Inflation Impact on Real Economic Growth

Econometric stady relative to Algerian Economy during the period 1995-2021

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Abstract

This research paper is related to the Algerian economy, it focuses on measuring the impact of inflation on economic growth through estimating the Autoregressive Distributed Lag (ARDL) model of time series gaps during the period 1995-2021. The study finds -based on the model's outputs - that the return of short-term economic growth to its long-term equilibrium value takes approximately 1.05 years. There is a significant negative and symmetrical effect of inflation rate, and a positive effect of industrial and agricultural sectors added value on real economic growth rates between the short and long terms. This implies that an increase in inflation levels up to certain thresholds affects positively the performance of the industrial and agricultural sectors in Algeria.

Keywords: *inflation, economic growth, Autoregressive Distributed Lag (ARDL) model, value added.*

Introduction:

The primary objective of macroeconomic policy in its equilibrium function is to improve certain levels of various economic variables. However, inflation and economic growth are two variables that have received significant attention from researchers and decision-makers, despite their often unclear relationship.

An observer of these two variables developments in the Algerian economy during the study period notices both positive and negative values, reflecting the economic, social, and even political reality of Algeria. Therefore, understanding and managing the relationship between inflation and economic growth becomes crucial for decision-makers, considering the characteristics of the Algerian economy related to the evolution of aggregate supply and demand components, as well as the performance of macroeconomic policies.

A significant links have been observed between gross domestic product (GDP) and the hydrocarbons sector in Algeria, where a major role of imports in meeting market needs, and substantial growth in consumption, government expenditure, and investment. This situation makes the effectiveness of macroeconomic policies dependent on the efficiency and performance of economic agents.

Research Problem: Based on the above description, we can pose the following research problem:

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What is the extent impact of inflation fluctuations on economic growth in Algeria during the period (1995-2021)?

Research Hypotheses: To address the previous research problem, the following hypotheses have been formulated:

- There is a negative impact of inflation on economic growth in Algeria during the period 1995-2021.
- There is no symmetry in the effect of inflation on economic growth between the short and long terms.
- Certain sectors have a positive impact on economic growth in both the short and long terms.

Study Objective: This study aims to understand the relationship between inflation and economic growth in Algeria, taking into account the subrelationships between inflation and the level of economic activity in certain non-hydrocarbon productive sectors, while also assessing the equilibrium return of growth in the long term.

Research Methodology: To address the research problem, we employed a descriptive-analytical methodology to present the most significant studies explaining the inflation-growth relationship. Additionally, we used an experimental approach by employing economic measurement tools, specifically relying on the Autoregressive Distributed Lag (ARDL) model to determine the equilibrium relationship between inflation, economic growth, and the sectors that impact national output levels in the short and long terms during the period 1995-2021.

Structure of the Study: This study covered three aspects: theoretical and empirical studies explaining the impact of inflation on economic growth, extracting the appropriate standard model to determine the nature of the effect.

I- The Theoretical Aspect of the Study:

Studying the reciprocal relationship between inflation and economic growth is of utmost concern to decision-makers. This relationship, however, appears to be variable and challenging to determine the nature and direction of the impact between them. Isolating the effect of inflation from other stimulating or hindering growth factors is practically difficult, as Johnson stated. Therefore, studying and analyzing the impact of inflation on economic growth requires identifying the channels through which specific variables interact with price levels and affect production. Consequently, this section of the study addresses the most important findings from economic theories and empirical studies by renowned economists in explaining the relationship between inflation and economic growth, as well as determining the mechanism of transmission from inflation to economic growth.

The Impact of Inflation on Economic Growth through Economic Theories:

Economic theories have yielded multiple and diverse results regarding the sensitivity or responsiveness of output growth to inflation. Therefore, they are always limited as they represent different perspectives on the phenomenon.

To a large extent, the acceptance of the Phillips curve relationship during that period (the 1960s) seemed unsustainable. This was evident in periods of high inflation and negative output growth, where price levels sharply increased. Economies were faced with the global experience of high unemployment levels, highlighting the importance of addressing the impact through the presentation of some growth theories regarding inflation and its relationship to economic growth. These theories include the classical, Keynesian, monetary, neoclassical, neo-Keynesian, and endogenous growth theories .

Firstly, the Classical Theory: The foundation of analysis in the classical theory is based on the Classical Growth Model introduced by Adam Smith, where the production function is as follows:

Y=F(L,K,T).......(1.4)

y : production, L : labour, k : capitol, and t: earth

Therefore, production growth (g_Y) is derived from population growth , investment (g_K) and land growth (g_T), as well as growth in total productivity (g_f), i.e.:

$$g_Y = \phi \big(g_f, g_K, g_L, g_T \big) ....(2.4)$$

Adam Smith has proven that growth reinforces itself, and he also believes that:

- Saving is the creator of investment and hence growth.

- Income distribution is one of the key determinants of how a country's growth increases or accelerates (or slows down).

- Low profit levels are not due to a decrease in marginal productivity but rather due to the competitive nature of the capitalist system in granting workers higher wages. Therefore, the specific relationship between changes in price levels (inflation) and its cost effects on profit and production levels is not explicitly explained in the classical growth theory. However, it is clear that the relationship between them is negative (a decrease in firm profits due to high wage costs).

Secondly, the Keynesian Theory: The Keynesian model includes both the Aggregate Demand (AD) curve and the Aggregate Supply (AS) curve, which clearly illustrate the relationship between inflation and economic growth. In this model, the Aggregate Supply (AS) curve in the short run slopes upward to the critical position, which represents the vertical position. Changes in demand only affect prices and if the slope is inclined, changes in demand affect both prices and output (DORANBUSH ET AL,1996). This is evidenced by the fact that many factors affect inflation rates and production levels in the short run, including changes in expectations, labor forces, prices of other factors of production, tax policies, and monetary policies.

When transitioning from the short-run to the hypothetical long-run, the aforementioned factors and their shocks on the overall economy's steady state are considered to be moving outward, where "nothing changes."

The dynamic equilibrium of the Aggregate Supply (AS) and Aggregate Demand (AD) curves in the short run provides a path to equilibrium , allowing for an initial positive relationship between inflation and growth. However, it later turns into a negative direction at the end of the adjustment path. The initial positive relationship between output and inflation is explained by movements from point A to point B on the curve below, always due to the problem of "time inconsistency." Producers realize that their prices are the only ones that have increased, while other producers are operating at the same price level. However, in reality, all prices have increased, which makes producers continue to increase production and, thus, maintain rising output.

Blanchard and Kiyotaki (1987) also believe that the positive relationship is a result of agreements among producers to supply goods at later times and at agreed-upon prices. Therefore, as prices of goods in the economy rise, production cannot decline because the producer is obligated to fulfill the demand of consumers that was agreed upon.

Figure 1: The relationship between inflation and economic growth according to Keynesian analysis.
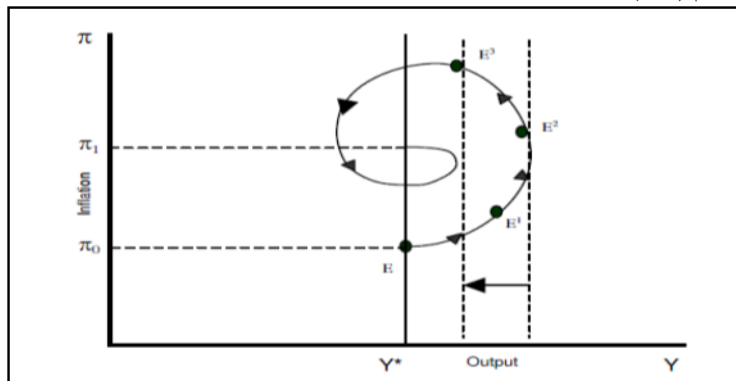
Source : Subrina Hanif, Remationship Between Inflation and Economic Growth, Working Paper, Economics Department, Reserve Bank of Figi, Suva, 2004, p :08

Through the diagram, it becomes evident that there are two characteristics of the adjustment or equilibrium path:

1. The first characteristic: There is a time lag when output decreases and inflation rate increases, for example, between points E^2 and E^3 ؛. Here, the importance of the negative relationship between inflation and growth emerges, as it is observed in reality and as highlighted by the empirical theory (the phenomenon of stagflation). In this scenario, inflation rates rise while output level declines or remains stable.

2. The second characteristic: The economy does not respond directly to high inflation rates, but it appears in a brief manner where inflation rises and then declines. Through this model, an inverse relationship between output and inflation changes becomes apparent in the short run, although it is not continuous. For inflation to be more stable at any level, actual output must equal potential output $\left(Y^*\right)$.

3. Monetary Theory: Monetary thought has important and distinct characteristics, particularly regarding its focus on the long-run aspects of the economy's supply and its difference from short-run dynamics. The quantity theory of money links inflation with economic growth through a simple equality between the total amount of spending in the economy and the total quantity of money in circulation. Therefore, Friedman proposed that inflation is the result of growth in the money supply or its velocity of circulation at a higher rate than economic growth. He also challenged the Phillips curve principle, arguing that if individuals anticipate future inflation rates and incorporate them into their behavior, it would not have an impact on employment and production. Economists refer to this as the "neutrality of money" principle, which holds if the equilibrium values of real variables (such as GDP) are independent of the level of money supply in the long run. However, in reality, the effects of inflation have been observed to impact other aggregate economic variables, such as capital accumulation, investment, and exports. In this context, inflation has a negative impact on the country's economic growth rate.

Foutrthly, Neoclassical Theory: Recent models in neoclassical economics, as proposed by Solow (1956) and Swan (1956) , have shown a separate decline in the productivity of labor and capital, with a constant return to scale when both factors are combined. Technological changes are compensated by investment

(capital growth), which represents the primary factor explaining long-run economic growth. Its level is considered an exogenous determinant by Solow and some growth theorists, independent of factors related to inflation (Todaro, 2000).

1. Mundell's analysis (Mundell, 1963): Mundell was the first to describe the mechanism that links inflation and output growth, deriving it from the excess demand for goods. According to his model, an increase in inflation or inflationary expectations directly leads to a decrease in individuals' wealth, assuming that the real rate of return on money holdings fluctuates downward. To accumulate the desired wealth, individuals save more and direct their savings towards certain assets (deposits), causing their prices to rise. This movement lowers real interest rates and increases the level of savings, resulting in more capital accumulation and rapid production growth.

2. Stochman's impact (Stochman, 1981): Stochman developed a model in which an increase in the inflation rate leads to a state of production stability at a low level, accompanied by a decrease in people's welfare. In his view, money is a complement to capital, allowing institutions to allocate some liquidity. However, he takes into account the negative relationship between production stability and the inflation rate. If inflation erodes the purchasing power of cash balances, individuals will reduce their purchases of both goods and capital. This leads to a decrease in the equilibrium level of production in response to an increase in the inflation rate. The "Stochman effect" can also manifest through its impact on labor-leisure decisions, which will be highlighted in the analysis below.

Fifthly: Analysis of Neo-Keynesianism

Neo-Keynesian analysis relies on the principles of partial economic analysis, adopting both neoclassical and Keynesian principles. Their analysis of the relationship between inflation and growth is derived from the Tobin effect, as well as the analyses of "Koo" and "Hansen."

1. The Tobin Effect: Tobin, in 1965, developed the "Mundell" model by incorporating the perspectives of Solow (1956) and Swan (1956), making money a store of value in the economy. In this model, individuals substitute current consumption with future consumption by either holding money or earning capital gains. Under this framework, individuals can maintain their budget regardless of the high rates of return provided by capital. Simply put, the Tobin effect suggests that inflation leads to the external conversion of money into acquired asset benefits, which result in a strong (dense) capital and stimulate economic growth, thus indicating a positive relationship between inflation and economic growth.

2. Cooley and Hansen Analysis (Cooley and Hansen, 1989): Cooley and Hansen extended the mechanism to consider capital accumulation, assuming that the marginal production of capital is positively related to the amount of labor. When the quantity of labor decreases in response to an increase in inflation, this leads to a reduction in capital, consequently reducing the equilibrium level of capital and production. They also illustrate that the level of production always decreases with a higher inflation rate.

3. Greenwood and Huffman Analysis (Greenwood and Huffman, 1987): Their analysis of the relationship between inflation and economic growth is based on the development of mechanisms for leisure time in work. Individuals hold money to purchase consumer goods and transfer utility through consumption and leisure time. They explain that the labor force price (wages) decreases with an increase in the inflation rate, leading individuals to shift from consumption to leisure time due to the declining labor force prices.

Sixthly: Endogenous Growth Theory

Endogenous growth theory describes economic growth through the factors of production involved in the production process. In this theory, the growth rate is determined by a single variable, which is the rate of return on capital . Variables such as inflation can reduce this rate, leading to a decrease in capital accumulation and a reduction in the growth rate . This may result in a convergence between the analysis of neoclassical theory and endogenous growth theory. However, there is a distinctive characteristic that highlights the difference in their analyses.

In neoclassical economics, returns on capital decrease as capital accumulation increases. However, in the simplest model of endogenous growth, growth continues to rise because returns on capital do not decline below a positive margin. Considering that any form of capital taxation results in a lower return, an increase in the inflation rate (as a form of taxation) will reduce the returns on capital and the growth rate. This has a negative impact on financial capital and, consequently, on the growth rate.

Furthermore, the impact of inflation as a tax also affects human capital by depressing the workforce (increasing leisure time during work), leading to a decrease in the return on human capital. This can also reduce the growth rate.

II- Empirical Analysis of the Relationship between Inflation and Economic Growth:

Experimental analysis of the relationship between inflation and economic growth has yielded diverse results over time, despite the variations in the economies of the countries involved. These studies aimed to provide evidence on the existence of an impact of inflation on economic growth, the time horizon in which it affects, the type of relationship between them, and the threshold level at which the nature of the relationship changes. These aspects have been subject to disagreement among many researchers. Therefore, our study in this subject aims to clarify the nature of the relationship between inflation and economic growth, determine the form of the relationship between them while identifying the threshold level, and subsequently highlight the mechanism through which the impact of inflation is transmitted to economic growth.

1. The Nature of the Relationship between Inflation and Economic Growth

Many economists generally agree on the existence of a negative impact of inflation on economic growth. However, researchers did not discover this relationship during the period between the 1950s and 1960s. This was evident in the experiences of some advanced countries in their early stages of growth, where economic growth occurred with or without price increases. This lack of conclusive evidence regarding the positive or negative nature of the relationship between inflation and the growth rate was highlighted in the following series of studies:

1. International Monetary Fund (IMF) in the 1960s (Dorrance, 1963-1966; Bhatia, 1960; Wai, 1959), where no evidence was found regarding the detrimental effects of inflation.

2. Johanson (1967) found a weak or fragile relationship, while Levin and Zorvos (1993) emphasized the variability of the correlation between inflation and growth based on pure inflationary observations with high data volatility .

3. Bruno and Easterly (1998) as well as Bullard and Keating (1995) were able to identify the reasons that cause the negative relationship to emerge or grow, particularly when inflation exceeds certain thresholds. This aligns with the findings of Fisher (1993) who demonstrated, through a large sample of countries

and a long time series, that inflation hinders the efficient allocation of resources by obscuring the informative role of price changes, which is crucial for activating economic decision-making.

4. Barro (1995) arrived at robust results indicating that a 10-percentage-point increase in the inflation rate per year slows down economic growth by 0.2 to 0.3 percentage points annually. He demonstrated that the negative impact between inflation and growth appears to be small, while the long-term effect on living standards is fundamental.

2. The Shape of the Relationship Between Inflation and Economic Growth and Determining the Threshold Level:

The shape of the relationship between inflation and economic growth and determining the threshold level refers to whether the relationship is linear or not. Several studies have highlighted the presence of a nonlinear relationship between these variables, where the relationship is positive at low inflation rates and negative at higher levels .

1. Through the nonlinear relationship first discovered by Fisher (1993), Sarel (1996) found the intervention of the structural gap in the relationship between the variables. Moreover, he estimated the inflection point or threshold for the annual inflation rate at around 8%.

2. Ghosh and Philips (1998) revisited the research on threshold effects using a large sample similar to Sarel's study in 1996. Surprisingly, they found a significant low threshold effect at a 2.5% inflation rate.

3. Christoffersen and Doyle (1998) estimated the threshold level at 13% for transitional countries.

4. Bruno and Easterly (1998) pointed out that several countries experienced stable inflation rates between 20% and 30% without negative effects on economic growth. However, when inflation exceeded certain levels (estimated by Bruno and Easterly at 40%), real economic growth was significantly affected negatively.

5. Kahan and Sanhadji (2001) conducted a thorough examination of the nonlinear relationship between inflation and economic growth using an unbalanced panel of 140 countries over 40 years. They estimated the threshold level for industrialized countries to be between 3% and 1%, while for developing countries, it ranged from 12% to 11%. These empirical findings did not align with macroeconomic models. However, applied studies suggest that financial markets can be an important channel through which inflation affects economic growth nonlinearly.

3. The Mechanism of Transmission from Inflation to Economic Growth

Concerning the mechanism through which inflation affects long-term economic growth based on a nonlinear relationship, it operates through two channels: capital accumulation channel and total factor productivity (TFP) channel . The TFP channel refers to the relationship between output and all input factors used to obtain it, representing the ratio between the quantity of outputs produced over a specific time period and the quantity of inputs used to achieve that level of output. It serves as a measure of the efficiency of economic units in the process of transforming inputs into outputs, i.e., resource utilization efficiency. Therefore, current intensive research focuses on the nonlinear relationship between inflation and economic growth. At low inflation rates, the relationship is positive, but at high rates, it has a strong negative impact on growth. The existing theoretical foundations have indicated the mechanism of transmission from inflation to economic growth, as shown in the figure below.

Figure 2: The Mechanism of Transmission from Inflation to Economic Growth
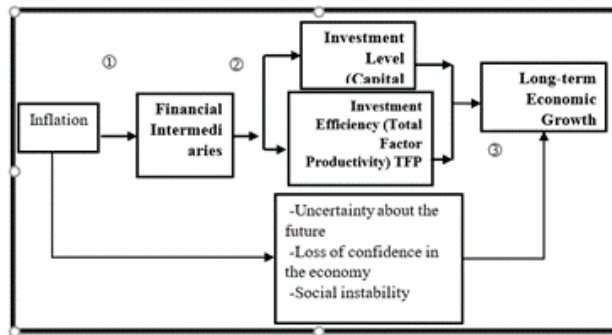
Source: Min Li. Inflation and Economic Growth (Threshold Effect and Transmission Mechanism). P5.

As shown in the above figure, inflation can impact economic growth through financial intermediaries, thus exerting a direct effect on growth. This effect is known and difficult to model, which has led many theoretical studies to focus on six channels represented by the thick lines in the figure. To further clarify the theoretical assumptions of these channels, they can be divided into three sections, represented in the figure above as ①،②،③.

Firstly, the Inflation-Finance Linkage: It is the starting point of the channel through which inflation affects economic growth by influencing the expectations of inflation rate hikes on the development of the financial market, hindering its progress. Given the strong positive correlation between financial market development indicators and real economic performance (Atje and Jovanovic, 1993; Levine and Zervos, 1998; King and Levine, 1993a,b), the basic mechanism of numerous empirical studies focuses on studying the relationship between financial market development and inflation as an attempt to justify the results concerning the inverse nonlinear impact of inflation on growth. By unifying the analysis of both Boyd et al. (2001) and Khan et al. (2001), the complete picture of the inflation-finance relationship can be explained . The threshold level estimated by Khan et al. (3% and 6%) represents the lower threshold level, while the threshold level estimated by Boyd et al. (ranging from 7.5% to 40%, with 15% chosen as a representative rate) represents the upper threshold. Thus, the inflation-finance relationship is stable and evident when the inflation rate is between the highest and lowest threshold levels. If inflation exceeds the upper threshold level, it can hinder the economy, whereas when inflation is below the lower threshold level, it is not harmful and can stimulate financial depth (Khan et al., 2001).

Secondly, the Inflation-Investment Linkage and Investment-Growth Linkage: Based on our understanding of the characteristics of the inflation-finance relationship, it is expected that the inflation-investment and investment-growth relationships share similar characteristics. Regarding these two sections of the channel, several empirical studies have indicated a strong positive correlation between various indicators of financial market development and the level of investment, investment efficiency, and real economic growth (Levine and Zervos, 1998; King and Levine, 1993a,b; Atje and Jovanovic, 1999). Furthermore, Xu (2000) found that investment is considered the most significant channel through which financial development affects growth. Additionally, Barro (1998) suggested that the most probable channel through which inflation negatively affects economic growth is by reducing investment

willingness. His estimations revealed that a 10 percentage point increase in inflation per year reduces the investment-to-GDP ratio by 0.4 to 0.6 percentage points. Barro's study also found a linear relationship between inflation and economic growth, as well as between inflation and investment. However, recent studies have shown a strong non-linear (threshold) effect of inflation on economic performance, justifying the presence of an impact threshold in the inflation-investment relationship if the assumptions of the transmission mechanism are valid and effective.

III- The Econometric Study

In this study, which focuses on econometrics, the following issues are addressed: defining the study model and examining the time series stability. The model estimation is conducted using the ARDL (Autoregressive Distributed Lag) approach, based on a sample of data specific to the Algerian economy from 1995 to 2021. The estimated model is then evaluated to determine the nature of the relationship between inflation and economic growth, as well as identifying the sectors that support economic growth levels in Algeria.

1. Introduction to the Study Model and the Examination of Time Series Stationarity:

In this study, annual data for Algeria from 1995 to 2021 are utilized. The data is obtained from the World Bank and the International Monetary Fund, and based on previous studies, the following variables are included in the model:

PGDP: The growth rate of per capita Gross Domestic Product (GDP) as an indicator of economic growth (unit: %).

INF: The inflation rate (unit: %).

AGVA: The growth rate of value added in the agricultural sector (unit: %).

INDVA: The growth rate of value added in the industrial sector (unit: %).

OPEN: Trade openness as a percentage of GDP (unit: %).

GFCF: Gross Fixed Capital Formation as a percentage of GDP (unit: %).

Secondly, the examination of time series stability is summarized in the table below, which presents the results of the augmented Dickey-Fuller and Phillips-Perron tests conducted on the time series used in the study during the period 1995-2021.

Table 1: Time series stationarity study.

Philips perron test			Augmented Dickey-Fuller Test			
Without constant and general direction	BThe odd constant	BThe individual constant and general direction	Without constant and general direction	BThe odd constant	BThe individual constant and general direction	
Stability in the level						
0.0044	0.0116	0.0048	0.1711	0.7038	0.0050	**PGDP**
0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	**INF**
0.0000	0.0000	0.0000	0.0014	0.0000	0.0000	**AGVA**
0.0322	0.0072	0.0059	0.1527	0.0096	0.0196	**INDVA**
0.5812	0.6071	0.8963	0.5797	0.6041	0.8747	**OPEN**
0.0088	0.0012	0.0060	0.0061	0.0012	0.0058	**TGFCF**
Stability in the first differences						
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**PGDP**
0.0000	0.0000	0.0001	0.0000	0.0000	0.0001	**INDVA**
0.0000	0.0013	0.0004	0.0000	0.0013	0.0041	**OPEN**

Source: Prepared by the researchers using EVIEWS 13 software

The results of the stationarity tests at the level (using both augmented Dickey-Fuller and Phillips-Perron tests) indicate that the probability associated with these tests is lower than the significance level of 0.05 or 0.01 for the variables: agricultural sector value-added growth rate, inflation rate, and gross fixed capital formation growth rate. Therefore, these series are stationary at the level. However, for the remaining time series, the probability associated with the tests was higher than the significance level of 0.05 or 0.01 (in most models), indicating that they are non-stationary at the level. However, after taking the first differences of the economic growth rate, industrial sector value-added growth rate, and trade openness as a percentage of GDP, it was found that the probability associated with these tests is lower than the significance level of 0.05 or 0.01, indicating that these series have become stationary in the first differences.

The stationarity of the economic growth rate series (dependent variable) in the first difference and some of the independent variables being stationary at the level or in the first difference suggests the possibility of a common integrated relationship among these time series. Therefore, under the condition of the dependent variable being integrated of order one and a mix of first-order and zero-order integration for the independent variables, we employ the Autoregressive Distributed Lag (ARDL) model for the distributed time lag gaps.

2. Model Estimation:

In this article, we estimate the Autoregressive Distributed Lag (ARDL) model for the distributed time lag gaps by applying the Bounds Test methodology first, then selecting the optimal estimated model, and finally estimating the long and short-run relationships.

Firstly, Bounds Test for Cointegration: The Bounds Test methodology is based on the assumption of no cointegration relationship among the variables in the study, against the alternative hypothesis indicating the presence of a cointegration relationship among the variables. To determine the decision rule for this test, where either of the aforementioned hypotheses is accepted or rejected, we compare the computed

Fisher F-statistic with the critical values provided by Pesaran and Al (2001) (upper and lower bounds) as shown in the table below. The results of the Bounds Test indicate that the computed Fisher F-statistic of 39.8425 exceeds the upper critical value at various significance levels, thus rejecting the null hypothesis of no cointegration and accepting the alternative hypothesis indicating the presence of a cointegration relationship between the economic growth rate series and the other explanatory variables included in the model.

Table 2: results of Bounds Test

Bounds Test		
Bounds Test		
The bare minimum	Moral limits	F-statistic = 39.8425
2.578	10%	Upper limit10
3.125	%5	3.858
4.537	%1	4.608

Source: Prepared by researchers based on EVIEWS 13

Secondly, Selection of the Optimal Autoregressive Distributed Lag (ARDL) Model for the Distributed Time Lag Gaps: The ARDL model requires incorporating lagged variables as explanatory variables in the model. Therefore, we determine the appropriate number of lags for the variables included in the model based on the Akaike Information Criterion (AIC). From the figure presented in Appendix 01, it is evident that the optimal ARDL model, in terms of the number of lags, is the ARDL (1,1,0,0,0,0) model.

Thirdly, Results of Long-Run Relationship Coefficient Estimation: The results presented in the table below illustrate the coefficients of the long-run relationship according to the ARDL model methodology. Based on the corresponding probabilities of the t-statistic, the coefficients of AGVA (agricultural sector value-added growth rate), INDVA (industrial sector value-added growth rate), and INF (inflation rate) are statistically significant, as their probabilities are lower than the significance level of 0.05 and 0.1. However, the coefficient of GFCF (gross fixed capital formation growth rate) and OPEN (trade openness as a percentage of GDP) are statistically insignificant, indicating that these variables do not contribute significantly to long-term growth in per capita income and therefore do not contribute to economic growth. Additionally, the constant term is also statistically insignificant.

Table 3: Long-term Coefficient Estimation Results (Cointegration Relationship).

Variable	Coefficient	The p-value corresponding to the Fisher statistic
PGDP (-1)	0.050306	0.5873
INF	-0.185167	0.0783
INF (-1)	0.064491	0.2229
INDVA	0.657354	0.0000
AGVA	0.101107	0.0019
OPEN	0.014244	0.5580
TGFCF	0.060113	0.1387
C	-1.749871	0.2288

Source: Prepared by researchers based on EVIEWS 13

The above estimation results indicate the presence of a positive lagged effect of the per capita income growth rate variable on the per capita income growth rate, but it is not statistically significant. The inflation rate has a negative impact on the per capita income growth rate, and it is statistically significant. For every 0.01% increase in inflation (INF), the per capita income growth rate decreases by 0.185%. This implies that inflation negatively affects economic growth by reducing the value of the national currency, consumers' purchasing power, and increasing production costs, which leads to a decline in output. This result is consistent with most economic theories and studies. For instance, as mentioned earlier, both Fisher (1993) and Barro (1997) confirmed the negative relationship between inflation and economic growth. According to Fisher, inflation distorts price mechanisms, affecting resource allocation efficiency and, consequently, negatively impacting economic growth. On the other hand, Barro argues that inflation reduces the level of investment, which in turn has a negative effect on economic growth.

We find that the growth rate of value-added in the agricultural sector has a positive impact on the per capita income growth rate. A 0.01% increase in AGVA leads to a 0.101% increase in economic growth. Similarly, the growth rate of value-added in the industrial sector also has a positive effect on the per capita income growth rate. A 0.01% increase in INDVA results in a 0.657% increase in economic growth. It is noteworthy that the impact of the industrial sector's value-added has a greater effect compared to the agricultural sector on economic growth. This may be explained by the higher productivity of the industrial sector and the increased focus of the government on it compared to the agricultural sector in previous years. This demonstrates the importance of productivity in non-oil sectors in economic diversification and reducing the impact of inflation, especially imported inflation. Having real economic sectors that generate wealth and are capable of achieving self-sufficiency can greatly mitigate the impact of price hikes, especially those influenced by global factors, and reduce the decline in local purchasing power.

The positive impact of both AGVA and INDVA on economic growth in Algeria during the study period highlights the role of non-oil economic sectors in wealth creation. This aligns with economic theory and most economic models that explain economic growth. It also corresponds to the findings of previous studies, such as the study conducted by Agwu Gabriel, Mohammed Abdulrahman, Best Abah, and Udi Joshua (2022), which emphasizes the important and effective role of both the agricultural and industrial sectors in promoting economic growth and ensuring food security, particularly in developing countries.

Fourthly, Estimation Results of the Short-Run Relationship (Error Correction Model): The table below presents the estimation results of the error correction model for the short run.

Table 4: Short-term Relationship Estimation Results According to the ARDL Methodology

| Variable	Coefficient	The p-value corresponding to the Fisher statistic
COINTEQ*	-0.949694	0.0000
D(INF)	-0.185167	0.0001
C	-1.749871	0.0000
R-squared	0.933178	
Adjusted R-squared	0.927368	
F-statistic	160.5996	
Prob(F-statistic)	0.000000	

Source: Prepared by researchers based on EVIEWS 13

The table above indicates that the coefficient of determination shows that 92.73% of the variations in the per capita income growth rate are explained by the variables incorporated in the model, while the remaining variation is attributed to unincorporated random factors within the estimated model, falling within the margin of error. Additionally, the Fisher test demonstrates that the model is statistically significant since the corresponding probability for this test is below the significance level of 0.05 and 0.1. The estimation results indicate that all coefficients are statistically significant at the 0.01 significance level. Furthermore, it is noteworthy that the coefficient of the error correction term (COINTEQ*) is significantly negative and its absolute value is less than one, confirming the presence of a long-term equilibrium relationship among the study variables. The value of the error correction coefficient indicates a high adjustment speed, with economic growth rate returning from the short-run deviation towards its equilibrium value in the long run with an adjustment speed of 94.96%. This means that when the per capita income growth rate deviates (PDPG) from its long-term equilibrium value during the short period (t-1), approximately 94.96% of this deviation is corrected in period (t). It can also be stated that it takes approximately 1.05 years to return to its equilibrium value due to any shocks in the model resulting from changes in the explanatory variable. By comparing the estimation results of the short-run relationship with the long-run relationship, it is observed that there is a significant and largely consistent effect of the inflation rate on economic growth in terms of value and significance.

3. Evaluation the estimated Model

Firstly, the test of normal distribution of residuals: By examining the figure provided below, we find that the corresponding probability for the Jarque-Bera test (Prob=0.5118) is greater than the significance level of 0.01 or 0.05. Therefore, we conclude that the residuals of the estimated model follow a normal distribution.

Figure 3: Residual Normality Test for the Estimated Model
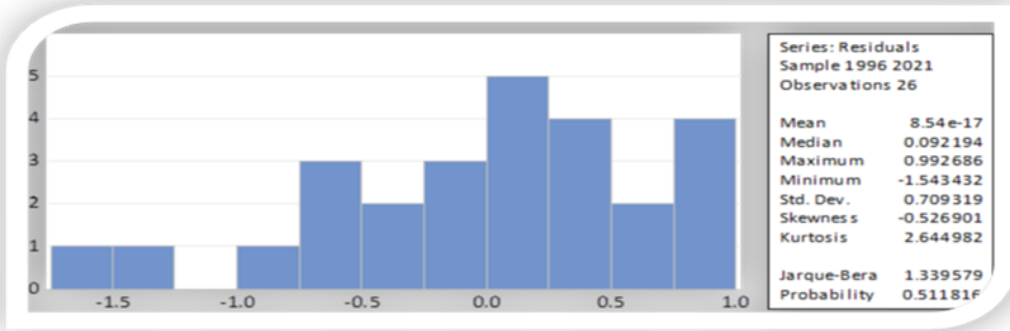
Source: Prepared by researchers based on EVIEWS 13

Table 5: Heteroskedasticity Test for the Estimated Model

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
Null hypothesis : Homoskedasticity			
F-statistic	**0.461772**	Prob. F (7,18)	**0.8493**
Obs*R-squared	**3.958216**	Prob. Chi-Square (7)	**0.7846**
Scaled explained SS	**1.560375**	Prob. Chi-Square (7)	**0.9801**
Heteroskedasticity Test : ARCH			
F-statistic	**1.065850**	Prob. F (1,23)	**0.3126**
Obs*R-squared	**1.107223**	Prob. Chi-Square (1)	**0.2927**

Source: Prepared by researchers based on EVIEWS 13

Thirdly, the test for autocorrelation of errors: From the table below and by conducting the Breusch-Godfrey Serial Correlation LM Test, it is evident that the corresponding probability for this test is 0.5876, which is greater than the significance level of 0.01 or 5%. Therefore, we reject the hypothesis of the presence of autocorrelation and accept the alternative hypothesis, which states the absence of autocorrelation among the errors in the estimated model.

Table 6: Autocorrelation Test between Errors

Breusch-Godfrey Serial Correlation LM Test			
Null hypothesis: No serial correlation at up to 2 lags			
F-statistic	**0.549856**	Prob. F(2,16)	**0.5876**
Obs*R-squared	**1.672104**	Prob. Chi-Square (2)	**0.4334**

Source: Prepared by researchers based on EVIEWS 13

Fourthly, the test for structural stability of the model over the period: To test the structural stability of the estimated model, we rely on both the CUSUM test (cumulative sum of recursive residuals) and the CUSUMSQ test (cumulative sum of square recursive residuals). From the figures provided in Appendices 02 and 03, it is evident that the estimated coefficients of the model are structurally stable over the study

period. This is because the graphical representation of the aforementioned tests falls within the critical bounds at the significance level of 0.05.

Conclusion:

Economic policy focuses on achieving macroeconomic goals by increasing real GDP accompanied by efficient utilization of economic resources and price stability, while considering the impact of international trade on the national economy. However, this task is not easy due to the complex interrelationships between these factors, the effectiveness of economic policy tools, their prioritization, and the specific characteristics of each economy related to the behavior of economic agents and their comparative advantage. It is also important to consider the political and diplomatic relations with other countries in the world. Therefore, based on a time series study spanning from 1995 to 2021 and using the ARDL model, we have derived the following results:

- The observed developments in inflation and economic growth in Algeria, along with the significant fluctuations they have caused, have negatively impacted economic stability, especially internally. This is due to the specificity of the Algerian economy, with a dominant hydrocarbon sector, which has weakened the effectiveness of other economic sectors in supporting domestic production as much as import substitution policies. This has greatly contributed to the increase in inflation levels, particularly after the decline in oil prices in late 2014 and the government's decision (in 2020) to restrict imports, leading to a reduction in supply in the goods and services market, creating relative scarcity that significantly affected price levels.

- According to the results of the stability tests for the time series, it is evident that the time series used in the study are integrated of order I(1) and I(0), allowing us to apply the cointegration approach using the ARDL model. Based on the AIC criterion, the optimal autoregressive distributed lag model for the error term is ARDL(1,1,0,0,0,0).

- The estimation results in the long and short run indicate a negative impact of inflation on economic growth in Algeria. Additionally, there is a significant similarity in the magnitude of the influence between the two terms, indicating that a 1% increase in inflation (INF) leads to a 0.185% decrease in the economic growth rate (per capita income growth). This aligns with the findings of most economic theories and studies.

- Both the growth rate of value-added in the agricultural sector and the industrial sector have a positive impact on economic growth.

- The coefficient of the error correction term (COINTEQ*) indicates a high speed of adjustment of the economic growth rate towards its equilibrium level from the short run to the long run, taking approximately 1.05 years.

Therefore, it is essential for the Algerian government and decision-makers to pursue economic policies (monetary, fiscal, and trade) that adopt a standardized approach. This involves using a combination of tools that systematically affect the variables causing imbalances in the goods and services market. The objective should be to target inflation levels at a level that enhances the performance of productive sectors and consequently raises real economic growth outside the hydrocarbon sector. This requires the government to effectively implement its three key functions: optimal resource allocation, income redistribution, and maintaining equilibrium.

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ANNEX:

Annex 01: Selection of the Optimal ARDL Model
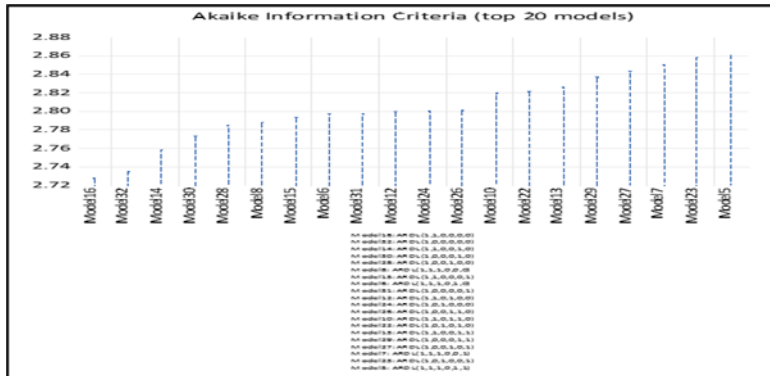
Annex 02: TEST CUSUM Test for Structural Stability of the Estimated Model