Population Growth
And its Effects on Labour Productivity in Tanzania

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Abstract

This paper uses macro data to analyse the effects of population growth on economy-wide productivity. Specifically, it looks at how increased labour participation due to change in population size affects productivity. Since labour-intensive technology is dominant in major economic sectors of rural agriculture and urban informal and service sectors, the paper anticipated that an increase in population size would create demographic dividend in the form of increased workforce and higher output per labour. The paper estimates a Cobb Douglas production function using time series data from the censuses of 1967 (12.3m people), 1978 (17.5m people), 1988 (23m people), 2002 (34.4m people), and of 2012 (44.9m people). The results reveal a positive effect of population size on labour productivity, controlling for other production inputs like capital, intermediate inputs, raw materials, and others. The estimated difference in underlying productivity was 30 percent higher in the early 1970s, and peaked in the mid-1970s, reaching 45 percent higher than what we observe in 2012. The paper concludes that there are evidences of positive effects of population growth on the economy through increased output. This calls for the need to consider labour-intensive production when setting up new economic enterprises.

1 Introduction

This paper assesses the effects of change in population on Tanzanian productivity. The analysis is based on the human capital theory that attributes increased productivity with change in the quality and quantity of labour. Labour productivity is defined as output per unit of labour input. Common to all measures of productivity is that they relate output to inputs that are required to produce them. In the case of labour productivity, the question is how much output is generated per unit of labour input. This simple definition of labour productivity—output per unit of labour input—already points at two fundamental issues that have led to much controversy: (i) how best to measure output; and (ii) how to define labour input. With respect to the measurement of output, the two main alternatives are to use gross output or value-added. The first tracks the quantity of goods or services produced (e.g., the number of cars produced or baskets woven) without taking into account how many intermediate inputs were used.

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A series of studies—such as those by Knight and Sabot (1990), Teal and Mans (2002) and Harding and Teal (2004)—have estimated the productivity effect of change in labour quality on overall productivity in Tanzania, measured by education, training, and other skills. But this is just one dimension of the human capital predictions. An increased quantity of labour due to change in population is very important, especially for developing countries for several reasons. Most significantly, developing economies are usually dominated by rural-based agriculture or urban informal and/or private service sectors. To a large extent such economies are dependent on less skilled and low investment quality jobs. The activities can be performed with a minimum primary level education. Hence, we expect increased quantity of labour due to population growth to have major impact on productivity.

Experiences from other developing countries such as China, Brazil and India have shown how economies have benefited from increased labour quantity due to high and increasing population. Such benefits are forms of demographic dividends as they allow more participation of a workforce, and ultimately increased productivity. In African economies, we have witnessed persistent dependence on agriculture and rural-based primary products as major economic sectors. Even in urban areas informal activities account for over 90 percent of employment sources. Technology in rural-based activities is still backward, being more labour-intensive and less automotive, with insignificant capital intensity. The manufacturing sector also has been less automated, marked with more labour-intensive technology.

Based on the highly labour intensity of production, this paper hopes that population growth rate will have significant positive effect on productivity, which might also imply increased population dividend. The paper uses Tanzania's censuses and manufacturing survey statistics to estimate the impact of population growth on productivity at the industrial level. In particular, it investigates the different regimes of the population size in Tanzania, and how they have impacted on productivity over time.

2. Tanzania Population Dynamics Trends and Growth

2.1 Trends of Population Growth since Independence

Tanzania has conducted five censuses since independence. The first was in 1967, which reported that Tanzania had a total population of 12.3m people. This was just six years after independence and two years after the Union of Tanganyika and Zanzibar. This census was deemed necessary to give clues on the actual number of people before making major policy implementations. The second population census was conducted in 1978; and it revealed that Tanzania's total population was 17.5m people. This was critical in making a follow-up of the implementation of the various development initiatives introduced after 1967. This was the time when Tanzania adopted the Arusha Declaration, a development vision to make

Tanzania a developed country with equality, equal opportunities and egalitarian society that owns all the major means of production. The adoption of this vision was followed by major reforms in all social and economic settings. In education, there was education for self-reliance and the famous Musoma Resolution that brought in major shift in education and training. In agriculture, there was the Iringa Resolution. In manufacturing, the country set to be self-sufficient in all manufactured products and aimed to process its major cash crops—cotton, tea, tobacco, sisal, coffee, and pyrethrum—and sell them in an added-value forms rather than exporting them in raw forms. This was the motivation of the import substitution and basic industrial development strategy.

The economy of Tanzania was growing very fast, especially from the early 1970s. The implementation of industrial policies led to an increased number of factories in Dar es Salaam, Arusha, Mwanza, Morogoro and Tanga. This was the time when Tanzania was leading in sisal production in the world. Also, exports were exceeding imports, hence leaving a positive trade balance. The exchange rate between Tanzania shilling with other major currencies was very favourable, at less than TZS10 for US$1.Though there were perceptions of over-valuation of the currency, the disputed value was less than 60 percent. Similarly, productivity increased rapidly following the introduction of agricultural research centres and increased extension services. In the textile sector, Tanzania was able to establish fully integrated textile industry with major firms like Sungura Textile, Kiltex, Mwatex, Tabora Textile, Musoma Textile, Mbeya Textile, Kiltex Arusha, Morogoro Polyster, Magunia, Moro Canvas, and other major industries. However, all these positive developments were brought into halt in the 1980s by the war with Idd Amin, and the oil crisis.

The economic crisis of the 1980s made the need for population size and dynamics critical. Hence, another census was undertaken in 1988. This census found that Tanzania's total population had reached 23m people. Other population censuses were conducted in 2002 and 2012; times of major changes in the country. The population census of 2002 and 2012 indicated population sizes of 34.4m and 44.9m people, respectively.

In short, the population censuses conducted since independence are very important for the implementation of development plans and the national Vision 2025, when the economy shall be able to provide improved services for enhancing quality of life for all Tanzanians. Hence, one area of contribution of this paper is to provide reliable and accurate data on population dynamic-size and growth impact required for implementation of Vision 2025 and other long-term development policies. This is to ensure proper services delivery, as well as monitoring and evaluating national and international development frameworks. For instance, the censuses of 2002 to 2012 reveal that in ten years the population of Tanzania increased by 30 percent, from 34.4m to 44.9m. The 2012 population and Housing Census revealed that Tanzania's population grew from 12,313,469 persons in 1967 to 44,928,923 persons in 2012 as shown in Fig. 1.

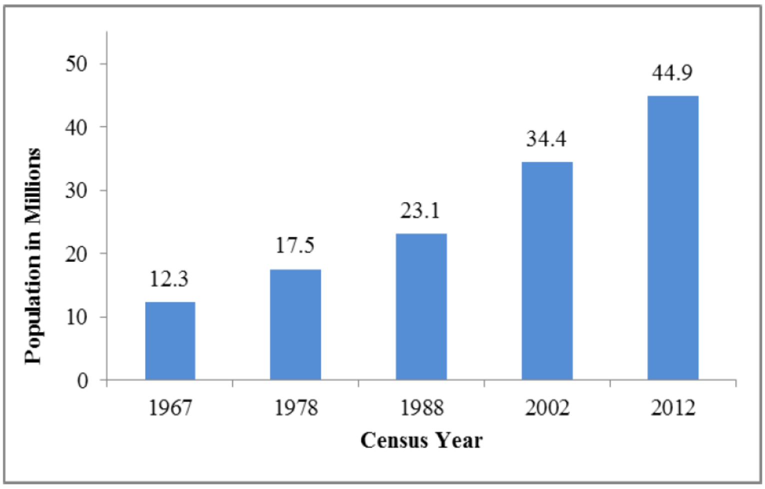

Figure 1: ***Tanzania Population Size from 1967 to 2012***
Source: National Bureau of Statistics (2012)

2.2 *Average Annual Growth Rates*

The population growth rate in Tanzania declined from 3.3 percent in 1967 to 2.7 percent in 2012. Tanzania Mainland shows a decline from 3.2 percent in 1967 to 2.7 percent in 2012. Tanzania Zanzibar shows a different pattern of growth. The growth rate increased from 2.7 percent in 1967 to 3.1 in 2002, and then declined to 2.8 percent in 2012 (Fig. 2).

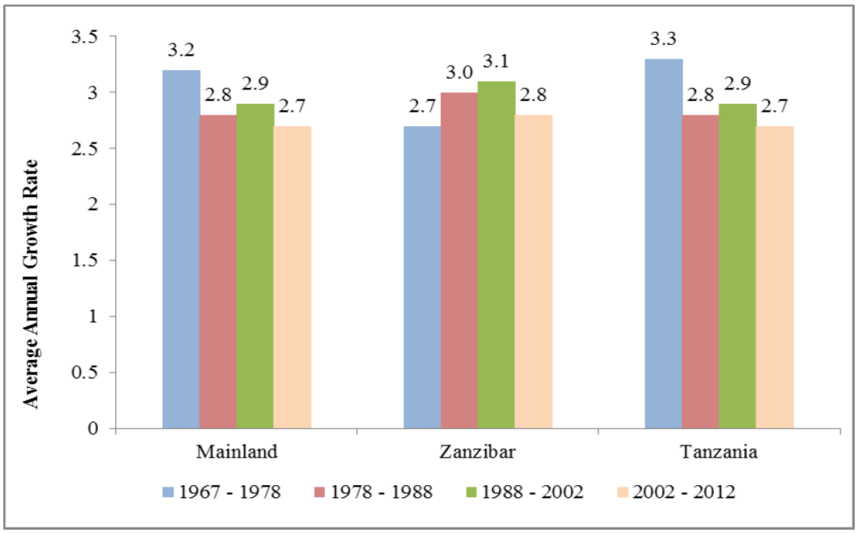

Figure 2: ***Tanzania Population Growth Rates since Independence***
Source: National Bureau of Statistics (2012)

The average annual growth rates vary from region to region (Fig. 3). The average rates of growth for the period of 2002 to 2012 range from 5.6 percent recorded in Dar es Salaam region, to 0.8 percent recorded in Njombe. Regions dominated by large urban populations recorded the highest growth rates. These are Dar es Salaam (5.6 percent) and Mjini Magharibi (4.2 percent).

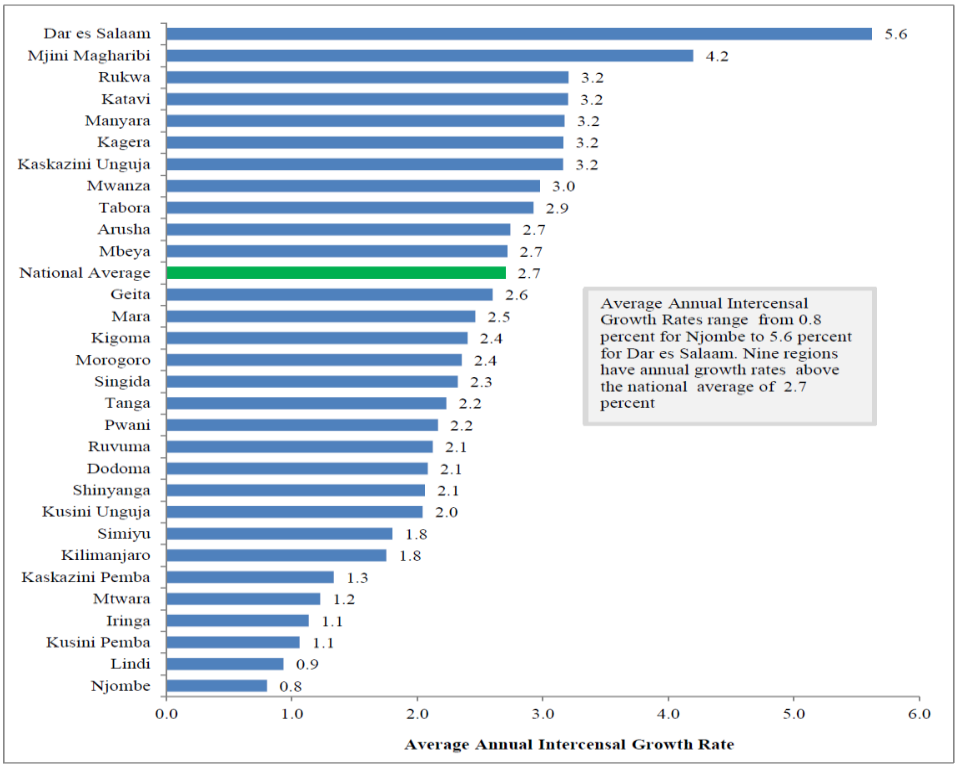

Figure 3: ***Population Growth Rates by Regions***
Source: National Bureau of Statistics (2012)

2.3 Regional Dimensions of Population Size

The United Republic of Tanzania is a union of Tanganyika (Tanzania Mainland) and Zanzibar (Tanzania Zanzibar). Administratively, during the 2012 census Tanzania had 30 regions (25 in Tanzania Mainland and 5 in Tanzania Zanzibar). Table 1 shows regional populations during the 2002 and 2012 censuses and their inter-censal growth rates. In the 2012 census, Dar es Salaam had a population of 4.36m, accounting for 10 percent of the total population of Tanzania Mainland. Regions with a population of over 2m people were Mwanza (2.77m), Mbeya (2.71m), Kagera (2.46m), Tabora (2.29m), Morogoro (2.22m), Kigoma (2.13m), Dodoma (2.08m), and Tanga (2.05m). In Tanzania Mainland, there were four regions with a population of less than 1m. These were Katavi (564,604), Njombe

(702,097), Lindi (864,652) and Iringa (941,238). In Tanzania Zanzibar, the region with the largest population was Mjini Magharibi (593,678), which accounted for 46 percent of the total population of Tanzania Zanzibar. The region with the smallest population was Kusini Unguja, with a population of 115,588.

Table 1: Population by Region and Average Annual Growth Rate, 2002 and 2012 Census

Region	Population (Number)			Population Increase	Average Annual Rate (Percent)	
	2002 Census Counts	2012 Projected Population	2012 Census Counts	2002-2012 (Number)	1988-2002	2002-2012
Tanzania	34,443,603	45,798,475	44,928,923	10,485,320	2.9	2.7
Tanzania Mainland	**33,461,849**	**44,439,683**	**43,625,354**	**10,163,505**	**2.8**	**2.7**
Dodoma	1,692,025	2,214,657	2,083,588	391,563	2.2	2.1
Arusha	1,288,088	1,758,196	1,694,310	406,222	3.9	2.7
Kilimanjaro	1,376,702	1,702,207	1,640,087	263,385	1.6	1.8
Tanga	1,636,280	2,054,042	2,045,205	408,925	1.8	2.2
Morogoro	1,753,362	2,209,072	2,218,492	465,130	2.6	2.4
Pwani	885,017	1,110,917	1,098,668	213,651	2.4	2.2
Dar es Salaam	2,487,288	3,270,255	4,364,541	1,877,253	4.3	5.6
Lindi	787,624	960,236	864,652	77,028	1.4	0.9
Mtwara	1,124,481	1,374,767	1,270,854	146,373	1.7	1.2
Ruvuma	1,113,715	1,449,830	1,376,891	263,176	2.5	2.1
Iringa	840,404	1,789,779	941,238	100,834	1.6	1.1
Mbeya	2,063,328	2,822,396	2,707,410	644,082	2.4	2.7
Singida	1,086,748	1,440,682	1,370,637	283,889	2.3	2.3
Tabora	1,710,465	2,539,715	2,291,623	581,158	3.6	2.9
Rukwa	729,060	1,615,098	1,004,539	275,479	3.5	3.2
Kigoma	1,674,047	1,971,332	2,127,930	453,883	4.8	2.4
Shinyanga	1,249,226	4,161,091	1,534,808	285,582	3.3	2.1
Kagera	1,791,451	2,763,329	2,458,023	666,572	3.1	3.2
Mwanza	2,058,866	3,771,067	2,772,509	713,643	3.2	3.0
Mara	1,363,397	1,963,460	1,743,830	380,433	2.6	2.5
[2]Manyara	1,037,605	1,497,555	1,425,131	387,526	3.9	3.2
[3]Njombe	648,464	N/A	702,097	53,633	N/A	0.8
[4]Katavi	408,609	N/A	564,604	155,995	N/A	3.2
[5]Simiyu	1,317,879	N/A	1,584,157	266,278	N/A	1.8
Geita	1,337,718	N/A	1,739,530	401,812	N/A	2.6
Tanzania Zanzibar	**981,754**	**1,358,792**	**1,303,569**	**321,815**	**3.1**	**2.8**
Kaskazini Unguja	136,639	189,574	187,455	50,816	2.5	3.2
Kusini Unguja	94,244	117,475	115,588	21,344	2.1	2.0
Mjini Magharibi	390,074	506,907	593,678	203,604	4.5	4.2
Kaskazini Pemba	185,326	275,806	211,732	26,406	2.1	1.3
Kusini Pemba	175,471	269,030	195,116	19,645	2.3	1.1

Source: National Bureau of Statistics (2012)

3. Literature on the State of Productivity in Tanzania

There are limited number of empirical works on the state of productivity in Tanzania. The most extensive study in this area was conducted by Mbelle (2005). His study investigated productivity performance in Tanzania, with the focus being on the growth of the overall economy during the period from 1968 till 2000. He used growth accounting to assess the contributions of physical capital, labour, and total factor productivity. His findings were that Tanzania experienced growth in labour productivity and total factor productivity for the whole period. There was high capital deepening during 1967-1985, compared to the reform period 1986-2000. If one reflects on the record of growth, this means that capital was less productive during 1967-1985. For the period 1986-2000, labour productivity growth declined marginally by 0.4%, while total factor productivity growth was highest, implying that the impressive growth performance during 1986-2000 can be associated more with growth in total factor productivity.

Three measures of efficiency were used: partial factor productivity, a modified measure of labour productivity, and a simple measure of investment productivity. The author 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 percent 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. It was only during the latter part of the 1980s that exports started to pick up because of 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. They used the international comparisons of output and productivity project (ICOP) methodology, 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. They found that there was a rapid initial increase after 1965, reaching a 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.

Using cross-sectional firm-level data, Goedhuys et al. (2008) examine the determinants of productivity among manufacturing firms in Tanzania. In particular, they seek to evaluate the relative importance of technological advances and the business environment in which firms operate in affecting productivity. Of the technological variables, they find that R&D, 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 a lack of business support services depress productivity; while membership of a business association is associated with higher productivity.

The trend of labour productivity in Tanzanian manufacturing sector from 1990 till 2010 shows that labour productivity in manufacturing is higher than productivity in agriculture. The trend of productivity has been growing, and in some cases showing a downward trend. The rapid growth in industrial output, coupled with increased emplyoment, largely explain the observed trend. But one of the dillemas in manufacturing productivity and growth is the size of total employment, which is low compared to the existing pressure for job-seekers in urban areas. Rural-urban migration has intesified, thus increasing the number of the joblesses in urban areas. Failure to get employment in manufacturing has resulted into increased informal activities.

Table 2 shows trends in labour productivity index in Tanzania in the period 2000-2010. The trend in labour productivity is downward, indicating that overall productivity has declined during the last decade.

Table 2: Trends in Labour Productivity Index in Tanzania over the Period 2000-2010

Labour Productivity	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Agriculture, Hunting and Forestry	100	57.6	41	33.1	27.9	121.7	125.5	130	132.9	137.2
Mining and quarrying	100	66.2	54.1	48.1	45.4	44.1	27.5	19.6	15.2	12.7
Manufacturing	100	85.3	77	72	68.8	66.3	61.6	59.1	56.6	54.9
Electricity, gas & Water	100	57.9	42.5	34.7	30.4	25.4	19.3	15.6	13.6	12.5
Construction	100	96.4	96.4	97.2	96.5	96.3	93.8	93.2	91	91.8
Business	100	101.1	103.2	102.6	103.4	106.7	95.6	88.6	82.4	78.6
Transportation	100	87.4	79.2	75.9	73.2	71.2	62	56.8	53.7	52.5
Finance	100	62.4	47.1	38.9	34.2	31.1	3.6	2.1	1.5	1
Social service	100	102.6	105	110.6	115.4	117.4	119.5	122.3	123.1	119.1
Overall Labour productivity Index	**100**	**79.7**	**71.7**	**68.1**	**66.1**	**75.6**	**67.6**	**65.3**	**63.3**	**62.3**

Source: Author's computation using Statistical Abstracts and Economic Surveys (Relevant Years)

The analysis of this trend is important for several reasons. One is that it is very likely that increased productivity might be happening at the expense of job losses; or job creation might be happening in low productive labour-intensive sectors. The results show a negative trend in productivity over the period 1995 to 2010.The observed movement is partly attributed to the increased labour-intensive activities in low productive areas, especially in rural-based agriculture and informal urban-based activities.

4. Methodology and Approach

In assessing the effects of population growth on labour productivity, the paper uses the production function to examine trends in total factor productivity in the manufacturing sector from 1967 to 2012. Estimation of the production function will enable us to control for changes in other inputs in the production process to examine trends in underlying productivity or total factor productivity over different population size regimes. As we saw above, the population size of Tanzania in 1967 was 12.3m people, 17.5m people in 1978, 23m people in 1988, 34.4m people in 2002, and 44.9m people in 2012. This paper assumes that if labour intensity is the dominant labour production technology in Tanzania, then we expect more production as the population increases. This implies growth in population releases more workforce of farmers, increased areas for agricultural production, increased number of livestock, as well as the number of people engaged in micro enterprises in urban informal activities. The paper allows for shifts in the production function (technological progress) by explicitly including a time effect.

4.1 Model Estimation

As indicated, the paper estimates the industry-level production function that gives output as a function of intermediate inputs, capital inputs, labour, and time. The time is computed in such a way that it captures the different population regimes of the time-period when different sizes of population were observed. Specifically, the model is presented as follows:

$$Y = F(Xt, Kt, Lt, T) \qquad [1]$$

Where T is time, Y is output, X, K and L are quantity of the intermediate, capital, and labour inputs. Based on the input output relationship in equation [1], we can specify a simple production function as follows:

$$Y_t = A_t K^{\beta 1_t} L_{t_{\beta 2}} X_{t_{\beta 3}} e^{\beta 4Tt} \qquad [2]$$

Where Y_t is the value of aggregate manufacturing output in year t; A_t is an index of total factor productivity or a coefficient that denotes the level of technology; and K_tL_t and X_t are the stocks of physical capital, labour and intermediate inputs for year t, respectively. Annual data on production costs are derived from the value-added and gross output figures. To estimate our production function [2] we introduce log variables that give us the following equation.

$$LnYt = LnAt + \beta 1LnKt + \beta 2LnLt + \beta 3LnXt + \beta 4Tt + \varepsilon_t \qquad [3]$$

Where LnY_t is the log of output, LnK_t, LnL_t and LnX_t are logs of capital stock, labour and indirect costs respectively, T is time (in years), and ε_t is the error term. To estimate value-added production function, output is measured as value-added; hence the dependent variable in equation [2] is the log of value-added. This function is specified in equation [4] below:

$$LnVt = LnAt + \beta_1 LnKt + \beta_2 LnLt + \beta_3 T_t + u_t \quad [4]$$

Where $LnVt$ is the log of value-added, and $LnKt$ and $LnLt$ are as defined above.

Both functions of value-added and gross output production will be estimated for reasons given below. Previous studies in this area (see, e.g., Soderbom & Teal, 2002) indicate that there are advantages and disadvantages of both measures. According to them, the advantage of the gross output measure is that it allows firms to have different efficiencies at transforming intermediate inputs (e.g., raw materials) into output. They mention the correlation of capital stock and raw materials as a disadvantage of estimating the gross output production function as it makes it difficult to know what the effect of capital stock is on output.

More problems of choice between gross and net output as a productivity measure arise when firms operate in an imperfectly competitive environment (Griliches & Klette, 1996). Basu and Fernald (1997) indicated that estimates of the increasing returns to scale measured by the value-added production function do not imply increasing returns to scale in the gross-output production function. Therefore, to mitigate the shortcomings of the production specifications outlined here, we will estimate both forms of production functions. Table 3 shows the results for the production functions presented in this section.

5 Estimation Results

5.1 Labour Productivity Effect and Returns to Scale

Table 3 presents production functions using both gross output and value-added measures as the dependent variables. The first column shows the results of the gross output production function. As a requirement, the study first checks if constant returns to scale are accepted. From the production theory, if the data accept constant returns to scale, then the variables can be transformed into the per labour units. Based on the gross output production functions shown in column [1], constant returns to scale cannot be rejected at 5 percent critical value (p-value is 0.15).

The estimated coefficient on capital stock is 0.135, and that on production cost is 0.58. Both are statistically significant. The labour coefficient is 0.09, but not statistically even at 10 percent level. The most significant effect comes from production cost. It has a positive sign, implying that a 1 percent increase in production cost increases gross output by 0.58 percent. Since our model does not reject the assumption of constant returns to scale, we can proceed to column [2] and discuss the gross output per employee production function.

Table 3: The OLS Estimates of the Gross Output and value-added Production Functions Based on Aggregate Manufacturing Data

	Gross Output Production Function		**Value-added Production Function**	
	Model (1)	**Model (2)**	**Model (3)**	**Model (4)**
Dependent Variable	***Log Output Employee***	***Log Output/ Employee***	***Log Value Added***	***Log Value added/ Employee***
Log of labour	0.091	0.154		
	(0.67)	(0.60)		
Log of Capital	0.135	0.555		
	(1.59)*	(2.59)**		
Log of capital per Employee		0.183		0.640
		(1.77)*		(2.80)**
Log of Production Cost	0.580			
	(6.78)***			
Log Production Cost Per employee		0.582		
		(6.57)***		
1966-1970	0.163	0.372	0.381	0.700
	(1.27)	(2.88)	(0.90)	(2.76)**
1967-1979	0.312	0.456	0.763	0.980
	(2.06)**	(3.87)***	(2.63)**	(5.52)***
1980-1989	0.357	0.424	0.771	0.871
	(2.85)	(3.55)*	(3.53)**	(4.50)***
1990-2013	-0.072	-0.045	-0.250	-0.197
	(1.61)*	(1.04)	(2.40)**	(1.77)*
Observations	48	48	48	48
R-squared	0.95	0.98	0.833	0.94
AR F(2,24)	2.29[0.12]	1.74[0.19]	2.68[0.08]	2.2[0.1252]
ARCH F(1,24)	28.05[0.00]**	27.6[0.00]**	20.8[0.00]**	6.06[0.0205]*
Normality Chi^2(2)	13.10[0.04]**	11.2[0.00]**	12.0[0.00]**	3.81[0.1473]
RESET	0.55[0.46]	6.54[0.016]*	0.04[0.84]	0.02[0.8756]
HSF(12,13)	3.50[0.06]*	5.00[0.00]**	2.42[0.05]	2.63[0.0348]*
Test for Constant Returns to Scale	2.18[0.15]		0.96[0.35]	

Note: (a) Significance at the 1 percent, 5 percent and 10percent level is indicated by ***, ** and * respectively. Aggregate data sources are: economic surveys, statistical abstracts, national accounts (various issues) and official statistics from National Bureau of Statistics. Production cost is estimated using gross output and value-added figures. According to the National Bureau of Statistics, value-added figures reported here are obtained as the difference between gross output and production costs, measured by the cost of raw materials, packaging and other indirect costs incurred during production. Since we have both gross output and value-added figures, we can compute production costs as the difference between gross output and value-added.

(b) AR= F-test for the residual autocorrelation; ARCH= F-test for Autoregressive conditional Heteroscedasticity; Normality Chi^2(2)= Test for normality; HS=Test for Heteroscedasticity; RESET= is test for functional form misspecification.

The results in column [2] show that the coefficient on capital stock is 0.183. It has a positive sign and is statistically significant, suggesting that a 1 percent increase in capital stock per employee increases gross output per labour by 0.18. The estimated coefficient of production cost per employee is 0.58, indicating that a 1 percent increase in production cost per employee is associated with about 0.58 percent increase in gross output. Consistent with the constant returns to scale, the coefficient sizes of the production cost reported in the first and second columns are roughly the same.

5.2 Population Growth Rate and its Effect on Labour Productivity

The fundamental question addressed here is whether there is any evidence of change in underlying productivity overtime. The time trends formulated above coincide with the population size regimes from the census of 1967, 1978, 1988, 2002, and 2012. Reading the results in Table 3, the coefficient estimates size signs and their level of significance indicate the effect of population increase on productivity, controlling for other production factors.

The real output per employee production function shows evidence of higher levels of underlying productivity during the pre-1980s, when compared with the post-2012 period. The estimated difference in underlying productivity was 30 percent higher in the early 1970s, and peaked in the mid-1970s, reaching 45 percent higher than what we observe in 2012. There are no significant differences in underlying productivity in some years of the 1990s. This suggest that there was no significant change in efficiency in generating output from capital and other inputs over the period 2012. However, there is some evidence of recovery in productivity after 2012.

In the third and fourth columns we report OLS estimates of the production function that consider capital and labour as the determinants of value-added. The constant return to scale is accepted at 5 percent critical value (p-value is 0.35). The estimated coefficient on capital stock shown in column [4] is 0.64. It is statistically significant, implying that a 1 percent rise in capital leads to 0.64 percent rise in value-added. Further results from column [4] are that the pattern of the coefficients on the time dummies for value-added is similar to that already observed for gross output per employee.

A common pattern across both the gross output and value-added per employee production functions are that the underlying productivity was high during the period of 1966-1980. But most strikingly is that the estimated difference in change in underlying productivity based on value-added is substantially higher than the change indicated by the gross output production function. For instance, the results in column [4] show that the difference in underlying productivity measured by value-added per employee between the base period and the years between 1971-1975 was 97 percent. This is very high when compared with the productivity difference of 45 percent shown by the real output production function. The fundamental question addressed here is whether there is any evidence of change in underlying productivity.

Fig. 6 describes changes in underlying productivity based on the coefficient estimates on time dummies presented in columns [2] and [4] for gross output and value-added per employee production functions. The figure shows that there is a common pattern across the two production functions. But the change in underlying productivity described by value-added production function per employee is higher than the change shown by the gross output per employee production function.

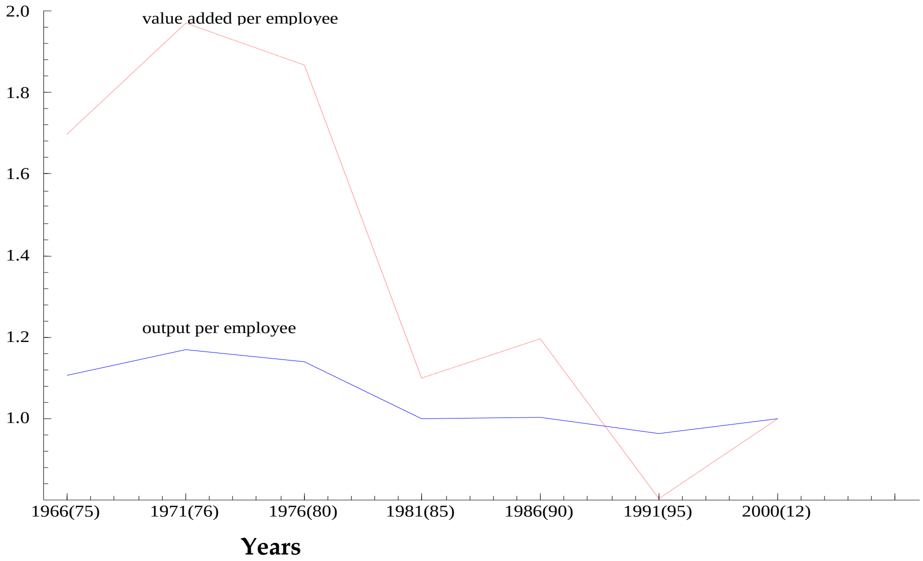

Figure 6: ***Trends in Underlying Productivity (1966-2002) Based Upon Macro Level Changes in Value-Added and Gross Output per Employee***

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

In sum, the estimates in Table 3 show large differences in the magnitude of changes in productivity between the gross output and value-added estimates. For instance, over the period 1976-1980, the underlying productivity, measured by the value-added production function, was 77 percent higher than its 1996-2001 value. Based on the gross output production function, the underlying productivity corresponding to the same period was 35 percent higher than its 1996-2001 value. Two questions may arise here: (i) What causes the difference? (ii) Which results are believable?

We believe that the trends in real output are more reliable than those in value-added. Works by Basu and Fernald (1995, 1997) and Söderbom and Teal (2002) shows that value-added estimates suffer from an important omitted variable bias. This is likely to bias the estimated elasticises upward, hence our value-added estimates might be overstated. Also, Söderbom and Teal (2002) argue that the value-added production function, in which value-added is defined as gross output less intermediate inputs, does not allow for the different efficiencies with which firms convert intermediate inputs into outputs. In addition, the value-added production function assumes constant returns to scale, and the existence of competition (for details, see, Basu and Fernald, 1995). Given the environment in which the Tanzanian manufacturing sector operates, the assumption of perfect competition is unrealistic.

The last part of Table 3 presents a broad range of diagnostic tests obtained after our model estimations. The diagnostic tests presented are for residual autocorrelation (AR); autoregressive conditional heteroscedasticity (ARCH), non-normality; and the RESET test for functional form misspecification and heteroscedasticity. Based on the results, the test for residual autocorrelation is passed by all four models. The hypothesis that there is residual autocorrelation is rejected. Therefore, based on this test, there is no significant serial correlation. However, the hypothesis that there is autoregressive conditional heteroscedasticity cannot be rejected in all four models. There is no evidence to support the functional form misspecification in our models (although there is a weak evidence for this form of misspecification in model 2).

The final test in Table 4 is for heteroscedasticity. In testing for this problem, we find a weak evidence of the presence of heteroscedasticity in our data.

Table 4: Augmented Dickey-Fuller Tests for the Unit Root

	Z(t)	*p-value*[a]	*Z(t)*	*p-value*
Log value-added	-1.992	0.606	-1.431	0.755
Log value-added/ Employee	-1.7888	0.755	-2486	0.386
Log real output	-1.971	0.299	-2.867	0.174
Log real output/Employee	-0.866	0.800	-2.220	0.480
Log of capital	-2.211	0.202	-2.186	0.498
Log of capital/ Employee	-1.923	0.604	-1.709	0.999
Log of labour	-3.574	0.006	-2.750	0.216
Log of Costs	-2.600	0.251	-2.943	0.149
Log of cost/Employee	-1.440	0.500	-2.922	0.360

Note: [a] P-value is the approximated Mackinnon p-value for *z (t)* reported in the Augmented Dickey Fuller unit root test. The critical values are -3.682, -2.972 and -2.618 for 1 percent, 5 percent, and 10 percent of statistical significance, respectively.

In addition to the diagnostic tests described in Table 4, we test for non-stationarity of our variables. We use the Augmented Dickey-Fuller test for unit root tests to investigate the hypothesis that our series are integrated of order 1 or 2 against the alternative that they are stationary. As per the results in Table 5, the hypotheses testing shows that the coefficients of *t* values are greater than all the critical values, i.e., the critical value of -4.28 at 1 percent, the critical value of -3.56 at 5 percent, and the critical of -3.2 percent at 10 percent. Therefore, we do not reject the null hypothesis that the variables in our level equation of gross output production function exhibit unit roots, i.e., they are non-stationary time series.

Having established that all the variables are integrated, we next test for cointegration relationships. We test these relationships by using Augmented Dickey-Fuller tests on the generated residuals, which is known as Augmented Engle-Granger (AEG) test. This is simply the Augmented Dickey Fuller for unit roots applied to the least square residuals, based on OLS regressions. The results obtained from the AEG test in Table 5 show that all *t-statistics* are greater than the critical values at 1 percent, 5 percent, and 10 percent. Based on these results, the hypothesis of the presence of cointegration cannot be rejected.

Table 5: Engle-Granger Test for Cointegration[a]

	Without Time Trend				**With Time Trend**			
	Lag (1)		***Lag (2)***		***Lag (1)***		***Lag (2)***	
	Z (t)[b]	*p-value*	*Z (t)*	*p-value*	*Z (t)*	*p-value*	*Z(t)*	*p-value*
Value-added production function	-5.82	0.000	-4.90	0.000	-5.91	0.000	-4.77	0.000
Value-added per employee production function	-5.41	0.000	-4.42	0.002	-5.50	0.000	-4.62	0.002
Gross Output production function	-6.251	0.000	-4.20	0.000	-5.20	0.000	-4.22	0.007
Gross output per employee production function	-5.877	0.000	-4.02	0.016	-4.80	0.000	-3.99	0.006

Note: [a] This is a residual based version of Augmented Dickey-Fuller test. The critical values are -3.96, -3.37 and –3.07 for 1 percent, 5 percent, and 10 percent of statistical significance respectively for no trend regressors; and –3.96, -3.41 and –3.13 for 1 percent, 5 percent, and 10 percent of statistical significance, respectively, for regressors with trend.

6 Summary and Conclusion

This paper set up to examine the impact of population growth on productivity. Guided by the reality of technological regimes in developing countries where most activities are conducted using labour than capital, one would expect that an increase in population size would have a positive effect on productivity. Therefore, the paper used macro data from annual surveys of industrial production, national census data and other information from official sources to analyse the effect of population growth on economy-wide productivity. The analysis is based on the human capital theory that attributes increased productivity with change in quality and quantity of labour.

It is also worth noting that developing economies are usually dominated by rural-based agriculture, or urban informal and/or private service sectors. Such economies are largely dependent on less-skilled and low-investment quality jobs. The activities can be performed with a minimum primary level education. Hence, we expect increased quantity of labour due to population growth to have major impact on productivity.

The paper has also shown that experience from developing countries—such as China, Brazil, and India—have revealed how economies have benefited from increased labour quantity due to high and increasing population. Such a benefit is a form of demographic dividend as it allows more participation of workforce, and ultimately increased productivity. We have witnessed persistent dependence on agriculture and rural-based primary products in African economies as major economic sectors. Technology in rural-based activities is still backward, being more labour-intensive and less automotive, with insignificant capital intensity. In urban areas, informal activities account for over 90 percent of employment sources. The manufacturing sector also has been less automated, and is marked by more labour-intensive technology.

In assessing the effects of population growth on labour productivity, the paper used the production function to examine trends in total factor productivity in the manufacturing sector since 1967. Estimation of the production function enabled a control for changes in other inputs in the production process, and an examination of the trends in underlying productivity or total factor productivity over different population size regimes. Estimations based on both real output and gross output production functions indicated that constant returns to scale cannot be rejected at 5 percent critical value (p-value is 0.15). The estimated coefficient on capital stock is 0.135, and that on production cost is 0.58. Both are statistically significant.

Real output per employee production function shows evidence of higher levels of underlying productivity during the pre-1980s when compared with the post-2012 period. The estimated difference in underlying productivity was 30 percent higher in the early 1970s, and peaked in the mid-1970s; reaching 45 percent higher than what we observe in 2012. There are no significant differences in underlying productivity in some years of the 1990s. This suggest that there was no significant change in efficiency in generating output from capital and other inputs over the period 2012. However, there is some evidence of recovery in productivity after 2012.

A common pattern across both the gross output and value-added per employee production functions are that the underlying productivity was high during the period of 1966-1980. Most striking, however, is that the estimated difference in change in underlying productivity based on value-added is substantially higher than the change indicated by the gross output production function. In summary, the results show large differences in magnitudes of changes in productivity between the gross output and value-added estimates. In sum, the results reveal a positive effect of population size on labour productivity, controlling for other production inputs like capital, intermediate inputs, raw materials, etc. Hence, the paper concludes that there are evidences of positive effect of population growth on an economy through increased output. This calls for the need to consider labour-intensive production when setting up new economic enterprises.

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