

The impact of research and innovation on socio-economic development: perspectives from selected developing economies

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1. Introduction

1.1 Background

- The importance of research and innovation in achieving economic growth in developed countries has been firmly established by theoretical and empirical studies (Adam Smith, 1776; Schumpeter, 1934; and Solow, 1957).

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Introduction...ctd

- Sratmann (2005), one of the latest contributors in this area, has clearly demonstrated that there is a direct positive correlation between R&D investment and economic growth.
- To date, however, the link between research and innovation and economic growth has been left largely unexplored in the case of developing countries.
- The purpose of this study is to attempt to supply this necessary link by examining the effect of research and innovation on economic growth in sub-Saharan Africa.

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Introduction...ctd

- Gaillard (2008) noted that research and innovation comprises all fields of Science and Technology (i.e. natural sciences, social sciences, engineering and humanities).
- Link (1982) perceives research as primarily concerned with the search for technical or scientific advancement and development, and the translation of such advancement into **product** or **process** innovation.

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Introduction... ctd

- The *Frascati Manual* (2002) has given a comprehensive typological classification of research:
 - basic research,
 - applied research and
 - experimental development
- **Basic research** (fundamental, pure or “curiosity-driven” research), is “experimental or theoretical work undertaken primarily to acquire new knowledge without any particular application or use in mind”.

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Introduction... ctd

- **Applied research**, on the other hand, is concerned with the acquisition of new knowledge, directed primarily towards a specific practical aim or objective.
- **Experimental development** is “systematic work, drawing on existing knowledge gained from research and/or practical experience, which is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed”

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Introduction... ctd

1.2 Problem statement

- ***Is there a link between research /innovation and economic growth in developing countries?***
- Of particular interest is the correlation between research and innovation and economic growth in Sub-Saharan Africa. Cognate questions include:

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Introduction... ctd

- What is the relationship between the composition of R&D expenditure and growth of productivity in developing countries?
- What are the factors that influence and determine the division of resource among the three types of research – basic, applied and development research?
- What are the interrelationships between these three types of research?
- Is there evidence of under-investment in any or all of these types of research activities in developing countries?

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Introduction... ctd

1.3 Objective

- The objective of this study is to analyse the impact of research and innovation on socio-economic development in developing countries in general, and in the selected countries in Sub-Saharan African countries.

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Introduction...ctd

1.4 Hypotheses

- There is a strong positive correlation between investment in R&D activities and innovation rate.
- Countries with higher R&D quantity (intensity) and quality (efficiency) have a higher innovation rate than those with lower R&D activities.
- Countries with higher R&D quantity (intensity) and quality (efficiency) have higher economic growth rate (higher GDP) than those with lower R&D activities.

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Introduction...ctd

1.5 Constraints of the study

- This investigation suffered from a number of constraints, chief amongst which was data availability in many SSA countries.
- This factor constitutes a formidable disincentive to research in the field of science, technology and innovation in Africa.
- It is important to note, however, that a highly detailed process for gathering data on research and innovation in Africa has recently been initiated by the African Science and Technology Innovation Indicators (ASTII) (2007) in a survey being carried out in 19 African countries including Algeria, Angola, Ghana, Kenya, Nigeria, South Africa and Zambia.

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Introduction... ctd

Questionnaires were sent by the ASTII to

- government departments,
- research institutions and
- private sector organisations

requesting information on areas such as

- R&D expenditure,
- where the money goes, and
- what innovative products or services have emerged as a result of investments.

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Introduction... ctd

- Two reports are anticipated to emerge from the ASTII survey:
 - African R&D activity in 2007 and
 - innovation activity in the three-year period 2006-2008.
- According to *Science and Technology Development Network (2009)*, the data generated would be
 - managed and owned by Africans and
 - there are plans to store such data by the African Observatory for Science, Technology and Innovation, which is being set up by the African Union (AU) in Equatorial Guinea.

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2. Literature Review

- Solow (1957) was the first to have conducted an empirical study between technical progress (innovation) and economic growth.
- Cameron (1996) in *Innovation and Economic Growth* argued that “any serious study of the literature on technical progress and growth must start with the work of Solow (1957)”.
- Solow analysed data on total factor productivity in the United States between 1909 and 1949 and concluded that technical change was responsible for about 87.5 per cent of economic growth.

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Literature Review... ctd

- Mansfield (1972), after reviewing contemporary literature concluded that research and development expenditures contributed substantially to output growth in a variety of industries in the United States and Japan.

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Literature Review...ctd

- A number of empirical studies have estimated the impact of research and development and innovation on productivity in advanced economies such as the USA, Japan, France and Germany (Griliches, 1994; Nadiri, 1993; Fagerberg, 1994; Bassanini and Scarpetta, 2001; de la Fuente and Ciccone, 2002).
- Most of these studies again confirm the following:

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Literature Review...ctd

- There is a positive correlation between R&D intensity and productivity growth.
- Productivity growth is fuelled by R&D investment
- R&D has a positive impact on total factor productivity
- Social rates of return on R&D investment 'remain significantly above private rates' of return.
- There is a positive correlation between investment in R&D and the quality of the human capital
- There is a positive correlation between R&D intensity and the inflow of foreign direct investment (FDI).

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Literature Review... ctd

- Lichtenberg (1992) examined the macroeconomic effect of R&D using national level data. Using cross-sectional data from 98 countries Lichtenberg estimated directly a non-linear production function that included the rates of investment in labour, physical capital and research as regressors.
- The results show that privately-funded R&D investment has positive significant effects on the level and growth rate of productivity.

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Literature Review... ctd

- Birdsall and Rhee (1993) used UNESCO data for research and development (R&D) expenditures and personnel to analyse the differences in R&D activities and assess the determinants of these differences and the link between R&D and economic growth.
- They found that R&D activity (expenditure) and economic growth are positively correlated only in countries in the OECD while there was no significant relationship in the case of developing countries.

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Literature Review... ctd

- Ulku (2004) investigated the link between innovation, R&D and economic growth. The writer employed various panel data techniques and relied on patent and R&D data for 20 OECD and 10 Non-OECD countries for the period 1981-97.
- The results suggest a positive relationship between per capita GDP and innovation in both OECD and non-OECD countries.

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Literature Review...ctd

- Goel and Ram (1994) used data from a cross-section of 52 countries in the late 1970s and early 1980s to assess the effect of research and development (R&D) outlays on economic growth.
- The variables in the growth model include labour, capital and R&D expenditure. The estimated impact of R&D outlays on economic growth is positive and large.

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Literature Review... ctd

- Yang (2006) investigated the importance of innovation efforts and the discovery of new ideas worldwide in promoting Taiwan's economic growth.
- Using patents application as proxy of innovation, the empirical estimates show that increase in patenting leads to increase in economic growth for both the long-run and short-run.

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Literature Review...ctd

- Samini and Alerrasoul (2009) used panel data to estimate the impact of R&D on economic growth in 30 developing countries over the period 2000-2006, the period for which data was available.
- They used three proxies for R&D:
 - number of researchers in one million population,
 - the share of government expenditure on research in GDP, and
 - the scientific output of each country.
- Their findings, based on panel data regressions indicate that in general, no significant positive relationship exists between R&D and economic growth in the countries studied

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Literature Review...ctd

- Gerrits and Buy (2008) study the link between R&D and innovation in South Africa based on data from the South African Innovation Survey of 2001.
- The findings suggest that South African enterprises had a relatively high level of innovation with very low innovation costs.
- A cross tabulation analysis of the data revealed a significant positive link between innovation and R&D.

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Literature Review...ctd

- Cameron (1996) presents an overview of the empirical literature that investigates the link between innovation and economic growth.
- The author relied on a number of different measures of innovation, such as
 - R&D spending,
 - Patenting and innovation counts,
 - technological spillovers between firms, industries, and countries.

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Literature Review...ctd

- Three conclusions were drawn from the study:
 - i) innovation makes a significant contribution to growth;
 - ii) there are significant spillovers between countries, firms and industries, and to a lesser extent from government funded research; and
 - iii) the spillovers tend to be localized, with foreign economies gaining significantly less from domestic innovation than other domestic firms.

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3. Methodology

3.1 Data

- The main sources of data are the World Development Indicators (WDI) of the World Bank, UNESCO Institute of Statistics, and IMF's International Financial Statistics (IFS).

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Methodology...ctd

3.2 The model

- The basic model estimated on panel data for selected developing countries is a simple Cobb-Douglas production function:

$$GDP_{it} = e^{\alpha_i} (GDP_{it-1})^{\beta_1} (L_{it})^{\beta_2} (K_{it})^{\beta_3} (RD_{it})^{\beta_4} U_{it} \dots (1)$$

Where

GDP_{it} = the gross domestic product for country i in time t .

L_{it} = Labour force for country i in time t

K_{it} = Investment measured by gross fixed capital formation

RD_{it} = R&D expenditure for country i in time t

U_{it} = error term

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Methodology...ctd

- Equation (1) can be rewritten in logarithmic (linear) form as follows:

$$- \ln(GDP_{it}) = \alpha_i + \beta_1 \ln(GDP_{it-1}) + \beta_2 \ln(L_{it}) + \beta_3 \ln(K_{it}) + \beta_4 \ln(RD_{it}) + U_{it}$$

Where

$\beta_{i's}$ = social output elasticities with respect to lagged GDP, labour, investment and Research and Innovation, respectively.

α_i = an index of efficiency or total factor productivity

U_{it} = error term

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Methodology ...ctd

- Generally a regression model for panel data analysis is stated as follows:

$$Y_{it} = \alpha + \beta_1 X_{1it} + \beta_2 X_{2it} + \dots + U_{it}, \quad U_{it} = \mu + v_{it}$$

- Where
 - $E(U_i) = 0$, and has constant variance.
 - μ include fixed effects that show differences among countries' characteristics
 - $V_{it} \sim \text{IND}(0, \sigma^2)$

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Methodology...ctd

- To obtain the estimates of the effects of independent variables:
 - ***R&D, labour, Investment and lagged GDP***,
 - Fixed effect (fe) model was first estimated.
 - Then the random effect (re) model was also estimated.
- In panel data regression, a choice is usually made between fixed effect and random effect models.
- The regression results using the fixed effect model shown in the table below:

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Methodology ...ctd

3.3 Analysis and interpretation

Table 1: Fixed Effect Regression Results

 Dependent variable : Ln (GDP)
 Observations (countries): 5 (Burkina Faso; Madagascar, Mauritius, South Africa, Sudan)
 Period : 1997-2007
 Total panel observations: 55

Variable	Coefficient	Std error	t-statistic	Prob.
C	0.022	0.0103	2.14	0.0385
Ln(GDP _{t-1})	0.148	0.0382	3.87	0.0004
Ln (Labour)	0.126	0.3818	0.33	0.5789
Ln (K)	0.236	0.0918	2.57	0.0295
<u>Ln (R&D)</u>	<u>0.326</u>	<u>0.0600</u>	<u>5.43</u>	<u>0.0000</u>

R- Squared: 0.904

Adjusted R- Squared: 0.901 Durbin Watson Statistic: 2.128

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4. Discussion

- The results of our regression analysis reveal an important dimension in the empirical literature on the role of research and innovation in economic growth.
- On the one hand, our results are consistent with many previous studies on the impact of R&D on developed countries which have indicated strong positive association between R&D and growth rates (Barro, 1991; Birdsall and Rhee, 1993; Coe and Helpman, 1995; Ulku, 2004).
- On the other hand, the results are inconsistent with many a study on developing countries which have shown generally insignificant and in some cases negative impact of R&D on economic growth in developing economies (Samini & Alerasoul, 2009, Birdsall & Rhee, 1993, Goel & Ram, 1994).

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Discussion...ctd

- From our regression results, the estimated parameters of all the independent variables, with the exception of labour, are statistically significant at the 5 percent (or better) level of significance.
- The coefficients (elasticities) of
 - lagged GDP,
 - gross fixed capital formation (investment) and
 - R&D are all positive and significant.
- The size of the coefficients implies that a 1% increase in investment, increases economic growth by about 0.236%.

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Discussion...ctd

- Similarly our results show that a 1% increase in gross domestic expenditure on R&D will lead to an increase of about 0.326% in economic growth.
- The insignificance of the labour variable may be attributed to how the variable was measured in this study. Our inability to obtain comparable measure of the **quality of labour** across all countries in the study meant that the only measure of labour we could use was the total number of economically active population (aged between 15-65 years)

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5. Conclusion

- Study assessed empirically, the link between R&D (and other variables) and economic growth for 5 Sub-Saharan African countries for the period 1997 to 2007.
- Within the group of Sub-Saharan African countries, **R&D expenditure and economic growth are found to be highly correlated.**
- Given the paucity of studies on R&D impact that are limited to only sub-Saharan Africa, our study supports the general contention among development scholars that technological innovation and their adoption (through increased investment in R&D) remains **the** avenue to increased growth among emerging economies of the sub-Saharan African region.
- Thus governments in these countries should increase support for R&D in the relevant institutions and industries

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THANK YOU

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