NEAR EAST UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
ECONOMICS PROGRAM

ON THE INFLATION GROWTH NEXUS: EVIDENCE FROM TIME SERIES METHODS IN THE GAMBIA

SANG MENDY

MASTER'S THESIS

NICOSIA
2019

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NICOSIA
2019

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DECLARATION

I. Sang Mendy, hereby declare that this dissertation entitled ‘On the inflation growth nexus: evidence from time series methods in Gambia’ has been prepared myself under the guidance and supervision of ‘Assoc.Prof.Dr Huseyin Ozdeser’ and ‘Dr. Andisheh Saliminezhad’ in partial fulfilment of the Near East University, Graduate School of Social Sciences regulations and does not to the best of my knowledge breach and Law of Copyrights and has been tested for plagiarism and a copy of the result can be found in the Thesis.

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DEDICATION

This Thesis is dedicated to the almighty God for the wisdom and strength he bestowed on me during this time. It is also dedicated to my parents, not forgetting my late Dad and Stepmom, for their endless love, support and encouragement. The Thesis is also dedicated to my entire family for the support and believe they have in me.

ACKNOWLEDGMENTS

First, I would like to acknowledgement the wonderful contributions of my supervisors Assoc.Prof.Dr. Huseyin Ozdeser and Dr. Andisheh Saliminezhad. Without their continuous support and encouragement, this Thesis would have never been accomplished. Much of the analysis presented in section V is owed to DR. Andisheh Saliminezhad. She kindly assisted me with the statistical analysis in this thesis and was very patient with my knowledge gaps in the area.

I would also like to show gratitude to my committee, including Asst. Prof. Dr. Behiye Tüzel Çavuşoğlu,and Assoc.Prof.Dr Aliya Zhakanova Isiksal. I would like to recognize the outstanding performance of Prof.Dr. Irvan Civir during lectures. His masterly account of Econometrics coupled with his teaching style and enthusiasm for the topic had made me develop passion for Econometrics.

I greatly appreciate the support received from my employer, Gambia Revenue Authority. I would like to thank the management for the continued support and confidence they have in me. I assure them that that I will utilize the knowledge gained to impact positively towards the attainment of the authority's goals and objectives.

Getting through my MSc program required more than academic support thus I owe gratitude to Mr. Alhagie K Mbye and Sheikh OL Faye for their support. Thank you for the financial aid and the encouragement. God will reward you abundantly. To my dear friend and brother, Alhagie Momodou Jallow, thank you for borrowing me your laptop to finish my thesis. I appreciate it a lot.

I am grateful to Mr. Madi Magan for providing me the data. I also appreciate his support especially in my first semester when Econometrics was a bit challenging. I would also want to thank Thomas Apanke who has been my working partner from the start of the program to the end. I would want to show gratitude to Efe, Jardon, and Sulayman Jaiteh for their unwavering support during the time I spent at the university. To Dr. Assan Jallow, thank you for the encouragement. You've been an inspiration to many including my humble self.

None of this could have happened without my family and Good News Mission Church, Gambia branch. This Thesis stands as a testament to the unconditional love and encouragement I continue to receive from my family and Good News Mission Church, Gambia branch.

ABSTRACT

ON THE INFLATION GROWTH-NEXUS: EVIDENCE FROM TIME SERIES METHODS IN THE GAMBIA

This thesis investigates inflation growth nexus in Gambia between the years 1968-2016; secondary data obtained from Gambia Bureau of Statistics were used. The DF-GLS and KPSS techniques were adopted to test the unit root property of the series while Granger Causality was used to test the causation between GDP growth and Inflation. The BDS test confirmed the existence of nonlinear relationship between Inflation and GDP growth in the Gambia. Therefore, a threshold nonlinear relationship best describes dependence between growth and Inflation in the Gambia. The objectives of this Thesis are: to describe the threshold level of Inflation below or above which Inflation impedes or encourages growth: to empirically ascertain whether the two variables have any long run relationship and proffer recommendations based on the findings of the Thesis.

The results of the preliminary test revealed that the series are nonstationary at level. However, given the result of table 5.3 A and B respectively, the series both I and Y are stationary at first difference. Since there is cointegration among the variables, the result of ECT is negative which implies that the previous period's deviation from long-run equilibrium is corrected in the current period as an adjustment speed of 24 percent. Going by the result of the threshold regression we can see that below the 0.72 (low regime), the relationship between inflation and growth is negative which means that as the level of inflation increases by one unit up to 0.72 the level of growth will decrease by 1.11 units. The same relationship exists when inflation is between 0.72 and 1.68 (medium regime), meaning that if inflation increases by one unit up to 1.68, also it will decrease the growth by 1.24 units. However, if inflation is above 1.68 units in the country, GDP growth will increase; although the P-value is insignificant at this level, consequently Inflation above 1.68 units has no impact on the Economy. Based on the observation highlighted above, the Thesis recommends that policies aimed at controlling Inflation be adopted since it is observed that Inflation below certain threshold level impedes growth. The Thesis also recommends further studies on the topic so as to bridge the shortcomings registered herein.

Keywords: Inflation, Economic growth, nexus, fluctuations, threshold, Impact, impedes.

ÖZ

GAMBIA'DA ENFLASYON BÜYÜME-İLİŞKİSİ ÜZERİNE BİR ÇALIŞMA: ZAMAN SERİSİ YÖNTEMLERİ

Bu tez, 1968-2016 yılları arasında Gambiya'daki enflasyon artış bağını; Gambiya İstatistik Bürosu'ndan elde edilen ikincil verilerİ kullanarak analiz etmeye çalışmaktadır. Serilerin durağanlık analizleri, birim kök özelliğini test etmek için DF-GLS ve KPSS teknikleri kullanılmıştır. Granger Nedensellik testi ise GSYİH büyümesi ve Enflasyon arasındaki nedensellik analizinde kullanılmıştır. BDS testi, Gambiya'daki Enflasyon ve GSYİH büyümesi arasındaki doğrusal olmayan ilişkinin varlığını doğrulamıştır. Bu nedenle Gambiya'daki büyüme ve Enflasyon arasındaki bağımlılığı tanımlarken, eşik olmayan bir doğrusal olmayan ilişki ifadesi en iyi şekilde kullanılabilir. Bu tezin amaçları şunlardır: Enflasyonun büyümeyi engellediği ya da teşvik ettiği özeliikle alt ve üst sınır oranlarının etkilediği durumu ortaya koymak: İki değişkenin uzun vadeli bir ilişkisi olup olmadığını ampirik olarak tespit etmek ve Tez'in bulgularına dayanarak önerilerde bulunmak. Öncelikli testlerin sonuçları, serilerin durağan seviyede olmadığını ortaya koydu. Bununla birlikte, sırasıyla Tablo 5.3 A ve B'nin sonuçlarına bakıldığında, hem I hem de Y serisi ilk farkta durağandır. Değişkenler arasında eşbütünleşme olduğu için, ECT'nin olumsuz olması, bir önceki dönemin uzun vadeli dengeden sapmasının mevcut dönemde yüzde 24'lük bir ayar hızı olarak düzeltildiğini ima etmektedir. Eşik regresyonunun sonucuna bağlı olarak, 0,72'nin (düşük rejimin) altında, enflasyon ile büyüme arasındaki ilişkinin negatif olduğunu görüyoruz, bunun anlamı enflasyonun 0,72 birime kadar artması durumunda, büyüme seviyesinin 1.11 birim düşeceği anlamına geliyor. Aynı ilişki, enflasyonun 0,72 ile 1,68 (orta rejim) arasında olması durumunda da gerçekleşmektedir; yani enflasyon 1,68 birime kadar artarsa, büyümeyi 1,24 birim azaltacaktır. Bununla birlikte, ülkede enflasyonun 1,68 birimin üzerine çıkması, GSYİH büyümesini artıracaktır; Fakat bu analizde P-değerinin bu düzeyde önemsiz olduğu görülmektedir. Sonuç olarak enflasyonun 1.68 birimin üzerinde olamsı durumu Ekonomi üzerinde bir etki yaratmamaktadır. Yukarıda vurgulanan gözlemlere dayanarak, Tez, Enflasyonu kontrol etmeye yönelik politikaların, belirli bir eşik seviyesinin altındaki Enflasyonoranı için büyümeyi engellediğini savunur ve benimsenmesini önermektedir.

Tez ayrıca, burada kaydedilen eksiklikleri gidermek için konuyla ilgili daha ileri çalışmalar önermektedir.

Anahtar Kelimeler: Enflasyon, Ekonomik büyüme, Bağ, Dalgalanmalar, Eşik, Etki, Engeller.

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ABBREVIATIONS

ADF: Augmented Dickey-Fuller

AIC: Akaike Information Criteria

BDS: Brock, Dechert, Scheinkman Test

CUSUM: Cumulative Sum

ECT: Error Correction Term

GDP: Gross Domestic Product

GLS: Generalized Least Squares

GBoS: Gambia Bureau of Statistics

DF-GLS: Dickey Fuller- Generalized Least Squares Test

VECM: Vector Error Correction Model

GJR-GARCH: Glosten, Jagannathan, and Runkle- Generalized Autoregressive Conditional Heteroskedasticity Model

ARDL: Autoregressive Distributed Lag Model

WAMZ: West Africa Monetary Zone

IFM: International Monetary Fund

IRF: Impulse Response Function

PP: Phillips-Perron Test

RAMSEY RESET: Ramsey Regression Equation Specification Error Test

TAR: Threshold Autoregressive Model

TR: Threshold Regression

USD: United States Dollar

CPI: Consumer Price Index

NDP: National Development Plan

OLS: Ordinary Least Squares

KPSS: Kwiatkowski-Phillips-Schmidt-Shin Test

SBC: Schwartz Bayesian Criteria

VAR: Vector Autoregression Model

CHAPTER ONE

1.1. Background of the Study

The topic of this thesis has been addressed by numerous scholars. These scholars include Friedman (1969), Bhattacharya et al (2014), Blanchard and Fischer (1991) etc. Their assessment of this topic differs. In recent years, our understanding of inflation rates and their impact on variables of policy concern has again been put under test for several reasons. According to Temple (2000), a certain magnitude of inflation is necessary for a sustained economic growth. Therefore, it is important for policy makers to understand the relationship between inflation and economic growth. In most countries, policy makers are tasked with keeping low inflation rate which they believe will lead to conducive environment for businesses to grow and eventually contribute to the GDP growth. However, other scholars argued that low inflation is necessary for economic growth but not a sufficient condition for economic growth. This is evidence by the fact that many countries experience low inflation rate but yet GDP growth in these countries is low. This happened in the France zone of 1980's (Fisher, 1983). Several studies prove that inflation and gross domestic product growth are negatively related. Nevertheless, the weight of this relationship is observed to change from one country to another depending on the amount of development and different factors. Although there are a lot of studies investigating inflation growth nexus both in developed and developing countries, but very few or no research is done about The Gambia. The aim of this thesis is to examine inflation growth nexus in the Gambia. For too long, the economic progress of Gambia depends solely on sustained liberal and multilateral aids and donors. With a GDP of 964.6 million USD (2016) and annual growth rate averaged

3.94% from 1968 to 2017, it is undoubtedly clear that Gambia remains one of the poorest countries in the sub-region.

1.2. Introduction

The main focus of many central banks in the world is to maintain price stability in the economy with sound and vibrant macroeconomic policies. The importance given to price stability in conducting monetary policy is to excite an acceptable economic growth and boosting the domestic currency purchasing power. The question of whether inflation causes damage to economic growth is of late seen to be a matter of solid contention to economists and policy makers. The argument is if inflation has been detrimental to economic growth or not. The consequences of inflation on GDP growth are to some extent prejudiced on the submission that inflation is harmful to economic growth. There are a lot of theoretical expositions submitting to the fact that inflation can lead to economy growth Adusei M. (2012). However, many literatures have shown the harmful effect of inflation on growth. Based on a topic advanced by Datta and Kumar (2011), they contended that economic growth of any nation relies mainly how polices (monetary and fiscal) are interacted. This policy interaction, they contended, is also believed to rely on institutional settings of a country. Of recent, we have seen an increase in the study of inflation growth nexus especially in developing countries and the impression gathered from these studies so far revealed that the conventional view of inflation towards growth could be misleading. Thus empirical findings should be utilized as a gauge in examining this relationship. Economic policies that are aimed at influencing a rise in aggregate demand might also cause rise in inflation. In such cases, we do not take inflation as a threat to growth because of the increase in output. Therefore, policies aimed at controlling the rate of inflation and maintaining growth should be encouraged.

The burning issue that continues to give a serious problem to macroeconomists is keeping stable price which do not only mean inflation, but could also mean deflation. Jhingan (2002) argued that the definition of inflation only makes sense if there is what he called ‘persistent and considerable’ upward movement in domestic prices. However, an increase in the general price index will solely be termed as inflation if it is unfluctuating, lasting and consistent. Muritala (2011) reasoned that a significant upsurge

in a country's exchange rate against other nations and an unbearable decline in its currency value are referred to as inflation. This is very clear on account of the dalasi (is the currency of the Gambia that was adopted in 1971) which once has rivaled several currencies within the international market. Throughout the years, the dalasi has fallen considerably against these currencies and this impacted negatively and brought about a ravaging impact on the livelihood of average Gambians.

The importance of this thesis is to uncover the relationship that exists in the long-run between GDP growth and inflation in the Gambia through employing Johansen Co-integration method. Moreover I also attempt to detect the causality nexus between the variables by applying the Granger Causality approach. The thesis is divided into six segments which includes;

I. The introduction section
II. Literature/ empirical exposition
III. Overview of Gambia Economy
IV. Methodology
V. Findings, results and discussion
VI. Policy recommendation as well as conclusion

1.3. Significance of Research

Due to lack of insufficient work on this topic by researches for the case of Gambia, I am motivated to conduct a research on the topic with the aim of minimizing the gap that has been left blank for too long. In doing that, the literature review will help to explore and identify a suitable theoretical framework for this study. The ideas put forward herein will contribute positively to the future study of the topic in the Gambia.

In addition, the findings of this study will also impact positively on the government through the central bank on the use of monetary policies on inflation. The main practical contributions of the study, I believe, are as follows:

- To serve as a guide for the government through the central bank on the effect of inflation towards growth

- It will help the government to reconsider its macroeconomic policy especially policies that has to do with inflation targeting.
- The study will serve as a reference to the potential researchers who might have interest in examining this relationship.

1.4. Objectives of the Study:

The contribution of inflation towards economic growth especially in the developing countries such as The Gambia cannot be overemphasized thus; the main object of this study is to uncover the effect of inflation on economic growth and development of The Gambia. Explicitly, below are another objectives that motives this study:

- To examine and report the relationship between GDP growth and inflation in Gambia.
- To empirically ascertain if these two macroeconomic indications have any long relationship in the Gambia
- To understand the nature of relationship among these variables; that is, whether they are positively or negatively related

1.5. Research Questions

This Thesis begs to provide answer and recommendation to the following questions:

a. What is the threshold value (if exist) that determines regime-specific regressions?
b. What is the measurable statistical relationship between these two variables in Gambia?
c. How does inflation rate affect GDP growth in The Gambia?
d. Should policies aim at controlling inflation be adapted in The Gambia?
e. How significant is the speed of adjustment towards long run equilibrium?
f. What is the overall significance of having high or low inflation on GDP?

1.6. Research Hypothesis

Given the research questions asked above, the hypotheses to be tested in the course of this thesis are stated below:

1.6.1. The null hypothesis is stated as follows:

- There is no significant relationship between Inflation and Gross Domestic Product of the Gambia
- There is no causality among the two variables
- There is no long-run relationship among the two variables
- There the two variables have nonlinear relationship

1.6.2. The alternative, on the other hand is stated as follows:

- There is a significant relationship between inflation and GDP.
- There exists causality among the two variables
- There is long-run relationship among the variables
- The variables have linear relationship

1.7. Possible Outcomes

Based on theoretical exposition of other works conducted on the topic, it will be quite interesting to see the results of this thesis. Many theories posit that these two variables have a negative relationship while others argued the opposite. However, some studies found the relationship to be statistically insignificant. While the results of this study may not conform to what the literature review stated, the belief here is that higher inflation will have a negative effect on economic growth hence conforming to what many theories posited. Overall, the projection is that inflation and GDP has a long-run relationship and it is also believe that with stable price and sound monetary policies, the economy of The Gambia will celebrate growth both in the short-run and the long-run.

1.8. Limitations

i. **Lack of Prior Research Studies on the Topic:** As noted earlier, to the best of my knowledge there is no research done on the topic that is linked to The Gambia. Only small research is being conducted on inflation which, in fact, is not the same with what this thesis aims to examine. Therefore the theoretical literature advance herein is not richly originated from the country under focus (Gambia).

ii. **Limitation in the Availability of the Data:** This is one of the problems why scholars do not research for Gambia on topics that have a direct link to the country. The data are not appropriately available as one would expect thus some transformation is done to convert the frequency of the data from low to high to make it more suitable for conducting the analysis.

1.9. Contribution to Knowledge

This thesis seeks to understand the significance of the relationship between these two variables in The Gambia and in doing so; it will contribute new knowledge to what is already known from previous studies.

Moreover, the thesis contributes to the available literature by discovering whether high or low inflation can enhance growth. In the light of this, the thesis intends to include prior omissions of this relationship to the previous works in the Gambia which will better harmonize the contents with the intended needs for future research.

CHAPTER TWO

LITERATURE REVIEW

2.1. Evolution of inflation

Several years ago inflation was never seen as a threat to economic growth. This was the assertion advanced by (Reid et al, 2012). While this argument could be true, recent empirical findings have shown that inflation has a serious consequence on GDP growth both in developing and developed countries. In this section of the thesis, we try to examine the evolution of inflation over time; relationship between inflation and GDP growth from the perspectives of the Classical, Neoclassical, Keynesian, Monetarism, Structuralism; and cost and benefits of inflation. The chapter concludes by providing some intriguing theoretical exposition as well as empirical evidence on the link between inflation and GDP growth.

The argument of whether inflation is good for economic growth is an open debate in economics. While we try to understand the relationship between inflation and GDP growth in a small open economy like Gambia, it is important to know the origin of the inflation. Many are of the view that poor monetary policy is the reason behind inflation. This statement may appear narrow to some, however, Milton Friedman believe that inflation occurs because there is excessive increase in money supply. Historically, inflation has ever been a major concern to macroeconomists especially when it comes to policy interaction (Bryan, 1997). Inflation in those days was not just about significant increase in money supply but many other things, Bryan argued. Bryan further posits that money growth and general price level are synonymously used to refer to inflation. This,

he asserted, has brought some form of misunderstanding of the usage of these two distinctive words. Inflation resulting from excessive money growth is blamed on central bank and in order to address this, Bryan and other economists, argued that central bank must lessen the growth of money so as to offset any potential negative threat on growth.

Adam Smith was a leading Classical economist who many believe is the brainchild behind the study of economics. As earlier economists, Classical economists argued that changes in quantity of money can only have direct effect on money prices of goods but not the value. This theory was later advanced by Irving Fisher in 20th century and has since then been famously referred to as 'quantity theory of money'. Inflation emerged in the mid 1830s according to Bryan (1997). During this period, as stated by Bryan, 'banknotes' which were used to exchange for precious metal emerged. Since this period witnessed the advent of banking industry commonly called 'free banking era' during which banks traded banknotes for metals while banks did not have enough of gold and silver in stock, therefore 'banknotes' began to depreciate. Bryan observed that the advent of 'banknotes' and its quick depreciation had caused a lasting havoc on the economy and due to this the word 'inflation' emerged. This 'inflation' was not because of increase in price of goods and services but was rather due to paper currency. As world events change over time and with much improvement in technology, the meaning of 'inflation' also change to adjust to these changes and this can be justified by different definitions assigned to the meaning of inflation. At some point inflation was once seen as a case of currency, a case of money, but today the meaning reflects prices.

2.2. Costs and Benefits of Inflation for economic growth from theoretical exposition

Perhaps some have already opined that deflation, defined as the general fall in price, is better than inflation because with deflation purchasing power of money increases. While inflation deprives us from consuming many baskets of goods and services due to decline in purchasing power of money, deflation provides us with such a rare privilege but this privilege comes with costs.

- **Benefits**

Inflation is not as bad as we think it is. Generally, inflation is said to have a negative effect on growth but recent empirical findings have proved that, in some cases, inflation and growth have positive and significant relationship. Rudiger Dornbush and Stanley Fischer (1994) stated the following reasons in responding why deflation is damaging to growth:

- Decrease in spending during deflation

  Dornbush and Fischer (1994) argued that during deflation people are reluctant to spend money in the economy. Their argument is premised on the fact that whenever there is price fall, people always anticipate further decline in price in future thus they would be reluctant to spend today. The ramification of such behavior will lead to an increase in real value of debt and correspondingly disposable income will fall.
- A moderate inflation can lead to increase in real wages

  The argument here corroborate that with a moderate inflation, firms find it undesirable to cut wages thus in order to take full advantage of the price increase, firms would be enticed to increase real wages so as to retain workers.
- Inflation leads to growth

  Empirically this argument is inexplicit; however, economists argued that targeting high inflation during recession is an important approach to boost growth, although this argument is controversial because economists are yet to agree the optimal level of inflation rate.

- **Costs**

Tejvan Pettinger (2017) argued that high inflation is damaging to growth. Pettinger, unlike Dornbush and Fischer (1994), argued on the basis of the following:

- Inflation discourages investment

  Pettinger stated that due to rational expectation with high level of uncertainty, investment would be discouraged.
- Decrease in savings

The second reason he advanced is that during period of high inflation the value of money falls, therefore, savings is discouraged because the return on savings (interest rate) will be less than the inflation rate.

- Menu cost

  The third reason stated by Pettinger is the cost firms incur while changing prices lists. Given the advancement in technology, this argument seems invalid.

2.3. Theoretical Literature

An overall increase in price over a particular period of time is what is referred to as inflation (Mankiw, 2010). Fluctuations of business cycle in economies are partly believed to be caused by inflation. We care about inflation not because of the name, but we do care simply because it reflects the rising cost of living standards and thereby deprives us from consuming as many baskets of goods and services as we would have wanted. Firms also do care about inflation and so does the government. Inflation have many potential sources such as rise in price level which may be due to increase in money supply, increase in interest rate, decrease in output etc, Romer (2012). Romer argued that the most significant factor that gives a longer term understanding of inflation is growth of the money supply. Romer do not discredit the importance of the aforementioned variables, but he pointed out that money growth plays a special role in determining inflation not because money affects prices more directly than other factors, but because empirically, money supply varies more than other determinants of inflation.

2.3.1 Relationship between inflation and GDP growth from the perspectives of different schools of thought

Irving Fisher asserted that inflation cannot be assessed without examining the aggregate demand and supply. Fisher stated that the use of expansionary fiscal policy (increase in government spending to be specific) will cause increase in inflation as well as GDP growth.

The Keynesian assertion about inflation is premised on the earlier submission advanced by Irvin Fisher which has to do with aggregate demand and supply being viewed as the cause of inflation in any economy. The Keynesian believe that whenever demand outnumbered supply in the economy there will be price increase. This increase in price

which is precipitated by ‘demand-pull’ is what the Keynesian believe as one of the main causes of inflation. On the side of the supply, they argue argued that increase in raw materials or input factors will lead to increase in domestic price of goods and services in the economy. This, they contended, will eventually lead to inflation. So, it is observed that the views of the Keynesian, to some extent, defer with that of the monetarism.

The Monetarism posits that increase in money supply is the primary cost of inflation. To simply understand the intuition behind their submission, we look at the expression stated below.

MV=PQ

In the above relation, M is taken as money supply, V as velocity of M, P as price and Q is the level of output in the economy. In the meantime, Q and V are held fix while the others are not. Going by this expression, the monetarism believe that since aggregate supply is fixed, inflation will occur whenever money supply increases. The analogy there is that as money supply increases, it creates an avenue for the demand for goods to increase; however, supply is not increasing because the resources at this material time are believed to be fully employed. The end effect in this scenario is that prices will eventually increase. Milton Friedman, a monetarist, made an important remark that it is the continuous increase in supply money that leads to inflation but not otherwise.

The argument advanced by the neoclassical is premised on the endogenous growth models, which have significant impact on both inflation and GDP growth.

Among these schools, one can conjecture that there is a variation in views with regards to the relationship between inflation and GDP growth; however, this difference in opinions is not wide. Monetarism and Structuralism are the two schools with wide variation in views. As far as the Monetarism is concerned, inflation has a far more negative impact on growth than one can imagine. For the case of the Structuralism, inflation is very vital for economic growth.

2.4. Empirical evidence

There was very little empirical proof for any relationship between inflation and growth before the mid of 1970's and even there were questions hanging as to the bearing the relationship ought to be. Just like the theoretical models, findings of empirical studies do vary through time from the general view of negative relationship to positive and to nonlinear relationship as of late. Presently, numerous empirical findings buy in to the view that low however positive inflation is vital for sustainable growth.

Alush Kryeziu (2016) examines effect of macroeconomic variables on economic growth in Kosovo by utilizing linear regression model. Among the variables he focused are budget deficit, public debt, and inflation. Employing data from 2005 to 2014, Alush wants to know how these aforementioned variables impact on growth in Kosovo. For the case of inflation, the result showed that it has a positive effect on growth; however, he argued that higher inflation could be detrimental to growth.

Using secondary data obtained from the Central Bank of Nigeria, Hakeem et al (2015) investigate the relationship between GDP growth and other macroeconomic variables in Nigeria. Inflation and GDP were the targets variables. They contended that economic growth of Nigeria does not only depend on inflation but other factors. Their argument is that since the constant term in the model is positive and statistically significant at 1% level, it implies that there are other important macroeconomic variables that the government can implore to advance growth in Nigeria, although their study was only confined to the effect of inflation on growth. According to their finding, inflation has a negative effect on growth. Since inflation impedes growth, they advised that government through the central bank should implement policies that are aimed at controlling inflation.

Employing nonlinear specification, George Marbuah (2011) examined inflation-growth nexus in Ghana covering the period 1955-2009. George wants to know if there exists a level of inflation below which inflation will be a threat to economic growth of Ghana. He initially conducted the test without accounting for any structural break. The initial finding confirmed that there exist multiple inflation thresholds of 6% and 10%. When he accounted for the structural break in his model, the result reveals 10% as the optimal

threshold level of inflation. These results left George with the following recommendation that the central bank of Ghana should strive to keep inflation as low as below 10%. Secondly, that 8.5% and 8.8% respectively should be the average as well as yearly inflation rate targets for Ghana.

Nasir Iqbal and Saima Nawaz examine inflation growth-nexus in Pakistan employing data from 1961-2008. The results showed the existence of nonlinear relationship between these two variables over the period under study. 6% and 11% are being reported as the thresholds. Their finding revealed that any inflation target below 6% will have no significant impact on the economy. However, if inflation falls between the two thresholds of 6% and 11%, it will lead to a negative growth. They came to conclusion that inflation target should not hover above the 6%. Growth will be impeded anytime inflation hovers above the 6%.

Using VECM, Evans Agalega and Prince Acheampong used time series data sourced from World Bank from 1980 to 2010 to study the effect of macroeconomic variables on growth in Ghana. Among the variables under consideration are inflation (being the focus variable), policy rate, and government consumption expenditure. Series of tests such as unit roots and co-integration were conducted. After the preliminary tests, VECM was found as the appropriate model given the set of data. The co-integration test revealed the existence of long-run relationship and so does policy rate and GDP growth. Government consumption expenditure showed the opposite. Inflation in the short-run has a negative effect on growth in Ghana between these periods. Based on the results, they recommended that prudent monetary policies should be the central focus of the central bank since high inflation impedes growth.

Evaluating the impacts of price changes on growth in Nigeria, Bakare, Kareem and Oyelekan (2015) employed annualized time series for the period 1986 to 2014 in their study. The data were sourced from Central Bank of Nigeria. The Augmented Dicky-Fuller econometric method was utilized to decide the stationarity of the data, while Granger causality test was utilized to verify the existence of causality among the variables. The results discovered that inflation and growth are negatively related and the relationship is said to be significant. Additionally, their study showed that GDP growth

Granger-cause inflation, however, inflation do not have any predictive effect on growth. As to ramifications of the outcome, it was suggested that beneficial action ought to be increased in the economy in order to decrease and maintain stable prices in the economy.

Chughtai, Malik and Aftab (2015) explored the effect of macroeconomic variables on growth in Pakistan. They used secondary data in their study and the data range from 1981-2013. Their study revealed that interest rate and inflation are negatively related to GDP. Semuel and Nurina (2015) obtained similar results to those attained by Chugtai, Malik and Aftab (2015). However, inflation showed a negative relationship but it had no statistical influence on growth.

Agwu (2015) tried to investigate the variables that can advance economic growth in Nigeria. He made use of Vector Error Correction Model after confirming that the series were I(1). Their results revealed that inflation decreases economic growth.

Using the GJR-GARCH model, Mendy et al. (2018), on the inflation-Uncertainty in The Gambia: A Multi-Sample View on Causality Linkages modeled inflation-uncertainty hypothesis employing monthly inflation series from 1970(1)-2017(5). The outcomes give proof to empirical as well as policy inference for the Central Bank of The Gambia.

Employing ARDL and threshold models, Mira Andomi and Myslym Osmani examined the relationship between inflation, growth and fiscal deficit in Albania. Their finding showed negative relationship between inflation and growth. The result support positive relationship between inflation and GDP growth. Due to nonlinearity between inflation and GDP growth, threshold model was utilized and result showed two stages of relationships. In both stages, the relationship remain negative, however, the level of inflation is not same.

K. Khaoza et al (2006) investigates inflation thresholds for South Africa from 1960Q1 to 2016Q2 by employing smooth transition regression. The aim of their study is to ascertain the optimal level of inflation in South African that can maximise growth. The data used were sourced from the South Africa Reserve Bank. Their finding revealed 5.3 percent as the optimal level of inflation in South Africa. The results further revealed that

inflation below 5.3 percent propels growth while any level of inflation above 5.3 percent impedes growth. Since the optimal level of inflation is 5.3 percent, they recommended that the South Africa Reserve Bank should implement policies aimed at controlling inflation. They concluded that inflation targeting should be between 3-6 percent but strongly suggested that it should be about 5.3 percent, since the 5.3 percent is what is estimated as the optimal level.

Still on South Africa, Michael Adusei (2012) examines inflation growth nexus by employing data from 1965 to 2010. The data were sourced from the World Bank. His preliminary tests revealed that the two variables are nonlinear thus the reason he estimated nonlinear regression models. Unlike K. Khaoza et al (2006), his results showed 7 percent as the threshold level of inflation in South Africa during the period under study. The study revealed that high inflation (above 7 percent) will disrupt growth and therefore advised that inflation targeting should not be above the 7 percent.

David Drukker et al (2005) examine the threshold effect between inflation and GDP from the period 1950 to 2000 by employing panel-data models. The study covers about 138 countries. Their empirical finding showed 19.16 percent as the estimated threshold. In the case of industrialized countries, they obtained two threshold levels of inflation: 2.57 percent and 12.61 percent. Overall, they concluded that if inflation is below 19.16 percent GDP growth will increase but inflation which is above 19.16 percent will lead to a contraction in growth. In view of the results, they advised that inflation targeting should not be above the 19.16 percent.

Fakhri Hasanov (2011) tried to uncover the possibility of threshold effect of inflation on growth in Azerbaijan by employing data from 2000 to 2009. The two variables were found to have nonlinear relationship during the period under consideration. The results indicated that if inflation is below 13 percent (the optimal level), there will be a positive growth in GDP. However, the results revealed inflation which is above the 13 percent will decrease GDP growth by 3 percent in Azerbaijan. Given these results, he suggested that central bank of Azerbaijan should implement policies aimed at controlling inflation and that inflation targeting should be below the 13 percent since high (above 13 percent) has a significant negative effect on growth.

Examining inflation growth nexus in Bangladesh, Md. Sazib Miyan utilized annual data from 1986 to 2016. Given the results of Engle-granger and Johansen cointegration, the two variables were found to have a positive and significant relationship during the period under study. The results of the VECM indicated if there is any departure in one direction, the correction would have to be pulled back as an adjustment speed of 79 percent. 8 percent was reported as the threshold level of inflation. He concluded that if inflation is above the 8 percent, the result will have no statistical impact on growth in Bangladesh thus he recommended that tight monetary policies aimed at keeping inflation below 8 percent should be the central focus of the central bank of Bangladesh.

Christian Regobeth Kofi Ahortor et al (2011) investigate the threshold and optimal range of inflation in West Africa Monetary Zone (WAMZ) in which they focused on the economy of two countries: Ghana and Nigeria. They employed data obtained from Statistical Bulletin of Nigeria (2008) and Database of World Economic Outlook. The study covered the period from 1970 to 2008. Nonlinear model was employed to determine threshold level while conditional least squares was employed to ascertain the optimal level of inflation in these two countries. The results revealed the existence of thresholds for the two countries; 10 percent for Ghana while 13 percent was reported for Nigeria. For the optimal level of inflation, the result for Ghana showed 6 to 12 percent whereas 9 to 14 percent was estimated for Nigeria. Based on the results, they suggested that inflation in both countries should not be above their respective threshold levels. They advised that monetary authorities in two countries should implement policies aimed at controlling inflation.

Employing error correction model and Johansen cointegration, Madurapperuma (2016) examines the effect of inflation on growth in Sri Lanka by using data from 1988 to 2015. His results showed that the variables have a long-run relationship in Sri Lanka. The results further revealed that the relationship between the two variables is negative and statistically significant during the period under study. He recommended that keeping inflation low, single digit preferably, should be the main aim of the monetary authorities in Sri Lanka because it has been empirically ascertain that 47 percent of changes in GDP growth is explained changes in inflation.

Employing cointegration and error correction models, Mallik et al (2001) examine the impacts of inflation on growth by using data of four South Asian countries sourced from International Monetary Fund (IFM). Interestingly, their results showed that the two variables in all the four countries have a long-run relationship and the relationship is found to be positive. This implies increase in inflation will lead to an increase in growth. But they maintain that higher inflation (above double digits) will be detrimental to growth thus they advised the monetary authorities in these countries to keep stable prices by controlling inflation.

Using vector error correction model, Marwa Sahnoun and Chokri Abdennadher examine the effect of inflation on growth in North Africa countries from 1965 to 2006. Dicky-Fuller (DF) and Phillips-Perron (PP) methods of unit roots were utilized in testing Granger causality and Johansen cointegration. Their study revealed that the two variables have a long relationship. They concluded that tight monetary policies aimed at controlling inflation should be implemented monetary authorities in these North Africa countries (Morocco, Algeria, Egypt and Tunisia to be precise).

Aydin et al (2016) used panel data approach to examined threshold levels for Azerbaijan, Uzbekistan, Kazakhstan, Turkmenistan and Kyrgyzstan. Nonlinear relationship between the two variables was found in these five Turkish Republics. 7.79 percent was reported as the threshold level of inflation. Inflation which is above this threshold is said to have negative effect on growth while inflation below this threshold impacts growth positively. They advised that these transition economies should device policies designed at keeping inflation below this threshold level which they believe, when implemented, will lead to stable domestic prices and also sustainable economic growth in these countries.

Esen et al (2016) made similar observation for Turkey where they investigated the threshold level of inflation by employing data from 2002Q1 to 2015Q1. After obtaining the threshold value, they went on to estimate threshold autoregressive (TAR) model where it was established that 8.89 percent is the threshold level of inflation. They came to conclusion that inflation which is above this threshold level will disrupt growth whereas inflation below this threshold promotes growth.

Summary of the Literature

Table 2. 1: Summary of Literature Review

Author	The Aim of the Study	Date and country	Methodology	Results
Kryeziu (2015)	The main purpose of this study was to examine the effect of macroeconomic variables on economic growth	Kosovo Data for period between (2005-2014)	Linear Regression Model	Positive relationship between Inflation and GDP growth
Hakeem (2015)	The focus of the study was to investigate the relationship between GDP growth and other macroeconomic variables	Nigeria Data for period between (2001-2013)	ARDL	The results revealed that inflation has a negative effect on growth
Marbuah (2011)	The main purpose of this study was to examined inflation-growth nexus	Ghana Data for period between (1955-2009)	Bounds Test	Without considering structural break in his model, multiple inflation thresholds of 6% and 10% were obtained. However, with structural break, the result reveals 10% as the optimal threshold level of inflation.

Iqbal and Nawaz (2014)	The focus of the study was to examine inflation growth-nexus	Pakistan Data for period between (1961-2008)	Simple Linear Regression	The results showed the existence of nonlinear relationship between these two variables over the period under study. 6% and 11% are being reported as the thresholds.
Bakare et al. (2015)	The purpose of the study is to examine the impacts of inflation on growth	Nigeria Data for period between (1986-2014)	OLS	The results revealed a negative relationship between inflation and GDP growth
Chughtai et al. (2015)	The study explored the effect of macroeconomic variables on growth	Pakistan Data for period between (1981-2013)	Multiple Linear Regression Model	Their study revealed that interest rate and inflation are negatively related to GDP
Agwu (2015)	The study attempts to uncover the effect of macroeconomic variables on growth	Nigeria Data for period between (2003-2012)	VECM	The study revealed a negative relationship between the variables

Andomi et al. (2017)	The aim of the study was to examine the relationship between inflation, growth and fiscal deficit.	Albania Data for period between (1993-2015)	ARDL	Their finding showed negative relationship between inflation and growth
Khaoza et al (2006)	The aim of their study was to ascertain the optimal level of inflation in South African that can maximise growth	South Africa Data for period between (1960Q1-2016Q2)	Threshold Regression Model	Their finding revealed 5.3 percent as the optimal level of inflation in South Africa
Drukker et al (2005)	The purpose of the study was examine the threshold effect between inflation and GDP	The study covers about 138 countries Data for period between (1950-2000)	Panel-data Models	Their empirical finding showed 19.16 percent as the estimated threshold. In the case of industrialized countries, they obtained two threshold levels of inflation: 2.57 percent and 12.61 percent
Adusei (2012)	The aim of the study was to examines inflation growth nexus	South Africa Data for period between (1965-2010)	Nonlinear Regression Models	His results showed 7 percent as the threshold level of inflation in South Africa during the period under study

Hasanov (2011)	The study tried to uncover threshold effect of inflation on growth	Azerbaijan Data for period between (2000-2009)	Threshold Regression Model	. The results indicated that if inflation is below 13 percent (the optimal level), there will be a positive growth in GDP. However, the results revealed inflation which is above the 13 percent will decrease GDP growth by 3 percent in Azerbaijan
Miyan (2017)	The study aims at examining inflation growth nexus	Bangladesh Data for period between (1986-2016)	VECM	8 percent was reported as the threshold level of inflation.
Ahortor et al (2011)	The study aims at investigating the threshold and optimal range of inflation	WAMZ Data for period between (1970-2008)	Threshold Regression Model	The results revealed the existence of thresholds for the two countries; 10 percent for Ghana while 13 percent was reported for Nigeria. For the optimal level of inflation, the result for Ghana showed 6 to 12 percent whereas 9 to 14 percent was estimated for Nigeria

Madurapperuma (2016)	The study examines the effect of inflation on growth	Sri Lanka Data for period between (1988-2015)	VECM	His results showed that the variables have a long-run relationship in Sri Lanka. The results further revealed that the relationship between the two variables is negative and statistically significant.
Mallik et al (2001)	The study aims at examining the impacts of inflation on growth	The study covers four South Asian countries Data for period between (1970-1995)	VECM	Interestingly, their results showed that the two variables in all the four countries have a long-run relationship and the relationship is found to be positive. This implies increase in inflation will lead to an increase in growth
Sahnoun and Abdennadher (2019)	The study tried to uncover the effect of inflation on growth in North Africa countries	The study was conducted for North Africa countries Data for period between (1970-1995)	VECM	Their empirical results show a unidirectional causality running from inflation to economic growth. In the long term, inflation and economic growth are mutually causal so there is a feedback between these variables. This feedback implies that the two

				variables can reinforce each other
Esen et al (2016)	The aim of the study was to determine the threshold of inflation	Turkey Data for period between (2002Q-2015Q1)	TAR	The results established that 8.89 percent is the threshold level of inflation

CHAPTER THREE

ANALYSES OF THE RECENT ECONOMIC GROWTH AND INFLATION STRUCTURE IN GAMBIA

3.1. General Analyses of Gambia Economy

With a GDP of 964.6 million USD (2016) and annual growth rate averaged 3.94% from 1968 to 2017, it is undoubtedly clear that the Gambia remains one of the poorest countries in the sub-region. The Gambia Bureau of Statistics provides estimate of the main contributors to the economic growth and it is found that the leading indicators that propel the GDP growth over the years in the Gambia are Service with 57%, Agriculture with 22% and industry with 15%. The main sector of the economy is agriculture, 75 percent of population depend on crops and livestock. Over the past years the economy has been growing steadily which is attributed to development in the tourism, inflow of remittances and re-exports. Since the country relies on international economy, it is endangered to external shocks. Being the main driver of growth, Agriculture employs a huge chunk of the population especially in the rural areas. Tourism is the main foreign exchange earner and remains an important sector contributor to national growth and development. After political standoff in the final and early months of 2016 and 2017 respectively which witnessed the incumbent refusing to relinquish power to the present elect and series of exogenous shocks that hit the economy, there was a contraction in growth in 2016. As the main source of foreign earner, tourist advent declined 20% short of anticipated numbers at the close of the year, however, arrivals stayed above their 2014-2015 figures. This unexpected ebb in the tourism was mainly credited to an uncertain political climate that engulfed the country.

Table 3.1: **Macroeconomic Indication**

	2016	2017	2018	2019
Real GDP growth	2.2	3.5	5.4	5.0
Real GDP per capita growth	-1.0	0.3	2.2	1.9
CPI Inflation (annual average)	7.2	8.1	5.7	4.8
Budget balance (% of GDP)	-9.7	-3.9	-0.8	-1.7
Current account (% of GDP)	-8.9	-14.3	-17.6	-16.8

Source. 2018 African Economic Outlook by Adalbert NSHIMYUMUREMYI

The December 2016 presidential elections marked the end of 22 years of former regime and welcomes the birth of 'new Gambia' which ulcers democramcy and freedom. The new administration faced a lot of challenges which includes unmaintainable debt, weak public enterprises as well as increase in interest rate accompanied by reduction in private spending in 2015 and this has led to the contration of the gross domestic product contracted from 4.4 percent to 2.2 percent in the following year. Decline in rainfall as well as months of border closure by the government of Gambia and Senegal amid increase in political tension between these two countries has contributed negatively to the decline in growth. However, growth was quick to rise to 3.5 percent in 2017 which was mainly propelled by the improved service sector and better agricultural harvest. In 2016, there was a significant surge in domestic debt from 37.1 percent to 67.9 percent of the gross domestic product. This shows an increase of 30.8 percent which was very alarming. To reestablish fiscal discipline and exalt cogency, the new government implemented a financial plan for 2017 that was predictable with its adjustment targets, which were aimed at holding the deficit to 2.5% of gross domestic product in 2017 and partnered with some international and regional authorities to help achieve the goal. In 2016, net domestic borrowing of the state fell dramatically from 12 percent of the gross domestic product to an anticipated 1 percent in the following year, which was ascribed to the controlled mechanisms aimed at monitoring the expenditure, enhanced residential income generation, and budget support. 2017 witnessed a decline of 3.9 percent of the budget deficit from the 9.7 percent of the gross domestic product recorded in the previous year and it was anticipated to even fall to 0.8 percent in 2018.

In spite of huge investment in infrastructure, Gambia still confronts a serious infrastructure deficit which is additionally worsen by poor caring culture which represses the country from amassing growth. The new National Development Plan has pinpointed key areas that are meant to seal poverty gap and other economic challenges for the period of 5 years starting 2018. The task to finance the infrastructure deficit is enormous and this would be way beyond the policymakers' reach. The gross budget of NDP remains at USD 2.4 billion and this is without representing accessible assets. Out of this, infrastructure and energy record 57 percent. Furthermore, it is incumbent on the government to deal with the country's considerable debt insecurities and danger of foreign debt adversity. It must endeavor to put in the correct approach towards coherent fiscal integration and try to ensure there is significant improvement in infrastructure development.

3.2. The Main Economic Sectors and Their Contribution to GDP Growth in Gambia

The services sector remains the most influential sector and its contribution to GDP growth is highly noticeable. In 2017, service sector encountered a little mishap which saw its growth declining from 5.1 percent in the previous year to 4.5 percent in 2017 representing an overall fall of 0.6 percent. The sub-sector of Service witnessed a contraction in growth of about 14.7 percent in 2017. This low performance is blamed on the period of the political impasse which has seen stagnation in growth in the tourism sector and as a result, demand for hotel occupancy fell sharply. Since tourism is the most significant sub-sector of the service, its contraction in growth has led to the overall decline in the service sector under this period. 2017 has seen service sub-sectors encountering negative growth than they had in the previous year, even though most of the sub-sectors have been growing positively over the years.

The main sources of growth in the Gambia is agricultural sector with 22.5 percent of the gross domestic product in 2016 and tertiary sector with 66 percent of gross domestic product, as well as tourism with 30.3 percent of the gross domestic product. These sectors are prone to external shocks as can be seen in the past. Being one of the fundamental drivers of the economic, agriculture remains the sector with most employment record of the population. Statistics showed that agricultural sector employs

about 68 percent of the labour force and accounts for about 23 percent of GDP growth in the Gambia. The sector continues to be the main source of income generation for many Gambians especially rural households. Among its sub-sectors, crops have the largest share in overall GDP growth followed by livestock, fishing and forestry. Due to the important role it plays towards economic growth, agricultural sector continues to be the government most prioritized sector when it comes to resources allocation.

Given the three broad sectors (i.e. Services, Industry, and Agriculture) of GDP, industry is the smallest in the Gambian economy. Being the smallest of the three sectors, industry only accounts for 12 percent of GDP. Among the sub-sectors of industry are: manufacturing, mining and quarrying, construction and public utilities (which comprises of electricity production, gas and water supply). Manufacturing is the main driver of the industry sector followed by construction, mining and public utilities. Statistical from GBoS showed that manufacturing accounts for about 6 percent of GDP which implies it contributes about 50 percent of the overall growth in the industry sector. The manufacturing activities includes but not limited to following: peanut processing, bakeries, brewery, soap, soft drinks, and clothing.

3.3. Monetary policy application and Inflation structure in Gambia

In the end of year 2018, inflation rate was recorded as 6.55 percent. 1964 registered the lowest record of inflation with -10.91 percent while the highest inflation rate was recorded in 1986 as 75.64 percent. The average growth is 8.13 percent from 1962 to 2018. Inflation rate estimates the overall increase in prices of goods and services that people purchase for a bundle of goods. Cost of food in Gambia rose 6.41 percent in October of 2018 over the same month in the previous year. Food Inflation in Gambia averaged 7.20 percent from 2012 until 2018, attaining an all time high of 10 percent in January of 2017 and a record low of 4.57 percent in April of 2012.

The decline of the dalasi against in the U.S. dollar has led to the downwards fall in headline inflation in wake of being driven up by rise in food prices. Having remained at 7.2 percent toward the finish of 2016, inflation had adjusted to 8.1 percent in 2017 which is higher than the 5 percent target set by the Central Bank of the Gambia. Nonetheless, inflation fell to 6.4 percent in early part of 2018 mirroring the stability of the home

currency and a slow decline in food prices. The government decreased borrowing which was justified by the consistent decline in the money market interest rates. 2017 recorded a contraction in money supply from 22 percent to 8.3 percent recorded in 2016. This, if anything, infers a huge increment in net foreign assets kept by the banking system. Additionally, there was a significant rise in banks' foreign assets. Narrow money expanded by 17.7 percent in 2017, whereas quasi money (defined as assets easily convertible to cash), increased by 26.4 percent in the same year. With increasingly enhanced monetary control and fiscal discipline, the dalasi has stayed stable since 2017. However, in the later part of 2017, there was fluctuation in the dalasi against major currencies such as the US dollar, Euro, and the British pound. It was recorded to have appreciated by 0.5 percent against the dollar, depreciated against the pound and euro by 1.6 percent and 6.5 percent respectively. There was an expansion in gross foreign reserves by 1.3 months of import cover in 2017.

CHAPTER FOUR

DATA AND METHODOLOGY

4.1. Data and Model Specifications

This thesis applies time series data in examining the relationship between inflation and economic growth in the Gambia from 1968 to 2016. The annual series on inflation and economic growth are converted into quarterly series using a quadratic match-sum method. This method makes adjustments for seasonal variations in the data when the data are converted from low frequency into high frequency by reducing the point-to-point data variations (Cheng et al., 2012; Sbia et al., 2014; Shahbaz et al., 2017). These data were obtained from Gambia Bureau of Statistics and Central Bank of The Gambia. In examining the nexus between these two variables, Granger Causality approach is being implemented. This will help us to know the causal relationship and also the direction of causality linking these variables. Bear in mind that if nonstationary time series are integrated of the first order, I (1) that is, and found to be cointegrated, we can advance and run the Vector Error Correction Model (VECM). This will enable us to examine both the short-run and long-run dynamics of the cointegrated series. To examine this relationship, one may choose different econometrics procedures since there are many procedures that can be used but in the case of this thesis, I employed Granger Causality method and Johansen Cointegration approached. Since I am utilizing time series data, some fundamental statistical tests were performed in the early stages in order to find out relationship of the series and the level of integration.

4.2. Stationary

A series is said to be stationary if the mean and autocorrelation of the series do not depend on time (Gujarati and Porter, 2009). If the series is not stationary, we conclude that the series in question is nonstationary. Time series data continuously create a serious trouble for econometricians. When the mean, covariance, variance, etc. are consistent with time, it infers that the series are stationary. That is, the series is time invariant. Nonetheless, the series will be nonstationary if the revise is the case. Words, such as, nonstationary, unit root etc are utilized interchangeably in time series study. Spurious regression occurs when two nonstationary series are regressed and this can be detected by looking at the value of R Square against Durbin-Watson's. The Rule-of-thumb here is that, if the R square is greater than the Durbin-Watson statistics, it confirms that the regression is spurious. There are bunch of tests can be employed and among them are Kwiatkowski-Phillips-Schmidt-Shin, Augmented Dickey-Fuller, Dickey-Fuller GLS (ERS), and Phillips-Perron etc. This thesis employed Kwiatkowski-Phillips-Schmidt-Shin and DF-GLS. However, Augmented Dickey-Fuller (ADF) was utilized during the preliminary test. The Null hypothesis of Kwiatkowski-Phillips-Schmidt-Shin states that series is stationary which implies that series has no unit root. As for the DF-GLS, the Null hypothesis states the revise which confirms that the series has unit root. When there is a unit root, it implies that the series is nonstationary. The rejection of Null hypothesis is premised on the fact that when absolute value of the tau statistic exceeds the interpolated critical values we reject the null. The preferred benchmark for significance level is 5%. The contrasting view where ADF test and DF test differ is that, the ADF test modifies the DF test to deal with potential time serial correlation in the disturbance terms by including lagged difference of the controlled variable. An example of a nonstationary series in random walk is given by the equation below;

$$y_t = y_{t-1} + \epsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4.1.0$$

Where the Epsilon variant/epsilon ϵ is a stationary random disturbance term. As can be seen in the above equation, the series y has a constant forecast value, conditional on t,

and the variance is increasing over time. The random walk is a difference stationary series hence the first difference of y is stationary:

$$y_t - y_{t-1} = (1 - L)y_t = \epsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4.1.1$$

A difference stationary series is said to be integrated and is signified as I(d) where d is the order of integration. The order of integration is the number of unit roots accommodated in the series, or the number of differencing operations it takes to have the series stationary. In the case of the random walk above, there is one unit root, therefore it is an I(1) series. Comparably, when series is stationary, we conclude that the series is I(0) . Standard inference methods do not apply to regressions which has an integrated dependent variable or integrated regressors. For this reason, it is vital to confirm whether a series is stationary or not before using it in a regression. The conventional approach to test the stationarity of a series is the unit root test. What does it mean when the data are stationary? The data will be stationary if the mean and variance do not change over time (Jeffrey M. Wooldridge, 2013). If any of them change, then there is existence of unit root in the data. The analogy behind having stationary series is that when nonstationary is run, it will lead to false and incorrect results. Thus, for the results to be trusted and accepted in VECM, stationary series is preferred to nonstationary.

4.2.1. The Augmented Dickey-Fuller (ADF)

This test is an extended version of the Dickey Fuller test. Augmented Dickey-Fuller test is one of the many tests available when examining stationarity. It has to do with the incorporation of more lagged terms of the controlled variables with the view of deposing autocorrelation in the model. In conducting lag length; there are many selections benchmarks that a researcher can these criteria include but not limited to following: Akaike Information Criteria (AIC), Schwartz Bayesian Criteria (SBC), Hannan-Quian etc. Consequently Augmented Dickey Fuller test takes the form of equation 4.1.3 below

$$\Delta y_t = \delta + \varphi y_{t-1} + \sum_{k=1}^{p} \omega_k \Delta y_{t-1} + \mu_t \ldots\ldots\ldots\ldots 4.1.3$$

Where:

y= time series

δ = the intercept

p = lag length

μ= white noise error term

Given the above equation, the assumption here is that the error terms have a constant variance and are statistically independent. When implementing ADF test, it is very vital to be sure that the above condition which highlights the underlining assumption this is met.

4.2.2. DF-GLS

This is another form of stationarity test approach on time series data. DF-GLS test is a modified form of ADF explained above. Elliott et al (1996) argued that DF-GLS test has a more notable power than the ADF. The idea behind this test as advanced by Elliott (1996) is to examine an autoregressive unit root in the detrended series. Since DF-GLS is a modified version of ADF, Elliot et al (1996) contended that it is important to note that DF-GLS is applied on ADF therefore standard ADF equation has to be obtained first. Below is an example of DL-GLS equation:

$\Delta {\gamma_t}^d = \alpha {\gamma^d}_{t-1} + \beta_1 \Delta {\gamma^d}_{t-1} + \cdots + \beta_p \Delta {\gamma^d}_{t-p} + \mu_t$ as earlier mentioned, this test is a modified version of ADF therefore, from the above equation; the operation ${\gamma_t}^d$ (detrended) is substituted for γ_t in the ADF equation stated earlier. The null hypothesis of DF-GLS is that series are nonstationary. The revise is the alternative hypothesis.

4.2.3. Kwiatkowski Phillips Schmidt and Shin (KPSS) test

This form of unit root test is a bit different from the ones discussed above. In order to specify this test, exogenous regressors as well as the method of estimating must be specified clearly KPSS (1992). The null hypothesis of this test is different from that of ADF and DF-GLS. While the null hypothesis of ADF and DF-GLS state that series are

nonstationary, the null of KPSS states that series are stationary. The expression that defines KPSS test can be stated as below:

$KPSS = \frac{1}{T^2} \frac{\sum_{t=1}^{T} S_t^2}{\hat{\sigma}_{\infty}^2}$ where

$S_t = \sum_{s=1}^{t} \hat{e_s}$ represents partial sum

$\hat{\sigma}_{\infty}^2$ represents Heteroskedasticity and Autocorrelation Consistence (HAC) of the variance $\hat{e_t}$

4.3. Vector Auto regression Model (VAR)

In time series analysis VAR models are employed to ascertain and relate linear interdependencies of the variables being used in a model. A system of equation can only be called a VAR (m) if the number of lags in every equation is the same and equivalent to m. When a Vector Autoregression is made of two time series variables, it should equally have two equations as seen below.

$$Y_t = \beta_{10} + \beta_{11} Y_{t-1} + \cdots + \beta_{1m} Y_{t-m} + \alpha_{11} \mathrm{I}_{\mathrm{t-1}} + \cdots + \alpha_{1\mathrm{m}} \mathrm{I}_{\mathrm{t-m}} + \mu_{1\mathrm{t}} \ldots\ldots\ldots 4.1.3$$

$$I_t = \beta_{20} + \beta_{21} Y_{t-1} + \cdots + \beta_{2m} Y_{t-m} + \alpha_{21} I_{t-1} + \cdots + \alpha_{2m} I_{t-m} + \mu_{2t} \ldots\ldots\ldots 4.1.4$$

In the above equations, the betas are parameters or coefficients that are not known while μ_{1t} and μ_{2t} represent error terms. When variables are said to be correlated, which does not happen to macroeconomic variables all the time, the error term likewise will be correlated in the given model. Like any other test in time series, there are different approaches that can be utilized in determining optimal lag. Among the approaches that can be utilized in lags selection in a vector autoregression system, the most popular methodology is the information criterion methods. This approach usually conduct hypothesis test on the lag that is last in the model and in most cases, it begins with models that have many lags. Suppose that the last lag in question is statistically significant at a particular level, for example 1%, 5% 0r 10%; in that case the lag should be selected in the model. However, if that fails to hold, the lag in question won't be

captured in the model and this goes on until the required lags are obtained. Another approach that can be used in lag selection is the Akaike information criterion commonly known AIC and it's believed to be the most commonly used one Ngozi Adeleye (2018. One of the important features of Vector Autogression in time series analysis and forecasting is the ability to test and confirm if lags of the variables in the model have the forecasting and predictive potency. When a variable lacks a predictive potency in a model, it affirms the assertion of the Null hypothesis that the lags coefficients of that particular variable are statistically insignificant.

4.4. Granger Causality

The role of Granger causality test is to determine if lagged values of a variable can forecast other variables in the model. If inflation Granger causes GDP growth, in that case inflation is said to be an important predictor of GDP growth. However, that does not mean that change in inflation can lead to future change in GDP growth. Therefore, the VAR model can always help to test and relate if inflation can Granger cause GDP growth or whether GDP growth can help predict inflation. Equations 4.1.5 and 4.1.6 respectively summarize this explanation.

$$y_t = \sum \alpha y_{t-1} + \sum \beta i_{t-1} \ldots\ldots\ldots\ldots 4.1.5$$

$$i_t = \sum \theta y_{t-1} + \sum \delta i_{t-1} \ldots\ldots\ldots\ldots 4.1.6$$

y_t is the GDP growth at time t and i_t is the inflation rate at time t. If, in the above equation 4.1.5, β is the only statistically significant parameter, in that case we say that there exists unidirectional causality which runs from inflation to GDP growth. However, if GDP growth has any demonstrable effect on inflation, then only θ is expected to be significant. Apparently, equation 4.1.7 summarizes this intuition by looking at the case of inflation.

$$y_t = \beta_0 + \beta_1 i_t + \mu_t \ldots\ldots\ldots\ldots 4.1.7$$

As noted above, y_t and i_t represent GDP growth and inflation both at time t respectively.

In the above equation, if β_1< 0 we conclude that inflation impedes growth but if β_1>0, we would conclude that inflation is good for economic growth.

4.5. Impulse Response Function (IRF)

Impulse responses follow out the reaction of present and future values of every variable in the model to a one unit positive change in the present value of the vector autoregression error, given that the error goes back to 0 in following periods and that every single error are equivalent to zero. Impulse response by extension alludes to response of dynamic system to some exogenous change.

As indicated by Hamilton (1994), a vector autoregression can be explicitly expressed as below

$$Y_t = \beta + \varepsilon_t + \alpha_1\alpha_{t-1} + \alpha_2\varepsilon_{t-2} + \cdots \quad \text{.....4.1.8}$$

Therefore, the matrix α_s has the interpretation $\partial Y_{t+1} / \partial \grave{\varepsilon}_t = \alpha_s$ that is, the row m, column n element recognizes the effects of a unit increase in the n'th variable's innovation at date t (ε_{nt}) for the value of the m'th variable at time t+s $\left(Y_{m(t+s)}\right)$. Therefore, the operation $\frac{\partial Y_{m(t+s)}}{\partial \varepsilon_t}$ is what can be referred to as impulse response function. It describes the response of $Y_{m(t+s)}$, to a one-time impulse in εmt with every single other variable dated t or earlier held fix. In essence, this approach is applied in order to establish the effects of a unit increase in inflation on present and future values of output growth and the revise also holds when looking at it in the perspective of GDP growth.

4.6. Johansen cointegration

The Johansen cointegration test is a multivariate generalization of the ADF test discussed earlier. Stationary test discussed earlier is an important prerequisite test for

the Johansen cointegration. The precondition in this test is that the variables should be nonstationary at level, but when converted to first difference, they should be stationary. For this test to be run, the variables should be integrated of the same order. The criterion here is that if there is a long-run relationship or integration among the variables, the Vector Error Correction Model (VECM) should be utilized. However, if there is no cointegration, as it sometimes happens in time series, the VAR should be estimated. The null hypothesis in Johansen Cointegration states that there is no cointegrating equation while the alternative hypothesis posits that there is cointegarting equation. Like many tests, the golden rule of rejecting the null hypothesis is premised on the 5%. In the event that series are cointegrated, they would always merge in the long-run regardless of whether there are shocks in the short-run which is highly likely to influence the movement in the individual series.

4.6.1. The Maximum Eigenvalue Statistic

The maximum eigenvalue null hypothesis states that there exist r cointegating equations where the alternative states that there are r+1 cointegration relations. Sometimes the trace test results and that of maximum eigenvalue may be conflicting thus it is better to examine the cointegrated vector and apply your analysis on the interpretation of the cointegrating equation; refer to Johansen and Juselius (1990). Johansen infers this relation as given below.

$-\mathrm{T}\ln(1-\hat{\pi}_{r+1})$.....4.2.0

T and $\hat{\pi}_i$ represent number of observations and estimated eigenvalues respectively.

4.7. Vector Error Correction Model (VECM)

$\Delta y_t = \beta_0 + \sum_{k=1}^{n} \beta_k \Delta y_{t-1} + \sum_{k=1}^{n} \delta_k I_{t-1} + \varphi z_{t-1} + \mu_t$ 4.2.1

The intuition behind the above equation is that the change in y denoted as Δy_t which means change in GDP growth in this case, is a function of not only previous changes in GDP growth denoted as Δy_{t-1}, but also current and past changes in Inflation. In the equation though, all the variables are considered as endogenous.

Z Is the Error Correction Term (ETC) and is a variable of the lagged OLS residuals from the following long-run cointegrating regression:

$$y_t = \beta_0 + \beta_1 i + \varepsilon_t \quad \text{.....4.2.2}$$

and it is defined as

$$z_{t-1} = ETC_{t-1} = y_{t-1} - \beta_0 - \beta_1 i_{t-1} \quad \text{.....4.2.3}$$

The term, error-correction, relates to the fact that last period deviation from long run equilibrium (the error) influences short-run dynamics of the dependent variable. Therefore, the coefficient of ECT,φ, is the speed of adjustment, because it measures the speed at which y returns to equilibrium after a change in I.

4.8. BDS Independence Test

It is very important for a researcher to examine and ascertain the status of any series before going on to analysis the data. For it is a general case that time series data could be linear or non-linear thus the need to confirm if there exist any linearity in the data. To check this, there are several tests that one may employ but this thesis utilizes the BDS approach. Like the RAMSEY RESET test often used in the OLS models, the BDS test is can be used to examine if there is any model misspecification. If there is a model misspecification it leads to wrong judgment and thereby renders the results invalid. (Guglielmo M.C. 2005) argued that due to the fact that the BDS test has more significant power over GARCH models, it has been employed has a dynamic tool to examine the efficiency of the GARCH models for unearthing non-linearity of the series. In this case, the standardized residuals from the fitted GARCH models are bound to the BDS test under the null hypothesis of sufficient linear components of the series. The residuals of the fitted generalized autoregressive conditional heteroskedasticity developed by Robert F. Engle and commonly expressed as GARCH are liable to the BDS test in accordance with the null hypothesis which states that there is a sufficient linear component of the series. The GARCH model may sometimes be the appropriate

characterization process of the data and this can be confirmed by the BDS rejecting the null hypothesis.

This test statistic can be computed as follows. First, the 'm' - histories' of the data $x_t^m = x_{t+1}, \dots, x_{t-m+1}$ are calculated for $t = 1, 2, \dots, T-m$ for some whole number embedding size $m \geq 2$. In order to change the series of scalars to overlapping vectors, m value has to be chosen as shown below.

$x_1^m = (x_1, x_2, \dots, x_m)$.....4.2.4

$x_{T-m}^m = (x_{T-m}, x_{T-m+1}, \dots x_T)$.....4.2.5

$x_2^m = (x_2, x_3, \dots, x_{m+1})$.....4.2.6

The rejection of the null hypothesis is hypothesized on the conventional benchmark which, in this case, is premised on 5% significance level.

4.9. Threshold Regression

Threshold regression models are regime switching models. The parameters of threshold regression models vary and the variation is aligned to regime switching mechanism which depends on a threshold variable. These models are known as non-regular methodologies that are able to provide a handy and interpretable approach for modeling any kind of nonlinear relationships between the series (Fong et al. 2017). There can be two possible types of relationship in a single data set. It is quite obvious that within some specific time periods, inflation can either be low or high. These two separate regimes can have different impact on the dependent variable therefore, it is important to establish which regime is causing what and the significant of the effect on the controlled variable. Some literature argued that inflation lead to growth while other argued that countries with low inflation tend grow faster. However, recent empirical findings have shown that both low and high inflation could lead to growth in GDP. Threshold regression helps to uncover this regime changes in time series analysis.

The conventional threshold regression can be stated as below:

$$y_t = \alpha + \beta'_0 x_t + \beta'_1 h(q_t : \theta) + \varepsilon_t \quad \text{.....4.3.1}$$

Where

β_0 and β_1

q_t is a threshold variable

$h(q_t : \theta)$ is a transition function

CHAPTER FIVE

RESULTS AND DISCUSSIONS

5.1. Descriptive Statistics

After conducting several tests in chapter 4, we analyze the results of these tests. In doing so, we will see whether these two variables that have been discussed all along have any relationship. The direction of the relationship will be known in this section.

Table 5.1: shows the descriptive statistic among the two variables. With respect to Normality, only Skewness and Kurtosis are considered in this situation. Skewness measures the degree of asymmetry of series around its mean value. For normal Skewness, the value is 0. Kurtosis on the other hand, measures Kurtosis measures whether the data are heavy-tailed or light-tailed. It is important to note that a distribution may be mesokurtic, leptokurtic or platykurtic. Mesokurtic embodies a normal distribution with a kurtosis of 3. While leptokurtic implies a positive kurtosis with higher values than the sample mean, platykurtic embodies a negative kurtosis with lower values than the sample mean. The skewness can be either negative or positive. Positive skewness implies the distributor will have a long right tale, meaning that there are higher values than the sample mean. The reverse is true for negative skewness. From the table, we can say the variable GDP growth, mirrors a normal skewness. With a kurtosis of 3.12 for GDP growth, which is clearly higher than the normal kurtosis (mesokurtic), we can see that this series is leptokurtic which implies the series has values above the sample mean. However, it is preferable to have series below the sample mean (platykurtic). Similar interpretation is made for inflation. Inflation has a long-right tail (positive skewness) and leptokurtic (because 3.11>3). The Jarque-Bera test measures the

difference of the skewness and kurtosis of the series with those from the normal distribution. The null hypothesis is that the distribution is normal whereas the alternative implies the reverse. As seen in the table, the distribution for the Inflation is not normal (for some reasons that need further elucidation) thus we reject the null hypothesis. For GDP growth, since the probability value of the Jarque-Bera is greater than the 5% (the benchmark here), we conclude that distribution is normal.

Table 5. 1: Descriptive Statistics

	INFATION	GDP GROWTH
Mean	2.282085	0.942784
Median	1.704276	0.966783
Maximum	14.77825	3.211652
Minimum	-0.620884	-1.256925
Std. Dev.	2.316863	0.86005
Skewness	3.114509	-0.044477
Kurtosis	15.64468	3.127549
Jarque Bera	1572.950	0.191436
Probability	0.000000	0.908720
Sum	433.5962	179.1290
Sum Sq. Dev	1014.524	141.7435
Observations	196	196

5.2. Stationarity

As discussed earlier, Stationarity test is very important when dealing with time series variables. From both table 5.2 A and B respectively, the tau test is less than the critical value at 5%. This implies the series are nonstationary at level. In essence, Inflation and GDP growth, after conducting preliminary test, are found to be nonstationary at level.

Table 5. 2 A: Unit root

Null Hypothesis: I has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 13 (Automatic - based on SIC, maxlag=14)

		t-Statistic
Elliott-Rothenberg-Stock DF-GLS test statistic		-2.604012
Test critical values:	1% level	-3.481600
	5% level	-2.948000
	10% level	-2.658000

*Elliott-Rothenberg-Stock (1996, Table 1)

Table 5. 2B: **Unit root**

Null Hypothesis: Y has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 13 (Automatic - based on SIC, maxlag=14)

		t-Statistic
Elliott-Rothenberg-Stock DF-GLS test statistic		-2.458682
Test critical values:	1% level	-3.481600
	5% level	-2.948000
	10% level	-2.658000

*Elliott-Rothenberg-Stock (1996, Table 1)

5.3. Unit root test result

Based on the Table 5.2 A and B, the null of unit root cannot be rejected. Hence it shows that the series both I and Y are nonstationary at level. Given that the null is rejected at 5% level, looking at table 5.3A, the conclusion is that inflation is stationary at first difference. In table 5.3.B, the null hypothesis is that the series is stationary. Since the p-value of the Kwiatkowki-Phillips-Skhmidt-Shin is great that the conventional

benchmark, 5%, we do not reject null hypothesis therefore the D(Y) is stationary. It is important to recall that the only time we run VECM is when variables being used are found to be nonstationary at level but stationarity at first difference and going by that, we have seen that in table 5.2 A and B respectively, stationarity condition do not hold. However, after performing stationarity test at first difference by utilizing the Kwiatkowki-Phillips-Skhmidt-Shin approach the two variables (inflation and GDP growth) are found to be stationarity hence the reason to estimate the VECM.

Table 5. 3A: Unit root

Null Hypothesis: D(I) is stationary

Exogenous: Constant, Linear Trend

Bandwidth: 10 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.034310
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	0.689737
HAC corrected variance (Bartlett kernel)	0.813754

Table 5. 3B: Unit root

Null Hypothesis: D(Y) is stationary

Exogenous: Constant, Linear Trend

Bandwidth: 14 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.055690
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	0.241078
HAC corrected variance (Bartlett kernel)	0.162131

To cross check for stationarity of the variables at first difference, I conducted different unit root tests that in the following (table 5.4. A and B respectively) you can see the reported result by PP test. All the tests proved that both series are stationary at their first difference. The null hypothesis is that the series are not stationary. Looking at the p-values, we reject the null.

Table 5. 4A: Unit root

Null Hypothesis: D(I) has a unit root

Exogenous: Constant, Linear Trend

Bandwidth: 73 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-9.292505	0.0000
Test critical values:	1% level	-4.007084	
	5% level	-3.433651	
	10% level	-3.140697	

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

Residual variance (no correction)	0.553088
HAC corrected variance (Bartlett kernel)	0.054112

Table 5. 4.B: Unit root

Null Hypothesis: D(Y) has a unit root

Exogenous: Constant, Linear Trend

Bandwidth: 81 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-11.65366	0.0000
Test critical values:	1% level	-4.007084	
	5% level	-3.433651	
	10% level	-3.140697	

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

Residual variance (no correction)	0.195700
HAC corrected variance (Bartlett kernel)	0.011862

5.4. Estimation Results of Vector Autoregression (VAR)

In the preliminary test, it is established that GDP growth as well as inflation are I(1). Lag selection is an important prerequisite in the VAR model. Therefore, it is important to know the maximum number of lag that to be included in the VAR model before conducting regression on the model. Based on the lag selection criteria, the maximum lag chosen is 6.

Table 5. 5: Lag Selection

VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-662.9007	NA	4.045714	7.073412	7.107842	7.087362
1	-350.8676	614.1078	0.152699	3.796464	3.899754	3.838313
2	-292.8653	112.9194	0.085970	3.221971	3.394122	3.291720
3	-284.9017	15.33411	0.082424	3.179805	3.420817	3.277454
4	-283.6277	2.426095	0.084856	3.208805	3.518677	3.334354
5	-222.8169	114.5054	0.046372	2.604435	2.983168	2.757884
6	-186.8117	67.03109*	0.032996*	2.263954*	2.711547*	2.445302*
7	-185.1824	2.998510	0.033847	2.289175	2.805628	2.498422
8	-184.2457	1.704036	0.034979	2.321763	2.907077	2.558910

* indicates lag order selected by the criterion

5.5. Granger Causality Test Results

The idea here is, we want to establish or know if Inflation Granger-causes economic growth (GDP growth) or GDP growth Granger-causes Inflation or is bidirectional relationship. So such kind of hypothesis can be tested under Granger Causality framework. The null hypothesis is GDP growth does not Granger-cause Inflation and Inflation does not Granger-cause GDP growth. From table 5.5, based on the hypothesis that is premised at 5% level of significance, the result in the above table states that the

null hypothesis cannot be rejected thus, the conclusion is that GDP growth does not Granger-cause inflation and likewise, inflation does not Granger-cause GDP growth.

Table 5. 6: Granger Causality

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 12/15/18 Time: 11:05
Sample: 1968Q1 2016Q4
Included observations: 190

Dependent variable: I

Excluded	Chi-sq	df	Prob.
Y	1.351482	6	0.9687
All	1.351482	6	0.9687

Dependent variable: Y

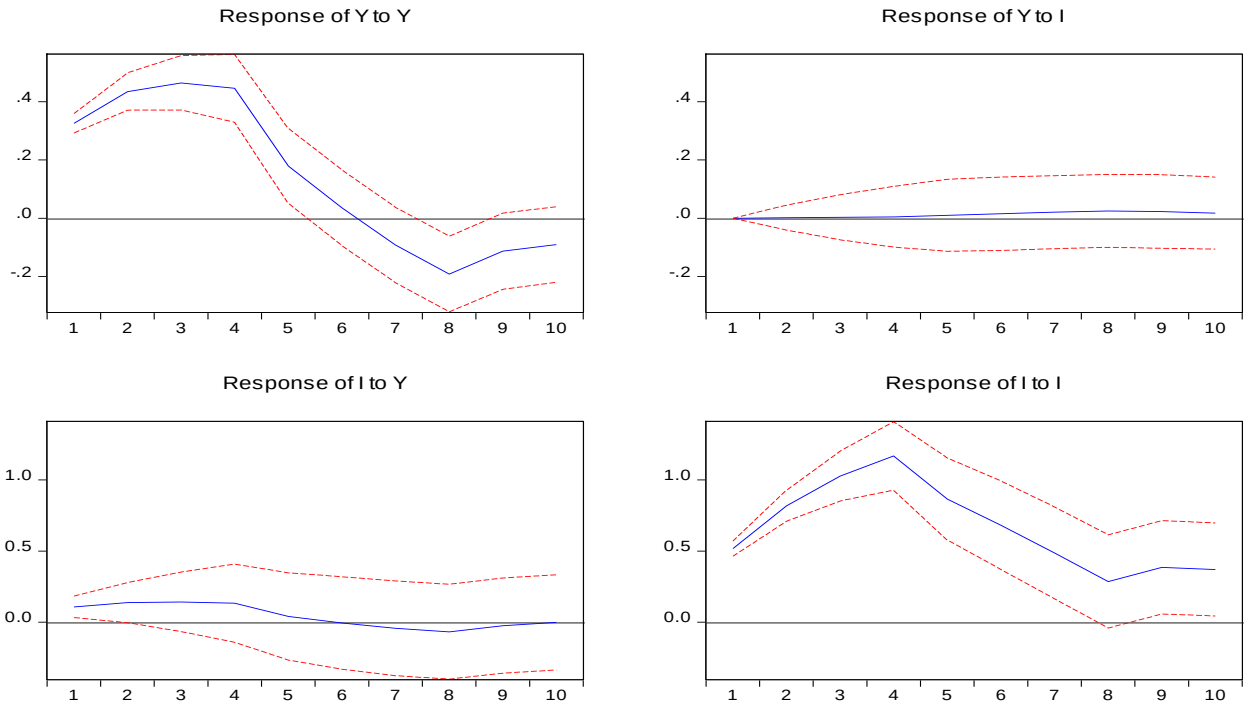
Excluded	Chi-sq	df	Prob.
I	0.175144	6	0.9999
All	0.175144	6	0.9999

5.6. Results of Impulse Response Function

Impulse Response Function (IRF) gives a clear reaction of an endogenous variable to one time unit shock in a given moment. In essence, IRF searches the effects on present and future values of the endogenous variable of one standard deviation shock in a given moment. The figure below further explains this idea. In the figure the blue line is the impulse response while the red line is the 95 percent confident interval. The impulse response (blue) must lie inside the confidence interval. From the figure below, we see that in the earlier stages there is no significant response of GDP growth to inflation rate in the Gambia, given the period under consideration. In fact, the figure shows that the response of GDP growth to shocks in inflation is not effective which collaborates to the earlier submission in the methodology section in chapter 4. A one standard deviation

shock in inflation causes no much reaction from GDP growth. It is almost stable though remain positive because it is above the zero line. From the 4th period inflation gradually declines then it hits its steady state value from where it remains in the negative region from the 6th period to most part of the 9th period, however with increasing tendencies. Finally, the response of GDP growth to its own shocks, as shown in the figure below, declines sharply towards its steady state after the 6th period before attaining the negative region for most part of the 7th period with increasing tendencies in the 8th period.

Figure 5. 1. Impulse Response



5.7. Cointegration Test Result.

Before vector error correction model is estimated, it is important to confirm if the two variables are cointegrated. If the resulting answer confirms the fact that inflation and GDP growth are cointegrated of the same order, then we can make conclusion that there exist long-run relationship between them in Gambia. Explicitly, the existence of

long-run relationship means short-run shocks which influence movement in the individual series cannot deprive these variables from converging in the long-run. In the Johansen cointegration test, two outputs are proposed: Trace and Max statistics. The decision rule, which is premised at 5% significance level, is that if the value of the Trace and Max statistics are greater than 5% critical value, reject the null, otherwise, fail to reject the null hypothesis. Since both the Trace and Max statistics values are greater the critical value at 5%, the null is rejected thus we say that inflation and GDP growth have a long-run relationship in Gambia. By looking at the table 5.6, the conclusion is that there is 1 cointegrating eqn(s) at the 0.05% level.

Table 5. 7: Cointegration

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.089919	21.47206	12.32090	0.0011
At most 1	0.019200	3.664141	4.129906	0.0659

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.089919	17.80792	11.22480	0.0031
At most 1	0.019200	3.664141	4.129906	0.0659

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

5.8. Estimation Results of Vector Error Correction (VEC)

As noted earlier, inflation and GDP growth are cointegrated and this affirms that there is long-run relationship between these variables. Since there exist long-run cointegration, we can drive this relationship as $\varepsilon_{t-1} = 1.000G_{t-1} - 0.034I_{t-1}$.

Below is the estimation result of the VECM obtained from table 5.8.1

$$\Delta G_t = -0.2421ect_{t-1} + 0.5556\Delta G_{t-1} + 0.2535\Delta G_{t-2} + 0.1514\Delta G_{t-3} - 0.5432G_{t-4} + 0.3018\Delta G_{t-5} + 0.0592\Delta G_{t-6} - 0.00051\Delta I_{t-1} + 2.5100\Delta I_{t-2} - 0.0051I_{t-3} + 0.001\Delta I_{t-4} - 0.0025\Delta I_{t-5} + 0.0067\Delta I_{t-6} - 0.001 \ldots\ldots\ldots\ldots 5.1.0$$

5.8.1. Interpretation:

For the ECT to retain its economic interpretation it has to be negative and statistically significant, however it is not a necessary condition, and as we can see, it does satisfy both conditions. Being negative it implies that if there is a departure in one direction, the correction would have to be pulled back to the other direction so as to ensure that equilibrium is retained. Explicitly, the economic interpretation of the coefficient of ECT can be stated as: the previous period's deviation from long-run equilibrium is corrected in the current period as an adjustment speed of 24%.

Table 5. 8: Vector Error Correction Model

Vector Error Correction Estimates

Cointegrating Eq:	CointEq1
Y(-1)	1.000000
I(-1)	-0.034151
	(0.05118)

	[-0.66734]	
C	-0.871140	

Error Correction:	D(Y)	D(I)
CointEq1	-0.242064	-0.032604
	(0.04792)	(0.07999)
	[-5.05159]	[-0.40762]
D(Y(-1))	0.555641	-0.061496
	(0.07484)	(0.12493)
	[7.42438]	[-0.49226]
D(Y(-2))	0.253533	-0.020496
	(0.08526)	(0.14233)
	[2.97348]	[-0.14400]
D(Y(-3))	0.151449	0.013022
	(0.06450)	(0.10766)
	[2.34813]	[0.12095]
D(Y(-4))	-0.543223	0.032713
	(0.06512)	(0.10871)
	[-8.34146]	[0.30093]
D(Y(-5))	0.301838	-0.070948
	(0.07752)	(0.12940)
	[3.89368]	[-0.54829]
D(Y(-6))	0.059180	-0.045506
	(0.07519)	(0.12551)

	[0.78709]	[-0.36258]
D(I(-1))	-0.005143	0.594348
	(0.04616)	(0.07706)
	[-0.11140]	[7.71287]
D(I(-2))	2.51E-06	0.136676
	(0.05001)	(0.08348)
	[5.0e-05]	[1.63715]
D(I(-3))	-0.005132	0.031883
	(0.03620)	(0.06043)
	[-0.14176]	[0.52756]
D(I(-4))	0.000149	-0.756141
	(0.03621)	(0.06044)
	[0.00410]	[-12.5108]
D(I(-5))	-0.002467	0.426965
	(0.04996)	(0.08339)
	[-0.04938]	[5.12027]
D(I(-6))	0.006656	0.042969
	(0.04611)	(0.07696)
	[0.14435]	[0.55831]
C	-0.001488	0.001224
	(0.02382)	(0.03976)
	[-0.06248]	[0.03080]

5.9. Long Run Granger Causality

As earlier mentioned, if there exist a relationship among variables that does not simply mean there also exist causality among the variables. Therefore, the direction of influence of the variables used in a model is proven by the existence of causality. Therefore, the result of table 5.9 shows that there is no causality running from Inflation to GDP growth and vice versa.

Table 5. 9: Long Run Granger Causality

VEC Granger Causality/Block Exogeneity Wald Tests

Date: 05/23/19 Time: 22:46

Sample: 1969Q3 2016Q4

Included observations: 189

Dependent variable: D(I)

Excluded	Chi-sq	df	Prob.
D(Y)	0.753992	6	0.9933
All	0.753992	6	0.9933

Dependent variable: D(Y)

Excluded	Chi-sq	df	Prob.

D(I)	0.126060	6	0.9941
All	0.126060	6	0.9941

5.10. VAR Stability

The estimated VAR is stationary if all the roots lie inside the unit circle. This is very important because if the VAR is not stable, certain results such as impulse response standard error are not valid. So, if the solution to the characteristics polynomial has a root for L=1, then it implies that either some or all the variables in the VAR process are integrated of order one. It may be also be the case that cointegration between the variables exist and existence will be better analyzed in the context of Vector Error Correction Model (VECM) as done above. Given the table below, conclusion can be drawn that VAR satisfies the stability condition since no roots lies outside the unit circle.

Table 5. 10: Roots of Characteristic Polynomial/ VAR Stability

Roots of Characteristic Polynomial

Root	Modulus
-0.674610 - 0.656144i	0.941075
-0.674610 + 0.656144i	0.941075
-0.654883 - 0.632241i	0.910275
-0.654883 + 0.632241i	0.910275
0.633423 - 0.612289i	0.880978
0.633423 + 0.612289i	0.880978
0.832109 - 0.102136i	0.838353
0.832109 + 0.102136i	0.838353
0.608819 - 0.538958i	0.813103
0.608819 + 0.538958i	0.813103
0.713217 - 0.285071i	0.768078
0.713217 + 0.285071i	0.768078

No root lies outside the unit circle.

VAR satisfies the stability condition.

5.11. BDS Test Results

The Brock-Dechert-Scheinkman test (BDS) is test for time based dependence in the series. BDS test examines if there exist any possible deviations and as well as non-linear dependence, or chaos among the variables. The null hypothesis alludes that there exist sufficient linear combination. The benchmark here is 5% significance level. By focusing on the probability column, we observe that the p-values are all significant in all the dimensions. Since the p-values are very significance, we reject the null hypothesis and conclude there is nonlinearity among the variables. The existence of nonlinearity gives birth to the estimation of the threshold regression.

Table 5. 11: BDS

Dimension	BDS Statistic	Std. Error	z-Statistic	Prob.
2	0.065624	0.010195	6.436789	0.0000
3	0.095114	0.016339	5.821437	0.0000
4	0.111317	0.019638	5.668527	0.0000
5	0.134301	0.020669	6.497757	0.0000
6	0.141675	0.020135	7.036312	0.0000

5.12. Threshold Regression Result

Given the evidence of nonlinearity from the results of BDS test for the linkage of the variables under examination, we further apply the threshold regression model. Going by the result of the threshold regression we can see that, below the 0.72 (low regime), the relationship between inflation and growth is negative it means that as the level of inflation increases by one unit up to 0.72 the level of growth will decrease by 1.11 units. The same relationship exists when inflation is between 0.72 and 1.68 (medium regime), meaning that if inflation increase by one unit up to 1.68, also it will decrease the growth by 1.24 units. However, after the threshold point of 1.68 (high regime) the relationship

between inflation and growth will get positive sign. In other words, inflation rate more than 1.68 in the country leads to higher level of economic growth. However, it is observed that the p-value is insignificant at 5% thus inflation has no impact on economy.

Table 5. 12: Discrete Threshold Regression

Method: Discrete Threshold Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I < 0.7212396 -- 29 obs				
I	-1.112167	0.266741	-4.169464	0.0000
C	1.018680	0.141303	7.209204	0.0000
0.7212396 <= I < 1.685181 -- 61 obs				
I	-1.244906	0.455614	-2.732368	0.0069
C	2.356308	0.689389	3.417966	0.0008
1.685181 <= I -- 100 obs				
I	0.035764	0.128428	0.278474	0.7810
C	0.965481	0.363191	2.658327	0.0085

The model is presented in the following:

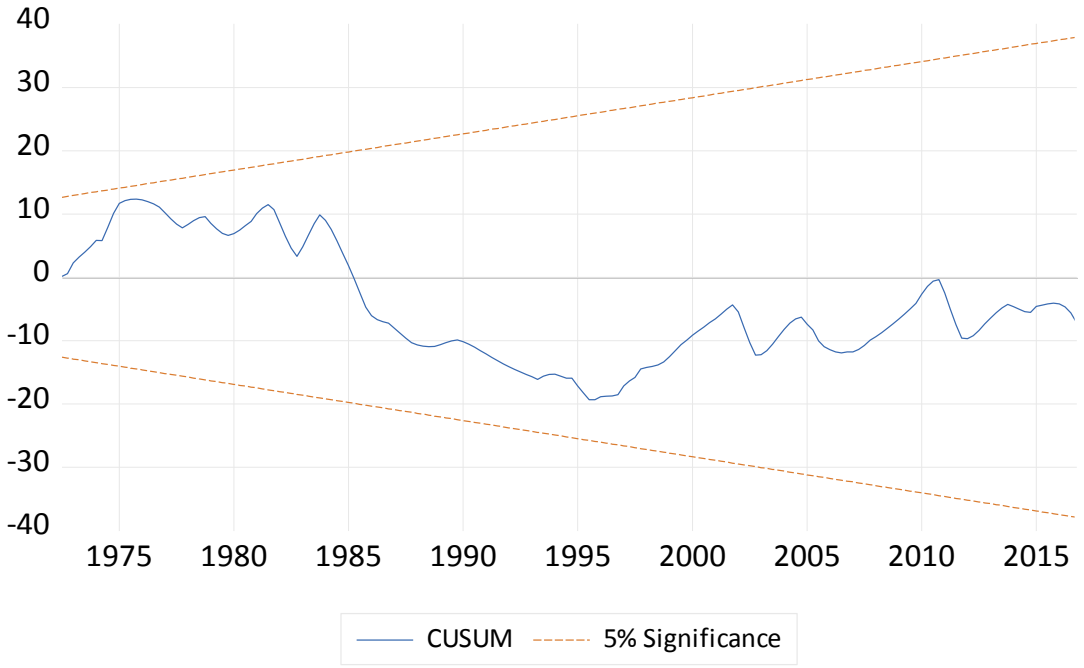
Y = (I<0.7212396)*(-1.11216728184*I + 1.01868044437) + (I>=0.7212396 AND I<1.685181)*(-1.24490616558*I + 2.35630781323) + (I>=1.685181)*(0.0357639051803*I + 0.965481096782)

5.13. TR Stability

Nonlinear models are usually faced with parameters instability (Saliminezhad et al., 2018). Therefore, it is useful to examine the stability of the estimated model to test the accuracy of the results. To this end we apply the CUSUM test of Brown et al. (1975). Stability of any model is paramount if the post estimation test is to be trusted (Hansen, 2000). Since CUSUM line lies within the significance boundaries, 5% in this case, then

we can make conclusion that the TR is stable (for details see Brown, Durbin, and Evans, 1975).

Figure 5. 2: TR Stability



5.14. Granger Causality Summary

Regression analysis deals with the dependence of one variable on other variables; it does not necessarily imply causation. In other words, the existence of a relationship between does not prove causality or the direction of influence. Although cointegration indicates presence of Granger causality, at least in one direction, it does not indicate the direction of causality between variables. The direction of Granger causality in this case

can only be detected through the error correction model derived from the long-run cointegration vectors. From the table, we can see there is no causality between inflation and GDP growth in the Gambia both in the short run and long-run.

Table 5. 13: Granger causality summary

	Short Run		Long Run	
	Test	P-value	Test	P-value
GDP growth does not Granger Cause Inflation	Chi-sq	0.9687	0.753992	0.9933
Inflation does not Granger Cause GDP growth	Chi-sq	0.9999	0.126060	0.9941

CHAPTER 6

SUMMARY, CONCLUSION AND RECOMMENDATION

6.1. Summary

The thesis analyzes inflation growth nexus in Gambia using quarterly data obtained from the Gambia Bureau of Statistics (GBoS) for the period 1968 to 216. The question of whether inflation retards growth is an open debate in the field of economics. Frankly speaking, inflation is known to be a serious threat to growth and many countries around the world today are experiencing high inflation and this has impacted negatively on the living standard of an average citizen in these countries. However, there many theories that posit that inflation is an important element to growth. One of the essential goals of macroeconomic components is to measure the health condition of a domestic economy with respect to how a particular factor influences overall performance of that economy. Consequently, this study deems it important to separate the factors with the ultimate aim of examining how inflation can influence GDP growth in Gambia.

In view of that, a VAR model was run in order to difference the variables so as to evade issues related to using nonstationary data. Employing DF-GLS and Kwiatkowski-Phillips-Schmidt-Shin approaches of testing unit roots, it was found that the variables are I (1) thus the reason for estimating the Vector Error Correction Model (VECM). The VECM was utilized simple because the two variables were I (1) and cointegarion was found to exist between the variables in the model.

6.2. Conclusion.

From the results obtained, the following major findings were observed and reported:

1. A linear relationship between GDP growth and inflation may be observed in many countries as advance by the literature in chapter 2, but in this thesis a non-linear relationship in the case of Gambia was established.
2. By use of threshold regression which reports two states for the relationship between GDP growth and inflation over the studied time horizon, a threshold level of inflation is obtained. In the low and medium regimes of inflation the relationship is negative and statistically significant at 5% level. While in the high regime of inflation, however, the relationship is positive but is statistically insignificant.
3. Inflation and GDP growth have a long-run relationship in the Gambia.
4. The coefficient of the speed adjustment is negative and it is statistically significant which implies that if both inflation and GDP growth are not in equilibrium, inflation will adjust to reduce the equilibrium in the long-run.
5. Granger-causality result showed that GDP growth does not Granger-cause inflation. It additionally demonstrates that inflation does not have any predictive power about GDP growth.

The findings of Kryeziu (2015) are in line with the study of Mallik et al (2001). They both found positive relationship between growth and inflation in Kosovo and South Asian countries respectively. However, Kryeziu (2015) employed simple regression model whereas Mallik et al (2001) made used of VECM. Many studies found the relationship between two variables negative. Hakeem (2015), Andomi et al. (2017), Agwu (2015), Chughtai et al. (2015) all found a negative relationship between growth and inflation in the respective regions of their researches. It is equally important to note that these studies applied different methods. For the case of this thesis, the investigation obtained here is that inflation and GDP growth have a negative relationship in The Gambia. This, if anything, conforms to the investigations of Kryeziu (2015), Mallik et al (2001) among others. However, the approaches are opposite. While Kryeziu (2015) and Mallik et al (2001) employed simple regression model and VECM respectively, this thesis utilizes threshold regression.

6.3. Recommendation

Since the results showed that there exist long-run relationship between inflation and growth in Gambia and the threshold regression also confirmed that even low levels of inflation changes have impacts on growth changes; which implies there is no specific tolerable minimum value, this study recommends that policies aimed at controlling inflation should capture the fact that low rate and medium rate of inflation will significantly lead to decrease in growth.

The study further suggests that government ought to exert tight monetary policy approaches design at controlling inflation since low and medium rates of inflation lessen economic. The Thesis also recommends further studies on the topic so as to bridge the shortcomings registered herein.

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APPENDIX

Appendix I: Descriptive Statistics

Date: 01/06/19
Time: 16:52
Sample: 1969Q3 2016Q4

	I	Y
Mean	2.282085	0.942784
Median	1.704276	0.966783
Maximum	14.77825	3.211652
Minimum	-0.620884	-1.256925
Std. Dev.	2.316863	0.866005
Skewness	3.114509	-0.044477
Kurtosis	15.64468	3.127549
Jarque-Bera	1572.950	0.191436
Probability	0.000000	0.908720
Sum	433.5962	179.1290
Sum Sq. Dev.	1014.524	141.7435
Observations	190	190

Appendix 2: Granger Causality

VAR Granger Causality/Block Exogeneity Wald Tests

Dependent variable: DI

Excluded	Chi-sq	df	Prob.
DY	1.084201	5	0.9555
All	1.084201	5	0.9555

Dependent variable: DY

Excluded	Chi-sq	df	Prob.
DI	0.115509	5	0.9998

All	0.115509	5	0.9998

Appendix 3: Long-run Granger Causality

VEC Granger Causality/Block Exogeneity Wald Tests

Date: 05/23/19 Time: 22:46

Sample: 1969Q3 2016Q4

Included observations: 189

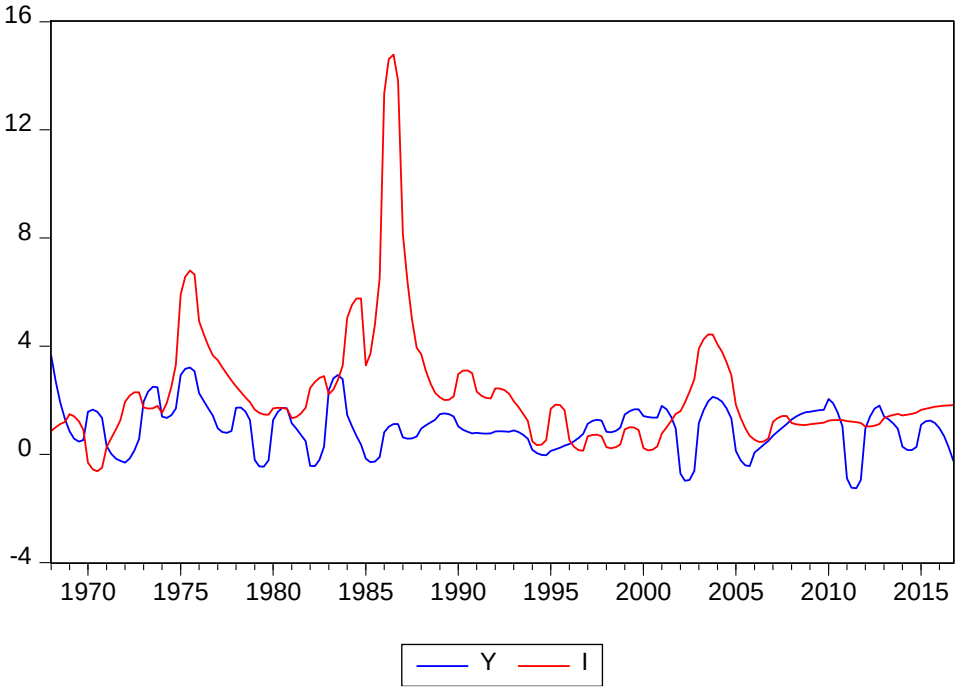
Dependent variable: D(I)

Excluded	Chi-sq	df	Prob.
D(Y)	0.753992	6	0.9933
All	0.753992	6	0.9933

Dependent variable: D(Y)

Excluded	Chi-sq	df	Prob.
D(I)	0.126060	6	0.9941
All	0.126060	6	0.9941

Appendix 4: Graph



Appendix 5: Var Stability

Roots of Characteristic Polynomial
Endogenous variables: Y I
Exogenous variables: C
Lag specification: 1 6
Date: 12/17/18 Time: 14:40

Root	Modulus
-0.674610 - 0.656144i	0.941075
-0.674610 + 0.656144i	0.941075
-0.654883 - 0.632241i	0.910275
-0.654883 + 0.632241i	0.910275
0.633423 - 0.612289i	0.880978
0.633423 + 0.612289i	0.880978
0.832109 - 0.102136i	0.838353
0.832109 + 0.102136i	0.838353
0.608819 - 0.538958i	0.813103
0.608819 + 0.538958i	0.813103
0.713217 - 0.285071i	0.768078
0.713217 + 0.285071i	0.768078

No root lies outside the unit circle.
VAR satisfies the stability condition.

Appendix 6: data

year	Inflation	GDP growth
1969Q3	1.217875	0.470572
1969Q4	0.902905	0.533296
1970Q1	-0.31054	1.578074
1970Q2	-0.55976	1.655187
1970Q3	-0.62088	1.577018
1970Q4	-0.4939	1.343568
1971Q1	0.267973	0.311657

1971Q2	0.592439	0.024913
1971Q3	0.92629	-0.15984
1971Q4	1.269524	-0.24261
1972Q1	1.935501	-0.30829
1972Q2	2.17216	-0.15312
1972Q3	2.292859	0.138015
1972Q4	2.297599	0.5651
1973Q1	1.736434	1.951624
1973Q2	1.689233	2.321223
1973Q3	1.706052	2.497382
1973Q4	1.786889	2.480101
1974Q1	1.530426	1.399601
1974Q2	1.899829	1.343352
1974Q3	2.493779	1.441574
1974Q4	3.312276	1.694267
1975Q1	5.916152	2.939049
1975Q2	6.559409	3.165638
1975Q3	6.802878	3.211652
1975Q4	6.646561	3.07709
1976Q1	4.92458	2.266351
1976Q2	4.43504	1.968878
1976Q3	4.012062	1.68907
1976Q4	3.655649	1.426927

1977Q1	3.489113	0.961435
1977Q2	3.216501	0.823027
1977Q3	2.961127	0.79069
1977Q4	2.72299	0.864424
1978Q1	2.513623	1.720401
1978Q2	2.305349	1.735807
1978Q3	2.109699	1.586815
1978Q4	1.926675	1.273424
1979Q1	1.654165	-0.21079
1979Q2	1.537235	-0.45041
1979Q3	1.473775	-0.45186
1979Q4	1.463784	-0.21513
1980Q1	1.7025	1.267153
1980Q2	1.721353	1.577257
1980Q3	1.71558	1.722571
1980Q4	1.685182	1.703098
1981Q1	1.342343	1.15133
1981Q2	1.377819	0.949283
1981Q3	1.503795	0.72945
1981Q4	1.720271	0.491831
1982Q1	2.453933	-0.42266
1982Q2	2.680735	-0.43222
1982Q3	2.827362	-0.19592

1982Q4	2.893815	0.286216
1983Q1	2.223342	2.370847
1983Q2	2.392147	2.802026
1983Q3	2.743479	2.936396
1983Q4	3.277337	2.773957
1984Q1	5.045379	1.455482
1984Q2	5.523627	1.043115
1984Q3	5.763739	0.677631
1984Q4	5.765715	0.359029
1985Q1	3.292851	-0.15685
1985Q2	3.713235	-0.28402
1985Q3	4.790163	-0.26665
1985Q4	6.523636	-0.10474
1986Q1	13.33905	0.818552
1986Q2	14.61545	1.022821
1986Q3	14.77825	1.124903
1986Q4	13.82742	1.124795
1987Q1	8.151119	0.624089
1987Q2	6.417813	0.578968
1987Q3	5.015639	0.591023
1987Q4	3.944596	0.660253
1988Q1	3.70349	0.953176
1988Q2	3.095188	1.070151

1988Q3	2.618496	1.177694
1988Q4	2.273413	1.275806
1989Q1	2.103482	1.487618
1989Q2	2.004201	1.517615
1989Q3	2.019114	1.488929
1989Q4	2.148219	1.40156
1990Q1	2.966773	1.035166
1990Q2	3.094161	0.918566
1990Q3	3.10564	0.83142
1990Q4	3.00121	0.773727
1991Q1	2.320407	0.790859
1991Q2	2.168342	0.773923
1991Q3	2.084554	0.768292
1991Q4	2.06904	0.773966
1992Q1	2.443544	0.844136
1992Q2	2.435886	0.851142
1992Q3	2.367806	0.848175
1992Q4	2.239306	0.835236
1993Q1	1.966944	0.884704
1993Q2	1.750979	0.822868
1993Q3	1.507968	0.722107
1993Q4	1.237913	0.582422
1994Q1	0.481625	0.166452

1994Q2	0.341155	0.043862
1994Q3	0.357317	-0.02271
1994Q4	0.530109	-0.03326
1995Q1	1.686744	0.128267
1995Q2	1.841913	0.183332
1995Q3	1.822828	0.247995
1995Q4	1.629489	0.322254
1996Q1	0.530823	0.377963
1996Q2	0.281406	0.482675
1996Q3	0.150163	0.608242
1996Q4	0.137097	0.754665
1997Q1	0.668456	1.133319
1997Q2	0.72124	1.236902
1997Q3	0.721699	1.276792
1997Q4	0.669834	1.252986
1998Q1	0.264316	0.838281
1998Q2	0.228332	0.817968
1998Q3	0.260555	0.864843
1998Q4	0.360985	0.978906
1999Q1	0.92145	1.476562
1999Q2	1.001562	1.598437
1999Q3	0.993149	1.660937
1999Q4	0.896211	1.664062

2000Q1	0.231037	1.4125
2000Q2	0.148934	1.375
2000Q3	0.170191	1.35625
2000Q4	0.294808	1.35625
2001Q1	0.762868	1.787109
2001Q2	0.998171	1.659766
2001Q3	1.240801	1.386328
2001Q4	1.490757	0.966797
2002Q1	1.598106	-0.71289
2002Q2	1.922689	-0.97898
2002Q3	2.314573	-0.94555
2002Q4	2.773756	-0.61258
2003Q1	3.907939	1.157031
2003Q2	4.258643	1.634219
2003Q3	4.433569	1.956094
2003Q4	4.432715	2.122656
2004Q1	4.072182	2.064831
2004Q2	3.79333	1.948399
2004Q3	3.41226	1.704284
2004Q4	2.928971	1.332486
2005Q1	1.830651	0.120931
2005Q2	1.34805	-0.2214
2005Q3	0.968355	-0.40659

2005Q4	0.691566	-0.43462
2006Q1	0.536873	0.070126
2006Q2	0.458221	0.20613
2006Q3	0.4748	0.349027
2006Q4	0.586609	0.498817
2007Q1	1.197276	0.688486
2007Q2	1.338095	0.838868
2007Q3	1.412693	0.982947
2007Q4	1.421071	1.120725
2008Q1	1.156919	1.290687
2008Q2	1.11538	1.400467
2008Q3	1.090144	1.48855
2008Q4	1.081211	1.554938
2009Q1	1.114909	1.570392
2009Q2	1.128052	1.605081
2009Q3	1.146967	1.629768
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2010Q1	1.245443	2.051017
2010Q2	1.264344	1.884947
2010Q3	1.271684	1.548123
2010Q4	1.267466	1.040545
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2011Q2	1.213795	-1.23622

2011Q3	1.18897	-1.25693
2011Q4	1.159622	-0.94881
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2012Q3	1.062222	1.695959
2012Q4	1.121498	1.804505
2013Q1	1.336225	1.40684
2013Q2	1.407838	1.295162
2013Q3	1.460739	1.139388
2013Q4	1.494929	0.939518
2014Q1	1.439654	0.282897
2014Q2	1.464721	0.159898
2014Q3	1.499377	0.157866
2014Q4	1.543622	0.2768
2015Q1	1.639006	1.089769
2015Q2	1.68581	1.22141
2015Q3	1.725582	1.24479
2015Q4	1.758323	1.15991
2016Q1	1.784034	0.966769
2016Q2	1.802714	0.665368
2016Q3	1.814363	0.255707
2016Q4	1.818981	-0.26222

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Sang Mendy

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ETHICS COMMITTEE

YAKIN DOĞU ÜNİVERSİTESİ

BİLİMSEL ARAŞTIRMALAR ETİK KURULU

01.04.2019

Dear Sang Mendy

Your project "On the inflation-growth nexus: evidence from time series methods in the Gambia" has been evaluated. Since only secondary data will be used the project it does not need to go through the ethics committee. You can start your research on the condition that you will use only secondary data.

Assoc. Prof. Dr. Direnç Kanol

Rapporteur of the Scientific Research Ethics Committee

Direnc Kanol

Note: If you need to provide an official letter to an institution with the signature of the Head of NEU Scientific Research Ethics Committee, please apply to the secretariat of the ethics committee by showing this document.