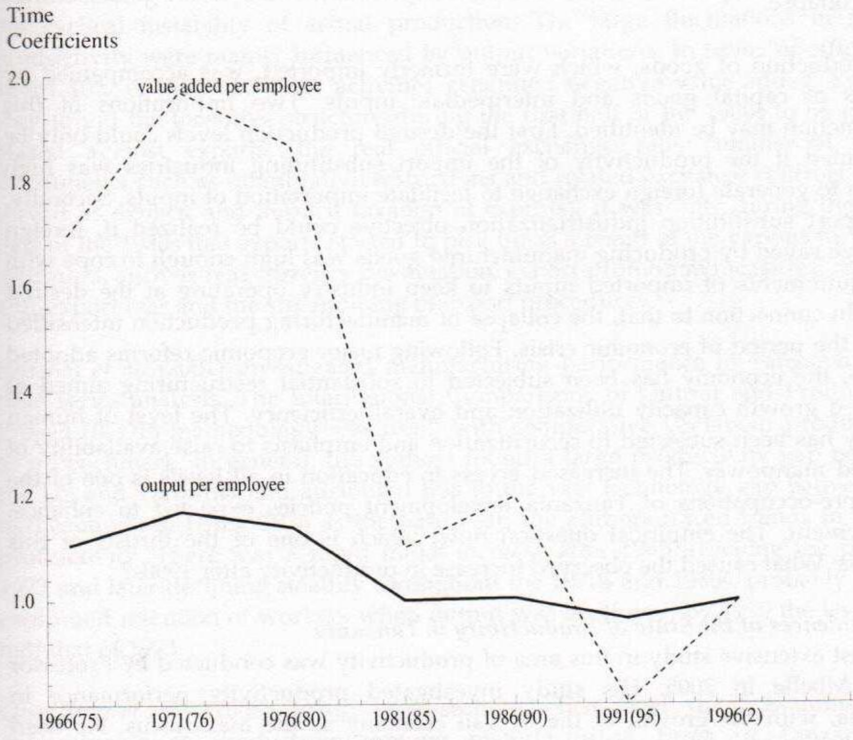
Table 1: Students Enrolled in Universities and University Colleges by Programme Categories 2003/2004 - 2007/2008

Category	2003/2004			2004/2005			2005/2006			2006/2007			2007/2008		
	F	M	T	F	M	T	F	M	T	F	M	T	F	M	T
Agriculture	223	748	971	206	766	972	167	764	931	210	814	1024	315	1221	1536
Engineering Science	177	1442	1619	433	1132	1565	295	1302	1597	352	1405	1757	528	2107	2635
Medical Science	802	1688	2490	892	1959	2851	1151	2577	3728	1650	2451	4101	2475	3676	6151
Natural Science	187	572	759	221	673	894	282	727	1009	315	795	1110	473	1192	1665
Science & ICT	802	2567	3369	989	2358	3347	995	3812	4807	1120	4168	5288	1680	6252	7932
Total Science	**2191**	**7017**	**9208**	**2741**	**6888**	**9629**	**2890**	**9182**	**12072**	**3647**	**9632.2**	**13279**	**5471**	**14448**	**19919**
% Female/Male	**23.79**	**76.21**	**100.00**	**28.47**	**71.53**	**100.00**	**23.94**	**76.06**	**100.00**	**27.46**	**72.54**	**100.00**	**27.46**	**72.54**	**100**
Business Mgt & Admin	1183	3356	4539	2249	4835	7084	2036	5029	7065	2730	6101	8831	4641	10372	15013
Education	2015	4344	6359	2610	5344	7954	3237	5609	8846	3800	7258	11058	6460	12338	18798
Law & Social Science	3936	7730	11666	5261	9189	14450	5043	8393	13436	6945	9850	16795	11807	16745	28552
Total Arts	**7134**	**15430**	**22564**	**10120**	**19368**	**29488**	**10316**	**19031**	**29347**	**13475**	**23209**	**36684**	**22908**	**39455**	**62362**
% Female/Male	**31.62**	**68.38**	**100.00**	**34.32**	**65.68**	**100.00**	**35.15**	**64.85**	**100.00**	**36.73**	**63.27**	**100.00**	**36.73**	**63.27**	**100**
Grand Science & Arts	**9325**	**22447**	**31772**	**12861**	**26256**	**39117**	**13206**	**28213**	**41419**	**17122**	**32841**	**49963**	**28378**	**53903**	**82529**
% Female/Male	**29.35**	**70.65**	**100.00**	**32.88**	**67.12**	**100.00**	**31.88**	**68.12**	**100.00**	**34.27**	**65.73**	**100.00**	**34.39**	**65.31**	**100**

The change in returns to schooling induced by changes in enrolment rates may have impact on the demand for education. Human capital theory suggests that individuals decide to pursue education and training based on a comparison of costs and expected benefits in the form of enhanced lifetime earnings. The increased rates of returns to schooling will thus raise the demand to acquire higher levels of education. Hence, this article assesses the changes in availability of graduates in the labour market.

2.2 Trends in Productivity in Tanzania

The trends in labour productivity in Tanzania are indicated in Figure 1. The figure uses both gross output and value added measures of productivity to display the shape of the productivity curve from 1960 to 2000s.



Note: Time coefficients are obtained from gross output and value added per employee production function estimates. Years are time dummies for the years from 1966-2000s. The base period is 1996-2002.

Figure 1: ***Trends in Underlying Productivity (1966-2002) based upon Macro-level Changes in Value Added and Gross Output per Employee***

From the graph, productivity trends in Tanzania reflect three periods of development in the post-independent Tanzania namely: a period of expansion (1974-1980); a period of collapse (1981-1990); and a period of adjustment, privatization and re-structuring (1991-2000)s. It will be recalled that after the introduction of rural development policies that contained the population under community village settlements, nationalization, import substitution and basic industrialization strategies, the Tanzanian manufacturing sector became a fast-growing sector. However, rapid expansion particularly in the 1960s and 1970s was followed by a collapse in the early 1980s. The war with Uganda, extensive periods of drought, failure of crop production especially sisal, inefficiency due to high protection in the form of tariff and non-tariff instruments, scarcity of foreign exchange, excessive state involvement in industrial production (including subsidization), anti export bias are among possible factors explaining the severity of the collapse.

The production of goods, which were formerly imported, was accompanied by imports of capital goods and intermediate inputs. Two implications of this phenomenon may be identified. First the desired production levels could only be maintained if the productivity of the import substituting industries was high enough to generate foreign exchange to facilitate importation of inputs. Secondly, the import substitution industrialization objective could be realized if, foreign exchange saved by producing manufactured goods was high enough to cope with the requirements of imported inputs to keep industry operating at the desired levels. In connection to that, the collapse of manufacturing production intensified during the period of economic crisis. Following major economic reforms adopted in 1986, the economy has been subjected to substantial restructuring aimed at increased growth capacity utilization and overall efficiency. The level of human capacity has been subjected to securitization and emphasis to raise availability of qualified manpower. The increased access to education in all levels is one of the major pre-occupations of Tanzania development policies expected to enhance, development. The empirical question now, which is one of the thrusts of this article, is: What caused the observed increase in productivity after 1990s?

2.3 *Evidences of the State of Productivity in Tanzania*

The most extensive study in this area of productivity was conducted by Professor Amon Mbelle in 2005. His study investigated productivity performance in Tanzania, with the growth of the overall economy as the main focus. He used growth accounting, to assess the contributions of physical capital, labour and Total Factor Productivity (TFP). His findings were that Tanzania experienced growth in labour productivity and TFP for the whole period. There was high capital deepening during 1967-1985, compared to the reform period 1986-2000. If the record of growth is reflected on, this means that capital was less productive during

1967-1985. For the period 1986-2000, labour productivity growth declined marginally by 0.4%, while TFP growth was highest, implying that the impressive growth performance during 1986-2000 could be associated more with growth in TFP. The detailed literature review on productivity is provided in UNIDO country case study of 2005.

Ndulu and Semboja (1994) investigated productivity, efficiency and export performance in the manufacturing sector in Tanzania. Productivity was assessed in terms of domestic prices. Three measures of efficiency were used: partial factor productivity, a modified measure of labour productivity and a simple measure of investment productivity. The authors found variations in output to be totally explained by changes in factor inputs and that productivity growth in the manufacturing sector was statistically insignificant. This was explained partly by the cyclical instability of actual production. The large fluctuations in labour productivity were mainly influenced by output variations. In terms of efficiency, about 40% of manufacturing activities generated negative value-added. Further, they found the incentive structure during the first half of the 1980s to be grossly biased against exports (the real official exchange rate, commercial policy instruments such as quantitative restrictions and related exchange controls which served as explicit and implicit taxation of exports). It was only during the latter part of the 1980s that exports started to pick up as a result of the various measures instituted, such as real currency devaluation, export promotion measures, reduced anti-export bias and the streamlining of export procedures.

Szirmai *et al.* (2001) investigated manufacturing performance in Tanzania using time series analysis. The International Comparisons of Output and Productivity Project (ICOP) methodology was used, with comparative US labour productivity as a benchmark. In general, the authors found a large productivity gap between the US and Tanzania and attributed this to the vast technology gap between the two economies. Using 1976 as the base year, the authors traced trends in labour productivity. There was a rapid initial increase after 1965, reaching the peak in 1973 and later declining steadily throughout the 1970s and 1980s, probably due to continued retention of workers when output was declining. By 1990 the level was half that of 1973.

Goedhuys *et al.* (2008) using cross-sectional firm-level data, examined the determinants of productivity among manufacturing firms in Tanzania. In particular, they sought to evaluate the relative importance of technological advances and the business environment in which firms operate in affecting productivity. Of the technological variables, R&D as well as product and process innovation, licensing of technology, and training of employees fail to have any impact; only foreign ownership, ISO certification and higher education of the management appear to affect productivity. Some important influences from the broader business environment, however, appear to affect productivity and are robust to different specifications of the model. The study shows that credit constraints, administrative-regulatory burdens and lack of business support services depress productivity; and membership of a business association is associated with higher productivity.

3.0 Theoretical Framework and Literature

3.1 Theoretical Framework

The theoretical framework of this study relies on human capital conceptual framework to determine whether higher education can influence productivity at enterprise level. Such framework facilitates interpretations of estimating the impact of higher education on observable processes of production of goods and services. Using this framework, the estimation strategy of this article uses production function specifications in which a proxy for higher education is one of the determinants of production. There is extensive literature analyzing the effects of education on productivity (Griliches, 1960, 1963; Denison, 1962; Chaudhri, 1968; Nelson and Phelps, 1966; Bartel, 1994, 1995; Black and Lynch, 1996). The main question addressed in these empirical studies is whether education has any effect on production. The analysis of the effects of productivity on education has mainly focused on two effects of education on production: allocative and productive effects (Griliches, 1963; Chaudhri, 1968; Nelson and Phelps, 1966). The allocative effect of education is assessed in terms of the role of education in enhancing ability to acquire information about production and learn new methods of production; innovative ability is one form of allocative ability (Nelson and Phelps, 1966). In connection to these two types of education, writers that have assessed the role of education in production have regarded education as an aspect that affects quality of labour input in production.

Following Wright (1936), Rapping (1965), (Griliches 1960) Denison (1962) and others, the approach of estimating education effects on production has treated education as a separate variable in a production function. Productive effects of education in the context of such empirical frameworks come from the education effects whereby higher education adds more value to production, or increases the ability to produce more outputs with given inputs from other factors than lower education. The source of this more capability in production is from the predictions of the human capital theory that investment in education raises the ability to produce such that it increases productive capacity. This productive capacity raises marginal productivity of labour. The observed high pay for higher education represents a reward to increased marginal productivity. Thus, failure to observe the productive effects of higher education is disapproval of the role of education as stipulated by human capital, and supporting the signalling models of education. According to such models, as alluded to earlier, schooling acts as a signal or a filter for ability differences among workers that firms would wish to reward but cannot reward directly (Spence, 1973; Stiglitz, 1975). In such models, workers choose education not to increase their productivity, as in the human capital model, but to *signal* to employers their productivity. Therefore, ability, screening costs and equilibrium determine wages.

The theoretical interpretation of the model is that ability differences may be positively correlated with length of schooling because, for example, more able persons: i) receive higher benefits from given amount of schooling; ii) value future earnings more highly; and iii) enjoy education. From the firm's perspective, these attributes are likely to go unnoticed but valuable nonetheless, because they may enhance the return to on-the-job training within the firm and reduce the likelihood that workers would quit or become absent (Weiss, 1988), or simply this would reduce monitoring costs. Therefore, this study contributes knowledge on testing the versions of education effects by models of human capital and signalling and screening.

Empirical studies (see for example, Griliches (1963) and Lorraine *et al.* (2000) that have provided measures of labour quality at firm level have used a weighted schooling-based labour quality index and proportion of skilled or trained labour among the employees as proxies for labour quality. The schooling weight assigned to each worker has been regarded as an increasing function of worker's educational attainment. The proxy's coefficients are then regarded as the coefficients of labour quality. Other forms of education considered in empirical studies are learnt by doing, which is a form of education process whereby worker's skills in specific tasks are enhanced through experience, doing routine jobs and becoming better adjusted to the jobs (Hirsch (1952). Information about work experience or work tenure can be used to assess the effect of education on productivity. Work experience acquired through the number of years spent in the labour force or age and job tenure are proxies used to measure learn-by-doing. In this study, we use weighted average of the years of work experience of workers for each firm, along with weighted average of years of job tenure to proxy for learn-by-doing.

Studies such as Griliches (1960) and Denison (1962) produced estimates of quality change in labour input, using data on the changing distribution of the workforce by educational attainment and mean income by education as weights. The authors found that labour quality improvement through change in education attainment had positive effects on production. Griliches (1963) using the same data set analysed the productive effects of education in agriculture, by estimating agricultural production function of gross revenue. Griliches found schooling to be an important source of productivity. There are authors who have focused on analysing the effect of job training on productivity using representative firm-level data.

The second trial proved that training measured by the number of employees trained still had no impact on productivity. However, the trial found some evidence the training had on productivity, through other personnel measures. Computer skills development is one of the training measures found to have a significant positive effect on firm productivity. Other forms of training that had significant effect on productivity were the proportion of time spent in formal off-the-job training. Based on the findings of the Lynch and Black study, it is apparent that the measurement and design of training have significant influence on the assessment of training effects on productivity.

Dearden, Reed and Van Reenen (2000) present a study on the productivity impact of training at the industry level, in Great Britain. They use a panel of British industries between 1983 and 1996 to estimate the effects of training on productivity. The authors combine training information (and other individual productivity indicators such as education and experience) with complementary industry-level data sources on value added, wages, labour and capital. They address unobserved heterogeneity as well as endogeneity by using a variety of estimation strategies including system GMM methods. They find positive and significant effects of training on sector productivity (thereby including inter-firm knowledge spill-overs). The study reports that raising the proportion of workers trained in an industry by 5 percentage points (say from the average of 10% to 15%) is associated with a 4% increase in value added per worker and a 1.6% increase in wages.

Thomas Zwick (2002) measured the impact of training intensity on establishment productivity in a production function, using the German establishment panel set. The author simultaneously corrected unobserved time-invariant heterogeneity of establishments by using a fixed effect panel regression and for selectivity of training by instrumenting the training intensity variable. In addition, the study included a broad variety of control variables for establishment and employee characteristics, as well as several personnel management methods as further attempt to mitigate biases. The study findings were that the share of trained employees in 1997 had a significant impact on productivity in 1998 (but not in 1999) and on average productivity in the period 1997 - 2000. The study concluded that unobserved heterogeneity and selectivity both lead to an underestimation while omitted variable bias leads to an overestimation of the productivity effect.

The literature reviewed in this section points to the fact that in estimating productivity effects of education, a production function specification is a key estimation technique. However, there are a number of estimation problems that need to be controlled. In fact, since as early as 1944, applied researchers have worried about the potential correlation between input levels and the unobserved firm-specific productivity shocks in the estimation of production function parameters.

The economics underlying this concern are intuitive. Firms that have a large positive productivity shock may respond by using more inputs. To the extent that this is true, ordinary least squares (OLS) estimates of production functions will yield biased parameter estimates, and, by implication, biased estimates of productivity.

4.0 Estimation Techniques and Model Specification

To analyze the productivity effects of higher education, this article assesses the impact of the accumulation of human capital measured by the weighted average of years of education, formal training of the workers, job experience and informal training such as learning-by- doing acquired on the job on firm productivity. The estimates control for firm age, size, sector and location. However, there are limitations of estimating the effects of learning on productivity. The problems of endogeneity, specification of production function and input measurement are likely to affect the estimates. The OLS estimates will be biased if there are omitted unobserved firm fixed effects that are correlated with the determinants of productivity, i.e. the regressors. There is also a potential for simultaneity problem when estimating the productivity effects of training using a production function. One source of this simultaneity is that inputs are not really independent variables and are chosen by firms in some behavioural fashion (Griliches and Mairesse, 1998). In this study, we use panel data and estimate fixed effect models to control for fixed effects that might be the potential sources of the estimation problems.

4.1 Model Specification

In the model specification, two forms of production functions - the value added production function and the gross output production function - are displayed. In both forms of production function, measures of higher education are used as the regressors along with other inputs in the micro data. The higher education variables in our micro production functions are weighted average of years of education at enterprise level, years of education of the managers and the proportion of workers with higher education. The models are described below.

The value added production function is specified as follows:

$$LnV_{jt} = a_0 + a_1 LnK_{jt} + a_2 LnL_{jt} + a_3\, JT_{jt} + a_4 LnHEDUCATION_{jt} + a_5 C_{jt} + \mu_j + \epsilon_{jt} \quad [2]$$

Whereby j and t are firm and time subscripts

LnV = log of value added

LnK = log of physical capital

LnL = log of a number of labour available in a firm

JT = variable for firm level job training

$HEDUCATION$= Measure of Higher Education (as averages of schooling, managers education and proportion of workers with higher education).

C = observable firm characteristics such as firm location, sector ownership, age export and others
μ = Fixed effects
ϵ = error term.

The variable μ represents fixed effects, i.e. omitted variables that may be correlated with explanatory variables and ε is the error term. The gross real output production function is specified as follows:

$$LnY_{jt} = a_0 + a_1 LnK_{jt} + a_2 LnL_{jt} + a_3 JT_{jt} + a_4 LnOH_{jt} + a_5 LnRM_{jt} + a_6 LnIND_{jt} + a_7 HEDUCATION_{jt} + a_8 C_{jt} + \mu_j + \epsilon_{jt} \quad [3]$$

Whereby j and t are firm and time subscripts

LnY = log of real gross output
$LnRM$ = log of raw materials
$LnIND$ = log of indirect costs

Other variables are as defined in the second equation.

The gross real output is the deflated value of total manufactured output. It should be noted that, in both forms of specifications, we also estimate per unit labour productivity. In this case we use value added per employee and gross output per employee as dependent variables, and introduce capital labour ratio as an additional regressor on the right hand side

4.2 Data and Variables

The data used is from Tanzania Enterprises data. This data was collected under the Word Bank regional enterprises development surveys (RPED) in early 1990s, and then extended by the Oxford University from 1999 till 2002. In this study the key variables have been updated to capture the situation of recent years. The interviews under this type of data are conducted at two levels. The first level aims at collecting employer information and the main respondent is the chief executive of an enterprise. In the second level, employees are randomly selected to collect detailed worker characteristics including education and training information. The survey covers all major towns of Tanzania, i.e. Mwanza, Dar-es-Salaam, Arusha, Tanga, Kilimanjaro and Iringa. The higher education incidence of the workers in the sample is measured both as a continuous variable (reflecting the number of years of education) and as a level of higher education attained. At enterprise level, weighted average of schooling, manager's years of education and proportion of the workers with higher education are derived from firm level information about individual highest level of education. The other important variables are the occupational specialization, work tenure and age that help to control incidences of other human capital sources.

In order to assess productivity at enterprise level, the real value added is the deflated value of the difference of total manufactured output minus indirect costs and minus raw materials used in producing the output. The capital stock is a real capital stock series based upon an initial observation of the firm's replacement value of plant and machinery, which is augmented with subsequent investments in plant, and machinery made by the firm. Each value is weighted by the proportion of workers in a given occupational category, in each firm, to obtain a weighted average for each firm. The occupational categories used are managers, administration, sales, clerical supervisor, technicians, production workers and support staff. Control variables in the production function are firm age, exports, location, sector and ownership. Firm age is based upon the year in which the firm originally started its operations; while the export variable is a dummy. Firm location variable is categorized into six towns of Morogoro, Dar-es-Salaam, Tanga, Arusha, Mwanza and Moshi where the surveys have been conducted. Sector variables are for four main manufacturing sectors covered in the surveys mainly food, textile, metal and wood. The ownership variable is derived from a direct response of whether a company is wholly or partially owned by Tanzanians or foreigners, private foreign, private Tanzanians, publicly owned or joint venture between public and private.

5.0 Empirical Results

In this section, we report the results of the estimate of productivity effects of higher education in Tanzania, using firm level data and via estimating firm level production functions. It will be recalled that the main question addressed and ultimately the hypothesis to be tested is: What is the impact of higher education in observable enterprise level productivity? It is anticipated that if the human capital theory holds, then higher education influences the observed productivity positively. Thus, to test such hypothesis or address the posed question, firm level measures of education are inserted in the production function among other determinants of production, and assessed if their parameter estimates can show robust positive coefficients after controlling all potential productivity determinants. The three measures of higher education entered in the production function reported here are years of education of a manager, proportion of graduates in the surveyed enterprise and the weighed average of years of education at the firm level. To capture the effects of higher education, the weighed average of years of education and the average years of education contain square terms that capture the effects of having higher education. For reasons mentioned before, we estimate both value added and gross output production functions. The estimates first establish if the data accept the returns to scale. If the hypothesis that constant returns to scale exist is accepted, then our estimate can be presented using either the general level of productivity or labour productivity without loss of generalization.

Our estimate first reports the gross output production functions in the tables below. The results in Table 2 present the estimate of the effects of higher education on firm level productivity, when higher education is measured as a proportion or percentage of workers with higher education employed within a specific firm. In column 1, the estimates include only key variables that measure productivity namely, labour capital, raw materials and intermediate inputs. The test for constant returns to scale indicates that the data strongly display constant returns to scale. Furthermore, the results show that all input variables, i.e. physical capital, labour, raw materials and indirect costs still have positive effects on gross output. But most importantly, it will be recalled that our primary focus is to examine if there is evidence of any effects of higher education on productivity. The results strongly support our hypothesis. In particular, the coefficient estimate on the proportion of higher education is 0.027, suggesting that 1% increase in the proportion of the workforce with higher education increases observed productivity by 0.27%. The results in columns 2 and 3 control location, sector and firm size. It is evident that the productivity effects of higher education are heavily influenced by such factors. Specifically, the inclusion of such controls reduces the impact of higher education by more than tenfold. The point estimates show that after such factors are controlled, the effects of higher education on productivity is just 0.2% compared to the effects of 2.7% reported in column 1. The effects are not reduced when firm fixed effects are controlled in column 4, and instead rise to 0.3%.

Table 2: OLS and Fixed Effects Regression Results of the Estimates of Higher Education on Productivity Measured as Gross Real Output

Variable	Coefficient			
	OLS1	OLS2	OLS3	FEM
Log of capital	0.072	0.078	0.077	0.011
	(6.57)	(7.08)	(6.73)	(0.73)
Log of labour	0.274	0.330	0.349	0.254
	(12.83)	(14.67)	(9.75)	(11.05)
Log of raw materials	0.116	0.120	0.121	0.093
	(16.41)	(16.74)	(16.73)	(12.55)
Log of inputs	0.518	0.485	0.486	0.482
	(30.96)	(28.35)	(28.10)	(25.03)
Proportional of graduate	0.0027	0.002	0.002	0.003
	(3.57)	(2.97)	(3.07)	(3.48)
Round 1	0.469	0.416	0.422	0.771
	(3.32)	(2.59)	(3.00)	(7.00)
Round 2	0.383	0.342	0.342	0.691
	(2.66)	(2.39)	(2.39)	(6.36)
Round 3	0.448	0.392	0.388	0.631
	(0.601)	(2.59)	(2.56)	(5.63)
Round 4	0.601	0.556	0.556	0.403
	(3.87)	(3.63)	(3.61)	(3.74)

Round 5	0.718	0.685	0.687	0.565
	(4.99)	(4.83)	(4.84)	(5.62)
Round 6	-0.068	-0.12	-0.124	-0.121
	(-0.40)	(-0.72)	(-0.73)	(-1.04)
Round 7	-0.226	-0.275	-0.279	-1.164
	(-1.57)	(-1.93)	(-1.96)	(-1.69)
Round 8	0.002	-0.024	-0.028	0.000
	(0.02)	(-0.17)	(-0.19)	(0.00)
Round 9	0.023	0.00	-0.002	0.018
	(0.16)	(0.01)	(-0.01)	(0.02)
Round 10	0.061	0.047	0.045	0.059
	(0.41)	(0.32)	(0.31)	(0.22)
Round 11	0.079	0.069	0.065	0.063
	(0.53)	(0.47)	(0.44)	(0.23)
Round 12	0.103	0.099	0.097	0.141
	(0.68)	(0.67)	(0.65)	(0.054)
Round 13	0.065	0.065	0.064	0.034
	(0.43)	(0.44)	(0.43)	(0.35)
Round 14	0.036	0.030	0.029	0.001
	(0.24)	(21.45)	(11.71)	(20.08)
CONTROL VARIABLES				
Location	NO	NO	YES	YES
Ownership	NO	NO	YES	YES
Sector	NO	NO	YES	YES
Firm Fixed Effect	NO	NO	NO	YES
Observations	1761	1761	1761	1761
R-squared	0.80	0.80	0.80	0.80
CRS[1] test $\Sigma \beta i=1$(p-value)	0.31	0.38	0.32	0.17

Absolute values of t-statistics are in parentheses. Significance at 1%, 5% and 10% level is indicated by ***, ** and * respectively.

CRS test is an F-test for constant returns to scale that the coefficients on inputs sums to unity.

Although the results in Table 3 confirm a positive correlation between higher education and productivity, they are limited by the ability to control the endogeneity problem. Such a problem is critical when there are omitted variables that can be correlated with the observed input variables and also correlated with the error term. It is possible to include some observable missing variables through adding more variables like what columns 2 and 3 do. But the main problem is whether one can have all the information needed to explain the omitted variables effects on productivity. The traditional approach has been to find variables that are correlated with the endogenous variables and use them as instruments for the endogenous variables; but, the associated problem of estimating the instrumental variable technique is finding the best instruments. Both natural and theoretical selections of instruments have been criticized. In some instances, instruments have passed the diagnostic tests but failed to prove as convincing instruments or even when they can be the best, they have tended to result into more biased estimates.

Table 3: GMM Regression Results of the Estimates of Higher Education on Productivity Measured as Gross Real Output

Column	[1]	[2]	[3]
Log of Capital	0.033	0.034	0.034
	(2.01)	(2.09)	(2.00)
Log of labour	0.074	0.061	0.073
	(2.50)	(1.80)	(2.21)
Log of Raw materials	0.005	0.005	0.370
	(0.87)	(0.94)	(4.91)
Log of intermediate inputs	0.310	0.310	0.310
	(13.3)	(13.12)	(13.18)
Proportion of graduates	0.0009	0.0006	0.0006
	(1.80)	(1.78)	(1.65)
Round 1	0.400	0.390	0.300
	(0.96)	(0.94)	(0.99)
Round 2	0.110	0.100	0.120
	(0.80)	(0.81)	(0.70)
Round 3	0.60	0.580	0.500
	(2.00)	(1.98)	(1.99)
Round 4	0.305	0.300	0.290
	(0.74)	(0.65)	(0.60)
Round 5	0.086	0.085	0.230
	(0.93)	(0.71)	(0.56)
Round 6	0.437	0.400	0.100
	(2.73)	(1.06)	(0.83)
Round 7	0.306	0.300	0.155
	(1.43)	(2.84)	(1.32)
Round 8	0.460	0.450	0.156
	(1.72)	(1.57)	(1.66)
Round 9	0.271	0.280	0.599
	(1.80)	(1.86)	(1.73)
Round 10	0.507	0.600	0.800
	(1.83)	(1.93)	(1.77)
Round 11	0.605	0.829	0.951
	(1.85)	(1.97)	(1.80)
Round 12	0.722	0.977	0.990
	(1.83)	(1.99)	(1.82)
Round 13	0.794	0.990	0.891
	(1.88)	(2.02)	(1.84)
Round 14	0.904	0.190	0.200
	(1.91)	(2.04)	(1.86)
Round 15	0.882	0.391	0.210
	(1.92)	(2.06)	(1.87)
CONTROL VARIABLES			
Location	NO	NO	YES
Ownership	NO	NO	YES
Sector	NO	NO	YES
Observation	666	666	666

Notes: Absolute values of t-statistics are in parentheses. Significance at 1%, 5% and 10% level is indicated by ***, ** and * respectively.

The weighted average of schooling, tenure, job training and age are derived from firm level information about individual highest level of education completed, the occupational specialization, work tenure whether an individual attended job training and experience.

Hence, a GMM technique that utilizes first differences of the endogenous variables as instruments for endogenous variables in the level equation has recently gained much acceptance and proved to provide more convincing estimates. The added advantage of the GMM is that it utilizes the panel dimension of the data that has time variation component of all variables, which allows keeping constant the time invariant characteristics and measuring their effects on time varying variables. Hence, the results in Table 3 estimate the gross output per employee production function using GMM techniques.

The same approach of estimating the basic equation in the production function is maintained in the column 1. The other controls are added from column 2 and the last one. The results show that all key determinants of labour productivity have strong effects on labour productivity, i.e. raw materials, labour, capital and intermediate inputs. The results in the table confirm that there is positive correlation between proportion of graduates in a workplace and the observed labour productivity. The coefficient estimates of the proxy for higher education is 0.0009 showing that our OLS estimates were biased. But the good news is that the control for endogeneity does not eliminate the effects of higher education on labour productivity. It can be concluded that the evidence of productivity effects in our data has strong support. The results are statistically significant and do not disappear even when the endogeneity problem is accounted for.

Since the data used accept constant returns to scale, the results in Table 4 use a gross output per employee production function to assess if the average years of a manager can have effects on raising labour productivity of workers in a given firm. The logic of such estimates is that a well-educated manager knows how to better manage production, to align best workers to different tasks and possibly to design the best production techniques that can provide incentives for workers to work hard. The estimates use GMM techniques to controls time invariant aspects that might bias the productivity effects of inputs variables including education. Using the quadratic term of the effects of years of education of the manager we estimate the equation bManeger + cManager*2. Based on such estimate, the productivity effect of a manager who completed secondary education is about 2%. But this increases to 14% if a manager has O-level and goes up to 32% if a manager has higher education. The results for all over productivity inputs show the same findings as reported above.

In Table 4, the results reported use average years of schooling as a measure for higher education. More specifically, the results include a square term that captures the productivity effects of higher education induced by changes in years of education. The results on the effects of higher education on productivity are very interesting here. It shows the productivity effects of having more workers with higher education displaying a non-linear relationship.

Table 4: GMM Regression Results of the Estimates of Higher Education on Productivity Measured as Gross Real Output per Employee

Column	[1]	[2]	[3]
Log of Capital per employee	0.036	0.037	0.036
	(1.74)	(1.77)	(1.70)
Log of Raw materials per employee	0.648	0.630	0.622
	(15.2)	(13.9)	(13.27)
Log of intermediate inputs per employee	0.001	0.001	0.001
	(5.00)	(5.00)	(5.04)
Manager year's education	-0.00	-0.00	-0.00
	(0.00)	(0.10)	(0.14)
Manager year's education square	0.001	0.002	0001
	(0.13)	(0.10)	(0.19)
Round 1	0.350	0.390	0.300
	(1.00)	(0.94)	(0.99)
Round 2	0.090	0.100	0.102
	(0.90)	(0.81)	(0.80)
Round 3	0.710	0.680	0.600
	(1.98)	(1.95)	(1.90)
Round 4	0.280	0.300	0.099
	(0.80)	(0.65)	(0.76)
Round 5	0.077	0.085	0.263
	(1.07)	(0.10)	(1.54)
Round 6	0.240	0.400	0.227
	(2.00)	(0.85)	(0.56)
Round 7	0.101	0.300	0.286
	(1.48)	(1.51)	(1.17)
Round 8	0.280	0.450	0.346
	(1.10)	(0.50)	(1.41)
Round 9	0.338	0.280	0.408
	(1.26)	(1.32)	(1.49)
Round 10	0.398	0.600	0.470
	(1.36)	(1.42)	(1.53)
Round 11	0.450	0.829	0.530
	(1.40)	(1.45)	(1.57)
Round 12	0.517	0.977	0.592
	(1.44)	(1.50)	(1.57)
Round 13	0.576	0.990	0.891
	(1.48)	(1.54)	(1.60)
Round 14	0.632	0.900	1.064
	(1.51)	(1.57)	(1.63)
Round 15	0.699	0.391	0.0.99
	(1.53)	(1.59)	(1.65)
CONTROL VARIABLES			
Location	NO	NO	YES
Ownership	NO	NO	YES
Sector	NO	NO	YES
Observation	666	666	666

Notes: Absolute values of t-statistics are in parentheses. Significance at 1%, 5% and 10% level is indicated by ***, ** and * respectively.

The weighted average of schooling, tenure, job training and age are derived from firm level information about individual highest level of education completed, the occupational specialization, work tenure whether an individual attended job training and experience.

In particular it reveals that controlling all possible factors, the productivity effects of average years of education is highly significant and substantially positive for average years of education above secondary. Using the coefficients of the quadratic terms of the higher education effects, i.e. average years of education and its square term, the study computes and finds the productivity effect of 21% that is accounted for by an extra year of average education above 16 years of education, which is the average number of years for those with university education. Similar results show that for average education of 8 years, the productivity effects are only 8%. Such findings suggest that the productivity effects of education are nearly threefold higher for the higher education compared with non-higher education. The control for all factors does not reduce the statistical significance of the productivity gap between higher education and non-higher education. Based on such findings, there are strong reasons to support the findings that higher education is important for productivity and performance of firms in Tanzania's labour market.

Table 5: GMM Regression Results of the Estimates of Higher Education on Productivity Measured as Gross Real Output per Employee

Column	[1]	[2]	[3]
Log of Capital per employee	0.036	0.037	0.036
	(1.74)	(1.77)	(1.70)
Log of Raw materials per employee	0.648	0.630	0.622
	(15.2)	(13.9)	(13.27)
Log of intermediate inputs per employee	0.001	0.001	0.001
	(5.00)	(5.00)	(5.04)
Average year's education	-0.073	-0.074	-0.075
	(4.13)	(4.13)	(4.16)
Average year's education square	0.0013	0.0013	0004
	(3.71)	(3.70)	(3.72)
Round 1	0.350	0.390	0.300
	(1.00)	(0.94)	(0.99)
Round 2	0.090	0.100	0.102
	(0.90)	(0.81)	(0.80)
Round 3	0.710	0.680	0.600
	(1.98)	(1.95)	(1.90)
Round 4	0.280	0.300	0.099
	(0.80)	(0.65)	(0.76)
Round 5	0.077	0.085	0.263
	(1.07)	(0.10)	(1.54)
Round 6	0.240	0.400	0.227
	(2.00)	(0.85)	(0.56)
Round 7	0.101	0.300	0.286
	(1.48)	(1.51)	(1.17)
Round 8	0.280	0.450	0.346
	(1.10)	(0.50)	(1.41)

Round 9	0.338	0.280	0.408
	(1.26)	(1.32)	(1.49)
Round 10	0.398	0.600	0.470
	(1.36)	(1.42)	(1.53)
Round 11	0.450	0.829	0.530
	(1.40)	(1.45)	(1.57)
Round 12	0.517	0.977	0.592
	(1.44)	(1.50)	(1.57)
Round 13	0.576	0.990	0.891
	(1.48)	(1.54)	(1.60)
Round 14	0.632	0.900	1.064
	(1.51)	(1.57)	(1.63)
Round 15	0.699	0.391	0.0.99
	(1.53)	(1.59)	(1.65)
CONTROL VARIABLES			
Location	NO	NO	YES
Ownership	NO	NO	YES
Sector	NO	NO	YES
Observation	666	666	666

Notes: Absolute values of t-statistics are in parentheses. Significance at 1%, 5% and 10% levels is indicated by ***, ** and * respectively.

The weighted average of schooling, tenure, job training and age are derived from firm level information about individual highest level of education completed, the occupational specialization, work tenure whether an individual attended job training and experience.

6.0 Conclusion and Policy Recommendations

This article has examined the impact of higher education on worker productivity in Tanzania labour market. The analysis presented in the article has used employer-employee matched data from Tanzania's manufacturing firms to directly estimate the responsiveness of observed productivity due to changes in the composition of higher education work force at establishment level. The conceptual framework adopted has hinged around the human capital theory that explains factors that determine whether higher education can influence productivity at enterprise level. Measures of education used are the number of years of education of the manager, weighted average of years of education of the workers in an enterprise and a proportion of workers with higher education in a given enterprise. The time dimension of the data used helped to account for the unobserved time invariant variables that have been sources of bias when estimating productivity effects using micro data. Furthermore, the study assessed the long-term relationship between trends in enrolment along with productivity in Tanzania.

According to the study findings, the trends in growth of higher education in Tanzania during the past ten years have shown a monotonic rise in enrolments. From the early 1990s, total enrolment in higher education increased from 4,594 in 1993 to 13,442 in the year 2000, an increase which was more than threefold. Measures of labour productivity trends in Tanzania suggest that labour productivity reflects three phases namely, a period of expansion (1974-1980), a period of collapse (1981-1990) and a period of adjustment, privatization and re-structuring (1991-2000s). The last phase of labour productivity rise is the most relevant aspect assessed by this article. Since this rise coincided with growth in higher education enrolment, the article analysis helps to investigate whether growth in higher education sector had any contribution to the observed upward trend.

In relation to the analysis of the productivity effects of education, the results presented in this article strongly support the hypothesis of a positive correlation between higher education and observed labour productivity. The OLS estimates show that increase in the proportion of graduates in an establishment by 1% raises productivity by 0.027%; but such effects are influenced by firm and worker characteristics of location, occupation, sector and sector ownership. Control of firm's fixed effects further suggests a correlation between unobserved time invariant firm's attributes with the productivity effects. The GMM estimates for the productivity effects of the proportion of graduates in an establishment show that the productivity effects of raising the workforce by 1% is gained in productivity by 0.01; although this suggests that OLS estimates are upwardly biased, they confirm robustness of the findings.

When the average years of a manager are used, it is found that the productivity effects of a manager who completed secondary education is about 2%, and increases to 14% if a manager has O-level, and rises up to 32% if a manager has higher education. When the measure of education is represented as the weighted average of years of education of the workforce in an establishment, it is found that having more workers with higher education displays a non- linear relationship. In particular, it reveals that by controlling all possible factors, the productivity effects of average years of education is highly significant and substantially positive for average years of education above secondary. Using the coefficients of the quadratic terms of the higher education effects, the productivity effects are highest for higher education as raise productivity by 21% compared to only 8% for the workforce with average years of education at below secondary school. The main policy recommendation of the article is that the efforts to stimulate growth through raising human capital should focus on efforts to increase the proportion of workers with higher education because that is where the effects are significantly large. Most significantly, enterprises should be encouraged to attract graduates in management and administration levels. Finally, there are significant social returns to higher education in the form of gain in productivity.

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