Master thesis for the Master of Arts in Economics

AGRICULTURE – INDUSTRY SECTORS LINKAGE FOR GDP GROWTH IN ETHIOPIAN ECONOMY:

A Time Series Empirical Analysis, 1991-2016

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ANNEXURE B

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Project Work submitted to the Indira Gandi National Open University in partial fulfillment of the requirements for the award of the Degree – Master of Arts (Economics). I hereby declare that this work has done by me and has not been submitted elsewhere.

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CERTIFICATE

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Acronyms

ADF	Augmented Dickey Fuller
ADLI	Agriculture Development Led Industrialization
AIC	Akaike Information Criterion
CSA	Central statistics Agency
EPRDF	Ethiopian People Revolutionary Democracy Front
GDP	Gross Domestic Product
GTP	Growth and Transformation Plan
HQIC	Hannan-Quinn Information Criterion
IMF	International Monetary Fund
LAGRI	Log of Income for Agriculture Sector
LGDP	Log of Income for Gross Domestic Product
LINDU	Log of Income for Industry Sector
LL	Log Likelihood
LR	Likelihood Ratio test
LSERV	Log of Income for Service Sector
MOFED	Ministry of Finance and Economic Development
NBE	National Bank of Ethiopia
OLS	Ordinary Least Square
PASDEP	Plan for Accelerated and Sustained Development to End Poverty
PP	Phillips – Perron
SDPRP	Sustainable Development and Poverty Reduction Programs
SBIC	Schwartz Bayesian Information Criteria

VARM	Vector Autoregressive Model
VECM	Vector Error Correction Model
WB	World Bank
∆ LAGRI	Change in Log of Income for Agriculture Sector
∆ LGDP	Change in Log of Gross Domestic Product
∆ LINDU	Change in Log of Income for Industry Sector
∆ LSERV	Change in Log of Income for Service Sector

Abstract

The objective of this study is investigating the relationship (linkage) between agriculture and industry in the short and long run time dynamics. To conduct this paper, secondary time series data from World Bank (WB) Data-Base has taken in which the sample observation covers from 1991 to 2016. Before running the model, to understand the stationary property of time series data; graphical analysis method, and correlogram and Q statistics approach of stationary test is carried out. To further check the existence of unit root problem, Augmented Dickey – Fuller (ADF) and Phillip - Perron (PP) unit root test is done. The result of stationary test implies that, all variables are co-integrated at the same order, I(1) since all of them are non-stationary at a level but stationary after first difference.

To investigate the presence of long run long run relationship between variables, Johansen co-integration test (trace and max statistics) has employed. The result of this co-integration test shows that, there is at least one co-integrated vector. Hence, VEC is selected to run the model.

The empirical finding reveals there is one-way relationship between agriculture and industry both in the short and long run dynamics which goes from agriculture to industry. In the short run, agriculture impact industry positively but in the long run it has a negative causality during the sample period from 1991 to 2016.

CHAPTER ONE

I. Introduction

1.1. Background

Agriculture has a vital role for the provision of food, in supplying raw materials for small scale industries, for the creation of foreign currency, and source of employment for the rural people especially for underdeveloped states like Sub – Saharan African countries. In Mellor's (1999), theory of growth in agriculture and poverty reduction, the rapid expansion of agriculture causes to rise the income and demand of goods and services which can be produced by small scale enterprises in the context of underdeveloped states like Asian and African countries. The rise in effective demand through growth in agricultural incomes is the first step to ensure rapid growth of micro-enterprise. (John W. Mellor, 1999)

According to C. Timmer (1998), agriculture contributes development of agriculture assists for the expansion of industrialization through; taxation, the provision of surplus labor, saving for the creation of capital, foreign exchange abundance, and the fall in the price of agricultural output. An improved integration of agricultural product and factor market to the rest of the economy augments market for industrial products sources like: chemicals, fertilizer, improved tools and machineries which can increase the productivity of agricultural sector. (E. Wayne Nafziger, 2006)

In Lewis (1954), surplus labor in the agricultural sector characterized by zero (negligible) marginal productivity which can easily be transferred to the industry sector in unlimited quantity at the wage rate which is below its marginal productivity. It is due to the fixed quantity of capital in the agriculture sector that is land. The supply of surplus labor to the industry sector will continue till the marginal productivity of labor becomes equal in two sectors with no impact on the agricultural output and the employer can accrue high profit because of lower wage rate. The growth of output in the economy is determined by the speed of expansion in investment and capital accumulation in the industry sector. It is possible because excess of modern sector profit assuming that all the profit is reinvested in the industry sector.

Indeed, the expansion in the capitalist sector must precede or accompanied by the growth in agriculture. As long capitalists produce no food, its expansion increase demand for food which can cause for the rise in price and in-turn it reduces profit in the industry sector. It is one reason industrialization depend on agricultural improvement. It is not profitable producing a growing volume of manufacturing unless production in agricultural sector grows simultaneously. It is why both sectors must grow together and stagnant agricultural growth doesn't mean that industrial development. (P.Todaro, C.Smith, 2012)

In literature the linkage between sectors are different in respect to economic policy (macro and sectoral polices), resource base, and human and natural factors. For example, according to Vijay Subramarniam (2010); the growth of industry sector has a long run positive role for agriculture in Poland while agriculture is negatively affected by the growth of industry in long run in Romania. In Hungary, agriculture and industry have a positive and balanced growth relationship whereas in Bulgaria agriculture suffered from a lack of forward and back ward linkage between agriculture and industry in long run.

In light of the above and other similar economic growth and development literature, the current regime of Ethiopia has formulated and implemented a medium term poverty reduction and economic development programs, policies and strategies at different times such as: Sustainable Development and Poverty Reduction Programs (SDPRP) which run from fiscal year 2002/03 to 2004/05, Plan for Accelerated and Sustained Development to End Poverty (PASDEP) which had implemented in the fiscal years between 2005/06 to 2009/10, and Growth and Transformation Plan having phases in five year term started in 2011 and intended to continues to fiscal year 2030/31. In all these development strategies and programs; the integration and interdependence between sectors especially agriculture and industry has been given a huge focus. (MOFED, 2010)

Therefore, empirical study on Agriculture – industry sectors linkage for GDP growth in Ethiopian economy context is important.

1.2. Statement of the Problem

Since Ethiopian People Revolutionary Democracy Front (EPRDF) government come to power in 1991, to alleviate the country's deep rooted and pervasive poverty, the regime has implemented different economic policies, strategies, plans and programs in medium and long term bases.

Currently, the government has implemented a long run Growth and Transformation Plan (GTP) which runs from the fiscal year (2010/11 – 2030/31) having four phases in five year terms. Economic sector wise, GTP is guided by a specific country's vision: "building an economy which has a modern and productive agricultural sector with enhanced technology and an industrial sector that plays a leading role in the economy, sustaining economic development and securing social justice and increasing per capita income of the citizens so as to reach the level of those in middle-income countries." (MOFED, 2010)
GTP is implemented by maintaining agriculture as main sources of food security, to curb inflationary pressure on agricultural products, earning for foreign exchange and as spring board for the expansion of industry in long run by supplying adequate inputs and market, and for the structural transformation of the economy. Besides, GTP paper has taken into consideration the assessment of the previous SDPRP (2001/02 – 2004/05), and PASDEP (2005/06 – 2010) programs achievement. During these, the major constraint to generate the demanded foreign

exchange and in creating job opportunities for the growing labor force was the countries narrow industry base. In GTP period, to absorb the surplus labor force, for the expansion of urban development and to give a close support and scaling up agricultural productivity it is expected that the industry sector plays a role and it can be achieved by giving support to strengthen the vertical and horizontal linkages between agriculture and industry sector. (MOFED, 2010)

Even before GTP implementation, the linkage between sectors especially agriculture – industry linkage had given emphasis. For example, in SDPRP the forward and backward (demand and supply) linkage between two sector had been the basic principle for adopting and implementing this economic development program. (MOFED, 2002, p.37)

Furthermore, in PASDEP the linkage between these sectors had expected to play a key role to accelerate economic development, socio-economic transformation, and for the expansion of service sector. (MOFED, 2006, p.149-150)

In the study of Steven A. Block; agriculture and industry sector have weak linkage in Ethiopia. A $ 1 income shock in the agriculture sector generates $0.2 income in traditional and modern industry together. Whereas $ 1 income shock in the modern industry can only generates $0.04 for the agriculture income which is least benefited from the other sector from the change in income in the modern industry. And he stated the modern industry sector the most 'selfish' sector relative to other sectors. This sector contributes a far smaller share of net benefits for the other sector.

Furthermore, the traditional industry sector contributes $0.04 income (3% of the total benefit) for the 86% of Ethiopia's labor force in agriculture sector from $1 income shock. He added, *("--- the traditional industry lack forward linkage through which the output of traditional industry becomes the input for other sector. The macroeconomic impact of traditional industry is limited largely to consumption effects of laborers in this sector as well as to the increased factor demand for certain modern sectors output such as electricity and construction.")(Steven A. Block, 1999, p.247 -252)*

Even though, there is no enough empirical literature on the linkage between these two major productive economic sectors, the assessment of the country's economic policies, strategies and programs showed that the structural transformation of the economy from the primary sector to the secondary sector is very gradual.

Reports on SDPRP and PASDEP implied, the narrow industrial base and a weak link between agriculture and industry sector are the constraint for foreign exchange generation, for job opportunities and for the transformation of the economy. In the same manner, in the first phase of GTP the growth and GDP share (4.8%) of the manufacturing sector which is expected to be the engine of structural transformation has lagged behind the target and is below the Sub – Saharan African average.

The traditional, narrow based and the slow growth of industry sector consequently is now struggling to create enough job opportunities for the existing labor force in rural and urban areas, to meet demand for consumption and production from agriculture sector. Indeed, it in-turn causes for the slow growth of the overall economy and gradual structural transformation.

By the end of GTP1(2014/02015) period, from the share of the county's GDP, agriculture and allied activities takes 38.5%, industry 15.1% (manufacturing only 4.8%) and service 46.3%. Agriculture showed a decline in terms of GDP percentage share and service sector grows above the target but industry sector has performed under the target especially the manufacturing sub-sector. The under-performance of industry sector and the increased growth of the service sector indicate that the structural shift is not as yet, expected and desired direction. This assessment in addition shows that, more that 23.6 million (23.4% of the population) people are under poverty line which is below the MDG target.

This empirical study is done on the linkage between two major economic sectors can be one way to investigate the reason on the gradual structural transformation of the economy or on the under-achievement of the economic policies, strategies, plans and programs employed over years in the country. This paper tried to answer the question; really is there significant linkage between agriculture and industry sector in the GDP growth of Ethiopian economy in value added terms over the past three decades?

In investigating this research question, to avoid false relationship between variables which is mainly occurred in the OLS method of estimation, Unrestricted Vector Autoregressive (VAR) or Vector Error Correction Model (VECM) is selected in which all variables are endogenous or lagged endogenous. To test stationary property of the variables specified in the model, graph analysis method, sample correlogram, Augmented Dickey Fuller (ADF) and Phillips – Perron (PP) unit root tests are carried out. To determine the long run relationship (co-integration) between variables Johansen's co integration test is applied. Since there is a long run relationship between variables, Vector Error Correction (VEC) method is applied to run the model. The data analysis is carried out using STATA software package.

1.2. Objectives of the Study

1.3.1. General Objective of the Study

The general objectives of this paper are investigating the linkage between agriculture and industry sector in the economy in value added terms.

1.3.2. Specific Objectives of the Study

Specific objectives of this study are:

1. To understand the income growth linkages between the agricultural and industry sectors in the economy.
2. To identify the existence of long-run income growth relationships between industry and agriculture sectors in the economy.
3. To understand the dynamics of short-run income growth relationship between agriculture and industry sectors during the sample period.

1.3. Questions of the Research

This paper mainly tried to answer: first, the strength of income growth relationship between agriculture and industry sector in Ethiopia. Second, the short run income growth relationship between agriculture and industry. Third, long run income growth relationship between agriculture and industry. Fourth, the direction of causality between two sectors. Fifth, determine the sign of relationship in the income growth between these two sectors are either positive or negative in short run and long run.

1.4. Hypothesis

By making Ethiopian structural transformation strategies; Sustainable Development and Poverty Reduction Programs (SDPRP), Plan for Accelerated and Sustained Development to End Poverty (PASDEP), Growth and Transformation Plan I & II, the economic growth survey reports of the country, and literatures done on the economic transition of the country as a theoretical departure; the study has done based on the following hypothesizes which has formulated to guide the empirical analysis of the study.

1. *The income growth of agriculture sector in value added terms has a positive impact on the income growth of industry sector both in short run and long run.*
2. *The income growth of industry sector in value added terms has a positive impact on the income growth of agriculture sector both in short run and long run.*

1.5. Scope of the study

The paper mainly focuses on investigating the relationship between agriculture and industry sector in Ethiopian economy context the time ranges from 1990 to 2016 years i.e. since Ethiopian People Revolutionary Democracy Front (EPRDF) government has come to power.

1.6. Significance of the Study

As stated above in the statement of the problem, the government of Ethiopia has implemented different economic development policies, programs and strategies on medium and long run bases to achieve food security and transform the country from primary sector based economic system to secondary economic system (industrialization) by creating a favorable condition for the interdependence or inter-linkage between agriculture and industry sectors. In the interdependence economic system investment in once sector can contribute a significant benefit for the other sectors. Hence, if there is a strong linkage between agriculture and industry in Ethiopia, any change in agriculture can affect industry negatively or positively at significant amount and Vis versa.

So that empirical studies on the linkage between two sectors can be a source for policy makers and researchers for the evaluation of macroeconomic and sectoral policies and strategies, and to identify priorities for the growth and development of the country. It also will serve as a reference for further studies.

CHAPTER TWO

I. Review of Related Literature

1.1. The Role of Agriculture in Transforming the Economy

In less developed countries at the beginning of the drive for economic development, the role of agricultural sector in the transformation of the economy can be seen into two distinct resource transfer base which are dynamic and static views according to Reynolds (1975. (1) In stagnant agricultural sector of the economy, the sector contains the potential to release; labor, output for food and the saving capacity which can be released through appropriate economic policies can be termed as static role of agriculture. But in different way the active role of agricultural sector which is supported by technology and technical progress, by which a part of resource transfer from the rise in output and income available for the non-agriculture sector of the economy can be termed as the dynamic role of agriculture. (P.Timmer, 1988)

A statistical survey conducted by World Bank (1982, pp.44 - 45), on the link between agricultural sector and overall economic growth for the economy of less developed countries and have reached the following conclusion:-

"The parallels between agricultural and GDP growth suggests that the factors which affects agricultural performance may be linked to economy – wide social and economic policies --- expanding agricultural production through technological change and trade creates important demands for the outputs of other sectors, notably fertilizers, transportation, commercial services, and construction. At the same time, agricultural households are often the basic market for a wide range of consumer goods that loom large in the early stages of industrial development; Textiles and clothing, processed foods, kerosene and vegetable oil, aluminum hollowware, radios, bicycles, and construction materials for home improvements." (P.Timmer, 1988)

In the Lewis – Fei – Ranis model, in less developed countries economic growth occurs because of the expansion in the size of industrial sector which can accumulates capital relative to the subsistence agriculture sectors in which capital accumulation is almost impossible. The accumulation of capital is from surplus labor supply from the agricultural sector in unlimited amount as the wages paid for workers are low. (E. Wayne Nafziger, 2006)

Fei and Ranis believe their model applies to Japan from 1888 to 1930. But actually unlike Lewis assumption the marginal productivity of labor in agricultural sector during this period was always positive. On the other hand, low industrial wage and high profit, increased business saving, labor intensive manufactured competitiveness was consistent with the model. Moreover, labor supply elasticity of demand was high although not infinite with a perfect horizontal supply curve as in Lewis – Fei – Ranis assumption. (E. Wayne Nafziger, 2006)

Further, Lewis – Fei – Ranis theory for Chinese economy tested for the period 1965- 2002, and it is founded that the reallocation of labor from agriculture to other sectors had a positive contribution to the economy. But there were a continual existence of disguised unemployment in the agriculture sector. (Marco G. Ercolani, Zheng Wei, 2010)

2.1.1. The Dynamic Role of Agriculture for Economic Growth

According to Timmer (1998) in less developed countries growth in income from farm augment's the market for industrial products and contributes much for economic growth through the linkage between agriculture and the rest of economic sectors."--- agriculture contributes to economic growth through domestic and export surpluses that can be tapped for industrial development through taxation, foreign exchange abundance, outflows of capital and labor, and falling farm prices. As agricultural product and factor markets become better integrated by links with the rest of the economy, farm income expansion augments the market for industrial products. Some less developed countries squeeze agriculture in early stages of modernization, hoping to skip a stage in transforming the economy, a strategy virtually doomed to failure." (E. Wayne Nafziger, 2006)

In Johnson and Mellor (1961), agriculture stimulates the economy in the early stage of development through supply and demand linkage in the goods market, by the creation of saving and release of labor to rest of economic sectors. Aggressive investment on this sector can reduce poverty, increase food production and stimulates the growth of other sector the economy which fosters economic and political stability and in turn attracts domestic and foreign investment.

For P.Timmer (1993), no poor country those worked in favor of the agriculture sector deemed to fail in promoting economic growth and to reduce poverty since overvaluing the agriculture sector is the best way to alleviate poverty for which much of their people are under absolute poverty. But by contrast nearly all countries those formulated policies and strategies which "undervalued" agriculture sector missed their dividend and fail to grow rapidly in their early stage of development.

Among the classical as long as the capitalist sector produces no food, expansion of the sector increase the demand for agricultural products which in turn increases food prices. This can reduce the profitability of industrial sector through an increase in real wage, if not the agricultural production increase simultaneously with the growing industry sector. It is one of the reason industrialization depends on agriculture. Japan's rapid economic growth from 1968 to 1914 had gone through the research based green revolution in rice, low food prices, and low real wages implied that industrialization had accompanied by rapid growth in agriculture sector. (P.Timmer, 1988)

For the economy of Vietnam according to Timmer (1998), ignoring the role of agriculture and extracting resources from this stagnant sector almost always create a wide spread poverty and even sometimes famine. Connecting a market linkage between agriculture with industry and service sector have the potential to create more opportunities than they destroy if they grow together. But in addition to market link it needs a substantial government investment in rural infrastructure and price incentive for agricultural products.

2.1.2. Agriculture as a Static Potential for Economic Growth

In neoclassical view, agriculture was declining sector which potentially contributed for supply of labor, food and perhaps capital to the essential modernization of industry, but no policy effort could be applied in behalf of agriculture's own as it is a naturally declining sector. Even the interpretation of Lewis model (1954), especially Fei – Ranis version (1964) which becomes the main teaching paradigm had ignored the factor needed, to modernize traditional agriculture but it illustrates the positive contribution on the role of development on the rest of the economy. (E. Wayne Nafziger, 2006)

In addition, in the declining term of trade for primary products Prebisch (1950) and the unbalanced economic growth model view of Hirschman (1958) agriculture doesn't have direct through linkage as the industries sectors does the greatest all they advocates investment on industry sector at the expense of agriculture at the early stage of development. (E. Wayne Nafziger, 2006)

1.1. Agriculture – Industry Linkages

Hirschman in his theory of unbalanced growth, backward and forward inter-industry linkage needed for economic development and agriculture can't significantly support for the establishment of new activities through direct linkage. Hence, industry sector is a loving sector for economic development in low income countries. To him, agriculture can't be a leading sector because of the failure in the creation of induced capital. (E. Wayne Nafziger, 2006)

Contrary to the above development theories, Kuznets (1968) well balanced development strategy, by transforming agriculture (increase agriculture productivity) by support of technological advancement from the result of industrializing economy concomitant with the development of industry sector. In the economic development process of low income countries, according to Kalecki (1960) the development of agricultural sector is a prerequisite for industrialization. (E. Wayne Nafziger, 2006)

In many theoretical and empirical literature, the linkage between agriculture and industry sector is different based on macro policies (sectoral and macro policies), resource base, and other human and natural factors. In that context according to Mirza Md. Moyen Uddin (2015), the causal relationship between industry and agriculture in the economy of Bangladesh from the year

1980-2013 recognizes that the two sectors have a bidirectional relationship which implies the sectors influences on each other for the growth of Bangladesh GDP.

While the research work on the economy of Jammu and Kashmir India in the years 1999 – 2012 shows that the linkage between industry and agriculture are weak. The change in the agriculture sector has an impact on the industry sector but the change in the industry sector has no effect on the agriculture sector. The weak link between these sectors slows the growth in both sectors in addition it causes for the slow growth of the overall growth of the economy in those states. (Samir – UI – Hassan, Kanhaiya Ahuja and Munasir Hussain, 2015)

In the Easter European countries, a research work by Vijayaratnam, Subramaniam (2010) after the liberalization of their economic policy imply that linkages between sectors among countries are different. For instance, the industry sector had a positive role on agriculture sector and also there exists a strong forward and backward linkage between these two sectors in Poland economy. While in Romania the agriculture sector was negatively affected by the increase in the industry sector but positively affected by the growing service sector. Whereas, for the economy of Bulgaria in long run the agriculture sector was affected by lack of forward and backward linkages between the agriculture and industry sectors. On the other hand, during the sample period after communism the long run relationship showed that the industry and service sector had a balanced contribution for the growth of agriculture sector for Hungarian economy.

Steven A. Block (1999) in his research work on Agriculture and economic growth in Ethiopia: growth multipliers from a four-sector simulation model, the result showed that a $1 income change in the agriculture sector can generate $0.24 income in the service sector while $ 0.11 income in the traditional industry sector and $0.09 income in the modern industry sector.

A $1 shock in the modern industry sector can generate $0.04 (income in the agriculture sector which is the least benefited sector from the shock in relative to other sectors (and only 3% of the gross benefit). In Block's the modern industry is the most 'selfish' sector in the economy of Ethiopia which retains 81% of the gross benefit of the shock and the other sector benefits the far smaller amount from the shock in the modern industry sector. In the same manner, from $1 income shock in the traditional industry sector the agriculture sector can only indirectly gain $0.04 which is the least. In addition, according to Block the traditional industry lacks the forward linkage in which the output of the sector becomes the input of the other sector and the macroeconomic impact of the sector is limited within itself.

The above stated literature shows the glimpse of the growing theoretical and empirical literature on sectoral economic development in general and agriculture - industry sectors linkage in particular. Moreover, it implies that the linkages between sectors are different from country to country even from time to time. In this regard it is intended that research study on the inter linkage between agriculture – industry in the context of Ethiopian economy is important as long the main economic base of the county are these two sectors in terms of the contribution of GDP and employment.

2.3. Ethiopian Policies and Strategies on Sectoral Linkages since 1991

Ethiopia: Sustainable Development and Poverty Reduction Program (SDPRP) which had implemented from the year 2003 to 2005 stated that; to realize rapid and accelerated growth, integration and coordination between sectors are necessary to tape the benefits of opportunities from sectors. Without the support and complementarily between sectors it is impossible to register sustainable development and food security. Thus, agriculture must closely linked with secondary and tertiary sectors such as; industry, trade, finance, and social development. (MOFED, 2002)

A Plan for Accelerated and Sustained Development to End Poverty (PASDEP) from 2006 to 2010 similarly had given an emphasis for sectoral linkages for which agriculture had aimed to play a major role to supply raw material to the industry sector and to create a demand for the output of industry. Furthermore, this sector had expected to serve as a means for the imported necessary inputs like; machinery, and raw material for industry. This growth and development strategy paper further elaborates that, the linkage between agriculture and industry can provide the opportunity for the expansion of service sector. (MOFED, 2006)

In the current ongoing long term growth and development strategic plan which has implemented since 2011i.e. Growth and Transformation Plan (GTP); agriculture expected to shift to a high level to achieve food security, to curb the inflationary pressure on agricultural products, and to broaden the export base of the country. Besides, this sector could be a spring board for the structural transformation in the long run by sufficient delivery of industrial inputs.

During this period, the appropriate support has expected to strengthen the vertical and horizontal linkage between agriculture and industry. Industry sector expected to closely support agriculture, create enough employment opportunities for the growing labor force, and to be a foundation for the expansion of urban development by strengthening micro and small scale manufacturing enterprises which could be a corner stone for the establishment and expansion of medium and large scale industries. (MOFED, 2010)

From these economic development policies and strategies perspective, empirical assessment of linkage between agriculture and industry in short and long term dynamics seen as an important topic as if these sectors could be the key driver to achieve food security, for the structural transformation of the economy, and for the overall growth and development of the country’s economy from the above mentioned empirical and theoretical economic development literatures point of view.

CHAPTER THREE

III. Data and Methodology

3.1. Data Collection

All the time serious data is collected from World Bank (WB) data base covering from 1990 – 2016 valued in terms of US dollar. The data are in value added terms taking 2010 base year price and transformed to log function for easy interpretation of elasticities among variables. Agriculture sector include; crop production, livestock and livestock production, forestry, fishing but manufacturing, leather and textile, construction, and mining are categorized under industry sector while service sector incorporates; trade, transport, communication, tourism and other service deliveries.

3.2. Specification of the Model

In these models, four variables are incorporated GDP, agriculture, industry, and service sector all of which are determinant in the specification of the model as long they are theoretical interdependent macro variables. To avoid the spurious relationship among variables which commonly occurs in OLS model, Restricted Vector Autoregressive (VAR) model or Vector Error Correction (VEC) model is employed to make all variables endogenous or lagged endogenous since there exists co-integration among variables.

Though the main objective of the study is investigating the dynamic relationship between two sector linkages (agriculture – industry) in short and long run, four models are specified as long from which two target models can be extracted. Hence, for the analysis of this empirical work the following model are represented.

$$GDP_t = \alpha_{10} + \beta_{11}GDP_{t-1} + \beta_{12}IND_{t-1} + \beta_{13}SERV_{t-1} + \beta_{14}AGRI_{t-1} + \varepsilon_{1,t} \text{ ---------- } (1)$$

$$AGRI_t = \alpha_{20} + \beta_{21}GDP_{t-1} + \beta_{22}IND_{t-1} + \beta_{23}SERV_{t-1} + \beta_{24}AGRI_{t-1} + \varepsilon_{2,t} \text{ --------- } (2)$$

$$IND_t = \alpha_{30} + \beta_{31}GDP_{t-1} + \beta_{32}AGRI_{t-1} + \beta_{33}SERV_{t-1} + \beta_{34}IND_{t-1} + \varepsilon_{3,t} \text{ -------- } (3)$$

$$SERV_t = \alpha_{40} + \beta_{41}GDP_{t-1} + \beta_{42}AGRI_{t-1} + \beta_{43}SERV_{t-1} + \beta_{44}IND_{t-1} + \varepsilon_{4,t} \text{ ------- } (4)$$

Where GDP = Real Gross Domestic Product, AGRI = income of value added in agriculture sector to real GDP, IND = income of value added in industry sector to real GDP, SERV = income of value added in services sector to real GDP, α_{10}, α_{20}, α_{30} and α_{40} are intercepts, all β values are coefficients and $\varepsilon_{1,t}$, $\varepsilon_{2,t}$,$\varepsilon_{3,t}$ and $\varepsilon_{4,t}$ represent error terms and $_{t-1s'}$ shows time lag. It is assumed that GDP_t, $AGRI_t$ and IND_t, $SERV_t$ are endogenous variables the rest; GDP_{t-1}, IND_{t-1}, $AGRI_{t-1}$, $SERV_{t-1}$ are exogenous variables. (Gujarati, 2003)

3.3. Stationary Test

In the analysis of time series data one thing that needs a great attention and security for researchers and practitioners is stochastic stationary property of data. The common assumption on such type of data is; it has stationary property.

The stochastic time series data is stationary means that its mean, variance and auto covariance (at various lags) are not changed over time. In other words they are time invariant. In such cases a time series data will tend to its mean after a shock and its fluctuation is measured by its variance having constant magnitude. But if the stochastic time series data is not stationary mean it has a time varying mean or a time varying variance or both.

The importance of stationary test in a time series data is; it is impossible to generalize if a data is not stationary to forecast future results. Hence, an empirical analysis will have a less practical value. For this reason, different method of stationary test is employed like graphical analysis, autocorrelation function, and correlogram, Dickey Fuller (DF) unit root test, Augmented Dickey – Fuller (ADF) test, and Phillips - Perron (PP) are usually applied. (Gujarati, 2003)

3.3.1. Unit Root Test

In the empirical estimation of time series data, analysis's often encounters a problem of non-stationary. The example of such model is Random Walk Model (RWM). This model have two types; 1) Random Walk without drift (i.e. with no constant or intercept term) 2) Random Walk with drift (with constant or intercept term).

Mathematically this model represented as;

Random Walk without drift: - suppose that u_t is a white noise error term having a zero mean and variance δ^2. The time series is random walk if it has the following form;

$Y_t = Y_{t-1} + u_t$ ------------------- (1)

This implies that y at a time t is equal to its value at time (t-1) plus error term.

Random Walk with drift (with constant or intercept term):- by modifying eq.(1),

$Y_t = \delta + Y_{t-1} + u_t$ --------------------- *(2)*

Where δ is known as the drift parameter and in this case we can write this equation as:-

$Y_t - Y_{t-1} = \Delta Y_t = \delta + u_t$ ---------------- *(3)*

It shows that Y_t drifts upward or downward depends on the sign of δ.

For the discussion of unit root problem we can write eq. (1) as;

$Y_t = \rho Y_{t-1} + u_t$ ----------------------- *(4)* $\quad -1 \leq \rho \leq 1$

If *$\rho=1$, there exists a problem of unit root in eq. (4) for which the Random Walk Model is non stationary having a time varying variance. While $\rho<1$, the equation is stationary.*

Eq. (4) again can be written as below by subtracting $Yt-1$ from both sides:-

$Y_t - Y_{t-1} = \Delta Y_t = \rho Y_{t-1} - Y_{t-1} + u_t$

$\Delta Y_t = (\rho - 1)\, Y_{t-1} + u_t$ --------------- *(5) or,*

$\Delta Y_t = \delta Y_{t-1} + u_t$ --------------------- *(6)*

Where $\delta = (\rho - 1)$, *and* Δ are the first difference operator.

In practice instead of estimating eq.(4), we estimate eq.(6), and test the null hypothesis that δ = 0, then *$\rho=1$ that is a problem of unit root, meaning that the time series is non stationary.*

From eq. (6) if δ = 0, then it becomes;

$\Delta Y_t = (Y_t - Y_{t-1}) = u_t$ -------------- *(7)*

The null hypothesis that δ = 0, the estimated t statistics to the coefficients of Y_{t-1} in eq. (6) follows Tau statistic in Dickey – Fuller (DF) test. Tau statistic or test known as Dickey – Fuller test in the name of its discoverers in which the hypothesis that δ = 0, is rejected when the time series is stationary at which we can use t statistics.

In Dickey – Fuller (DF) test, there are procedures in which a random walk process may have a drift, may have not a drift or it may have both deterministic and stochastic trends. The (DF) test is estimated at different forms under three null hypotheses.

Y_t is a random walk: $\Delta Y_t = \delta Y_{t-1} + u_t$ --------- *(6)*

Y_t is a random walk with drift: $\Delta Y_t = \beta_1 + \delta Y_{t-1} + u_t$ ---------------- *(8)*

Y_t is a random walk with drift around a stochastic trend; $\Delta Y_t = \beta_1 + \beta_{2t} + \delta Y_{t-1} + u_t$ ---------- *(9)*

Where t is the time or trend variable. In all cases the null hypothesis is $\delta = 0$ i.e. there is a unit root or the time series is not stationary. While the alternative hypothesis is δ less than zero i.e. the time series is stationary.

If the null hypothesis is rejected, the time series is stationary with zero mean in case of eq.(6), stationary with non-zero mean [$= \beta 1/(1- \rho)$] for eq. (8), and stationary around deterministic trend in case of eq. (9). (Gujarati, 2003)

3.3.1.1. The Augmented Dickey Fuller (ADF) Test

In the mentioned above eq. (6,8,9) the error term u_t is assumed uncorrelated, but if it is correlated Dickey – Fuller developed a test called Augmented Dickey Fuller (ADF) test by adding a lagged values of dependent variable ΔY_t in the equation.

If we use the eq. (6), the ADF test will have the following forms;

$$\Delta Y_t = \beta_1 + \beta_{2t} + \delta Y_{t-1} + \sum_{i=1}^{m} \alpha i \Delta Yt - 1 + \varepsilon t --------(10)$$

Where εt is pure white noise error term and $\Delta Y_{t-1} = (Y_{t-1} - Y_{t-2})$, $\Delta Y_{t-2} = (Y_{t-2} - Y_{t-3})$, etc.

DF test follows the same asymptotic distribution of t statistics; the same critical values can be taken. (Gujarati, 2003)

3.3.1.2. The Phillips – Perron (PP) Unit Root Test

In the ADF test the existence of serial correlation among error terms are adjusted by adding the lagged values of dependent variable while the Phillips – Perron (PP) test uses non parametric statistical method to avoid serial correlation in the error terms without adding lagged values of dependent variable.

In this paper work both Augmented Dickey Fuller (ADF) test and Phillips – Perron (PP) test are applied for the test of stationary property or to check the existence of unit root problem (non-stationary in time series). (Gujarati, 2003)

3.4. Johansen Co–Integration Test

In the time series data, variables having the same level of stationary property imply that; there is a long run relationship between two or more variables i.e. they are co-integrated at the same order. Hence co-integration is the statistical property in which the collection time series data (y_1, y_2,---,y_k) have the same order of integration.

In such cases, researchers commonly applied two co-integration tests to confirm whether there is a long run a relationship among variables using Johansen test and Eagle – Granger method of co-integration test.

For this study Johansen test of co-integration is employed, as long it allows for more than one co-integration test to which the test has the following mathematical representation.

$$\Delta yt = \Pi yt - 1 + \sum_{t=1}^{p-1} \Gamma \Delta \mathrm{yt} - 1 + \mathrm{vt} - - - - - - - - - (1)$$

Where $\Pi = \sum_{t=1}^{p} \Gamma\Delta\mathrm{At} - \mathrm{I}$, $\Gamma = - \sum_{j=i+1}^{p} \Delta\mathrm{At}$ and Δ is the first different operators, *yt* is a vector of endogenous variables ($LGDP_t$, $LAGRI_t$, $LINDU_t$ and $LSERV_t$) and υ_t's are the error term. Π represents the matrix containing information for the long run relationship among variables. In Johansen and Juselius (1990) formulated two co-integration test, which are trace statistics, mathematically represented by;

$LR(\lambda_{trace}) = -T\sum_{i=r+1}^{k} \ln(1 - \lambda i)$, and the maximum likelihood statistics $LR(\lambda_{max}) = -T\ln(1 - \lambda_{\gamma+1})$, T represents the number of observations, while λ_i are the estimated *p-r* smallest eigen-values. The null hypothesis is; there is co-integration among variables against the alternative hypothesis there is at least one co-integration vector between variables. (IMF, June 2007)

3.5. Vector Error Correction Model (VECM)

After going through unit root test for to detect the stationary property of time series variables and Johansen test of co-integration for the presence of long run association-ship between variables specified in the model; then if there exists co-integrated rank we run Vector Error Correction Model (VECM) for the estimation of coefficients of the variables and to test the significance of their relationship at different level of confidence in both short run and long run dynamics. In this paper I have four macro variables for which their relationship can be represented in VECM as;

$\Delta LGDP_t = \alpha_{10} + \sum_{t=1}^{n} \beta 11 \Delta GDPt - 1 + \sum_{t-1}^{n} \beta 12 \Delta INDt - 1 + \sum_{t-1}^{n} \beta 13 \Delta SERVt - 1 + \sum_{t-1}^{n} \beta 14 \Delta AGRIt - 1 + \gamma_1 ECT_{t-1} + \varepsilon_{1,t}$ -- (1)

$\Delta LAGRI_t = \alpha_{20} + \sum_{t=1}^{n} \beta 21 \Delta GDPt - 1 + \sum_{t-1}^{n} \beta 22 \Delta INDt - 1 + \sum_{t-1}^{n} \beta 23 \Delta SERVt - 1 + \sum_{t-1}^{n} \beta 24 \Delta AGRIt - 1 + \gamma_2 ECT_{t-1} + \varepsilon_{2,t}$ -- (2)

$\Delta LINDU_t = \alpha_{30} + \sum_{t=1}^{n} \beta 31 \Delta GDPt - 1 + \sum_{t-1}^{n} \beta 32 \Delta INDt - 1 + \sum_{t-1}^{n} \beta 33 \Delta SERVt - 1 + \sum_{t-1}^{n} \beta 34 \Delta AGRIt - 1 + \gamma_3 ECT_{t-1} + \varepsilon_{3,t}$ --(3)

$\Delta LSERV_t = \alpha_{40} + \sum_{t=1}^{n} \beta 41 \Delta GDPt - 1 + \sum_{t-1}^{n} \beta 42 \Delta INDt - 1 + \sum_{t-1}^{n} \beta 43 \Delta SERVt - 1 + \sum_{t-1}^{n} \beta 44 \Delta AGRIt - 1 + \gamma_4 ECT_{t-1} + \varepsilon_{4,t}$-- (4)

Where t represents the time period running from (t =1,---,n), $ECT_{t's}$ are error correction terms, $\gamma_{t's}$ are coefficients for error correction terms, β_{ij}'$_s$ are coefficients for the lagged values of independent variables, α_{i0}'s are constant or intercept terms of the equations, while ε_{it}'$_s$ are white noise error terms.

The coefficients of error correction terms are the speed of adjustment towards stable long run equilibrium situation for dependent variables ($\Delta LGDP_t$, $\Delta LAGRI_t$, $\Delta LINDU_t$, and $\Delta LSERV_t$) after a short run deviation from equilibrium because of the change in independent variables.

In this paper since the objective of the study is investigating the short and long run relationship (linkage) between agriculture and industry sectors in their income growth; I have only two target models which are equation (2) and equation (3).

For target model one (eq.2); the income growth of GDP, industry, service and its own lagged value expected affect the dependent variable agriculture both in the short run and long run in value added terms. While in target model two (eq.3) it is expected that there is a causality which runs from GDP, agriculture, and service sectors to industry sector due to their income growth change which could in turn causes the income growth of industry sector to be affected both in the short and long run dynamics.
To test the causalities in these two target model VECM is comfortable from which both the short and long run impacts can be extracted.

CHAPTER FOUR

IV. RESULT AND DISCUSSION

4.1. Stationary Test

4.1.1. Graphic Analysis

Before taking a formal test for stationary behavior of variables, it is advisable to see the pattern of data how it is distributed over time using a plot graph. (Gujarati, 2003)

From the graph below at a level all variables have an upward trend or increasing pattern. It implies that their mean are increasing or changing over time i.e. a sign of non –stationary for time series data. But after a first differencing it resembles stationary.

4.1.1.1. Plot graph stationary test at a level form

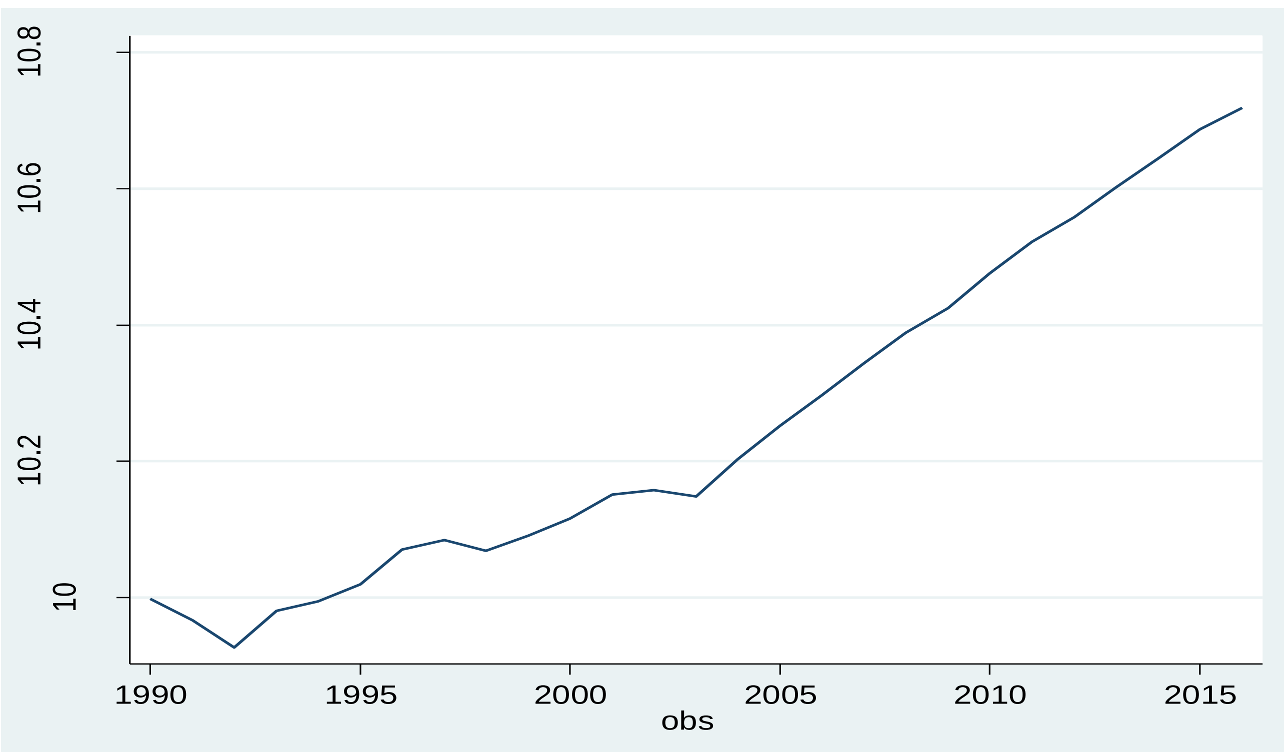

Fig.1:- plot graph stationary test at a level for $LGDP_t$

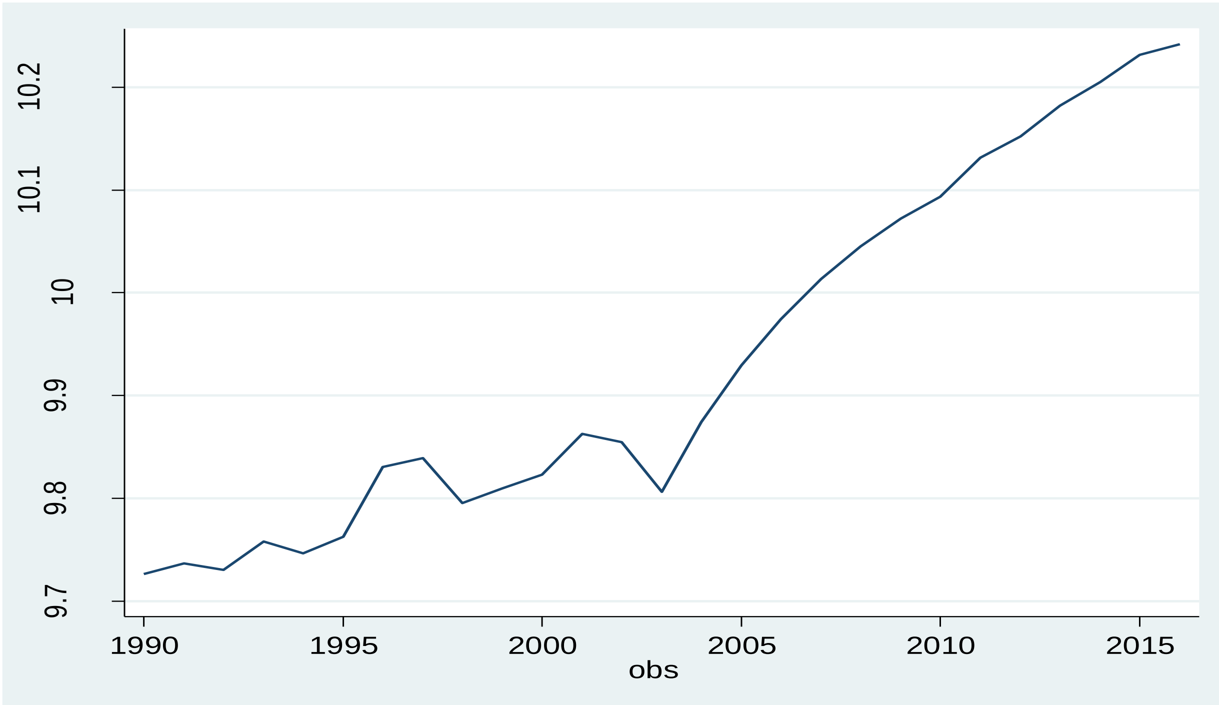

Fig.2:- plot graph stationary test at a level for $LAGRI_t$

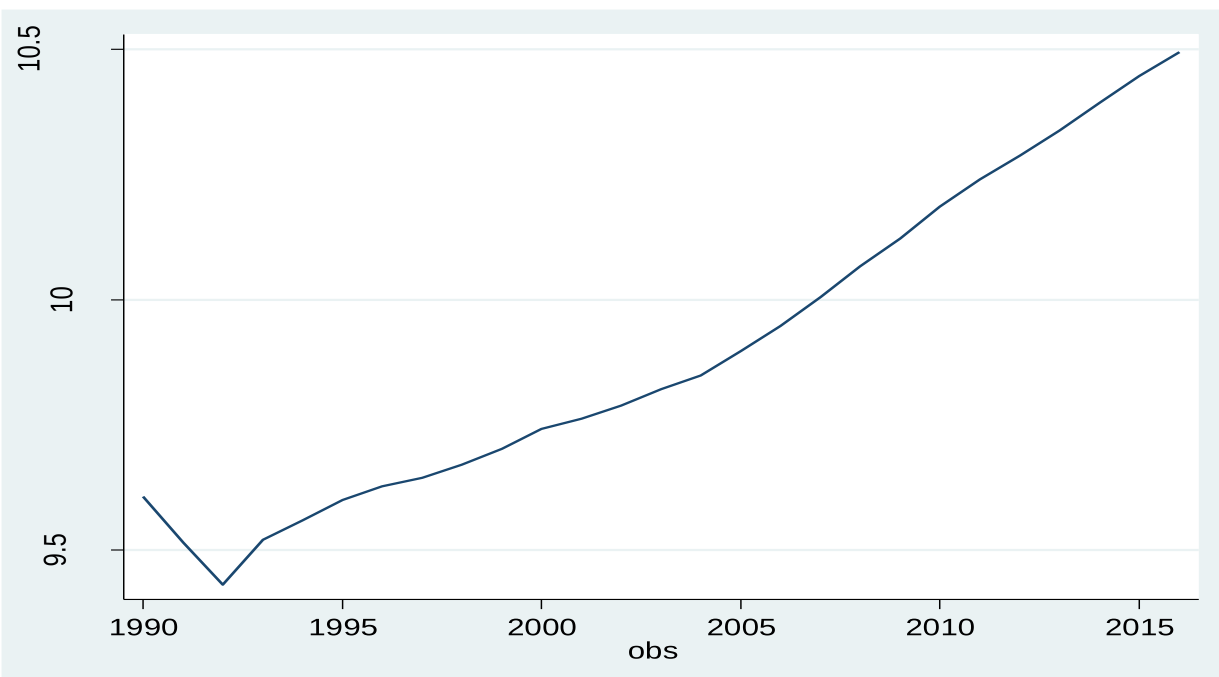

Fig.3:- plot graph stationary test at a level for $LINDU_t$

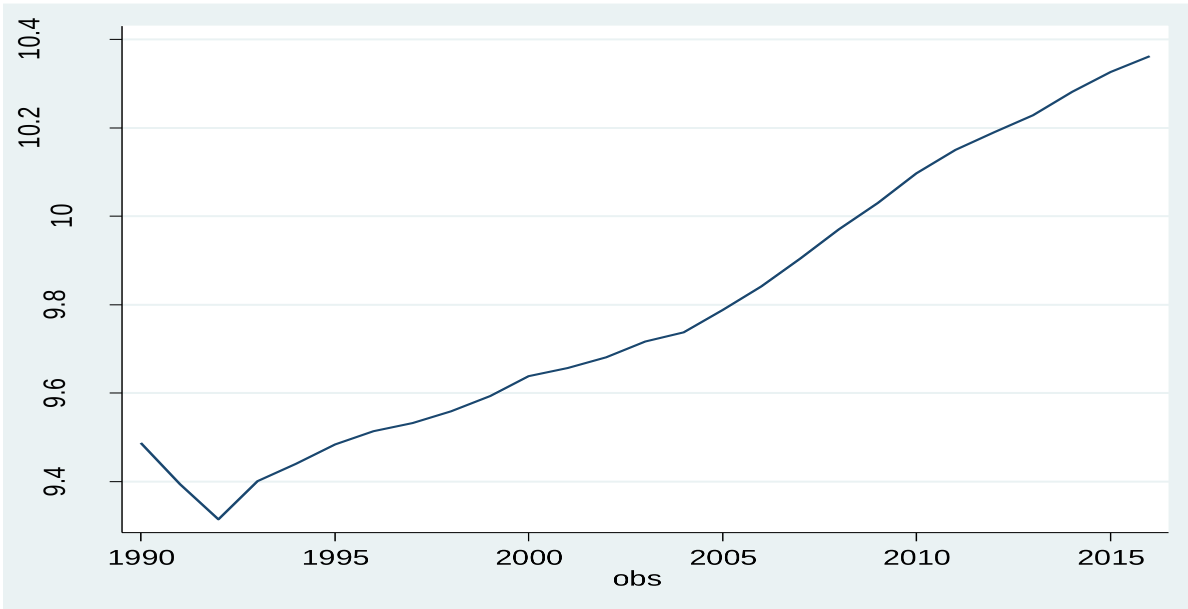

Fig.4:- plot graph stationary test at a level for $LSERVI_t$

4.1.1.2. Plot graph stationary test at a difference form

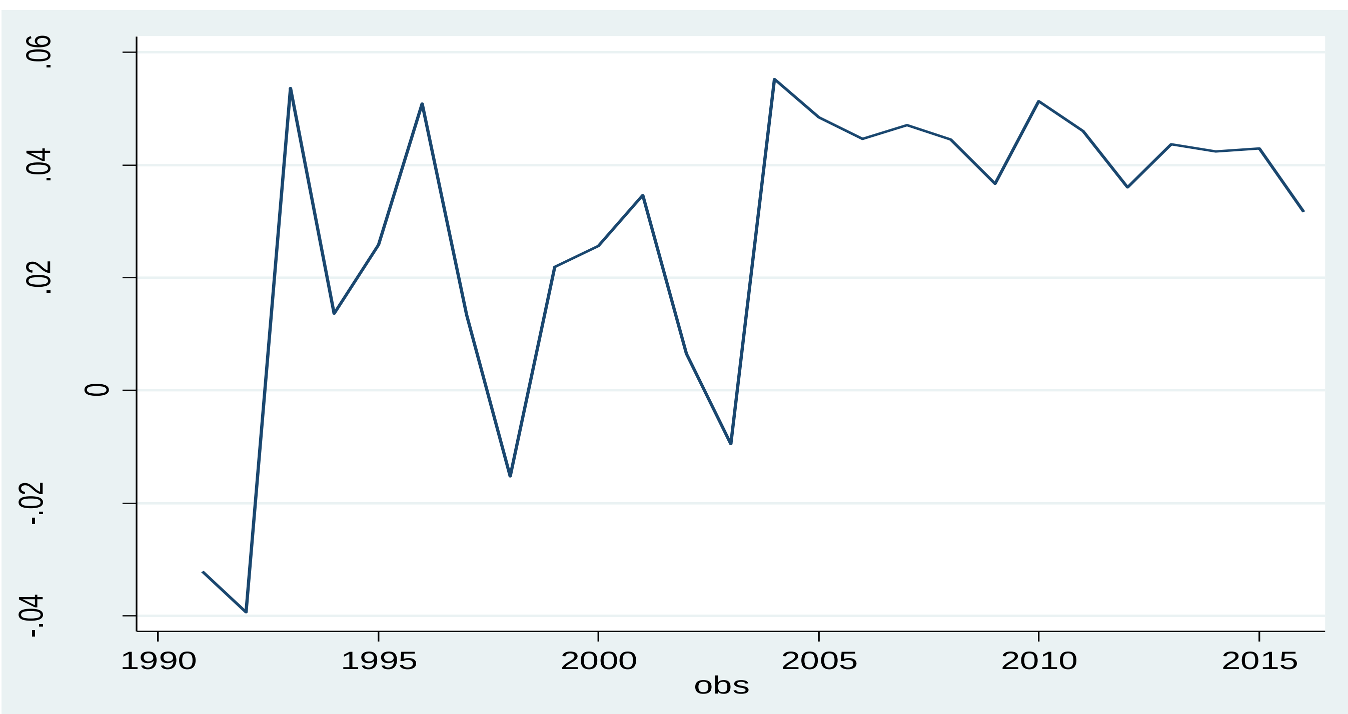

Fig.5:- plot graph stationary test at a first difference for $LGDP_t$

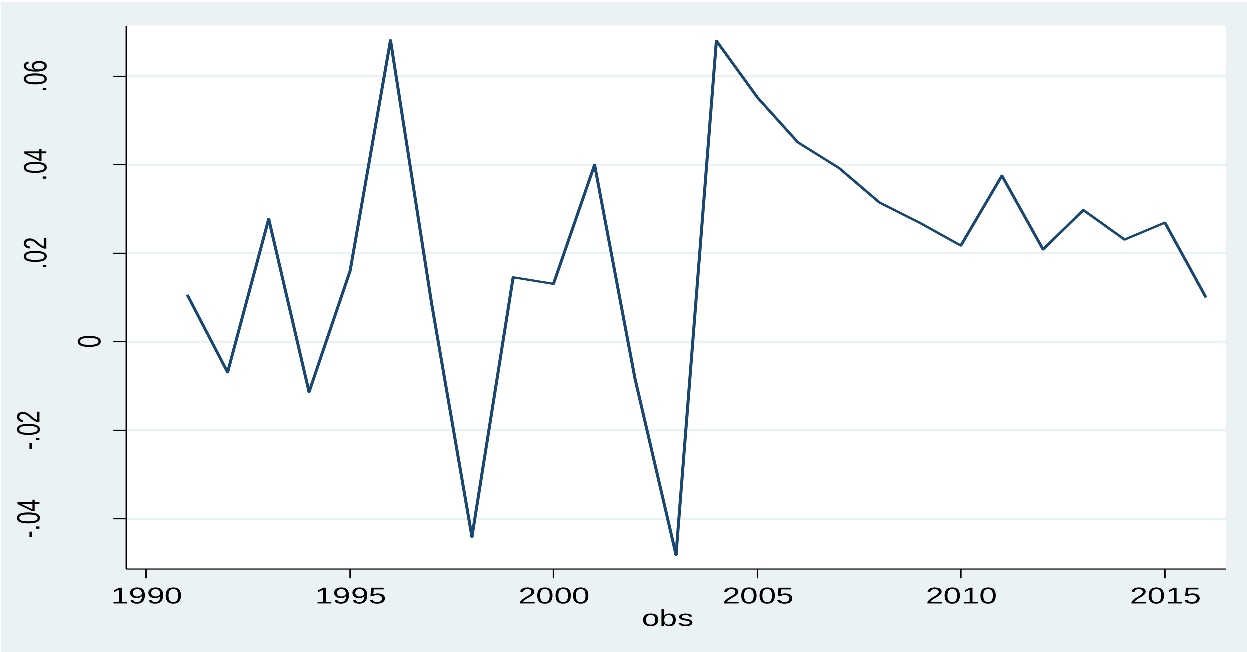

Fig.6:- plot graph stationary test at a first difference for $LAGRI_t$

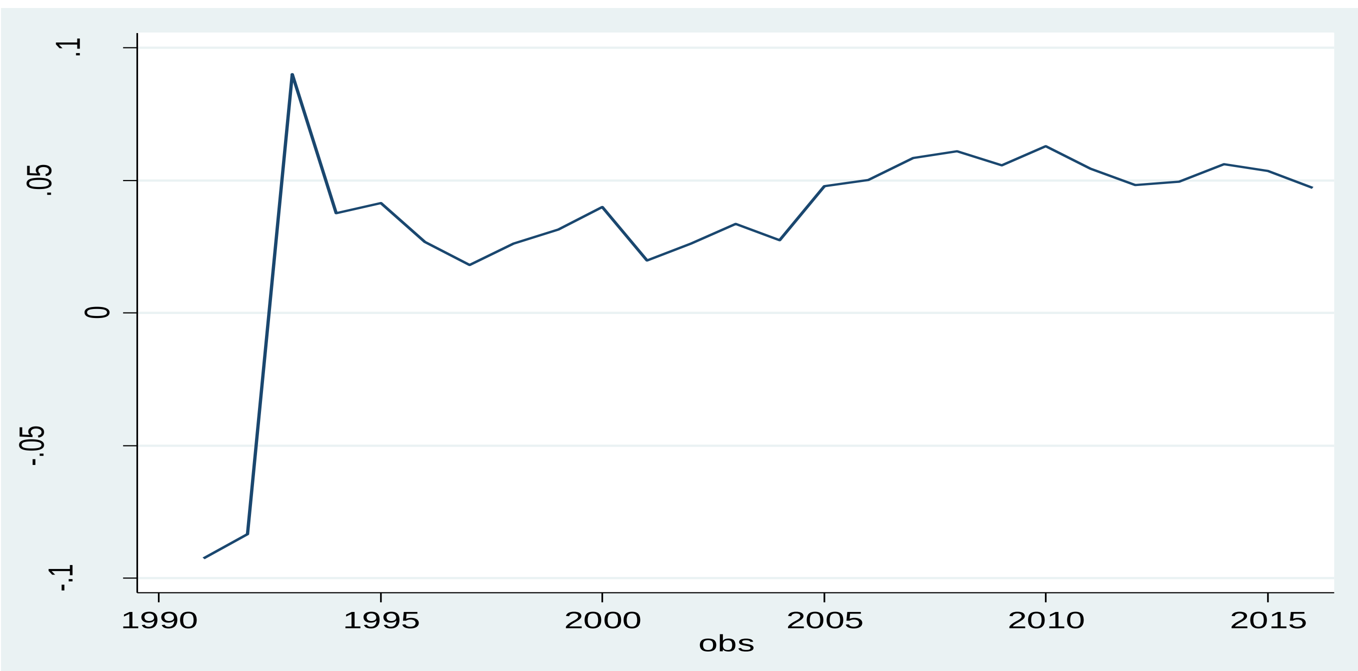

Fig.5:- plot graph stationary test at a first difference for $LINDU_t$

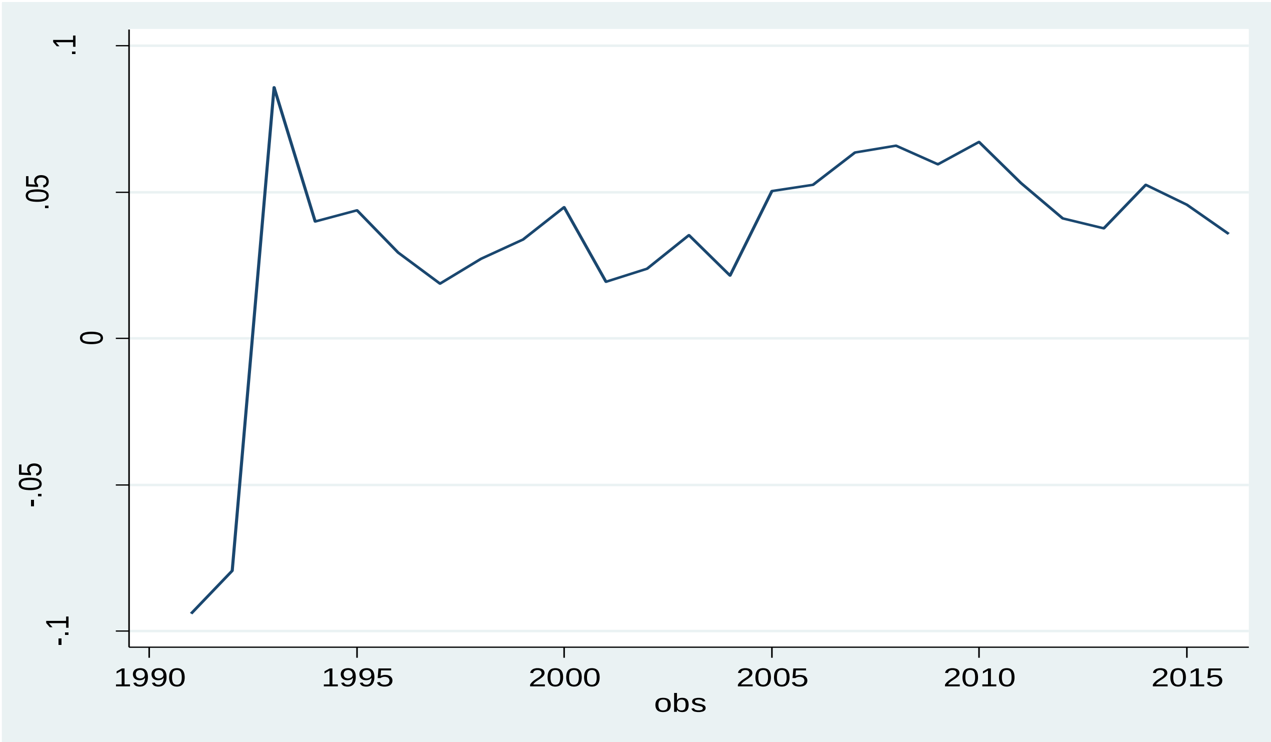

Fig.8:- plot graph stationary test at a first difference for $LSEVI_t$

4.1.2. Sample Correlogram and Q Statistics Stationary Test

After testing stationary manner of data using plot graphical analysis method it is better to double check, the behavior of time series data by employing the mathematical approach called correlogram and Q statistics. (Gujarati, 2003)

The guide line in correlogram and Q statistics stationary test approach is;

Null hypothesis: a variable is stationary and

Alternative hypothesis: the variable is non-stationary.

After running this stationary test the result implied that for all variables the probability value is less than 5% at a level; meaning that they are not stationary. Hence, we can reject the null hypothesis that the variable is stationary. But, after first difference we can't reject the null hypothesis that the variables are stationary at 5% significance level since the probability values are greater than 5%.

From the above methods i.e. plot graph analysis, and correlogram and Q statistics method of stationary test we have the same result; that is, all time series variables are non-stationary at a level but they are stationary after first difference.

4.1.2.1. Sample Correlogram and Q Statistics for Stationary Test at a Level Form

```
. corrgram LGDP
```

LAG	AC	PAC	Q	Prob>Q	-1 0 1 [Autocorrelation]	-1 0 1 [Partial Autocor]
1	0.8990	1.0508	24.341	0.0000		
2	0.7857	-0.1458	43.673	0.0000		
3	0.6653	0.2354	58.113	0.0000		
4	0.5515	-0.1249	68.468	0.0000		
5	0.4402	0.2240	75.367	0.0000		
6	0.3315	-0.0992	79.465	0.0000		
7	0.2323	-0.0792	81.577	0.0000		
8	0.1402	0.1240	82.387	0.0000		
9	0.0465	0.0339	82.481	0.0000		
10	-0.0390	0.2235	82.551	0.0000		
11	-0.1139	0.3105	83.186	0.0000		

Fig.9:- Correlogram and Q Statistics stationary test at a level for $LGDP_t$

LAG	AC	PAC	Q	Prob>Q	[Autocorrelation]	[Partial Autocor]
1	0.8935	1.0244	24.042	0.0000		
2	0.7786	-0.0436	43.031	0.0000		
3	0.6667	0.3694	57.532	0.0000		
4	0.5582	-0.0043	68.14	0.0000		
5	0.4436	0.0794	75.144	0.0000		
6	0.3236	-0.3055	79.05	0.0000		
7	0.2287	0.2039	81.097	0.0000		
8	0.1415	0.2180	81.922	0.0000		
9	0.0416	0.0493	81.997	0.0000		
10	-0.0537	0.0629	82.13	0.0000		
11	-0.1369	0.3995	83.047	0.0000		

Fig.10:- Correlogram and Q Statistics stationary test at a level for $LAGRI_t$

LAG	AC	PAC	Q	Prob>Q	[Autocorrelation]	[Partial Autocor]
1	0.9032	1.0534	24.565	0.0000		
2	0.7891	-0.2642	44.068	0.0000		
3	0.6657	0.1644	58.527	0.0000		
4	0.5525	0.0299	68.918	0.0000		
5	0.4427	0.0067	75.892	0.0000		
6	0.3360	-0.0949	80.101	0.0000		
7	0.2330	0.0043	82.226	0.0000		
8	0.1359	0.0021	82.988	0.0000		
9	0.0460	0.2123	83.08	0.0000		
10	-0.0347	-0.0173	83.135	0.0000		
11	-0.1055	0.2225	83.68	0.0000		

Fig.11:- Correlogram and Q Statistics stationary test at a level for $LINDU_t$

LAG	AC	PAC	Q	Prob>Q	[Autocorrelation]	[Partial Autocor]
1	0.9091	1.0446	24.888	0.0000		
2	0.7980	-0.3170	44.835	0.0000		
3	0.6761	0.1318	59.747	0.0000		
4	0.5631	0.0224	70.54	0.0000		
5	0.4513	0.0061	77.789	0.0000		
6	0.3413	-0.1096	82.132	0.0000		
7	0.2349	0.0128	84.291	0.0000		
8	0.1350	-0.0057	85.042	0.0000		
9	0.0431	0.2725	85.123	0.0000		
10	-0.0383	0.0852	85.191	0.0000		
11	-0.1087	0.3092	85.769	0.0000		

Fig.12:- Correlogram and Q Statistics stationary test at a level for $LSERVI_t$

4.1.2.2. Sample Correlogram Stationary Test at a Difference Form

LAG	AC	PAC	Q	Prob>Q	[Autocorrelation]	[Partial Autocor]
1	0.3008	0.3016	2.6342	0.1046		
2	-0.0337	-0.0550	2.6687	0.2633		
3	0.2004	0.2386	3.9401	0.2680		
4	0.0654	-0.0736	4.0815	0.3951		
5	0.0879	0.2072	4.3495	0.5003		
6	0.2137	0.1382	6.012	0.4218		
7	0.0654	-0.0437	6.176	0.5194		
8	0.0319	0.0157	6.2172	0.6229		
9	-0.0334	-0.0916	6.2649	0.7131		
10	-0.0545	0.0153	6.4002	0.7806		
11	0.2002	0.3804	8.3446	0.6821		

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Fig.13:- Correlogram and Q Statistics stationary test at a first difference for $LGDP_t$

LAG	AC	PAC	Q	Prob>Q	[Autocorrelation]	[Partial Autocor]
1	0.0845	0.0848	.20806	0.6483		
2	-0.2893	-0.3003	2.7462	0.2533		
3	0.0268	0.0936	2.7688	0.4287		
4	0.1036	-0.0168	3.124	0.5373		
5	0.2393	0.3019	5.1096	0.4027		
6	-0.0781	-0.1439	5.3316	0.5020		
7	-0.2583	-0.0992	7.8887	0.3425		
8	0.0536	0.0001	8.0048	0.4330		
9	0.0699	0.0130	8.214	0.5127		
10	-0.0815	-0.1514	8.5165	0.5785		
11	0.0510	0.3197	8.6429	0.6548		

Fig.14:- Correlogram and Q Statistics stationary test at a first difference for $LAGRI_t$

LAG	AC	PAC	Q	Prob>Q	[Autocorrelation]	[Partial Autocor]
1	0.3420	0.3453	3.407	0.0649		
2	-0.0809	-0.0371	3.6053	0.1649		
3	0.0435	0.0317	3.6651	0.3000		
4	0.0478	0.0466	3.7408	0.4422		
5	0.1273	0.1057	4.3022	0.5068		
6	0.1143	0.0102	4.778	0.5726		
7	0.0702	0.0128	4.9667	0.6640		
8	-0.0170	-0.1133	4.9783	0.7599		
9	0.0048	0.1384	4.9793	0.8361		
10	0.0541	0.0148	5.1125	0.8835		
11	-0.0044	0.1086	5.1134	0.9256		

Fig.15:- Correlogram and Q Statistics stationary test at a first difference for $LINDU_t$

					-1 0 1	-1 0 1
LAG	AC	PAC	Q	Prob>Q	[Autocorrelation]	[Partial Autocor]
1	0.3533	0.3536	3.6342	0.0566		
2	-0.0860	-0.0585	3.8583	0.1453		
3	0.0195	0.0096	3.8704	0.2758		
4	0.0152	0.0285	3.8781	0.4228		
5	0.0995	0.1069	4.2212	0.5180		
6	0.0877	-0.0001	4.5011	0.6092		
7	0.0499	0.0217	4.5963	0.7091		
8	-0.0511	-0.1315	4.7021	0.7889		
9	-0.0205	0.1444	4.72	0.8580		
10	0.0640	0.0836	4.9064	0.8973		
11	-0.0012	0.0957	4.9065	0.9356		

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Fig.16:- Correlogram and Q Statistics stationary test at a first difference for $LSERVI_t$

4.1.3. Unit Root Test

After plot graphical analysis and correlogram and Q statistics method of stationary test, Augmented Dickey – Fuller (ADF) and Phillips – Perron (PP) unit root test are carried out for further check to determine the unit root problem. In both method of test we have a null hypothesis: variable is not stationary and alternative hypothesis a variable is stationary.

The result of stationary test from the table below implies that; almost all variables are non – stationary at a level but they are stationary at first differencing both in ADF and PP test. Hence, we can't reject the null hypothesis at a level but we reject it at a difference.

Table 1:- Augmented Dickey-Fuller and Phillips - Perron unit root test results for both Trend and Without Trend of four variables in Level and First Difference

Results of Augmented Dickey-Fuller (ADF) Unit Root Test								
Variables	Statistics	Critical value			Statistics	Critical value		
	With Intercept	1%	5%	10%	With trend and intercept	1%	5%	10%
Level Form								
LGDP	2.456	-3.743	-2.997	-2.629	-2.498	-4.371	-3.596	-3.238
LAgr	0.716	-3.743	-2.997	-2.629	-1.815	-4.371	-3.596	-3.238
Lind	2.186	-3.743	-2.997	-2.629	-4.264	-4.371	-3.596**	-3.238***
LServ	1.824	-3.743	-2.997	-2.629	-4.770	-4.371*	-3.596**	-3.238***
Difference Form								
Variables	Statistics	Critical value			Statistics	Critical value		
	With intercept	1%	5%	10%	With trend and intercept	1%	5%	10%
LGDP	-4.017	-3.750*	-3.000**	-2.630***	5.466	-2.658*	-1.950**	-1.600***
LAgr	-4.404	-3.750*	-3.000**	-2.630***	3.627	-2.658*	-1.950**	-1.600***
Lind	-4.669	-3.750*	-3.000**	-2.630***	4.526	-2.658*	-1.950**	-1.600***
LServ	-4.723	-3.750*	-3.000**	-2.630***	4.496	-2.658*	-1.950**	-1.600***
Results of Phillips-Perron (P.P.) Unit Root Test								
Variables	Statistics	Critical values			Statistics	Critical values		
	With Intercept	1%	5%	10%	With trend And intercept	1%	5%	10%
LGDP	1.322	-17.268	-12.500	-10.220	-4.932	-22.628	-17.976	-15.648
LAgr	0.699	-17.268	-12.500	-10.220	-5.045	-22.628	-17.976	-15.648
Lind	1.363	-17.268	-12.500	-10.220	-9.346	-22.628	-17.976	-15.648
LServ	1.117	-17.268	-12.500	-10.220	-10.587	-22.628	-17.976	-15.648
Difference Form								
Variables	Statistics	Critical value			Statistics	Critical value		
	With intercept	1%	5%	10%	With trend and intercept	1%	5%	10%
LGDP	-14.682	-17.200	-12.500**	-10.200***	-19.105	-22.500	-17.900**	-15.600***
LAgr	-20.602	-17.200	-12.500**	-10.200***	-21.572	-22.500	-17.900**	-15.600***
Lind	-13.640	-17.200	-12.500**	-10.200***	-15.528	-22.500	-17.900	-15.600
LServ	-13.692	-17.200	-12.500**	-10.200***	-14.704	-22.500	-17.900	-15.600

Note:-*,**,*** denotes the rejection of the null hypothesis at 1%, 5% and 10% level of significance.

4.2. Lag Selection Criteria

From the test of unit root problem, the result of all stationary tests implies that all variables are not stationary at a level but they are stationary after their first difference i.e. they are I (1). But before testing the existence of long run relationship among variables, the length of lags must be chosen using the appropriate criteria.

From the Literature we know that in the selection of lag length, for small sample size up-to 30 years SBIC dominates the other criteria while HQIC is as accurate as AIC for a sample size up-to 60 years. But for large sample size AIC dominates the other (Ivanov, Kilian, 2005).

The result shows us that, HQIC and SBIC suggest 1 lag length while AIC and FPE tells 2 lag. But because of its small sample size, 1 lag is selected based on the above empirical literature.

Table 2:- Lag Selection Criteria

Selection-order criteria
Sample: 1993 - 2016 Number of obs = 24

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	235.691				4.8e-14	-19.3076	-19.2555	-19.1113
1	345.631	219.88	16	0.000	2.0e-17	-27.1359	-26.8755*	-26.1542*
2	364.126	36.989	16	0.002	1.8e-17*	-27.3438*	-26.875	-25.5767
3	377.725	27.199*	16	0.039	3.2e-17	-27.1438	-26.4666	-24.5913

Endogenous: LGDP LAGRI LINDU LSERVI
Exogenous: _cons

Note: LL = log likelihood, LR = Likelihood Ratio test , AIC = Akaike Information Criterion, HQIC = the Hannan-Quinn Information Criterion, SBIC = Schwartz Bayesian Information Criteria, * denotes a chosen lag.

4.3. Johansen Test of Co-Integration

After applying the Johansen co-integration test, the result from the table shows that, in both tests of trace and max Eigen value; the null hypothesis is rejected at 5% level of significance and accepts the alternative hypothesis that there is one co-integrated rank among four variables. Meaning that, they move together in the long run. Hence, we can run the VECM.

Table 3:- Johansen Test of Co-integration (trace and max statistics)

```
. vecrank LAGRI LGDP LINDU LSERVI, trend(constant) max

                       Johansen tests for cointegration
Trend: constant                                         Number of obs =      25
Sample:  1992 - 2016                                             Lags =       2
```

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	20	329.54411	.	66.9247	47.21
1	27	351.37713	0.82564	23.2587*	29.68
2	32	358.38898	0.42933	9.2350	15.41
3	35	363.00205	0.30861	0.0088	3.76
4	36	363.00646	0.00035		

maximum rank	parms	LL	eigenvalue	max statistic	5% critical value
0	20	329.54411	.	43.6660	27.07
1	27	351.37713	0.82564	14.0237	20.97
2	32	358.38898	0.42933	9.2261	14.07
3	35	363.00205	0.30861	0.0088	3.76
4	36	363.00646	0.00035		

Note:-* donates the rejection of null hypothesis at 5% significant level.

4.4. Vector Error Correction Model (VECM)

4.4.1. Long Run Relationship (Co-integration Vectors)

From the Johansen co-integration test of both maximal and trace Eigen-value test statistics, there is at least one co-integrated vector at 5% level of significance by rejecting the null hypothesis i.e. there is no long run relationship among variables. For this reason, restricted autoregressive model or Vector Error Correction Model (VECM) is employed for the estimation of the model. Checking the reliability of models is done using Vector Error Correction diagnostic and test of LM test for residual autocorrelation, and for the test of normality distribution of disturbances the Jarque-Bera normality statistics has been carried out. For this purpose the co-integration equation are specified as below:-

Normalized Long run estimates and speed of adjustment coefficients

Target Model 1:- Long run estimates and speed of adjustment coefficients for target model one

Long run estimates speed of adjustment coefficients

$$\begin{matrix} LAGRIt \\ LGDPt \\ LINDUt \\ LSERVI \\ CONST. \end{matrix} = \begin{matrix} 1 \\ -1.897 \\ 1.623 \\ -0.702 \\ 0.328 \end{matrix} \quad \begin{matrix} LAGRIt \\ LGDPt \\ LINDUt \\ LSERVI \end{matrix} = \begin{matrix} -0.574 \\ -1.992 \\ -4.472 \\ -3.28 \end{matrix}$$

Target Model 2:-Long run estimates and speed of adjustment coefficients for target model two

Long run estimates speed of adjustment coefficients

$$\begin{matrix} LINDUt \\ LGDPt \\ LAGRIt \\ LSERVI \\ CONST. \end{matrix} = \begin{matrix} 1 \\ -1.169 \\ 0.616 \\ -0.433 \\ 0.202 \end{matrix} \quad \begin{matrix} LINDUt \\ LGDPt \\ LAGRIt \\ LSERVI \end{matrix} = \begin{matrix} -6.562 \\ -3.233 \\ -0.931 \\ -5.326 \end{matrix}$$

But target model 1 is not significant at any level of confidence; therefore we don't have any long run stability equation for this model. Hence, we only have one reliable stable long run relationship equation from target model 2 which can be written as:-

$LINDU_t = 1.169LGDP_t – 0.616LAGRI_t + 0.433LSERVI_t – 0.202$

Based on this equation we further discuss the long run relationship between variables especially focuses on the objective of the study i.e. investigating the long run relationship between agriculture and industry sector.

4.4.1.1. The Impact of Agriculture on Industry

The result of VECM implied that, there is a long run relationship which runs from agriculture to industry sector at 5% significant level after rejecting the null hypothesis that there is no long run relationship which causes the industry to be affected by agriculture, GDP, service sector income growth in value added terms. **(See: - annex table 13 and 14)**

From the above long run stability equation, a 1% increase/decrease in the income growth of agriculture sector in value added terms can cause to the income growth of industry sector to decrease/increase by 0.62% in value added terms in the long run. This implies that, there is a strong relationship between these two sectors which is unidirectional running from agriculture to industry sector.

But the sign of relationship is negative which contradicts with the country's economic policies and strategies those basically have formulated on the development economic theories which support the transformation of agriculture sector to industrialization by active development of agriculture through investment and innovation rather than taking the sector the reservoir of resources for the industrialization. But the result shows that, there is a significant resource rivalry among these two sectors like land, capital and labor. In addition, an increase in the price of agricultural output in the country over the past ten years causes the cost of industry sector to increase by raising the cost of labor, price of raw material, and the rental price of land which negatively affects the demand for industrial output by changing the price to increase. It means that, it causes the two sectors to have a negative relationship in the long run.

Hence, the result of the study contradicts with the hypothesis which stated the two sectors will have a bi-directional causality in the long run and will have a positive relationship. There we can reject the hypothesis of the study from the long run relationship point of view.

4.4.1.2. The Impact of GDP on Industry

From the above equation, in the long run GDP growth in the real income value added terms can highly affects the industry sector having a positive relationship by rejecting the null hypothesis in the VECM which states variables like agriculture, GDP, and service sectors will not cause the industry sector in the long run and accepting the alternative hypothesis that there will have a relationship between these variables in the long run.

1% increase/decrease in GDP growth can cause the industry sector to increase/decrease by 1.17% in the long run dynamics. This shows that the industry sector benefited from the growth of GDP. Meaning that; the sector is highly advantageous sector from the government policies and strategies perspective.

4.4.1.3. The Impact of Service Sector on Industry

From the normalization of Johansen, there is a strong positive relationship between the two sectors. 1% increase/decrease in the income growth service sector can cause the industry sector to increase/decrease by 0.433% in value added terms in the long run. This means that the industry sector benefited from the expansion of service sectors like financial institutions (banking, insurance), telecommunication, education, health, power supply, water supply etc. and by their performance.

4.4.1.4. The Impact of GDP, Industry, and Service Sectors on Agriculture

In the study, macro-variables like GDP, industry and service sectors were specified in our target model as exogenous variables by taking agriculture as an endogenous variable because it is expected that they can affect the income growth of agriculture sector in the long run according to development economics theory. But the result of the study from VECM implied that; these variables are not significant to explain the agriculture sector to be affected in the long run context at any confidence level.

The result of VECM fail to reject the null hypothesis that there is no causality which runs from GDP, industry and service sectors to agriculture in the long run after running the model at all level of significance.

In the context of the Ethiopian economy; though services sector is coming to be one of the dominant sector in the GDP share in the economy, agriculture sector was a dominant sector over the years by taking more than 50% share of GDP contribution and by absorbing more than 80% of labor force employment even in the sample period.

The way of farming in Ethiopia is characterized by traditional and subsistence nature. Almost all crop and livestock production are raised from farmers who own small land holdings. Underdeveloped method of agricultural practice might cause the sector exogenous to the above mentioned variables.

It implies that agriculture is not significantly supported by industry and service sectors, even economic development policy and strategy wise it is not benefited from the income growth of country's GDP. Hence, we can conclude that agriculture has a uni-directional long run causality which run from itself to GDP, industry and service sector i.e. it is exogenous variable.

But this empirical finding contradicts with the country's economic policy and strategies since all medium and long term policies and strategies has formulated and implemented by giving strong emphasis on the sectoral-linkage especially between agriculture and industry sectors. The industry sector is expected to absorb the surplus labor force from agriculture sector, to supply agricultural inputs and to create demand for agricultural output to meet the target set to transform subsistence agriculture sector to industrialization.

4.4.2. Short Run Relationship between Sectors for GDP Growth

Table 4:- The summery of short run sectoral linkages from VECM

Explanatory variables	Dependent variables			
	$\Delta LGDP_t$	$\Delta LAGRI_t$	$\Delta LINDU_t$	$\Delta LSERV_t$
$\Delta LGDP_{t-1}$	-1.360 (2.0253)	0.9790 (2.7426)	-4.4724** (2.2443)	-4.0987*** (2.3106)
$\Delta LAGRI_{t-1}$	0.6992 (1.114)	-0.5736 (1.5087)	2.3724*** (1.2345)	2.2285*** (1.2710)
$\Delta LINDU_{t-1}$	-0.9443 (1.4557)	-2.3112 (1.9712)	0.1491 (1.613)	-0.2415 (1.6607)
$\Delta LSERV_{t-1}$	1.8129 (1.1705)	2.0243 (1.5850)	2.1928*** (1.2970)	2.4048*** (1.3353)

Note:-**, *** donates the estimates are significant at 5%, and 10% level of significance respectively

- Numbers in the parenthesis represents standard errors

4.4.2.1. The Short Run Effects of GDP, Agriculture and Service Sectors on Industry

The result of Vector Error Correction Model (VECM) implies that all variables (GDP, agriculture, service) at 10% significant level granger causes the income growth of industry sector at 5% and 10% level of significance in the short run by rejecting the null hypothesis i.e. these variables will not granger cause industry in the short run. From table 4, we can understand that GDP negatively granger causes industry in which 1% increase/decrease in the income growth GDP will lead to 4.47% change in the income growth of industry sector holding other variables remain constant.

While agriculture granger causes industry sector positively by the magnitude of 1% change in the income growth of agriculture sector affects the industry sector by 2.37%. Similarly 1% change in the income growth of service sector cause the industry sector 2.2% change holding other variables constant. But this sector is not significantly affected by the past year growth of its own value.

Hence, agriculture sector granger causes industry sector both in the short run and long run.

4.4.2.2. The Short Run Effects of GDP, Industry and Service Sectors on Agriculture

From the result of VECM, agriculture is not affected by the short run income growth change in GDP, industry, and service sector at any level of significant which fail to reject the null hypothesis that these variables will not granger cause agriculture in the short run. And it is also not affected by its own past year growth in the value added terms.

In a nutshell, the direction of causality is unidirectional which runs from agriculture to industry but the sign of their relationship is different having a negative impact in the long run while positive in the short run. Meanwhile, agriculture is not affected by any given macro variables both in the short and long run dynamics.

CHAPTER FIVE

5.1. Summary of Findings

The result of the finding shows us that, there is one way relationship between agricultural and industry sector income growth i.e. unidirectional causality running from agriculture income growth to industry sector income growth in the long run which has a negative sign. A significant and a high figure of Error Correction Term (-5.56) in the stable long run equation target model (2) indicates that once the industry sectors income growth deviates from equilibrium because of the change in other explanatory variables it can be back to its long run steady state in the short period of time. Similarly in the short run agriculture granger causes industry but industry doesn't cause, but the sign is different. While agriculture granger causes service sector and GDP in the long run at 5% and 10% level of significance, but in the short run this sector affects service only at 10% level of significance. On the contrary, agriculture is not affected by other sectors and GDP both in the short run and long run at any level of significance.

The negative relationship between agriculture and industry sector implies that an increase in the price of agricultural products in the past 10 years in the country affects the industry sector through an increase in the labor cost, raw material and land rent which in turn decrease the demand for the output of the sector through an increase in price. As long as the industries are traditional, small scale, and are not technologically advanced to produce at minimum cost and their market size are very small and not internationally competitive, they are sensitive to an increase in the price of inputs and by the lower price imported foreign products.

As a whole, the agriculture sector is not significantly supported or benefited from the income growth of GDP and also from industry and service sector both in the short run and in the long run contrary to the implemented economic policy and strategies of the country which advocates the sectoral linkage especially agriculture and industry sectors.

5.2. Recommendation

From this study what policy makers should care about the time frame for which the linkage between sectors can have? In the short run the finding implies that the two important sectors in the economy has positive relation-ship uni-directionally which run from agriculture to industry but in the long run similarly their relationship is one directional from agriculture to industry and it is negative. Here is what the policy makers should care while formulating sectoral policies and strategies.

The one side relationship imply that the agriculture sector is not supported by industry sector for its development while the industry sector is suffered by an increase in the price of agricultural products over the past ten years in the country which causes for the rise in the cost of industrial inputs like labor, raw material, and land rent. An increase in the cost of industrial inputs in turn can cause the price of its product to increase which affects its demand negatively.

To better off their interdependence positively, an improvement in agriculture productivity through innovation, research and development can lower the price of agricultural products which could significantly affect the cost of industrial inputs to decrease by reducing the cost of labor, price of raw material, and decrease in rental cost of land. Hence, a reduction in the cost of inputs in the industry sector can increase the demand for its output by lowering its price.

To support the agriculture sector the establishment of small and medium scale industry both at local and urban areas which can produce agricultural inputs, absorb the surplus labor in the agriculture sector, and can use agricultural products as input; can boost the productivity of agriculture sector through a decrease in the cost of agricultural inputs, decrease in surplus labor force and consumption, by creating market for agricultural products.

In addition, the development of infrastructure could increase inter-sectoral linkage, by interconnecting; rural–rural, rural–urban, urban-urban areas; by the empowerment of the society through the development of education, health, delivery of electricity, telecommunication; and by creating market (demand) for products and also increase productivity in all sectoral-development.

In all the above mentioned ways, the inter-sectoral linkage between especially agriculture – industry can be improved positively and would help to meet the targets set by the government of the country in its sectoral policies and strategies for the transformation of the economy and to insure food security.

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ANNEXES

Annex A

Augmented Dickey-Fuller and Phillips - Perron unit root test results for constant, constant and Trend and Without constant and Trend of four variables in Level

Table 1:- Augmented Dickey-Fuller unit root test results for with constant and no Trend of four variables in Level (yearly time variable: obs, 1990 to 2016)

Dickey-Fuller test for unit root Number of obs = 26

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	2.456	-3.743	-2.997	-2.629

MacKinnon approximate p-value for Z(t) = 0.9990

D.LGDP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LGDP L1.	.0507791	.0206783	2.46	0.022	.0081013	.0934569
_cons	-.4921377	.2117445	-2.32	0.029	-.929157	-.0551185

dfuller LAGRI, regress lags(0)

Dickey-Fuller test for unit root Number of obs = 26

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	0.716	-3.743	-2.997	-2.629

MacKinnon approximate p-value for Z(t) = 0.9902

D.LAGRI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LAGRI L1.	.0244005	.0340743	0.72	0.481	-.0459255	.0947265
_cons	-.2223009	.3381503	-0.66	0.517	-.9202089	.4756071

dfuller LINDU, regress lags(0)

Dickey-Fuller test for unit root Number of obs = 26

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	2.186	-3.743	-2.997	-2.629

MacKinnon approximate p-value for Z(t) = 0.9989

D.LINDU	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LINDU						
L1.	.053384	.024418	2.19	0.039	.0029878	.1037802
_cons	-.4930753	.2412526	-2.04	0.052	-.9909963	.0048457

. dfuller LSERVI, regress lags(0)

Dickey-Fuller test for unit root Number of obs = 26

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	1.824	-3.743	-2.997	-2.629

MacKinnon approximate p-value for Z(t) = 0.9984

D.LSERVI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LSERVI						
L1.	.0445712	.0244321	1.82	0.081	-.0058542	.0949967
_cons	-.4016911	.2387518	-1.68	0.105	-.8944506	.0910684

Table 2:- Augmented Dickey-Fuller unit root test results for with constant and Trend of four variables in Level (yearly time variable: obs, 1990 to 2016)

. dfuller LGDP, trend regress lags(0)

Dickey-Fuller test for unit root Number of obs = 26

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-2.498	-4.371	-3.596	-3.238

MacKinnon approximate p-value for Z(t) = 0.3289

D.LGDP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LGDP						
L1.	-.1854391	.0742312	-2.50	0.020	-.3389981	-.0318801
_trend	.007391	.0022576	3.27	0.003	.0027209	.0120611
_cons	1.826349	.7303589	2.50	0.020	.3154866	3.337212

. dfuller LAGRI, trend regress lags(0)

Dickey-Fuller test for unit root Number of obs = 26

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-1.815	-4.371	-3.596	-3.238

MacKinnon approximate p-value for Z(t) = 0.6975

D.LAGRI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LAGRI						
L1.	-.2063731	.1137033	-1.82	0.083	-.4415862	.0288401
_trend	.0052141	.0024662	2.11	0.046	.0001124	.0103158
_cons	1.997175	1.09632	1.82	0.082	-.2707355	4.265085

. dfuller LINDU, trend regress lags(0)

Dickey-Fuller test for unit root Number of obs = 26

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(t)	-4.264	-4.371	-3.596	-3.238

MacKinnon approximate p-value for Z(t) = 0.0036

D.LINDU	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LINDU						
L1.	-.3290252	.0771613	-4.26	0.000	-.4886456	-.1694049
_trend	.0154143	.0030328	5.08	0.000	.0091406	.0216881
_cons	3.075402	.7221773	4.26	0.000	1.581464	4.569339

. dfuller LSERVI, trend regress lags(0)

Dickey-Fuller test for unit root Number of obs = 26

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(t)	-4.770	-4.371	-3.596	-3.238

MacKinnon approximate p-value for Z(t) = 0.0005

D.LSERVI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LSERVI						
L1.	-.3700549	.0775841	-4.77	0.000	-.5305498	-.20956
_trend	.016965	.0031022	5.47	0.000	.0105476	.0233825
_cons	3.419118	.7169426	4.77	0.000	1.93601	4.902227

Table 3:- Augmented Dickey-Fuller unit root test results for without constant and Trend of four variables in Level (yearly time variable: obs, 1990 to 2016)

. dfuller LGDP, no constant regress lags(0)

Dickey-Fuller test for unit root Number of obs = 26

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	5.466	-2.658	-1.950	-1.600

D.LGDP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LGDP L1.	.0027305	.0004995	5.47	0.000	.0017017	.0037593

. dfuller LAGRI, no constant regress lags(0)

Dickey-Fuller test for unit root Number of obs = 26

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	3.627	-2.658	-1.950	-1.600

D.LAGRI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LAGRI L1.	.002003	.0005522	3.63	0.001	.0008658	.0031402

. dfuller LINDU, no constant regress lags(0)

Dickey-Fuller test for unit root   Number of obs = 26

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(t)	4.526	-2.658	-1.950	-1.600

D.LINDU	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LINDU						
L1.	.0035005	.0007734	4.53	0.000	.0019075	.0050934

dfuller LSERVI, no constant regress lags(0)

Dickey-Fuller test for unit root   Number of obs = 26

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(t)	4.486	-2.658	-1.950	-1.600

D.LSERVI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LSERVI						
L1.	.0034845	.0007768	4.49	0.000	.0018847	.0050842

Table 4:- Phillips - Perron root test results for with constant and no Trend of four variables in Level (yearly time variable: obs, 1990 to 2016)

Phillips-Perron test for unit root Number of obs = 26

Newey-West lags = 2

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(rho)	0.699	-17.268	-12.532	-10.220
Z(t)	0.875	-3.743	-2.997	-2.629

MacKinnon approximate p-value for Z(t) = 0.9928

LAGRI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LAGRI L1.	1.024401	.0340743	30.06	0.000	.9540745	1.094727
_cons	-.2223009	.3381503	-0.66	0.517	-.9202089	.4756071

pperron LINDU, regress

Phillips-Perron test for unit root Number of obs = 26

Newey-West lags = 2

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(rho)	1.363	-17.268	-12.532	-10.220
Z(t)	2.012	-3.743	-2.997	-2.629

MacKinnon approximate p-value for Z(t) = 0.9987

LINDU	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LINDU L1.	1.053384	.024418	43.14	0.000	1.002988	1.10378
_cons	-.4930753	.2412526	-2.04	0.052	-.9909963	.0048457

pperron LSERVI, regress

Phillips-Perron test for unit root Number of obs = 26

Newey-West lags = 2

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(rho)	1.117	-17.268	-12.532	-10.220
Z(t)	1.585	-3.743	-2.997	-2.629

MacKinnon approximate p-value for Z(t) = 0.9978

LSERVI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LSERVI						
L1.	1.044571	.0244321	42.75	0.000	.9941458	1.094997
_cons	-.4016911	.2387518	-1.68	0.105	-.8944506	.0910684

Table 5:- Phillips - Perron root test results for with constant and Trend of four variables in Level (yearly time variable: obs, 1990 to 2016)

pperron LGDP, trend regress

Phillips-Perron test for unit root Number of obs = 26

Newey-West lags = 2

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(rho)	-4.932	-22.628	-17.976	-15.648
Z(t)	-2.477	-4.371	-3.596	-3.238

MacKinnon approximate p-value for Z(t) = 0.3394

LGDP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LGDP						
L1.	.8145609	.0742312	10.97	0.000	.6610019	.9681199
_trend	.007391	.0022576	3.27	0.003	.0027209	.0120611
_cons	1.826349	.7303589	2.50	0.020	.3154866	3.337212

pperron LAGRI, trend regress

Phillips-Perron test for unit root Number of obs = 26

Newey-West lags = 2

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(rho)	-5.045	-22.628	-17.976	-15.648
Z(t)	-1.775	-4.371	-3.596	-3.238

MacKinnon approximate p-value for Z(t) = 0.7167

LAGRI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LAGRI						
L1.	.7936269	.1137033	6.98	0.000	.5584138	1.02884
_trend	.0052141	.0024662	2.11	0.046	.0001124	.0103158
_cons	1.997175	1.09632	1.82	0.082	-.2707355	4.265085

pperron LINDU, trend regress

Phillips-Perron test for unit root Number of obs = 26

Newey-West lags = 2

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(rho)	-9.346	-22.628	-17.976	-15.648
Z(t)	-3.897	-4.371	-3.596	-3.238

MacKinnon approximate p-value for Z(t) = 0.0123

LINDU	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LINDU						
L1.	.6709748	.0771613	8.70	0.000	.5113544	.8305951
_trend	.0154143	.0030328	5.08	0.000	.0091406	.0216881
_cons	3.075402	.7221773	4.26	0.000	1.581464	4.569339

pperron LSERVI, trend regress

Phillips-Perron test for unit root Number of obs = 26

Newey-West lags = 2

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(rho)	-10.587	-22.628	-17.976	-15.648
Z(t)	-4.258	-4.371	-3.596	-3.238

MacKinnon approximate p-value for Z(t) = 0.0036

LSERVI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LSERVI						
L1.	.6299451	.0775841	8.12	0.000	.4694502	.79044
_trend	.016965	.0031022	5.47	0.000	.0105476	.0233825
_cons	3.419118	.7169426	4.77	0.000	1.93601	4.902227

Table 6:- Phillips - Perron root test results for without constant and Trend of four variables in Level (yearly time variable: obs, 1990 to 2016)

pperron LGDP, noconstant regress

Phillips-Perron test for unit root Number of obs = 26

Newey-West lags = 2

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(rho)	0.071	-11.940	-7.316	-5.308
Z(t)	4.710	-2.658	-1.950	-1.600

LGDP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LGDP						
L1.	1.002731	.0004995	2007.41	0.000	1.001702	1.003759

pperron LAGRI, noconstant regress

Phillips-Perron test for unit root Number of obs = 26

Newey-West lags = 2

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(rho)	0.052	-11.940	-7.316	-5.308
Z(t)	3.806	-2.658	-1.950	-1.600

LAGRI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LAGRI L1.	1.002003	.0005522	1814.68	0.000	1.000866	1.00314

pperron LINDU, noconstant regress

Phillips-Perron test for unit root Number of obs = 26

Newey-West lags = 2

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(rho)	0.091	-11.940	-7.316	-5.308
Z(t)	3.863	-2.658	-1.950	-1.600

LINDU	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LINDU L1.	1.0035	.0007734	1297.46	0.000	1.001908	1.005093

.

pperron LSERVI, noconstant regress

Phillips-Perron test for unit root Number of obs = 26

Newey-West lags = 2

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(rho)	0.091	-11.940	-7.316	-5.308
Z(t)	3.807	-2.658	-1.950	-1.600

LSERVI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LSERVI						
L1.	1.003484	.0007768	1291.89	0.000	1.001885	1.005084

<u>Augmented Dickey-Fuller and Phillips - Perron unit root test results for constant, constant and Trend and With-out constant and Trend of four variables at Difference</u>

Table 7:- Augmented Dickey-Fuller unit root test results for with constant and no Trend of four variables at a difference (yearly time variable: obs, 1990 to 2016)

dfullerd.LGDP, regress lags(1)

Augmented Dickey-Fuller test for unit root Number of obs = 24

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-4.841	-3.750	-3.000	-2.630

MacKinnon approximate p-value for Z(t) = 0.0000

D2.LGDP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LGDP						
LD.	-.9672543	.1998039	-4.84	0.000	-1.382769	-.5517393
LD2.	.0550467	.1636622	0.34	0.740	-.2853074	.3954008
_cons	.031844	.0070743	4.50	0.000	.0171322	.0465557

dfullerd.LAGRI, regress lags(1)

Augmented Dickey-Fuller test for unit root Number of obs = 24

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-4.358	-3.750	-3.000	-2.630

MacKinnon approximate p-value for Z(t) = 0.0004

D2.LAGRI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LAGRI						
LD.	-1.202408	.275931	-4.36	0.000	-1.776238	-.6285784
LD2.	.3003357	.2042585	1.47	0.156	-.1244431	.7251145
_cons	.0252779	.0080507	3.14	0.005	.0085355	.0420203

dfullerd.LINDU, regress lags(1)

Augmented Dickey-Fuller test for unit root Number of obs = 24

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-9.499	-3.750	-3.000	-2.630

MacKinnon approximate p-value for Z(t) = 0.0000

D2.LINDU	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LINDU						
LD.	-1.142517	.1202738	-9.50	0.000	-1.39264	-.8923937
LD2.	.0371476	.0969391	0.38	0.705	-.1644484	.2387435
_cons	.0496261	.0056818	8.73	0.000	.0378103	.061442

dfullerd.LSERVI, regress lags(1)

Augmented Dickey-Fuller test for unit root Number of obs = 24

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-9.041	-3.750	-3.000	-2.630

MacKinnon approximate p-value for Z(t) = 0.0000

D2.LSERVI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LSERVI						
LD.	-1.126057	.1245501	-9.04	0.000	-1.385073	-.8670405
LD2.	.0585316	.1011513	0.58	0.569	-.1518239	.2688872
_cons	.0482486	.0058857	8.20	0.000	.0360086	.0604887

Table 8:- Augmented Dickey-Fuller unit root test results for with constant and Trend of four variables at a difference (yearly time variable: obs, 1990 to 2016)

fullerd.LGDP, trend regress lags(1)

Augmented Dickey-Fuller test for unit root Number of obs = 24

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-5.626	-4.380	-3.600	-3.240

MacKinnon approximate p-value for Z(t) = 0.0000

D2.LGDP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
D.LGDP						
L1.	-1.343594	.2388357	-5.63	0.000	-1.841796	-.8453913
LD.	.2578917	.1701319	1.52	0.145	-.0969973	.6127807
_trend	.0017161	.000714	2.40	0.026	.0002267	.0032055
_cons	.0193471	.0082345	2.35	0.029	.0021702	.036524

dfullerd.LAGRI, trend regress lags(1)

Augmented Dickey-Fuller test for unit root Number of obs = 24

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-4.613	-4.380	-3.600	-3.240

MacKinnon approximate p-value for Z(t) = 0.0010

D2.LAGRI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
D.LAGRI						
L1.	-1.357763	.2943626	-4.61	0.000	-1.971792	-.7437334
LD.	.3791581	.2088212	1.82	0.084	-.0564353	.8147516
_trend	.0012003	.0008923	1.35	0.194	-.000661	.0030615
_cons	.0122223	.0125141	0.98	0.340	-.0138815	.0383262

dfullerd.LINDU, trend regress lags(1)

Augmented Dickey-Fuller test for unit root Number of obs = 24

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-11.759	-4.380	-3.600	-3.240

MacKinnon approximate p-value for Z(t) = 0.0000

D2.LINDU	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
D.LINDU						
L1.	-1.388684	.1180941	-11.76	0.000	-1.635024	-1.142344
LD.	.1718565	.0860917	2.00	0.060	-.0077277	.3514408
_trend	.0017945	.0005001	3.59	0.002	.0007513	.0028376
_cons	.0341491	.0062629	5.45	0.000	.021085	.0472132

dfullerd.LSERVI, trend regress lags(1)

Augmented Dickey-Fuller test for unit root Number of obs = 24

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-9.158	-4.380	-3.600	-3.240

MacKinnon approximate p-value for Z(t) = 0.0000

D2.LSERVI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
D.LSERVI						
L1.	-1.261188	.1377184	-9.16	0.000	-1.548464	-.9739126
LD.	.1400189	.1048307	1.34	0.197	-.0786541	.358692
_trend	.0010968	.0005817	1.89	0.074	-.0001166	.0023102
_cons	.0382223	.0076916	4.97	0.000	.0221779	.0542667

Table 9:- Augmented Dickey-Fuller unit root test results for without constant and Trend of four variables at a difference (yearly time variable: obs, 1990 to 2016)

. dfullerd.LGDP, noconstant regress lags(1)

Augmented Dickey-Fuller test for unit root Number of obs = 24

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-1.484	-2.660	-1.950	-1.600

D2.LGDP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LGDP						
LD.	-.2371543	.1597967	-1.48	0.152	-.5685523	.0942438
LD2.	-.2080795	.2093536	-0.99	0.331	-.6422523	.2260934

dfullerd.LAGRI, noconstant regress lags(1)

Augmented Dickey-Fuller test for unit root Number of obs = 24

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-2.555	-2.660	-1.950	-1.600

D2.LAGRI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LAGRI						
LD.	-.600498	.2350504	-2.55	0.018	-1.087963	-.1130332
LD2.	.0058098	.2148934	0.03	0.979	-.4398518	.4514713

dfullerd.LINDU, noconstant regress lags(1)

Augmented Dickey-Fuller test for unit root Number of obs = 24

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-2.018	-2.660	-1.950	-1.600

D2.LINDU	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LINDU						
LD.	-.3134613	.1553298	-2.02	0.056	-.6355957	.0086731
LD2.	-.1002246	.2011517	-0.50	0.623	-.5173876	.3169384

dfullerd.LSERVI, noconstant regress lags(1)

Augmented Dickey-Fuller test for unit root   Number of obs = 24

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-2.081	-2.660	-1.950	-1.600

D2.LSERVI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LSERVI						
LD.	-.3159118	.1517744	-2.08	0.049	-.6306727	-.0011509
LD2.	-.0589897	.2004876	-0.29	0.771	-.4747756	.3567962

Table 10:- Phillips - Perron unit root test results for with constant and no Trend of four variables at a difference (yearly time variable: obs, 1990 to 2016)

```
. pperron d.LGDP, regress

Phillips-Perron test for unit root                Number of obs   =        25
                                                  Newey-West lags =         2
```

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(rho)	-14.682	-17.200	-12.500	-10.200
Z(t)	-4.063	-3.750	-3.000	-2.630

MacKinnon approximate p-value for Z(t) = 0.0011

D.LGDP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LGDP						
LD.	.301594	.1738525	1.73	0.096	-.0580473	.6612352
_cons	.0217947	.0066274	3.29	0.003	.0080848	.0355045

```
. pperron d.LAGRI, regress

Phillips-Perron test for unit root                 Number of obs    =        25
                                                   Newey-West lags =         2

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)          -20.602           -17.200           -12.500           -10.200
 Z(t)             -4.367            -3.750            -3.000            -2.630
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0003

------------------------------------------------------------------------------
     D.LAGRI |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       LAGRI |
         LD. |    .084778   .2078298     0.41   0.687    -.3451508    .5147067
             |
       _cons |   .0184701   .0071622     2.58   0.017      .003654    .0332861
------------------------------------------------------------------------------

. pperron d.LINDU, regress

Phillips-Perron test for unit root                 Number of obs    =        25
                                                   Newey-West lags =         2

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)          -13.640           -17.200           -12.500           -10.200
 Z(t)             -5.363            -3.750            -3.000            -2.630
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
     D.LINDU |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       LINDU |
         LD. |   .3453411   .1402041     2.46   0.022     .0553069    .6353753
             |
       _cons |   .0275961   .0072489     3.81   0.001     .0126007    .0425915
------------------------------------------------------------------------------
```

```
. pperron d.LSERVI, regress

Phillips-Perron test for unit root                Number of obs   =        25
                                                  Newey-West lags =         2
```

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(rho)	-13.692	-17.200	-12.500	-10.200
Z(t)	-5.395	-3.750	-3.000	-2.630

MacKinnon approximate p-value for Z(t) = 0.0000

D.LSERVI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LSERVI						
LD.	.3535993	.1368613	2.58	0.017	.0704802	.6367184
_cons	.026891	.0070488	3.81	0.001	.0123095	.0414726

Table 11:- Phillips - Perron unit root test results for with constant and Trend of four variables at a difference (yearly time variable: obs, 1990 to 2016)

```
. pperron d.LGDP, trend regress

Phillips-Perron test for unit root                Number of obs   =        25
                                                  Newey-West lags =         2
```

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(rho)	-19.105	-22.500	-17.900	-15.600
Z(t)	-4.564	-4.380	-3.600	-3.240

MacKinnon approximate p-value for Z(t) = 0.0012

D.LGDP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
D.LGDP						
L1.	.0852865	.202462	0.42	0.678	-.334594	.5051671
_trend	.0013694	.0007397	1.85	0.078	-.0001646	.0029035
_cons	.0099514	.0089807	1.11	0.280	-.0086735	.0285763

```
. pperron d.LAGRI, trend regress

Phillips-Perron test for unit root                 Number of obs   =        25
                                                   Newey-West lags =         2

                         ---------- Interpolated Dickey-Fuller ----------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)         -21.572           -22.500           -17.900           -15.600
 Z(t)            -4.524            -4.380            -3.600            -3.240
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0014

------------------------------------------------------------------------------
D.LAGRI      |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     D.LAGRI |
         L1. |   .0152059   .2162917     0.07   0.945    -.4333557    .4637674
      _trend |   .0009225   .0008373     1.10   0.282    -.0008139     .002659
       _cons |    .007883   .0119646     0.66   0.517      -.01693    .0326961
------------------------------------------------------------------------------
```

```
. pperron d.LINDU, trend regress

Phillips-Perron test for unit root                 Number of obs   =        25
                                                   Newey-West lags =         2

                         ---------- Interpolated Dickey-Fuller ----------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)         -15.528           -22.500           -17.900           -15.600
 Z(t)            -5.336            -4.380            -3.600            -3.240
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
D.LINDU      |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     D.LINDU |
         L1. |   .2212303   .1656247     1.34   0.195    -.1222542    .5647148
      _trend |   .0012182   .0009024     1.35   0.191    -.0006533    .0030896
       _cons |   .0159312   .0111983     1.42   0.169    -.0072926    .0391551
------------------------------------------------------------------------------
```

```
. pperron d.LSERVI, trend regress

Phillips-Perron test for unit root                 Number of obs    =        25
                                                   Newey-West lags =          2

                          ——————————— Interpolated Dickey-Fuller ———————————
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
-------------------------------------------------------------------------------
 Z(rho)         -14.704           -22.500           -17.900           -15.600
 Z(t)            -4.899            -4.380            -3.600            -3.240
-------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0003
```

D.LSERVI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
D.LSERVI						
L1.	.2817721	.1606895	1.75	0.093	-.0514775	.6150217
_trend	.0007535	.0008704	0.87	0.396	-.0010515	.0025585
_cons	.0195069	.0110899	1.76	0.092	-.0034921	.0425059

Table 12:- Phillips - Perron unit root test results for with constant and Trend of four variables at a difference (yearly time variable: obs, 1990 to 2016)

```
. pperron d.LGDP, noconstant regress

Phillips-Perron test for unit root                 Number of obs    =        25
                                                   Newey-West lags =          2

                          ——————————— Interpolated Dickey-Fuller ———————————
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
-------------------------------------------------------------------------------
 Z(rho)          -5.685           -11.900            -7.300            -5.300
 Z(t)            -1.815            -2.660            -1.950            -1.600
```

D.LGDP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LGDP						
LD.	.7147978	.1426217	5.01	0.000	.4204411	1.009155

```
. pperron d.LAGRI, noconstant regress

Phillips-Perron test for unit root                 Number of obs   =        25
                                                   Newey-West lags =         2
```

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(rho)	-14.054	-11.900	-7.300	-5.300
Z(t)	-3.149	-2.660	-1.950	-1.600

(Interpolated Dickey-Fuller)

D.LAGRI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LAGRI						
LD.	.3990607	.1871185	2.13	0.043	.0128672	.7852542

```
. pperron d.LINDU, noconstant regress

Phillips-Perron test for unit root                 Number of obs   =        25
                                                   Newey-West lags =         2
```

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(rho)	-7.774	-11.900	-7.300	-5.300
Z(t)	-2.318	-2.660	-1.950	-1.600

(Interpolated Dickey-Fuller)

D.LINDU	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LINDU						
LD.	.6922949	.1331654	5.20	0.000	.4174551	.9671347

```
. pperron d.LSERVI, noconstant regress

Phillips-Perron test for unit root                 Number of obs   =        25
                                                   Newey-West lags =         2

                              ---------- Interpolated Dickey-Fuller ----------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)           -7.947           -11.900            -7.300            -5.300
 Z(t)             -2.382            -2.660            -1.950            -1.600

------------------------------------------------------------------------------
    D.LSERVI |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      LSERVI |
         LD. |   .6939286   .1298336     5.34   0.000     .4259653     .961892
------------------------------------------------------------------------------
```

Annexes B

<u>Long run estimates and speed of adjustment coefficients for target model one and two on VEC</u>

Table 13:- Long run estimates and speed of adjustment coefficients for target model one on VEC

(time variable: obs, 1990 to 2016)

. vec LAGRI LGDP LINDU LSERVI, trend(constant)

Vector error-correction model

Sample: 1992 - 2016		No. of obs	= 25
		AIC	= -25.95017
Log likelihood = 351.3771		HQIC	= -25.58506
Det(Sigma_ml) = 7.28e-18		SBIC	= -24.63378

Equation	Parms	RMSE	R-sq	chi2	P>chi2
D_LAGRI	6	.030083	0.4206	13.79401	0.0320
D_LGDP	6	.022215	0.7417	54.55106	0.0000
D_LINDU	6	.024616	0.8096	80.79423	0.0000
D_LSERVI	6	.025344	0.7923	72.48313	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
D_LAGRI						
_ce1 L1.	-.5736105	1.611599	-0.36	0.722	-3.732286	2.585065
LAGRI LD.	-.5021242	1.508718	-0.33	0.739	-3.459157	2.454908
LGDP LD.	.979079	2.742673	0.36	0.721	-4.396462	6.35462
LINDU LD.	-2.311274	1.971269	-1.17	0.241	-6.174891	1.552343
LSERVI LD.	2.024338	1.585047	1.28	0.202	-1.082296	5.130973
_cons	.0073642	.0153412	0.48	0.631	-.022704	.0374325
D_LGDP						
_ce1 L1.	-1.991706	1.190114	-1.67	0.094	-4.324286	.3408745
LAGRI LD.	.699223	1.11414	0.63	0.530	-1.48445	2.882896
LGDP LD.	-1.359996	2.025376	-0.67	0.502	-5.32966	2.609668
LINDU LD.	-.9443169	1.455719	-0.65	0.517	-3.797474	1.90884
LSERVI LD.	1.812977	1.170506	1.55	0.121	-.4811731	4.107127
_cons	.0044919	.011329	0.40	0.692	-.0177126	.0266963
D_LINDU						
_ce1 L1.	-4.041962	1.318739	-3.07	0.002	-6.626643	-1.457281
LAGRI LD.	2.372474	1.234554	1.92	0.055	-.0472067	4.792155
LGDP LD.	-4.472377	2.244275	-1.99	0.046	-8.871074	-.0736789
LINDU LD.	.1491093	1.61305	0.09	0.926	-3.012411	3.31063
LSERVI LD.	2.19278	1.297012	1.69	0.091	-.3493172	4.734878
_cons	-.0043791	.0125534	-0.35	0.727	-.0289834	.0202251
D_LSERVI						
_ce1 L1.	-3.280826	1.35774	-2.42	0.016	-5.941947	-.6197046
LAGRI LD.	2.228503	1.271065	1.75	0.080	-.262738	4.719744
LGDP LD.	-4.098714	2.310648	-1.77	0.076	-8.6275	.4300724
LINDU LD.	-.2415109	1.660755	-0.15	0.884	-3.496531	3.01351
LSERVI LD.	2.404817	1.335371	1.80	0.072	-.212461	5.022095
_cons	.0013806	.0129247	0.11	0.915	-.0239513	.0267125

Cointegrating equations

Equation	Parms	chi2	P>chi2
_ce1	3	90007.43	0.0000

Identification: beta is exactly identified

Johansen normalization restriction imposed

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
_ce1						
LAGRI	1	.	.	.	.	.
LGDP	-1.897703	.0304387	-62.35	0.000	-1.957362	-1.838044
LINDU	1.623478	.0781649	20.77	0.000	1.470278	1.776679
LSERVI	-.7028762	.0674695	-10.42	0.000	-.8351139	-.5706384
_cons	.3280397	.	.	.	.	.

Autocorrelation test

. veclmar

Lagrange-multiplier test

lag	chi2	df	Prob > chi2
1	23.9669	16	0.09023
2	12.2218	16	0.72858

H0: no autocorrelation at lag order

```
. vecnorm, jbera

Jarque-Bera test
```

Equation	chi2	df	Prob > chi2
D_LAGRI	0.988	2	0.61022
D_LGDP	3.586	2	0.16648
D_LINDU	1.416	2	0.49256
D_LSERVI	2.395	2	0.30189
ALL	8.385	8	0.39677

Table 14:- Long run estimates and speed of adjustment coefficients for target model two on VEC

. vec LINDU LGDP LAGRI LSERVI, trend(constant)

Vector error-correction model

Sample: 1992 - 2016 No. of obs = 25

AIC = -25.95017

Log likelihood = 351.3771 HQIC = -25.58506

Det(Sigma_ml) = 7.28e-18 SBIC = -24.63378

Equation	Parms	RMSE	R-sq	chi2	P>chi2
D_LINDU	6	.024616	0.8096	80.79423	0.0000
D_LGDP	6	.022215	0.7417	54.55106	0.0000
D_LAGRI	6	.030083	0.4206	13.79401	0.0320
D_LSERVI	6	.025344	0.7923	72.48313	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
D_LINDU						
_ce1 L1.	-6.562037	2.140944	-3.07	0.002	-10.75821	-2.365863
LINDU LD.	.1491093	1.61305	0.09	0.926	-3.012411	3.31063
LGDP LD.	-4.472377	2.244275	-1.99	0.046	-8.871074	-.0736789
LAGRI LD.	2.372474	1.234554	1.92	0.055	-.0472067	4.792155
LSERVI LD.	2.19278	1.297012	1.69	0.091	-.3493172	4.734878
_cons	-.0043791	.0125534	-0.35	0.727	-.0289834	.0202251
D_LGDP						
_ce1 L1.	-3.233491	1.932124	-1.67	0.094	-7.020384	.5534023
LINDU LD.	-.9443169	1.455719	-0.65	0.517	-3.797474	1.90884
LGDP LD.	-1.359996	2.025376	-0.67	0.502	-5.32966	2.609668
LAGRI LD.	.699223	1.11414	0.63	0.530	-1.48445	2.882896
LSERVI LD.	1.812977	1.170506	1.55	0.121	-.4811731	4.107127
_cons	.0044919	.011329	0.40	0.692	-.0177126	.0266963
D_LAGRI						
_ce1 L1.	-.9312441	2.616395	-0.36	0.722	-6.059285	4.196797
LINDU LD.	-2.311274	1.971269	-1.17	0.241	-6.174891	1.552343
LGDP LD.	.979079	2.742673	0.36	0.721	-4.396462	6.35462
LAGRI LD.	-.5021242	1.508718	-0.33	0.739	-3.459157	2.454908
LSERVI LD.	2.024338	1.585047	1.28	0.202	-1.082296	5.130973
_cons	.0073642	.0153412	0.48	0.631	-.022704	.0374325
D_LSERVI						
_ce1 L1.	-5.326349	2.204261	-2.42	0.016	-9.646622	-1.006077
LINDU LD.	-.2415109	1.660755	-0.15	0.884	-3.496531	3.01351
LGDP LD.	-4.098714	2.310648	-1.77	0.076	-8.6275	.4300724
LAGRI LD.	2.228503	1.271065	1.75	0.080	-.262738	4.719744
LSERVI LD.	2.404817	1.335371	1.80	0.072	-.212461	5.022095
_cons	.0013806	.0129247	0.11	0.915	-.0239513	.0267125

Cointegrating equations

Equation	Parms	chi2	P>chi2
_ce1	3	749076.1	0.0000

Identification: beta is exactly identified

Johansen normalization restriction imposed

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_ce1						
LINDU	1	.	.	.	.	.
LGDP	-1.168912	.0457034	-25.58	0.000	-1.258489	-1.079335
LAGRI	.6159615	.028967	21.26	0.000	.5591872	.6727358
LSERVI	-.4329447	.0205904	-21.03	0.000	-.4733011	-.3925882
_cons	.2020598	.	.	.	.	.

veclmar

Lagrange-multiplier test

lag	chi2	df	Prob > chi2
1	23.9669	16	0.09023
2	12.2218	16	0.72858

H0: no autocorrelation at lag order

Normality test

. vec norm, jbera

Jarque-Bera test

Equation	chi2	df	Prob > chi2
D_LINDU	0.883	2	0.64292
D_LGDP	1.175	2	0.55579
D_LAGRI	14.025	2	0.00090
D_LSERVI	2.395	2	0.30189
ALL	18.479	8	0.01791

Annex C

Table 15:- Used Data

	income in value added terms (constant 2010 US $)				Log Value of income			
year (obs.)	GDP	AGRICULTURE	INDUSTRY	SERVICE	LGDP	LAGRI	LINDU	LSERVI
1990	9,964,477,334.55	5,326,848,378.13	4,044,393,513.36	3,073,565,298.63	9.998454524	9.726470335	9.606853405	9.487642444
1991	9,253,264,786.76	5,458,539,860.74	3,267,344,944.34	2,475,452,834.80	9.96629499	9.737076486	9.514194987	9.393654656
1992	8,450,777,236.92	5,373,034,778.16	2,696,154,805.55	2,061,549,432.41	9.926896654	9.730219652	9.430744825	9.314193753
1993	9,561,448,857.47	5,726,953,044.10	3,317,838,258.36	2,512,537,947.00	9.980523706	9.757923622	9.520855211	9.40011263
1994	9,866,455,688.41	5,579,207,919.42	3,617,869,287.86	2,754,511,270.03	9.99416117	9.746572546	9.558452872	9.440044554
1995	10,471,023,886.72	5,789,359,764.12	3,979,619,308.33	3,046,102,300.43	10.01998915	9.762630538	9.599841529	9.483744485
1996	11,772,171,511.41	6,771,350,268.43	4,233,172,545.34	3,259,126,038.79	10.07085658	9.83067528	9.626665971	9.513101156
1997	12,141,100,402.80	6,906,922,665.53	4,412,297,623.23	3,402,424,585.66	10.08425805	9.839284593	9.644664799	9.531788508
1998	11,721,244,256.72	6,241,072,707.00	4,685,476,853.06	3,623,025,880.27	10.06897372	9.795259242	9.670753797	9.559071436
1999	12,326,311,977.67	6,453,129,768.77	5,037,681,070.16	3,916,968,010.78	10.09083316	9.809770399	9.702230669	9.592950025
2000	13,074,915,712.86	6,650,154,319.93	5,523,964,179.58	4,343,307,448.99	10.1164389	9.822831723	9.742250854	9.637820573
2001	14,160,304,517.47	7,290,185,565.88	5,781,549,551.60	4,540,511,900.84	10.15107259	9.862738583	9.762044252	9.657104818
2002	14,374,794,288.23	7,153,454,685.89	6,140,841,950.13	4,796,477,063.90	10.15760164	9.85451583	9.78822792	9.680922372
2003	14,064,103,274.45	6,403,423,195.08	6,634,041,138.40	5,202,620,771.65	10.14811205	9.806412205	9.82177816	9.716222171
2004	15,972,968,199.00	7,488,471,818.79	7,064,979,665.93	5,466,867,456.23	10.20338563	9.8743932	9.849110916	9.737738545
2005	17,860,775,923.36	8,502,630,914.70	7,889,038,583.07	6,140,205,711.81	10.25190032	9.929553327	9.89702408	9.788182921
2006	19,795,942,247.58	9,430,164,339.81	8,855,495,191.80	6,928,909,645.51	10.29657618	9.974519261	9.947212852	9.840664898
2007	22,063,798,449.78	10,321,156,150.26	10,130,730,910.02	8,020,671,709.48	10.34368028	10.01372835	10.00564078	9.904210741
2008	24,444,156,129.29	11,095,394,891.80	11,659,908,946.91	9,336,093,833.26	10.38817505	10.04514276	10.06669516	9.970165208
2009	26,595,865,977.44	11,801,168,561.53	13,255,436,132.26	10,706,831,222.20	10.42481414	10.07192501	10.12239402	10.02966096
2010	29,933,790,334.34	12,406,604,220.00	15,323,167,814.75	12,498,876,340.08	10.47616171	10.09365293	10.18534856	10.09687097
2011	33,279,878,092.46	13,525,057,706.32	17,372,245,141.38	14,124,003,106.18	10.52218173	10.13113913	10.23985595	10.1499578
2012	36,157,859,262.38	14,190,774,400.17	19,409,655,210.92	15,523,529,094.58	10.55820271	10.1520061	10.28801782	10.19099046
2013	39,984,181,570.29	15,198,100,509.53	21,751,235,211.40	16,928,447,157.37	10.60188821	10.18178931	10.33748392	10.22861712
2014	44,085,556,181.88	16,025,899,901.70	24,751,089,376.38	19,106,385,681.86	10.64429632	10.20482243	10.39359432	10.28117854
2015	48,667,131,306.04	17,047,998,116.03	27,993,158,765.41	21,228,196,278.00	10.68723575	10.23167339	10.44705191	10.32691309
2016	52,347,226,230.23	17,444,485,271.35	31,207,023,961.33	23,051,321,375.46	10.71889367	10.24165816	10.49425235	10.36269583

Sourec:- World Bank (WB) Data-Base, 2017