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THE INTERACTIVE EFFECT OF AGRICULTURAL INPUT AND RESEARCH AND DEVELOPMENT ON AGRICULTURAL SECTOR EXPANSION

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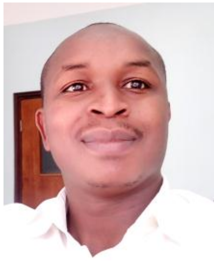

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ABSTRACT

The paper investigated the interactive effect of agricultural capital and labour input and research and development on agricultural sector expansion in East African Community between the period 2000 and 2014. According to the endogenous growth theory, research and development leads to increase in the stock of knowledge which in turn has got spillover effects hence leads to economic growth. However, empirical studies on the interactive effect on the agricultural sector are minimal in the EAC hence the study sought to fill this gap. The objective of this study was to determine the interactive effect of agricultural capital, labour and agricultural research and development on agricultural sector growth. Using Levin-Lin-Chu panel unit test, some variables were stationary at level while others were stationary after first differencing. Most panel diagnostic test concluded autocorrelation, heteroscedasticity and cross dependence was absent. Random effects regression results showed that interaction of R&D and capital had a positive relationship with agricultural expansion. While the interaction of agricultural R&D expenditure and agricultural labour had a significant negative relationship. The study recommends that R&D to be allocated more funds, firms to train agricultural labourers on how new technologies are being used and also to allocate them duties and responsibilities that match their skills and that agricultural capital costs be subsidized.

Contribution/ Originality: There have been mixed results on the effect of R&D on growth in other regions and economies and little is also known on R&D interaction with capital and labour. The study has also contributed to an increase in the stock of knowledge about agricultural R&D.

1. INTRODUCTION

1.1 Background to the Study

In earlier neo-classical theory, knowledge was regarded as an exogenous variable that, together with a company's input goods, labour and capital, affects productivity. In endogenous growth theory, on the other hand, investments in R&D that provide new knowledge are seen as an important factor that explains growth and increased productivity (Romer, 1990). This theory regards new technology not only as an exogenously produced input good that the company utilises but new technology can also be created within the company. In endogenous growth theory, investments in R&D can provide long term growth and lead to rising returns to scale. This is because previous R&D investments that were made to generate specific knowledge do not need to be made again. The replication of previous production does not therefore have to bear the burden of any R&D costs.

Common capital goods such as machines and means of transport and even labour are products for which there is rivalry; they cannot be used at the same time for different purposes. Knowledge, however, is a product that is non-rivalry. This means that a company's use of the product (knowledge) does not diminish any other company's use of the product (Jones, 2004). However, knowledge is often, also non excludable. A company that has invested in R&D to acquire new knowledge may find it difficult to prevent other companies from using this new knowledge unless it is patented thus knowledge becomes "a public good". It is also highly unlikely that a company will itself have the expertise required to utilise all the knowledge generated by the R&D concerned. These factors explain how R&D can lead to spillovers to other companies and can lead to rising returns to scale which otherwise contradict the neo-classical theory.

The non-excludability of new knowledge and the occurrence of spillovers lead, as mentioned above, to a great risk that companies on a free market will invest too little in R&D. There are three ways of addressing the problem. First, intellectual property rights can protect the originators of new knowledge. Patents are the most common instruments used here, but copyright and trademarks are also used. These exclude others from using the knowledge concerned. Secondly, the state can assume responsibility for the funding and production of new knowledge, with the aim of ensuring that the knowledge is then disseminated. State universities and laboratories that conduct R&D are the foremost examples of this system. Sometimes the state just provides the funding and allows companies to perform the R&D. This is particularly effective if the private return is low and the social return high. Third, a contract can be drawn up between a party that produces the new knowledge and another party that is interested in it. Contract research where the state funds companies that perform R&D in the defence industry is an example of this.

EAC states have formulated policies to guide research and innovations and technology transfer, for example in Kenya, there is facilitation of acquisition of intellectual property rights by scientists; researchers and innovators, in Tanzania, there is the high level scientific research and technological trainings, motivation and retention programmes which include provision of attractive terms and conditions of service for scientists and technologists while in Rwanda, there is regular audit of research and knowledge transfer capacity to enable the quality and extent of research and knowledge transfer activity be properly assessed and in Uganda, there is support for local innovation and scientific excellence by funding national research priorities and providing infrastructure for technology generation and incubation and these if fully implemented, would see great accomplishments in higher-education research, science and technology activities, as well as increased collaborations with industry that would lead to the economic development of these nations.

2. THEORETICAL LITERATURE

2.1. The Arrow Model of Endogenous Growth

Arrow (1962) model regarded learning by doing as endogenous in the growth process. The theory hypothesised that at any moment of time, new capital goods incorporate all the knowledge then available based on accumulated experience, but once built, their productive deficiencies cannot be changed by subsequent learning. The theory showed that if the stock of labour is held constant, growth ultimately comes to a halt because socially very little is invested and produced. This was supported by Segura and Rodriguez (2004) who said that learning is a product of experience (doing) that takes place during activity, since it usually occurs through the attempt to solve a problem. Rotheli (1993) also supported this theory by saying that the observation by Arrow proved the capability of workers to improve their productivity by regularly repeating the same type of action. The increased productivity is achieved through practice, self perfection and minor innovations. However, Romer (1994) criticised this model by saying that for technical reasons, the fact that this model could lead to sustained endogenous growth was not emphasised.

2.2. Lucas Theory

Lucas (1988) theory says that investment on education leads to the production of human capital which is the crucial determinant in the growth process. He makes a distinction between the internal effects of human capital where the individual worker undergoing training becomes more productive, and external effects which spill over and increase the productivity of capital and of other workers in the economy. The theory says that it is investment in human capital rather than physical capital that have spill over effects that increase the level of technology and hence increasing the productivity of capital and workers in the economy. While the approach initiated by Lucas (1988) views accumulation of human capital as the source of economic growth, the approach of Benhabib and Spiegel (1994) assumes that stock of human capital determines the ability of an economy to develop and assimilate technologies and thus produce economic growth. A criticism raised against the Lucas model is that intentionally accumulated nontrivial knowledge is neglected. According to Romer (1989) education yields primarily skills which are tied to human bodies and therefore rival. Non-rival knowledge that is passed on to future generations is viewed only as a by-product of production. In reality, non-rival knowledge is intentionally accumulated, scientific research and commercial development yield primarily ideas and designs that can be employed by workers but are not necessarily tied to them.

2.3. Empirical Literature Review

McArthura and Gordon (2017) estimated the role of agronomic inputs in cereal yield improvements and the consequences for countries' processes of structural change. The results suggest a clear role for fertilizer, modern seeds and water in boosting yields. The study test for respective empirical links between agricultural yields and economic growth, labor share in agriculture and non-agricultural value added per worker. The identification strategy includes a novel instrumental variable that exploits the unique economic geography of fertilizer production and transport costs to countries' agricultural heartlands. Estimating that half ton increase in staple yields generates a 14 to 19 percent higher GDP per capita and a 4.6 to 5.6 percentage point lower labor share in agriculture five years later. The results suggest a strong role for agricultural productivity as a driver of structural change.

Gisore *et al.* (2014) analyzed the effect of different types of government spending on overall economic growth across 3 East African countries between 1980 and 2010 using OLS method and found mixed result. In East Africa, government spending on agriculture was particularly weak on promoting economic growth. This insignificance can be attributed to low government spending especially in infrastructure, research and extension which culminates in low factor productivity. On average, none of the EAC countries spends more than 5% of total government expenditure on the agriculture sector.

Nunes *et al.* (2012) conducted a study to determine whether there is a similar relationship in terms of R&D intensity and growth between small and medium size enterprises with high technology and those who lack high technology. According to their findings, R&D intensity restricts the growth of enterprises with high technology at lower levels of intensity and encourages them to grow at higher levels. However, R&D intensity restricts the growth of enterprises without high technology regardless of the level of R&D.

Kim (2011) analysed the effect of R&D activities on economic growth for Korea by using R&D based Cobb-Douglas production function and the data for the period 1976-2009. According to his empirical findings, traditional production factors i.e labour and capital contributed to economic growth by approximately 65%. The contribution of R&D stocks on economic growth was approximately 35%. Detailed analysis showed that the contribution of private and public R&D stocks on economic growth is 16% and 19% respectively.

According to Bronzini and Paolo (2006) who studied the long-run relationship between regional total factor productivity, public infrastructure, human capital, and R&D in Italy during the period 1980-2001; R&D has a positive effect on productivity whereas R&D stock in one region affects productivity levels in nearby regions. This showed that geographical location is relevant for R&D spillovers.

2.4. Theoretical Framework

This study will be based on Romer (1990) model of technological change. The model identifies a research sector specialising in the production of ideas. This sector involves human capital along with the existing stock of knowledge to produce ideas or new knowledge. To Romer, ideas are more important than natural resources. The study cites the example of Japan which has very few natural resources but it was open to new western ideas and technology. Therefore, ideas are essential for the growth of an economy. These ideas relate to improved designs for the production of producer durable goods for final production. In the Romer model, new knowledge enters into the production process in three ways. First, a new design is used in the intermediate goods sector for the production of a new intermediate input. Second, in the final sector, labour, human capital and available producer durables produce the final product. Third and a new design increase the total stock of knowledge which increases the productivity of human capital employed in the research sector. While Romer's approach postulates innovation of new capital goods that make production of final goods less costly, Grossman and Helpman (1991) together with Aghion and Howwit (1992) developed models where innovation improves the quality of existing varieties of capital goods.

In the neoclassical model, a higher population growth rate reduces the level of per capita income a long a balanced growth path. More people means that more capital is needed to keep K/L constant, but capital runs into diminishing returns.

In the Romer (1990) model, people create new innovations which are non-rivalrous, so everyone benefits.

In the original model, assumed that $\lambda=1$ and $\Phi=1$ so that:

$$\dot{A}=\delta L_A A \qquad (12)$$

And

$$\dot{A}/A=\delta L_A \qquad (13)$$

In this case, the productivity of research is proportional to the existing stock of ideas: $\bar{\delta}=\delta A$

In this form, the productivity of researchers grows over time even if the number of researchers is constant.

In case of a permanent increase in the R&D share (assuming that $\lambda=1$ and $\Phi=0$?), temporarily technological progress, $\frac{\dot{A}}{A}=\delta L_A$ exceeds population growth, n, so the ratio, L_A/A declines over time.

As this ratio declines, the rate of technological progress gradually falls until the economy returns to a balanced growth path where, $g_A=n$. The level of technology is permanently higher as a result of the permanent increase in R&D. There is a scale effect in levels; a larger world economy is a richer economy.

3. METHODOLOGY

3.1. Panel Unit Root Test

Panel unit root test was conducted using Levin *et al.* (2002) to avoid analysing non stationary data at level which in turn could lead to spurious results or results that do not make sense. Data found to be non-stationary at level were differenced for stationarity to be achieved.

3.2. Panel Co integration Test

▼

Pedroni (1999) developed a residual-based panel co integration test statistics based on within dimension and between- dimensions.

3.3. Panel Hausman Test

To establish whether to employ fixed effects model or random effects model, the study conducted Hausman (1978).

3.4. Data Analysis

Descriptive methods were used to show relevance of the information as this gave information on the mean, variance and standard deviation of the variables. Regression random effect model was used to estimate the data.

3.5. Model Specification

The basic regression equation that was used to determine the interactive effect between Agricultural inputs and research and development and agricultural sector growth was represented as.

$$lnY_{i,t} = \beta_1 lnREA.AC + \beta_2 lnREA.AL + \mu_i + v_t + \varepsilon_{i,t}$$

Where;

$Y_{i,t}$ –is the dependent variable i.e. Agricultural sector growth.

$REA.AC_{i,t}$ is the embodiment/ interaction of agricultural R&D and agricultural capital.

$REA.AL_{i,t}$ is the embodiment/interaction of agricultural R&D and agricultural labour.

μ_i represents unobserved country specific effects.

v_t represents unobserved time specific effects.

$\varepsilon_{i,t}$ is the error term.

Interaction of agricultural capital and agricultural R&D leads to increased efficiency and hence increased agricultural output. The product of agricultural capital and agricultural R&D expenditure was used as a measure of interactive agricultural capital and agricultural R&D. Interactive agricultural capital and agricultural R&D was expected to have a positive effect.

3.6. Post-Estimation Panel Diagnostic Tests

There are some econometric problems which when present in the regression results makes the parameter estimates biased and may lead to biased estimations. These are Cross-sectional dependence, heteroscedasticity, autocorrelation and multicollinearity. Therefore tests for the mentioned problems were conducted so as to effect the appropriate corrections.

4. DISCUSSION OF FINDINGS

4.1. Descriptive Analysis

Table-1. Results of Descriptive Analysis

Variable	N	Mean	Std.	Min	Max
LnY	75	18.7870	2.9991	9.2103	24.9867
LnREA.AC	75	25.2661	3.0492	20.0109	28.6754
LnREA.AL	75	25.6560	1.6623	21.7914	27.7325

Where,
LnY is the natural log of agricultural output growth
LnREA.AC is the natural log of the interactive effect of agricultural capital and agricultural R&D expenditure.
LnREA.AL is the natural log of the interactive effect of agricultural labour and agricultural R&D expenditure.

From Table 1 result above, the mean of agricultural output growth is 18.8 This means that on average, agricultural output growth for the period 2000-2014 in EAC was 18.8.The standard deviation is 3 which means that for the period 2000-2014, agricultural output growth in EAC was deviating from the mean by 3. The minimum of agricultural output growth in EAC for the period 2000-2014 was 9 while the maximum of agricultural output growth for the same period was 25. This means that the range of agricultural output growth in EAC for the period 2000-2014 was 16. For the case of the interaction of agricultural capital and agricultural R&D expenditure, the mean is 25. This means that for the period 2000-2014, the interaction of agricultural capital and agricultural R&D expenditure was on average 25 in the EAC. The standard deviation is 3. This means that for the period 2000-2014, the interaction of agricultural capital and agricultural R&D expenditure was deviating from the mean by 3 in the EAC. The interaction of agricultural capital and agricultural R&D expenditure has a minimum level of 20 and a maximum level of 29. This means that for the period 2000-2014, the range of the interaction of agricultural capital and agricultural R&D expenditure was 9 in the EAC. Examining the case of the interaction of agricultural labour and agricultural R&D expenditure, the mean is 26. This means that for the period 2000-2014, the interaction of agricultural labour and agricultural R&D expenditure was on average at the level of 26 in the EAC. The standard deviation of the interaction of agricultural labour and agricultural R&D expenditure is 2. This means that in the period 2000-2014, the interaction of agricultural labour and agricultural R&D expenditure was deviating from the mean by 2 in the EAC. The minimum of the interaction of agricultural labour and agricultural R&D expenditure is 22 and the maximum is 28. This means that for the period 2000-2014, the range of the interaction of agricultural labour and agricultural R&D expenditure was 6 in the EAC.

4.2. Correlation Results

Correlation is the measure of the degree of association between variables. It also shows the direction of relationship between variables and the correlation coefficient ranges from -1 to +1 with closeness to absolute 1 showing a strong correlation between variables.

Table-2. Results of Correlation Coefficients

	LnY	**LnREA.AC**	**LnREA.AL**
LnY	1.0000		
LnREA.AC	0.4731***	1.0000	
LnREA.AL	0.4132***	0.9477***	1.0000

*** is significance at 1%

The correlation coefficient between interactive agricultural capital and agricultural R&D expenditure and agricultural output growth is 0.4731. This means that there is a weak positive correlation between the interactive agricultural capital and agricultural R&D expenditure and agricultural output growth. When there is increased interaction of agricultural capital and agricultural R&D expenditure, agricultural output growth also increases and when the interaction of agricultural capital and agricultural R&D expenditure decreases, agricultural output growth also decreases. The positive correlation between interactive agricultural capital and agricultural R&D expenditure of 0.4731 is statistically significant at 1% level. The positive relationship is because agricultural capital and agricultural R&D expenditure complement each other and this makes agricultural capital to be more efficient in production hence increased agricultural output.

For the interaction of agricultural labour and agricultural R&D expenditure and agricultural output growth, the correlation coefficient is 0.4132. This means that there is a weak positive correlation between the interaction of agricultural labour and agricultural R&D expenditure and agricultural output growth. When there is an increase in the interaction of agricultural labour and agricultural R&D expenditure, agricultural output growth also increases and when it decreases, agricultural output growth also decreases. The positive correlation of 0.4132 between the interactive agricultural labour and agricultural R&D expenditure and agricultural output growth is statistically significant at 1% level.

4.3. Panel Econometric Tests

4.3.1. Panel Unit Root Test

The Levin Lin Chu panel unit root test was conducted to find out whether the variables were stationary at level or whether they were non stationary.

Table-3. Results of Levin-Lin-Chu Panel Unit Root Test

Variable	LLC (level)	LLC(first difference)	LLC(p-value)	Order of integration
LnY	-4.1090***		0.0000	I(0)
LnREA.AC	0.7237*		0.7654	
		-5.6177***	0.0000	I(1)
LnRE.AL	1.2275*		0.1098	
		-5.5079***	0.0000	I(1)

*** 1% significance level, ** 5% significance level, * 10% significance level

From Table 3 above, agricultural output growth, was found to be stationary at level and statistically significant at 1% level while the remaining variables, that is, interactive agricultural capital and agricultural R&D expenditure, interactive agricultural labour and agricultural R&D expenditure were found to be non stationary but became stationary after first differencing that is integrated of order one and this was statistically significant at 1% level.

4.3.2. Panel Cointegration Test

Since the dependent variable (agricultural output growth) was found to be stationary at level, conducting cointegration test was impossible because the dependent variable and the independent variables were now not integrated of the same order.

4.3.3. Hausman Test

To determine whether to use fixed effects or random effects regression model, Hausman (1978) test was applied. From the Hausman test, the p-value (0.30 is greater than 0.05 which means that the difference is not statistically significant and so the null hypothesis of the preferred model being random effects model was not rejected.

4.3.4. Panel Diagnostic Tests

Cross sectional dependence is the inter-dependence between cross sectional units. From the results of Pesaran's test for cross sectional dependence, the P-value (0.31) is greater than 0.05 hence the null hypothesis of cross sectional independence was accepted. This means that there was cross sectional independence in the regression analysis.

Heteroscedasticity refers to a situation whereby the error terms do not have constant variance across observations. The study used Breusch and Pagan (1980). From the result, the p-value (0.9) is greater than 0.05 and so the null hypothesis of constant variance was not rejected. This means that heteroscedasticity was not a problem in the regression analysis.

Autocorrelation in linear panel models causes biased standard errors and makes the estimators less efficient. Wooldridge (2002) was used to test for autocorrelation. From the results above, the p-value (0.97) is greater than 0.05 and so the null hypothesis of no serial correlation was not rejected.

4.3.5. Panel Regression Analysis

Table-4. Results of Regression

Ln_Y	Coef.	Std. Err.	Z	P>Z	95% Confidence Interval
Diff LnREA.AL	-0.9728**	0.4537	-2.14	0.032	-0.9873 -0.9583
Diff LnAC	0.1216**	0.0576	2.11	0.035	0.1196 0.1236
-cons	0.2975	0.6071	0.49	0.627	-0.0832 0.6782
R-Squared: within = 0.57 Between = 0.51 Overall = 0.58					

*** 1% significance level, ** 5% significance level, * 10% significance level

From the results in Table 4 above, Interaction of agricultural capital and agricultural research (REA.AC) was omitted in the analysis because it was found to be contributing to multicollinearity. The coefficient of the interaction between agricultural labour and agricultural research is -0.9728. This means that a one percent increase in the interaction of agricultural labour and agricultural research leads to a decrease in the agricultural sector growth (output) by 0.9728%. The p-value is 0.032 and being that it is less than 0.05, it means that the decline in agricultural sector growth (output) by 0.9728% is statistically significant at 5% level. This translates that there is an elastic relationship between the interaction of agricultural and agricultural labour and agricultural sector growth.

This negative result could be attributed to substitutability between agricultural labour and agricultural R&D expenditure. This implies that increased agricultural labour reduces resources for investment in agricultural R&D hence limited the discovery of new methods of agricultural production hence low agricultural output. Technological unemployment could have also contributed to this whereby the technological advancements made through agricultural R&D makes the skills of the agricultural labour obsolete hence leading to low agricultural output. The negative result could also be attributed to the presence of unskilled labour or lack of properly educated agricultural labour force that did not have the ability to assimilate and properly use the new and advanced technologies developed as a result of agricultural research and development.

In addition, the negative effect could have been as a result of a short-period use of the advanced technologies developed through agricultural research and development by the agricultural labour and hence the capability of workers to improve their productivity by regularly repeating the same type of action which is achieved through practice and self perfection was not the case in this situation and hence the negative coefficient.

Another factor that could have made this variable to affect agricultural output growth negatively could be resistance by agricultural labourers and labour unions to embrace the use of advanced technologies developed through agricultural R&D as this could be seen as a way of rendering workers jobless in addition to the general negative mentality towards some new technologies and machines.

The issue of underemployment can also be attributed to this result because highly educated, trained and skilled workers when assigned low-skilled and low-wage jobs may feel demoralised and frustrated and as a result their productivity becomes very low even if the use of advanced technologies and better machines developed through agricultural R&D is embraced. The constant is 2.9750.This means that without the variables like the interaction of agricultural labour and agricultural research, agricultural capital and agricultural labour in the EAC, agricultural output growth remains at the level of 2.9750. The p-value is 0.627 and being that the p-value is greater than 0.05, this implies that the constant is not statistically significant at 10% level.

Within R squared is 0.57. This means that 57% of the variations on the agricultural sector growth (dependent variable) within the individual countries are explained by the explanatory variables in the model. The between R squared is 0.51. This means that 51% of the variations on the agricultural sector growth between the entities (countries of the EAC) are explained by the explanatory variables in the model. The overall R squared is 0.58. This means that 58% of the changes on the dependent variable (agricultural output) in EAC are explained by the explanatory variables that are included in the model.

5. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

The negative and statistically significant effect of the interaction of agricultural labour and agricultural R&D expenditure on agricultural sector growth implies that agricultural labour and agricultural R&D expenditure were substitutes and so when there was increased agricultural labour, there was a decrease in agricultural R&D expenditure.

5.2. Policy Recommendations

The interaction of agricultural labour and agricultural R&D expenditure was found to be influencing agricultural sector growth negatively and the influence was statistically significant. This implies that agricultural labour and agricultural R&D expenditure are substitutes. The governments of the EAC states and the firms also should ensure that agricultural labour is trained on new skills to match the technological advancements that have been made. Firms should also ensure that only trained and skilled agricultural labourers are employed since they can catch up with new technological changes faster compared to untrained and unskilled agricultural labour.

In addition to these, firms should also ensure that agricultural labourers are educated on the importance of the use of new technologies or new machines developed through agricultural R&D so as to avoid resistance from labourers as far as their use is concerned, labour unions should also be consulted whenever new technologies and new machines developed through agricultural R&D are to be used so as to avoid their resistance also. Allocation of duties and responsibilities by firms to labourers should also be done in such a way that their skills, education levels and experience are matched for them to feel motivated since this helps in boosting productivity. Lastly, the governments and also the firms should carry out agricultural R&D that responds to the needs of the society since this will not lead to technological unemployment.

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REFERENCES

Aghion, P. and P. Howwit, 1992. A model of growth through creative destruction. Econometrica, 60(2): 323-351. *View at Google Scholar* | *View at Publisher*

Arrow, K.J., 1962. Economic welfare and the allocation of resources for invention. In K. Arrow (Ed.) The Rate and Direction of Inventive Activity: Economic and social Factors. Princeton University Press. pp: 609-626.

Benhabib, J. and M. Spiegel, 1994. The role of human capital in economic development: Evidence from aggregated cross country data. Journal of Monetary Economics, 34(2): 143-173. *View at Google Scholar* | *View at Publisher*

Breusch, T. and A. Pagan, 1980. The langrange multiplier test and its applications to model specification in econometrics. Review of Economic Studies, 47(1): 239-253. *View at Google Scholar* | *View at Publisher*

Bronzini, R. and P. Paolo, 2006. Determinants of long-run regional productivity with geographical spillovers: The role of R&D, human capital and public infrastructure. Regional Science and Urban Economics, 2(39): 187-199.

Gisore, N., S. Kiprop, A. Kalio and J. Babu, 2014. Effect of government expenditure on economic growth in East Africa: A disaggregated model. European Journal of Business and Social Sciences, 3(8): 289 – 304. *View at Google Scholar*

Grossman, G.M. and E. Helpman, 1991. Innovation and growth in the economy. Cambridge, MA: MIT Press.

Hausman, J., 1978. Specification tests in econometrics. Econometrica, 46(6): 1251-1271. *View at Google Scholar | View at Publisher*

Jones, C., 2004. Growth and ideas. Handbook of Economic Growth, 3(1): 1063-1111.

Kim, L., 2011. The economic growth effect of R&D activity in Korea. Korea and the World Economy, 12(1): 25-44. *View at Google Scholar*

Levin, A., C. Lin and C. Chu, 2002. Unit root tests in panel data: Asymptotic and finite-sample properties. Journal of Econometrics, 108(1): 1-24. *View at Google Scholar | View at Publisher*

Lucas, R., 1988. On the mechanics of economic development. Journal of Monetary Economics, 22(1): 3-42. *View at Google Scholar*

McArthura, J. and C. Gordon, 2017. Fertilizing growth: Agricultural inputs and their effects in economic development. Journal of Development Economics, 127(1): 133-152. *View at Google Scholar | View at Publisher*

Nunes, P., Z. Serrasqueiro and J. Leithao, 2012. Is there a linear relationship between R&D intensity and growth? Empirical evidence of Non-High-Tech SMEs. Research Policy, 41(1): 36-53. *View at Google Scholar | View at Publisher*

Pedroni, P., 1999. Crucial values for cointegration tests in heterogenous panels with multiple regressors. Oxford Bulletin of Economics and Statistics, 61(S1): 653-670. *View at Google Scholar | View at Publisher*

Romer, P., 1989. Capital accumulation in the theory of long run growth. Cambridge,Massauchete: Havard University Press.

Romer, P., 1990. Endogenous technological change. Journal of Political Economy, 98(5): S71-S102. *View at Google Scholar*

Romer, P., 1994. The origins of endogenous growth. Journal of Economic Perspectives, 8(1): 3-22. *View at Google Scholar | View at Publisher*

Rotheli, T.F., 1993. Exogenous and endogenous growth. Journal of Political Economy, 44(4): 1-10. *View at Google Scholar*

Segura, J. and B. Rodriguez, 2004. An eponymous dictionary of economics: A guide tolaws and theories named after economists. Chetanham: Edward Elgar Publishing Limited.

Wooldridge, J., 2002. Econometric analysis of cross section and panel data. 2nd Edn., London: The MIT Press.