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The Determinants of Economic Growth in Algeria: Evidence for the Period 1970-2019

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Dedications

Mbwana K. Salim

I firstly dedicate this Dissertation to my Mother for being there in my whole journey of studies, secondly to all my siblings especially to my sister Mwanamisi who had a very unique contribution in my studies. Thirdly to all friends, classmates, teachers who on one way or another played unforgettable and significant contribution in my studies.

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Abstract

This study aims at investigating the key determinants of economic growth in Algeria by using time series data over the period 1970-2019. We are particularly interested in the extent to which foreign direct investment, gross domestic saving, government expenditure, degree of openness, labor force, and inflation affect economic growth. Autoregressive distributed lag bounds test was used to examine if there was a cointegrating relationship among these macroeconomic determinants under study in relation to economic growth in Algeria. The short-run and long-run relationship were also examined using the Autoregressive distributed lag model (ARDL) with error correction term. The ARDL bounds test shows that there exists long-run cointegration relationship between the variables. The long-run ARDL model shows that foreign direct investment, gross domestic saving, government expenditure and inflation have long-run positive impact on Algeria's economic growth while degree of openness and labor force have negative impact. The short-run model shows all variables are significant; except foreign direct investment and government expenditure. The study concluded that gross domestic saving, foreign direct investment and government expenditure are the most important determinants of economic growth in Algeria. We also found some evidence that improving international trade policies, human capital development; and controlling the rate of inflation have positive impact on country's economy.

Key words: Economic Growth, Autoregressive Distributed Lags (ARDL) and Determinants

Résumé

Cette étude vise à étudier les principaux déterminants de la croissance économique en Algérie en utilisant des données de séries chronologiques allant de 1970 à 2019. Les facteurs déterminants étudiés sont l'investissement direct étranger, l'épargne intérieure brute, les dépenses publiques, le degré d'ouverture, la main-d'œuvre, et l'inflation. Le test ARDL bounds a été utilisé pour examiner s'il existait une relation de cointégration entre ces déterminants macroéconomiques à l'étude en relation avec la croissance économique en Algérie. La relation à court terme et à long terme ont également été examinée à l'aide du modèle ARDL avec un terme de correction d'erreur. Le test ARDL bounds montre qu'il existe une relation de cointégration à long terme entre ces variables. Le modèle ARDL à long terme montre que les investissements directs étrangers, l'épargne intérieure brute, les dépenses publiques et l'inflation ont un impact positif à long terme sur la croissance économique de l'Algérie tandis que le degré d'ouverture et la main-d'œuvre ont un impact négatif. Le modèle à court terme montre que toutes les variables sont significatives, à l'exception de l'investissement direct étranger et des dépenses publiques, ce qui montre que ces variables ne sont pas capables d'expliquer la croissance économique à court terme. L'étude a conclu que l'épargne intérieure brute, les investissements directs étrangers et les dépenses publiques sont les déterminants les plus importants de la croissance économique en Algérie, tandis que l'amélioration des politiques commerciales internationales, le développement du capital humain et le contrôle du taux d'inflation auront également un impact positif sur l'économie du pays.

Les mots clés : Croissance économique, Autorégressive Distribution Lags (ARDL) et Déterminants

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LIST OF ABBREVIATIONS

- AIC : Akaike Information Criterion
- ADF : Augmented Dickey- Fuller
- ARDL : Autoregressive Distributive Lags
- BLUE : Best Linear Unbiased Estimators

- COEFF : Coefficient
- CPI : Consumer Price Index
- CUSUM : Cumulative sum of recursive residuals
- CUSUMQ: Cumulative sum of square recursive residuals
- DA : Dinar Algerian
- DOLS : Dynamic Ordinary Least Square
- DOP : Degree of openness
- D-W : Durbin- Watson
- ECM : Error correction model
- ECT : Error correcting term
- EU : European Union
- FDI : Foreign direct investment
- GDP : Gross domestic product
- GDS : Gross domestic saving
- GE : Government expenditure
- GNI : Gross national income
- HAC : Heteroscedasticity and Autocorrelation Consistence
- IMF : International monetary fund
- INF : Inflation
- J-B : Jarque - Bera
- K : Capital factor of production
- KRT: Kurtosis
- L : Labor factor of production
- LABF : Labor force
- MAX: Maximum
- MIN: Minimum
- OECD : Organisation for Economic Cooperation and Development
- OLS : Ordinary Least Square
- ONS : Office Nationale des Statistiques
- PCSC : Programme Complementaire de Soutien à la Croissance
- PSRE : Programme de Soutien à la Relance Economique
- PIB : Produit Interieur Bruit
- P-P : Philip Perron
- PROB : Probability

- RESET : Regression Equation Specification Error Test
- SAP : Structural Adjustment Program
- SD : Standard deviation
- SDE : Standard Error
- SIC : Schwarz Information Criterion
- SKW : Skewness
- TFP : Total factor productivity
- T-stat : T- statistic
- USD : United states Dollar
- VAR : Vector Autoregressive
- VEC : Vector Error Correction
- VECM : Vector Error Correction Model

CHAPTER ONE

INTRODUCTION

This introductory chapter provides an introduction to the study by first discussing the detailed background of the study, then economic context of Algeria, followed by problem statement and research questions, purpose of the study, significance and contribution of the study, and finalises by giving the structure of the study.

1.1. Background

The investigation into the factors that increase or hinder economic growth has been one of the central debates amongst theoretical and empirical growth researchers. Economic Growth rate which is mostly measured by the increase in growth rate of GDP varies enormously across countries over long period of time. It is regarded as fundamental requisite to economic development. The concern and one of the main strategic and policy issues for the policymakers of every government. Countries try to formulate, reformulate, changing and improving several policies in order to achieve the real growth. In fact the objective of every sovereign nation like Algeria is to improve the standard of living of its citizens by promoting economic growth and economic development but the challenge is, what determine economic growth? This question has been a challenging topic in all over the world. Many theoretical and empirical researches have been conducted to seek to understand this issue for the purpose of assisting governments in the formulation of plans and policies that can sufficiently bring economic growth and so economic development

The significant and sustainable expansion of the economy is considered to be a crucial factor in improving people's standard of living in a country (Nyasulu, 2013). Despite being the outcome of combination of many factors including natural endowments (hydrocarbons, fertile land, minerals, forests, animals, etc.) of a given country, but macroeconomic policies are considered as the main determinant (source) of the performance of any contributing factor on economic growth of a given country. Appropriate policies on different sectors influence productivity then economic growth while inadequate ones hinder the economic growth rate. Monetary, fiscal and the international trade policies are the main keys which control economies of different nations since through them the answers of the most complicated economic questions

to economic policy makers of where, what, how and to whom to produce are often obtained (Akuffo, 2012, and Mukti, 2018).

Fiscal policy is considered as a major economic stabilization weapon that involves measures taken to regulate and control the volume, cost and availability as well as direction of money in an economy to reach some specified macroeconomic policy objectives and to counteract undesirable trends in the economy. However, economies especially those in transitions do spend heavily on physical infrastructures such as ports, roads, schools, and hospitals in order to improve economic welfare of the people and facilitate production of goods and services across all sectors of the economy so as to stimulate rapid growth in aggregate output. (Tang, 2009). In Algeria, government expenditure has been on the rise owing to the huge receipts from production and sales of crude oil and gas (hydrocarbons), and the increased demand for public goods and services like roads, power, education, communication, security and health. Unfortunately, this rising of government expenditure has not been translated into meaningful growth and development, as Algeria still ranks among the poorer countries in the world (Doing Business, 2020, and Okba et al., 2018).

The German economist Adolph Wagner (1883) considers public spending as an endogenous variable, a consequence rather than cause of national income. In other words, the causality between public expenditure and national income runs from national income to public expenditure implying that public expenditure plays no role in generating national income. However, Keynes (1936) contradicts with Wagner's view, for him government expenditure is an exogenous variable that can be used to generate national income, therefore, public expenditure is a cause rather than effect of national income. He raised the idea that during economic depression government expenditure can be used to heighten economic activities (Tang, (2009); Aladejare et al., (2013); and Aniefiok et al., (2014)).

Monetary policy maintains economic stability and also promotes economic growth in a given country. The relationship between financial development and economic growth has also attracted widespread attention since a long time, and many studies focusing on this area have illuminated the real performance of the financial sector and its contribution in stimulating economic growth of countries, therefore financial development is one of very important tools for economic growth (Calderon, (2003); Levine, (2005); and Levine et al. (2008)). However, monetarists believe that an increase in the money supply will not affect the national output or gross domestic product (GDP), but money supply will affect mainly on inflation (Monekeo et

al. 2015). The link between money supply and output has been getting increasing attention in recent times for the important role it plays in economic growth in the emerging and industrialized economies (Haque et al, 2017). Some Keynesians believe that money does not matter, hence irrelevant to stimulate economic growth; on the other hand, some monetarists believe that money does matter. However, the new Keynesians argue that in the short-run, changes in the money supply seem to affect the real variables like exchange rate, inflation and employment levels because of price-stickiness and imperfect information flow in the market thus this explains that there may not be possibility of economic growth in a big chance without an appropriate level of money supply, credit and appropriate financial conditions (Hussan et al., (2017); and Domigo, (2001)).

Strong performance of financial sector has a direct positive impact on economic growth since the efficiency of almost all macroeconomic variables such as foreign direct investment, gross domestic saving rate of a nation, inflation, and international trade (exports and imports) depends on the performance of the financial sector in a given country. In Algeria where the financial sector is not strong enough (Doing Business, (2020), and World Bank, (2019)), resulted to the very small contribution of the foreign direct investment on the economic growth of a nation. The importance of strong financial sector in country's economy can be seen by the global financial crisis of 2008, where the crisis turned into a global economic recession that affected developed and developing countries, global GDP growth was projected to decline by 1.3 percent in 2009 lower than 4.8 percent in 2007 and 2.2 percent in 2008 (IMF, 2014).

Therefore, policies on interest, money supply, taxation, public spending, international trade which are all fall in macroeconomic policies, in their togetherness determine the economic growth rate of a nation as the optimal allocation of resources and effective exploitation of natural endowments all depend on the efficiency and adequacy of the macroeconomic policies.

1.2. The Economic Context of Algeria

Algerian government is like all other African countries, it has been in hurry to enforce economic growth of the country by formulating, redesigning and changing its economic policies and plans for purpose of finding the appropriate ones that will ensure sustainable economic growth and development.

Immediately after her independence, the Algerian policy-makers focused on a centralised planning process as a system to lead the nation in all aspects (i.e. economically and politically). Indeed, in a political system that quickly gave a key role to central administration, the political and economic systems were entirely led by central government, organised as a state bureaucracy aiming at consolidating economic independence by implementing a socialist model of development in which the public sector would dominate the entire economy of the nation (Teulon, Bonet, 2016). The public approach adopted was reflected in a socioeconomic program and national development plans which were a conventional means of agrarian reform and a policy of "industrialising industries," applied without exception throughout the country.

Moreover, Algerian public policy has undergone major changes since independence which can be grouped in three main phases. During the first phase (1962–1979), public policy concentrated on a planned and controlled economy that was designed as an instrument that could provide a definitive and reasonable answer to the economic and social difficulties experienced during the colonisation period. This economic planning process resulted in three unforgettable plans: (i) The first three-year plan (1967–1969) which was an indicative program, (ii) The first four-year plan (1970–1973) was a public policy backed by a theoretical model in order to diversify Algerian industry. (iii) The second four-year plan (1974–1977) launched after the nationalisation of the oil industry in 1972 (Maklouf, 2017).

The second phase (1980–1989) was devoted to self-adjustment of the economy, where the government launched plans in all economic and social areas but unfortunately it ended with major macroeconomic imbalances due to a sharp drop in oil prices in 1986 and a situation where other sectors of the economy were unable to cope with being heavily subsidised (Cigainero, (2014), Maklouf, (2017), and Hanane, (2020)). The third phase (1990–1998) targeted the development of the Algerian economy and its integration into a free-market economy. The intention was not only to liberalize the economy but also to reduce government subsidies substantially which impacted on prices and on free healthcare services. The Structural Adjustment Program (SAP) was applied during this phase (1990s), when Algeria was facing social and economic difficulties and was obliged to adjust its policy and its government strategies to face global economic realities that could not be ignored and were essential for future development (Joffé, 2002 and Maklouf, 2017).

Precisely, Houari Boumedien , who took over in 1965 through a military coup, was a more pragmatic president who came up with the first Three Years Plan (1967-1969) which marked the beginning of long-term development planning in Algeria (Zergoune et al., 2018). The nationalisation of economic activities centralised planning and massive public investment especially in industry seemed to be the best option to enforce economic growth in the country. The government completely changed the model of production from market-based production to direct management by the state. During this period of five year, capitalist model of economic growth was completely abandoned, the organisation and functioning of the economic system put in place after independence in 1962 and strengthened after the coup d'état of 1965, was not based on any individual economic institution. The Central Bank and the banking system were in the hands of the state. Public enterprises, chambers of commerce and industry, and other economic activities were all organised and managed like any other government property (Cigainero (2014), Maklouf (2017)). Their roles were to carry out the decisions taken in the framework of the plan drawn up at the top of the state.

The government also controlled the local prices of goods and services in the country knowing that price is fundamental in the allocation of resources, circulation of goods and in the distribution of income. Regarding foreign exchange rate policy, the government of Algeria adopted a system where central Bank itself set a constant exchange rate against other currencies and controlled exchange operations. In general, evolution of economic growth in independent Algeria during 1960's started with regime change from capitalist to socialist.

The concrete development plan to establish stable economy in Algeria started in the first three-year plan of 1967-1969, followed by four-year plan (1970-1973), second four-year plan (1974-1977), five-year plan (1980-1984), and the second five-year plan of 1985-1989. The main feature of these different plans was the permanent progression of public investments, especially industries. During ten years period (1967-1977), government of Algeria maintained continuously investment in industries including hydrocarbons, while abandoning agricultural sector. After having a 53.4% (or 4.9 million DA) during the three-year plan, the share of industrial investment rose to 57.3% (20.8 million DA) during the first four-year plan (1970-1973) to reach 61.1% (74.1 Million DA) during the second four-year plan (1974-1977), that shows more than 50% of the investments made during a decade (Ouchichi, 2014).

Continuing with its process of enforcing economic growth and solving various problems facing the economy, in the five-year plan of 1980-1984, agriculture was made the top of the state's

economic policy priorities. The objective was to improve the general conditions for the functioning of the agricultural sector to alleviate the country's dependence on food. According to Mourad Ouchichi (2014), in terms of investment, the agricultural and hydraulic sectors received 47.1 billion DA from 1980-1984, against only 15.2 billion DA from 1974 to 1977. The fact that shows the huge change in government economic policy. During all this period Algeria had never experienced financial constraints, and the contribution of hydrocarbons (Petrol and natural gas) in the government's resources raised by huge margin going from 31.5% during the period 1970-1973 to 63.3% in 1980, after having been of only 12% between 1963 and 1966. And bad enough in the year 1986 Algeria encountered a major problem of "Oil Price Crisis", the problem that had left a huge scars in Algerian economy. This problem showed a vulnerability of Algerian economy and how dependent it is on hydrocarbons. Many structural reforms had to be done during this period (1986-1989) in order to help the country's economy.

In the beginning of 1990, Algerian economy characterised by the reforms that aimed to transfer the economy from centralised economy to a market economy. Algeria had to accept two International Monetary Fund (IMF) stabilisation programs: A macroeconomic stabilisation program[1] from April 1994 to March 1995 and a structural adjustment program (SAP)[2] from April 1995 to March 1998. These programs were designed for Algerian economic reforms as the country was experiencing a recession after inheriting the imbalances like high unemployment rate, a large deficit on the balance of trade, inability to pay accumulated external debts and high inflation from the previous years, deteriorated further at the beginning of the 1994 after a further fall of oil prices (Samad (2011), Robert (2014), Zergoune et al., (2018)). The SAP was the most effective program that had effect on Algerian economy. In 1994 the government signed a "stand-by agreement" with the IMF to commit itself in taking radical economic and financial measures in order to achieve financial stability and repay their external debt. After four years of application of the program, government budget was restored after several years of deficit, to achieve a significant budget surplus, monetary balances were restored, restrictive monetary policy succeeded to bring down the rate of inflation after having 29.07% in 1994, 29.7% in 1995, changed to 0.34% in 2000 (World Bank data). Exchange rate

[1]The program aimed at restoring price stability as well as reducing monetary, fiscal and the balance of payments imbalances in the country.

[2]The adjustment program in Algeria since early 1994 was structured aiming at promoting a high rate of economic growth so as to absorb the increase in the labor force and gradually reduce unemployment; ensuring a rapid convergence of inflation toward rates prevailing in industrial countries; mitigating the transitional costs of structural adjustment on the most vulnerable segments of the population; and restoring balance of payments viability while ensuring adequate levels of foreign exchange reserves.

was stabilized after the strong depreciations recorded throughout the 1990s (5.9% in 1993, 77.8% in 1994, 21.6% in 1995, and 7.7% in 1996). The program also improved external balances, balance of payments improved as a result of raising the oil price and the control of the service and the ratio of the external debt achieved through rescheduling. External debt declined from 83.5% of gross national income (GNI) in 1995 to 48.8% of GNI in 2000 (World Bank data). In the individual level, especially for the majority of Algerians who lived through the 1990s, the SAP meant "austerity," with increasing prices, falling purchasing power, and raising unemployment, alongside the declining fortunes of the middle class and the further marginalization of the poor (Achy, 2013). The Algerian dinar experienced a series of successive devaluations that led to a significant drop in the purchasing power as Algeria by that time was still in planned economy, meaning the price in the market was not free and thus any importation could stimulate the intensive increase in prices of goods and services at the local market.

In the beginning of 2000s, after the end of SAP, Algeria began to launch various economic recovery and economic growth programs. The government launched a three-year economic recovery support program (Programme de Soutien à la Relance Economique (PSRE), 2001-2004), followed by a five-year program of strengthening economic growth (Le Programme Complementaire de Soutien à la Croissance (PCSC), 2004-2009). The economic recovery support program (2001-2004) had the main objectives of stimulating the growth dynamic in the economy, job creation in order to reduce poverty and improve standard of living of the population, preservation of regional balances and revitalisation of rural areas. The program contributed to acceleration of economic growth from in 3% in 2001 to 7.2% in 2003, also dropped unemployment to 17.6% in 2004, from 29.7% in 2000 (World bank data). In the 2005-2009 Complementary Growth Support Program, the government aimed at developing and modernising the roads and rail network, improving living conditions in terms of housing and access to healthcare, improving higher education and training, ensuring constant supply of water and the development and modernisation of public service. In 2005, economic growth recorded an overall rate of 5.9%, declined to 1.7% in 2006, 3.4% in 2007, 2.4% and 1.6% in 2007 and 2008 respectively (World Bank data). All these trends show unstable economic growth experienced by Algerian economy.

Algeria is the great producer of hydrocarbons and fourteenth largest oil exporter in the world, and it supplies 20% of Europe's natural gas, the country has the eighth largest proven gas reserves in the world (Tani, 2013). The quantity of natural resources in some developing

countries is relatively higher than other areas of the world. Algeria is among these countries that have significant valuable petroleum oil reserves and natural gas but still backward and its economic growth is relatively insufficient. These factors affect directly and indirectly to the socio-economic condition of the country and therefore the growth rates of developed and developing countries are different as the utilisation of the resources is different.

The Algerian regime may have secured relative stability for the time being, but it faces looming challenges that threaten to derail this success. The elaborated redistribution system on which the government relied for everything from civil servants' salaries to subsidies cannot be sustained indefinitely. Eventually, the weakness of Algeria's economy which is overly dependent on its rapidly depleting hydrocarbon resources will expose the regime to the demands of its disgruntled population. The country's commitment to the path toward a market economy apparently frees entrepreneurial vocation (Atmane 2015) but masks a serious deindustrialisation (Fatiha, (2012), Achy, (2013), and Nadji (2014)).

In view of the above, it can be observed that despite all the effort made by Algerian government on formulating a good number of economic policies and reforms since her independence, it was not enough to bring about the desired level of economic growth. By being the desire of every country to achieve and maintain a high growth rate that is sustainable, Algerian policy makers need to examine and understand the real if not the most powerful determinants of growth so that policies are focused and directed towards growth enhancing sectors. Arguably, poor understanding of the drivers of economic growth leads to formulation of ineffective policies and national development plans thereby undermining the key areas and focus on less important ones. Hence, this study seeks to ascertain and to put more emphasis on the factors that determine and influence economic growth in Algeria on the basis of empirical analysis of the data gathered from the bulletin sources of the World Bank.

By using econometric methods, the research will analyse what determine economic growth in Algeria. Econometric may be defined as the quantitative analysis of actual economic phenomena. The fact that, economic theory gives statements that are mostly qualitative in nature, the job of econometric is to provide numerical estimates. Stated differently, econometrics gives empirical content to most economic theory (Gujarat, 2009). These methods will assist in analysing the key determinants of economic growth in the country so as to give an idea to the government and other private institutions on where to put the efforts in the pursuit of the sustainable economic growth.

1.3. Problem Statement and Research Questions

Understanding the determinants of economic growth is highly important in the country on the pursuit of sustainable economic development. Numerous studies have investigated the main determinants of economic growth in different countries for the need of finding out and helping the respective countries in formulating economic policies. By using theoretical and empirical methods those researches have given insights and provided the answers on what determine economic growth.

However, regarding to Algeria, the number of empirical researches that have been done to analyse determinants of economic growth in general is minimum and have not put in context the background of economic growth in Algeria so as to give an idea on where the economy came from and where is heading to. More than that, in Algeria, most researches done in this area are theoretical, and the most of empirical ones only based on analysing the importance of single factor separately like exportation (Amina and Nadia, 2017), government expenditure and money supply (Igoucimene and Kirouane, 2018), foreign direct investment (Lamia and Ilia, 2018), human capital (Dahbia and Noura, 2018) in the contribution of economic growth of the country. The number of researches that include several variables for purpose of finding out the key determinants are numbered.

In general, this research is direct at answering the following questions

1. What are the key determinants of economic growth in Algeria?

2. How these determinants individually relate to economic growth?

3. What is the long-run impact of the determinants on economic growth?

4. What is the direction of causality between the determinants and economic growth in the country?

1.4. Purpose of the Study

The main purpose of this study is to investigate the key determinants of economic growth in Algeria that should be taken into consideration in the process of national economic planning for achieving economic development. The study also intends to know how the determinants individually relate to economic growth, and ascertaining their long-run impact.

The motivation of doing this research comes from the fact that, economic growth is the principal influencer of sustainable economic development in the country and in today's economy knowing these drivers of economic growth is very important for assisting the government of the country in the process of formulating effective national economic policies such as monetary and fiscal policies, and effective development plans.

1.5. Significance and Contribution of the Study

Recently, most countries have been changing their macroeconomic policies and development plans in order to boost economic development, but their decisions have been fruitless because they put much emphasis on the policies which do not have direct influence on economic growth because they lack accurate information.

In light of Government of Algeria's implementation of largely economic development policies, since her independence in 1962 and more especially after the adoption SAP in 1994, it is vital that this study be carried out to empirically determine and quantify the impact that the macroeconomic variables examined in this research have had on economic growth which are the very important components of the economic development process.

Particularly now that the government of Algeria is urgently seeking alternative ways of reviving the ailing economy after experiencing the bad effect of Covid-19. It is essential that the final decision made should be evidence-based.

The study will therefore be of significant help to Algerian's policy makers in deciding whether or not the country should persist with the economic growth agenda or alternatively pursue a completely different economic development. This study will also act as a vital reference for researchers in the development economics field pursuing further research on the topic both in Algeria and beyond.

1.6. Structure of the Study

The remainder of the study is organised as follows; chapter two discusses literature review, which is divided into theoretical and empirical sections that aim at giving insights from previous studies related to the title of this research and the theory used. The third chapter discusses the methodology of the work, that is, econometrical and statistical methods that used to do the work. The empirical results and analysis of the findings will be in chapter four, and finally conclusion together with policy recommendations will be presented in the final chapter five.

CHAPTER TWO

LITERATURE REVIEW

Several studies have addressed the issue of economic growth either theoretically or empirically. Most of theoretical studies have tried to explain the notion of economic growth, what causes economic growth and why some countries grow faster than the other, and authors have tried to give answers to these questions theoretically. The origin of these theories can be traced back from the classical school to the modern theories

On other side, most empirical studies have discussed the issue of economic growth by using various methods such as Granger Causality test, and also have generated various econometric models such as Autoregressive Distributed Lags (ARDL) models, Cointegration and Vector Autoregressive model (VAR). This section will attempt to overview all these theoretical and empirical studies.

2.1. Factors of Economic Growth

- **Capital**

Capital in its narrow sense refers to only productive assets which produce goods and services directly, like machinery, tools, equipments and buildings. In its broad sense, capital means all 'man-made of production'. Capital contributes to economic growth by increasing labor productivity per unit of time. In Solow's economic growth model, capital accumulation is considered as one among the most important factors influencing the growth (Karl, 2005 and Acemoglu, 2011)

- **Human capital**

Human capital is the knowledge and skill embedded in human being. It is the most important factor of the growth. Economists' right from the early days recognised knowledge, the mental power of human beings, as the most important factor in human survival and its material prosperity. As Todaro has observed, "most economists would probably agree that it is the human resource of a nation and not its capital or its material resource that ultimately determines the character and pace of the economic and the social development" (Dwivedi 2012).

If the human resource of a country is well skilled and trained then the output would also be of high quality. On the other hand, a shortage of skilled labor hampers the growth of an economy. Therefore, the human resources of a country should be adequate in number with required skills and abilities, so that economic growth can be achieved (Gruzina et al. 2021)

- **Technology**

Technological development helps in increasing productivity with the limited amount of resources. Countries that have worked in the field of technological development grow rapidly as compared to countries that have less focus on technological development. It allows economy to overcome some of the limits imposed by diminishing marginal returns and results in an upward shift in the production function.

Many economists claim that technical change (technological progress) is the most powerful and most dependable engine of economic growth as it acts as the cause of higher productivity. Technology and adoption of technology have been important subjects of research in the literature of economic growth in the recent years (Nguyen, 2009).

- **Government**

The growth of government has proved to be both positive and negative factor in the process of economic growth and development. The governments have contributed significantly in the process of growth and development under the category of building social overhead capital and under the promotional role such as maintaining and developing an efficient capital market, protecting domestic industries against foreign competition (Adeniyi, 2013).

On the other hand, Anaman (2004) empirically proved that government can also negatively affect economic growth through massive intervention, corruption and formulation of inappropriate policies.

- **Land**

Land as a growth factor or as a factor of production refers to all the natural resources of a country. It includes arable land, fertility of soil, plain land surface, underground resources, water resources, climate, topography, forest, weather conditions and rainfall. In this sense of the land, it has always been considered as the very important factor of economic growth as it is the source of food, the basic needs of human life, and the endowed land with vast area of natural

resources is the richest source of industrial raw materials. A country having skilled and educated workforce with rich natural resources takes the economy on the growth path.

2.2. Theoretical Literature Review

2.2.1. Classical Theory of Economic Growth

The economic changes in the 18th and 19th century influenced the philosophers of that time to develop various economic theories, they developed the so called the classical economic growth theory. The classical economists thought that economic growth was linked with supply, they sought to provide an account of the broad forces that influence economic growth and of the mechanisms underlying the growth process. The most notably work of these classical economists were the work of Adam Smith, Robert Malthus and David Ricardo.

- **Adam Smith**

In 1776 Adam Smith published his famous book "An Inquiry into the Nature and Causes of the Wealth of the Nations", in this book he analyses the dynamics of wealth of nations and welfare of individuals and societies. According to him, the main factors affecting the engine of the economic growth are population growth, the division of labor and the institutions framework of the economy (competitive-free traded market economy). He emphasises on the importance of legal framework in which invisible hand[3] of the market could function and open trading system. He argues in favor of free trade and against planned economies and also tries to answer the primary one question and that is how to measure the national wealth.

Moreover, in Smith's idea capital accumulation is very important factor for growth. He believes that increasing capital accumulation leads to increased population and employment which in turns causes division of labor and specialisation which boost labor productivity. Capital accumulation also increases wages above subsistence level and so purchasing power would be higher and permits the expansion of the market. He thinks this chain of events would finally generate economic growth.

[3]Invisible hand is the concept used by the father of economics Adam smith, signifying the market mechanism on how forces of demand and supply regulate the disequilibrium in the market without involving the government's intervention.

Smith had a big impact with his publication, not because he established a new model of economic growth, but because his certainty of the model's success. He was determined to change the institutions, and moreover, his promise of a better life for those who were struggling to survive on the previous decades made his work popular (Ayhan, 2015). He showed the little progress that had been achieved with the mercantilism and suggested a radical change.

- **Thomas Malthus**

Malthus turned the *Wealth of Nations* into the "Poverty of Nations" as for him an increase of wages would increase population growth, but the increase in population would eventually decrease wages again. Known for the population growth philosophies outlined in his 1798 book "An Essay on the Principle of Population", in it, Malthus theorised that populations would continue expanding until growth is stopped or reversed by disease, famine, war, or calamity. Malthus specifically stated that the human population increases geometrically, while food production increases arithmetically (Micevska, (2001), Charbit, (2009), and Chowdhury et al. (2018)). Under this paradigm, humans would eventually be unable to produce enough food to sustain them.

He wrote that overpopulation was the root of many problems industrial European society suffered from— poverty, malnutrition, and disease could all be attributed to overpopulation. According to Malthus, this was a mathematical inevitability. Malthus observed that, if left unrestricted, human populations would continue to grow until they would become too large to be supported by the food grown on available agricultural land. In other words, humans would outpace their local carrying capacity, the capacity of ecosystems or societies to support the local population.

- **David Ricardo**

David Ricardo explicitly subscribed to the works of Adam Smith and he gave himself the task of correcting Smith on what he believed is wrong. Ricardo agreed with Smith on the matter of increasing returns in manufacturing and not in agriculture. He believed in manufacturing labor productivity increases over time but in agriculture the land will be faced with decreasing returns. Because he didn't take into account the effect of improvement in technology, he

believed the productivity would fall with the use of less fertile land (Batoche, (2001), Harris, (2007), and Lanza, (2012)). In the long term, prices in agriculture would grow and cause increasing in wages and this would cause economic growth (increasing in agricultural production).

Ricardo's view on public expenditure is that the States should redirect their efforts towards investment in order to generate capital accumulation so that the economy of a nation can move to the higher steady state (Handa, 2011).

Ricardo provided the first rigorous analysis of the several topics in economics. Among these were: the theory of distribution of income into rents, wages and profits; the theory of comparative advantage according to which nations benefit by specialising in the production of items in which they have a comparative advantage; the theory of value or relative prices, according to which the relative prices of commodities would depend on their relative cost of production in the long run and their scarcity in the short run.

2.2.2. Harrod-Domar Growth Model

Harrod-Domar growth model is a Keynesian model of economic growth presented independently by Roy F. Harrod in 1939 and Evsey Domar in 1946. The model stresses the importance of savings and investment as the key determinants of economic growth. In their separate writings both Harrod and Domar came up with the same conclusion, and so the name Harrod-Domar growth model.

This model not only shows that in which conditions growth follows stable or unstable path but also shows that the market mechanism may not provide stable growth rate in the long run therefore they confirmed that the proposal of Keynes which capitalist system was inherently unstable is valid not only in the short run but also in the long run.

In extending Keynesian analysis over the long term, both Harrod and Domar considered any act of investment (capital accumulation) could have two distinct effects on the economy (Dwived, 2012);

- An income effect; this is whereby investment acts on demand. The increase in investment generates income for those who supply labor and raw materials and that leads to the increase in demand through a multiplier effect.

- A capacity effect; this is a long term effect, whereby investment acts on supply. In this case the increase in investment increases capital stock and leads the increases in supply, through the channel of increasing production capacity of the economy through an accelerator effect

Harrod and Domar insist that the new demand (or spending) must be adequate enough to absorb the output generated by the increase in capital stock.

They also emphasise that to boost economic growth rate the country has to increase saving rate and investment and so in developing countries low rates of economic growth and development are linked to low saving rates. The major challenge of this model is that the parameters used in the model like capital-output ratio and marginal propensity to save are all determined independently out of the model (Dwived, 2012).

2.2.3. Neoclassical theory of economic growth.

The approach adopted by growth theorists like Solow, Tobin, Swan, Johnson, Meade and Phelps in their economic growth models is based on the assumptions usually made by the Neo-classical economists (Pigou, Marshall and Wicksell), that's why the contributions made by these theorists to the growth theory have been given a collective name as 'The Neo-classical Growth Theory'. The most renowned neo-classical economic growth model is Solow-Swan growth model, popularly known as the Solow Model.

The Solow growth model was the famous neoclassical economic theory that revolutionised the understanding of economic growth. The theory was named after economist Robert Solow who proposed it in 1956. Solow criticises the Keynesian Harrod-Domar long term growth model for the crucial assumption that production takes place under conditions of fixed proportions (Schiliro, 2017). Thus Solow (1956, p.66) proposed a model of long run growth which accepts all Harrod-Domar assumptions except that of fixed proportion in production.

The Solow growth theory states that economic growth is the result of three factors; labor, capital and technology. Solow explains the impact of capital and labor force on the long run growth of output, he shows output growth is the result of labor force growth and growth in the capital stock. He then added technological progress as the third factor that augments labor's productivity and increases the output capabilities of labor, increasing the total output (that's economic growth) through increased efficiency of labor. Solow defines the following aggregate production function;

$$Y=AF(K, L)$$

Where, Y is aggregate output, K and L are the factors of production capital and labor respectively, A represents technological progress, or as it is usually called Total Factor Productivity (TFP).

Total factor productivity refers to all inputs that affect the aggregate output (Y) except labor and capital. An important assumption of the Solow model is that technological progress is exogenous. The production function is assumed to have the Cobb-Douglas form and exhibits constant returns to scale: if all the inputs are doubled, output will exactly double.

Regardless its mathematical simplicity, the Solow model is also appreciated by going back to the microeconomics foundations of general equilibrium theory and that's why it is also considered as the workhouse model of macroeconomics in general (Schiliro, 2017). A good grasp of its workings and foundations is not only useful in investigations of economic growth, but also essential for the modern economic analysis.

2.2.4. Endogenous Growth Model

Endogenous growth models consider that the sources of economic growth emanate from the economy under consideration. It considers that economic growth comes from the economic activities that conducted inside the country and particularly explains long run growth as emanating from economic activities that create new technological knowledge. The aim of the endogenous growth theory is first, to overcome the shortcomings of the Solow and Ramsey models which are unable to explain sustained growth, and on the other hand, to provide a rigorous model in which all variables which are crucial for growth, in particular savings, investment, and technical knowledge, are the outcome of rational decisions. Endogenous growth model particularly contains the works done by Romer (1986, 1990), Lucas (1988) and Barro (1990).

In 1986 and 1990 Romero highlighted the importance of physical capital, research and development in stimulating economic growth. He emphasised that the collective accumulation of fixed capital creates positive externalities between firms and through the phenomenon of learning by doing workers increase knowledge. In the second part, research and development is one of the fundamentals of growth, states thanks to the spending in this area could create positive externalities in the economic field for example Innovation.

Lucas in 1988 highlighted the significance of human capital in economic growth. He emphasises that the collective productivity of capital depends on individual accumulation in training, education and health. Investment in human capital is a vital component of growth, it presents wealth for the country concerned because it constitute a profitable investment in the long term. In this case we can even prove in the today's world in which the countries like China and Malaysia have taken off economically, starting with investing in the human factor.

Endogenous growth model also analysed the necessity of public capital, it was Barro who highlighted public capital in 1990. Barrow emphasises that public investment in infrastructure would increase the marginal productivity of private capital. He considers that infrastructures present free factors of production for companies, since they create positive externalities for them.

The first version of endogenous growth theory was AK theory. The AK theory did not make an explicit distinction between capital accumulation and technological progress. In effect it lumped together the physical and human capital whose accumulation is studied by neoclassical theory with the intellectual capital that is accumulated when innovations occur. The simple functional form of the theory is,

$$Y=AK$$

Where Y is proportional to the aggregate stock of capital K, and A is positive constant that reflects the level of technology. According to AK theory, an economy's long run growth rate depends on its saving rate.

Theoretical models of endogenous growth are relevant in the sense that they adapt to current economic problems. But it was also faced by criticisms and one of the biggest criticism aimed at this theory is that it is impossible to validate with empirical evidence.

2.3. Prior Evidence on Economic Growth

This section reviews the relationship between economic growth and its determinants as empirically discussed by various authors. Unsurprisingly, over the last two to three decades a wide range of studies has investigated the determinants of economic growth. Using differing

conceptual and methodological approaches, these studies have placed emphasis on a number of explanatory parameters and offered various insights to the process of economic growth.

2.3.1. Review of Empirical Works

- **Foreign Direct Investment (FDI)**

The effect of FDI in economic growth is always expected to be positive from the fact that FDI flows new investment into the country. Although this positive relationship can be used as the rule of thumb, many authors have also found a negative relationship between FDI and economic growth as measured by GDP. Mukupa et al. (2016) in the study of empirical analysis of the determinants of economic growth in Zambia for the period of 1973-2013 using ordinary least square method found that economic growth as measured by gross domestic product (GDP) is positive related with FDI and it's also the major contributor of economic growth. The study emphasised that FDI is meaningful to the empirical model for predicting economic growth in Zambia. They concluded by recommending that the central focus of economic policy in Zambia should be directed towards providing an enabling environment for investment in the various sectors of the economy.

Jahanger (2019) in his study of Determinants of Economic Growth, empirical Evidence from China over the period 1990-2017, by using multiple linear regression method his empirical results exhibited a negative relations between GDP and FDI. The negative relation between GDP and FDI is a surprising and conflicting result of his study because hypothetically GDP is always positive correlated with FDI but the author emphasised this negative relation and concluded that this negative relation led us to believe that the foreign direct investment in a developing nation like China would be negatively affecting its economic performance and growth. A developing nation like China that is rich in many resources may help from the capital formation, which means domestic investment would more benefit the country's economy than foreign investment because foreign investors repatriate profits back to their respective countries.

Havi et al. (2013) in the study of Macroeconomic determinants of economic growth in Ghana by Cointegration approach concluded that foreign direct investment has direct impact on growth in real GDP per capita, a unit increase in foreign direct investment causes growth in real GDP per capita to increase by 18.4 units. They found there is existence of long run and short run

relationship between growth in real GDP per capita and foreign direct investment, as a result increase in this variable lead to an increase in economic growth in Ghana.

- **Human Capital**

Actually there is strong correlation between human capital and economic growth. Several authors have tried to explain this relationship between human capital and economic growth. A challenging problem comes to what is the better proxy to be used as human capital in empirical analysis. Authors choose different proxies in their analysis to find the impact of human capital in the economy, Khungwa (2017) used secondary school enrolment rate, Havi et al. (2013) used labor force (measured as the percentage of total population aged 15-64), Machuki (2013) used government expenditure on education and health, and Jahanger (2019) chose total population as a proxy of human capital.

A study by Khungwa (2017) on Determinants of Economic Growth in Malawi using time series data from 1970 to 2003 showed the positive relationship that exists between human capital and economic growth as measured by GDP. By using an Error Correction Model that was specified and estimated using OLS technique, the author showed that the impact of human capital on economic growth using secondary school enrolment rates used as a proxy was found to be positive and significant both in the short run and long run. The results show that a 10 percent increase in human capital causes a 3.8 percent increase in economic growth in the short run and 6.8 percent increase in growth in the long run. The author concluded that in order to achieve growth the investment on human capital development should be emphasised and that can be achieved by increasing expenditure by government on education and training.

Barro's study in 1991 used data for 98 countries for the period of 1960-1985 to investigate the relationship between human capital and economic growth as measured by real growth rate of GDP. He found that output growth was significantly positively determined by human capital as proxied by both primary and secondary school enrolment, in the presence of other determinants. A one percentage point increase in primary school enrolment was associated with 2.5% increase in GDP growth and a similar increase in secondary school enrolment produced 3% growth.

Wilson et al. (2004) reviewed the impact of human capital on economic growth. Their study presented an extensive international review on the link between investment in education, training and skills and economic performance at the macro level. They showed that increased

investment in education lead to higher productivity and earnings for the individual. The examination of EU statistics that measure GNP, employment, unemployment and various educational and vocational training investments suggested that economic growth across 15 Member States is associated with increases in both education and training. Studies on the general rate of return were found to demonstrate strong links between education and training and economic performance, not only for the individual, but for society as a whole.

By using labor force as a proxy, Ajide (2014) in his study on Nigeria economy by using a multivariate regression approach found that labor force is positively and significantly related to economic growth. An increase in the quantity of labor force was shown to cause an increase in economic growth in the country.

- **Gross domestic saving**

The impact of gross domestic saving on economic growth is widely known and extensive research has been conducted in this area. From a theoretical point of view, the relationship between saving and economic growth is positive because saving help to create investment, production, employment and finally enhance economic growth. The increase in saving could stimulate economic growth and on the other hand economic growth could stimulate the growth of domestic saving. Worku and Elias in 2015 analysed the causal relationship between economic growth and savings in East Africa (1981-2014) by applying Vector Error Correction (VEC) method and Johnson's approach and used the time series data gathered from World Bank database. The empirical study confirmed that a significant relationship between domestic savings and economic growth in the case of Ethiopia and Uganda. However, there is no significant relationship obtained in the case of Kenya over the study period by Johnson co-integration approach. The results of Granger Causality between economic growth (GDP) and gross domestic savings indicated the existence of unidirectional causality between economic growth and gross domestic savings in the case of Ethiopia and Uganda. Gross domestic product does Granger cause gross domestic savings; this means that economic growth accelerates gross domestic savings in the case of Ethiopia and Uganda. It is recommended that the countries need to design a policy which enhances higher economic growth through increasing total factor productivity and, which ultimately increases the country domestic saving level. Moreover, to achieve sustainable growth the government needs to embark on policy measures, which increase saving and investment into the country due to its dual effect.

Misztal (2011) analysed the relationship between gross domestic savings and economic growth in countries with different level of economic development. He analysed this relationship in advanced economies and in emerging and developing countries. The author carried out Engle-Granger cointegration test which confirmed the existence of correlation between these variables. Therefore, he analysed the correlations between economic growth and savings in advanced economies and in emerging and developing economies in the 1980-2010 period, he used the correlation methods which indicated long-term cause and effect relationships between the analysed variables. By using Granger causality approach the findings showed the changes of GDP were not the cause of the gross domestic savings in Granger sense but at the same time the gross domestic saving were the cause of changes in GDP in Granger sense in advanced economies. Similarly, in the case of emerging and developing countries gross domestic savings were the cause of changes in GDP in the Granger sense while the changes in GDP were not a cause of gross domestic savings in Granger sense. So the results confirmed the existence of positive, unidirectional causal relationship between economic growth and savings. The author concluded by advising that the main objective of national economic policies should be to encourage the people to save because saving seemed to be a more important factor of economic growth.

The relationship between domestic savings and economic growth also investigated by Rasmidatta (2011), the case study of Thailand during the period of 1960-2010, the result also showed there is relationship between domestic savings and economic growth. Employing Granger's causality test the results showed unidirectional causal relationship between domestic saving and economic growth, that is, the direction of causality is only from GDP per capita growth rate to gross domestic saving per capita growth rate and so there is no reverse causation from gross domestic saving per capita growth rate to GDP per capita growth rate. The results suggested that in Thailand economic growth rate does play an important role to Granger causes growth rate of savings, so the country tends to have a higher level of income first in order to generate higher rate of domestic saving.

Ferdaus et al. (2021) got a conflicting results on their research in Pakistan for the period of 1973 to 2018. They used Dynamic Ordinary Least Squares (DOLS) approach to estimate long-run elasticities. The results demonstrated that domestic savings have a negative impact on economic growth that means savings are not effective in enhancing the growth domestic product growth figures in Pakistan. A rise in gross domestic savings was found to reduce the GDP growth level by 0.73%, on average, ceteris paribus and this result was statistically significant at 1% level of

significance. Similar result was found by Joshi et al (2019), Verma (2007) and Bist and Bista (2018). Therefore, savings seemed to be detrimental to the growth process of Pakistan. This can be due to the reason that the savings in Pakistan were not used on investment in economic activities.

- **Trade Openness**

Openness is the degree to which non domestic business transactions (imports and exports) take place in the country's economy. Theoretically, openness results to providing access to goods and services, transfer of technology, knowledge and skills spillovers across countries, and efficiency allocation of resources, so enhance economic growth. Most researches conducted in this area proved this statement. Keho (2017) discussed the impact of trade openness on economic growth, the case of Cote d'Ivoire over the period 1965-2014 in a multivariate framework including capital stock, labor and trade openness as regressors. He used the Autoregressive Distributed Lag (ARDL) bounds test to cointegration and the Toda and Yamamoto Granger causality tests. The results of the ARDL bounds test demonstrated long-run relationship existed among the variables when regression is normalised in GDP, trade openness and capital stock. After finding the existence of cointegration between the variable, the author estimated the long-run effects of capital, labor, and trade openness on economic growth (GDP). He estimated this long-run relationship by using ARDL, Fully Modified OLS, and Dynamic OLS methods. The coefficient trade openness was statistically significant and had a positive sign, suggesting that, the relationship between trade openness and economic growth is positive. Other things remain the same, a 1% rise in trade openness increases output by 0.15%. The results of Granger causality test clearly showed there exists a strong unidirectional causality from trade openness to GDP. The same result was found by Andersen et al. (2008) that the empirical survey confirmed there is a link between trade openness and economic growth. Although they warned that it is not clear whether international trade causes growth, whether growth causes trade, or there is a bidirectional link between them. And since openness may affect growth through many channels, it is difficult to develop a single, universal measure that includes all aspects of how trade openness affects growth.

Other studies by other scholars contradict the findings above by showing a diverse nature of the relationship between trade openness and economic growth. Khungwa (2007) on her research on economic determinants in Malawi found that the degree of openness of the country to foreign trade revealed to negatively affect economic growth and it is significant. A 10 percent increase

in degree of openness Malawi as a small open economy is not competitive such that it imports more than it exports. Hence due to high degree of openness it has suffered the effects of dumping of goods, as is the case in most developing countries. With few tradable good mostly traditional products, it is not competitive to take advantage of the openness to attract imports of its export hence that the more open it is the more the reduction in economic growth.

- **Inflation**

Theoretically, high inflation rate is negatively affecting economic growth as inflation increases the cost of living by raising up the price of goods and services, cost of capital, investment expenditure, management cost, and finally reduce purchasing power. Most researchers have found this fact that inflation has adverse effect on economic growth but contradicting results have also been found. A study made Milenković et al. (2017) on Macroeconomic determinants of economic growth in Serbia by using Ordinary Least Square method the authors found that independent variable inflation has positive effect on GDP, but it is not statistically significant. They also found a positive correlation between inflation and GDP.

Andrés et al. (1997) estimated the impact of inflation upon the long-run performance of the OECD countries. The main finding of their work is that there is a significant negative correlation between inflation and income growth during rather long periods. Even though they added another additional regressors such as savings, population growth and schooling rates, and the imposition of theoretical restrictions implied by the constant returns of technology, the negative correlation between inflation and growth still survived. And the most remarkable feature was that the negative coefficient of inflation in growth equations remained significant even after allowing for country-specific time-invariant effects in the equations. The analysis of causality also gave the same results that Granger causality from inflation to growth is always significant and never positive.

The empirical research conducted by Kasidi et al. (2013) on the impact of inflation on economic growth, a case study of Tanzania for the period of 1990-2011, the authors also found that inflation has negative impact on economic growth. The results implied that as the general level of prices increases, the GDP decreases. The increase in the general price level (inflation rate) by one percent resulted in a decrease of GDP by 18.3%. So they literally showed that increase in inflation rate was harmful to economic growth. The authors also regressed inflation on GDP

in order to know the nature of their relation when inflation is dependent variable and GDP is independent variable. The results of their relation was also negative. In addition, their study also revealed that there was no cointegration between inflation and economic growth during the period of study.

Mbulawa (2015) on his research concerning Macroeconomic Determinants of Economic Growth in Zimbabwe for the period of 1975-2012 his findings showed that inflation had a significant negative impact on economic growth. By employing the Vector Error Correction Model (VECM) his findings revealed that inflation and per capita GDP converged to long run equilibrium and inflation was detrimental to economic growth. Per capita GDP converges to long run equilibrium with inflation because their signs and the adjustment parameters were correct. That situation showed that the model fits very well. When inflation is below equilibrium it will be taken up towards the level of GDP per capita in the long term. When the level of GDP per capita is above equilibrium it will be pulled back to equilibrium because the adjustment parameter is negative. So the model fits well because the coefficient and adjustment parameter for inflation is statistically significant. He concluded that the level of inflation should be kept at a low threshold to minimise its impact on growth in the long term. If the rate of inflation remains unchecked there is potential to reverse the rate of growth of per capita GDP in the long term.

- **Government expenditure**

Government expenditure is considered as an important variable which may determine changes in national income in any country. In other words, fiscal policy is a major economic stabilisation weapon that involves measures taken to regulate and control the volume, cost and availability as well as direction of money in an economy to achieve some specified macroeconomic policy objective and to counteract undesirable trends. Economies in transition do spend heavily on physical infrastructures to improve economic welfare of the people and facilitate production of goods and services across all sectors of the economy so as to stimulate rapid growth in aggregate output.

Fajingbesi in 1999 empirically investigated the relationship between government expenditure and economic growth in Nigeria. The results indicated that real government capital expenditure has a significant positive influence on real output. However, the results showed that real government recurrent expenditure affects growth only by little. In 1998 again Fajingbesi and

Odusola, by using vector autoregressive (VAR) method in their study of public expenditure and growth in Nigeria found that real capital expenditure positively and significantly affects real output while the effects of real recurrent expenditure was relatively marginal. Similar results were found in the study carried on by Lebina and Thabane in 2016. In their study they examined the long-run and causal relationship between government spending and economic growth in Lesotho by employing the ARDL bounds testing procedure and used the times series data of the period ranging from 1980 to 2012. The results of the study indicate the presence of a very stable long-term relationship between government spending and economic growth in Lesotho. However, the Granger causality test shows the direction running from economic growth to government expenditure, confirming Wagner's Law in Lesotho. In addition, the outcomes of this study fail to support the Keynesian theory. The results highlight the need for policy makers to shift public outlays towards investment in physical infrastructure which will stimulate growth and consequently improve fiscal sustainability as opposed to recurrent expenditure.

The contradicting findings on the place of government expenditure on economic growth of a country were found in the study done by Mulugeta (2012) who investigated The Impact of Government Expenditure on Economic growth in Ethiopia by using time series data of 1970-2010, VECM is employed to estimate the short run dynamics and the result revealed that all components of government expenditure do not have significant effect in explaining growth of real per capita income in the short run. And so he suggested that Issues of quality, transparency, accountability and capacity building should be well established in public expenditures particularly on huge investment projects to ensure fiscal regulation and management of scarce resources and promotion of sustainable development.

In the view of what discussed above, from the causes of economic growth to theoretical and empirical literature review, this study will try to verify the following hypotheses

H1: The government intervention which is simply translated in terms of its massive expenditures in the economic activities, is expected to have the considerable positive impact on the economic growth.

H2: The second hypothesis is a causal positive relationship between degree of openness and economic growth, through most common evidence among economists is that, degree of openness has positive impact on economic growth, that's, a rise in exports stimulates an increase in aggregate economic growth rather than vice versa.

H3: Investment that come from outside the country (foreign direct investment) stimulate economic growth in the country by speeding up production activities.

H4: Negative relationship between inflation and economic growth. As shown by various economic theory, the relationship between inflation and economic growth in Algeria is expected to be negative.

H5: Saving made by the natives in the country (gross domestic saving) are expected to have positive relation with economic growth.

H6: Human capital (as proxied by the number of labor force) which brings labor force who work in various economic activities is expected to have a positive relationship with economic growth.

In short, many theoretical and empirical studies have been conducted to seek to understand the determinants of economic growth. In those studies many factors that positively and negatively affecting economic growth were mentioned. Apart from the factors that determine economic growth mentioned above, other factors mentioned by several researchers are exchange rate policy, index of terms of trade, domestic credit to private sectors, life expectancy, foreign aid, unemployment rate, monetary aggregates, public debts and so on. A lot of explanatory variables have been used, especially over the last two or three decades, but still the issue of determinants of economic growth is challenging because economic growth is not determined by only one or two factors.

CHAPTER THREE

RESEARCH METHODOLOGY

This chapter presents the methods used to conduct the research. It describes economic growth model which explains the relationship between dependent variable economic growth as proxied by GDP and various independent economic variables that determine economic growth. In fact, conducting empirical research needs the understanding of various quantitative methods used in the analysis and estimation of data, the quantitative method used in this research is presented in this chapter.

The chapter is organised into four sections. First section explains research design, second section presents model specification, estimation technique is presented in the third section and finally fourth sections focused on diagnostic test to validate the model.

3.1. Research design

This study is conducted by empirical research of quantitative type. Empirical research is that which depends upon the experience or observation of phenomena and events, and whose conclusions are exclusively derived from concrete and verifiable evidence. Econometric technique was used to estimate and analyse the parameters of the model. Econometric technique seems to be the appropriate one in this study due to the nature of the data gathered for the study (time series data) as well as the investigation of relationship particularly the long run relationship between the selected variables being the main target of the study.

The quantitative research method used in this research is “Causal-Comparative research”. A causal-comparative research is based on comparison. It is primarily utilised to determine the cause and effect relationship among variables (Schenker and Rumrill, 2004). The researcher seek to find out whether a set of independent variables have a significant effect on a dependent variable. We used the selected major determinants and measured their effect on economic growth.

3.2. Model Specification

The first step in constructing a model for a specific purpose or let’s say for a particular sector of an economy in a given country, is, to decide on the variables to be included in the analysis. It is usually important to take into account what economic theory has to say about the relations

between the variables of interest (Aniefiok and Effiong, 2014). The variables that determine economic growth have been varying from country to country, various school of thoughts have tried to investigate these determinants, from classical economists, to endogenous growth model.

Solow and Swan were the first economists to specify an economic growth model in 1956. The model postulated in this study is based on this Solow growth model which emphasises the vital role that investment (i.e. capital accumulation) and labor effectiveness play in promoting economic growth in a given country. The reason behind this choice is that; the Solow model is considered to be both a starting point and a springboard for the richer models because of its simplicity and abstract representation of a complex economy. The study extended this original Solow model by incorporating more factors that determine economic growth. A similar model was employed by many of the recent studies, including George Mukupa (2016), Zergoune Mohamed (2018) and Papa Mensah (2019). The model specified economic growth (as proxied by GDP) as a function of foreign direct investment, gross domestic saving, government expenditure, degree of openness, labor force and inflation. The implicit function of the model was specified as,

GDP=F (foreign direct investment, gross domestic saving, government expenditure, labor force, degree of openness, inflation) _____ (1)

Writing equation (1) in a linear form, we have the equation as,

$$GDP_t = \beta_0 + \beta_1 FDI + \beta_2 GDS + \beta_3 GE + \beta_4 LABF + \beta_5 DOP + \beta_6 INF + u_t \quad (2)$$

where; GDP represents gross domestic product and is the dependent variable, FDI is the foreign direct investment, GDS is gross domestic saving, GE represents government expenditure, LABF is the labor force, DOP and INF are degree of openness and inflation respectively. β_0 represents intercept; β_i are the coefficients of respective explanatory variables and also present slopes of the regression equation, where $i = 1,2,\ldots.6$. u_t is a disturbance term, which is a surrogate for all those variables that are omitted from the model but that collectively affect Y.

The above equation (2) was transformed to a log-linear model for the following reasons;

(i) Logarithmic transformation is a convenient means of transforming highly skewed variables into more normalised variables.

(ii) To determine the percentage change. The act of putting the log of one or both variables we effectively change the case from a unit change to a percentage change. For example, 0.1 unit change in log (X) is equivalent to 10% increase in X.

(iii) To help bring all units to the same level and help the model to be stationary regardless of the unit size of the variable, and

(iv) To help minimise the likelihood of autocorrelation and heteroskedasticity in the model.

The resulting log-linear model was:

$$LnGDPt = \beta_0 + \beta_1 lnFDI + \beta_2 lnGDS + \beta_3 lnGE + \beta_4 lnLABF + \beta_5 lnDOP + \beta_6 lnINF + u_t \quad (3)$$

where, GDP, INF, FDI, DOP, GDS, LABF, GE and βs are as explained earlier in equation (1). In here βs are also representing the elasticities, *ln* presents natural log.

3.3. Estimation Technique and Procedures

In this empirical analysis, the coefficients of the econometric model are estimated by using Ordinary Least Square (OLS). OLS is the method that estimates the parameters of a regression model by minimizing the total squared residuals. The method is attributed to a German mathematician, Carl Friedrich Gauss.

There are various econometric techniques that can be used to estimate the parameters, such as the method of Maximum Likelihood (ML), but the study opted to use OLS because it is relatively easy to use. The method is intuitively appealing and mathematically and statistically much simpler than other methods; in OLS the goal of minimising the sum of squared residuals ($\sum e^2$) is quite appropriate from a theoretical point of view; under certain assumptions, the method of least squares has some very attractive statistical properties, i.e. BLUE properties (Best Linear Unbiased Estimator); the OLS technique has been used in a wide range of economic relationship with satisfactory results

Moreover, this study made use of time series data, therefore, there is need that certain tests be carried out on the data to determine their nature and suitability for the intended purpose. So the procedures used to test the data are as follows:

3.3.1. The Stationarity Tests

A stationary time series is one whose basic statistical properties such as mean and variance do not change over time. In contrast, a non-stationary time series has one or more basic properties that do change over time (Studenmund, 2017). The major purpose for conducting stationarity tests is that; if we use the data without checking their stationarity properties, the results derived from the regression models would produce the so called spurious results (Datta and Kumar, 2011). Therefore, before estimating the specified model, it is very important to test out stochastic properties of the variables that are going to be included in the model.

In this study, the two prominent unit root tests of Augmented Dickey-Fuller and Philip-Perron which are well-known and valid in large samples were chosen to test for stationarity problem in the data because of their simplicity and capability in taking care of serial correlation in the error terms.

- **Graphical analysis**

Graphical analysis is an informal analysis which is a rough and ready method of testing for stationarity where the time series is plotted then often some initial clue will be given out from the graph on whether a given time series is stationary or not. The visual examination of the most time series data often show that the mean and variance are increasing or decreasing dramatically over time and so the time series is non-stationary. The time series of the selected variables in this study were first plotted for the purpose of studying their stationarity, since it is worth remembering that "anyone who tries to analyse a time series without plotting it first is asking for trouble" (Chatfield, 2004).

- **Unit Root Analysis**

Non-stationarity often takes the form of random walk. The series Y_t is said to be a random walk if

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

It shows that, the value of Y_t at time t is equal to its value at time (t-1) plus a random shock, thereby neither the mean nor the variance of Yt is constant. That means a random walk model is non stationary. The random walk model (RWM) above can be written as,

$$Y_t = \rho Y_{t-1} + u_t \quad (5)$$

It is the parameter ρ in equation (5) that would determine whether the time series are stationary. Specifically, if $|\rho| = 1$, equation (5) becomes random walk and thus the time series follow a non-stationary. However, if $|\rho| < 1$, then Y_t is not a random walk and is stationary.

The most prominent unit root test for stationarity is the Dickey-Fuller (DF) test. The DF test enables to understand the nature and characteristic of economic time series whether its deterministic or stochastic trend.

The DF test estimates the equation (5) and tests if $|\rho| < 1$ to see if Y is stationary. The test proceeds as follows:

we subtracted Y_{t-1} from both sides of the above equation

$$(Y_t - Y_{t-1}) = (\rho - 1)\, Yt_{-1} + u_t \quad (6)$$

If we define $\Delta Y_t = Y_t - Y_{t-1}$, then we have the simplest form of the Dickey-Fuller test:

$$\Delta Y_t = \beta_1 Yt + u_t \quad (7)$$

Where $\beta_1 = (\rho - 1)$. We test by two hypotheses;
H_0: $\beta_1 = 0$, that is, $\rho = 1$, and that means Y_t contains a unit root and therefore is non-stationary
H_1: $\beta_1 < 0$, that is, $|\rho| < 1$, that means Y_t is stationary.

The actual procedure of implementing the DF test involves estimation and testing the three standard equations:

(i) $\Delta Y_t = \beta_1 Y_{t-1} + u_t$ (8)

(ii) $\Delta Y_t = \beta_0 + \beta_1 Y_{t-1} + u_t$ (9)

(iii) $\Delta Y_t = \beta_0 + \beta_1 Y_{t-1} + \beta_2 t + u_t$ (10)

where, $\beta_2 t$ is time or trend variable.

The study also conducted the Augmented Dickey-Fuller (ADF) test, where the ADF test is the expansion of the traditional Dickey-Fuller test. It was developed for instances where the error terms are assumed to be correlated. This test was conducted by augmenting the preceding three equations of DF by adding the lagged values of the dependent variable ΔY_t. The ADF test estimates the following regressions:

(iv) $\Delta Y_t = \beta_1 Y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta Y_{t-i} + u_t$ (11)

(v) $\Delta Y_t = \beta_0 + \beta_1 Y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta Y_{t-i} + u_t$ (12)

(vi) $\Delta Y_t = \beta_0 + \beta_1 Y_{t-1} + \beta_2 t + \sum_{i=1}^{m} \alpha_i \Delta Y_{t-i} + u_t$ (13)

The Phillip-Perron (P-P) test named after Peter Philips and Pierre Perron. Is another unit root test that used in time series to test the null hypothesis that a time series is integrated of order 1. Whilst the ADF test care the issue of possible serial correlation in the error by introducing lagged difference term of the regressand as regressors in the test equation, Phillips and Perron use nonparametric statistical methods to take care of the serial correlation in the error terms without adding lagged difference terms. The test does heteroscedasticity and autocorrelation consistence (HAC) correction to Dickey-Fuller test statistic. In P-P test, the following model is estimated:

$\Delta Y_t = \beta_0 + \rho Y_{t-1} + u_t$ (14)

The idea here we use some corrected form of t-test in order to correct for the presence of serial correlation and heteroscedasticity in the error term. We tested the null and alternative hypothesis,

H_0: $\rho = 1$ (Nonstationary)

H_1: $\rho < 1$ (Stationary)

The Phillip-Perron test is also like Dickey-Fuller test, we can choose to include a linear time trend and also to whether or not include constant term (β_0)

3.3.2. The Autoregressive Distributed Lags (ARDL) Model

The ARDL which is essentially a regression model and a VAR model is considered as the most dynamic unrestricted model in econometric literature containing the lagged values of the dependent variable, current and lagged values of the exogenous variables. The model was developed by Pesaran and Shin (1998) and Pesaran et al. (2001). The methodology of the model follows a general to specific approach, that's why it could be possible to tackle many econometric problems like misspecification and autocorrelation then come up with most appropriate interpretable model (Fabozzi et al., (2007), and Ghouse et al., (2018)). The generalised ARDL (p q) model is given as:

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{p} \delta_i \Delta Y_{t-i} + \sum_{i=0}^{q} \beta_i \Delta X_{t-i} + \varepsilon_{it} \quad (15)$$

where Yt is a dependent variable, α_0 is constant, δ_i and β_i are coefficients of explanatory variables in which i=1,2….=p, and i=1,2,…..=q. ε_{it} the white noise error term.

In order to empirically analyse the long-run relationship between the Algerian economic growth and the determinants, the study employed the ARDL bounds testing cointegration approach.

3.3.3. ARDL Bounds test for cointegration

The ARDL bounds test is very appropriate method for cointegration and was chosen because of its unique advantage comparing to other cointegration methods. There are three advantages of this method: firstly, unlike traditional methods such as Engle-Granger and Johansen cointegration test, ARDL bounds cointegration test does not need all the variables under study to be integrated in the same order, that is, it can use the combination of the variable integrated by order 0 and order 1 (Adom et al., (2012), Belloumi, (2008)). Secondly, ARDL test is relatively more efficient in the case of small and finite sample data sizes (Pesaran et al., 2001). It provides robust and consistent results even for small sample sizes. Thirdly, the method integrates the short-run impact of the given variables with a long-run equilibrium using an error correction term without dropping long-run information, so one may simultaneously assess the short-run and long-run relationship between the given variables (Larsson et al., 2016), because the method provides unbiased estimates of the long-run model and valid t statistics even when some of the regressors are endogenous (Harris and Sollis, (2003), Udoh et al., (2015)).

Despite having all these advantages but still the existing cointegration techniques including bounds test and other econometric time series techniques, in their procedures they do not provide any reasonable criteria regarding their specifications; choice of deterministic part, lag length determination and innovation process distribution.

For our model, in seeking to investigate the short-run and long-run relation between economic growth and the chosen explanatory variables, the ARDL bound test was specified as,

$$\Delta lnGDP_t = \alpha_0 + \delta_1 lnGDP_{t-1} + \delta_2 lnLFDI_{t-1} + \delta_3 lnGDS_{t-1} + \delta_4 lnGE_{t-1} + \delta_5 lnLABF_{t-1} + \delta_6 lnDOP_{t-1} + \delta_7 lnINF_{t-1} + \sum_{i=1}^{p} \beta_{1i} \Delta lnGDP_{t-i} + \sum_{i=0}^{P} \beta_{2i} \Delta lnFDI_{t-i} + \sum_{i=0}^{P} \beta_{3i} \Delta lnGDS_{t-i} + \sum_{i=0}^{P} \beta_{4i} \Delta lnGE_{t-i} + \sum_{i=0}^{P} \beta_{5i} lnLABF_{t-i} + \sum_{i=0}^{P} \beta_{6i} \Delta lnDOP_{t-i} + \sum_{i=0}^{P} \beta_{7i} \Delta lnINF_{t-i} + \varepsilon_t \quad (16)$$

where $\Delta lnGDP_t$ is a dependent variable, α_0 is constant, δ_j coefficients introduced in the model to test for the long-run relationship (cointegration) where j=1….7; β_{ji} are the short-run dynamic coefficients of explanatory variables in which i=1, 2…. =p and q. (p stands for lags of dependent variable while q represent lags of explanatory variables which can differ) and ε_{it} is the white noise error term.

To examine if the long run relationship between the GDP and independent variables the F test was established. The bounds test is mainly based on the joint F-statistic under the two alternative hypothesis,

H_0: $\delta_{1i} = \delta_{2i} \ldots\ldots\ldots = \delta_{7i} = 0$ (Long-run relationship does not exist)

H_1: $\delta_{1i} \neq \delta_{2i} \ldots\ldots\ldots \neq \delta_{7i} \neq 0$ (Long-run relationship exist)

Under these hypothesis two sets of critical values for a given significance level can be determined, one is given on the assumption that all variables included in the ARDL model are stationary, such as they are integrated by order zero, I (0). The other critical value given is based on the assumption that all variables are stationary after first difference, such as integrated by order on, I (1) (Pesaran et al., 2001). The decision is based on the comparison between the computed F-statistic and these critical values. If F statistic exceeds the upper critical bound value under given level of significance, the null hypothesis is rejected, that means there is cointegration between the variables. If the computed F statistic is lower than the lower bounds value at the given level of significance, the null hypothesis cannot be rejected and that means

no long-run relationship between the variables. However, if the value of the computed F-statistic lies between the lower and upper bounds of the critical table value, the decision whether the variables have long-run cointegrating relationship becomes inconclusive.

From the bounds test both long-run and ECM models are specified if the variables are cointegrated, but if not only the short-run ARDL model is appropriate. If cointegration exists the following ECM model is estimated,

$$\Delta lnGDP_t = \alpha_0 + \sum_{i=1}^{p} \beta_{1i}\, \Delta lnGDP_{t-i} + \sum_{i=0}^{P} \beta_{2i}\, \Delta lnFDI_{t-i} + \sum_{i=0}^{P} \beta_{3i}\, \Delta lnGDS_{t-i} + \sum_{i=0}^{P} \beta_{4i}\, \Delta lnGE_{t-i} + \sum_{i=0}^{P} \beta_{5i}\, lnLABF_{t-i} + \sum_{i=0}^{P} \beta_{6i}\, \Delta lnDOP_{t-i} + \sum_{i=0}^{P} \beta_{7i}\, \Delta lnINF_{t-i} + \varphi ECM + \mathcal{E}_t \quad (17)$$

Where all the variables are like explained above in equation (2), ECM is the error correction term with φ adjustment term.

3.3.4. The Causality Test

In accordance with general equilibrium theory, economists usually assume that everything depends on everything else; hence the causal relationship determination between different time series plays an exceptional role in ascertaining whether one time series is useful in forecasting another (Biresaw, 2013). According to Granger causality test if one variable X granger causes another one Y, then to predict variable Y is better to use the past values of both variables X and Y than using the past values of variable Y alone. The essence of this test is to investigate the causal links amongst the variables; pairwise Granger causality test is performed under the following hypotheses;

$\boldsymbol{H_0}$ **:** There is no granger causality

$\boldsymbol{H_1}$ **:** The null hypothesis is not true

The null hypothesis is rejected when the p-value of the f-statistic is less than 0.05, and therefore in this case to predict the future values of variable Y, the past values of both variable X and Y have to be used since X granger causes Y.

3.4. Validation of the model

Once a statistically satisfactory model of a set of time series has been constructed, an analysis of the dynamic interactions is often of interest. The evaluation tests have to be conducted in the

model. It is deciding whether the estimated coefficients of the model are theoretically meaningful and statistically satisfactory.

Conducting evaluation and diagnostic test is one among the important steps in econometric modeling. It consists deciding of whether the estimated coefficients of the model are theoretically meaningful and statistically satisfactory. Diagnostic test and evaluation of the model in this study based on the economic, statistic, and econometric criteria.

3.4.1. Economic Criteria (A priori expectations)

Theoretical relationship criteria which is so-called economic criteria for validating the model where positive and negative signs carried by the coefficients of the respective explanatory variables represent direct and inverse relationship respectively between dependent and independent variables.

Therefore, based on the theories and empirical review already discussed, independent variables are expected to have the following signs on dependent variable;

Table 1. Expected signs of variables

Dependent variable	Independent variable	Economic A priori expectation
GDP	Foreign Direct Investment (FDI)	+
GDP	Gross Domestic Saving (GDS)	+
GDP	Government Expenditure (GE)	+
GDP	Labor Force (LABF)	+
GDP	Degree of Openness (DOP)	+
GDP	Inflation (INF)	-

Notes: + and - Represent positive and negative relationship respectively between variables; GDP means Gross Domestic Product

3.4.2. Statistical Validation

In statistical criteria we investigated the quality of statistical properties of the model. We investigated the overall fit of the estimated model (R^2 and adjusted R^2), the F-test and the t-test.

- **The Student's t-test**

A student's t-test is a statistical hypothesis test where under null hypothesis it follows a student's t-distribution. We used t-test to test a null and alternative hypothesis about individual partial regression coefficient, such as

$$H_0: \beta_i = 0$$

$$H_0: \beta_i \neq 0$$

We applied this statistical test to measure the individual significance of the coefficients of the explanatory variables included in the model. If the computed t value exceeds the critical t value at the chosen level of significance, we may reject the null hypothesis; otherwise, we may not reject it (Gujarat et al). Alternatively, the coefficient is largely statistically significant if its p-value from the estimated model is less than 0.05. For the model to be valid according to this test, all coefficients must individually be statistically significant different from zero (i.e. their p-values must be inferior to 0.05); otherwise the insignificant coefficients have to be removed from the model (Wiley, 2016).

- **Goodness of Fit**

The commonly used measure of goodness of fit is R^2, or the coefficient of determination, it gives the percentage of total variation in the variable of interest (GDP) that is explained by all the explanatory variables (EXP, GVT, HC, GDS, INF and FDI**)**. R^2 is the ratio of the explained sum of squares (ESS) to the total sum of squares (TSS). Such as,

$$R^2 = \frac{ESS}{TSS} = 1 - \frac{RSS}{TSS} = 1 - \frac{\sum(Yi - \bar{Y})}{\sum(Yi - \bar{Y})}$$

By definition, R2 is a number between zero and one, and it never decreases, usually increases when the new independent variable is added in the model with the same set of observations (Wooldridge, 2009). A value of R^2 close to one shows an excellent overall fit, whereas a value near zero shows a failure of the estimated regression equation to explain the value of dependent variable (Yi) better than could be explained by the sample mean, $\bar{Y}$ (Studenmund, 2016).

The adjusted R^2 used the same way as R^2, but also used as a penalty for the adding more regressors. Adjusted R^2 measure has some punishment for the inclusion of additional explanatory variables in the model and therefore does not automatically increase when regressors are added to the model (Verbeek, 2004).

- **The F-test**

The F test used to test the overall significance of the sample regression. It is used to test whether the independent variables explain or have significant impact on dependent variable. We tested the null hypothesis,

$$H_0: \beta_1 = \beta_2 = \beta_3 \ldots\ldots\ldots = \beta_k$$

This is a jointly hypothesis explaining that the estimated values of βs are simultaneously equal to zero, that is, all regressors have zero impact on Algerian GDP. Then, comparing the computed F value with the critical F value from the F distribution table. If the computed F value exceeds the critical F at certain level of significance, we reject H_0 that means, there is significant impact between the dependent and the independent variables in the regression equation, otherwise we do not reject. Alternatively, the null hypothesis is also rejected when the p-value of the f-statistic is less 0.05 which means that, statistically the model as a whole is valid and it can be used for the prediction of the future values GDP as our variable of the interest (Johnstone, 1987)

3.4.3. Diagnostic Checking

In diagnostic testing we employed the test for autocorrelation, heteroscedasticity, normality, misspecification (RESET) and stability in the residuals.

- **Autocorrelation Test**

Autocorrelation is the violation of classical linear regression assumption that different error term are uncorrelated with each other such as, covariance $(\varepsilon_i, \varepsilon_j) = 0, \forall\ i \neq j$. The tendency of using OLS method to estimate the model while the error term are serially correlated has consequences such as cause OLS estimates to no longer be BLUE (Best Linear Unbiased Estimator), and also cause bias in hypothesis testing. Econometricians introduced numerous tests of autocorrelation such as Runs test, Durbin-Watson (D-W) test and Breusch-Godfrey (L-M) test. Because of simplicity and accuracy, this study used a D-W test. The D-W test is conducted by examining the estimated residuals of a particular estimation. The D-W **d** is defined as,

$$\mathrm{d} = \frac{\sum_{t=2}^{t=n}(\widehat{u_t} - \widehat{u}_{t-2})^2}{\sum_{t=1}^{t=n} \widehat{u}_t{}^2}$$

where $\hat{u}_t$ is the residual estimated from the regression equation.

The decision rule is,

- If **d** is equal to 2(d= 2) we accept that there is no serial correlation. That is, there is neither negative nor positive autocorrelation,
- If **d** is equal to zero (d=0) it indicates a perfect positive correlation in the residuals. The closer the d is to zero, the greater the evidence of positive autocorrelation,
- If **d** is equal to 4(d=4) we accept that there is perfect negative serial correlation in the residuals. The closer the d is to 4, the greater the evidence of negative autocorrelation,

Because Durbin-Watson test has number of limitations such as it can be used only when the serial correlation is of the first order and when the equation doesn't include a lagged dependent variable, the Breusch-Godfrey test was used to further emphasize the results. A Breusch-Godfrey tests the autocorrelation by regressing the residuals obtained from OLS estimated equation on the original explanatory variables of the model to create an auxiliary regression model. Breusch-Godfrey have shown that $N*R^2$ (sample size times coefficient of determination) obtained from the auxiliary regression follows the Chi-square distribution. If NR^2 exceeds the critical Chi-square value at the chosen level of significance, we reject the null hypothesis of autocorrelation. Alternatively, if the probability of chi-square distribution is greater than 0.05 means the errors are not correlated.

- **Heteroscedasticity Test**

Heteroscedasticity is a situation where the variance of the error term of the estimated equation is not constant, such as $\text{Var}(u_{i)} \neq \delta^2$. It's the violation of the classical linear assumption of homoscedasticity. The presence of heteroscedasticity in the regression equation cause OLS estimates of the standard errors and t-values to be biased and leading to unreliable hypothesis testing. Knowing this consequence, in this study the Breusch-Pagan-Godfrey test was used to test for heteroscedasticity. The test is based on the running the regression of estimated squared residuals on the independent variables

The decision rule is based on the Chi-square test. Calculating NR^2, the sample size (N) times the coefficient of determination (R^2) and then comparing it with the critical chi-square value. If NR^2 is greater than critical Chi-square value then we reject the null hypothesis of homoscedasticity.

- **Stability Test**

Investigating the Stability over time is another important way to check a model. In order to assess the stability of the long-run and short-run coefficients the Cumulative sum of the recursive residuals (CUSUM) and the Cumulative sum of squared recursive residuals (CUSUMQ) were employed in this study. The tests were proposed by Brown et al. (1975). The tests are in graphical nature where the residuals are plotted against the break points for the 5% significance line. The decision is, the coefficients are stable if the plot stay within the 5% significance level.

- **Normality Test**

Normality test we test the violation of the assumption that disturbances are normally distributed, $\varepsilon_t \sim N(0, \delta^2)$. Under this assumption, the OLS estimator is the best unbiased estimator (Bin Dong et al, 2004). Non-normality may cause problems regarding statistical inference of the coefficient estimates such as significance tests and confidence intervals that relies on the normality assumption (Brooks, 2014). A simple asymptotic test for the normality assumption is given by Jarque and Bera (1987). This is based on the fact that the normal distribution has a skewness measure of zero and a kurtosis of 3 (Badi Baltagi).

For the normal distribution Skewness (S) = 0 and Kurtosis (κ) = 3. Hence, the Jarque-Bera (JB) statistic is given by,

$$JB = n\left[\frac{S^2}{6} + \frac{(\kappa-3)^2}{24}\right]$$

Where, S = skewness and κ = kurtosis of the OLS residuals. The test base on the null hypothesis,

H_0: There is normality in the residuals

This statistic follows the chi-square with degree of freedom of 2. Rejecting H0, rejects normality of the disturbances but does not offer an alternative distribution. Alternatively, if probability of Jarque-Bera is greater than 0.05 we accept the hypothesis that residuals are normally distributed.

- **Specification Error Test (RESET)**

Model specification as the first step of the regression analysis and the process of developing a regression model, it consists of selecting an appropriate functional form for the model and to choose which variables to be included. If an estimated model is not well specified, it will be biased and inconsistent. In this study we applied Ramsey's Regression Equation Specification Error Test (RESET) of 1969 which is a general specification test for the linear regression model. It tests whether non-linear combinations of the fitted values help in explaining the variable of interest. The intuition behind the test is that, the model is not well specified if non-linear combinations of the explanatory variables have any power in explaining the regressand. (Lütkepohl, 2005, Ghali and Snow, 1987)

CHAPTER FOUR

DATA AND EMPIRICAL RESULTS

This chapter presents data used in the study and empirical results of the work and analysis. The chapter is divided into two main sections; the first section presents data which is subdivided into data source and data description.

The second section contains six parts which are statistics descriptive, graphical presentations, unit root test, estimation of the ARDL model, causality test and finally model evaluation (validation) in the final part.

4.1. Data

4.1.1. Nature and Sources of Data

This study is based on annual secondary data covering the period ranging from 1970 to 2019. The data were sourced from statistical bulletin of the World Bank. The variables of interest in the study are: Gross Domestic Product, Foreign Direct Investment, Government Expenditure**,** Gross domestic saving, Labor force, Degree of openness, and the inflation where all of them are measured in millions of US dollars except degree of openness, the inflation rate and labor force.

The estimation period was chosen by considering the data availability as well as various steps and movements that Algeria has been going through during the period 1970-2019 aiming at stabilizing its economy.

4.1.2. Data Description

The data used in the study is time series data. A time series is a collection of data taken sequentially in time. Observations in time series data usually appear with a fixed time interval between their appearance (everyday, weekly, monthly, quarterly, or yearly).

This section describes the data used in the analysis of the study and their measurements.

Dependent variable

- **Gross Domestic Product (GDP)**

GDP is the total value of all final goods and services produced in an economy during a given period, usually a year (Krugman, 2009). In accordance with Shah (2012), Jahanger (2019) and Khungwa (2007), in this study either we made the GDP as the variable to explain simply because it's one of the important indicators of healthy economy; its increase means that there is an economic growth in a given country. The GDP data we used in this study are the current ones measured in millions of US dollars so that the economic growth could be identified.

Independent variables

- **Foreign Direct Investment (FDI)**

FDI refers to direct investment by a firm in one country (the source country) in productive assets in a foreign country (host country). FDI is usually conducted by Multinational Corporations, the companies that operating in more than one country or they have subsidiary firms in more than one country. By enabling positive externalities like the diffusion of *know-how* and new technology, FDI can have a direct impact in the sectors in which these funds were allocated, but also an indirect impact on the whole productivity in the economy (de Vita and Kyaw, 2009).There is a huge number of literature emphasising the positive impact that FDI may have on economic growth (Morrissey and Lensink, (2001), Hermes and Lensink, (2003), and Abdulghader, (2014).

Algeria has addressed the investment issue since independence through a number of successive statutes where it issued a number of legislations included many motives and advantages for investors (Abdulghader, 2014). Many developing countries see FDI as a means of reducing the domestic savings gap, improving technological development, creating employment and generally improve the economic condition of the host country. Due to these advantages, in our study we involved FDI which is also expressed in millions of US dollars so that we can provide the empirical evidence on how this macroeconomic variable plays a vital role in promoting economic growth.

- **Inflation rate (INF)**

The inflation rate is the rate of change in the price level. The act of increasing of this price level is called Inflation. Inflation is commonly measured using the Consumer Price Index (CPI) or GDP deflator. This study used CPI as the measure of inflation because it is more relevant for deriving the impact of inflation on the real value of consumer income. Hence in accordance with (Kasidi and Mwakanemela, 2013) ,(Xiao, (2009), (Shattarov, 2011) and (Tsegaye, 2012) and as well by being motivated by controversial substantial debate on whether inflation promotes or harms economic growth, in this study we aimed at examining the impact of inflation in Algeria on economic growth then established the long-run inflation - economic growth relationship.

- **Gross Domestic Saving (GDS)**

Gross domestic saving is the saving made by national household sector, private corporate sector, and public sector. According to World Bank, gross domestic savings are normally calculated as GDP less final consumption expenditure (total consumption). From the accounting fact called savings–investment spending identity, country's saving is always equal to investment (Krugman, 2015). It is believed that increase in saving stimulates the national capacity for investment and production, while a serious constraint to sustainable economic growth can result from the low rate of saving (Ellias and Worku, 2015). Moreover, according to (Mohan, 2006), (Misztal, 2011), (De Gregorio, 1992), and (Rasmidatta, 2011) on basis of their empirical studies they concluded that, increase in savings stimulates more rapid expansion of the capital stock and; therefore, higher rates of investment lead to higher rates of economic growth. In this study, we investigated the place of gross domestic saving in Algerian economy which is the part of Algerian GDP, by using the World Bank data expressed in millions of US dollars so that we can provide a vivid and empirical analysis on why Algerian government should increase its saving rate which will stimulate domestic investment and then economic growth.

- **Degree of Openness**

Degree of openness is the measure of extent to which an economy depends on trade with other countries. The ideas that openness is one of the most important determinants of economic growth is becoming increasingly popular among the governments of developing countries (Gudlach, 1996). Calculation of country's gross domestic product always involves the effect of

exports and imports, such as, in an open economy like Algeria's, the national account calculates economic growth (GDP) by including net exports (Exports minus imports). If exports exceed imports, net exports is added in the calculation of the country's GDP, and is subtracted if otherwise (Mankiw, 2009). The relation between economic growth and degree of openness is often expected to be positive because of the benefits the country expected to get from the international trade such as the transfer of technology. Degree of openness is calculated by dividing the sum of imports and exports to gross domestic product, such as;

$$\text{Degree of openness} = \frac{Exports+Imports}{GDP} * 100$$

The positive relationship with GDP it means the respective country benefits from foreign trade. In the long-run openness can enhance economic growth by providing capital goods and services, assisting in the efficient allocation of resources and improving total factor productivity through technology diffusion and knowledge dissemination (Romer, 1991). Following the consequences of the oil price crisis of 1980s, the Algerian economy began to show a severe deterioration which was an important turning point in the history of the Algerian economy led to the implementation of structural reforms which insisted the removal of barriers to the establishment of domestic or foreign import firms through tariff reform which was implemented in 1992 (Boussalem et al, 2017).

Since then till nowadays Algeria is participating effectively in international trade through exporting and importing goods and services and thus by considering that, in this study by using the times series data on Algerian exports, imports and GDP gathered from World Bank in which the Degree of openness which is expressed in terms of rate was generated, the real impact of Degree of openness on the Algerian economy is investigated.

Although there is no specific or standard model relating trade openness and economic growth, but economically trade should have a firm impact on the GDP. Furthermore by comparing the number of advantages that a country can profit of from the international trade to the inconvenient, the a priori expectation in this study is that, the trade openness in Algeria plays a very important role and so it has a positive effect on accelerating the Algerian economic growth. In this we are in accordance with a group of quantitative researchers (Romer et al, 1999), (Sachs and Warmer, 1995), (Seklou and Boussalem, 2017) who found out in their studies that trade openness has a positive impact on the economy, although there is another group of researchers

(Vlastau, 2010) and (Polat et al, 2015) who found that degree of openness has a negative impact on economic growth.

- **Labor Force**

Labor force is defined as the number of people who are employed and people who are unemployed and seeking unemployment. In most countries the part of labor force in population is grouped from the age of 15 years old to 64 years old. Labor force is one among the important factors that accelerate economic growth of the country. It is the source of human capital, and various economists have discussed the contributions of this factor, started by Adam Smith who analysed how the combination of labor force and investment could bring into economic growth.

Although human capital is largely proxied by expenditure in education still quantitative researchers differ in the proxies of the human capital to include in their studies, data availability being the main cause for this difference. Conventionally, human capital formation is proxied either by expenditure on education and health, school enrolment, active population and the life expectance of the people in a given area of study. School enrolment was used in the studies done by Barnanke and Gurkynak (2001) whereas Odusola (1998), and Grammy and Assane (1996) used both enrolment and expenditures then (Machuki, 2013) used only expenditures. This study investigated the relationship between human capital (as proxied by Algerian population) and economic growth, but also since government expenditure is included in the study as an independent variable, its significance can also be related to the direct impact that human capital has on Algerian economic growth.

In developing countries, the labor force development scheme is largely based on the education that provided by governments through public school. Increasing in the accumulation of human capital increases knowledge and skills to the people which later boost economic activites (production activities) in the country.

- **Government expenditure (GE)**

Government expenditure is the money that government spends in an economy. Government expenditure which is considered as a major economic stabilisation weapon is also an important variable which may determine changes in national income in developing countries like Algeria. In the past two decades, the hydrocarbon boom has allowed Algeria to make advances in economic and human development and thus Algeria cleared its external debt, invested in infrastructure projects, and implemented redistributive social policies that contributed to a

significant reduction in poverty (World Bank 2019). Hence In accordance with Barro (1996), Adeyemi (1999), Tang (2009), Thabane and Lebina (2016), in this study either we expect government expenditure which is also measured in millions of US dollars to carry up a positive sign in the model estimated which implies a positive impact and of great contribution in the Algerian economy.

4.2. Descriptive Statistics

Descriptive statistics is used in summarising and describing numerical data for easier interpretation (Kazmier, 2004). In analysing many economic phenomenon there is always too much information for the mind to assimilate so the task of descriptive methods is to summarise all this information and draw out the main features, without distorting the picture (Barrow, 2006). The statistic descriptive technique was employed in which measures of central tendency, dispersion, location and normality are discussed. The table 1 below presents the summary of descriptive statistics of the data,

Table 2. Descriptive statistics

Variables	Mean	Median	Max	Min	SD	SKW	KRT	J-B P-Value
GDP	79835.1	54767.48	213860.5	4863.487	62424.7	0.872	2.415	0.029
GDS	33151.5	17832.63	99356.99	1323.129	30775.1	0.973	2.476	0.015
FDI	635.642	223.5	2746.931	-537.793	836.512	1.059	3.008	0.009
DOP	58.162	58.302	76.685	32.685	10.612	-0.241	2.469	0.585
GE	1981.18	645.469	8273	5.876	2687.96	1.216	2.922	0.002
INF	8.637	5.939	31.669	0.339	7.602	1.638	4.956	0
LABF	16.564	16.015	27.079	7.173	6.608	0.131	1.596	0.119

Note: GDP, GDS, FDI, DOP, GE, INF, LABF stand for gross domestic product, gross domestic saving, foreign direct investment, degree of openness, government expenditure, inflation, labor force respectively; Max, Min, SD, SKW, KRT, J.B P-Value stand for maximum value, minimum value, standard deviation, skewness, kurtosis and Jarque Bera probability value respectively.

The results in the table show the mean and the middle values of each variable are presented in the second and the third column respectively where GDP has the highest mean value (79835.14) millions of US dollar compare to other variables involved in the study (DOP, FDI, GDS and GE) which are expressed in the same unit of measurement (millions of US dollar). From the 4th up to the 6th column in the table are the measures of dispersion in which GDP again is the

variable having the highest maximum value (213860.5) in millions of US dollar whereas FDI is the variable having the most minimum value (-537.793). Moreover the results demonstrate that GDP and GE are the variables in the study whose observations are too far from their respective sample mean compare to the other variables.

The 7th and the 8th column in the table present the measures of location where SKW which represents skewness (measuring the peakness or flatness) and the KRT which is kurtosis (measuring the degree of asymmetry of the series) are described. The results show that the time series of DOP, GDP, GDS, GE and LABF are clearly platykurtic (have flatted -curve) as their kurtosis values are less than 3. Moreover, FDI is the only time series which is mesokurtic with the kurtosis of 3.008 on the other hand INF is also the only time series which is leptokurtic (have a peaked-curve) having the kurtosis of 4.926 greater than the normal one (3). For the skewness, the series of FDI, GE and INF have positive skewness (have long right tail) meaning that these series are asymmetric as their respective skew values are above zero while DOP has long left tail (negative skewness) with the skew value of -0.241. On the other hand, the series of GDP, GDS and LABF have normal skewness (symmetric around the mean) as their respective skew values are around zero[4].

Alternatively, the test of normality of the data is conducted by Jarque-Bera statistic under the null hypothesis that distribution is normal, a probability value below 0.05 allows the rejection of this null hypothesis. Jarque-Bera probability in our table means only Labor Force and Degree of Openness are normally distributed, all other remaining variables allow the rejection of the null hypothesis.

4.3. Graphical Representation

The graphical presentation enables visual displays of the data. It gives insight into the characteristics of a data set without using mathematics (Doane et al., 2016). The graphs below represent the evolution of Gross Domestic Product, Foreign Direct Investment, Gross, Gross Domestic Saving, Government Expenditure, Inflation Rate, Degree of Openness and Labor Force for the period of time ranging from 1970 to 2019. The graphical representation of all the variables involved in the study was performed in their raw forms and not in their transformed logarithmic forms as there are some time series (FDI) that contain negative values which would disturb the graphical analysis by having gaps

[4] See appendix one for the full table

in their plots since the logarithm of a negative value does not exist. The graphical presentation for our data is as follows

Figure 1. Graphical Representation of data

Figure 1a

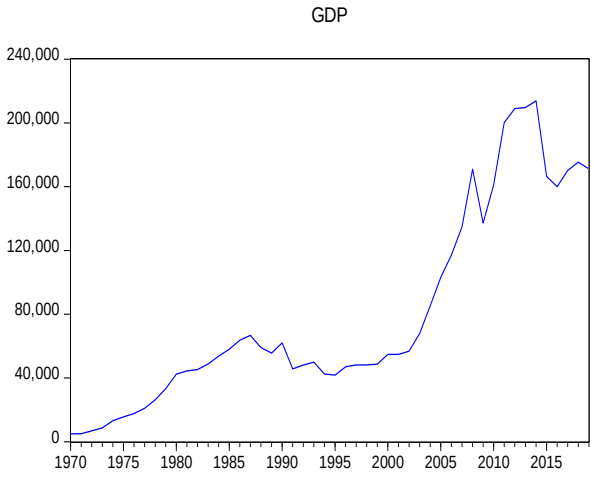


Figure 1b

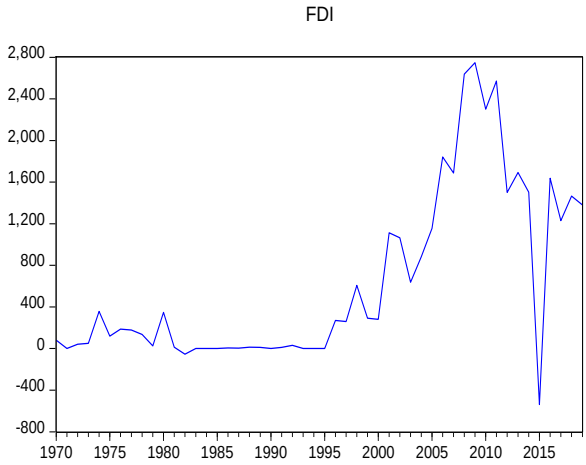


Figure 1c

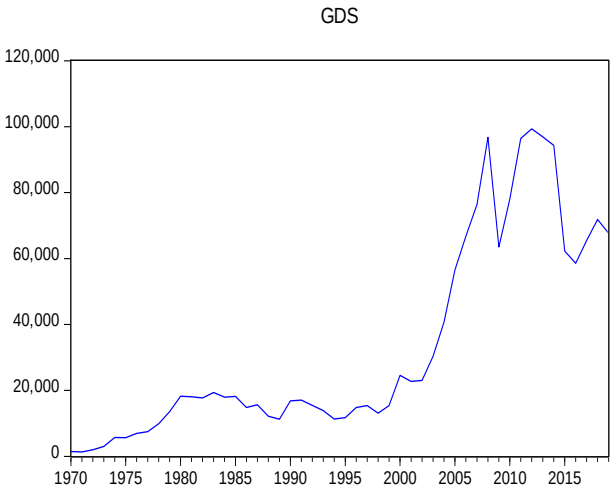


Figure 1d

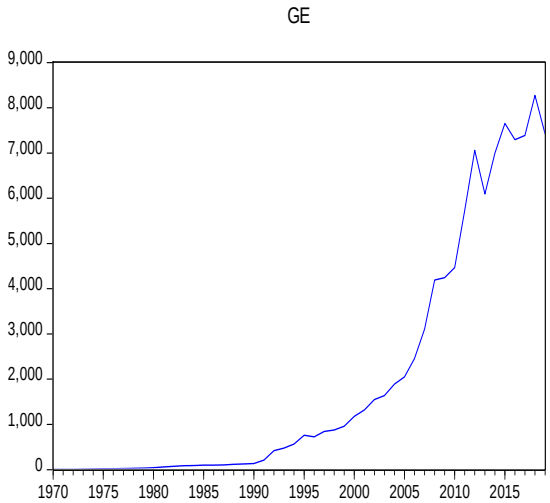


Figure 1e

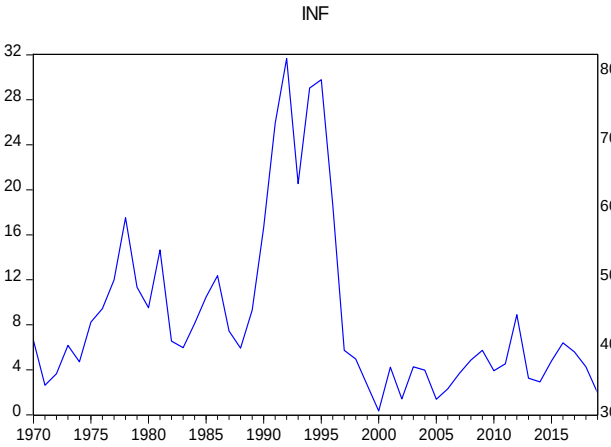


Figure 1f

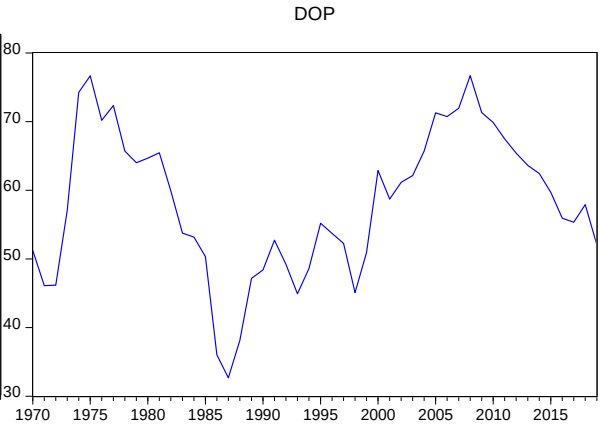
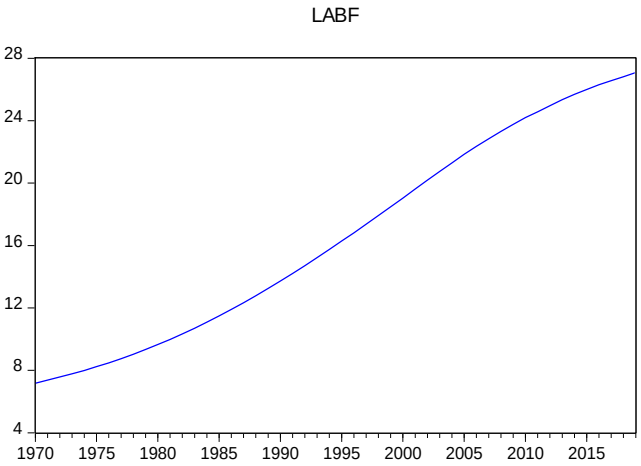


Figure 1g



The graphs above give visual presentation of the Gross Domestic Product, Foreign Direct Investment, Gross Domestic Saving, Government Expenditure, Inflation Rate, Degree of Openness and Labor Force. The graphs show that the time series of GDP, GDS, LABF and GE possess the upward slopes. During 1970-1985, the GDP graph shown in figure 1a shows an upward trend, the economy was increasing with an increasing rate of 6 percent per year. This might be due to the number of reasons such as, during this period Algerian government initiated various development plans such as, the first four year plan (1970-1973), the second four year plan (1974-1977), and the five year plan (1980-1984). The GDS graph also shows an upward trend during this time (1970-1985), this virtually shows the relationship between economic growth and GDP. The years (1986-2000), Algerian economy faced various problems started by the oil price shock in 1986 that affected the economic growth of the country, and in 1990s the civil war that happened in the country also disturbed the economy. From the year 2000 (four years after SAP), the inflation rate dropped from 29.07% in 1994 to 0.34% in 2000, followed

by various economic recovery and economic growth program such as, the three-year economic recovery support program (programme de soutien à la relance economique, PSRE, 2001-2004), and the five-year program of strengthening economic growth (Le Programme complementaire de soutien à la croissance, PCSC, 2004-2009) accelerated the economic growth rate in the country from 3% in 2001 to 7.2% in 2003. The global financial crisis of 2008 had very negative impacts to the economies all over the world especially the developing countries. This can be witnessed from the graphs of GDP, GDS, FDI and GE in figure 1a, 1c, 1b, 1d respectively which demonstrate the significant downward sloping. Last ten years of the study (2010 -2019) were as good as the first ten years (1970-1979) for the Algerian economy which can be attributed to the control of the global financial crisis and the huge revenues of hydrocarbons. This can be witnessed from the significant upward movements of GDP, FDI, GDS, GE, and the downward sloping of the INF.

The series of FDI, DOP and INF shown in figure 1b, 1f, 1e respectively have undefined slopes. Algeria has experienced high volatility in inflation rate. The graph shows there is three major episodes of inflation volatility in Algeria. The walking inflation from 1970-1989, where the average inflation rate was, 8.63; the galloping inflation from 1990-2000, where the average inflation rate was, 16.9%; and the walking inflation again in 2001-2019, where the average inflation rate was, 4.123%.

Since graphical analysis is just an informal and rough method of investigating the stationarity of the time series, therefore it can be concluded that according to the graphical analysis all time series involved in this study are nonstationary at their levels except the time series of INF which might be stationary at level since it does not possess neither upward nor downward slope (its mean and variance are constant over time) which is the major sign of a stationary time series.

4.4. Stationarity test

Although the unit root test is not the crucial requirement for the cointegration test of Pesaran et al. (2001), but still it is better to verify that all-time series involved in the study are stationary at their levels or at order one and not more. The table below represents the unit root testing outcomes obtained after undertaking the ADF and P-P tests to ensure that the time series data involved in the study do not bring the spurious relationships. The optimal lag length for ADF test was automatic selected by SIC whereas for P-P was based on Newey-West bandwidth selection. Before performing the unit root tests, all variables were first transformed into their

logarithm form so that to reduce their variability. For all seven variables, the two tests were performed starting from the model having intercept and the linear trend, but in all times series trend was not found to be significant , therefore the table below demonstrates the results of two tests for the model with intercept and model with neither intercept nor trend.

Table 3. Results of ADF and P-P Unit Root Test

Variable	Assumption	Test	Level	First Difference	Critical value for rejection of null hypothesis at 5%	Decision	Order of intergration
LnGDP	Intercept	ADF	-3,423**	-	-2,922	stationary	I (0)
		P-P	-2,867*	-	-2,928	stationary	I (0)
Ln GE	Intercept	ADF	-2,452	-5,085	-2,924	stationary	I (1)
		P-P	-2,313	-5,114	-1,949	stationary	I (1)
LnFDI	None	ADF	-2,675	-5,219	-1,951	stationary	I (1)
		P-P	-2,584	-9,533	-1,949	stationary	I(1)
LnGDS	None	ADF	-2,535	-5,501	-2,924	stationary	I(1)
		P-P	-2,461	-5,524	-2,924	stationary	I(1)
LnDOP	None	ADF	-2,831	-5,659	-2,923	stationary	I(1)
		P-P	-2,176	-4,924	-2,924	stationary	I(1)
LnINF	None	ADF	2,874	-9,636	-2,924	stationary	I(1)
		P-P	-2,888	-9,68	-2,924	stationary	I (1)
LnLABF	Intercept	ADF	-6,332	-	-2,927	stationary	I(0)
		P-P	-3,034	-	-2,922	stationary	I (0)

Note: LnGDP, LnGE, LnFDI, LnGDS, LnDOP, LnINF, LnLABF stand for logarithm of gross domestic product, government expenditure, foreign direct investment, gross domestic saving, degree of openness, inflation, and labor force respectively; ADF and P-P are Augmented Dickey Fuller and Phillip Perron tests respectively; I(1) and I(0) are first order and zero order integration respectively. The stars, ** and *, represent significance level at 5% and 10% respectively.

By comparing the ADF-statistic and the adjusted t-statistic of P-P to their respective critical values at the 5% significance level, the null hypothesis of unit root is rejected when the critical values are less than absolute value of their respective computed statistics. The results in the table above show that, lnGDP is stationary at level in 5% and 6% on ADF and PP respectively, lnLABF is stationary in 5% significance level in all two tests. On the other hand the rest of the variables (lnGE, lnDOP, lnFDI, lnGDS and lnINF) are stationary at first difference. Therefore

it is concluded that the time series are integrated of order 0 and 1 which is the crucial requirement for the cointegration test of Pesaran et al (2001).

4.5. Lags Selection

To estimate ARDL model and conducting bounds test the maximum lags of the regression system has to be selected. Thus, before proceeding with bounds test of cointegration the appropriate number of lags to be used in estimation process was determined. Two information criterions of AIC and SIC were used to determine the number of lags. According to these criterions, the optimal lag length is the one that minimises these two criterions. The table below shows the summary of these two criterions;

Table 4. Lags Selection Results

Lags	AIC	SIC
0	-1,800	-1,516
1	-2,450	-2,125*
2	-2,459*	-2,095
3	-2,443	-2,037
4	-2,436	-1,990

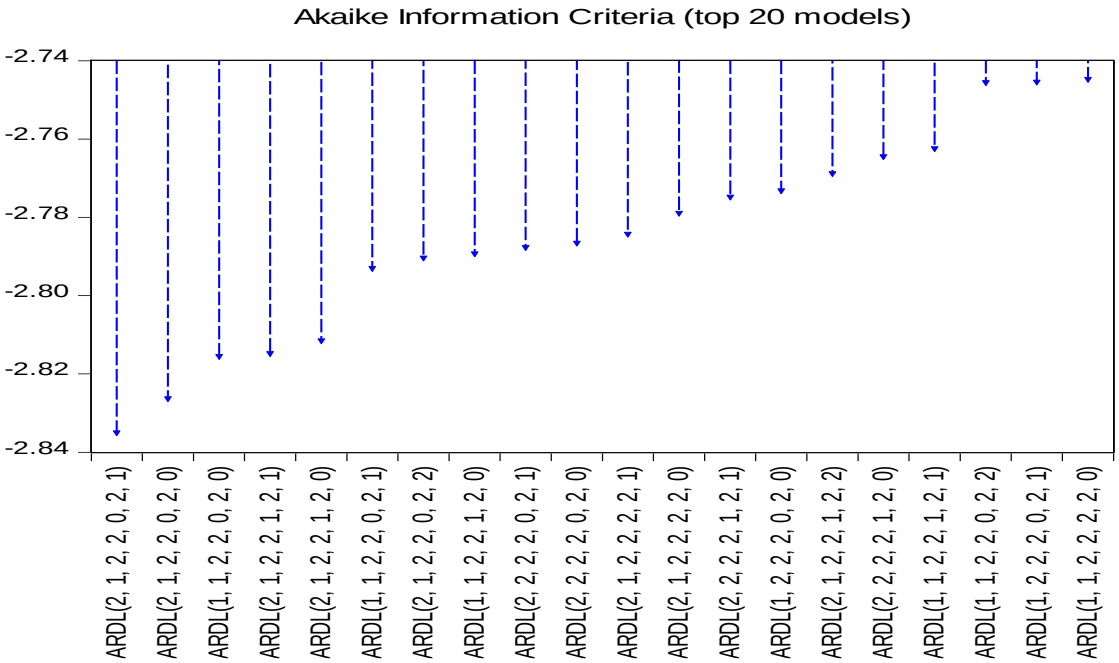
Note: AIC and SIC stand for Akaike and Schwarz Information Criterions respectively. The star, *, represents the minimum value for each criterion

The minimum number for both SIC and AIC are found in one and two lags respectively. Since it is AIC that gives the minimum value between these two criterions (-2.459* < -2.125*) hence the maximum number of lags used in the estimation of ARDL (p,q1,q2,q3,q4,q5,q6), bounds test and the ECM models will consider lags at order 2 by AIC as the maximum number of lags[5].

By putting maximum number of lags to be used as 2, AIC automatic selection in Eviews selected the lags (2,1,2,2,0,2,1) as the optimum number of lags for ARDL (p,q1,q2;q3,q4,q5,q6).

[5] See appendix two for the full table

Figure 2. Lags selection Results



The graph shows optimum lag length for our ARDL model is (2,1,2,2,0,2,1) for GDP, FDI, GDS, GE, LABF, DOP and INF.

4.6. ARDL Regression Results

4.6.1. ARDL (2,1,2,2,0,2,1) model

Before testing for cointegration, an ARDL (2,1,2,2,0,2,1) model mentioned in equation (3.8) was estimated. The summary of the results are shown in the following table,

Table 5. Results of ARDL (2,1,2,2,0,2,1) model

Variable	Coeff	SDE	t-stat	Prob
LNGDP(-1)	0.399	0.187	2.128	0.042
LNGDP(-2)	-0.209	0.15	-1.391	0.175
LNFDI	0.002	0.003	0.582	0.564
LNFDI(-1)	0.007	0.003	2.159	0.039
LNGDS	0.596	0.054	11.042	0
LNGDS(-1)	-0.173	0.13	-1.335	0.192
LNGDS(-2)	0.309	0.104	2.968	0.006
LNGE	0.019	0.101	0.19	0.85
LNGE(-1)	-0.075	0.117	-0.644	0.524
LNGE(-2)	0.198	0.084	2.358	0.025
LNLABF	-0.811	0.35	-2.314	0.028
LNDOP	-0.457	0.107	-4.277	0
LNDOP(-1)	0.217	0.159	1.364	0.183
LNDOP(-2)	-0.544	0.143	-3.795	0
LNINF	0.031	0.017	1.795	0.083
LNINF(-1)	0.017	0.016	1.072	0.293
C	6.077	1.013	5.994	0

Note: R-squared = 0.99, Adjusted R-squared = 0.99, Durbin-Watson stat = 2.334. LnGDP, LnGE, LnFDI, LnGDS, LnDOP, LnINF, LnLABF stand for logarithm of gross domestic product, government expenditure, foreign direct investment, gross domestic saving, degree of openness, inflation, and labor force respectively.

The results of ARDL model estimated shows that the coefficient of GDP at first lag, FDI at first lag, current GDS and GDS at second lag, GE at second lag, current LABF, current DOP and DOP at second lag are statistically significant at 5 percent level. It means they are well explaining the movement of economic growth in Algeria. The variables GDP at second lag, current FDI, GDS at first lag, current GE, GE at first lag, DOP at first lag and INF at first lag

have statistically insignificant relationship with economic growth in Algeria. R-squared and R-squared adjusted show that our model achieved a strong goodness of fit and approximately explanatory variables explain 99 percent of the variation of economic growth. The Durbin-Watson statistic shows that our model is not spurious[6].

4.6.2. ARDL Bounds test

The ARDL bounds test is employed to test the null hypothesis that no cointegration exists against the alternative hypothesis that the cointegration exists between the variable of interest GDP and the explanatory variables foreign direct investment, government expenditure, gross domestic saving, labor force, degree of openness and inflation. The results of F-bounds test and t-bounds test on the model are shown in the following table,

Table 6. Results of Bounds test

Test statistic	Value	I(0)	I(1)
		2.12	3.23*
F-stat	8.684	2.45	3.61**
		3.15	4.43***
		-2.57	-4.04*
t-stat	-5.715	-2.86	-4.38**
		-3.43	-4.99***

Note: ***, **, * significance level at 1%, 5% and 10% respectively. I(0) and I(1) stands for lower and upper bounds.

The table shows that both computed F-statistics of the bound test (8.684) and the absolute value of the computed t-statistic (-5.715) are larger than the upper bound critical value of 4.43 and 4.99 at 1% level of significance respectively[7]. In this case the null hypothesis of no

[6] See appendix three for the full table
[7] See appendix three for the full table.

cointegration is rejected implying that there is a stable long-run equilibrium relationship among the variables (cointegration) in equation 3.9. This means that there is a long-run relationship among the variables included in estimated model.

4.6.3. Long-Run ARDL Regression Results

After finding there is long run relationship between the variables of study the following long run ARDL model was estimated,

Table 7. Results of Long-run ARDL model

Variable	Coeff	SDE	t-stat	Prob
LNFDI	0.012	0.005	2.414	0.022**
LNGDS	0.904	0.028	32.092	0.000***
LNGE	0.175	0.092	1.903	0.067*
LNLABF	-1.002	0.503	-1.991	0.056*
LNDOP	-0.969	0.107	-9.035	0.000***
LNINF	0.061	0.021	2.834	0.008***

Note: LnGDP, LnGE, LnFDI, LnGDS, LnDOP, LnINF, LnLABF stand for logarithm of gross domestic product, government expenditure, foreign direct investment, gross domestic saving, degree of openness, inflation, and labor force respectively; Coeff, SDE, t-stat and Prob stand for coefficients, standard errors, t-statistics, and probability values respectively. The stars, ***, **, *, represent significance level at 1%, 5% and 10% respectively and LN: logarithmic forms of variables.

The long-run results show that foreign direct investment has positive significant impact on economic growth in Algeria. From a mathematical perspective the interpretation of the coefficients is of a percentage nature as the data is log-transformed. A 10 percent increase in foreign direct investment leads to 0.1 percent increase in economic growth. The results show the increasing rate of economic growth is too much slower than the rate of foreign direct investment, this might be attributed to the laws which do not attract much foreign investors such as 51/49 rule where foreign ownership of the company incorporated under Algerian law at 49%, versus 51% for local investors, thus forcing foreign investors to form joint ventures with Algerian companies; weak financial sectors and bureaucracy nature of the country which limits efficient functioning of the foreign investors which eventually decrease investment and obstruct economic growth. The results are the same as what obtained by Mebarki et al. (2020), in their study that covered the period of 1970-2015 they found that; in the long-run, one unit increase in foreign direct investment increases annual per capita GDP by 4.091. Bouyacoub

(2017) also by using ARCH and GARCH models found there is positive relationship between FDI and GDP in Algeria, a one percent increase in FDI leads to 0.24 percent increase in the economic growth.

Gross domestic saving shown to have a long-run higher percentage contribution in the economic growth of the country and statistically significant even by 1 percent level. A one percent increase in gross domestic saving has positive effect of increasing economic growth by 0.9 percent. As economically proven that, saving is the catalyst of investment which leads economic growth in the country. From 1960-2019 Algeria has average domestic saving rate of 35.3 percent (percentage of GDP), that shows how high domestic saving has been contributing to country's economic growth. Saving has been increasing the number of domestic investment in the country which is the key factor for economic uplift. Sellami and Rahmane (2020) also obtained the same results, they found that; in the long-run, one unit increase in domestic saving leads to an increase in GDP by 2.358 units.

The long-run coefficient of government expenditure shows a positive relationship with economic growth and it is statistically significant at 10 percent level. As Keynesian school of thoughts believes that government spending accelerates economic growth, the thought is proven by ARDL long-run model of Algeria's economy. A one percent increase in the government spending cause a significant 0.17 percent increase in economic growth. Algerian government has been spending much on education, health and infrastructures such as roads, railways, airports and seaports, the spending that maintained sustainable economic growth in the country by facilitating smooth conduct of economic activities. Comparing this result with other neighboring countries like Morocco, a study conducted by Jawad and Hefnaoui (2018) in Morocco found that; government consumption expenditure has positive impact on economic growth while government investment expenditure has negative impact on economic growth. A one percent increase in government consumption expenditure leads to 0.33 percent increase in the long-run economic growth in Morocco while a one percent increase in the government investment expenditure leads to 0.12 percent decrease in economic growth.

The conflicting result is on the long-run negative effect of labor force on economic growth. This is against our expectations. Economically, labor force which is the source of human capital increase economic growth because of skills, knowledge, experience and workforce possessed by labors. In Algeria, the negative effect might be due to the increasing rate of unemployment and dependent ratio. With average of 18 percent (percentage of population), this rate of

unemployment has negative impacts on economic growth of the country. Unemployment does not just have negative impact to the unemployed but the impact spread to the general economy as a whole. Unemployment increase poverty to the majority of population and leads to the increase of dependence on the employed population which eventually limits their saving rate and investment.

Degree of openness has long-run significant negative effect on economic growth of the country. A one percent increase in the degree of openness decrease economic growth by 0.96 percent. This might be due to the unique characteristics of Algerian economy where hydrocarbon (oil and gas) is the only major product exported to the outside world. The Algerian ratio of export and import is not consistent, and when the country's imports is more than exports it negatively affects the economy. For example, in 2019 Algeria spent 50013.4 million USD on imports comparing to what received from exports, 38999.16 million USD. This shows the country's dependence on imports than benefiting from exports. This leads the country to be a dumping market for low quality goods produced in outside world, killing of local industries which later cause unemployment, distort economic growth, and disturbs foreign exchange rate policy. This result is different from what was obtained by Mebarki et al., (2020), in their study they found that; in the long-run there is positive relationship between trade openness and economic growth in Algeria, their results showed a one unit increase in the degree of openness causes 0.143 unit increase in the annual GDP per capita.

The results also reveal in the long-run inflation has positive impact on economic growth and the impact is statistically significant at 5 percent level. This is contrary to what we expected. A one percent increase in inflation leads to 0.06 increase in economic growth. This little percentage increase in economic growth might be due to the fact that a small increase in inflation rate doesn't change consumption and spending pattern in the economy. Investors do not change their investment decision to the extent where it can affect the economic growth of the country because of a mere slightly increase of inflation rate. A small percentage increase in inflation sometimes act as incentive to investors. The result of positive relationship between inflation and economic growth is different from the result obtained by Touami and Bouyacoub (2016), in their study by using VAR, they found that inflation has negative impact in economic growth, a one percent increase in the rate of inflation causes 0.14 percent decrease in the economic growth.

4.6.4. Results of ECM model

The residuals generated from the estimated long-run model above used in the Error Correction Model as one of the regressors. It enables the estimation of Error Correction Model which contains short-run coefficients together with an adjustment term which indicates the speed and extent to which any disequilibrium of economic growth in the previous period is being adjusted in the current period.

Table 8. Results of ECM model

Variable	Coeff	SDE	t-stat	Prob
C	6.077	0.705	8.613	0.000***
D(LNGDP(-1))	0.209	0.112	1.86	0.073*
D(LNFDI)	0.002	0.002	0.835	0.41
D(LNGDS)	0.596	0.038	15.628	0.000***
D(LNGDS(-1))	-0.309	0.084	-3.682	0.001***
D(LNGE)	0.019	0.066	0.293	0.771
D(LNGE(-1))	-0.198	0.065	-3.024	0.005***
D(LNDOP)	-0.457	0.079	-5.744	0.000***
D(LNDOP(-1))	0.544	0.113	4.804	0.000***
D(LNINF)	0.031	0.011	2.819	0.008***
ECM (-1)	-0.81	0.093	-8.619	0.000***

Note: R-squared = 0.916, Adjusted R-squared = 0.891, Durbin-Watson stat = 2.334. LnGDP, LnGE, LnFDI, LnGDS, LnDOP, LnINF, LnLABF stand for logarithm of gross domestic product, government expenditure, foreign direct investment, gross domestic saving, degree of openness, inflation, and labor force respectively; ; Coeff, SDE, t-stat and Prob stand for coefficients, standard errors, t-statistics, and probability values respectively. The stars, ***, **,* represent significance level at 1%, 5% and 10% respectively. D is the first difference operator.

The overall significance of the model presented above demonstrates that globally the model is valid and it can be used for the prediction of the future values of the GDP as the F-statistic which is the measure of the global significance of the model is largely statistically significance at 1% level. For the good-ness of the fit, R-square indicates that the total variation of GDP is well explained by its explanatory variables involved in the model at approximately 90% implying that the independent variables used in the model jointly explain almost 90 percent of the total variation in the economic growth in Algeria. The D-W statistic is approximately 2 which is also a good sign that the model does not suffer from autocorrelation, further-more this D-W statistic is also greater than the R-square which implies that the regression does not possess the spurious estimates.

The results show that current year gross domestic product is positively affected by previous year's gross domestic product at significant of 10 percent level. This means the evolution of

economic activities in the present year is depending on the last year's by 0.2%. In short-run the foreign direct investment has nearly zero impact on economic growth but the value is statistically insignificant.

The current gross domestic saving has significant positive impact on economic growth but the last year's gross domestic saving has significant negative impact. This show that current gross domestic saving influence economic growth by increasing investment in the country, a one percent increase in the present year's saving leads to almost 0.6 percent increase in economic growth. Negative impact of previous year's saving might be due to the fact that, after one year people use their savings on non-productive activities.

The short-run impact of government expenditure is positive but not significant. This differs from the result we have gotten in the long-run. The reason behind might be government expenditure especially investment expenditure in infrastructure takes time to be accomplished and so delays in assisting economic growth of the country.

In the short-run, the current year's degree of openness has significant negative impact on economic growth but previous year's degree of openness has negative impact on economic growth. This might be due to the reason that the importation of technology and capital goods such as machines needs time to be invested in the country and reaping the profit from it. So in the present year it might negative impacted economic growth of the country but after one year the country start to benefit. Inflation has the same positive significant impact like in the long-run this proves a slight increase in inflation rate doesn't affect the economic growth.

The coefficient of error correction term (ECM) as could be observed in Table 6 above is negative, and significant, showing that the model has a self-adjusting mechanism for adjusting the short-run dynamics of the variables with their long-run values. The speed of adjustment to equilibrium is given by the coefficient of ECM (-1) as -0.81, which implies that the speed of adjustment to equilibrium after a shock is high. This indicates that a deviation of economic growth from equilibrium is corrected by as high as approximately 81 percent. When the level of GDP is above equilibrium it will be pulled back to equilibrium because the adjustment parameter is negative. The significance of ECM (-1) also means in the long run foreign direct investment, government expenditure, gross domestic saving, degree of openness, labor force and inflation cause economic growth.

5. Granger Causality test

The fact that existence of cointegration and long-run relationship between variables does not define the causality, the Pairwise Granger causality test was employed to test for causality effect of explanatory variables to dependent variable. The null hypothesis of no granger causality among variables in the test is rejected when the p-value of the f-statistic is less than 0.05. The following table shows the summary of the test;

Table 9. Pairwise Granger Causality tests

Null hypothesis	F-Stat	Prob
LNFDI does not Granger Cause LNGDP	4.03134	0.0261**
LNGDP does not Granger Cause LNFDI	0.07987	0.9234
LNGE does not Granger Cause LNGDP	1.49491	0.2357
LNGDP does not Granger Cause LNGE	0.00996	0.9901
LNGDS does not Granger Cause LNGDP	5.44602	0.0078***
LNGDP does not Granger Cause LNGDS	0.80559	0.4535
LNLABF does not Granger Cause LNGDP	2.56404	0.0887*
LNGDP does not Granger Cause LNLABF	0.84579	0.4362
LNDOP does not Granger Cause LNGDP	3.9534	0.0265**
LNGDP does not Granger Cause LNDOP	1.16272	0.3223
INF does not Granger Cause LNGDP	1.81891	0.1745
LNGDP does not Granger Cause INF	0.49865	0.6108

Note: LnGDP, LnGE, LnFDI, LnGDS, LnDOP, LnINF, LnLABF stand for logarithm of gross domestic product, government expenditure, foreign direct investment, gross domestic saving, degree of openness, inflation, and labor force respectively. The stars, ***, **,* respectively signify significance level at 1%, 5% and 10%.

From the Granger Causality result as shown in the table, the probability of foreign direct investment is less than 0.05 that means FDI granger causes economic growth. The results also

show gross domestic saving and degree of openness cause economic growth in Algeria over the period of study. This provides further support to the long-run gross domestic saving coefficient that shows a positive impact between gross domestic saving and economic growth and long run negative impact between degree of openness and economic growth.

Moreover, the variables government expenditure, labor force and inflation do not Granger cause economic growth.

The Granger causality help to improve ARDL regression results and significantly assisting policy makers in the country.

6. The Results of Diagnostic Tests.

Various diagnostic tests were conducted to ensure that our estimated ARDL (2, 1, 2, 2, 0, 2, 1) mode is free from serial correlation, heteroscedasticity, stability, normality and misspecification error. The results of the tests carried out are;

6.1. Test for Serial Correlation

The results for Breusch-Godfrey Serial Correlation test are shown below,

Table 10. Breusch-Godfrey Serial Correlation (LM) Test

F-Statistic	1.591	Prob. F(2,25)	0.223
Obs*R-Squared	4.969	Prob. Chi-Square(2)	0.083

Note: Obs* R-square is the LM statistic which stands for number of observations times R-squared.

The results show that the probability of F-Statistic is greater than 0.05 thus rejecting the hypothesis of serial correlation of errors. Therefore, it can be concluded that there is no serial correlation of errors in the model.

6.2. Heteroscedasticity Test

In order to make sure all residuals are homoscedastic Breusch-Pagan-Godfrey heteroscedasticity test was conducted, the summary of the results are,

Table 11. Breusch-Pagan-Godfrey Heteroscedasticity Test

F-statistic	1.217	Prob. F(16,27)	0.316
Obs*R-squared	18.443	Prob. Chi-Square(16)	0.298
Scaled explained SS	7.601	Prob. Chi-Square(16)	0.959

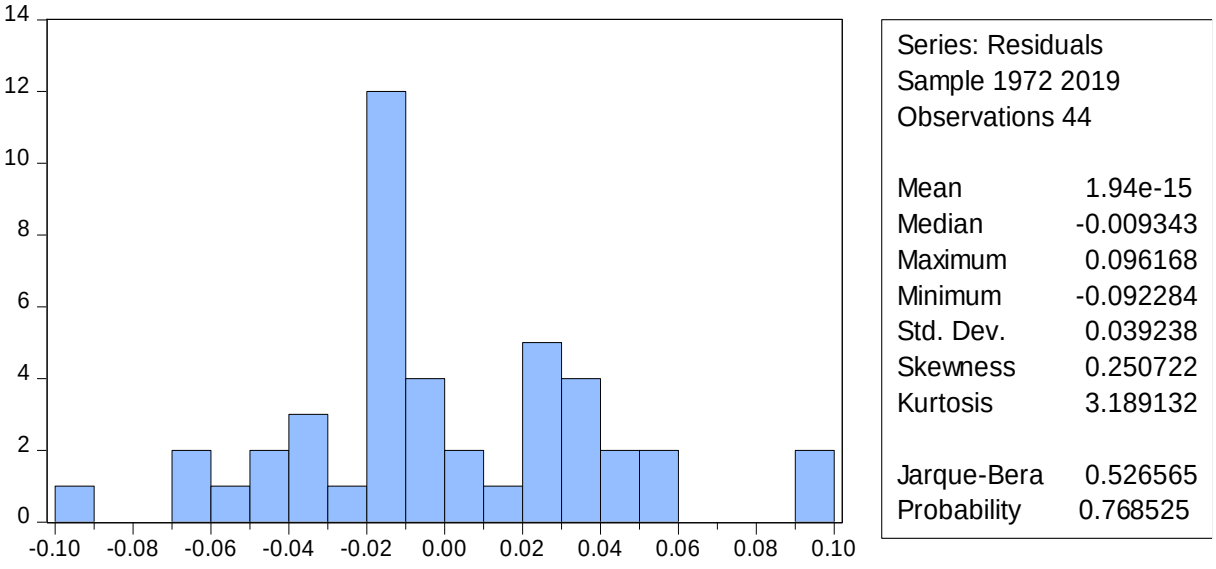
Note: Obs* R-square is the LM statistic which stands for number of observations times R-squared.

The decision is, the probability of Chi-square distribution and F-statistics are greater than 0.05 so we accept the null hypothesis of homoscedastic. This show that the residuals of the model do not have the problem of heteroscedasticity.

6.3. Test for Normality

The histogram test was applied for checking the normality of residuals. The histogram is shown together with the probability for Jarque-Bera statistic to test for normality in the residuals, such as, $\epsilon_t \sim N(0, \delta^2)$. The p-value of Jarque-Bera is greater than 0.05 shows that the residuals are normally distributed. The result of the test is shown below,

Figure 3. Histogram for Normality Test



The null hypothesis of normality in the residuals was accepted as the probability of Jarque-Bera statistic is greater than 0.05.

6.4. Test for Stability

The CUSUM and CUSUMQ test for stability of the long-run and short-run coefficients were carried out to further enhance the reliability of our results. The results displayed in the figures below suggest that the coefficients (showed by the blue line) of the ARDL model are stable and consistent as the results are still within the critical bound (represent the two red lines). The results of the tests are in the following graph.

Figure 4. The CUSUM Test for Stability

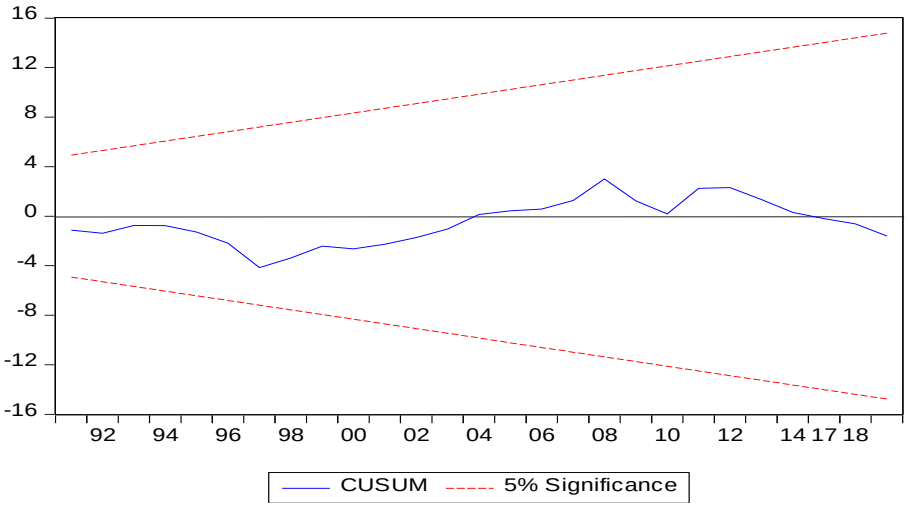
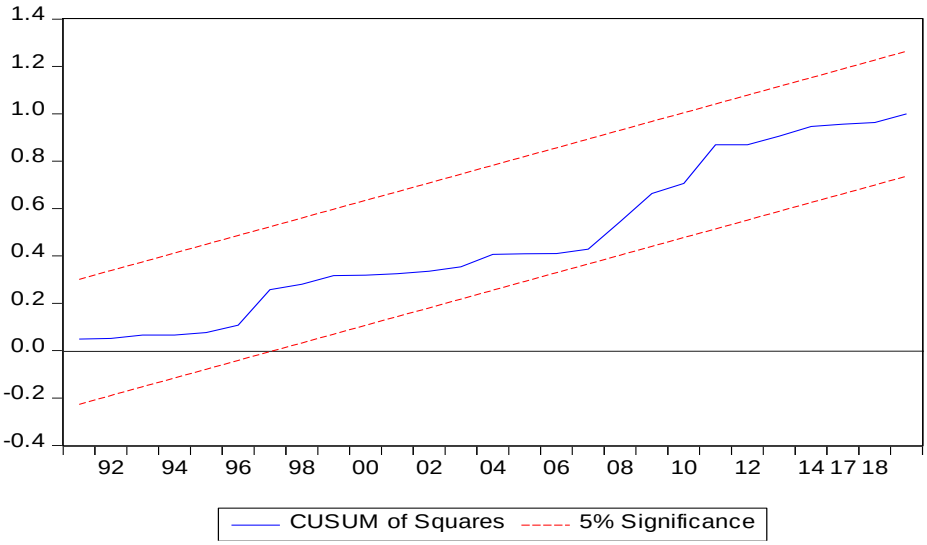


Figure 5. The CUSUMQ Test for Stability



As it can be seen in the figures that the movement path of the plotted residuals is always between the straight red lines, the 5% coefficient level. This implies that the obtained short-run and long-run coefficients are stable and can be used for prediction and policy inference.

6.5. Specification Error Test

Finally we tested misspecification error of the regression model. The results of Ramsey Regression Specification Error Test (RESET) are presented in the table below,

Table 12. RESET Test

	Value	Df	Prob
t-statistic	0.581	26	0.565
F-statistic	0.338	(1, 26)	0.565

Note: DF and Prob represent degree of freedom and probability values respectively.

The results show that both probability of F-statistic and t-statistic are greater than 0.05 that means the null hypothesis of no misspecification in the model is accepted. The variables in our ARDL (2, 1, 2, 2, 0, 2, 1) is quite well specified.

All in all, the estimation of ARDL bounds test found the existence of long-run cointegration relationship between economic growth and explanatory variables. The long-run and short-run ARDL models were estimated, all long-run coefficients found to be significant at 5% and 10% levels, that shows all explanatory variables used in the model explain economic growth in the long-run. In the short-run, all explanatory variables were statistically significant except foreign direct investment and government expenditure. Finally, the model was validated because all diagnostic tests were found to be good.

CHAPTER FIVE

SUMMARY, CONCLUSION AND POLICY RECOMMENDATION

This final chapter is divided into five parts, in first section we present the summary of major finding in our study, the second section brings the conclusion of the study, the third section is policy recommendation to the Algerian government, the fourth and fifth sections present limitations and recommendations for the future researches respectively.

5.1. SUMMARY OF THE STUDY

The main objective of this study is to investigate the key determinants of economic growth in Algeria. The empirical analysis is based on the econometric method by using an ARDL model. The analysis used secondary World Bank data ranging from 1970 to 2019. Due to data unavailability of other major macroeconomic variables our study chose six explanatory variables which are foreign direct investment, gross domestic saving, government expenditure, degree of openness, labor force and inflation and regressed them on the dependent variable gross domestic product. The ARDL bounds test of cointegration for the ARDL (2,1,2,2,0,2,1) proved the existence of long-run relationship between the variables. The long-run ARDL model shows foreign direct investment, gross domestic saving, government expenditure and inflation have positive impact on Algeria's economic growth while degree of openness and labor force have negative impact. Short-run model shows that all variables are significant except foreign direct investment and government expenditure that shows these variables are not capable to explain economic growth in the short-run. The coefficient of adjustment term in the ECM model is negative and significant which shows that the model has self-adjusting mechanism. The model estimated is valid in both statistical and economic aspects, as it possess all diagnostics and globally significant at 1% level, therefore it can be applied in so many uses such as forecasting and policy analysis.

5.2. Conclusion

Generally, there are many factors that determine economic growth in the country. Due to various reasons this study used six variables and measured their power in explaining economic growth. Among these variables only foreign direct investment, gross domestic saving, degree of openness and inflation found to have long-run positive significant impact on economic

growth at 5 percent level, while government expenditure and labor force are significant at 10 percent level. The results show gross domestic product is highly positively affected by gross domestic saving. Increase in domestic saving increases economic growth in both long run and short run, the fact that shows how important gross domestic saving is on economic growth of Algeria. On the other hand, degree of openness found to have a negative impact on economic growth which shows the country is not benefiting with its international trade policy. Lack of international trade exposure among Algerians and low economic diversification in the country limit the country's ability to benefit and compete in the international trade. Moreover, the study found labor force of the country contributes negatively in the economy.

Foreign direct investment is significant in long-run but insignificant in the short-run, this implies that the impact of foreign direct investment is only in the long-run and there might be some factors that limit its impact in the short-run such as bureaucracy, corruption, and business environment that provides weak incentives for foreign investment and depresses its return. In the long-run government expenditure increase economic growth, government spending for the social benefits such as building schools, hospitals and constructing infrastructures accelerate economic growth in the country.

Though inflation found to have a positive significant impact on economic growth in both long-run and short-run but the impact is very little in economic growth, with one percent increase in inflation leads to an approximately zero increase in economic growth in both long-run and short-run so government should be careful in managing it.

Labor force was also found to negatively contribute economic growth in the long-run. The quality of human capital skills given to the labor force, significant unemployment rate and low female labor force participation rate might be the factors behind this negative contribution of labor force to economic growth.

The Forecasting of the Algerian GDP has to consider both current and lagged values of Degree of openness, Gross Domestic Saving, Foreign Direct Investment and labor force as they were all found to individually granger cause the economic growth at 5 and 10 percent level. Inflation and government expenditure were not found to have individual impact on the economic growth (they individually don't granger cause GDP), so econometrically speaking, including their current and lagged values in forecasting the future of Algerian GDP will lead to the wrong predictions.

5.3. Policy Recommendations

In the light of the foregoing, the study recommends the following policy measures;

1. **Establishment of policies that enhance domestic saving.** The policy makers in the country should put in place the policies that promote economic growth in the country. The results showed that saving contributes on huge percentage in economic uplift. If this will be taken seriously, it will result in the faster economic recovery and growth as now the country suffers from the negative effects of Covid-19, since it is believed that increase in saving stimulates the national capacity for investment and production, while a serious constraint to sustainable economic growth can result from the low rate of saving (Ellias and Worku, 2015).

2. **Diversification of the economy**. Algerian economy is more dependent on hydrocarbons (oil and gas), that contributes approximately 97% of exports. The country is limited only in the exportation of hydrocarbons as a major product and that whenever the price shocks happen the country's export revenue is highly affected. Thus there is the need for the country to diversify the economy by producing other different goods that will compete in the international market and avoiding the effect of oil price shock and negative trade openness effect on economic growth.

3. **Promoting quality education and skills development**. Algerian government should improve the quality of education and training provided to the people and enhance skills to majority of the citizens in order to bring positive impact to economic growth. Education, training, and skills development would generate competent human capital and generate the self-employment minds to tackle unemployment problem.

4. **Improvement of investment policies and establishing conducive investment environment.** The study found positive impact of foreign direct investment on economic growth but the rate of contribution is very low. The protectionist measures, as well as corruption, bureaucracy and a weak financial sector still seem to be the very serious obstacles to investment in Algeria. The majority ownership even in its strategic sectors (hydrocarbon, mining, defense and pharmaceutical) will help in encouraging foreign investors to invest with huge capital in the country which in turn will increase the production capacity and hence help in solving the unemployment problem. Being ranked 157th out of 190 countries in the report published by the World Bank (Doing Business, 2020), is not good for Algeria and therefore much effort has to be offered on this starting by recognizing the above outlined main obstacles

then react in a very faster and positive way. To increase economic growth rate the country should allow more foreign direct investment so as to increase its contribution in the economy. This can be achieved by developing infrastructure, reducing bureaucracy in the public office, reducing government taxes and amending the 51%-49% investment law. .

5. **Government should increase public investment**.

Public spending such as investment in education, health and infrastructure found to have long-run positive impact on economic growth. The government of Algeria should increase and improve government expenditure with more budgetary allocations should be channeled towards health delivery schemes and education promoting activities and in constructing infrastructures such as roads, railways, airports and seaports which in general boost economic activities in the country and accelerate economic growth.

6. **Putting consideration on agricultural sector.** Algerian authorities should consider Agriculture as the sector that would take away Algeria from being the strong dependent of only hydrocarbon sector as its main contributing sector in economic growth. The Degree of openness which found to be statistically significant in both short and long-run models, but contradicts the a priori expectations as it has a very big negative impact in Algerian economic growth which can be attributed to the very weak performance of agricultural sector as the domestic agricultural production does not meet the Algerians needs and so the massive importation of alimentary products is inevitable. So even if the country depends over 90% of its exports earnings from hydrocarbons, but still because of the poor performance of other sectors (agriculture), the country will need to buy in a big quantity from other countries (importation) in order to meet the domestic needs, that's why the Degree of openness found to be negative as the exportation is largely covered by the importation.

5.4. Limitations of the study

Restricting discussion to limitations related to the research problem under investigation is of great significance, since all studies have limitations. Due to lack of available and /or reliable data on certain variables such as expenditure on education and rate of secondary school enrollment, the scope of the study had to be limited only to the variables involved and ignore some like human capital which on one way or another we really wished to include them in this study as they have an exceptional significance in determining the economic growth and development of a country.

Lack of enough prior studies on the topic adopting the same methodology is also a challenge we faced. Most of studies that investigated the determinants of Algerian economic growth (Samad, 2011 and Zergoune et al; 2018) were limited to a very small number of determinants (mainly considered exports as the major factor), and therefore the contribution of other macroeconomic variables like gross domestic saving onto the Algerian economy was not empirically investigated. Furthermore, the comparison between our findings (i.e. statistics descriptive) and the findings of other studies was also a challenge because of different methodology adopted.

Examining the real effect of each explanatory variable on the Algerian economic growth was also found to be a limit of the study. Not all variables involved in the study that are expressed in the same unit of measurements. Algorithmic transformation of all variables involved in the study had to be taken as a means of expressing all variables in the same unit but in reality the real overall or individual impact of the variables on Algerian economy could not be examined since variables are not of the same unit of measurement.

5.5. Future research recommendations

Following the massive Algerian government expenditure on social overhead infrastructures especially on education and health, plus by being rich in population ages 15-64 which is economically active participating in productive activities at 45% (statista, 2020), then by having the high literacy rate of (81.4%) compare to other African countries (World Bank, 2018), we recommend the future studies to intensively conduct an empirical investigation on the really impact of human capital on Algerian economy. Results of this investigation will alert Algerian authorities if its resources are allocated in an optimal way or not.

We also recommend on the sectorial investigation, authorities should allow researchers to quantify the individual contribution of each sector even of those strategic ones (hydrocarbons, mining, defense, and pharmaceutical). The really impact of agricultural sector has to be identified as the sector seems to be one of the means to diversify Algerian economy which depends strongly on hydrocarbon sector.

We finally recommend that future studies should examine on how negatively the Covid-19 has affected each productive sector and economy as a whole. This will help to identify in which sectors Algerian government should put more emphasize that will counterbalance the negative effects of those sectors which resources are not allocated because of the scarcity.

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APPENDIX ONE

WORLD BANK DATA SUMMARY AND DESCRIPTIVE STATISTICS

Year	GE	GDP	FDI	GDS	Labor Force aged 15 to 64	Inflation	DOP
1970	5.876	4863487493	80120000	1438091248	7173437	6.6	51.2254018
1971	6.941	5077222367	600000	1323128649	7372644	2.62664165	46.1062967
1972	8.197	6761786387	41490000	1962620991	7571168	3.65630713	46.1764303
1973	9.989	8715105930	51000000	2980400738	7775098	6.17283951	57.0934265
1974	13.408	1.321E+10	358000000	5716609309	7995677	4.6996124	74.2388192
1975	19.068	1.5558E+10	119000000	5621107130	8239041	8.23031665	76.6545354
1976	20.118	1.7728E+10	187000000	6964792641	8477685	9.4307354	70.1732569
1977	25.473	2.0972E+10	178452647	7499757427	8741876	11.9892833	72.3268842
1978	30.106	2.6364E+10	135152172	9909478756	9028927	17.5239234	65.7045689
1979	33.515	3.3243E+10	25692486	1.3573E+10	9334251	11.3486005	64.0140493
1980	44.016	4.2345E+10	348669038	1.8241E+10	9655388	9.5178245	64.6769232
1981	57.655	4.4349E+10	13207259.4	1.805E+10	9978355	14.6548426	65.4649936
1982	72.445	4.5207E+10	-53569192.6	1.7726E+10	10325285	6.54250963	59.9229313
1983	84.825	4.8801E+10	417641.163	1.9379E+10	10693624	5.96716393	53.7441174
1984	91.598	5.3698E+10	802668.874	1.794E+10	11082313	8.11639796	53.1763837
1985	99.841	5.7938E+10	397788.297	1.8199E+10	11490680	10.482287	50.3261206
1986	101.817	6.3696E+10	5316528.38	1.4802E+10	11900749	12.3716092	36.0267106
1987	103.977	6.6742E+10	3711537.9	1.5629E+10	12331589	7.44126091	32.6845845
1988	119.7	5.9089E+10	13018265	1.2139E+10	12780858	5.91154496	38.1115873
1989	124.5	5.5631E+10	12091646.8	1.1237E+10	13246553	9.30436126	47.1533197
1990	136.5	6.2045E+10	334914.564	1.6812E+10	13727365	16.6525344	48.3807137
1991	212.1	4.5715E+10	11638686.5	1.7079E+10	14210929	25.8863869	52.7175867
1992	420.131	4.8003E+10	30000000	1.5461E+10	14708763	31.6696619	49.1890842
1993	476.627	4.9946E+10	1000	1.3853E+10	15220061	20.5403261	44.9228134
1994	566.329	4.2543E+10	1000	1.1298E+10	15745482	29.0476561	48.5844378
1995	759.617	4.1764E+10	1000	1.1739E+10	16285293	29.7796265	55.1910052
1996	724.609	4.6941E+10	270000000	1.4784E+10	16813399	18.6790759	53.7051479
1997	845.196	4.8178E+10	260000000	1.5424E+10	17360011	5.73352275	52.2439115
1998	875.739	4.8188E+10	606600000	1.3112E+10	17919642	4.95016164	45.0944506
1999	961.682	4.8641E+10	291600000	1.538E+10	18481373	2.64551113	50.9291093
2000	1178.122	5.479E+10	280100000	2.4571E+10	19038163	0.33916319	62.8583589
2001	1321.028	5.4745E+10	1113105541	2.2726E+10	19626400	4.22598835	58.7061503
2002	1550.646	5.676E+10	1064960000	2.3004E+10	20193041	1.41830192	61.134212
2003	1639.265	6.7864E+10	637880000	3.0344E+10	20746611	4.26895396	62.1247612
2004	1888.93	8.5325E+10	881850000	4.0673E+10	21296420	3.9618003	65.7014218
2005	2052.037	1.032E+11	1156000000	5.654E+10	21841621	1.38244657	71.2785821
2006	2453.014	1.1703E+11	1841000000	6.6778E+10	22354239	2.31149919	70.7300041
2007	3108.669	1.3485E+11	1686736540	7.6414E+10	22845300	3.67899575	71.938106

2008	4191.053	1.7101E+11	2638607034	9.6809E+10	23315427	4.85859063	76.684539
2009	4246.334	1.3721E+11	2746930734	6.352E+10	23766656	5.73706036	71.3243234
2010	4466.94	1.6116E+11	2300369124	7.8084E+10	24198801	3.91106196	69.8666438
2011	5731.407	2.0025E+11	2571237025	9.6433E+10	24569857	4.52421151	67.4743064
2012	7058.2	2.0902E+11	1500402453	9.9357E+10	24959495	8.89145091	65.4049792
2013	6092.1	2.0972E+11	1691886708	9.6906E+10	25342749	3.25423911	63.6108237
2014	6996.2	2.1386E+11	1502206171	9.4327E+10	25690645	2.91692692	62.4143164
2015	7656.3	1.6636E+11	-537792921	6.2268E+10	25993588	4.78444701	59.6951665
2016	7297.2	1.5999E+11	1638263954	5.8553E+10	26300654	6.3976948	55.9256682
2017	7389	1.7016E+11	1230243451	6.5491E+10	26564914	5.59111591	55.3213327
2018	8273	1.7541E+11	1466099810	7.1835E+10	26810333	4.2699902	57.8986226
2019	7418	1.7109E+11	1381269144	6.7673E+10	27079012	1.95176821	52.0263556

	GDP	GDS	FDI	DOP	GE	INF	LABF
Mean	79835.14	33151.54	635.6420	58.16157	1981.181	8.736965	16.56403
Median	54767.48	17832.63	223.5000	58.30239	645.4690	5.939354	16.01539
Maximum	213860.5	99356.99	2746.931	76.68454	8273.000	31.66966	27.07901
Minimum	4863.487	1323.129	-537.7929	32.68458	5.876000	0.339163	7.173437
Std. Dev.	62424.70	30775.14	836.5166	10.61211	2687.956	7.601659	6.607869
Skewness	0.871887	0.972594	1.059092	-0.241253	1.216043	1.637515	0.131406
Kurtosis	2.415059	2.475599	3.007514	2.469147	2.922221	4.956332	1.595713
Jarque-Bera	7.047712	8.455737	9.347425	1.072118	12.33561	30.31885	4.252274
Probability	0.029486	0.014583	0.009338	0.585050	0.002096	0.000000	0.119297
Sum	3991757.	1657577.	31782.10	2908.078	99059.04	436.8482	828.2014
Sum Sq. Dev.	1.91E+11	4.64E+10	34288244	5518.230	3.54E+08	2831.476	2139.533
Observations	50	50	50	50	50	50	50

APPENDIX TWO

UNIT ROOT TEST

Null Hypothesis: LNGDP has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.423097	0.0148
Test critical values:	1% level	-3.571310	
	5% level	-2.922449	
	10% level	-2.599224	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNGDP)
Method: Least Squares
Date: 06/24/21 Time: 05:12
Sample (adjusted): 1971 2019
Included observations: 49 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNGDP(-1)	-0.064836	0.018941	-3.423097	0.0013
C	0.779529	0.207275	3.760837	0.0005

Null Hypothesis: LNLABF has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.332051	0.0000
Test critical values:	1% level	-3.581152	
	5% level	-2.926622	
	10% level	-2.601424	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNLABF)
Method: Least Squares
Date: 06/24/21 Time: 05:16
Sample (adjusted): 1974 2019
Included observations: 46 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNLABF(-1)	-0.003843	0.000607	-6.332051	0.0000
D(LNLABF(-1))	0.577605	0.148250	3.896156	0.0004
D(LNLABF(-2))	0.072458	0.175078	0.413859	0.6811
D(LNLABF(-3))	0.300119	0.140768	2.132016	0.0390
C	0.011345	0.001986	5.713260	0.0000

Null Hypothesis: LNDOP has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.830810	0.0615
Test critical values:	1% level	-3.574446	
	5% level	-2.923780	
	10% level	-2.599925	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNDOP)
Method: Least Squares
Date: 06/24/21 Time: 05:29
Sample (adjusted): 1972 2019
Included observations: 48 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNDOP(-1)	-0.207218	0.073201	-2.830810	0.0069
D(LNDOP(-1))	0.379770	0.136702	2.778079	0.0079
C	0.840754	0.296682	2.833851	0.0069

Null Hypothesis: D(LNDOP) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.658923	0.0000
Test critical values:	1% level	-3.577723	
	5% level	-2.925169	
	10% level	-2.600658	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNDOP,2)
Method: Least Squares
Date: 06/24/21 Time: 05:19
Sample (adjusted): 1973 2019
Included observations: 47 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNDOP(-1))	-0.961745	0.169952	-5.658923	0.0000
D(LNDOP(-1),2)	0.349676	0.142098	2.460805	0.0179
C	0.001230	0.014307	0.086003	0.9319

Null Hypothesis: LNGDS has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.534789	0.1137
Test critical values:	1% level	-3.571310	
	5% level	-2.922449	
	10% level	-2.599224	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNGDS)
Method: Least Squares
Date: 06/24/21 Time: 05:37
Sample (adjusted): 1971 2019
Included observations: 49 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNGDS(-1)	-0.069456	0.027401	-2.534789	0.0146
C	0.765833	0.272740	2.807927	0.0072

Null Hypothesis: D(LNGDS) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.003473	0.0000
Test critical values:	1% level	-2.614029	
	5% level	-1.947816	
	10% level	-1.612492	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNGDS,2)
Method: Least Squares
Date: 06/24/21 Time: 05:21
Sample (adjusted): 1972 2019
Included observations: 48 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNGDS(-1))	-0.694425	0.138789	-5.003473	0.0000

Null Hypothesis: LNGE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.452739	0.1332
Test critical values:	1% level	-3.571310	
	5% level	-2.922449	
	10% level	-2.599224	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNGE)
Method: Least Squares
Date: 06/24/21 Time: 05:39
Sample (adjusted): 1971 2019
Included observations: 49 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNGE(-1)	-0.020836	0.008495	-2.452739	0.0179
C	0.268946	0.053687	5.009559	0.0000

Null Hypothesis: D(LNGE) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.085338	0.0001
Test critical values:	1% level	-3.574446	
	5% level	-2.923780	
	10% level	-2.599925	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNGE,2)
Method: Least Squares
Date: 06/24/21 Time: 05:23
Sample (adjusted): 1972 2019
Included observations: 48 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNGE(-1))	-0.755969	0.148657	-5.085338	0.0000
C	0.108438	0.030041	3.609608	0.0008

Null Hypothesis: LNINF has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.874344	0.0557
Test critical values:	1% level	-3.571310	
	5% level	-2.922449	
	10% level	-2.599224	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNINF)
Method: Least Squares
Date: 06/24/21 Time: 05:40
Sample (adjusted): 1971 2019
Included observations: 49 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNINF(-1)	-0.317386	0.110420	-2.874344	0.0061
C	0.564610	0.225541	2.503359	0.0158

Null Hypothesis: D(LNINF) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.739183	0.0000
Test critical values:	1% level	-2.614029	
	5% level	-1.947816	
	10% level	-1.612492	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNINF,2)
Method: Least Squares
Date: 06/24/21 Time: 04:31
Sample (adjusted): 1972 2019
Included observations: 48 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNINF(-1))	-1.332246	0.136792	-9.739183	0.0000

Null Hypothesis: LNFDI has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.552755	0.1120
Test critical values:	1% level	-2.617364	
	5% level	-1.948313	
	10% level	-1.612229	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNFDI)
Method: Least Squares
Date: 06/24/21 Time: 05:56
Sample (adjusted): 1971 2019
Included observations: 45 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNFDI(-1)	-0.115670	0.074493	-1.552755	0.1276

Null Hypothesis: D(LNFDI) has a unit root
Exogenous: None
Lag Length: 2 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.218705	0.0000
Test critical values:	1% level	-2.630762	
	5% level	-1.950394	
	10% level	-1.611202	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNFDI,2)
Method: Least Squares
Date: 06/24/21 Time: 05:25
Sample (adjusted): 1974 2014
Included observations: 36 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNFDI(-1))	-1.603094	0.307182	-5.218705	0.0000
D(LNFDI(-1),2)	0.453023	0.240784	1.881448	0.0688
D(LNFDI(-2),2)	0.336990	0.156706	2.150454	0.0389

APPENDIX THREE

ARDL ESTIMATION

Dependent Variable: LNGDP
Method: ARDL
Date: 06/24/21 Time: 06:01
Sample (adjusted): 1972 2019
Included observations: 44 after adjustments
Maximum dependent lags: 2 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (2 lags, automatic): LNFDI LNGDS LNGE LNLABF LNDOP LNINF
Fixed regressors: C
Number of models evalulated: 1458
Selected Model: ARDL(2, 1, 2, 2, 0, 2, 1)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNGDP(-1)	0.399214	0.187580	2.128235	0.0426
LNGDP(-2)	-0.209394	0.150457	-1.391718	0.1754
LNFDI	0.002231	0.003828	0.582907	0.5648
LNFDI(-1)	0.007846	0.003634	2.159010	0.0399
LNGDS	0.596468	0.054016	11.04242	0.0000
LNGDS(-1)	-0.173655	0.130003	-1.335783	0.1928
LNGDS(-2)	0.309862	0.104388	2.968379	0.0062
LNGE	0.019402	0.101854	0.190486	0.8504
LNGE(-1)	-0.075684	0.117440	-0.644443	0.5247
LNGE(-2)	0.198738	0.084268	2.358403	0.0258
LNLABF	-0.811994	0.350869	-2.314238	0.0285
LNDOP	-0.457984	0.107073	-4.277298	0.0002
LNDOP(-1)	0.217202	0.159125	1.364981	0.1835
LNDOP(-2)	-0.544473	0.143461	-3.795275	0.0008
LNINF	0.031607	0.017603	1.795566	0.0838
LNINF(-1)	0.017825	0.016620	1.072501	0.2930
C	6.077429	1.013771	5.994874	0.0000

R-squared	0.997858	Mean dependent var	10.99378
Adjusted R-squared	0.996589	S.D. dependent var	0.847824
S.E. of regression	0.049517	Akaike info criterion	-2.888608
Sum squared resid	0.066203	Schwarz criterion	-2.199262
Log likelihood	80.54938	Hannan-Quinn criter.	-2.632966
F-statistic	786.1622	Durbin-Watson stat	2.334990
Prob(F-statistic)	0.000000		

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	8.684773	10%	2.12	3.23
k	6	5%	2.45	3.61
		2.5%	2.75	3.99
		1%	3.15	4.43
Actual Sample Size	44		Finite Sample: n=45	
		10%	2.327	3.541
		5%	2.764	4.123
		1%	3.79	5.411
			Finite Sample: n=40	
		10%	2.353	3.599
		5%	2.797	4.211
		1%	3.8	5.643

t-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-5.715468	10%	-2.57	-4.04
		5%	-2.86	-4.38
		2.5%	-3.13	-4.66
		1%	-3.43	-4.99

Levels Equation
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNFDI	0.012439	0.005151	2.414976	0.0228
LNGDS	0.904337	0.028179	32.09230	0.0000
LNGE	0.175832	0.092395	1.903054	0.0677
LNLABF	-1.002240	0.503293	-1.991366	0.0566
LNDOP	-0.969236	0.107269	-9.035590	0.0000
LNINF	0.061014	0.021528	2.834088	0.0086

EC = LNGDP - (0.0124*LNFDI + 0.9043*LNGDS + 0.1758*LNGE -1.0022 *LNLABF -0.9692*LNDOP + 0.0610*LNINF)

ARDL Error Correction Regression
Dependent Variable: D(LNGDP)
Selected Model: ARDL(2, 1, 2, 2, 0, 2, 1)
Case 3: Unrestricted Constant and No Trend
Date: 06/24/21 Time: 06:06
Sample: 1970 2019
Included observations: 44

ECM Regression
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	6.077429	0.705568	8.613528	0.0000
D(LNGDP(-1))	0.209394	0.112552	1.860424	0.0738
D(LNFDI)	0.002231	0.002672	0.835188	0.4109
D(LNGDS)	0.596468	0.038164	15.62894	0.0000
D(LNGDS(-1))	-0.309862	0.084147	-3.682384	0.0010
D(LNGE)	0.019402	0.066187	0.293135	0.7717
D(LNGE(-1))	-0.198738	0.065716	-3.024197	0.0054
D(LNDOP)	-0.457984	0.079730	-5.744219	0.0000
D(LNDOP(-1))	0.544473	0.113333	4.804194	0.0001
D(LNINF)	0.031607	0.011211	2.819215	0.0089
CointEq(-1)*	-0.810180	0.093989	-8.619922	0.0000

R-squared	0.916920	Mean dependent var	0.084362
Adjusted R-squared	0.891745	S.D. dependent var	0.136132
S.E. of regression	0.044790	Akaike info criterion	-3.161336
Sum squared resid	0.066203	Schwarz criterion	-2.715288
Log likelihood	80.54938	Hannan-Quinn criter.	-2.995920
F-statistic	36.42093	Durbin-Watson stat	2.334990
Prob(F-statistic)	0.000000		

* p-value incompatible with t-Bounds distribution.

APPENDIX FOUR

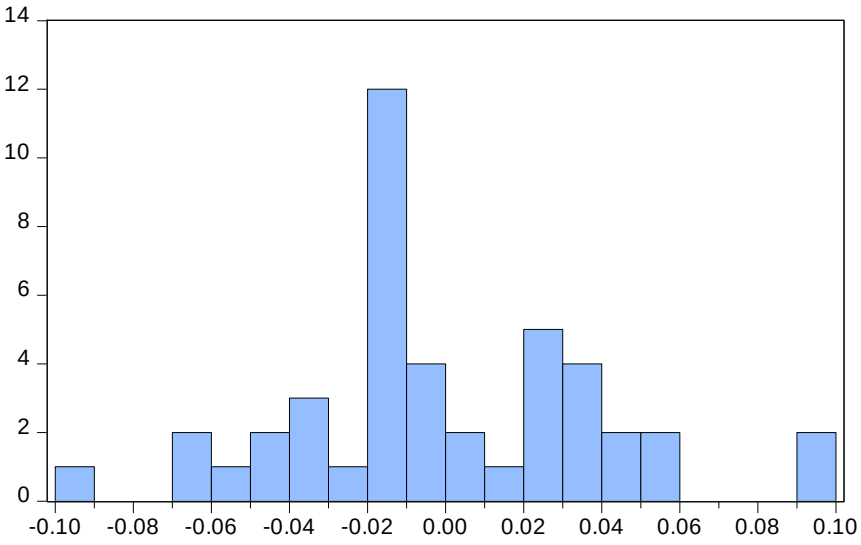
DIAGNOSTIC TESTS

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.591414	Prob. F(2,25)	0.2236
Obs*R-squared	4.969140	Prob. Chi-Square(2)	0.0834

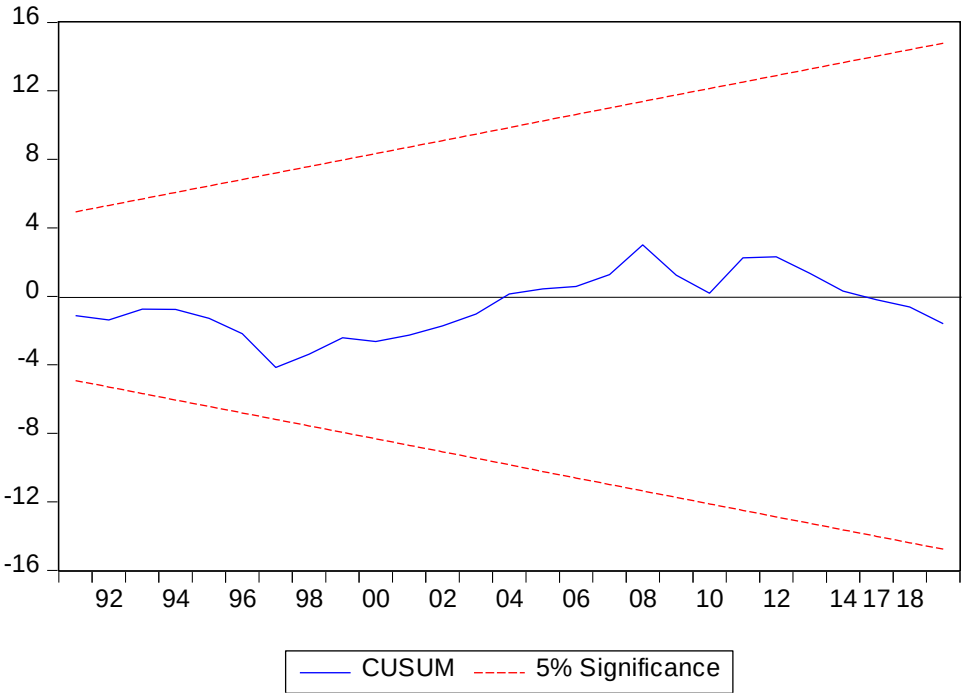
Heteroskedasticity Test: Breusch-Pagan-Godfrey

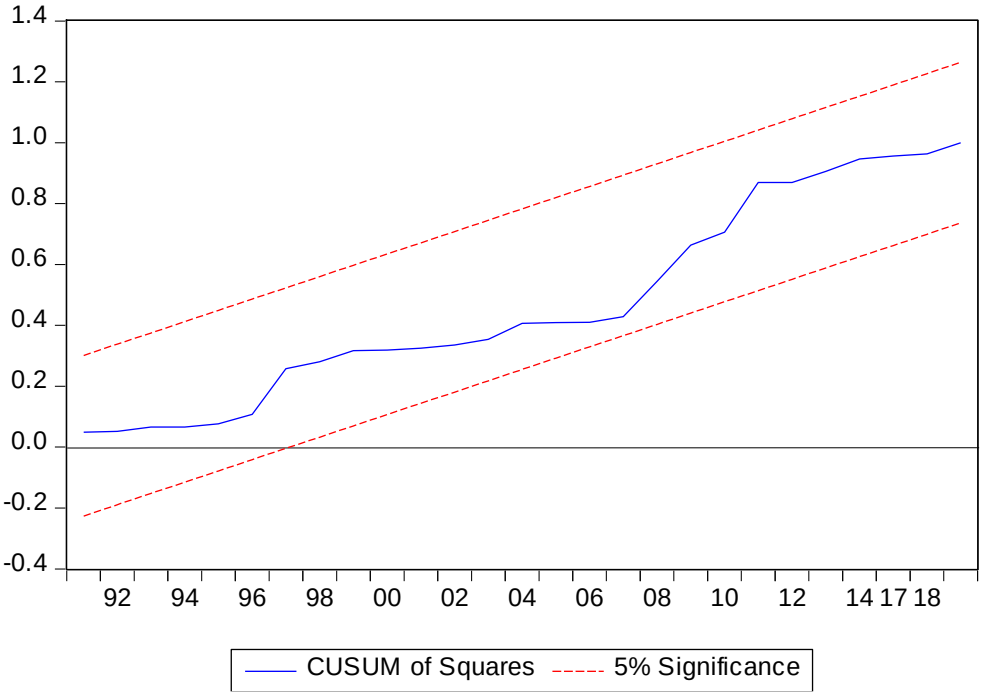
F-statistic	1.217855	Prob. F(16,27)	0.3163
Obs*R-squared	18.44374	Prob. Chi-Square(16)	0.2986
Scaled explained SS	7.601743	Prob. Chi-Square(16)	0.9598



Series: Residuals
Sample 1972 2019
Observations 44

Mean	1.94e-15
Median	-0.009343
Maximum	0.096168
Minimum	-0.092284
Std. Dev.	0.039238
Skewness	0.250722
Kurtosis	3.189132
Jarque-Bera	0.526565
Probability	0.768525


16
12
8
4
0
-4
-8
-12
-16
92
94
96
98
00
02
04
06
08
10
12
14
17
18
CUSUM
5% Significance


1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
92
94
96
98
00
02
04
06
08
10
12
14
17
18
CUSUM of Squares
5% Significance

Ramsey RESET Test
Equation: UNTITLED
Specification: LNGDP LNGDP(-1) LNGDP(-2) LNFDI LNFDI(-1) LNGDS LNGDS(-1) LNGDS(-2) LNGE LNGE(-1) LNGE(-2) LNLABF LNDOP LNDOP(-1) LNDOP(-2) LNINF LNINF(-1) C
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.581709	26	0.5658
F-statistic	0.338385	(1, 26)	0.5658

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.000851	1	0.000851
Restricted SSR	0.066203	27	0.002452
Unrestricted SSR	0.065353	26	0.002514