International Journal of Business and Economics Research
2018; 7(6): 191-202
http://www.sciencepublishinggroup.com/j/ijber
doi: 10.11648/j.ijber.20180706.13
ISSN: 2328-7543 (Print); ISSN: 2328-756X (Online)

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High Technology Exports, Gross Capital Formation and Economic Growth in Uganda: A Vector Auto Regressive Approach

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To cite this article:
Paul Wabiga, Sawuya Nakijoba. High Technology Exports, Gross Capital Formation and Economic Growth in Uganda: A Vector Auto Regressive Approach. International *Journal of Business and Economics Research*. Vol. 7, No. 6, 2018, pp. 191-202.
doi: 10.11648/j.ijber.20180706.13

Received: September 5, 2018; **Accepted**: September 26, 2018; **Published**: November 1, 2018

Abstract: This study examines the relationship between high technology exports, gross capital formation and economic growth in Uganda with the ultimate aim of establishing whether exportation of high-tech goods and gross capital formation have a significant effect on economic growth. Motivated by the continued policy shift in Sub-Saharan Africa and generally in the developing world, towards outward looking strategies, this study seeks to provide a validation test to this trend from a small open developing country perspective. The study utilizes data from the World Bank Development Indicators. This study estimates a basic Vector Autoregressive model to establish the likely effects of high-tech exports and gross capital formation on growth. The authors later provide in-depth analysis of our results using impulse response functions (IRF). Our Vector Auto Regression (VAR) results indicate that in the short run, high-tech exports do not have a significant effect on economic growth in Uganda and gross capital formation has a negative and significant effect. However, IRF reveals gross capital formation having a positive and significant effect on growth and the effect of high-tech exports improving significantly over a long horizon. Our findings do not contradict previous studies but support the belief that once economic fundamentals are put in place, high-tech exportation can spur growth more than mere export volumes.

Keywords: High Technology Exports, Gross Capital Formation, Economic Growth, VAR, IRFs, Uganda

1. Introduction

The role of exportation in spurring economic growth and development has been emphasized globally among researchers. The Export Led Growth (ELG) hypothesis has been empirically tested and many findings show significant support. Macro level studies indicate that exports are a source of foreign exchange, which is vital for financing both imports and social economic development projects especially in developing countries [1]. Given their small domestic markets, participation of developing economies in international trade via exportation boosts their revenues and accelerates growth and development. Indeed probably due to the growth merits associated with exportation, economies in sub Saharan Africa (SSA) have embraced significant shifts from inward to outward looking development strategies, especially in the last two decades as acknowledged by [2]. Although higher volumes of exports form the basis for the ELG hypothesis, there is evidence that high-technology exports have a superior impact on economic growth than mere volumes. Numerous studies, provide scholarly evidence to this assertion for instance [3-5]. Relative to economies exporting low technology goods, economies exporting high technology goods experience higher economic growth as put forward by [6].

The high technology ELG (htELG) hypothesis, however, remains not without criticism. Other scholarly circles have it that the composition of export goods (whether high-tech or not) does not matter as far as growth is concerned. It has been argued that export product sophistication does not matter when it comes to growth. A case in the point is a study by [7]. Elsewhere, because developing economies face scarcities of supportive infrastructure for high-tech industries, production of high-tech products does not necessarily imply higher growth for such economies [8].

The above inconclusiveness on the impact of high-tech exportation on economic growth still remains and validates the need for further investigation. Nevertheless, much glaring and related to the same is the fact that majority, if not all, of the scholarly studies on either side of the argument have been conducted in the developed world. There is little (or no) evidence in the developing world, Sub-Saharan Africa in particular, regarding the likely impact (or its absence) of high-tech exports on economic growth. This lack of scholarly evidence exists even as economies in SSA embrace the policy shift alluded to earlier.

In this paper, the authors utilize data from the World Bank Development Indicators (WDI) in an attempt to provide, to the best of our knowledge, the first evidence regarding the effect (or absence) of high-tech exports on economic growth in developing economies, taking Uganda as our case study. The study incorporates gross capital formation in the empirical analysis, given the role it plays in enabling technological development, a key ingredient in export goods' sophistication. Technological innovations play a crucial role in industrial and economic development and such innovations are key in the creation of heterogeneous export products, which improves a country's competitiveness in international trade. Our analysis, therefore, aims at evaluating the relationship between high-tech exports, gross capital formation and economic growth for the 1986 – 2016 period in Uganda.

Uganda provides a good case for the study-issue at hand. Since the take-over of power by the ruling National Resistance Movement (NRM) in 1986, several economic reform programs have been implemented. Noted among the numerous reform programs are; the Economic Recovery Program (ERP), Poverty Eradication Action Plan (PEAP), the current National Development Plan II, to mention but a few. One of the key areas of focus, in especially the recent economic frameworks, has been that of promoting exports through, among others, attracting and encouraging both domestic and foreign investment and promotion of science and technology for improved value addition. This strategic direction is thought to be effective in solving some of the growth and development challenges facing Uganda's economy, noted most, unemployment. Indeed, since the 1980s Uganda has been posting positive values of high-tech exports as part of her manufactured exports. Moreover, currently, policy makers believe that the average targeted growth rate of about 6.3 percent will be driven by growth in public and private investments and exports ([30], page 440).

In a further attempt to achieve steady economic growth, the Government of Uganda, over the last couple of years, has undertaken a capital accumulation technique aimed at propelling the country into middle-income status by 2020 with the fiscal policy greatly focusing on capital development. The World Bank classifies countries into middle-income status as those whose citizens' average income is between USD 1,000 to 12,000 [9]. Since Uganda is aiming at joining that category by 2020, heavy investments in infrastructural projects have been undertaken. The works and transport, energy and mineral development sectors have averaged a combined share of over 30% of the national budget over the last three years. These public investment strategies if prudently managed have the potential to transform the economy to some extent. Uganda's GPD per capita stands at $740 only. It will require a leap to $1,000 for Uganda to achieve the middle-income status goal by 2020. To achieve such economic milestones, there is need for increased gross capital formation which can be directed towards research and development, which consequently boost economic growth [10].

In the last eight years, Uganda's GDP per capita has increased by $161 from $578 in 2010 to $740 in 2016. With the economic growth rate averaging 4.6% over the same period it begs the question; will Uganda achieve middle status by 2020? To partly provide a vivid answer to this question, this paper investigates the effect of high technology export while controlling for gross capital formation in Uganda (1986-2016) using a Vector Auto Regression (VAR) approach.

The rest of this paper is organized as follows; In section 2, the authors present empirical literature highlights. In section 3, the authors describe the data and methodology used. Section 4 contains the empirical results while section 5 presents the conclusions and policy considerations.

2. Literature Review

Theoretically, the study is guided by the classical economists of the eighteenth and nineteenth centuries who argued that technological change and capital accumulation were the engines of growth. Robert Solow, who was a student of Schumpeter, advanced his professor's theories in such a way that, in the absence of technological progress, factor accumulation is subject to diminishing returns and an economy eventually settles at a steady state where economic growth ceases. The new theory of endogenous economic growth postulated that international trade through increased capital formation will speed up the rate of economic growth and development in the long run [11-12]. This is especially by allowing developing nations to absorb the technology developed in advanced nations and increasing the benefits that flow from research and development [13]. Uganda is considered one of the good examples of countries deriving her economic growth through international trade.

Empirically, numerous researchers and economists investigate economic growth determinants using diverse approaches and theories. To the best of our knowledge, none of them provides the exact parameter to foresee the determinants of economic growth in all environments. In this study, authors analyze the effect of high technology exports on economic growth while controlling for gross capital formation. Numerous scholars have examined the relationship between high technology exports and economic growth. Empirical findings, however, remain inconclusive.

scholars have investigated whether high technology exports really matter for economic growth. Using a Panel Approach to analyze upper middle-income economies, analysis of data about the technological diversification of export composition of upper middle-income countries and the impact of the technological composition of exported goods on GDP growth is undertaken by [8]. Using dynamic analysis techniques for 34 countries for the period 1995-2015, his findings confirm that exports of high technological products have a significant positive impact on economic growth for upper middle-income countries. Additionally, he finds that exportation of medium technological products has a limited effect on GDP growth. More so, the exports of low-tech products will have a negative effect for economic growth in the long run. In a related study which examines whether or not, high technology exports have recently been a determinant of per capita economic growth in countries with higher levels of technological achievement, utilizing data from a sample of countries based on the technological achievement index. The empirical results of the technological leader category of countries provides strong evidence of the positive impact of high technology exports on per capita economic growth [14].

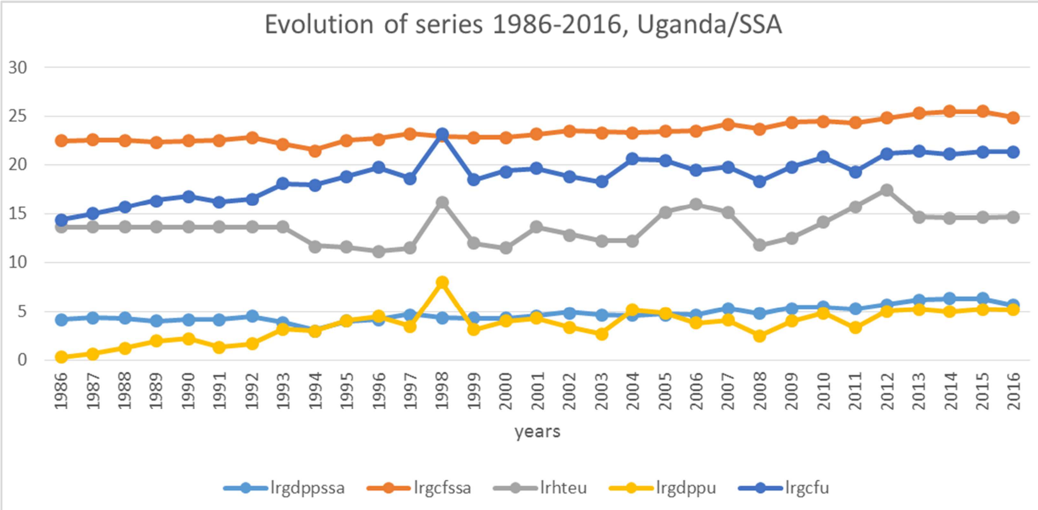
In addition, another researcher investigates the empirical relationship between Foreign Direct Investment, high-tech and no-high-tech exports, and GDP using 50 countries for the period 1992-2014. Estimating a random effect model, the findings show that non-high-tech exports affect positively on GDP growth on the entire sample. These findings somehow contradict those from [8], an indication of the inconclusiveness hinted on earlier in [15]. In a study about high-technology exports and economic growth in industrialized nations, findings agree with those of [8]. In estimating a dynamic growth model on a panel data set for 22 OECD countries for the period 1980–2004, in which the data is measured as 5-year averages. Using the system GMM panel estimator, which corrects for simultaneity, the share of high-tech exports are significantly positively related to the GDP per capita as per the findings of [16].

Despite their potential effect on economic growth, other scholars have argued that high tech -exports alone cannot account for economic growth. Perhaps there are other variables that work hand in hand with high tech -exports to impact on the economic growth and emphasis is put on gross capital formation. It has been established in economic theory that high levels of capital formation are prerequisites for long-term economic growth in any given country [17]. High levels of savings are necessary to finance high levels of capital formation, which will lead to increased productivity and ultimately long-term economic growth. Gross capital formation, just like gross savings can be used to promote research and development, which epitomizes the productive capacity of an economy, consequently resulting into economic growth. Capital formation therefore, naturally plays an important role in the economic growth and development process. It has always been seen as potential growth enhancing player. Capital formation determines the national capacity to produce, which in turn, impacts on economic growth. No wonder, deficiency of capital formation has been cited as the most serious constraint to sustainable economic growth. It is therefore not surprising that the analysis of capital formation has become one of the central issues in empirical macroeconomics [18]. Basing on these arguments, this study includes gross capital formation in the economic growth model.

Empirical studies about the linkage between gross capital formation and economic growth are equally numerous. A study was conducted to investigate the role of capital formation and savings in promoting economic growth in Iran with the aid of time series data spanning from 1960 to 2003. Study findings point to a positive relationship between gross capital formation and economic growth [19]. Elsewhere, studies conducted on empirical investigation about the effect of capital formation on economic growth in Nigeria. The study adopts co integration and vector error correction model in the analysis of the specified variables in addition to a Vector Error Correction (VEC) granger causality test. Empirical results indicate that a stable long run relationship exists between the dependent and independent variables as indicated by two (2) co integrating equations [20]. In the vector error correction model, results indicate that gross capital formation (gcf) has a positive impact on real gross domestic product (RGDP) in the short run and the long run. This result is in line with the findings of the study about the short and long run relationship between capital formation and economic growth undertaken by [21]. The study covers a long time period from 1950-51 to 2009 in which annual time series data are used in the analysis. These results, which further buffer the assertion that capital formation exert influence on economic growth, are in agreement with other studies conducted in Nigeria and Sub-Saharan Africa, which respectively are [22, 23].

Concisely, it is clear that the relationship between high technology exports and economic growth is inconclusive. Whereas numerous studies have empirically tested and found the relationship positive and significant, others have found dissimilar results. Moreover, few studies of this kind have been conducted in least developed economies like Uganda. Relatedly, effects of gross capital formation on economic growth although largely proved empirically significant, majority of the studies have been conducted in the developed world. Very few have been conducted in poor economies like Uganda.

In the next sub section, the authors provide background statistics about the case study economy of interest, starting with the series in Figure 1.



Source: Authors' own illustration based on World Bank-WDI data for Uganda 1980-2016

Figure 1. *Evolution of the series, 1986-2016 for Uganda and Sub-Saharan Africa.*

As Figure 1 above suggests, gross domestic product per capita (lrgdppu) for Uganda has been changing closely with the Sub- Saharan Africa (SSA) average with Uganda moving above SSA average in the years leading to 2000. Indeed the World Bank declared Uganda a development model for Africa in 2000[1] after a decade sustained average GDP growth of 5.6%. However, since then, just like in SSA (GDP per capita contracted by 1.1%) growth has been slow. This slump has been attributed to both internal and external factors[2]. According to the IMF projections, however, Uganda's economy was projected to grow at 5 percent in 2017 and 5.8 percent in 2018. It is apparent that, for Uganda, the series for real gross capital formation (*lrgcf*) exhibit identical variations with GDP per capita, pointing to the hypothesized close linkage between the two series. However, gross capital formation is still below the SSA average and this probably explains why the values for GDP per capita are below SSA average. This holds if our assumption that capital formation positively contributes to growth is valid. The series for high-tech exports, (authors only illustrate for Uganda) also exhibit an identical pattern with GDP per capita and gross capital formation. This further intimates to a likely linkage amongst the three variables used in the study analysis. High-tech exports, however, post lower values relative to capital formation over the years. This similar pattern in the series' movement over the period under investigation is reason enough to conduct additional and ultimately econometric inquiry regarding whether growth is impacted on by the other two variables. In Figure 2, the evolution of production in Uganda over the last three decades is illustrated.

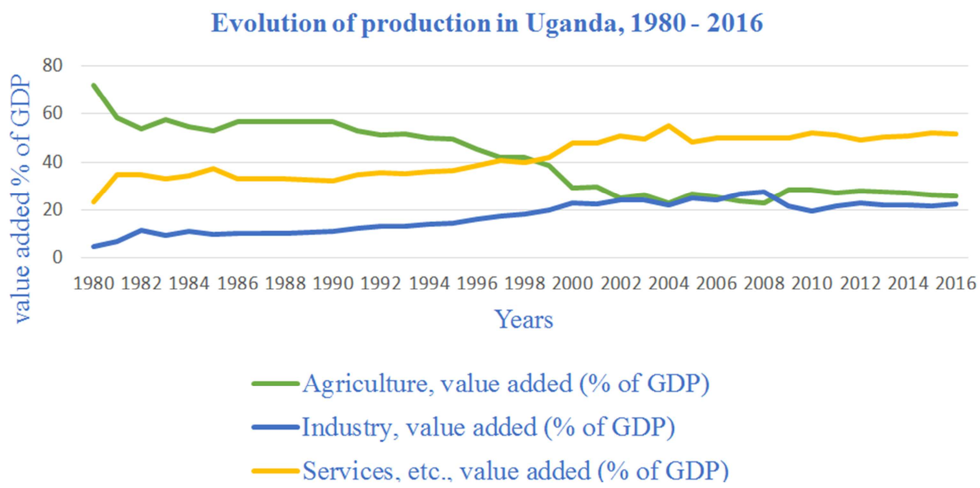
As Figure 2 indicates, Uganda has been a resource poor agrarian economy. At the start of the 1980s agriculture started taking a declining trend as the service and industrial sectors were slowly picking up. Before 1986, the agricultural sector, although on a declining trend, was the leading sector followed by the service sector. The liberalization policies of the early 1990s witnessed further decline of the agricultural sector and by 2000, the economy had become service sector led in terms of value added as a percentage of GDP. Meanwhile, continuous growth in the industrial sector surpassed growth contribution of the agricultural sector, only to fall below again between 2007 and 2009 probably due to the effects of the global financial crisis. Despite the above, growth in manufacturing has been evident and exports are expected to reach 16.5% of GDP by 2020 ([30], page 440). The agricultural sector alone targets to increase agricultural exports from \$1.3bn to \$4bn by 2020 ([30], page 157) and the trade subsector target is to increase the percentage of exports to GDP from 12.9% in 2012 to 16.5% by 2020.

In Figure 3, the authors show how Uganda's population has evolved over the last 30 years. This evolution is associated with serious implications for growth and probably the other two variables under study.

Uganda's population in 1960 was estimated to be 6.8 million people. Since then, however, the numbers have exploded to over 40 million people by 2017. This population explosion has been partly driven by its high growth rate of around 3.3%, one of the highest in the world. The fertility rate stands at 5.68 births per woman as of 2015. This massive population explosion has put pressure on the available resources. Its structure, composed of a considerable young and youthful segment, has come with challenges especially hyper unemployment. This means that growth must be in sectors that create more jobs and manufacturing presents the best opportunity. Technological advancements in the agricultural sector through value addition is also crucial, to take merit of the country's competitive advantage by exporting high value agricultural goods.

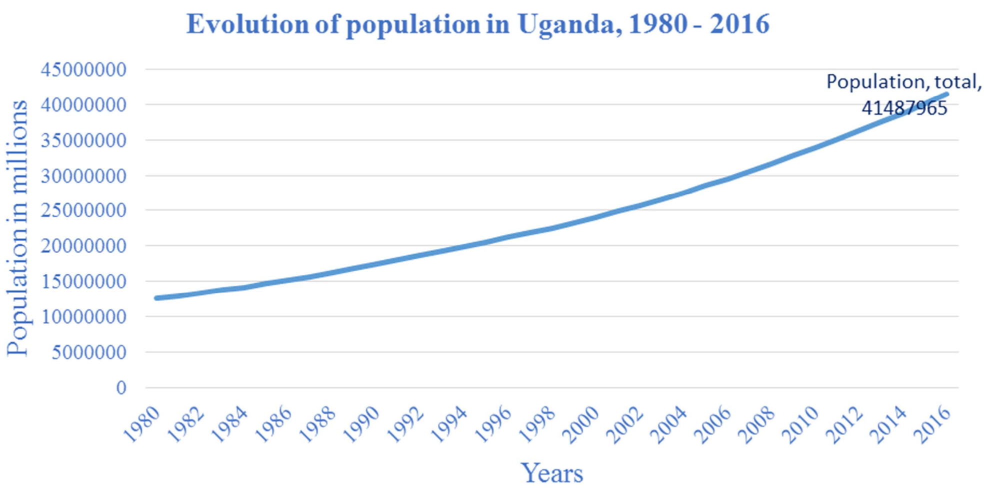
1 World Development Report (2000/01: pp 39)- attacking poverty, the World Bank

2 World Bank: Global Economic Prospects: Weak investment in Uncertain times: adapted from shttps://openknowledge.worldbank.org/bitstream/handle/10986/25823/9781464810169.pdf



Source: Authors' own illustration based on World Bank-WDI data for Uganda 1980-2016

Figure 2. *Evolution of production in Uganda 1980-2016.*



Source: Authors' own illustration based on World Bank-WDI data for Uganda 1986-2016

Figure 3. *Evolution of population in Uganda, 1980-2016.*

3. Data and Methodology

3.1. Data Description and Transformation

In order to investigate the effects of high technology exports and gross capital formation on economic growth in Uganda, the study utilizes data from the World Development Indicators (WDI) 2016 database of the World Bank. This data set contains, among others, series on GDP per capita, high technology exports in constant US dollars and gross capital formation. In our analysis, high technology exports are denoted as $hightec\_exp_t$, which is given in 2010 constant US dollars, GDP per capita as $gdppc_t$, which is also given in 2010 constant US dollars and gross capital formation as gcf_t, which is also given in 2010 constant US dollars. A log transformation on the variables is performed, which yields $lnhightec\_exp_t$, $lngdppc_t$, $lngcf_t$, respectively denoting the natural logs of high technology exports, GDP per capita and gross capital formation. The authors further compute the first differences of log transformed variables as; $\Delta lnhightec\_exp_t = (lnhightec\_exp_t - lnhightec\_exp_{t-1})$, $\Delta lngdppc_t = (lngdppc_t - lngdppc_{t-1})$, and $\Delta lngcf_t = (lngcf_t - lngcf_{t-1})$, which represent the annual rates of growth of the series respectively. The study uses annual time series data spanning from 1986-2016, that is 31 years. The choice of data was not based on arbitrary selection but rather guided by data availability.

3.2. Methodology Description

This study partly replicates the approach used in the modeling and Estimation of High-dimensional Vector Autoregressions in developing countries by [24]. Equation (1) predicts that economic growth in Uganda is determined by high tech-exports and gross capital formation. The general specification of the model is as follows;

$$gdppc_t = f(hightec\_exp_t, gcf_t, \varepsilon_t) \quad (1)$$

Empirically written as equation (2)

$$lngdppc_t = \beta_0 + \beta_1 lnhightec\_exp_t + \beta_2 lngcf_t + \varepsilon_t \quad (2)$$

Where, β_0 is the constant/intercept, β_1 and β_2 are the slope coefficients. $lngdppc_t$ is the measure of economic growth empirically proxied by Gross Domestic Product Per capita (GDPP). GDPP is gross domestic product relative to midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data used in the analysis are in 2010 constant U.S. dollars. High-technology exports ($lnhightec\_exp_t$) are products with high Research &Development intensity, such as in aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery. $lngcf_t$ denotes gross capital formation (formerly gross domestic investment) and ε_t is the stochastic error term that is assumed to be distributed with zero mean, μ_i and constant variance

$$\delta_i^2 \text{ that is to say } \varepsilon_t \to i \cdot i \cdot d(0, \delta_i^2) \quad (3)$$

Equation (2) above could be estimated by a simple Ordinary Least Squares (OLS) method. However, OLS assumes a single equation model where the dependent variable Y is explained by a set of independent variables. It is argued that most macroeconomic time series variables are endogenous, that is, they influence each other and with lags [25]. He also argues that the variables in the current period depend on the previous values hence macro-economic variables have to be modelled with lags. To surmount the above, this study estimates the effect of high tech-exports and gross capital formation on economic growth in Uganda using a Vector Auto Regressive technique (VAR).

As hinted on earlier, natural logarithms (ln) are taken for all the variables in order to normalize them, reduce the likely effect of outliers and obtain the rate of change of variables. The group of endogenous variables Y includes delete gross domestic product per capita (gdppc), high tech-exports (hightec_exp) and gross capital formation (gcf), These variables are assumed to influence each other with their own lags, lags of other endogenous variables, and current values of the exogenous variables. In this study, authors use a reduced-form of VAR model adopted but with some modifications from [24]. The model is specified as follows:

$$Y_t = A_0 + \sum_{i=1}^{k} A_t Y_{t-i} + \theta X_t + \varepsilon_t \quad (4)$$

Where Y_t and Y_{t-i} are both (jx1) column vectors with j as the number of endogenous variables, Y_t includes observations at time t and Y_{t-i} includes i-th lagged value of endogenous variables. A_0 denotes a (jx1) vector of intercept terms, while X_t indicates an (mx1) column vector of m exogenous variables. ε_t is a (jx1) vector of disturbance terms.

3.2.1. Estimation Procedure and Econometric Analysis

The first step involves preliminary analysis of the behavior of variables. In this endeavor, the study uses descriptive statistics. The authors also, among others, perform unit root tests on the variables, stability tests on the VAR model, and an LM test on VAR residuals.. Procedurally, these variable behavioral analyses are explained as follows;

3.2.2. Descriptive Statistics

These provide us with preliminary insights into the characteristic features of the series used in the analysis. These insights are achieved through use of measures of dispersion and central tendency. The authors also use graphical analysis to buffer up this behavioral analysis of variables.

3.2.3. Unit Roots Test

In order to assess whether variables are stationary, the authors perform unit root tests for all variables before running the model to avoid spurious regression as argued by one of the popular scholars, [26]. A variable is considered to be stationary if the null hypothesis of presence of a unit root is rejected. Random walk process is the major source of non-stationarity. Taking the first difference removes the usual types of trend-like behavior and makes variables stationary. The study uses the standard Augmented Dickey-Fuller (ADF) and the Philip Peron (PP) unit root test to examine the stationary properties for the long run relationship of the times series variables. The Augmented Dickey-Fuller (see Dickey and Fuller, 1979) test is based on the following equations:

$$\Delta y_t = \alpha_0 + \beta_t + \alpha_1 y_{t-1} + \sum_{j=1}^{k} d_j \Delta y_{t-j} + \varepsilon_t \quad (5)$$

Where: εt is the white noise error term, Δ is the first difference operator, y_t is the times series, α_0 is the intercept and k is the optimum number of lags of the dependent variable. Imposing the constraints that alpha and beta are equal to zero corresponds to modelling a random walk and using the constraint beta is equal to zero corresponds to modeling a random walk with a drift. The variable is said to be stationary if the value of the coefficient α_1 is less than the critical values from ADF table. The Philp Perron (see Phillips & Perron, 1988) unit root test equation is given as follows:

$$\Delta y_t = \alpha + \rho^* y_{t-1} + \varepsilon_t \quad (6)$$

The PP test is also based on t-statistics that is associated with estimated coefficients of ρ^* .In the literature, some conflicting evidence is available against the ADF and PP unit root tests.

3.2.4. Determination of Optimal Lag Length

In practice, when choosing the lag-length (the lag at which the residuals are free from serial correlation), econometricians want to reduce the number of lags as much as possible to get as simple a model as is possible, but at the same time analysts want enough lags to remove autocorrelation of the VAR residuals. In this study, authors choose the appropriate lag-length (ρ) of the VAR using the information criteria: Akaike information criterion (AIC), Schwarz Bayesian information criterion (SBC) and Hannan Quinn (HQ) information criteria. These criteria have the same basic formulation, i.e. derive from the log likelihood ratio (LR) function but penalize for the loss of degrees of freedom due to extra ρ lags to different degrees, hence, in practice, need not to select the same preferred model and often they do not.

A very detailed exposition of these frameworks is given by [27]. AIC asymptotically over estimates the order with positive probability, HQ estimates the order consistently and asymptotically, SBC is even more strongly consistent i.e., it selects a shorter lag than the other criteria hence the reason why, in applied work SBC is usually favored in choosing the appropriate order of VAR [28]. This notwithstanding, it is very important to note that the residuals from the estimated VAR should be well behaved, i.e., there should be no problems of autocorrelation. Therefore, the AIC, SBC or HQ may be good starting points for determining the lag-length of the VAR. In this study, authors use the LM test to check for residual autocorrelation.

3.2.5. VAR Residual Statistical Properties

It is also important, upon establishing the true order of VAR, to assess the suitability of the choice model in terms of a series of residual misspecification tests [29]. This study uses the residuals plots for the residual normality test. The idea with residual plots is to see if there are outlier observations and /or change in behavior over time. Such features, if detected, can be dealt with by taking appropriate modelling actions, to account for such outlier observations or mean shifts using the dummies particularly in the interest of preserving the degrees of freedom.

3.2.6. Stability of VAR/Roots of the Polynomial

Authors also check the stability of the VAR in this study. A lack of stability of the VAR means, certain results (such as impulse response standard errors) are not valid. In doing this procedure, there will be ($n \times p$) roots overall, where n is the number of endogenous variables and p is the particular lag length.

4. Empirical Results

The first stage of our analysis involves generating descriptive statistics and performing key tests regarding the behavioral properties of study variables. In Table 1, the descriptive statistics of the variables used in the analysis are given.

Table 1. *Descriptive statistics for the variables in logs and first differences.*

Variable	Statistics (N = 31)					
	Mean	**Median**	**st.dv**	**Min**	**Max**	**JB**
$lnhightec\_exp_t$	13.62	13.62	1.58	11.19	17.54	0.98 (0.61)
$\Delta lnhightec\_exp_t$	0.27	0.00	1.95	-4.31	5.28	
$lngdppc_t$	3.61	3.83	1.62	0.36	7.98	0.16 (0.92)
$\Delta lngdppc_t$	0.16	0.27	1.55	-4.83	4.50	
$lngcf_t$	18.96	19.37	2.10	14.42	23.11	1.00 (0.61)
$\Delta lngcf_t$	0.23	0.29	1.52	-4.63	4.43	

Source: Authors' own computations based on World Bank-WDI data 1986 - 2016

It is noticeable from Table 1, that on average, high technology exports have been posting positively promising values whereas GDP per capita has annually been posting relatively lower values compared to both gross capital formation and high technology exports. This is probably due to the annual increase in population, which reduces the ratio. Probably, it is also indicative of a likely mild effect of high technology exports and gross capital formation on economic growth in Uganda. Whether these preliminary postulations are accurate or otherwise is what authors seek to validate in our next stage of analysis. It is further noticeable that the median and mean values of the variables are approximately close to each other for all the variables. This approximate closeness indicates that the variables are normally distributed, at least fairly. Moreover, the Jarque-Berra (JB) test statistic reveals that, one cannot, at 5% level of significance, reject the hypothesis that the three series are normal. It should, however, be noted that the data set may also be subject to structural breaks, an issue the authors intend not to investigate in the scope of our current analysis. Structural breaks in Uganda's economy have been caused by a myriad of factors, whose discussion is beyond the scope of our analysis[3].

In Figure 5 in the appendices, the graphical illustrations of the series in both levels and first difference are given. A visual inspection of the panels in level for the three series shows that they are likely to be non-stationary. Use of non-stationary time series leads to spurious regression results, but only in a situation where a linear function of such series is stationary, in which case series are said to be cointegrated. However, it is noticeable that the panels for the series in first difference show features of stationarity. In order to confirm these graphical revelations, authors perform econometric unit root tests on the series. In this endeavor, the study employs both the Augmented Dickey Fuller (ADF) unit root test and Phillips & Perron (PP) unit root tests.

In Table 2, the results for the ADF and PP unit root tests on the variables are given. In this Table 2, the t-statistics and test results at a 5% significance level for both the Augmented Dickey Fuller test and Pillips-Perron test for variables in level are provided. These test results are generated with both

3 These have mainly been natural, political and external shocks and consequent policy re-orientations

intercept only and with intercept &trend. In the last column, the order of integration of the variables is provided. The order of integration reveals to us the status of the variable in terms presence or absence of a unit root. All the three series are integrated of order zero i.e. I(0), it is not imperative to difference them whatsoever since they are stationary in levels.

Table 2. *Unit root tests on variables in level with intercept and trend & intercept.*

Variable	Level-ADF		Level-PP		Level-ADF		Level-PP		Order of integration
	Intercept		Intercept		Intercept & Trend				
	t-stat	5%	t-stat	5%	t-stat	5%	t-stat	5%	
$lnhightec\_exp_t$	-3.38	-2.96	-3.27	-2.96	-3.98	-3.57	-3.62	-3.57	I (0)
$lngdppc_t$	-3.34	-2.96	-3.28	-2.96	-4.49	-3.57	-4.55	-3.57	I (0)
$lngcf_t$	-2.65	-2.96	-2.51	-2.96	-4.32	-3.57	-4.36	-3.57	I (0)

Source: Authors' own results based on World Bank-WDI data for Uganda 1986 - 2016

Results of unit root tests in Table 2 imply that it is not necessary to perform any differencing of the series before modelling. These tests rather provide assurance that the results from the analysis are reliably valid.

4.1. Vector Autoregressive Regression (VAR) and Lag Length Selection

Stationary test results in Table 2 and the order of integration, I(0), exhibited by the variables implies that there is no need for cointegration analysis as a method of establishing the effects of high-tech exports and gross capital formation on economic growth in Uganda. The authors therefore run a basic VAR model to establish the required causal relationships and to simulate shocks to the system and hence trace out the effects of such shocks on endogenous variables.

The authors determine the optimal lag length using information criteria as stated earlier. In Table 6 in the appendices, results of lag lengths by all the criteria are given. SB chooses 1 lag, AIC chooses 3 lags and HQ chooses 3. There is confusion on the optimal number of lags chosen as the selection criteria are based on different penalties. The SB is more superior and consistent than other criteria. What is important is to test for serial correlation in the residuals that is, the number of lags at which the residuals are free from serial correlation. The authors perform the Lagrange Multiplier (LM) test and in Table 7 in the appendices, the results based on the LM test are indicated. It is noticeable from the results, that any of the three lags is feasible since at all lags there is no serial correlation implying we fail to reject the null hypothesis. For purposes of preserving the degrees of freedom, the authors estimate a VAR (2) since at this lag length residuals are free from serial correlation.

The authors additionally test for residual heteroscedasticity to ascertain whether the residuals are free from the problem of heteroscedasticity. Table 8 in the appendices shows the results and the VAR residual heteroscedasticity tests with no cross terms indicates that the chi square value is 149.4978 with the probability of 0.2957. This means that we fail to reject the null hypothesis that residuals are not heteroscedastic and conclude that there is homoscedasticity in the residuals. In other words, the residuals exhibit a constant variance. After these vital tests, the authors run the VAR for further analysis.

In Table 3, the results for the VAR system are given. In order, each two equations constitute results in relation to the dependent variables, which are also logically ordered. The authors leave out results of each variable against itself and the diagnostic summary in the lower part of the table is associated with results for the first two equations i.e. where $lngdppc_t$ is the outcome variable. Additionally, only results based on two-lag length are presented.

Table 3. *Basic VAR results for $lngdppc_t$, $lnhightec\_exp_t$, and $lngcf_t$.*

Dependent Variables in order of equations: $lngdppc_t$, $lnhightec\_exp_t$, $lngcf_t$				
	Coefficient	**Std. Error**	**t-Statistic**	**Prob**
$lnhightec\_exp_t$	-1.628	2.148	-0.758	0.451
$lngcf_t$	-4.889	1.549	-3.157	0.002
$lngdppc_t$	-0.191	0.158	-1.209	0.231
$lngcf_t$	-0.187	0.152	-1.228	0.224
$lngdppc_t$	4.837	1.621	2.984	0.004
$lnhightec\_exp_t$	1.766	2.167	0.815	0.418

R-squared	0.653	Mean dependent var	3.824
Adjusted R-squared	0.558	S.D. dependent var	1.452
S.E. of regression	0.965	Sum squared resid	20.499
Durbin-Watson stat	1.503		

Source: Authors' own results based on World Bank-WDI data for Uganda 1986 - 2016

Referring to Table 3, it is noticeable that both high-tech exports and gross capital formation have negative effects on growth. However, it is only the effect of gross capital formation, which is significant at 1%. High-tech exports have an insignificant negative effect. It is also noticeable that $lngdppc_t$ has a positive and significant effect on gross capital formation at a level of 1%. Specifically, significant effects are noticed between $lngdppc_t$ and $lngcf_t$. It should be acknowledged, however, that it is cumbersome to attach economically sound interpretations on VAR results to make them relevant for policy recommendations. Indeed, the VAR results above paint only a faint picture of the relationships amongst the variables of interest. To gain more insightful conclusions, the authors technically turn to alternative means starting with testing the stability of the VAR model.

4.2. VAR Stability (V.S)

This involves checking the roots of the Polynomial of the VAR. If the VAR is not stable, then it implies that results of the impulse response in terms of standard errors are not valid and hence no solid conclusion can be based on them. V.S helps to test whether the VAR falls within the unit cycle. If a VAR is stable, none of the roots lies outside the unit circle then response standard errors are valid hence predications based on it can be made.

Table 4. *VAR Stability test.*

Roots of Characteristic Polynomial	
Endogenous variables : $lngdppc_t$ $lnhightec\_exp_t$ $lngcf_t$	
Exogenous variables: C	
Root	**Modulus**
0.947747	0.948
0.204996 - 0.554600i	0.591
0.204996 + 0.554600i	0.591
0.589818	0.890
-0.400954 - 0.317083i	0.511
-0.400954 + 0.317083i	0.511

No root lies outside the unit circle. VAR satisfies the stability condition
Source: Authors' own results based on World Bank-WDI data for Uganda 1986 – 2016

With reference to Table 4, it is evident that the total number of roots is six, indicative of the three endogenous variables and the lag length of two. Since all the moduli of the roots of the characteristic polynomial are less than one in magnitude, it implies that no root lies outside the unit circle hence VAR satisfies stability condition. This implies that impulse response functions can confidently be generated, as they are then reliable.

4.3. Impulse Response Functions (IRFs)

Table 5. *IRF analysis of $lngdppc_t$ against $lnhightec\_exp_t$ and $lngcf_t$.*

Horizon	$lnhightec\_exp_t$	$lngcf_t$	$lngdppc_t$
1	0.000	0.000	0.965
2	-0.297	-0.363	-0.092
3	-0.370	0.327	0.051
4	-0.152	-0.131	0.229
5	-0.008	0.033	0.036
6	0.007*	0.076*	0.029
7	-0.016*	0.064*	-0.018
8	-0.024**	0.087**	-0.015
9	-0.011**	0.066**	-0.004
10	-0.000**	0.067**	-0.011

Source: Authors' own results based on World Bank-WDI data for Uganda 1986 - 2016

IRFs are essential tools in empirical causal analysis and analysis of economic policy effectiveness. IRFs explain the response of endogenous variables to one of the innovations. These functions describe the evolution of the variables of interest over a specified period given a shock in a given moment. An IRF tracks the effect of a variable on other variables in the system i.e. the IRF traces the effects on present and future values of the endogenous variable ($lngdppc_t$) of a one standard deviation shock to one of the innovations ($lnhightec\_exp_t$ and $lngcf_t$). Given the difficulties associated with interpreting (with utmost economic sense) coefficients from the VAR system, in this study authors turn to the IRFs to attempt to trace out the likely effects of high technology exports and gross capital formation on economic growth. Table 5, shows the IRF results for gross domestic product per capita against the rest of the variables over a horizon of 10. In the third column, responses against itself are given.

Taking 0-5 as a short run horizon, it is noticeable that given a one standard deviation shock in high-tech exports, $lngdppc_t$ responds negatively almost throughout. The negative response is additionally insignificant. Suffice to note is that in period 5-10 (long run) $lngdppc_t$ is associated with still negative responses but the response is, on average, significant at 5% level. Besides this significant response from $lngdppc_t$, it is evident that the response on average takes on an increasing trend in this long run period. With reference to the IRF graphical illustration matrix in Figure 4, $panel_{12}$, buffers the result above. The graph in $panel_{12}$ shows that $lngdppc_t$ (blue line) is below the zero boundary up to period 5 but features an upward trend even when still below zero at least from period 3. Between period 4 and 5, $lngdppc_t$ hits the zero line, responding positively (blue line) in period 6 before reversing to negative values but on average at an increasing rate of response. This result shows that high technology exportation ($lnhightec\_exp_t$) has got an effect on economic growth ($lngdppc_t$) but the effect is not significantly positive in Uganda as it is in other countries around the world where numerous studies have empirically substantiated. The result further shows that there is a likely positive effect of high technology exportation on growth in Uganda in the long run if probably economic fundamentals are put in place. This result does not fundamentally contradict findings of other studies but lends justification to further empirical investigation of the question in our study as more high-tech data becomes available [5].

In Table 5 it is further evident that a one standard deviation shock in $lngcf_t$ elicits mixed responses from $lngdppc_t$ (blue line) in the short run period (1-5). However, after period 5, it is noticeable that $lngdppc_t$ responds positively and significantly. It is noticeable that from period 6, response on average is positive, significant and at an increasing rate. In the IRFs matrix, these results are corroborated by $panel_{13}$. This result buffers our conclusions from the VAR but above all, it echoes empirical findings from other studies for instance [9-10] and [17]. Albeit significant, the effect is still low, a probable pointer to exigent need for further economic reforms.

The role played by gross capital formation in spurring technology advances and hence growths in high-tech exports is manifested in $panel_{23}$. It is visible that a one standard deviation shock in gross capital formation elicits significantly positive response from high-tech exports (blue line) in both periods. This lends credence to our choice of variables, in which gross capital formation is thought to moderate the relationship between high-tech exports and economic growth.

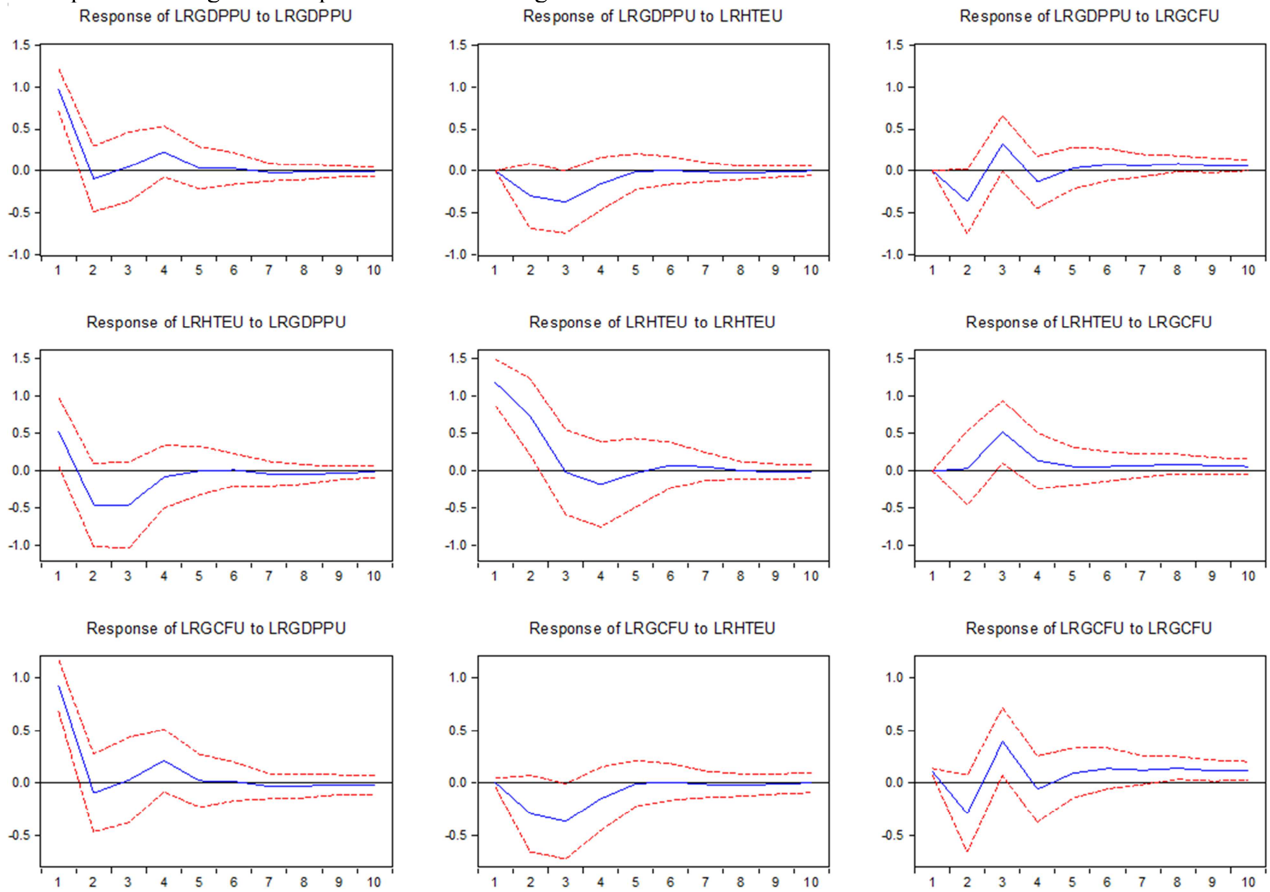


Figure 4. *Matrix of IRFs based on the VAR model.*

5. Conclusions and Policy Considerations

Right from the late 1980s, rigorous economic reforms have been undertaken in Uganda, most noted being the liberal market policies guided by the market economy policies associated with the Washington consensus. There is no doubt that, probably due to such policies, Uganda's economy has taken strides in terms of growth and poverty reduction. However, continued population explosion and recent increase in poverty levels make the need to strategize for sustainable growth and development very pertinent. Exportation has been globally proved to be one way to spur growth but evidence shows that it is even more effective once the exported goods are of higher value and not only quantities. Our empirical results indicate that the hypothesized effect of high-tech exports on growth is insignificant but increasing over time. This makes us to conclude on a likely positive and significant role of high-tech exports in spurring growth over time in Uganda. Gross capital formation is necessary for spurring exportation and growth too, although our VAR results show a significantly negative effect. The IRFs, however, confirm the likely opposite.

In terms of policy considerations, given the findings of the study, it is clear that government and policy makers need to consider more investments in research and development (R&D) coupled with human capital development to catalyze technology development and innovation. It is research and development that enables development of new heterogeneous products of high value whose exportation will then positively impact on economic growth and development. R & D can be undertaken in areas of new varieties of exports, improved quality and pest and disease resistant agricultural exports, medicines, among others.

Industrial manufacturing aimed at increasing exports holds the key to increased high-tech exports and policies should be considered to up the manufacturing sector. Current export volumes from Uganda and SSA in general are more of primary goods as opposed to manufacturing. This is confirmed in another study by [2]. Technology advances and innovation, which are vital drivers of high-tech export production, are more compatible with manufacturing industrialization. This calls for more investments in strategic infrastructure like energy and roads.

The current policy trend of developing and funding more of technical and vocational education is a step in the right direction. Technical education as opposed to other models of education has been lauded to be more catalyzing to light manufacturing and technology diffusions. The case of South Korea and other East Asian economies attest to this school of thought.

Appendix

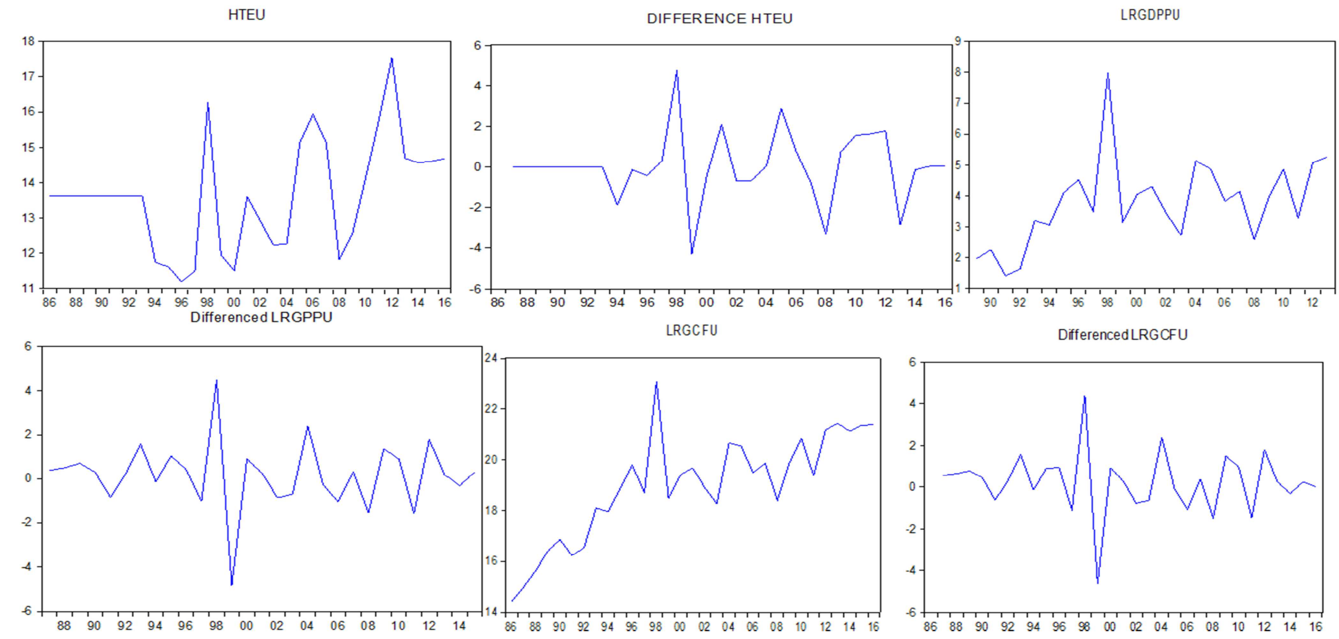


Figure 5. *Graphical representation of the series both in level and first difference.*

Table 6. *Determining the optimal lag length.*

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-109.697	NA	0.847	8.348	8.492	8.391
1	-61.773	81.648	0.048	5.465	6.041*	5.636
2	-49.630	17.990*	0.039	5.232	6.240	5.532
3	-37.031	15.865	0.032*	4.965*	6.405	5.393*
4	-30.095	7.1931	0.044	5.118	6.989	5.675

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table 7. *VAR Residual Serial Correlation LM Tests.*

Null Hypothesis: no serial correlation		
Lags	**LM-Stat**	**Prob**
1	7.670	0.568
2	6.709	0.667
3	11.617	0.236

Table 8. *VAR residual heteroscedasticity tests: No cross terms (only levels and squares).*

Joint test:		
Chi-sq	**df**	**Prob.**
149.498	144	0.360

Individual components:					
Dependent	**R-squared**	**F(24,2)**	**Prob.**	**Chi-sq(24)**	**Prob.**
res1*res1	0.901	0.761	0.712	24.335	0.443
res2*res2	0.891	0.680	0.750	24.053	0.459
res3*res3	0.907	0.816	0.689	24.499	0.433
res2*res1	0.815	0.367	0.914	22.009	0.579
res3*res1	0.905	0.796	0.697	24.440	0.437
res3*res2	0.824	0.389	0.902	22.241	0.565

References

[1] Ousmanou. N. (2018). Export market destination and performance: Firm-level evidence from Sub-Saharan Africa. Journal of African Trade 4 (2017) 1-19 Elsevier.

[2] Bbaale, E. and Mutenyo, J. (2011), “Export Composition and Economic Growth in Sub Saharan Africa: A Panel Analysis”. Consilience: The Journal of Sustainable Development. 6, 1–19.

[3] Ghatak, Subrata, and Stephen Wheatley Price. (1997), “Export Composition and Economic Growth: Cointegration and Causality Evidence for India” Review of World Economics, Vol. 133 (3), pp. 538–53.

[4] Cuaresma, J. C., & Wörz, J. (2005). On export composition and growth. Review of World Economics, 141(1), 33-49.

[5] Ayfer.U. and Ozgur.O.E.(2016). The effects of R&D and High Technology Exports on Economic Growth: A comparative cointegration analysis for Turkey and South Korea. The international conference on Euro-Asian Economies 2016.

[6] Lee, J. (2011). Export specialization and economic growth around the world. Economic Systems, 35(1), 45-63.

[7] Grancay, M., Grancay, N., Dudas T. (2015) “What You Export Matters: Does it Really?” Contemporary Economics, Vol. 9, No. 2, 233-244

[8] Oguz Demir (2018) Does High Tech Exports Really Matter for Economic Growth? Using a Panel Approach for Upper Middle-Income Economies, Online Academic Journal of Information Technology.

[9] Nweke G. Onyinye, Odo Stephen Idenyi and Anoke Charity Ifeyinwa (2017) aEffect of Capital Formation on Economic Growth in Nigeria, Asian Journal of Economics, Business and Accounting.

[10] Gulzar Ali (2015) Does Trade Openness has Noteworthy effect on Bilateral Trade Flows of E.C.O. Countries; an Empirical Investigation.

[11] Romer, P.M. (1986), Increasing return and long run growth. Journal of Political Economy, 94. 1002-1037.

[12] Lucas, R.E. (1988) “On the mechanics of economic development”, Journal of Monetary Economics, Vol. 22, No. 1, pp. 3–42, doi: 10.1016/0304-3932(88) 90168-7.

[13] Salvatore Capasso (2013). Endogenous information frictions, Stock market development and economic growth, University of Naples, ‘Parthenope’.

[14] Gani Azmat (2009) Technological Achievement, High Technology Exports and Growth Journal of Comparative International Management 2009, Vol.12,no.2,31-47.

[15] Mahjus Ekananda and Dion Jogi Parlinggoman (2017) The Role of High-Tech Exports and of foreign Direct Investments (FDI) on Economic Growth, European Research Studies Journal Volume XX, Issue 4A, 2017 pp. 194-212.

[16] Martin Falk (2007),High-tech exports and economic growth in industrialized,Austrian Institute of Economic Research (WIFO), P.O. Box 91, A-1103 Vienna, Applied Economics Letters, 2007, 1–4, First countries.

[17] Akinola Wilfred and Omolade Adeleke (2013) Savings, gross capital formation and economic growth nexus in Nigeria 1975-2008. IOSR Journal of Economics and Finance (IOSR-JEF)Volume 1, Issue 2 , PP 19-25. x.

[18] Abenga Kalaitzi. (2013). Exports and Economic Growth in the United Arab Emirates. Submitted to: RIBM Doctoral Symposium. Manchester Metropolitan University Business School.

[19] Pahlavani V. (2006). The role of capital Formation and Saving in Promoting Economic Growth in Iran. Department of Industrial Economics University of Sistan and Baluchescan.

[20] Ugwuegbe ,S. Uruakpa PC. (2013) The impact of capital Formation on the growth of Nigerian economy. Research Journal of Finance and Accounting.

[21] Rekha M. (2011) Short run and long run relationship between capital formation and Economic growth in India. International Journal of Management Technology (IJMT).

[22] Gbenga W, Akinola AO. (2013) Savings, gross capital formation and economic growth nexus in Nigeria. Journal of Economics and Finance. 2013.

[23] Eberechukwu Uneze (2013). The relation between capital formation and economic growth: evidence from sub-Saharan African countries, Journal of Economic Policy Reform, 16:3, 272-286, DOI: 10.1080/17487870.2013.799916.

[24] Tran Xuan (2018) Modeling and Estimation of High-dimensional Vector Autoregressions, university of west florida.

[25] Sims, C. (1980). Macroeconomics and Reality, Econometrica, 48(1), 1-48. https://doi.org/10.2307/1912017.

[26] Brooks (2008)Introductory Econometrics for Finance 2nd Edition.

[27] Juselius, K. (2006) The Cointegrated VAR Model: Methodology and Applications, Advanced Texts in Econometrics, Oxford University Press, Oxford.

[28] Bwire, T. J. O., & Anguyo, F. L. (2013). Exchange rate Pass-Through to Domestic Prices in Uganda: Evidence from a Structural Vector Auto-Regression (SVAR).

[29] Godfrey, L.G. (1988), Misspecification Tests in Econometrics. Cambridge:Cambridge University Press.

[30] Republic of Uganda. SECOND NATIONAL DEVELOPMENT PLAN 2015/16 –. 2019/20 (NDPII) Strengthening Uganda’s Competitiveness for Sustainable Wealth Creation, Employment and Inclusive Growth”.