

# **Harnessing the Demographic Dividend through Commercialization of Local Research in COMESA**

By

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### **ABSTRACT**

This study investigates the contribution of new knowledge and innovation as measured by the number of patents & scientific journals as well as the impact of total labour force on the manufacturing sector Gross Domestic Product (GDP). It employs the Fixed Effects method on a sample panel of 19 Common Market for Eastern and Southern Africa (COMESA) Member States for the period 2008 to 2016. FE estimation technique is preferred so as to address heterogeneity bias problem resulting from any correlation that may exist between the regressors and the country-specific effects.

The results show that number of science journals and mobile cellular subscriptions are important factors in generating growth in manufacturing sector output in COMESA Member States. The young population is expected to gain by undertaking research and

participating in its commercialization in the manufacturing sector. Access to mobile phones and ICT services plays a key role in sharing academic knowledge and research outputs with the manufacturers. These findings are consistent with results from other studies such as Mansfield (1997) and Vandebussche et al. (2006) who established a positive association between scientific research and firms' performance.

These findings lead to the recommendation that COMESA Member States need to incentivize the youth to participate in research carried out by universities and public research institutes. This will also lead to commercialization of research output as some of the research involves invention of new products. There is also need to increase research funding and set up incubation centers to facilitate incubation and commercialization of innovative research outputs. In addition, there is need for support for provision of quality tertiary education that contextualizes research, innovation and entrepreneurship.

## 1 INTRODUCTION

### 1.1 Background Study

Countries in Sub-Saharan Africa (SSA) have the highest proportion of young people in the world, with over 70 percent aged below 30 years<sup>3</sup>. This segment comprises of individuals who are building skills hence very important for economic growth and development. Economic growth and employment creation for the youth are a major challenge globally and in COMESA Member States (Anyanwu, 2014). Youth unemployment rates remain high especially in SSA (World Bank, 2018b), which calls for innovative approaches to address the problem. Over time several approaches have been used across the world that have led to quantitative and qualitative changes in the job market (Thurik, 2001). The evidence points at a shifting economic system, with one manifestation being a divergence in job creation and reduction of unemployment across countries. The forerunners like the Netherlands, Denmark and United Kingdom have shifted towards an entrepreneurial economy (Blanchard & Katz, 1997; Siebert, 1997); while the laggards are still obsessed with perfecting the managed economy like Germany, or rethinking the managed economy, like France (Nickell, 1997). An entrepreneurial economy is one where entrepreneurship plays a key role in generating economic growth and it's not organizationally based, but upon persons or individuals while a managed economy is one in which the framework and general policies are regulated by the government.

Investment in Research and Development (R&D) is one of the approaches used to address the problems of low economic growth and youth unemployment. Universities, Technical Vocational Education and Training Institutions (TVETs) and research institutes have continued to conduct research, which is considered a key driver of long-term economic growth. This is the primary basis for competitiveness in world markets and part of the response to many societal challenges (Audretsch & Thurik, 2001). In COMESA Member States, public expectations from technological innovations are evolving in line with social concerns (e.g. unemployment, sustainable development, youthful populations), while the innovation process itself is facing major challenges such as patenting, lack of adequate facilities offering incubation and acceleration services among others.

Commercialization of research has therefore become a central concern for applied economics and economic policy (Arvanitis *et al.*, 2008). Tanha *et al.* (2011) defines commercialization of research as the process of converting research output into marketable products. It is considered a key component of reinvigorating the manufacturing sector, generating highly productive jobs, accelerating economic growth and reducing youth unemployment (World Bank, 2012).

### 1.2 Population Structure in COMESA Member States

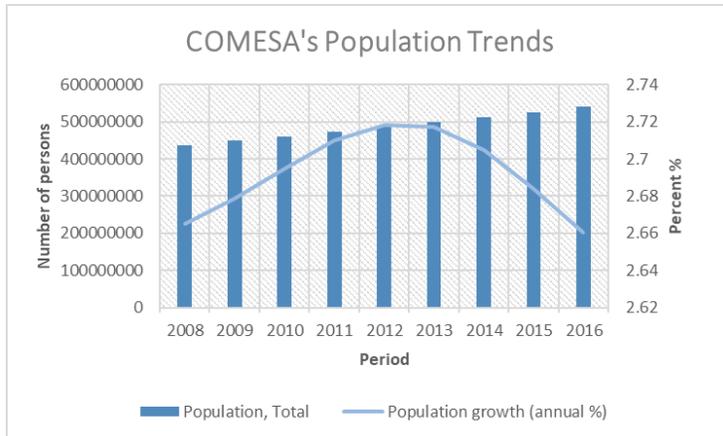
The population of COMESA Member States experienced a tremendous growth over the years. As at 2018, COMESA Member States were estimated to have a population of 5.69 Billion persons and this was projected to grow at an annual rate of 2.61 percent. With this

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<sup>3</sup> Estimate obtained from <http://www.unesco.org/news/en/unesco> viewed on 17th July 2018

high growth rate, COMESA's population will be expected to have added about 14,654,560 persons the 1st year of the estimate (See Figure 1 below).

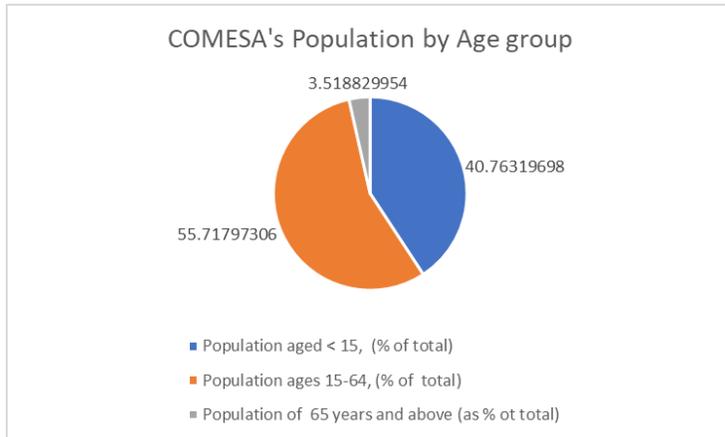
**Figure 1: Population Trends in COMESA Member States**



Source: Africa Development Bank database 2018

When it comes to the age structure of COMESA's population, it is clear from Figure 2 below that there is a high proportion of younger people within the COMESA population as a whole, with reports that 41% of the COMESA population is under the age of 15. According to the United Nation Population Division's current projections, nearly all of these countries are a few decades away from entering the "demographic window of opportunity". This is a period that is defined by: low proportions of children and seniors, high proportions of adults in their prime working ages of 25 to 55 years and an average family size that is small enough for parents. COMESA Member States can harness the demographic dividends that is arising from this window of opportunity by making strategic investments to improve education and skills development, health, economic reforms and job creation. In addition, given the relatively high rate of unemployment in these states, the unemployed youth can actively take part in research activities that will give them insight on what marketable products they can come up with.

**Figure 2: COMESA's Population by Age group**

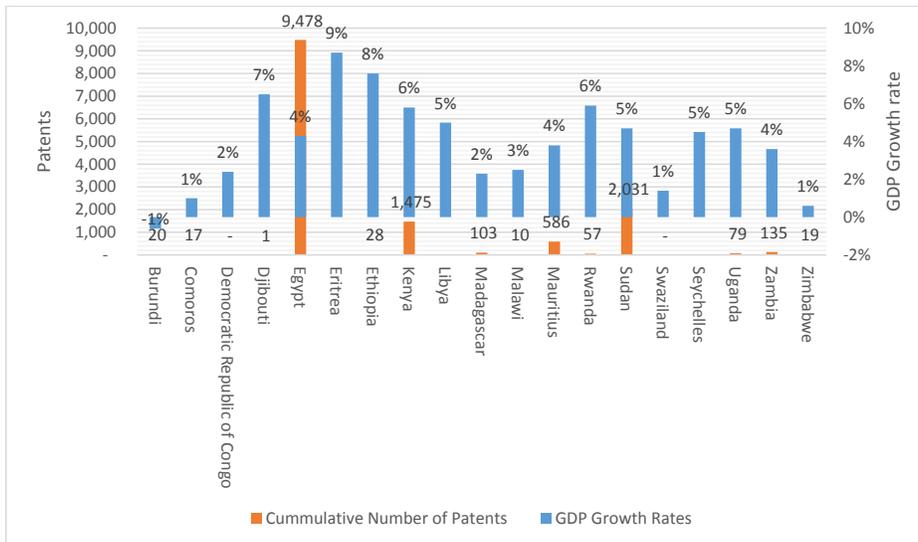


Source: Africa Development Bank database 2018

### 1.3 Patents and Economic Growth in COMESA

Figure 3 shows that COMESA Member States have patents, which demonstrates that knowledge is being produced. New knowledge out of research is imperative in providing the base for innovative products. Innovations are manifested by the number of patents. However, the rate of commercialization of research in African countries remains low compared to Organization for Economic Co-operation and Development (OECD) countries (Adoyo, 2015; Bansi, 2016). This can be attributed to lack of prioritization and inadequate incentives for commercialization among others. Commercialization of research requires provision of infrastructure services such as Technology Transfer Offices (TTOs) and Innovation Incubation Facilities.

**Figure 3: Cumulative Number of Patents and GDP Growth rates for COMESA Member States.**

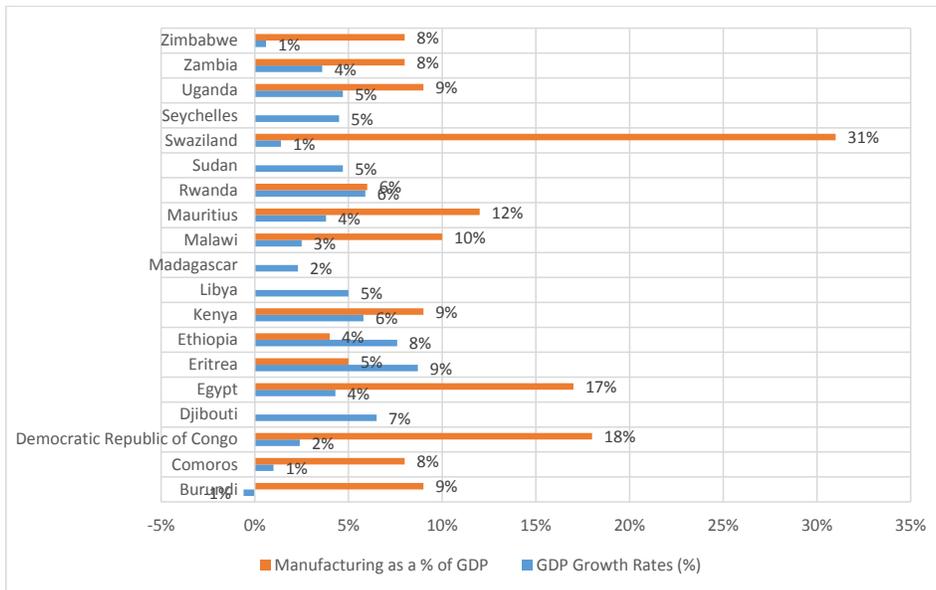


Source: World Intellectual Property Organization and COMESA database 2018

Figure 3 presents the cumulative number of patents and the GDP growth rates of COMESA Member States as at 2016 in constant 2011 prices in US\$. The trend reveals some degree of association between the two variables. For instance, countries with a large number of patents like Egypt, Sudan and Kenya seem to experience a relatively higher GDP growth rate.

It is envisaged that the role of the manufacturing sector as stipulated in COMESA Member States' economic policies, is to create employment and wealth through increasing the production and utilization of research and development output. Figure 4 shows the percentage contribution of the manufacturing sector to total GDP in COMESA Member States

**Figure 4: Contribution of Manufacturing to Total GDP (%) in COMESA Member States.**



Source: Author's Computation from (World Bank, 2018b)

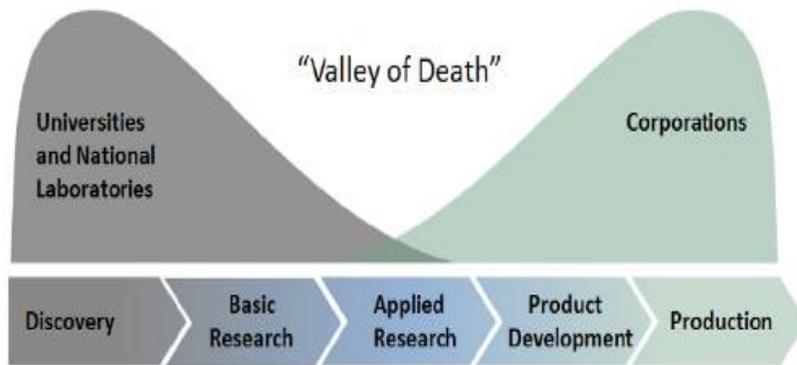
Figure 4 shows that manufacturing share of GDP ranges from 2 and 31 percent and is a key contributor to GDP. The performance of the manufacturing sector varies among COMESA Member States depending on technological innovations, cost of doing business, access to finance, R&D and availability of managerial, technical and entrepreneurial skills (World Bank, 2018b). Some of the COMESA Member States are among the fastest growing economies in the world; D R Congo, Djibouti, Ethiopia, Kenya, Rwanda and Uganda with growth rates ranging between 5% and 10% in the year 2018. The growth was supported in Member States by increased private consumption and investment. On ease of doing business, Mauritius, Rwanda Kenya, Zambia and Seychelles were among the best in Africa in 2018. (World Bank, 2018a). The COMESA region has also focused on strengthening business linkages and intra-regional trade in the COMESA-EAC-SADC<sup>4</sup> tripartite region through the Local Sourcing Project for Partnerships which specifically focuses on training Small and Medium Enterprises (SME) agro-food suppliers.

One of the major weaknesses of the innovation ecosystem in many economies is the existence of the “valley of death”. This arises from the realization that a significant proportion of research conducted in institutions of higher learning and laboratories is basic research, and very little it is translated into applied research. Majority of the research that is conducted in COMESA Member States universities is basic which is not applied. The

<sup>4</sup> EAC stands for East African Community while SADC is Southern Africa Development Community.

economy is therefore starved of high-quality products which could have obtained from the new knowledge. These dynamics are presented in Figure 3

**Figure 5: Accelerating the Transition from Discoveries to Production**



Source: Authors' conceptualization

Figure 5 implies that universities and national laboratories among other research institutions and innovation ecosystem partners should play a critical role in applied research to accelerate the transition of discoveries into products that increases employment and economic growth. This will provide COMESA Member States with an opportunity to harness the demographic dividend since the youth will churn out the required high productivity jobs, leading to employment creation and growth of the manufacturing sector.

**1.4 Statement of the Problem**

Despite the existence of numerous vibrant universities and research institutes within COMESA Member States, the rate of conversion of research into products has remained low, denying the society the much-needed solutions. This is happening under the backdrop of a shrinking manufacturing sector, which could have otherwise benefited from the commercialization of local research.

Furthermore, COMESA Member States have experienced a bulge in the proportion of young people over the past eight years, with over 70 percent aged below 30 years. With youth unemployment rates still high in these countries, critical questions remain regarding the innovative approaches to address the problem.

Harnessing demographic dividends and commercialization of local research has been explored by several studies. However, these studies have not demonstrated the link between commercialization of research and increasing manufacturing sector GDP, and the opportunity presented for harnessing the demographic dividend. The studies have also not separated the economic impact of the two key indicators of public research i.e. the inventive output of universities/Public Research Institutions (PRIs) and

**Commented [JK1]:** Does universities and national laboratories encompass all the institutions undertaking research?

**Commented [hf2R1]:** They are just a representation of the institutions that carry out research. In the paragraph that follows, this has been provided for.

commercialization output of universities/PRIs by their TTOs, Furthermore, very few studies have evaluated the same in the African context as most of the carried-out studies are US-based. This study is motivated by the limited evidence in this significant policy issue which calls for incentivization of the youth to take part in research that translates to marketable products.

### **1.5 Study Objectives**

The general objective of the study is to examine how commercialization of local research as measured by the number of patents and scientific journals can be used to harness the demographic dividend in COMESA Member States. The specific objectives are to;

- i. Determine the contribution of new knowledge and innovation (Patents & Scientific Journals) on Manufacturing Sector GDP.
- ii. Evaluate the impact of the total labour force on the capital-intensive Manufacturing sector's GDP.

## 2 REVIEW OF LITERATURE

### 2.1 Theoretical Review

Several theories exist that show how technology, capital and labour force enter the aggregate economy's production function to explain economic growth. In the Solow's growth model (1956), both labour and effective labour are seen as important variables in generating economic growth. This shows the importance of demographic dividend to economic growth through commercialization of research.

The endogenous growth models are simplified versions of the models of R&D and growth developed by P. M. Romer (1990), Grossman and Helpman (1993) and (Aghion & Howitt, 1992). The model has four variables; labor (L), capital (K), technology (A), and output (Y). The model is set in continuous time and has two sectors; a goods-producing sector where output is produced and an R&D sector where additions to the stock of knowledge are made. A fraction  $a_L$  of the labor is used in the R&D sector and fraction  $(1-a_L)$  in the goods producing sector. Similarly, fraction  $a_K$  of the capital stock is used in R&D and the rest in goods production. Both  $a_L$  and  $a_K$  are exogenous and constant. Because the use of an idea or a piece of knowledge in one place does not prevent it from being used elsewhere, both sectors use the full stock of knowledge, A.

The quantity of output produced at time t is thus given by:

$$Y(t) = [(1 - a_K)K(t)]^\alpha [A(t)(1 - a_L)L(t)]^{(1-\alpha)},$$
$$0 < \alpha < 1 \quad (1)$$

The AK model builds on the neoclassical growth model of Solow (1956). Solow (1956) model adopts capital in a broad perspective that excludes human capital from the national income accounts. The AK model emphasizes the importance of human and physical capital as well as innovation levels' contribution to economic growth (Lucas, 1988; Mankiw *et al.*, 1992; P. M. Romer, 1986). Mankiw *et al.* (1992) defines knowledge as a discernment of how the world works and human capital is used to transfer knowledge to the labour force. Since knowledge does not depreciate, endogenous growth models to assume non- diminishing and constant returns to scale.

Baumol (1990) and Murphy *et al.* (1991) observed that innovations and advances in knowledge are as a result of the work of talented individuals. They observed that such individuals have choices to pursue innovations and produce goods. These observations suggest that the economic incentives and social forces influencing the activities of highly talented individuals may be important to the accumulation of knowledge. D. Romer (2011) further argues that for individuals to produce goods, they inevitably think of ways of improving the production process. Thus, the accumulation of knowledge occurs as a side effect of conventional economic activity which refers to learning by doing. Analyzing learning-by-doing requires changes to the general endogenous growth model (equation

2) because all inputs are engaged in production of goods. The production function becomes:

$$Y(t) = K(t)^\alpha [A(t)L(t)]^{(1-\alpha)} \quad (2)$$

Since the increase in knowledge is a function of the increase in capital, the stock of knowledge is a function of the stock of capital. Thus, there is only one state variable. Making our usual choice of a power function, we have:

$$A(t) = BK(t)^\phi [A(t)L(t)]^{(1-\alpha)} \quad (3)$$

Where B is a shift parameter. As in the Solow model, the saving rate is exogenous and constant and depreciation is set to zero for simplicity. Thus:

$$\dot{K} = sY(t) \quad (4)$$

Likewise, we continue to treat population growth as exogenous, constant and non-negative for simplicity. This implies:

$$\dot{L}(t) = nL(t), n \geq 0 \quad (5)$$

Equations 2 and 3, together with equations 4 and 5 describing the accumulation of capital and labor, characterize the economy. To analyze this economy, equation 3 is substituted into equation 2. These yields:

$$Y(t) = K(t)^\alpha B^{(1-\alpha)} K(t)^\phi (1-\alpha) L(t)^{(1-\alpha)} \quad (6)$$

Since  $\dot{K} = sY(t)$ , the dynamics of K are given by:

$$\dot{K} = sB^{(1-\alpha)} K(t)^\alpha K(t)^\phi (1-\alpha) L(t)^{(1-\alpha)} \quad (7)$$

If  $\phi$  is less than 1, the long-run growth rate of the economy is a function of the rate of population growth, n. If  $\phi$  is greater than 1, there is explosive growth. And if  $\phi$  equals 1, there is explosive growth if n is positive and steady growth if n equals 0. Assuming a steady state growth, the production function (equation 6) becomes:

$$Y(t) = AK(t), \quad A = B^{(1-\alpha)} L^{(1-\alpha)} \quad (8)$$

Capital accumulation is therefore given by:

$$\dot{K} = sAK(t) \quad (9)$$

Equation 9 implies that K grows steadily at rate sA. And since output is proportional to K, it also grows at this rate. Thus, long-run growth is endogenous and depends on the saving rate.

## 2.2 Empirical Review

Several studies have been done on the role of commercialization of research in harnessing the demographic dividend and promoting economic growth. This section

presents a review of studies done to evaluate this relationship on both developed and developing countries.

Adams (1990) used the count of articles in a number of academic journals to construct a series of 19 industry-specific stocks of scientific knowledge. He used these stocks of publications to explain Total Factor Productivity (TFP) growth in 19 manufacturing industries in the United States (U.S) from 1953 to 1980 and found that publications stocks positively affected TFP growth.

Griliches (1992) reviewed the empirical literature on R&D externalities and found that investments in new knowledge by firms and other organizations not only generate the inputs for innovation for the organization making those investments, but also because of the propensity for knowledge to spill over, for the third-party firms as well. Such externalities are consistent with the basic properties inherent in what Arrow (1962) referred to as information, which is distinct from the traditional factors of production in that it is non-exclusive and non-rivalrous. By serving as a conduit for knowledge spillovers, entrepreneurship is the missing link between investments in new knowledge and economic growth (Audretsch, 2007; Audretsch & Thurik, 2001). Entrepreneurship is an important mechanism permeating the knowledge filter to facilitate the spillover of knowledge and ultimately generate economic growth. The emergence of entrepreneurship policy to promote economic growth is interpreted as an attempt to promote entrepreneurship capital, or the capacity of an economy to generate the start-up and growth of new firms.

Mansfield (1997) used the outcomes of a survey of 76 US firms that had carried out commercial innovations in seven industries to measure the benefits of academic research (within 15 years of the innovation under consideration). By estimating the social rate of return from academic research, he found that ten percent of product and process innovations of these firms could not have been developed without academic research. Using these results, he estimated the social rate of return from academic research and found that it ranged from 20 to 30 percent. He further found that the estimate was a lower bound as it left out the social benefits from other innovations based on the same academic research, accruing to consumers, outside the US and spillovers to firms in and outside the concerned industry.

Guellec and Van Pottelsberghe de la Potterie (2004) carried out a comprehensive analysis of the impact of R&D on Total Factor Productivity (TFP) using a sample of 15 OECD countries from 1980 to 1998. They distinguished between public sector and private R&D. They found that publicly funded research generates a higher degree of spillovers to the economy compared to privately funded R&D. They further found that the responsiveness of TFP to public R&D was higher when private R&D intensity was high. They further found the impact of public sector R&D on TFP growth was positively affected by university R&D and not by other public research institutes.

Vandenbussche *et al.* (2006) extended the endogenous growth model using a panel dataset covering 19 OECD countries between 1960 and 2000 to examine the contribution of human capital to economy-wide technological improvements. He drew a distinction between the channels of innovations and imitation effects. He found that skilled labor had a higher growth-enhancing effect to the technological frontier.

Audretsch (2007) studied the link between entrepreneurship capital and economic growth, further revealing how and why the Solow growth accounting framework is useful for linking entrepreneurship capital to economic growth. He used a sample consisting of 500 of the largest U.S. manufacturing over the period 1980 and 1993. The knowledge filter impedes the spillover of knowledge for commercialization, thereby weakening the impact of knowledge investments on economic growth.

Adoyo (2015) examined the factors influencing research outputs of selected universities in Kenya using the descriptive research design. She found that research output of selected public universities in Kenya was influenced by research funding, industrial involvement, university researchers' characteristics and institutional administrative structures.

Cheah and Yu (2016) analyzed economic impact of research and innovation originating from Public Research Institutions (PRIs) and universities in Singapore by employing a binary logistic regression. The authors applied the R&D-based endogenous growth theory by P. M. Romer (1990) and the Triple Helix by Etzkowitz *et al.* (2005) to model the flow of knowledge among universities and PRIs, firms and industries, the community and society. They found that firms that incur higher Intellectual Property Licensing (IPL) fees with universities/PRIs had lower propensity to repeat their IPL transactions, thereby reducing academic innovation impact on firms. In addition, firms that got higher levels of RICV with universities/PRIs were found to have higher propensity to repeat their license transactions, indicating an increase in academic innovation impact on firms.

Bansi (2016) investigated the reasons for the current low rate of commercialization of innovations in South African universities using a survey of intellectual property and technology transfer office managers and interviews with individual innovators. He found that lack of support from university management, insufficient incentives for innovators, limited access to funding opportunities, institutional bureaucratic regulations and an inefficient system of decision making on intellectual property were the major factors contributing to low rate of innovations commercialization.

### **2.3 Overview of Literature**

Several studies have been done on the role of commercialization of research in harnessing the demographic dividend (Adoyo, 2015; Bansi, 2016; Cheah & Yu, 2016; Veugelers, 2014). Most of these studies focused on establishing the different factors that influence academic research patenting, the contribution of research to economic growth and some of the challenges that hinder commercialization of research. The studies that, on an empirical basis, have examined the relationship between R&D and productivity or economic growth have usually used the endogenous production function (Veugelers, 2014). The studies differ greatly in terms of the aggregated level (company, industry or country), model specification (the explanatory factors included) and how key variables are measured (stocks, flows or changes).

However, these studies did not demonstrate the link between commercialization of research and increasing manufacturing sector GDP, and the opportunity presented for harnessing the demographic dividend. In addition, the studies did not separate the economic impact of the two key indicators of public research i.e. the inventive output of universities/Public Research Institutions (PRIs) and commercialization output of universities/PRIs by their TTOs, Furthermore, very few studies have evaluated the same in the African context as most of the carried-out studies are US-based. This study is therefore motivated by the limited evidence in this significant policy issue where today's decisions may influence the macroeconomic potential of this region in the long term.

### 3 METHODOLOGY

#### 3.1 Research Design

The study used a non-experimental causal design involving panel data for the period 2010 to 2016 for 19 COMESA Member States. The choice of the starting period was determined by the availability of data for most of the countries. The main sources of data were World Bank Database, the COMSTAT and the African Development Bank. The data for patents was obtained from World Intellectual Property Organization (WIPO) Database.

#### 3.2 Theoretical Framework

The study was based on the AK endogenous growth model that assumes total output is a function of capital accumulation according to the function below:

$$Y = AK^{1-\alpha} \quad 0 < \alpha < 1 \quad (10)$$

The AK model views capital to contain stocks of plant, equipment and knowledge accumulation. As a result, the capital, K in the AK model in equation (10) includes both physical and human capital.  $\alpha$  represents the output elasticity of capital (returns to scale) and it ranges from 0 to 1. Mankiw *et al.* (1992) stresses that the assumption of constant returns to scale holds, therefore,  $\alpha = 0$  such that the production function is linear in capital. This equally denotes that when inputs are doubled, output will double as well. Hence, equation (10) can be rewritten as:

$$Y = AK \quad (11)$$

Where A represents technology, which is a constant while Y and K are as described before. Thus, the theoretical framework postulates that a country's economic growth is a positive function of both physical and human capital.

#### 3.2 Empirical Model

The empirical model is based on the production function (equation 3.2) with constant returns to scale. The specific panel regression equation estimated is as follows:

$$mgdp_{it} = \beta_0 + \beta_1 lab_{it} + \beta_2 gfcf + \beta_3 joun_{it} + \beta_4 pat_{it} + \beta_5 mob_{it} + \varepsilon_{it} \quad (12)$$

$$i = 1, 2, \dots, 19; t = 1, 2, \dots, 9$$

where  $mgdp_{it}$  is the dependent variable represented by the manufacturing sector output/GDP.  $lab_{it}$  and  $gfcf$  are proxies for total labour force and physical capital while  $joun_{it}$  represents the number of Science and Technology Journals.  $pat_{it}$  denotes the number of patents and  $mob_{it}$  is the number of mobile cellular subscriptions per 100 people.  $\varepsilon_{it} = \mu_i + \lambda_t + e_{it}$  is the error term,  $\beta_i$  are the parameters to be estimated while  $it$  represents country  $i$  in time period  $t$ .

The explanatory variables included are: (i) total labor force and (ii) gross fixed capital formation as proxies for labour and physical capital respectively; (iii) the number of Science and Technology Journals to measure academic research input; (iv) number of patents, to capture the conception that countries with plenty of patents have managed to harvest the benefits of commercializing research i.e. corporate outcome (Narin *et al.*, 1997) ; and (v) the number of mobile cellular subscriptions per 100 people, to capture the effect of use of mobile phones and social media in general in enhancing the diffusion of research knowledge. Total labour force is included as an explanatory variable to address the second objective. Theoretically, the manufacturing sector is known to be capital-intensive hence this paper aims to find out if this is the case in COMESA Member States or if the youthful population as represented by total labour force plays a role in contributing to the manufacturing sector's GDP. All the explanatory variables are expected to have a positive sign as they are hypothesized to contribute to economic growth.

### 3.4 Estimation Technique

The static panel specification was estimated using Fixed effects (FE) method. This was after the Hausman test by Hausman (1978) that takes into consideration the assumptions about the error term was conducted in order to make a choice between FE and RE. In a FE model,  $\varepsilon_{it}$  was assumed to vary non-stochastically over  $i$  or  $t$  making the FE model analogous to a dummy variable model in one dimension. In a RE model,  $\varepsilon_{it}$  is assumed to vary stochastically over  $i$  or  $t$  requiring special treatment of the error variance matrix. FE addresses heterogeneity bias problem, resulting from any correlation that may exist between the regressors and the country-specific effects  $\mu_i$ , by controlling for unobserved effects that are correlated with the error term (Greene, 2012). The model for manufacturing sector GDP was therefore specified as equation (12).

**Commented [hf3]:** This explains reason for second objective. Since labour turned out to be insignificant, then we cannot advocate for policies that aim to employ the youth in manufacturing sector

## 4 ESTIMATION AND DISCUSSION OF RESULTS

### 4.1 Descriptive Statistics

Descriptive characteristics summarize the data for the 19 COMESA Member States for the period 2008 to 2016. The six variables employed in the study include: manufacturing GDP (*mgdp*), number of patents (*pat*), number of science and technology journals (*jour*), gross fixed capital formation (*gfcf*), total labour force (*labf*), and mobile cellular subscriptions per 100 persons (*mob*).

The summary statistics of these variables are presented in Table 1 displaying the mean, standard deviation and number of observations of each variable. The results show that the manufacturing GDP averaged 3.92 billion US \$ while the number of patents and science & technology journals averaged 65 and 601 respectively.

The manufacturing GDP has a standard deviation of 9.66 Billion US \$ while the number of patents and science & technology journals have a standard deviation of 180 and 1827 respectively. A large standard deviation implies that the countries in the sample are non-homogeneous and thus there may be issues of convergence of these group of countries.

**Table 1: Descriptive Statistics**

Variables	Mean	Std. Deviation	Min	Max	Obs
Manufacturing GDP	3.92B	9.66B	19.8M	56.1B	171
Patents	64.97	180.38	1	1053	171
Science and Technology journals	600.91	1827.45	0.7	10807	171
Gross fixed capital formation	21.45	8.22	3.10	45.27	171
Total labour force	57.14	6.27	48.11	70.78	171
Mobile cellular subscriptions	59.36	42.73	2.02	180.45	171

Source: Author's computation from the study data

### 4.2 Unit Roots Test Results

Unit roots tests were carried out using Levin-Lin-Chu test and the results are presented in Table 2. The LLC unit root test results showed stationarity without a trend at 1% and 5% levels of significance for all the variables.

**Table 2: Panel Unit Root Test**

	Levin-Lin-Chu (LLC) test	
	Levels	

Variables	Constant	Trend	Remarks
	Statistic	Statistic	
<i>lnmgdp</i>	-7.58***	-3.34***	Stationary
<i>labf</i>	-3.00***	-8.81***	Stationary
<i>gfcf</i>	-10.58***	-12.30***	Stationary
<i>lnjoun</i>	-4.52***	-12.84***	Stationary
<i>lnpat</i>	-14.22***	-42.87***	Stationary
<i>mob</i>	-6.28***	-6.22***	Stationary

Note: The asterisks \* and \*\* denote levels of significance at 10% and 5% respectively. *lnmgdp*, *lnjoun* and *lnpat* are logged forms of the variables manufacturing GDP, science and technology journals and patents respectively.

### 4.3 Specification Tests

**Table 3: Specification Tests' Results.**

Specification Test	Null hypothesis	P value
Hausman F-test for FE versus RE models	H <sub>0</sub> : RE model is consistent	0.0000
Hausman F-test for time fixed effects	H <sub>0</sub> : All $\lambda_t = 0$	0.3533
Serial correlation	H <sub>0</sub> : No serial correlation	0.1432
Heteroskedasticity	H <sub>0</sub> : No heteroskedasticity	0.0000
Cross-sectional dependence	H <sub>0</sub> : No cross-sectional dependence	0.4610
Pesaran's CD test		

Source: Author's Computation using STATA 13

The Hausman's Specification Test of exogeneity of the regressors (no misspecification) versus the alternative of endogeneity of regressors was conducted to choose between FE and RE model. The Hausman test results rejected the RE model hence the study estimated the FE model as shown in Table 3.

In addition, a series of specification tests were carried out to ensure that the classical linear regression assumptions hold. These include: Wooldridge test for autocorrelation in panel data, the Wald test for group wise heteroskedasticity, Pesaran's test of cross-

sectional independence and the F-test for time-fixed effects. The specification tests results are shown in Table 3. The results found the problem of heteroskedasticity which was solved using robust standard errors.

#### 4.4 Discussion of Fixed Effects Regression Results

**Table 4: Fixed-Effects (within) Regression Results.**

Explanatory variables	FE Regression
Total labour force	0.0151 (0.30)
Science and Technology journals	0.1611*** (3.06)
Gross fixed capital formation	0.0105 (1.23)
Number of patents	0.0101 (0.85)
Mobile cellular subscriptions	0.6178*** (6.63)
Constant	
<b>F test</b>	<b>19.70***</b>
<b>R-Squared</b>	<b>0. 4266</b>
<b>No. of observations</b>	<b>171</b>

Source: Author's Computation using STATA 13

Note: The t statistics are in parenthesis. Levels of significance: \*\*\* 1 %, \*\* 5 % and \* 10%.

The first objective of the study was to determine the contribution of new knowledge and innovation (patents & science and technology journals) on manufacturing sector GDP, while the second objective was to evaluate the impact of total labour force on COMESA Member States' manufacturing GDP.

The results presented on Table 4 shows a highly significant F-statistic indicating the joint significance of the explanatory variables. Further, the results show the estimated coefficients of all the explanatory variables have the expected signs. The model fits well and explains 43 percent of variations in the manufacturing sector GDP as indicated by the R-squared.

There is a positive and significant relationship between the number of science and technology journals and manufacturing sector GDP. This result is consistent with Mansfield (1997) and Vandenbussche et al. (2006) who established a positive association between scientific research and firms' performance. This implies that academic research is important for industrial growth and could play a critical role in harnessing demographic dividend.

Given the significantly high proportion of youth in COMESA Member States, the youth should be advocated for to be involved in both public and private research activities conducted in universities and PRIs research and commercialization of the research output. For this to happen more funding is required for research and commercialization as well as policy advocacy for the private sector to promote research and its output commercialization in the manufacturing sector.

This outcome suggests that it would be important for COMESA Member States to focus on motivating/ incentivizing the youth to take part in research work if their strategy is to increase the share of manufacturing output in GDP. This will lead to youth employment due to the “academic spin-off”. This is whereby an academic entrepreneur creates a new product/venture, an academic spin-off, by commercializing their research outputs.

The study further found a positive relationship between mobile cellular subscriptions and the manufacturing sector GDP. The result indicates that an increase in mobile cellular subscriptions by one percent increases manufacturing sector GDP by 0.62 percent. This confirms the increased use of technology in diffusing academic research and knowledge. Mobile phones have played a key role in sharing of information including scientific publications thus contributing positively to research work commercialization by the manufacturing sector.

## 5 CONCLUSION AND POLICY IMPLICATIONS

The main motivation for the study was to examine how commercialization of local research as measured by the number of patents and scientific journals can be used to harness the demographic dividend in COMESA Member States. The study employed the Fixed effects method to examine the impact of the number of patents and scientific journals on manufacturing GDP. FE estimation technique is preferred so as to address heterogeneity bias problem, resulting from any correlation that may exist between the regressors and the country-specific effects  $\mu_i$ .

The results from the FE analysis show that number of science and technology journals and mobile cellular subscriptions are important factors in generating growth in manufacturing sector output in COMESA Member States. The young population is expected to gain by undertaking research and participating in its commercialization in the manufacturing sector. Access to mobile phones and ICT services plays a key role in sharing academic knowledge and research outputs with the manufacturers.

These findings are consistent with results from other studies such as Mansfield (1997) and Vandebussche et al. (2006) who established a positive association between scientific research and firms' performance.

The study recommends that COMESA should:

- i. Encourage the culture of commercialization of research output.
- ii. Incentivize the youth to take part in academic research that translates to commercialization of research output.
- iii. Enhance/increase research funding and set up incubation centers to facilitate incubation and commercialization of innovative research outputs.
- iv. Strengthen the innovation ecosystem by developing and implementing policies on the same. This should ensure that intellectual property management system is robust and properly incentivized.
- v. Support provision of quality tertiary education that contextualizes research, innovation and entrepreneurship.

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