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The causal linkages among money growth, inflaion and interest rates in Ghana

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13 October 2019

Online at https://mpra.ub.uni-muenchen.de/96485/
MPRA Paper No. 96485, posted 16 Oct 2019 05:37 UTC

Abstract

This study instigates the causal linkages among money growth, inflation and interest rate in Ghana. The essence of ensuring price stability, a considerable increase in money growth that enhances economic growth and development and favorable rate of interest that encourage domestic business and foreign direct investment cannot be over emphasized. The data was extracted from two main sources. The main variable under study were money supply, interest rate and inflation rate. Other variables that affect inflation rate such as exchange rate, real gross domestic product were controlled for. Data on money supply, interest rate and exchange rate were extracted from world development indicator (WDI) whereas data on inflation and the GDP growth were extracted from annual report of the Central Bank. The data comprises of missed order of cointegration. That is I (0) and I(1). So bounds test of cointegration proposed by Pesaran, Shin and Smith (2001) was used. It was found out that money growth has both short run and long run relationship with inflation and all the other variables are insignificant in influencing inflation. The Granger causality test was conducted to help find the causality among the variables of interest. The null hypothesis that inflation rate does not does not Granger cause money growth was rejected at 5% which implies that there is a uni-directional causality between inflation and money growth. It was recommended that, in an attempt of reducing inflation both in the long run and short run, increase in money supply should be reasonable.

Keywords: Money growth, Inflation, Interest rate

1.1 Background to the study

Inflation occurs whenever there is a persistence and appreciable increase of prices in an economy over time. Romer and Chow (1996) raised an issue that no other factor apart from growth in money supply is likely to cause inflation in an economy. Thus considering demand and supply analysis, a repeatedly increase in prices of goods and services will require a repeatedly fall in aggregate supply or a repeatedly increase in aggregate demand despite an improvement in technology. Even though there are many factors that causes an increase in prices of goods and services, these increase will not be persistent in order to cause inflation.

Monetarist believes in the long run, money supply growth does not influence real variables. and that money is neutral in the sense that, a percentage (1%) increase in money supply will result in a percentage (1%) increase in inflation (Mishkin, 2004). Friedman (1963) postulated that, inflation is everywhere a monetary phenomenon. Thus the major determinant of inflation is money supply.

The fisher effect which is attributed to an American Economist Irving Fisher states that, as money supply increases and result in an increase in inflation, it affects interest rate. It has been established that a well performing capital market has it's one-period nominal interest rate to be the real interest rate plus the expected inflation (Fisher, 1930). Among series of studies conducted on the relation between these two variable, the utmost finding has proved that no relationship exist between the observed interest rate and inflation rate that are subsequently observed (Johnson, 2014). According to the fisher effect, the changes in inflation that occurs as a result of changes in money growth is reflected one-for-one in the nominal rate of interest thus, an increase in money growth increases expected inflation thereby causing an increase in the nominal interest rate (Romer and Chow, 1996).

For about three decades now, Ghana has been experiencing high and persistent increase in the general price of goods and services. Policies like economic recovery program (in 1983), structural Adjustment program (in 1986) has been implemented in an attempt of curbing inflation rate, but all has proved infertile. The economy of Ghana has been facing intractable problems in an attempt of curbing inflation. Immediately after independence in 1957, Ghana recorded a lower inflation rate until it jumped to a double-digit for the first time in 1964. Between 1967 and 1971, inflation rate in Ghana was below 10%. Inflation rate became tremendously high between 1972 and 1983. Ghana recorded an inflation rate of 10% and 123% in 1972 and 1983 respectively. Between these two years money supply growth were 41% in 1972 and 40% in 1983. The higher inflation rates between the years of 1972 and 1983 was due to the overwhelming increase in money supply.

Recently the rate of inflation has been low as compared to the 1970's and 80's. In the 2000's Ghana recorded an inflation rate between 11% and 34%. The highest rate of inflation in recent times (32.9%) was recorded in 2011 and the lowest rate of inflation (8.7%) was recorded in 2001. Money growth on the other hand, were 56.53% in 2001 and 34.04% in 2011.

In Ghana, decisions pertaining to how to set the rate of interest in the Ghanaian economy is strictly determined by the monetary policy committee. The official rate of interest is the monetary policy rate (MPR). The policy rate of the central Bank in 2013 was 16%. It was increased to 21% in 2014 and further increased to 26% in 2015. In 2016, the policy rate reduced to 25.5% and further reduced to 20% in 2017. According to the Central Bank of Ghana, Capital Bank gives their customers' the highest interest rate on deposits as at May 2016, which is 18% per annum. Considering the banking industry average rate of 12.3% per annum, seventeen banks gives its customers' an interest on deposits above the average deposit rate with standard chartered banks given only 4.3% per annum on the customers deposits. Again, the average rate of interest of interest on loans by the banking industry is 27.5% per annum with Bank of Baroda offering the least rate of 21% per annum, while Unibank offers the highest lending rate that is between 40.8% to 45.8% per annum.

Economist have tried to understand the relationship between money (monetary policy) and various macroeconomic variables like output, prices, credit, exchange rate and balance of payment etc. they have ought to find out find out if money has real effect on the economies of nations. An important piece of evidence in this direction was work done by Friedman and Schwartz (1963) on their monetary history of the United States. Generally the aim of monetary policies across most nations include price stability, enhancing employment, maintaining equilibrium in balance of payment, promotion of output growth and stability in the country's financial system among others. Achieving price stability for instance improves the efficiency of the economy, as it prevents distortions in savings and investment decisions and thus enhances economic growth. Failure to pursue the right monetary policies can have serious ramifications for the economy. For instance the great depression 1929-1933 and the recent financial crisis in 2008 have been partly attributed to the failure of monetary policy in the United States.

The process through which policy decisions of the monetary authorities are conveyed to the real side of the economy is termed the transmission mechanism of monetary policy. When monetary policy make conduct by influencing the instruments under their control, impulse are relayed to the real economy via various channel. thus monetary policy measures normally involve lags before they have an effect on the real economy. By setting the pace through altering its policy rate, a central bank is able to influence the money market and its rate therein.

According to the monetary policy report of the Central Bank of Ghana, the growth of Broad money (M2+) in July 2014 was 35.2% as compared to July 2013 which was 17.1%. The economy experienced a higher driven growth between these years. This increase in growth was influenced by net domestic assets (NDA) of the banking system. Growth in Broad money (M2+) over the period largely reflected growth in foreign currency deposits (reflecting the sharp depreciation of the Ghana cedi), currency outside banks and savings and time deposits expanded by 53.9%, 27.6% and 26.1% respectively in June 2014 as compare to the growth rate of 6.2%, 15.4% and 14.8% respectively during the corresponding period in 2013.

1.2 Problem statement

The essence of ensuring lower inflation, a considerable increase in money growth that enhances economic growth and development and favorable rate of interest that encourages domestic business and foreign direct investment cannot be overemphasized. These variables have be an anchor to the central bank of Ghana and decision making body towards the achievement of high rate of employment and economic growth. For about three decades ago, Ghana has been battling with higher inflation issues (Adu and Marbuah, 2011). But recently the central Bank has succeeded in its attempt of reducing inflation as compare to 1970's and 80's. In June 2010, Ghana recorded an inflation rate of 9.52% and 8.80% in January, 2013. Ghana adopted inflation targeting in 2006 to help curb the higher rate of inflation in Ghana. Since the adoption of inflation targeting, actual rate of inflation has always been above the targeted rate of inflation, which implies that, inflation rates are still high even though there is an adoption of inflation targeting framework. According to monetarists, inflation is everywhere a monetary phenomenon and they also have a strong believe in the neutrality concept of money. Irving Fisher through his well-known theory (Fisher effect) makes it clear that there exist a peculiar relationship between inflation rate and interest rate. This study will enable the central bank of Ghana to adopt a supportive intermediate instrument to help curb the rate of inflation down, since inflation rates are still high after the adoption of inflation targeting.

Exchange rate and economic growth can also affect inflation rates in many economies. The growth rate of Ghana has been experiencing volatility for about a decade now. During the major economic crisis in the 1970's, the per capita GDP was negative. In 1983 the Ghanaian economy was introduced to economic reforms and structural adjustment program. After the implementation of these policies per capita GDP has remain positive and steady. In Ghana, there are limitations in stabilizing the macroeconomy due to loans requirements agreements made with the international monetary fund and the World Bank. There is also a limitation on the quantum of loans that the Central Bank can loan to the government and also the central Bank has been advised to raise it foreign reserves in other to reduce the inflation rate to a single digit.

These limitations by the Central Bank has decline the prospect for growth and employment in Ghana. Immediately after 2000 elections Ghana begun experiencing financial programing. As a result of unfavorable terms of trade and some policy decisions by policy makers concerning the macroeconomy, inflation reached over 40% per annum, reserves from foreign exchange fall massively, the cedi experienced a rapid depreciation repeatedly. The new government introduced a set of commitment with the IMF to reduced inflation, money growth, fiscal deficit and borrowing drastically as well as to undertake a number of policy changes that stabilized the economy, the fall of inflation has been drastically since then, there has also be a decline in both domestic and foreign debts with an improvement in the economic growth.

1.3 Objectives of the study

The main objective of the study is to analyze the causal linkages between money growth, inflation and interest rates in Ghana. This study specifically seeks to:

1. Examine the nexus between money growth and inflation in Ghana.
2. Examine the relationship between money growth and interest rate in Ghana.
3. Examine the nexus between inflation and interest rate in Ghana.

1.4 Research question

1. What is the relationship between money growth and inflation rate in Ghana?
2. What is the relationship between money growth and interest rate in Ghana?
3. What relationship exist between inflation and interest rate in Ghana?

1.5 Significance of the study

This study will enable the Central Bank to know whether inflation in Ghana is indeed everywhere a monetary phenomenon, neutrality of money concept holds in Ghana and also either the fisher effect is true in the case of Ghana or otherwise. This will therefore give the monetary policy body series of intermediate tools to reduce inflation rather than just the inflation targeting framework. If this study shows that the neutrality of money concept is true in the case of Ghana for instance, policy makers can adopt monetary policy targeting as an intermediate tool in order to reduce inflation. Also if the fisher effect turns to be true in the case of Ghana, this study will enable policy makers to adopt interest rate targeting as an intermediate tool to help reduce inflation.

2.0 Literature Review

2.1 Introduction

This section presents a review of theoretical and current empirical literature on the relationship that exist among money growth, inflation, interest rates and other factors that affect inflation rate. The chapter consist of two main subdivisions. The first section denotes a review of theoretical on these variables. Existing empirical literature on the relationship between money growth, inflation and interest rates is reviewed in the second subsection of the chapter.

2.2 Theoretical Review

This subsection talks about series of theories on money growth, inflation and interest rate. Theories that will be considered includes: Friedman (1963)'s famous theory of money which states that inflation is strictly caused by monetary factors, the Irving Fisher's famous theory (Fisher's effect), the neutrality concept of money from the monetarist point of view, the monetarist view on quantity theory of money, the fiscal theory of the price level, the structuralist theory of inflation and the Keynesian approach to inflation which debunks Friedman's approach.

2.2.1 The monetarist theory of Inflation

From the monetarist point of view, factors that causes inflation in every economy like a country Ghana will be similar to factors that causes inflation everywhere. All results from excess aggregate demand. Monetarist view inflationary tendency as excess aggregate demand over aggregate supply. The quantity theory of money reports that, the change in inflation as a result of the change money growth are equal. In line with monetarist point of view, inflation is solely influence by changes in the quantity theory of money (Mishkin, 2004).

Lozano (2008) postulated that money supply is exogenously determined by the Central Bank and prices are allocated in order to equilibrate the purchasing power of money supply which is equal to the desire real balance.

Mishkin (2004) pointed out that what causes a great shift in aggregate demand curve is strictly money supply per monetarist point of view. Mishkin employed aggregate demand and aggregate supply curve, he further explained that money supply always rises to response to an increase in aggregate demand. In this case output will rise about its initial stage, there will be a fall in unemployment since output levels are now low which will result in a rise in wage rate which further cause aggregate supply curve to fall quickly. The aggregate supply curve will shift up to the point where the economy reaches it natural rate out level in the long run.

2.2.2 The Keynesian Approach of Inflation

They based their argument on the fact that budget deficit does not cause inflation, it only influence the price levels for some time through the influence of money aggregate and public expectations, which directly affect prices. Per Keynesian point of view, an increase in government expenditure will result in just a temporary increase in price which does not result in persistent and appreciable increase in the general prices of goods and services.

Keynesian analysis tries to reject Friedman's ideology that "inflation is always as a result of money growth". The only problem with this argument is that an increasing level of government expenditure continuously is not feasible. Government expenditure cannot exceed his GDP.

They further argued that money supply is just a component of aggregate demand and hence cannot be the only variable that influences price levels but rather it is aggregate demand that entirely influences inflationary situations in a country. Keynesians believe that factors that causes a shift in the aggregate demand curve (which includes money supply) are responsible for inflation in every economy.

Ackay et al. (1996) examined a possible channels through which higher deficit can cause higher inflation. In the government attempt of borrowing to finance its deficit, they are required to increase credit demand in the economy which will cause an interest rate to rise and crowd out investment. This will cause a slow growth rate of the economy and hence cause a decrease in the amount of goods for a given cash balances thereby increasing the price levels.

The new Keynesian framework established a relationship between money, inflation and budget deficit by using two equations namely; the aggregate supply and aggregate demand equation. The framework explained further that with a given output gap and expected inflation, if there is an expectation of a rise in government expenditure in the subsequent period, private consumption will be expected to slow down and hence output and inflation will be expected to go down.

2.2.3 The structuralist theory of inflation

This theory lay more emphasis on the fact that inflation is caused by structural regidities in developing countries. They based their argument on the fact that inflation is necessary in the assessment of growth. To them, inflation is never a monetary phenomenon, rather, inflation is caused by "cost push" factors. Cost push inflation occurs where there is an increase in cost of production. According to Khabo (2002) "the structuralist position on inflation is a reaction to the stabilization policies pursued by the Latin America government on the advice on the international monetary fund (IMF), These policies were considered harmful rather than merely austere and growth promotion".

Structuralist also believes that one of the major causes of inflation is the bottlenecks of "inelastic supply" in the sector of agriculture. The Latin America structuralist believes that the increase in money supply will increase along with prices.

2.2.4 The fiscal theory of price

Work by Leeper (1991) demonstrates the fiscal theory of price. Their view on price theory is been traced from the monetarist view of inflation. This theory postulates that government debt and tax spending are the main determinants of inflation the price level is determined and made no reference to monetary policy. The rationale behind this is that the price is determined through the inter-temporal government budget constraint. This implies that there is an adjustment of the price level that ensures the actual value of the nominal government debt when divided by the price level will be equivalent to the real present value of future budget surplus.

The fiscal theory of price holds that inflation is a fiscal phenomenon and not a monetary phenomenon. But it is necessary to have appropriate fiscal policy and also adequate monetary policy towards the achievement of price stability. Policy makers can target price level directly with fiscal policies alone. And also there is a minimal role of money in terms of inflation which is sometimes neglected (Bassetto, 2002).

2.2.5 Neo Fisherism Theory

According to this theory, a persistent increase in interest rate will cause an inflation rate to rise. This gives a contradiction to the conventional wisdom of Banking. According to the conventional wisdom of Banking, when there is an increase in targeted nominal interest rate, inflation rate increases as well and vice versa. This is due the tradeoff between interest rate and investment spending. This implies that the central Bank can influence one in an attempt of of influencing the other. According to them, it has become difficult to predict inflation nowadays. This is because inflation rate in recent days are hardly to be influenced by monetary policy. Some of these factors include oil prices, dollar rate etc.

2.2.6 Monetary policy and Transmission Mechanism

According to Samuelson and Nordhaus (2010), monetary policy transmission mechanism is defined as the way through which money policy get transmitted into the economy. since the main determinant of prices in every economy are basically demand and supply, prices of good and services cannot be controlled directly by the Central Bank. But a good monetary policy can help sustain the prices of these goods and services. Hence it has become necessary for central Banks to get a clear understanding of the monetary policy transmission mechanism in its attempt of determining the prices of goods and services. Thus prices are being influenced by monetary policy channels.

2.2.6 The interest rate Channel

Whenever there is a reduction of the prime rate by the Central Bank, it affects the interbank rate automatically. The interbank rate is simply the rate at which the banks borrow from each other. This on the other hand affect the lending rate. A decline in lending rate will automatically give rise to a aggregate demand since there will be a discouragement in the attitude of savings whereas the attitude of borrowing and spending are being encouraged. This will result in an increase in prices In other words, when the Central Bank influence the interest rate to go down, cost associated with credit falls with its demand rising. This however will cause investment and consumption to rise which will eventually result an increase in aggregate demand and inflation (Mishkin, 2004)

2.2.7 The Credit Channel

Apart from the fact that monetary policy affects interest rate, it also affects the store of value of external finances (Bernanke and Gertler, 1995). What best explains this statement is the credit channel. Two possible linkages enlightens the credit channel namely the Bank lending and the balance sheet channel. The effect of monetary policy on inflation through loans given out by the banks is attributed to the bank lending channel. Monetary policies such as policies that increases money in circulation, policies that reduces reserve requirements will increase bank reserves thereby causing an increase in the availability of loans available at the banks. Aggregate demand will increase as a result of the rise in investment and spending. On the other hand, the balance sheet channel examines how monetary policy affects the net worth of firms' borrowers. In reaction to the contractionary monetary policy, equity prices of borrowers may fall. This will result in a decrease in lending since borrowers will have less collateral to offer. As a result of the decline in investment and consumption moral hazard and adverse selection problem are likely to occur.

2.2.8 Exchange rate channel

Anytime interest rate rises, financial assets in the domestic country becomes very attractive foreign investor. This policy really will result in the exchange rate going up. Importations becomes relatively cheaper which causes an increase in goods and services that are imported into the domestic country. This will result in an alternative fewer exports of domestic goods. Demand for domestic products declines thereby causing inflation.

2.3 Empirical Literature

Chiaraah and Nkegbe (2014) conducted a study on the GDP growth, exchange rate and inflation rate in Ghana. They adopted co-integration and error correction model in their analysis. They found a significant relationship between money growth and inflation in the long run and no long run relationship between inflation and exchange rate. They based their short run analysis on the error correction model and found that money supply has very little influence on price levels. Their study on the other hand fail to establish a significant relation money growth and exchange rate. They concluded by saying that inflation in Ghana has a long run relationship with money growth and negatively related to real income and foreign price. It was recommended that the central Bank of Ghana should embark a monitoring strategy on money growth since it is strongly linked with price formation. On the other hand, their analysis fails to predict a long run relationship between inflation and exchange rate in Ghana.

Johnson (2014) in her analysis on fiscal Deficit, Money growth and Inflation Dynamics in Ghana used Autoregressive Distributed Lagged model (ARDL) over the period of 1960 to 2012. Her main objective was to find the causal relationship between fiscal deficit, money growth and inflation, however, she controlled for interest rate, exchange rate and real GDP. She used the Augmented Dickey Fuller and the Phillip Perron (PP) unit root test to test for stationarity. Her variables were both I(1) and I(0) so bounds test was employed. She further considered both the long run and short run relationship between inflation rate and the other variables. Her results showed a positive relationship between fiscal deficit and inflation in Ghana and this occurs only in the short run. Whereas money growth and inflation also has both short run and long relationship in Ghana. The granger causality on the other hand exhibited a bi-directional causal relationship between money growth and inflation in Ghana. Furthermore, the study showed a significant positive relationship between inflation and interest rates in Ghana both in the long run and short run. She also established a negative relationship between economic growth and inflation in the long run. Positive relationship was also found between government expenditure and inflation both in the long run and short run. It was recommended that there should be an immediate reduction measures by the central Bank to reduce money supply.

Pricilla (2014) conducted a study on how monetary policy affect inflation in Ghana. She employed an ARDL model which was based on macro data extracted from the period of 1980 to 2014. The monetary variables that she considered were M1, M2 and M2+. She also controlled for variables that has a relationship with money growth such as interest rate and exchange rate. Her test for unit root performed by using ADF and PP gave a result of a missed order of integration, so the Johansan cointegration became inappropriate. Therefore, the bounds test was conducted and both the long run and short run relationship was estimated as well. She found a long run and short run relationship between money supply and inflation rate in Ghana. She also finds a positive significant relationship between inflation and interest rates in both long run and short run in Ghana. And also a statistical significant negative relationship economic growth and inflation in both the long run and short run. There existed a negative relationship between trade openness and inflation in the short run and in the long run. She included in her recommendation that Bank of Ghana should reduce the total quantity of money it pumps into the economy through Open market Operations.

Hendry (2006) used multivariate co-integration analysis in modeling inflation rate in UK. He found out that the major determinant of UK's inflation includes excessive demand for goods and services, world price, long term interest, nominal money growth and changes in interest rate. He went ahead and postulated that, no single variable influences inflation rate in the UK economy. he concluded by saying that “the results remain tentative, but are consistent with the basic framework that inflation is the resultant of the many excess demands and supplies in the economy”.

According to Narayan et al. (2006) studied the relationship between fiscal deficit, money supply and inflation in Fiji. They used an annual data from 1970-2004 by employing ARDL and Granger causality test framework. They found out that both money supply, and inflation are co-integrated and also both money supply and deficit Granger cause inflation.

Dalhatu (2012) conducted a study how monetary policy influences prices in Nigeria. His objective of the study was to investigate how inflation rate, interest rate and exchange rate response to monetary policy shock. Data was extracted from December 2006 to February 2012. He adopted structural VAR model in his estimation. He found out that interest rate and exchange rate response to monetary policy shock than inflation rate in Nigeria. It was recommended that reserve requirements and open market operations can be used simultaneously with monetary policy rate in other to curb inflation.

Ahiabor (2013) examined the effect of monetary policy on inflation rate in Ghana. He also controlled for variables such as interest rate, inflation, money supply and exchange rate. He employed secondary data for his analysis. The data was extracted from 1985 to 2009. He found out that money growth and inflation has a long run relationship, inflation and interest rate exhibited a negative relationship whereas inflation and exchange rate saw a positive relationship.

Amarasekera (2009) conducted a study in Sri Lanka by investigating the impact of monetary policy on both inflation and economic. His analysis on money growth, fluctuations of the exchange rate and interest rate on inflation and economic growth was based on Vector autoregressive (VAR) framework by employing two lags. The study employed a quarterly data from the year 1978 to

2005, the variables used were interest rate, money supply, inflation and real GDP. Results indicated that a shrinking of monetary policy does not affect the inflation rate of the Sri Lanka economy.

According to Lozano (2008) investigated a causal relationship among money growth, budget deficit and inflation in Colombia. He employed a quarterly data from the period of 1982-2007 by using vector error correction (VEC) model. He found out that a positive relationship exist between inflation and money growth and also a positive relationship between money growth and fiscal deficit. After running series of tests he came into conclusion that, Sargent and Wallace hypothesis is the recommended approach in understanding the variables.

Bawumia and Abradu-Otoo (2003), investigated the relationship between money growth, exchange rate and inflation in Ghana by employing co-integration and error correction mechanism. They employed a structural vector error correction model in analyzing their cointegration relationship. Their results showed that in the long run there exist a correlation between inflation, money supply, exchange rate and real income in Ghana. They went further and explained that, inflation has a positive relation with money supply and exchange rate and a negative relationship with real income. They found out that inflation and output in the Ghanaian economy are affected by monetary policies.

Ocran (2007) employed the Johansen co-integration test and error correction model in his study "the cause of inflation in Ghana between 1960 and 2003". He found inflation inertia, money growth, Treasury bill rates and changes exchange rate to be the major causes of inflation in Ghana in the short. On the other hand, factors that causes inflation rate in the long run include inflation inertia, money growth. They considered a stylized facts that followed the exit from the west African Currency Board inflation management had been ineffective despite two decades of reform

.It was found out that excess money that circulate in the economy does not influence inflation in the Ghanaian economy.

Adu and Marbuah (2011) conducted an empirical study on factors that accounts for the dynamics of inflation by employing bounds test approach. In line with literature, they made a postulation that, the major causes of Ghana's inflation are both structural and monetary.

2.4 Summary

All the above empirical studies focuses on the money growth, exchange rate, deficit financing, interest rate, economic growth, GDP in different countries including Ghana. This study specifically look at the causal relationship that exits between money growth, inflation rate and interest rate in Ghana.

Methodology

3.1 Introduction

This section focuses on the mainly on the method used for the analysis. It also considers the source of data set, model specification and strategies used for the estimation.

3.2 Data source

The data set used is entirely time series data for the period 1960-2017. The main source of the data were extracted from two different sources. The main variables under study were money supply, interest rate and inflation rate. Other variables that affect inflation rate, exchange rate and real gross domestic product were also controlled for. Data on money supply, interest rate, and exchange rate were extracted from World development indicator (WDI) whereas data on inflation and the

GDP growth were extracted from annual report of the central Bank of Ghana. The sample was based on the availability of data set and the importance of the chosen variables and how they affect inflation.

3.3 Model Specification

The model that was used is quiet similar to the model presented by Adu and Marbuah (2011). Their model predicts the main determinants of inflation rate in developing economies like Ghana. The model is specified below;

$$P = f\left(Y_t, IR_{t,}EX_{t,}MS_tP_{t-1}\right)\ldots\ldots(3.1)$$

Equation (1) can be linearized by applying Ln to both sides.

$$\text{In}P_t = a_0 + a_1InY_t + a_2InIR_t + a_3InEX_t + a_4InMS_t + a_5InP_{t-1}\ldots\ldots(3.2)$$

where $denotes\ constant$

$a_1 \ldots \ldots . a_6$ represent coefficients.

Y denotes Real income

IR denotes nominal rate of interest

EX captures exchange rate

MS captures Money supply

There have been many concrete empirical evidence regarding the actual relationship that exist between money growth, inflation and interest rate. However, monetarist believes that inflation is everywhere a monetary phenomenon and that a one percent increase in money supply will lead a corresponding one percent increase in inflation. Structuralist also, believe that inflation is never a monetary phenomenon, rather inflation is caused by "cost push " factors which occurs as a result of an increase in production cost. Friedman (1963), on the other hand postulated that "inflation is always and everywhere a monetary phenomenon". Fisher (1930) on the other hand postulated that inflation there is a great relationship among interest rate and expected rate of inflation which in turn affects actual inflation.

It is expected that depreciation of the Cedi (more cedis chasing foreign currency) and nominal rate of interest should have a positive relationship with inflation rate in Ghana. Real income (Y) is expected to have to a positive relationship with inflation. This theory is in line with Willaim Philips long run explanation to the Philip's curve. He said that an increase in income will engender an increase in cost of production thereby causing inflation rate to increase. Real GDP was used as a proxy real income. Money supply and fiscal deficit on the other hand are also expected to have a positive relation with inflation.

3.4 Estimation strategy

This section talks about the strategies employed in analyzing the time series data that were extracted for the study. The analysis of the data is based on three important steps. Firstly, unit root test was conducted to make sure all the variables are stationary I(0). Secondary, the co-integration test was conducted and finally both the long run and short run relationship parameters were extracted and inference were made from them.

Results and Analysis

4.1 Introduction

The result of the study is analyzed in this chapter. It is sub-divided into four sections. The first section talks about the unit root test, followed by the cointegration bounds test in the second subsection. The third section presents the long run and short run ARDL error correction models and the final section talks about the direction of the causality. The entire estimations were obtained from Eviews 9.

4.2 Results of Unit Root test

In other to estimate a non-spurious long run relationship between money growth, inflation, interest rate, exchange rate and income, we first estimated the stationarity model where the results obtained by employing the Augmented Dickey Fuller (ADF) and the Phillips and Perron (PP) unit root test.

Table 4.1 Unit root test

variables	Level		First Difference	
	ADF	**PP**	**ADF**	**PP**
	Constant	**constant**	**constant**	**constant**
In P	1.139	0.269	0.409***	0.122***
In EX	-0.74	0.15	0.094**	0.094*
In IR	0.56	0.55	0.98**	0.109**
In M	1.58**	1.58**		
In Y	1.053***	1.052***		

*We test the null hypothesis of the series being non-stationary or has unit root against the alternative hypothesis of the existence of stationarity. Mackinnon (1996) critical values was used in rejecting the null hypothesis by both ADF and PP test, ***,**,* signifies the rejection of the null hypothesis of existence of a unit root at 1%,5%, and 10% significant levels respectively.*

Source: Authors own computation

It can be ascended from table 4.1 that, tests by ADF and PP clearly show that at log levels with trend of each of the variables, money supply growth and income are stationary, that is we reject the null hypothesis of no stationarity. Moreover after taking the first difference, price, exchange rate and interest rate became stationary. Thus these three variables are I(1) and the other two variables, money supply growth and income are I(0). In this case there is an absence of I(2) variables. Since we now have a missed order variables that is I(1) and I(0), Johansen test of cointegration become inappropriate. Hence we adopt the bounds test cointegration proposed by **Pesaran, Shin and Smith (2001**) in other to test for the long run relationship among the variables.

4.3 Bounds test

We used the Bounds test of cointegration proposed by Pesaran, Shin and Smith (2001) when we have missed order variables like this study. Johansen cointegration test becomes inappropriate. With bounds test, we test the null hypothesis of no cointegration against the alternative hypothesis of the existence of cointegration. Test for cointintegration is this stage is performed on the level form of the variables and not the first difference. It can also be performed on the log of the variables. We can reject the null hypothesis of cointegration at 1%, 5% or 10% if the F-value is greater than the critical value of the upper bound series I(1) hence we conclude that there is cointegration that is there is a long run relationship so we reject the null hypothesis after which we estimate the long run model which is the error correction model (ECM). Also if the F-value is lower than the critical bounds series I(0), we conclude that no cointegration exist between the variables. So we cannot reject the null. Here we only estimate the short run model which is the ARDL model. Finally if the F-value falls between the lower bound and the upper bound the test becomes inconclusive.

Table 4.2 Results of Bounds Test

Testing for the existence of a long run relationship among the variables in the ARDL				
K	95% lower bound	95% upper bound	90% lower bound	90% upper bound
4	2.86	4.01	2.45	3.52

Model	Calculated F-statistics	Inference
InP(InEX, InIR, InY, InM)	4.913134 **	Cointegration

Source: Authors own computation

It can be seen from the table above that the F-statistics is greater than both the 95% and 90% confidence level for the equation. Therefore we can conclude that a long run relationship exit in the equation. So we estimate both the long run and the short run error correction model of the ARDL.

4.4 Results of the Long run inflation model

Table 4.3 below depicts the results of the long run relationship that exist between the inflation rate and the independent variables estimated by the ARDL. The long run elasticities are represented by the coefficients of the variables.

Table 4.3 Estimated long run inflation model

Dependent variable: In P				
Regressors	**Autoregressive Distributed Lag Model**			
	Coefficient	**Std Errors**	**t-statistics**	**prob**
In Y	-0.4952	0.4255	(-1.1644)	0.2580
In M	0.4339	0.2935	(1.4800)*	0.0546
In IR	-0.2087	0.2950	(-0.7076)	0.4873
In EX	-0.0510	0.0565	(-0.9026)	0.3775
C	2.9515	1.8809	(1.5692)	0.1323

***,**,* denotes significance level at 1%, 5% and 10% respectively. Values in parenthesis are t-statistics. ARDL (1,1,0,1,0) was based on the Swchwarz Bayesian criterion

Source: Authors own construct

It can be seen from table 4.3 that the elasticity coefficient of broad money supply growth is positive and statistically significant at 10% error level. From the table broad money supply growth is the only covariate that exert an impact on price levels in the long run. With respect to the coefficient, a one percent increase in broad money growth will cause a 0.4% increase in inflation rate. This confirms the assertions by Friedman (1963), Bawumia and Abradu-Otoo (2003), Lozano (2008), Chiaraah and Nkegbe (2014) and Hendry (2006) that, a long run relationship exit between money growth and the rate of inflation.

4.5 Results of short run error correction model

The error correction model tries to provide a remedy by reconciling the short run behavior of a variable with the long run behavior. It becomes mandatory to estimate the short run error correction when there is a long run relationship among the variables. Thus it measures the dynamics of the short run model captured by the ECM and the coefficient help with the speed with which the model adjust to equilibrium whenever there is a shock. This model is represented by the first difference as seen in table 4.4

Table4.4 Estimated short run error correction model using the ARDL Approach

Dependent variable: In P

Regressors	**Autoregressive Distributed Lag Model**			
	Coefficients	**Std Error**	**t-statistics**	**Prob***
ΔIn Y	0.1399	0.3328	(0.4204)	0.6787

ΔIn M	0.4256	0.2957	(1.4396) **	0.0055
ΔIn IR	0.4065	0.3918	(1.0375)	0.3119
ΔIn EX	-0.0410	0.0563	(-0.8875)	0.3853
ecm_{t-1}	-0.981	0.2007	(-4.8876)	0.0001

***,**,* denotes significance level at 1%, 5% and 10% respectively. Values in parenthesis are t-statistics. ARDL (1,1,0,1,0) was based on the Swchwarz Bayesian criterion

Source: Author own construct

It can be seen from table 4.4 that the elasticity coefficients of broad money supply growth is positive and statistically significant at 5% error term. From the table 4.5 above, broad money supply growth is the only is the only covariant that exert an impact on price level in the short run. This confirms the assertion by Friedman (1963).

4.6 Results of Granger Causality

This section considers the results of the Granger Causality test in an attempt of investigating the causal linkages among growth, inflation and interest rate in Ghana. Whereby factors such as exchange rate and income that affect inflation rate are controlled for. It should be emphasized that the literal meaning of the Granger causality does not imply that occurrences of one variable is as a result of the other. It is much more a predictive test.

The unit root by ADF and PP clearly shows that inflation rate and interest rate are stationary at first difference that is they are I(1). We employ the first log difference of the variables in conducting the Granger Causality test.

Table 4.5: Results of Granger causality test

Null hypothesis	F-statistics	Prob
In IR does not Granger cause In P	0.26663	0.7680
In P does not Granger cause In IR	0.01965	0.9806
In IR does not Granger cause In P	1.65098	0.2028
In P does not Granger cause M	3.40954	0.0414
M does not Granger cause In IR	0.96241	0.3952
In IR does Granger cause M	0.97898	0.3891

Source: Output from Eviews estimation, 2019

The results from 4.6 indicates that the null hypothesis that inflation rate does not Granger cause money growth can be rejected at 5% significance level. This implies that, there is a uni-directional causality between inflation and money growth in Ghana.

Summary of findings

5.1 Introduction

This final section draws conclusion of the whole study. it gives a summary of the finding obtained from the study and their associated policy implications.

5.2 Summary

There is a general assumption that a higher rate of Inflation is a threat to economic growth, more importantly in developing economics. One of the prime motives of the Central Bank is to stabilize the price levels in Ghana. Due to policies laid down by the Central Bank, it has been able to lower inflation rate to a reasonable rate these days as compare to the 1980's. Many theories describe how money growth, inflation and interest rate are related. Therefore adding to knowledge the causal linkages among money growth, inflation and interest rate in Ghana for the period of 1961 to 2017 cannot be emphasized. The Augmented Dickey-Fully (ADF) and Phillips-Perron (PP) were used in conducting the unit root and it was found that, the model was made up of missed variables, that is I(1) and I(0) so we further employed the bounds test and proceed further to estimate the long run and short run error correction cointegration among inflation rate, interest rate, money growth, exchange rate and Income.

It was found out that, among all the independent variables (money growth, interest rate, exchange rate and income), only money supply growth had a significant long run and short run relationship with inflation rate in Ghana. Also with the Granger causality test we found a directional causality running from inflation to money growth.

5.3 Conclusions

This study concentrated on the causal linkages among money growth, inflation and interest in Ghana, however other factors that affects inflation such as exchange and income were controlled for. The study employed a time series data for the period of 1961 to 2017. The econometrics model that was used for the analysis was an ARDL model. Here both the short run and long run relationship between inflation and dependent variables were estimated. It was found that only money supply growth have a short run and long run relationship with inflation rate in the economy of Ghana. This simply implies that to maintain a sustainable rate of inflation, much attention should be paid to money supply growth in Ghana. Finally, no causality really exit between the main variables of interest that is money growth, inflation and interest rate in Ghana.

5.4 Recommendations

According to the results shown above, money supply is the only variable that has both short run and long run relationship on inflation rate in Ghana. So in other to reduce the inflation rate in Ghana, reduction of money supply is the only approach that the Central Bank of Ghana can adopt in other to curb inflation. It is recommended that, in an attempt of reducing inflation in Ghana, both in the long run and short run the Central Bank should make sure we have a reasonable money supply circulating in the economy.

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Appendix

Presentation of the Unit root test of the variables

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.037936	0.5679
Test critical values:	1% level	-4.133838	
	5% level	-3.493692	
	10% level	-3.175693	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INEX)
Method: Least Squares
Date: 09/12/18 Time: 21:39
Sample (adjusted): 3 57
Included observations: 55 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INEX(-1)	-0.071705	0.035185	-2.037936	0.0468
D(INEX(-1))	0.515640	0.116825	4.413779	0.0001
C	-0.737439	0.413728	-1.782424	0.0806
@TREND("1")	0.017903	0.008892	2.013319	0.0494

R-squared	0.308608	Mean dependent var	0.200321
Adjusted R-squared	0.267938	S.D. dependent var	0.276032
S.E. of regression	0.236175	Akaike info criterion	0.021457
Sum squared resid	2.844702	Schwarz criterion	0.167445
Log likelihood	3.409939	Hannan-Quinn criter.	0.077911
F-statistic	7.588086	Durbin-Watson stat	1.842940
Prob(F-statistic)	0.000274		

Null Hypothesis: INEX has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.917066	0.6324
Test critical values:	1% level	-4.130526	
	5% level	-3.492149	
	10% level	-3.174802	

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

Residual variance (no correction)	0.070264
HAC corrected variance (Bartlett kernel)	0.147651

Phillips-Perron Test Equation
Dependent Variable: D(INEX)
Method: Least Squares
Date: 09/12/18 Time: 21:44
Sample (adjusted): 2 57
Included observations: 56 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INEX(-1)	-0.062858	0.039252	-1.601411	0.1152
C	-0.561906	0.454849	-1.235369	0.2221
@TREND("1")	0.016688	0.009809	1.701348	0.0947

R-squared	0.052740	Mean dependent var	0.196744
Adjusted R-squared	0.016994	S.D. dependent var	0.274818
S.E. of regression	0.272473	Akaike info criterion	0.289527
Sum squared resid	3.934796	Schwarz criterion	0.398028
Log likelihood	-5.106762	Hannan-Quinn criter.	0.331593
F-statistic	1.475414	Durbin-Watson stat	0.983283
Prob(F-statistic)	0.237924		

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.176253	0.0089
Test critical values:	1% level	-4.133838	
	5% level	-3.493692	
	10% level	-3.175693	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INEX,2)
Method: Least Squares
Date: 09/12/18 Time: 21:49
Sample (adjusted): 3 57
Included observations: 55 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INEX(-1))	-0.501206	0.120013	-4.176253	0.0001
C	0.094043	0.070644	1.331227	0.1889
@TREND("1")	0.000253	0.002076	0.121740	0.9036

R-squared	0.252010	Mean dependent var	0.001942
Adjusted R-squared	0.223241	S.D. dependent var	0.275978
S.E. of regression	0.243230	Akaike info criterion	0.063382
Sum squared resid	3.076360	Schwarz criterion	0.172873
Log likelihood	1.256996	Hannan-Quinn criter.	0.105723
F-statistic	8.759825	Durbin-Watson stat	1.815245
Prob(F-statistic)	0.000526		

Null Hypothesis: D(INEX) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.047707	0.0126
Test critical values:	1% level	-4.133838	
	5% level	-3.493692	
	10% level	-3.175693	

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

Residual variance (no correction)	0.055934
HAC corrected variance (Bartlett kernel)	0.049536

Phillips-Perron Test Equation
Dependent Variable: D(INEX,2)
Method: Least Squares
Date: 09/12/18 Time: 21:46
Sample (adjusted): 3 57
Included observations: 55 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INEX(-1))	-0.501206	0.120013	-4.176253	0.0001
C	0.094043	0.070644	1.331227	0.1889
@TREND("1")	0.000253	0.002076	0.121740	0.9036

R-squared	0.252010	Mean dependent var	0.001942
Adjusted R-squared	0.223241	S.D. dependent var	0.275978
S.E. of regression	0.243230	Akaike info criterion	0.063382
Sum squared resid	3.076360	Schwarz criterion	0.172873
Log likelihood	1.256996	Hannan-Quinn criter.	0.105723
F-statistic	8.759825	Durbin-Watson stat	1.815245
Prob(F-statistic)	0.000526		

Null Hypothesis: INIR has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.766170	0.6981
Test critical values:	1% level	-4.262735	
	5% level	-3.552973	
	10% level	-3.209642	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INIR)
Method: Least Squares
Date: 09/12/18 Time: 21:51
Sample (adjusted): 20 55
Included observations: 33 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INIR(-1)	-0.161493	0.091437	-1.766170	0.0875
C	0.554819	0.304877	1.819811	0.0788
@TREND("1")	-0.002961	0.003588	-0.825179	0.4158

R-squared	0.103472	Mean dependent var	-0.003275
Adjusted R-squared	0.043703	S.D. dependent var	0.220975
S.E. of regression	0.216092	Akaike info criterion	-0.139716
Sum squared resid	1.400873	Schwarz criterion	-0.003670
Log likelihood	5.305321	Hannan-Quinn criter.	-0.093941
F-statistic	1.731204	Durbin-Watson stat	1.775927
Prob(F-statistic)	0.194295		

Null Hypothesis: D(INIR) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.551676	0.0057
Test critical values:	1% level	-4.309824	

	5% level	-3.574244	
	10% level	-3.221728	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INIR,2)
Method: Least Squares
Date: 09/12/18 Time: 21:53
Sample (adjusted): 22 55
Included observations: 29 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INIR(-1))	-1.131794	0.248654	-4.551676	0.0001
D(INIR(-1),2)	0.269324	0.177912	1.513807	0.1426
C	0.097865	0.165741	0.590467	0.5602
@TREND("1")	-0.002770	0.004140	-0.669257	0.5095

R-squared	0.504356	Mean dependent var	-0.013804
Adjusted R-squared	0.444879	S.D. dependent var	0.294478
S.E. of regression	0.219405	Akaike info criterion	-0.068353
Sum squared resid	1.203463	Schwarz criterion	0.120239
Log likelihood	4.991124	Hannan-Quinn criter.	-0.009289
F-statistic	8.479808	Durbin-Watson stat	1.877577
Prob(F-statistic)	0.000467		

Null Hypothesis: INIR has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.827760	0.6683
Test critical values:	1% level	-4.262735	
	5% level	-3.552973	
	10% level	-3.209642	

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

Residual variance (no correction)	0.042451
HAC corrected variance (Bartlett kernel)	0.047214

Phillips-Perron Test Equation
Dependent Variable: D(INIR)
Method: Least Squares
Date: 09/12/18 Time: 21:59
Sample (adjusted): 20 55
Included observations: 33 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.

INIR(-1)	-0.161493	0.091437	-1.766170	0.0875
C	0.554819	0.304877	1.819811	0.0788
@TREND("1")	-0.002961	0.003588	-0.825179	0.4158

R-squared	0.103472	Mean dependent var	-0.003275
Adjusted R-squared	0.043703	S.D. dependent var	0.220975
S.E. of regression	0.216092	Akaike info criterion	-0.139716
Sum squared resid	1.400873	Schwarz criterion	-0.003670
Log likelihood	5.305321	Hannan-Quinn criter.	-0.093941
F-statistic	1.731204	Durbin-Watson stat	1.775927
Prob(F-statistic)	0.194295		

Null Hypothesis: D(INIR) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.134427	0.0013
Test critical values:	1% level	-4.284580	
	5% level	-3.562882	
	10% level	-3.215267	

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

Residual variance (no correction)	0.047078
HAC corrected variance (Bartlett kernel)	0.043278

Phillips-Perron Test Equation
Dependent Variable: D(INIR,2)
Method: Least Squares
Date: 09/12/18 Time: 22:00
Sample (adjusted): 21 55
Included observations: 31 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INIR(-1))	-0.947986	0.184359	-5.142060	0.0000
C	0.108590	0.157204	0.690756	0.4954
@TREND("1")	-0.002721	0.003999	-0.680590	0.5017

R-squared	0.485697	Mean dependent var	0.007638
Adjusted R-squared	0.448961	S.D. dependent var	0.307554
S.E. of regression	0.228304	Akaike info criterion	-0.024515
Sum squared resid	1.459431	Schwarz criterion	0.114258
Log likelihood	3.379989	Hannan-Quinn criter.	0.020721
F-statistic	13.22129	Durbin-Watson stat	1.785977
Prob(F-statistic)	0.000091		

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.482098	0.0037
Test critical values:	1% level	-4.130526	
	5% level	-3.492149	
	10% level	-3.174802	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INM)
Method: Least Squares
Date: 09/12/18 Time: 22:04
Sample (adjusted): 2 57
Included observations: 56 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INM(-1)	-0.563583	0.125741	-4.482098	0.0000
C	1.576483	0.378029	4.170274	0.0001
@TREND("1")	0.009267	0.006232	1.486906	0.1430

R-squared	0.277632	Mean dependent var	0.010716
Adjusted R-squared	0.250373	S.D. dependent var	0.782709
S.E. of regression	0.677677	Akaike info criterion	2.111791
Sum squared resid	24.34004	Schwarz criterion	2.220292
Log likelihood	-56.13015	Hannan-Quinn criter.	2.153857
F-statistic	10.18491	Durbin-Watson stat	2.302799
Prob(F-statistic)	0.000181		

Null Hypothesis: INM has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.570045	0.0029
Test critical values:	1% level	-4.130526	
	5% level	-3.492149	
	10% level	-3.174802	

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

Residual variance (no correction)	0.434644
HAC corrected variance (Bartlett kernel)	0.467007

Phillips-Perron Test Equation

Dependent Variable: D(INM)
Method: Least Squares
Date: 09/12/18 Time: 22:05
Sample (adjusted): 2 57
Included observations: 56 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INM(-1)	-0.563583	0.125741	-4.482098	0.0000
C	1.576483	0.378029	4.170274	0.0001
@TREND("1")	0.009267	0.006232	1.486906	0.1430

R-squared	0.277632	Mean dependent var	0.010716
Adjusted R-squared	0.250373	S.D. dependent var	0.782709
S.E. of regression	0.677677	Akaike info criterion	2.111791
Sum squared resid	24.34004	Schwarz criterion	2.220292
Log likelihood	-56.13015	Hannan-Quinn criter.	2.153857
F-statistic	10.18491	Durbin-Watson stat	2.302799
Prob(F-statistic)	0.000181		

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.545300	0.0445
Test critical values:	1% level	-4.137279	
	5% level	-3.495295	
	10% level	-3.176618	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INP)
Method: Least Squares
Date: 09/12/18 Time: 22:07
Sample (adjusted): 2 57
Included observations: 54 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INP(-1)	-0.371286	0.104726	-3.545300	0.0009
C	1.139028	0.330099	3.450566	0.0011
@TREND("1")	0.000284	0.005170	0.054891	0.9564

R-squared	0.205230	Mean dependent var	0.016922
Adjusted R-squared	0.174063	S.D. dependent var	0.646468
S.E. of regression	0.587518	Akaike info criterion	1.828132
Sum squared resid	17.60402	Schwarz criterion	1.938631
Log likelihood	-46.35955	Hannan-Quinn criter.	1.870747
F-statistic	6.584754	Durbin-Watson stat	2.247683
Prob(F-statistic)	0.002859		

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.241527	0.0000
Test critical values:	1% level	-4.152511	
	5% level	-3.502373	
	10% level	-3.180699	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INP,2)
Method: Least Squares
Date: 09/12/18 Time: 22:09
Sample (adjusted): 4 57
Included observations: 50 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INP(-1))	-1.729887	0.209899	-8.241527	0.0000
D(INP(-1),2)	0.295238	0.127799	2.310181	0.0254
C	0.409484	0.188874	2.168026	0.0354
@TREND("1")	-0.011012	0.005427	-2.028996	0.0483

R-squared	0.730403	Mean dependent var	-0.018520
Adjusted R-squared	0.712821	S.D. dependent var	1.030911
S.E. of regression	0.552456	Akaike info criterion	1.727734
Sum squared resid	14.03957	Schwarz criterion	1.880695
Log likelihood	-39.19334	Hannan-Quinn criter.	1.785982
F-statistic	41.54166	Durbin-Watson stat	2.180458
Prob(F-statistic)	0.000000		

Null Hypothesis: INP has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.374414	0.0656
Test critical values:	1% level	-4.137279	
	5% level	-3.495295	
	10% level	-3.176618	

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

Residual variance (no correction)	0.326000
HAC corrected variance (Bartlett kernel)	0.269153

Phillips-Perron Test Equation
Dependent Variable: D(INP)
Method: Least Squares
Date: 09/12/18 Time: 22:10
Sample (adjusted): 2 57
Included observations: 54 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INP(-1)	-0.371286	0.104726	-3.545300	0.0009
C	1.139028	0.330099	3.450566	0.0011
@TREND("1")	0.000284	0.005170	0.054891	0.9564

R-squared	0.205230	Mean dependent var	0.016922
Adjusted R-squared	0.174063	S.D. dependent var	0.646468
S.E. of regression	0.587518	Akaike info criterion	1.828132
Sum squared resid	17.60402	Schwarz criterion	1.938631
Log likelihood	-46.35955	Hannan-Quinn criter.	1.870747
F-statistic	6.584754	Durbin-Watson stat	2.247683
Prob(F-statistic)	0.002859		

Null Hypothesis: D(INP) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 10 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-13.25452	0.0000
Test critical values:	1% level	-4.144584	
	5% level	-3.498692	
	10% level	-3.178578	

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

Residual variance (no correction)	0.362607
HAC corrected variance (Bartlett kernel)	0.121682

Phillips-Perron Test Equation
Dependent Variable: D(INP,2)
Method: Least Squares
Date: 09/12/18 Time: 22:12
Sample (adjusted): 3 57
Included observations: 52 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INP(-1))	-1.340935	0.134898	-9.940354	0.0000
C	0.278857	0.191543	1.455843	0.1518
@TREND("1")	-0.007759	0.005631	-1.377811	0.1745

R-squared	0.668549	Mean dependent var	-0.005860
Adjusted R-squared	0.655020	S.D. dependent var	1.056148
S.E. of regression	0.620328	Akaike info criterion	1.938825
Sum squared resid	18.85555	Schwarz criterion	2.051397
Log likelihood	-47.40946	Hannan-Quinn criter.	1.981983
F-statistic	49.41736	Durbin-Watson stat	2.023768
Prob(F-statistic)	0.000000		

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.562191	0.0002
Test critical values:	1% level	-4.186481	
	5% level	-3.518090	
	10% level	-3.189732	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INY)
Method: Least Squares
Date: 09/12/18 Time: 22:13
Sample (adjusted): 2 57
Included observations: 43 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INY(-1)	-0.925164	0.166331	-5.562191	0.0000
C	1.052776	0.254717	4.133124	0.0002
@TREND("1")	0.012059	0.005488	2.197203	0.0339

R-squared	0.436213	Mean dependent var	0.041266
Adjusted R-squared	0.408023	S.D. dependent var	0.693413
S.E. of regression	0.533512	Akaike info criterion	1.648545
Sum squared resid	11.38541	Schwarz criterion	1.771419
Log likelihood	-32.44372	Hannan-Quinn criter.	1.693857
F-statistic	15.47437	Durbin-Watson stat	1.347343
Prob(F-statistic)	0.000011		

Null Hypothesis: INY has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.586025	0.0002
Test critical values:	1% level	-4.186481	
	5% level	-3.518090	
	10% level	-3.189732	

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

Residual variance (no correction)	0.264777
HAC corrected variance (Bartlett kernel)	0.274055

Phillips-Perron Test Equation
Dependent Variable: D(INY)
Method: Least Squares
Date: 09/12/18 Time: 22:15
Sample (adjusted): 2 57
Included observations: 43 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INY(-1)	-0.925164	0.166331	-5.562191	0.0000
C	1.052776	0.254717	4.133124	0.0002
@TREND("1")	0.012059	0.005488	2.197203	0.0339

R-squared	0.436213	Mean dependent var	0.041266
Adjusted R-squared	0.408023	S.D. dependent var	0.693413
S.E. of regression	0.533512	Akaike info criterion	1.648545
Sum squared resid	11.38541	Schwarz criterion	1.771419
Log likelihood	-32.44372	Hannan-Quinn criter.	1.693857
F-statistic	15.47437	Durbin-Watson stat	1.347343
Prob(F-statistic)	0.000011		

Presentation of the Bounds test for the ARDL model

ARDL Bounds Test
Date: 09/11/18 Time: 18:42
Sample: 24 55
Included observations: 27
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	K
F-statistic	4.913134	4

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.45	3.52
5%	2.86	4.01
2.5%	3.25	4.49
1%	3.74	5.06

Representation of the short run Error correction model and long run model for the selected ARDL Model

ARDL Cointegrating And Long Run Form
Dependent Variable: LNP
Selected Model: ARDL(1, 1, 0, 1, 0)
Date: 03/26/19 Time: 22:28
Sample: 1 57
Included observations: 28

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNY)	0.139914	0.332839	0.420365	0.6787
D(LNM)	0.425622	0.295661	1.439563	0.0055
D(LNIR)	0.406469	0.391796	1.037450	0.3119
D(LNEX)	-0.049989	0.056323	-0.887543	0.3853
CointEq(-1)	-0.980995	0.200712	-4.887572	0.0001

Cointeq = LNP - (-0.4954*LNY + 0.4339*LNM -0.2087*LNIR -0.0510*LNEX + 2.9515)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNY	-0.495422	0.425461	-1.164435	0.2580
LNM	0.433868	0.293242	1.479557	0.0546
LNIR	-0.208725	0.294963	-0.707631	0.4873
LNEX	-0.050957	0.056458	-0.902566	0.3775
C	2.951519	1.880884	1.569219	0.1323

"Pairwise Granger Causality Tests
Date: 09/14/18 Time: 07:54
Sample: 1 57
Lags: 2

Null Hypothesis:	*Obs*	*F-Statistic*	*Prob.*
INIR does not Granger Cause INP	*31*	*0.26663*	*0.7680*
INP does not Granger Cause INIR		*0.01965*	*0.9806*
M does not Granger Cause INP	*52*	*1.65098*	*0.2028*
INP does not Granger Cause M		*3.40954*	*0.0414*
M does not Granger Cause INIR	*31*	*0.96241*	*0.3952*
INIR does not Granger Cause M		*0.97898*	*0.3891*

"