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The causal relationship between GDP growth, Foreign Direct Investment, and inflation in Ghana from 1970 to 2021: a co-integrated Study

A research paper presented by

Martin K. Kollie
Liberia, West Africa
ID 611722

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Make it happen.

The examining committee includes:

Prof. Dr. Lorenzo Pellegrini
Supervisor

Assoc. Prof. Dr. Elissaios Papyrakis
Second Assessor

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Den Haag, The Netherlands.
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List of Acronyms

GDP: Gross Domestic Product

FDI: Foreign Direct Investment

INFL: International Monetary Fund

ADF: Augmented Dickey-Fuller

PP: Phillips-Perron

IRF: Impulse Response Function

VAR: Vector Autoregression

WDI: World Development Indicators

WB: World Bank

TSM: Time Series Model

Acknowledgments

My journey in exile has been a source of motivation. It has not only strengthened my resilience and inspired my hope but also helped me look beyond difficult moments in pursuit of my dream. This research paper has taught me two major lessons - **DISCIPLINE** and **HARD WORK**. This study has made me rediscover myself in solving complex problems through openness, honesty, objectivity, and accountability. Amid all odds, I aimed to achieve this ultimate feat because of courage and consistency.

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I want to dedicate this academic work to my first daughter, **Nightingale Welleh Kollie.** As I look back, this accomplishment reminds me of Audrey Hepburn's famous quote, **"Nothing Is Impossible; the Word Itself Says I'm Possible."**

Abstract

The study used a time series model to assess the relationship between three macroeconomic variables in Ghana, namely economic growth (GDP), Foreign Direct Investment (FDI), and inflation (INFL). Data covering the period of 1970-2021 was sourced from the World Development Indicators of the World Bank. The Phillips-Perron Test was run to test for stationarity, and our results showed that the dependent variable (GDP) was non-stationary, thus violating the Time Series Model Assumption. Hence, we found the first difference of the variable, and the results showed that the first difference of our variable was stationary. The Augmented Dickey-Fuller Test also revealed results similar to the Phillips-Perron Test. The ADF Test used in the study showed that the first difference in GDP is stationary. The VAR Granger Causality Test also examined the causal relationship among GDP, FDI, and INFL. The empirical results showed that FDI granger-causes GDP while INFL does not granger-cause GDP in Ghana. The results also showed that all the dependent variables can granger-cause GDP. This suggests that FDI and INFL are good predictors of GDP. The study further investigated the long-run relationship between the variables by testing for cointegration. The results from the Johansen Cointegration Test revealed no cointegration among the variables, which also indicates no long-run relationship between the variables. The Max-Eigenvalue Test also validates this result because all the values of the Max-Eigen Statistics are less than the critical values at the 0.05 level.

Keywords: Co-integration, Economic Growth, Foreign Direct Investment, Inflation, Granger Causality

1. Introduction:

1.1 Economic Growth and Inflation.

Rising inflation substantially threatens economic growth in many emerging markets and developing nations. Significant concerns of social instability are present in some of these countries due to slower growth and limited resources to serve their most vulnerable citizens. Furthermore, growth in developing nations and emerging markets continues to be hindered by major structural barriers. These are caused by various challenges, including poor governance spurred by corrupt officials, unstable political systems, and ineffective governance (IMF, 2023).

Policymakers working to reduce poverty in emerging markets and developing nations aim to achieve strong, sustainable economic development driven by low inflation (Pesaran et al., 2001). Raising living standards in impoverished societies is a potential benefit of high economic growth. Both empirical and theoretical research disagree on the correlation between economic growth and inflation. High inflation, however, continues to be linked to slower economic growth, according to a substantial body of research. Economic growth in every developing country is hindered by the adverse impact of high inflation, which is predominantly responsible for the snail's pace of sustainable development. When prices are high, a nation’s ability to compete internationally significantly lowers.

1.2 Economic Growth and Foreign Direct Investment

According to Pesaran et al. (2001), foreign direct investment (FDI) is an essential means by which inflation impacts economic growth toward societal advancement. Economic stability is indicated by low inflation, which also suggests rising returns on foreign direct investment (FDI) and the ability of the central bank to implement appropriate monetary policies and fiscal responsibility on the part of the government. Thus, FDI is increased in countries with low levels of inflation.

Between 1970 and 2021, Foreign Direct Investment net inflows boomed to a record high of 3.1 trillion USD in 2007 and were at their lowest of 12.6 billion USD in 1970, as shown by the World Bank's Data. FDI is a major driver of economic growth in developing nations since it boosts overall investment and productivity through better managerial techniques and encourages the acceptance and use of new technologies (Coban, 2019). While it would seem reasonable to claim that foreign direct investment (FDI) can bring significant benefits to host nations, Alfaro (2003) shows that FDI's benefits are not evenly distributed among industries by looking at how FDI affects growth in the manufacturing, services, and primary sectors. Using cross-country data from 1981–1999, Alfaro's (2003) empirical research argues that overall foreign direct investment (FDI) has an ambiguous impact on growth. However, foreign direct investments in manufacturing tend to boost GDP, whereas they hurt the primary sector.

1.3 Inflation, FDI, and GDP in Ghana.

High inflation is one of the persistent issues facing Ghana's economy, as it is with most emerging nations. This has been ongoing for a while, supporting the notion that unstable and excessive inflation can impede economic expansion (Coban, 2019). In 2022, high inflation in Ghana resulted from large capital outflows, monetary policy tightening in advanced countries, and intense pressure on the currency rate due to budget deficit financing. Due to these factors, the economy's post-COVID-19 rebound was halted, with GDP growth falling from 5.1% in 2021 to 3.1% in 2022. The fiscal deficit for 2022 was 11.8%, far more than intended. In 2022, the public debt increased from 79.6% of GDP in 2021 to almost 90% as the debt service-to-revenue ratio hit 117.6%. August 2023 saw a high level of inflation, 40.1%, driven by food costs.

In response to these challenges geared towards restoring macroeconomic stability, Ghana has implemented several significant measures, such as a three-year, around $3 billion IMF Extended Credit Facility (ECF) program and thorough debt restructuring. The authorities have committed to a front-loaded fiscal consolidation, along with a tighter monetary policy.

They have also taken steps to address weaknesses in the energy and cocoa sectors. The government executed a formal debt restructuring under the Common Framework and concluded the Domestic Debt Exchange Programme (The World Bank, 2023). The continued rise and fall of inflation between 1970 and 2021 has been a concern. In 2019, annual inflation fell to 8.5% from 10.6% in 2018, according to World Bank data. In 2022, it sharply increased to 29.6% and has worsened to 40.1% since August 2023. Relative to FDI, Ghana has enjoyed massive inflows despite fluctuations, according to World Bank data. In 2018, FDI (net inflows) fell to 885.6 million USD from 2.19 trillion USD in 2017. It rebounded to 1.85 trillion in 2019 and fell to 1.2 trillion USD in 2020. FDI peaked at 2.2 trillion USD in 2021 amid an increase in inflation to 11.2% in 2021 from 9.4% in 2020. Due to these shifts in inflation and FDI, Ghana's GDP growth continues to be affected. In 2018, GDP accounted for 67.3 billion USD and increased to 68.34 billion in 2019. It rose to 79.16 billion USD in 2021 and dropped to 72.84 billion USD in 2022.

The question of whether inflation and foreign direct investment have a negative or positive effect on economic growth has emerged once more as a result of these macroeconomic dynamics in Ghana. As policymakers in Ghana continue to grapple with high inflation and low economic growth, the income or purchasing power of Ghanaian households remains under severe pressure, while public outcry for a more sustained solution to the problem continues to intensify.

With GDP growth falling from 5.1% in 2021 to 3.1% in 2022, inflation running as high as 40.1%, and foreign direct investment falling below its 2021 level of 2.2 trillion USD amidst an increase in public debt from 79.6% of GDP in 2021 to almost 90% of GDP, there still exist uncertainties about whether the rising prices and fall in FDI are primarily responsible for the sluggish growth of the Ghanaian economy.

With these emerging trends of low GDP growth, low FDI, and higher inflation, the correlation between economic growth and foreign direct investment is palpable. Hence, more studies are required to establish whether higher inflation and low foreign direct investment can negatively or positively impact economic growth in Ghana because the causal effect and long-run relationship between these macroeconomic variables remains of great interest to policymakers and researchers.

These concerns/issues served as the impetus for the study, which examined the relationship between INFL, FDI, and GDP growth in Ghana from 1970 to 2021 using time series data. It also established the long-term effect and tested if a causal relationship existed between the three variables during the period under review.

1.4 Research Questions:

The study considers the following questions as its main research questions:

1) Does a causal relationship exist between inflation, FDI, and GDP growth?
2) Does a co-integration or long-term relationship exist between inflation, FDI, and GDP growth?
3) Is GDP growth stationary or non-stationary?

1.5 Objectives of the study:

The primary goal of this research is to use time series data to evaluate the causal link between three macroeconomic variables in Ghana: GDP growth, FDI, and inflation (INFL) during the years 1970–2021. Determining whether co-integration or a long-term link between the variables exists is another important goal.

1.6 Research Hypotheses:

This study tests the following hypotheses:

1.1 Hypothesis (Stationarity vs. Non-stationarity)

H_0: GDP has a unit root (Non-stationary)
H_1: GDP doesn't have a unit root (Stationary)

1.2 Hypothesis (FDI and GDP growth)
H_0: There is no causal relationship between FDI and GDP growth
H_1: There exists a causal relationship between FDI and GDP growth

1.3 Hypothesis (INFL. and GDP growth)
H_0: There is no causal relationship between INFL and GDP growth
H_1: There is a causal relationship between INFL and GDP growth

1.4 Hypothesis (Co-integration)
H_0: There is no cointegration (No long-term relationship between variables)
H_1: There is cointegration (long-term relationship between variables)

1.7 Material and Method

1.7.1 Introduction

To fulfill the objective of this study, several tests were run, including stationarity testing, causality testing, co-integration as well as normality testing, and stability testing. These different tests produced appropriate results in response to this study's research objectives and research questions.

1.7.2 Data Source:

The study used secondary data sourced from the World Bank's World Development Indicators, which is available at https://databank.worldbank.org, and captured information on Ghana's GDP growth, inflation, and foreign direct investment (FDI). Econometric Views (EViews) software was utilized for the analyses in the study. The program was selected for time series analysis because of its user-friendly interface.

2. Theoretical Framework.

2.1 Econometric Method:

This section describes the econometric techniques that were applied in the analysis. Using a time series model, the study evaluated the relationship between Ghana's INFL, FDI, and GDP growth. As theorized, we started by conducting several tests while being cognizant of the basic assumptions of the Time Series Model. First, we checked the unit root of the variables. Levels and first differences were determined. Next, we tested for stationarity using the Phillips-Perron Test. We also performed the Johansen Co-integration Test and the Granger Causality Test to determine whether the variables have a long-term and causal link. Also, we used the Augmented Dickey Fuller (ADF) Test.

2.2 Regression

Regression analysis was applied to study the causal effect of inflation and foreign direct investment on economic growth. It is further explained in the linear regression model below.

$Ln(Y) = \beta + \beta ln(X) + \mu_t$ …….équation (1)

Ln……natural log

β_i…….coefficient

Y…….dependent/explained variable

X…….independent/explanatory variable

μ_t …….error term and time.

The interpretation is that a basic regression is that (Y) tends to change by Φ_i unit change in (X). Additionally, in a linear regression with two logged variables, the dependent variable typically changes by Φ_i percentage changes in the independent variables (X). In other words, elasticity is frequently used to explain the regression model or the equation containing logged variables. Equation 1 is transformed into equation 2 to suit our model specification.

$\ln GDP_t = \beta_0 + \beta_1 \ln FDI_t + \beta_2 \ln INFL_t + \mu_t$ **……Equation (2)**

$\beta_i = coefficient$

GDP = Gross Domestic Product

INFL. = Inflation

μ_t = Error term and time

The relationship between INFL, FDI, and GDP is explained by equation 2. It assesses the extent to which changes in FDI and INFL are reflected in changes in GDP growth.

2.3 Unit Root Test

Finding out if the variables are stationary at levels or the first difference is the goal of a stationarity test. Therefore, before we can estimate, we must do a unit root test to confirm that the series is stationary. The stationarity test for a series requires at least 20 observations; otherwise, the series' result will not be dependable, which is the unit root test's limitation. The Augmented Dickey-Fuller (ADF) unit root test is the most widely used estimation method in this study's unit root test. Equation (3) provides an estimate for the model.

$Y_t = \phi Yt_{-1} + t$ **……equation (3)**

Equation (3) is a non-stationary series if ϕ=1, turns into a random walk. If <1, Y tends to become stationary. When variables are not stationary at their level, a stationary series can still be obtained; however, this will require differencing before achieving stationarity can be achieved. Utilizing the ADF test to get the unit root essentially involves regressing the Y variable on its own lagged period value, Y_{t-1}. It is possible to alter equation 4 further as follows:

Y-Y_{t-1} = (ϕ − 1)−1 + t ……equation (4)

ΔY_t = δY_{t-1} + t ……equation (5)

With δ representing (ϕ − 1) and Δ denoting the difference operator. To compare the alternative hypothesis, δ ≠ 0, with the null hypothesis, δ = 0, the study evaluated equation (3). An absolute ADF test statistic and a 5 percent critical value are used to determine whether to reject H_o.

2.4 Granger Causality Test:

A statistical hypothesis test called the Granger causality test can be used to assess whether a time series provides information that can help anticipate another time series. Granger causality is a widely used technique in time series data analysis. We employed the Vector Autoregression (VAR) model to establish the relationship among the variables. Inflation, GDP growth, and foreign direct investment were all measured in this study.

2.5 Johansen Co-Integration Test:

If there is a relationship between time series variables and they have a long-run equilibrium, they are said to be co-integrated. However, in the long term, such series are said to be co-integrated if the response and explanatory variables are not stationary, but their residuals are. This study employed the Johansen test for co-integration to determine if this series has a long-run relationship.

2.6 Impulse-Response Function (IRF):

One helpful method for modeling how economic variables behave in response to shocks to the vector δt, was the impulse response function (IRF). The VAR model's estimates are used in the standard IRF production process. The standard process for creating IRFs uses non-linear functions of the predicted VAR parameters.

3. Conceptual Reviews and Theoretical Reviews

3.1 Introduction:

Even though there are works of literature that have examined the relationships between FDI, GDP, and INFL, there still exist knowledge gaps that need to be filled in regards to country-by-country contexts and particularities that, of course, impact how these variables interrelate. Hence, this review adopts a more theoretical approach in terms of surveying published works relating to specific theories, concepts, and empirical studies that have a link to our research question and methodology.

3.2 Summary of Key Papers:

No	Author/Year	Country	Purpose	Type of Source	Findings / Summary Points
1	Coban and Yussif (2019)	Ghana	To analyze the relationships among Foreign Direct Investment (FDI), Inflation, and Economic growth	Eurasian Research Journal	This study finds that a bidirectional causal effect between inflation and FDI
2	Opeyemi, A. F. (2020)	Nigeria	To find the impact of FDI and inflation on economic growth	Journal of Economics and International Finance	This study finds that FDI has a positive impact on economic growth.
3	Udoh, E., & Egwaikhide, F. O. (2010)	Nigeria	To examine the effect of exchange rate volatility and inflation uncertainty on foreign direct investment.	The Botswana Journal of Economics	This study shows that inflation uncertainty exerted a significant

					negative effect on foreign direct investment
4	Marbuah, G. (2011).	Ghana	To empirically reinvestigate the inflation-growth relationship	Research	This study finds evidence of a significant threshold effect of INFL on GDP growth, with and without a structural break.
5	Vintila, D. (2010).	European	To find the main trends in FDI theory.	European Journal of Interdisciplinary Studies	The results of this study reveal that for FDI, there is no unified theoretical explanation.
6	Mundell, A. (1957).	Canada	To explain FDI using an international trade model.	The American Economic Review.	This study finds that perfect mobility of factors results in factor-price equalization.
7	Mansur, Q. M. & K.	Malaysia	To analyze the relationship between the inflation rate	IDEAS	This study finds that the

	(2009).		and economic growth rate.		relationship between the inflation rate and economic growth is nonlinear.
8	Mamingi, N., & Martin, K. (2018).	Eastern Caribbean.	To empirically explore the relationship between foreign direct investment (FDI) and economic growth	Cepal Review.	The results of this study show that although FDI positively affects GDP growth, its impact is minimal when considered in isolation.

3.3 Theoretical and Conceptual Review.

3.3.1 Gross Domestic Product.

The Solow-Swan model, named after Robert (Bob) Solow and Trevor Swan and generally called the Solow model, is the main starting point of all analyses in modern economic growth theories. Thus, an insight into the model is essential to understanding the theories of Solow growth (RA, 2019).

Knight (1993) claims that in a steady-state equilibrium, the Solow-Swan growth model predicts that per capita income will be determined by the rates of saving, population growth, and technological advancement—all of which are assumed to be exogenous—as well as by the prevailing technology as represented in the production function.

Given the variation in these rates among nations, the Solow-Swan model produces testable hypotheses regarding the potential effects of varying population growth and saving rates on the steady-state levels of per capita income in various countries. Generally speaking, higher rates of saving correspond to a higher level of per capita income, while higher rates of population growth correspond to lower levels of per capita income (Knight, 1993).

According to Knight (1993), "endogenous growth" models, which presume steady or rising returns on capital, are preferred by the new growth theorists over the Solow-Swan model. According to these opponents, the conventional neoclassical model cannot account for the variations in per capita income between nations. The consequences of the two growth theories have prompted fresh empirical research in recent years.

The Endogenous Growth Model, on the other hand, maintains that economic growth is mainly the result of endogenous rather than exogenous forces and that investment in human capital, modernization, and knowledge are critical components of economic growth (Opeyemi, 2020). Endogenous growth model proponents promote their models as alternatives to the Solow model and are inspired by claims that the Solow model empirically fails to explain cross-country disparities (Mankiw et al., 1992).

3.3.2 Inflation

Mansur (2009) argues, in the context of mainstream macroeconomics theory, that promoting economic growth requires a low inflation rate. Whether there is a connection between inflation and economic growth has generated much attention and discussion, even though the exact nature of this relationship remains arguable. Both theoretically and empirically, the relationship between inflation and growth is still debatable. An ongoing debate between structuralists and monetarists has resulted from the controversy, which originated in Latin America in the 1950s. Inflation is seen as harmful to economic progress, while structuralists view inflation as necessary for economic growth (Mallik & Chowdhury, 2001).

The Keynesians' interpretation of the theory of inflation, according to Opeyemi (2020), holds that an increase in production costs, mainly when the Keynesians' understanding of the goods and services are factored into the prices, causes inflation. According to Keynesian theorists, the salaries and earnings of the people who work on the manufacturing line impact the costs of the goods —inflation results from rising manufacturing costs caused by an increase in these workers' salaries and pay. Savings lose value if consumer price indexes rise dramatically over the previous year, and the purchasing power of money declines as a result.

3.3.3 Foreign

Mundell (1957) used a two-country, two-good, two-factor, and two-identical production function international trade model to try and explain FDI, where producing one good requires a more significant proportion of one factor than the other. Since the foreign investments included were either portfolio or short-term investments, Mundell's model could not account for international production through FDI. Foreign direct investment (FDI) began to substantially impact the world economy following the Second World War. Theoretical work on FDI has led to a deeper understanding of the economic process and the behavior of economic agents, both at the micro and macro levels, opening up new areas of study in economic theory (Vintilă, 2010).

Mamingi and Martin (2018) claim that significant FDI inflows into emerging nations during the past three decades have fostered growth and economic transformation. Furthermore, Foreign Direct Investment has become the largest source of foreign funding for developing economies. It is a vital tool for transferring technology from developed to developing countries, encouraging local capital investment, and enabling improvements in host countries' human capital stock and institutions.

On the other hand, FDI could undermine regional enterprises and negatively impact economic growth (Vintila, 2010). Hanson (2001) believes beneficial effects are infrequent, while Lipsey (2002) concludes that although there are practical impacts, there is no reliable link between FDI stock and economic growth. According to Hirschman (1958), who argued that the benefits of mining and agriculture are limited, the potential good or adverse effects on the economy may also depend on the type of industry in which investment occurs.

3.4 Empirical Review:

Coban and Yussif (2019) argue that research on the relationship between FDI, INFL, and GDP growth has not been definitively generalized by empirical studies. An empirical study is still required to ascertain the relationship between these variables because each nation's distinctive economic features indirectly affect how the three variables interact.

Udoh and Egwaikhide (2010) studied how currency rate turbulence and inflation uncertainty affect foreign direct investment in Nigeria. The investigation spans the years 1970 through 2005. The GARCH model was used to evaluate inflation uncertainty and exchange rate volatility. The findings of the estimations showed that during the period, currency rate volatility and inflation uncertainty had a significant negative impact on FDI. The findings also indicate that essential factors influencing FDI inflow to a country include infrastructure development, the size of the government sector, and international competitiveness.

The study conducted by Marbuah (2011) re-examined the correlation between inflation and growth to determine if a threshold effect exists and, if so, to identify the ideal inflation level beneficial to Ghanaian economic growth. It is possible to identify significant threshold effects of inflation on growth using a nonlinear definition. According to the study, both economic growth with and without a structural break have a strong threshold effect of inflation. The research demonstrates 6% and 10% as the minimum and maximum threshold levels, respectively.

From 1970 to 2010, Olaiya et al. (2012) examined the causal connections between economic development, public spending, and inflation rate in Nigeria. The Philip Perron and Augmented Dickey-Fuller (ADF) tests were used in the study to look at the characteristics of the variables. The variables were found to be stationary, albeit not in their level form but in their first difference. In addition, the Johansen and Juselius (JJ) co-integration technique showed that the variables were correlated, and the tri-variate vector error correction model (VECM) demonstrated that there was both a short-term and long-term causal relationship between government spending and GDP growth. A unidirectional correlation between economic growth and government spending and the inflation rate was also found to exist in the short run, with no evidence of feedback from the inflation rate.

Empirical findings from Hossain (2005) imply a short-run bidirectional causal relationship between money supply increase and inflation and between currency devaluation and inflation. This finding supports the idea that inflation does have a feedback impact on the expansion of the money supply in an economy experiencing high or hyperinflation, which leads to a self-perpetuating inflationary process. For Turkey, the link was also looked into by Erbaykal and Okuyan (2008). Quarterly data from 1987 to 2006. Real GDP and CPI were found to be negatively and statistically significantly correlated. The Toda-Yamamoto method discovered a one-way causal relationship between inflation and economic growth.

Using a modified growth model, Awolusi and Adeyeye (2016) investigated the impact of FDI on economic growth in a few randomly chosen African economies between 1980 and 2013. According to the analysis, a 1% increase in FDI would lead to GDP growth of 0.12% in South Africa, 0.05% in Egypt, 0.03% in Nigeria, 0.02% in Kenya, and 1% in the Central African Republic. The results also show that FDI significantly impacts South Africa's growth more than the other four nations. Findings from Adedeji (2016) show that while FDI favorably supports growth in SSA, it is not a significant factor in determining economic performance in South Saharan Africa.

The empirical findings of Coban and Yussif (2019) show some relationship between inflation, FDI, and economic growth. The Toda and Yamamoto causality test determines the causal relationship between various economic variables in the study. According to this study's empirical findings, FDI and inflation have a bidirectional causal relationship in contrast to Udoh and Egwaikhide (2008), which could not establish such a relationship. Economic growth and inflation were correlated in a single-direction fashion, with inflation driving growth. These results are in line with those of Marbuah (2010) and Olaiya et al. (2011), but they contrast with those of Hossain (2005) and Erbaykal and Okuyan (2008) who found a bidirectional causal relationship between economic growth and inflation.

The ADF test was used by Opeyemi (2020) to investigate the stationary and establish the degree of integration of the chosen variables (GDP, FDI, and INF). Regression analysis was utilized in the study to show how foreign direct investment (FDI) and inflation affected each country's economic growth (Egypt, South Africa, Nigeria, Tanzania, and Kenya). According to the regression results, a unit increase in Foreign Direct Investment for these five countries will accelerate economic growth by 25.8, 23.7, 73.2, 65.4, and 29.2%, respectively, demonstrating that FDI positively impacts economic growth in all five (5) countries. In other words, the FDI infusion benefits all five nations, although Tanzania and Nigeria stand to benefit the most. This goes against the conclusions of a few recent studies discussed in our literature (Awolusi and Adeyeye, 2016; Adedeji and Rolle, 2016).

After a critical review of the examined literature, the findings are varied. Some papers show that significant FDI inflows into developing countries are critical to fostering economic growth, and a causal link exists between FDI and economic growth. In contrast, other papers conclude that FDI inflows could negatively impact economic growth, and there is no causal link between FDI stock and economic growth. On the inflation frontier, the reviewed papers show that low inflation is required to boost economic growth, and significant inflation could negatively impact economic growth, even though the conclusions offered by the various studies on the causal relationship between the three variables are diverse. Since many reviewed papers used panel and cross-sectional data to assess a specific group of countries, it is difficult to establish the proper relationship between GDP growth, FDI, and INFL and apply such findings to all other countries because only a sample was used. As a result, each country should be treated based on the nature of its economy. Country-specific context should be taken into consideration.

4. Results and Discussions:

4.1 Results of Unit Root Test.

The study conducted a unit root test to check for the sequence of integration before testing for co-integration. To determine whether the series is stationary at the first difference or level, the study employed the Augmented Dickey-Fuller (ADF) test for the unit root. The test results are reflected in Tables 1 and 2.

H_0: GDP has a Unit root (Non-stationary)
H_1: GDP doesn't have a Unit root (Stationary)

So, when Prob > 0.05 ---- Fail to reject Ho (Null hypothesis)
Prob < 0.05 ---- Reject Ho ----- The GDP is stationary.

Table 1: Unit Root Test at Levels (Results)

The GDP time series or GP at the levels have a unit root. As such, it is non-stationary at the level suggested by the Phillips-Perron test (PPT). The **probability is 1.000, which is greater than 0.05.** Therefore, the null hypothesis (H_0) is not rejected. Because a unit root exists, it is difficult to forecast or make inferences. Economically, we can conclude that the data is not normally distributed. Hence, the first difference is evoked in Table 2.

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		3.295099	1.0000
Test critical values:	1% level	-3.565430	
	5% level	-2.919952	
	10% level	-2.597905	

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

Residual variance (no correction)	1.61E+19
HAC corrected variance (Bartlett kernel)	8.54E+18

Phillips-Perron Test Equation
Dependent Variable: D(GDP)
Method: Least Squares
Date: 11/02/23 Time: 12:37
Sample (adjusted): 1971 2021
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP(-1)	0.056437	0.027158	2.078075	0.0430
C	5.26E+08	7.44E+08	0.707254	0.4828

R-squared	0.080993	Mean dependent var	1.51E+09
Adjusted R-squared	0.062237	S.D. dependent var	4.23E+09
S.E. of regression	4.10E+09	Akaike info criterion	47.14376
Sum squared resid	8.23E+20	Schwarz criterion	47.21952
Log likelihood	-1200.166	Hannan-Quinn criter.	47.17271
F-statistic	4.318395	Durbin-Watson stat	2.315667
Prob(F-statistic)	0.042962		

4.2 Unit Root Test at First Difference (Results)

The first difference of ***D(GDP(-1))*** in the GDP time series is stationary, as suggested by the Phillips-Perron test. The Prob. is 0.000. Here, the GDP does not have a Unit Root. Prob < 0.05. It is lower than any conventional level.

Table 2: Unit Root Test at First Difference, Phillips-Perron

Null Hypothesis: D(GDP) has a unit root
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.016148	0.0000
Test critical values:	1% level	-3.568308	
	5% level	-2.921175	
	10% level	-2.598551	

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

Residual variance (no correction)	1.78E+19
HAC corrected variance (Bartlett kernel)	1.89E+19

Phillips-Perron Test Equation
Dependent Variable: D(GDP,2)
Method: Least Squares
Date: 11/02/23 Time: 12:31
Sample (adjusted): 1972 2021
Included observations: 50 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GDP(-1))	-1.044056	0.149060	-7.004269	0.0000
C	1.59E+09	6.42E+08	2.482575	0.0166

R-squared	0.505459	Mean dependent var	1.78E+08
Adjusted R-squared	0.495157	S.D. dependent var	6.07E+09
S.E. of regression	4.31E+09	Akaike info criterion	47.24583
Sum squared resid	8.92E+20	Schwarz criterion	47.32231
Log likelihood	-1179.146	Hannan-Quinn criter.	47.27495
F-statistic	49.05979	Durbin-Watson stat	1.939197
Prob(F-statistic)	0.000000		

4.3 The Augmented Dickey-Fuller Test

The ADF test also revealed findings similar to those of the Phillips-Perron test. The first difference in GDP is stationary (blue circle). Prob < 0.05 ---- Reject Ho ----- The first difference of the GDP time series is stationary.

Table 3: Unit Root Test at First Difference, ADF

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		2.078075	0.9999
Test critical values:	1% level	-3.565430	
	5% level	-2.919952	
	10% level	-2.597905	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GDP)
Method: Least Squares
Date: 11/01/23 Time: 17:02
Sample (adjusted): 1971 2021
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP(-1)	0.056437	0.027158	2.078075	0.0430
C	5.26E+08	7.44E+08	0.707254	0.4828

R-squared	0.080993	Mean dependent var	1.51E+09
Adjusted R-squared	0.062237	S.D. dependent var	4.23E+09
S.E. of regression	4.10E+09	Akaike info criterion	47.14376
Sum squared resid	8.23E+20	Schwarz criterion	47.21952
Log likelihood	-1200.166	Hannan-Quinn criter.	47.17271
F-statistic	4.318395	Durbin-Watson stat	2.315667
Prob(F-statistic)	0.042962		

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.004269	0.0000
Test critical values:	1% level	-3.568308	
	5% level	-2.921175	
	10% level	-2.598551	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GDP,2)
Method: Least Squares
Date: 11/02/23 Time: 13:25
Sample (adjusted): 1972 2021
Included observations: 50 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GDP(-1))	-1.044056	0.149060	-7.004269	0.0000
C	1.59E+09	6.42E+08	2.482575	0.0166

R-squared	0.505459	Mean dependent var	1.78E+08
Adjusted R-squared	0.495157	S.D. dependent var	6.07E+09
S.E. of regression	4.31E+09	Akaike info criterion	47.24583
Sum squared resid	8.92E+20	Schwarz criterion	47.32231
Log likelihood	-1179.146	Hannan-Quinn criter.	47.27495
F-statistic	49.05979	Durbin-Watson stat	1.939197
Prob(F-statistic)	0.000000		

4.4 The Augmented Dickey-Fuller test vs. The Phillips-Perron test.

Here, we generated the first difference for GDP and then performed both tests. Once again, the first difference of the GDP time series is stationary.

Table 4: ADF Test Statistics

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.891644	0.0000
Test critical values:	1% level	-3.581152	
	5% level	-2.926622	
	10% level	-2.601424	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DGDP,2)
Method: Least Squares
Date: 11/02/23 Time: 14:05
Sample (adjusted): 1976 2021
Included observations: 46 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DGDP(-1))	-3.979015	0.504206	-7.891644	0.0000
D(DGDP(-1),2)	2.053798	0.421492	4.872689	0.0000
D(DGDP(-2),2)	1.141564	0.284476	4.012863	0.0002
D(DGDP(-3),2)	0.525477	0.137355	3.825686	0.0004
C	3.82E+08	6.33E+08	0.603501	0.5495

R-squared	0.858862	Mean dependent var	1.60E+08
Adjusted R-squared	0.845092	S.D. dependent var	1.09E+10
S.E. of regression	4.28E+09	Akaike info criterion	47.29638
Sum squared resid	7.52E+20	Schwarz criterion	47.49515
Log likelihood	-1082.817	Hannan-Quinn criter.	47.37084
F-statistic	62.37377	Durbin-Watson stat	2.155195
Prob(F-statistic)	0.000000		

Null Hypothesis: D(DGDP) has a unit root
Exogenous: Constant
Bandwidth: 35 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-40.28570	0.0001
Test critical values:	1% level	-3.571310	
	5% level	-2.922449	
	10% level	-2.599224	

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

Residual variance (no correction)	2.75E+19
HAC corrected variance (Bartlett kernel)	1.34E+18

Phillips-Perron Test Equation
Dependent Variable: D(DGDP,2)
Method: Least Squares
Date: 11/02/23 Time: 14:08
Sample (adjusted): 1973 2021
Included observations: 49 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DGDP(-1))	-1.510184	0.127989	-11.79935	0.0000
C	2.08E+08	7.65E+08	0.271723	0.7870

R-squared	0.747617	Mean dependent var	1.62E+08
Adjusted R-squared	0.742247	S.D. dependent var	1.05E+10
S.E. of regression	5.35E+09	Akaike info criterion	47.68029
Sum squared resid	1.35E+21	Schwarz criterion	47.75751
Log likelihood	-1166.167	Hannan-Quinn criter.	47.70959
F-statistic	139.2248	Durbin-Watson stat	2.421152
Prob(F-statistic)	0.000000		

4.5 Granger Causality (Causal Effect).

Test for Granger Causality (Causal Effect):

- FDI granger causes GDP since the p-value is less than 0.05.
  Prob is 0.0053

- INFL doesn't granger-cause GDP since the p-value is more significant than 0.05.
  Prob is 0.8756

- All the dependent variables, when put together, can granger cause GDP.
  Prob is 0.0316

  This suggests that FDI and INFL are good predictors of GDP. Therefore,
  H_o: Both variables (X & Y) are not predictive of each other beyond the lags of one another.
  H_1: Both variables (X & Y) are predictive of each other beyond the lags of one another.

Table 5 VAR Granger Causality

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 11/02/23 Time: 14:48
Sample: 1970 2021
Included observations: 49

Dependent variable: DGDP

Excluded	Chi-sq	df	Prob.
DFDI	10.47002	2	0.0053
DINFL	0.265762	2	0.8756
All	10.59089	4	0.0316

Dependent variable: DFDI

Excluded	Chi-sq	df	Prob.
DGDP	3.776834	2	0.1513
DINFL	0.151759	2	0.9269
All		2	---

Dependent variable: DINFL

Excluded	Chi-sq	df	Prob.
DGDP	0.089203	2	0.9564
DFDI	0.171789	2	0.9177
All	0.258705	4	0.9923

Test statistics not available for lag coefficients with restrictions

Table 6 VAR Estimates

Vector Autoregression Estimates
Date: 11/02/23 Time: 15:13
Sample (adjusted): 1973 2021
Included observations: 49 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	DGDP	DFDI	DINFL
DGDP(-1)	-0.015630	0.027822	-2.83E-10
	(0.14476)	(0.01450)	(9.5E-10)
	[-0.10797]	[1.91831]	[-0.29727]
DGDP(-2)	-0.103982	-0.002256	-5.47E-11
	(0.15336)	(0.01537)	(1.0E-09)
	[-0.67802]	[-0.14686]	[-0.05410]
DFDI(-1)	-1.140463	-0.334169	2.71E-09
	(1.54411)	(0.15470)	(1.0E-08)
	[-0.73859]	[-2.16007]	[0.26663]
DFDI(-2)	6.154045	0.199177	5.46E-09
	(2.18419)	(0.21883)	(1.4E-08)
	[2.81754]	[0.91018]	[0.37929]
DINFL(-1)	-10503306	-773617.4	-0.629783
	(2.3E+07)	(2307837)	(0.15174)
	[-0.45597]	[-0.33521]	[-4.15029]
DINFL(-2)	-10246398	-797066.8	-0.190775
	(2.3E+07)	(2305651)	(0.15160)
	[-0.44524]	[-0.34570]	[-1.25841]
C	1.30E+09	14895117	-0.043419
	(6.6E+08)	(6.6E+07)	(4.36983)
	[1.95876]	[0.22412]	[-0.00994]
R-squared	0.203558	0.191082	0.306334
Adj. R-squared	0.089781	0.075522	0.207239
Sum sq. resids	7.09E+20	7.12E+18	30765.83

R-squared	0.203558	0.191082	0.306334
Adj. R-squared	0.089781	0.075522	0.207239
Sum sq. resids	7.09E+20	7.12E+18	30765.83
S.E. equation	4.11E+09	4.12E+08	27.06510
F-statistic	1.789094	1.653534	3.091308
Log likelihood	-1150.431	-1037.697	-227.3653
Akaike AIC	47.24209	42.64069	9.565931
Schwarz SC	47.51235	42.91095	9.836191
Mean dependent	1.57E+09	53087547	-0.001960
S.D. dependent	4.31E+09	4.28E+08	30.39754

Determinant resid covariance (dof adj.)	2.05E+39
Determinant resid covariance	1.29E+39
Log likelihood	-2414.958
Akaike information criterion	99.42684
Schwarz criterion	100.2376
Number of coefficients	21

4.6 The test results below indicate no cointegration among these variables. In other words, there is no long-run relationship between the variables. The Akaike Information Criteria (AIC) was used to determine the number of lags. Even with lag intervals of 2 and 4, there is still no cointegration.

Table 7 Lags Intervals (in first differences)

Date: 11/02/23 Time: 17:26
Sample (adjusted): 1973 2021
Included observations: 49 after adjustments
Trend assumption: Quadratic deterministic trend
Series: GDP FDI INFL
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.242773	23.55084	35.01090	0.4731
At most 1	0.135970	9.924325	18.39771	0.4878
At most 2	0.054829	2.763091	3.841465	0.0965

Trace test indicates no cointegration 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	0.242773	13.62652	24.25202	0.6213
At most 1	0.135970	7.161234	17.14769	0.6954
At most 2	0.054829	2.763091	3.841465	0.0965

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Date: 11/02/23 Time: 22:43
Sample (adjusted): 1975 2021
Included observations: 47 after adjustments
Trend assumption: Quadratic deterministic trend
Series: GDP FDI INFL
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.348129	37.77434	35.01090	0.0247
At most 1	0.269826	17.66265	18.39771	0.0631
At most 2	0.059486	2.882437	3.841465	0.0895

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	0.348129	20.11169	24.25202	0.1608
At most 1	0.269826	14.78021	17.14769	0.1070
At most 2	0.059486	2.882437	3.841465	0.0895

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 8 VAR Lag Order Selection Criteria

VAR Lag Order Selection Criteria
Endogenous variables: GDP FDI INFL
Exogenous variables: C
Date: 11/03/23 Time: 01:02
Sample: 1970 2021
Included observations: 48

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2469.195	NA	1.09e+41	103.0081	103.1251	103.0523
1	-2369.331	183.0834	2.48e+39	99.22214	99.68994*	99.39892*
2	-2358.649	18.24870*	2.33e+39*	99.15205*	99.97070	99.46142
3	-2355.856	4.421787	3.05e+39	99.41068	100.5802	99.85264
4	-2350.864	7.280308	3.69e+39	99.57768	101.0980	100.1522

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

So, we see that for each selected lag interval (2 or 4), two of the probabilities are more significant than 0.05, suggesting that we cannot reject H_o. Hence, there is no long-run relationship. Additionally, the Trace Statistic < Critical Value (0.05), so we fail to reject H_o and conclude that there is no long-run relationship between variables or cointegration. The Max-Eigen Statistic validates this as well. For instance, all the values for Max-Eigen are less than the critical values.

4.6 Impulse Response Functions and Graph.

The graphs on the diagonal line show the effect of a shock of a variable on itself. For instance, the impact of GDP shock on GDP (first graph on the upper left). We are mainly interested in the other graphs and not necessarily the diagonal graphs.

- Column 1 Graph 2: The effect of GDP shock on FDI. Foreign Direct Investment (FDI) increases when a shock (increase) in GDP exists.
- Column 1 Graph 3: The effect of GDP shock on INFL. Inflation does not seem to have an immediate impact.

- Column 2 Graph 1: The effect of an FDI shock on GDP. A one-unit shock or increase in FDI will cause GDP to respond by growing. FDI is a predictor of GDP. It has a contemporaneous effect on GDP. Foreign Direct Investment (FDI) increases when a shock (increase) in GDP exists.
- Column 3 Graph 1: A one standard deviation shock on inflation has no contemporaneous effect on GDP.
- Column 3 Graph 2: A one standard deviation shock on inflation has no contemporaneous effect on FDI, etc.

Figure 1 Response to Cholesky

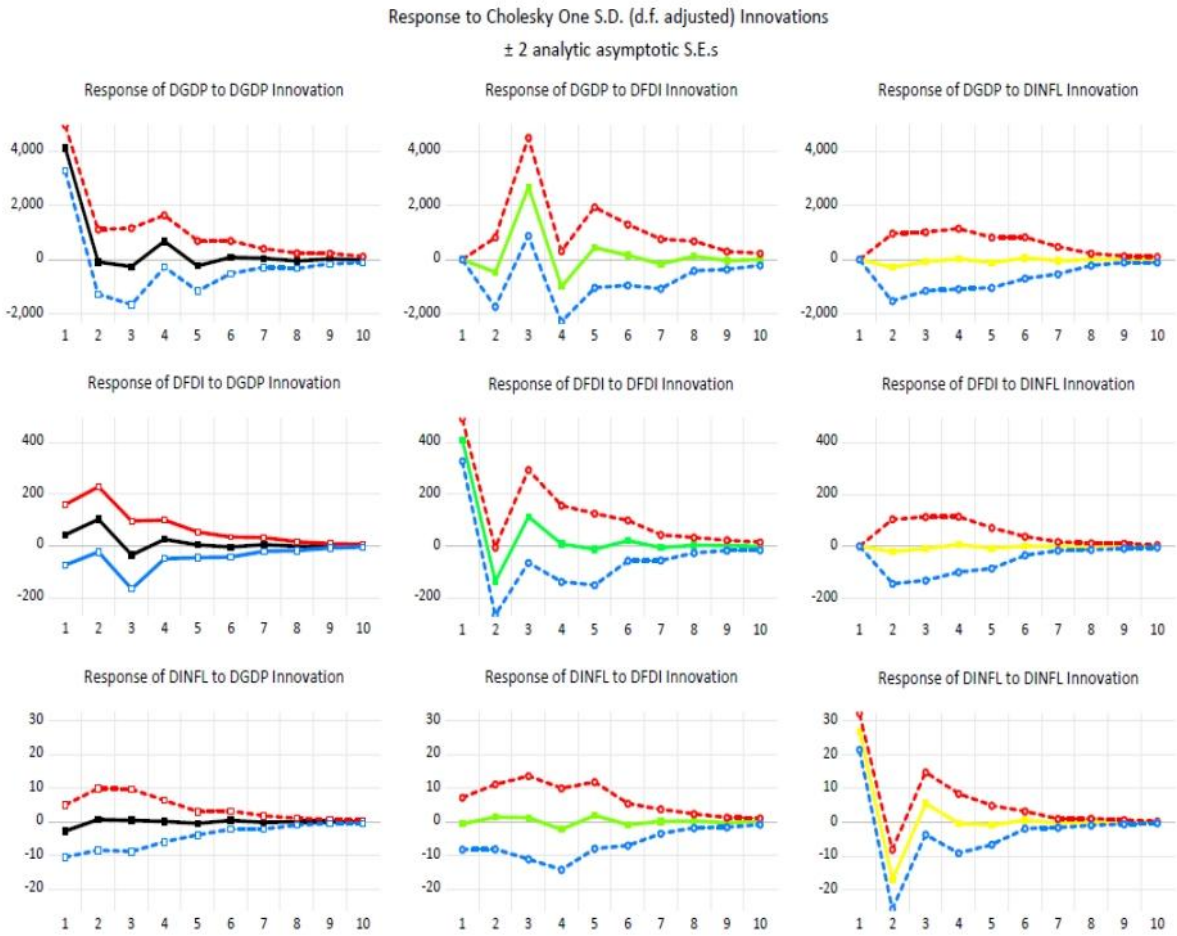
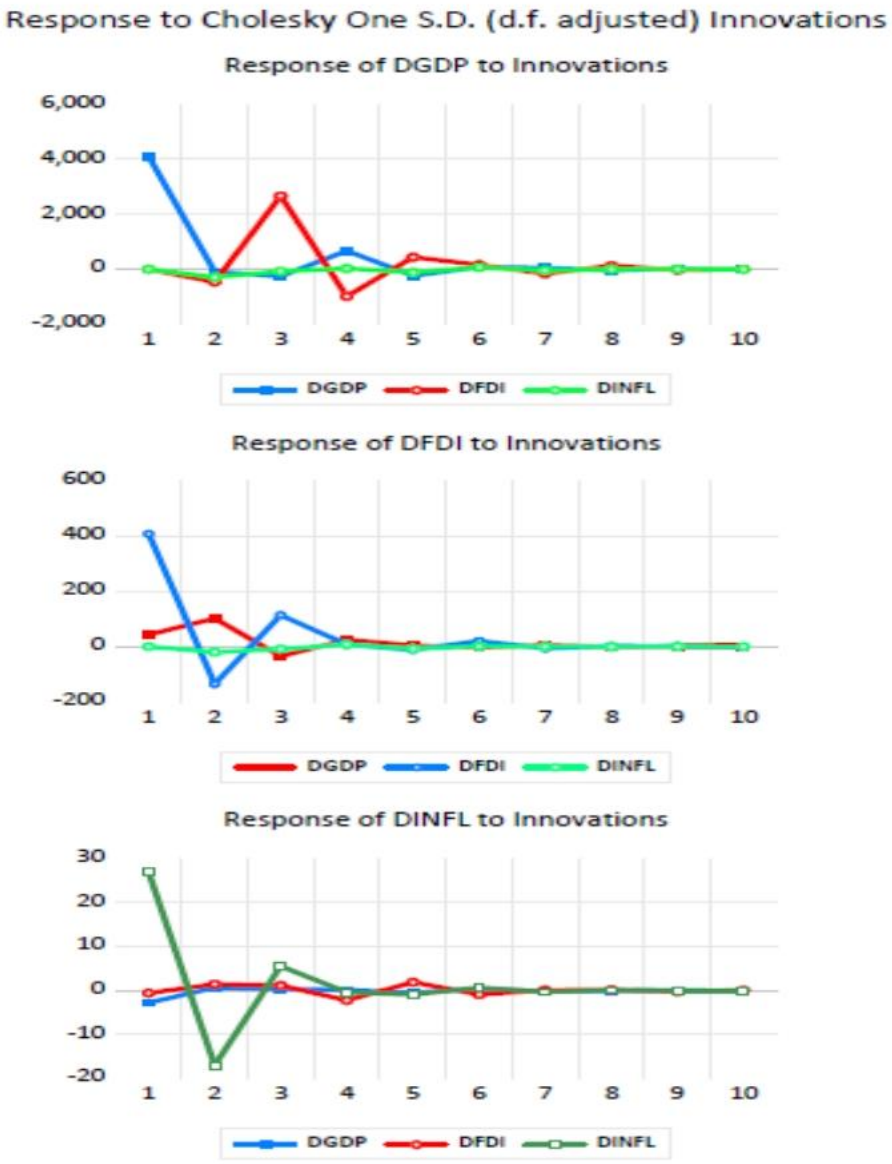


Figure 2 Impulse-response function combined graphs



4.7 Impulse-Response Function (Using Variance Decomposition)

The Variance Decomposition gives us an even clearer picture of the Impulse-Response Function (IRF). As seen in the table below (left), FDI and INFL have no contemporaneous effect on GDP in the first year. In year 2, we observe that FDI explains 1% of the variation in GDP, and 0.46% is explained by inflation. However, over time, we observe that both FDI and INFL gradually increase, suggesting that they present variations in GDP

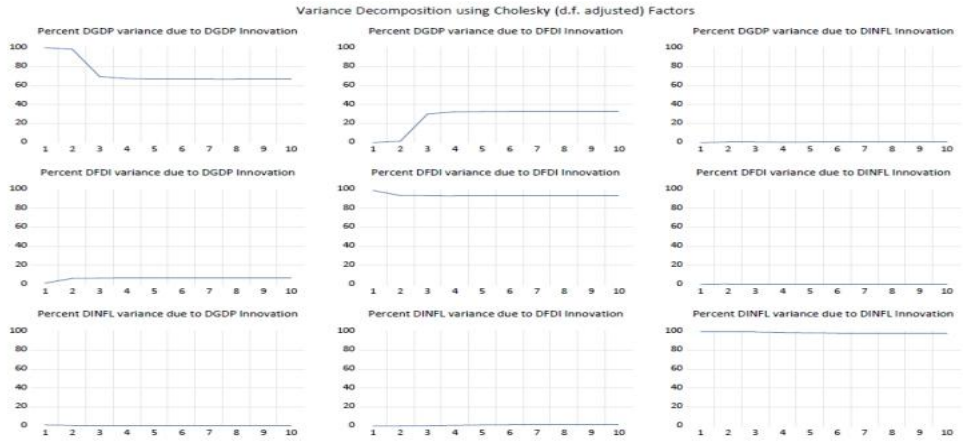
Table 9 Variance Décomposition

Variance Decomposition using Cholesky (d.f. adjusted) Factors

Variance Decomposition of DGDP: Period	S.E.	DGDP	DFDI	DINFL
1	4108.501	100.0000	0.000000	0.000000
2	4144.818	98.29662	1.238085	0.465296
3	4938.784	69.50221	30.15022	0.347571
4	5081.476	67.39252	32.27609	0.331390
5	5106.983	66.93405	32.69060	0.375347
6	5110.658	66.86446	32.74590	0.389636
7	5113.588	66.79746	32.80878	0.393758
8	5115.376	66.75793	32.84858	0.393483
9	5115.574	66.75615	32.85015	0.393700
10	5115.586	66.75600	32.85001	0.393988
Variance Decomposition of DFDI: Period	**S.E.**	**DGDP**	**DFDI**	**DINFL**
1	411.6258	1.092063	98.90794	0.000000
2	445.9685	6.168807	93.61316	0.218038
3	461.6658	6.347352	93.40906	0.243591
4	462.4325	6.604252	93.13101	0.264738
5	462.6854	6.602983	93.10742	0.289602
6	463.1667	6.597333	93.11243	0.290238
7	463.2434	6.606752	93.10309	0.290153
8	463.2520	6.607549	93.10172	0.290731
9	463.2554	6.607500	93.10156	0.290935
10	463.2577	6.607536	93.10149	0.290972
Variance Decomposition of DINFL: Period	**S.E.**	**DGDP**	**DFDI**	**DINFL**
1	27.06510	1.043465	0.039962	98.91657
2	31.97647	0.794530	0.234542	98.97093
3	32.48116	0.785334	0.360264	98.85440
4	32.55750	0.783859	0.811572	98.40457
5	32.62957	0.801717	1.158133	98.04015
6	32.65059	0.819160	1.225760	97.95508
7	32.65264	0.822485	1.226322	97.95119
8	32.65361	0.822442	1.231648	97.94591
9	32.65446	0.822786	1.236397	97.94082
10	32.65472	0.823060	1.237620	97.93932

Cholesky One S.D. (d.f. adjusted)
Cholesky ordering: DGDP DFDI DINFL

Figure 3 Variance Décomposition



5. Diagnostic Tests.

Table 10 Normality Test

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: Residuals are multivariate normal
Date: 11/03/23 Time: 02:05
Sample: 1970 2021
Included observations: 50

Component	Skewness	Chi-sq	df	Prob.*
1	0.884632	6.521442	1	0.0107
2	0.176916	0.260828	1	0.6096
3	1.519871	19.25008	1	0.0000
Joint		26.03235	3	0.0000

Component	Kurtosis	Chi-sq	df	Prob.
1	8.733131	68.47665	1	0.0000
2	10.64567	121.7839	1	0.0000
3	6.799019	30.06779	1	0.0000
Joint		220.3283	3	0.0000

Component	Jarque-B...	df	Prob.
1	74.99809	2	0.0000
2	122.0447	2	0.0000
3	49.31787	2	0.0000
Joint	246.3607	6	0.0000

*Approximate p-values do not account for coefficient estimation

Table 11 VAR Residual Serial Correlation

VAR Residual Serial Correlation LM Tests
Date: 11/08/23 Time: 21:35
Sample: 1970 2021
Included observations: 49

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	3.060870	9	0.9618	0.332799	(9, 90.2)	0.9619
2	1.734415	9	0.9950	0.187242	(9, 90.2)	0.9950
3	6.038834	9	0.7360	0.667187	(9, 90.2)	0.7364

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	3.060870	9	0.9618	0.332799	(9, 90.2)	0.9619
2	3.304356	18	0.9999	0.172247	(18, 96.7)	0.9999
3	28.73079	27	0.3741	1.078328	(27, 91.2)	0.3821

*Edgeworth expansion corrected likelihood ratio statistic.

The tables above show that we cannot reject the Hull hypothesis since the p-value is more significant than 0.05. Meaning there is no autocorrelation at any of those lags. So, using any of those lags is appropriate. Therefore, we are sure there is no autocorrelation to the lag two we selected for this model.

6. Testing VAR Stability Condition

6.1 VAR Stability Condition Check

Figure 4

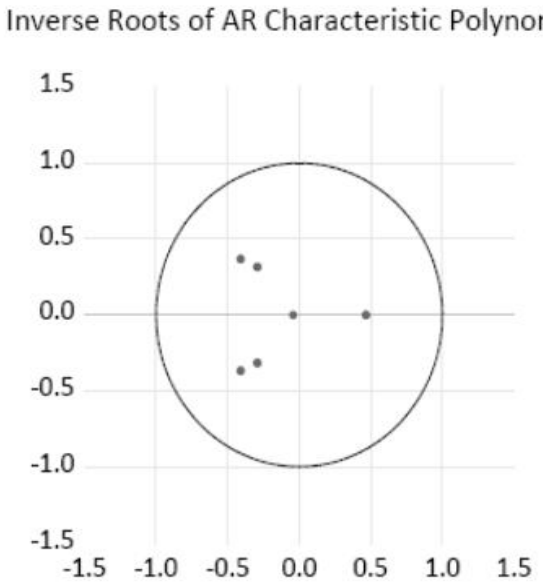


Table 12

VAR Stability Condition Check

Roots of Characteristic Polynomial
Endogenous variables: DGDP DFDI DINFL
Exogenous variables: C
Lag specification: 1 2
Date: 11/08/23 Time: 21:01

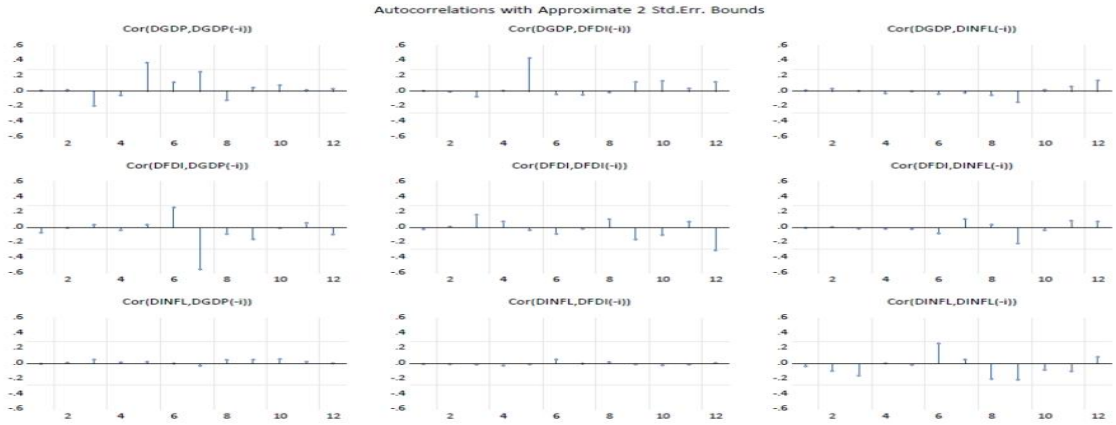
Root	Modulus
-0.409327 - 0.387379i	0.550015
-0.409327 + 0.387379i	0.550015
0.466904	0.466904
-0.292317 - 0.316425i	0.430783
-0.292317 + 0.316425i	0.430783
-0.043199	0.043199

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

Figure 5 shows that the VAR model is stable. No root lying outside the unit circle. Therefore, VAR satisfies the stability conditions. The stability of the VAR system implies stationarity. This is important because once a root lies outside the unit circle, we must use different lags to estimate your model. But with this result, the roots are all in the circle, meaning a lag specification of "2" is good or preferred for this model.

6.2 Residual Test with the aid of Correlograms

Figure 5



7. Johansen Cointegration Test Summary.

The Akaike Information Criteria (AIC) and Schwarz Criteria recommend two lag intervals, as highlighted in YELLOW. The cointegration test was run after that. And the results showed that cointegration exists. We see that all the probabilities are less than 0.05 suggesting that there is a long-run relationship between those variables.

Table 13

Johansen Cointegration Test Summary

Date: 11/08/23 Time: 15:44
Sample: 1970 2021
Included observations: 49
Series: DGDP DFDI DINFL
Lags interval: 1 to 1

Selected (0.05 level*) Number of Cointegrating Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	3	3	3	2	3
Max-Eig	3	3	3	2	3

*Critical values based on MacKinnon-Haug-Michelis (1999)

Information Criteria by Rank and Model

Data Trend:	None	None	Linear	Linear	Quadratic
Rank or No. of CEs	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
	Log Likelihood by Rank (rows) and Model (columns)				
0	-1099.132	-1099.132	-1099.068	-1099.068	-1098.772
1	-1080.231	-1080.104	-1080.042	-1080.001	-1079.705
2	-1068.068	-1066.614	-1066.579	-1062.675	-1062.393
3	-1063.199	-1061.037	-1061.037	-1056.945	-1056.945
	Akaike Information Criteria by Rank (rows) and Model (columns)				
0	45.22986	45.22986	45.34973	45.34973	45.46009
1	44.70332	44.73896	44.81802	44.85717	44.92672
2	44.45177	44.47404	44.51341	44.43573*	44.46502
3	44.49792	44.53214	44.53214	44.48756	44.48756
	Schwarz Criteria by Rank (rows) and Model (columns)				
0	45.57734	45.57734	45.81304	45.81304	46.03921
1	45.28244	45.35669	45.51298	45.59073	45.73750
2	45.26255*	45.36203	45.44002	45.43956	45.50745
3	45.54035	45.69040	45.69040	45.76164	45.76164

Johansen Cointegration Test

Date: 11/08/23 Time: 16:00
Sample (adjusted): 1974 2021
Included observations: 48 after adjustments
Trend assumption: Quadratic deterministic trend
Series: DGDP DFDI DINFL
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.465467	57.46150	35.01090	0.0001
At most 1 *	0.369580	27.39615	18.39771	0.0021
At most 2 *	0.103613	5.250397	3.841465	0.0219

Trace test indicates 3 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 *	0.465467	30.06535	24.25202	0.0076
At most 1 *	0.369580	22.14575	17.14769	0.0086
At most 2 *	0.103613	5.250397	3.841465	0.0219

Max-eigenvalue test indicates 3 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 Cointegrating Coefficients (normalized by b'*S11*b=I):

DGDP	DFDI	DINFL
-0.000275	0.001068	0.086704
-0.000514	0.002594	-0.051110
-4.47E-05	-0.005699	-0.000191

Unrestricted Adjustment Coefficients (alpha):

D(DGDP)	1413.317	2145.067	517.1969
D(DFDI)	-64.27905	-59.60053	121.6975
D(DINFL)	-19.94299	9.059281	-0.972012

1 Cointegrating Equation(s): Log likelihood -1047.271

Normalized cointegrating coefficients (standard error in parentheses)

DGDP	DFDI	DINFL
1.000000	-3.888847	-315.8352
	(3.68942)	(62.8567)

Adjustment coefficients (standard error in parentheses)

D(DGDP)	-0.387988
	(0.18297)
D(DFDI)	0.017646
	(0.01743)
D(DINFL)	0.005475
	(0.00115)

5. Conclusion

Empirically, it is essential to emphasize that the first difference in the GDP series is stationary after running the ADF Test. Furthermore, this result was also empirically supported by the PP Test. Both tests found a p-value of 0.000, which is less than 0.05 or any conventional level. The results from the Granger Causality Test or the causal effects showed that FDI granger-causes GDP because of Prob. 0.0053 < 0.05, while INFL does not granger-cause GDP because the p-value is more significant than 0.05. Additionally, when put together, all the dependent variables can granger-cause GDP with a p-value of 0.0316 being less than 0.05. This suggests that FDI and INFL are good predictors. The co-integration test results show that there is no cointegration among the variables. In other words, there is no long-run relationship between variables. Even at lag intervals of 2 and 4, there is still no cointegration. Further findings showed that FDI and INFL have no contemporaneous effect on GDP in the first year.

In year 2, we observed that FDI explains 1% of the variation in GDP, and 0.46% is explained by inflation. However, over time, we observed that both FDI and INFL increased gradually, suggesting that they presented variations in GDP. The Akaike Information Criteria (AIC) and Schwarz Criteria recommended two lag intervals. The cointegration test was run after that. And the results showed that cointegration exists. We see that all the probabilities are less than 0.05, suggesting a long-run relationship between the variables under investigation. Based on these results, Ghanaian policymakers must formulate policies that attract export-led Foreign Direct Investments, pursue monetary frameworks to tackle/stabilize inflation, and create favorable business climates that attract substantial inflows.

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