

**The impact of inflation on economic growth in the Arab Maghreb countries:
An empirical study for the period (1992-2022)****DIF Fodil Bachir**Lab MQEMADD, Djelfa University (Algeria), fb.dif@univ-djelfa.dz**Received:** 28/03/2025**Accepted:** 14/05/2025**Published:** 25/05/2025**Abstract:**

This study examines the impact of inflation on economic growth in the Maghreb countries (Algeria, Morocco, Tunisia, and Mauritania) during the period 1992 to 2022. This research relied on long-form panel econometric techniques. The results demonstrated that the study variables are in a state of cointegration, which allowed for the estimation of an error correction model. Using the FMOLS method, the study concluded that the estimated sign of the inflation parameter was negative, which is consistent with economic theory. A one-unit increase in the inflation rate leads to a 0.18% decline in economic growth. As for the unemployment rate, its sign was negative, which is also consistent with economic theory. A one-unit increase in the unemployment rate leads to a decline in economic growth by 1.19 units.

The estimation result was statistically and economically acceptable.

Keywords: : Inflation, economic growth, Maghreb countries, Panel .models, FMOLS method

JEL Classification: O40; O49.

1. Introduction:

The relationship between inflation and economic growth constitutes a cornerstone in macroeconomic theory. However, its dynamics vary from one context to another, and differ according to regions and economic structures.

This study seeks to identify the critical interaction within the Maghreb countries — Algeria, Mauritania, Morocco, and Tunisia a region marked by economic diversity and unique challenges. While Algeria relies heavily on oil exports, Morocco and Tunisia have economies based on agriculture and tourism, whereas Mauritania depends on mining. This divergence points to differing effects of inflation on growth, necessitating careful study. Inflation is often viewed, when moderate, as a stimulus for growth i.e., a force of demand.

However, excessive inflation can destabilize economies, weaken purchasing power, and hinder investment. The Maghreb's experience is further complicated by structural vulnerabilities such as import dependency and exchange rate volatility. For instance, import-reliant countries face imported inflation through currency depreciation, while oil-rich Algeria may exploit energy revenues to absorb inflationary shocks. These differences raise questions about how each economy responds to inflationary shocks and how these affect short- and long-term growth.

In the current global context marked by the repercussions of the COVID-19 pandemic, geopolitical crises, and supply chain disruptions studying inflation takes on exceptional importance. Does moderate inflation act as a growth driver by encouraging investment? Or does high inflation hamper growth by reducing purchasing power and increasing uncertainty? The answer depends on the economic structure and adopted policies, calling for an accurate econometric analysis that accounts for the particularities of Maghreb countries.

The existing literature offers conflicting insights into the links between inflation and growth, with limited focus on the Maghreb region. This study addresses that gap using panel data econometrics (from 1992 to 2022).

By clarifying the specific inflation and growth paths in each country, this research aims to guide policymakers on how to balance price stability with growth objectives and promote resilient economic strategies in a volatile global environment. The study's results aim to contribute to both academic discourse and practical policy-making, emphasizing the need for a tailor-made macroeconomic management approach in the Maghreb region.

2. THE RELATIONSHIP BETWEEN INFLATION AND ECONOMIC GROWTH

2.1. Classical Theory

Classical theorists laid the foundations for several growth theories. Adam Smith established the basis of the classical growth model, presenting a supply-side model of growth and its associated production function. Smith argued that growth is self-reinforcing, as it exhibits increasing returns to scale. Moreover, he considered saving to be the creator of investment and thus of growth. Therefore, he believed that income distribution is one of the most important factors determining the speed (or slowness) of a country's growth. He also

assumed that profits decline not due to a decrease in marginal productivity, but because competition among capitalists for workers would raise wages. Classical growth theories did not explicitly clarify the relationship between changes in price levels (inflation) and their "tax-like" effects on profit and output levels. However, it is implicitly suggested that the relationship between the two variables is negative, as evidenced by the decline in corporate profit levels due to rising wage costs. (Vikesh, G., & Subrina, H. , (2004). pp. 5–6.)

2.2. Neoclassical Theory

Although price stability is undoubtedly a critical factor for growth, there is no clear theoretical or empirical view regarding the impact of inflation on economic growth. According to Mundell (1963) and Tobin (1965), high inflation rates would push economic agents to hold assets instead of money, which in turn would raise investment levels, and thus increase economic activity. On the other hand, an alternative view holds that high inflation may negatively affect economic growth through increased uncertainty and macroeconomic instability, which would likely offset the effect assumed by Mundell-Tobin. The rising cost of capital due to inflation may reduce capital accumulation and productivity, thereby slowing economic growth (Abdalla, S., Saed, K., Abdelkarim, G., & Ahmed, E., (2023). , p. 7.) Moreover, the negative effect of inflation on growth due to uncertainty may arise from a decline in aggregate demand due to reduced consumption.

Fischer (1993) suggests a nonlinear relationship between inflation and economic growth. Up to a certain threshold, the effect of inflation on economic growth is positive, while beyond that it becomes negative. Choi et al. (1996) explain that low inflation rates are beneficial to economic growth, while high inflation rates harm economic growth due to credit rationing. To explain this mechanism, let us assume a financial market that includes lenders and borrowers. When inflation rises sharply, lenders hesitate to provide credit because the real return on assets (credit) decreases, leading to a reduction in funds available for lending. At the same time, high inflation rates encourage borrowers to request more loans, which may lead to adverse selection and increase the risk of default, prompting banks to reduce their lending. According to Choi et al., the reduction in bank lending due to high inflation rates will negatively impact economic growth, whereas low inflation rates will not lead to a reduction in lending, and economic growth will not be affected by this mechanism. (Abdalla, S., Saed, K., Abdelkarim, G., & Ahmed, E. (2023).)

As for Stockman, he considers money a complement to capital. He believes that companies and institutions allocate part of their cash liquidity to finance their investment projects. Since inflation erodes the purchasing power of financial balances, individuals reduce their purchases of monetary goods and capital when the inflation rate rises in society, which reflects in lower production rates meaning that the effect of inflation on economic growth is negative. (Mostafa Ahmed Hamed Radwan, Essam Ahmed El-Badri., January 2023, p. 17.)

2.3. Keynesian Theory

The Keynesian model consists of the aggregate demand and aggregate supply curves, which appropriately illustrate the relationship between inflation and economic growth. According to this model, in the short term, the aggregate supply curve slopes upward rather than being vertical — which is its critical feature. If the aggregate supply curve were

vertical, changes on the demand side of the economy would affect only prices. However, if it slopes upward, changes in aggregate demand affect both prices and output.

In short, the relationship between inflation and economic growth will depend on whether inflation is mainly driven by demand shocks or supply shocks. In an economy dominated by demand shocks, the relationship between inflation and growth is likely to be positive due to the dominant movement along the aggregate supply curve. Conversely, when supply shocks dominate, the relationship between inflation and growth is likely to be negative due to the dominant movement along the aggregate demand curve. (Ben El-Ayeb Abdelaziz, Kebir Mouloud., (2021), p. 101.)

2.4. Endogenous Growth Models

Endogenous growth models indicate that the rate of economic growth depends on both human capital and physical capital. As is the case in classical theory, this theory does not directly discuss the relationship between inflation and economic growth. However, the implicit relationship between the two variables appears through the capital component, as inflation causes a decline in the rate of return on capital, thus negatively affecting the economic growth rate. The inflation rate reduces the profitability of deposits to lower levels. As a result, the incentive to save decreases, which in turn leads to a decline in the investment rate and consequently in the level of output. (Iman Mohamed Abdel Latif. , July 2020, p. 112.)

2.5. The Quantity Theory of Money (Friedman's Theory)

The monetary theory is characterized by several fundamental features, focusing on the supply-side characteristics of the economy in the long term rather than on short-term dynamics (Vikesh, G., & Subrina, H. (2004). *ibid.*, p. 9.). Milton Friedman, who coined the term "monetarism," emphasized several key long-term economic properties, including the quantity theory of money and the neutrality of money. The quantity theory of money linked inflation to economic growth simply by equating total spending in the economy with the total money supply. Friedman proposed that inflation results from an increase in the money supply or its velocity at a rate that exceeds the growth rate of the economy.

Friedman also challenged the concept of the Phillips Curve. His argument was based on the assumption of an economy in which the cost of everything doubles. People have to pay twice as much for goods and services, but they do not mind, because their wages have also doubled. Individuals anticipate the future inflation rate and incorporate its effects into their behavior. Therefore, employment and output are not affected. Economists refer to this concept as the "neutrality of money." Neutrality is achieved when the equilibrium values of real variables including the level of GDP are independent of the level of the money supply in the long term. Superneutrality is achieved when real variables including the GDP growth rate are independent of the growth rate of the money supply in the long term. If inflation behaves in this way, it would be harmless.

3. PREVIOUS STUDIES

- **Study by Abdalla, S., Saed, K., Abdelkarim, G., Ahmed, E. (2023).** *The effect of inflation rates on long-run economic growth in Arab countries*, Arab Monetary Fund.

The study aimed to analyze the impact of inflation rates on economic growth in Arab countries during the period from 1990 to 2020 using panel time series data.

The results showed a nonlinear relationship between inflation rates and economic growth, measured by the per capita GDP growth rate. Low inflation rates were found to enhance long-term economic growth. On the other hand, the results indicated that when inflation rates exceed a certain high level (the turning point), the effect of inflation on growth becomes negative. The findings also pointed to differences in the turning point levels of inflation rates among Arab countries, reaching approximately 11.8 percent in middle- and low-income countries, and around 5.1 percent in high-income Arab countries.

- **Study by Rokia Ben Kheider**, titled *The Effect of Inflation on Economic Growth in Algeria in Light of Public Spending during (2000–2020)*, published in the *Journal of Economics and Business Management*, Volume 05, Issue 03, Year 2021, pp. 01–19. Multiple regression models and the descriptive analytical method were used. This study concluded that there is a significant negative impact on economic growth.
- **Study by Khaled Mjahdi and Hussein Bashir Elzaar**, titled *Measuring the Impact of Inflation on Economic Growth in Algeria during the Period 1980–2020*, published in the *Al-Academia Journal for Social and Human Studies*, Volume 15, Issue 02, Year 2023, pp. 720–727.

The study employed the Autoregressive Distributed Lag (ARDL) model, based on annual time series data covering the period from 1980 to 2020. The study concluded that inflation rates have a significant negative effect on economic growth in both the short and long term, though the effect is relatively weak.

- **Study by Redouane Ensaad and Nadjat Benfrieha**, titled *Impact of Inflation on Economic Growth – Standard Study – Algeria (1990–2018)*, published in the *Economic Researcher Review*, Volume 08, Issue 13, June 2020, pp. 172–192.

The study aimed to demonstrate the impact of inflation on Algeria's economic growth through an econometric analysis based on annual data for the period from 1990 to 2018. The study relied on economic variables: the per capita GDP growth rate as the dependent variable representing economic growth, and the inflation rate measured by the Consumer Price Index as the independent variable. The results concluded that there is a long-term negative impact of the inflation index on the growth rate, and a one-way long-term causal relationship, based on cointegration and causality testing.

- **Study by Omar Cheloufi**, PhD dissertation titled *Inflation and Economic Growth: Estimating the Inflation Threshold, A Comparative Study of Maghreb Countries for the Period (1980–2014)*.

The study used the PTR program and the methodology of Khan and Senhadji to identify an inflation threshold at around 5.7%, indicating that economic growth shifts from one regime to another. Inflation levels above this threshold have a significant impact on economic activity in the Maghreb countries.

- **Study by Ben Zarouk Iman**, titled *The Impact of Inflation Rates on the Economic Growth Rate in Algeria during the Period (1990–2019)*, published in the *Arab Journal of Scientific Publishing*, Issue 39, Year 2022, pp. 474–496.

Time series data were used to study the potential effect of the inflation rate on economic growth using the VAR model. The study concluded that the inflation rate does not affect economic growth in Algeria.

4. ECONOMETRIC STUDY

4.1. Model Specification:

Inflation is the rise in the general price level, and all countries strive to control it through specific policies due to its impact on the economic performance of any country. Based on this and previous studies on growth, we proposed using Gross Domestic Product (GDP) as the dependent variable in the model to represent economic growth, while inflation (INF) and the unemployment rate (TCO) are considered explanatory variables. The logarithmic form was used, making the model as follows:

$$LGDP_{it} = C_i + \beta_1 LiNF_{it} + \beta_2 LTCO_{it} + \varepsilon_{it} \quad (1)$$

Where: β_1 and β_2 represent the effect of changes in inflation and the unemployment rate, respectively, on GDP. i represents the countries, and t represents time, which in our case is measured in years. ε_{it} represents the random error.

4.2. Sample Specification:

The proposed sample for the study consists of the Maghreb countries; however, we limited it to Algeria, Morocco, Mauritania, and Tunisia due to the unavailability of data. The study covers the period from 1992 to 2022, and the data were obtained from the 2023 edition of the World Bank database.

4.3. Estimation and Analysis of Results

After specifying the model and selecting the study sample, we proceed to estimate the model and analyze the estimation results. The study involves identifying the appropriate model type, determining the nature of the effect, and then testing the stationarity of the panel data series for the model variables in order to avoid the problem of spurious regression. This is followed by testing the possibility of the existence of a cointegration relationship between the study variables.

4.3.1. Model Specification:

The methodology of working with panel data first requires estimation using static panel models, namely the Pooled Ordinary Least Squares (POLS) model, the Fixed Effects Model (Mef), and the third model, the Random Effects Model (Mea). After estimating these models, we proceed to compare them using appropriate statistical tests.

The estimation results are recorded in the following table

Table (01): Model Estimation Results (see Appendix 1)

Variables	POOLED	MEF	MEA
LINF	-0.605 (-4 ,17)*	-0.11 **(-1 ,95)	-0.115 **(-2,04)
LTCO	1 ,377 *(3,62)	-1,03 *(-7,83)	-1,26 *(-7,64)
C	21,39 *(22,60)	27 ,62 (66 ,13)	27,53 *(46,19)
R²	0,16	0,90	0,35
F-statistic	12 ,06	238 ,22	33,66
Probability	*0,000	*0,000	*0,000
DW	0 ,13	0 ,11	0,10
• (.) :Represents the computed statistic for the Student test of the parameter estimates. • **, * : Indicates the significance level at 1% and 5%, respectively.			

Source: Prepared by the researcher based on EvIEWS12 outputs.

After estimating the three models, we will first test the possibility of individual effects within the study sample data using the Fisher test, whose null hypothesis states that there is no individual effect in the studied sample. The test statistic is given as follows (Al-Aqoun Zahra, Al-Aqoun Om El-Kheir. , (2021) pp. 98–113.):

$$F(N - 1, NT - N - K) = \frac{(R^2_{MNC} - R^2_{MC})/N-1}{(1 - R^2_{MNC})/NT-N-K} \quad (2)$$

Where;

- N represents the number of countries in our case, there are 4 countries.
- K is the number of independent variables in our case, $K = 2$
- T is the length of the time series studied in our case, $T = 31$
- R^2_{MC} represents the adjusted coefficient of determination for the restricted model, i.e., the pooled model.
- R^2_{MNC} represents the adjusted coefficient of determination for the unrestricted model, i.e., the fixed effects model.

In this case, $FC=307,5$, and thus we reject the null hypothesis at the 1 significance level, concluding that there is an individual effect within the data of the study sample.

To determine the nature of the effect, we rely on the **Hausman** test, and based on the result, we decide whether the effect is fixed or random.

Table (02): Hausman Test Result

Correlated Random Effects - Hausman Test				
Equation: Untitled				
Test cross-section random effects				
Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.	
Cross-section random	10.427540	2	0.0054	
Cross-section random effects test comparisons:				
Variable	Fixed	Random	Var(Diff.)	Prob.
LINF	-0.110382	-0.115300	0.000009	0.1083
LTCO	-1.301122	-1.265465	0.000160	0.0048

Source: Prepared by the researcher based on Eviews12 outputs.

The results of the **Hausman** test indicate the rejection of the null hypothesis for this test, as the associated probability is less than **5%**. Consequently, the alternative hypothesis is accepted, which states that the fixed effects model is more appropriate, making its estimators the most suitable and statistically significant.

In evaluating the fixed effects model, we observe a negative and significant impact of inflation on economic growth, which aligns with economic theory namely, that a **1%** change in inflation leads to an **11%** decline in economic growth. Similarly, there is a negative and significant effect of the unemployment rate on economic growth.

Based on the **Fisher** test, the model is globally significant at the **1%** level. Additionally, the adjusted R-squared reached **90%**, indicating that **90%** of the variations in the dependent variable economic growth are explained by the explanatory variables (**INF**, **TCO**), which is a high percentage.

4.3.2. Stationarity Test of Panel Time Series Variables:

Econometric methodology requires testing the stationarity of variables in order to avoid the problem of spurious regression. In the case of panel time series data, there are several statistical tests specific to time series stationarity, which can be categorized into two generations:

- **First-generation tests** are based on the assumption of cross-sectional independence between individuals.
- **Second-generation tests** assume the presence of cross-sectional dependence between individuals.

Among the most important of these tests are: (Mohamed Al-Oqba., (2015). pp. 12–24.)

- **Levin, Lin and Chu Test (LLC – 2002)**
- **Im, Pesaran and Shin Test (IPS – 2003)**
- **Breitung t-stat Test (2000)**

The above-mentioned stationarity tests are based on the null hypothesis of non-stationarity of the series. To examine the stationarity of the model variables, we perform the previously mentioned tests, and the results are presented in the following table:

Table (03): Stationarity Test Results (see Appendix 2)

The Test Variables		LLC		IPS		Breitung t- stat	
		tc	prob	tc	prob	tc	prob
LGPP	At level	4,25	1,000	0,42	0,66	-0,11	0,45
	First difference	-4.84	0,000	-2,98	0,001	-2,53	0,005
LINF	At level	-0,88	0,18	-1,41	0,07	1,31	0,90
	First difference	-9,14	0,000	-6,37	0,000	-0,89	0,18
LTCO	At level	-0,25	0,39	-0,09	0,46	-0,47	0,31
	First difference	-6,82	0,000	-4,35	0,000	0,69	0,75

Source: Prepared by the researcher based on Eviews12 outputs.

The results in the previous table show that all the study variables are non-stationary at level, based on unit root tests at the 1% significance level. However, they become stationary at the first difference, according to most unit root tests at the 1% significance level.

4.3.3. Cointegration Test Results:

After confirming that the series are stationary at the first difference, we can now examine the possibility of a cointegration relationship among the study variables and explore the existence of a long-term relationship between them. Among the most well-known cointegration tests, we mention (Khadija Abbas, Ismail Qacham. , (2021)., pp. 155–177.):

✓ **Ko Cointegration Test (Ko, 1999)**

✓ **Pedroni Cointegration Test (Pedroni, 2000)**

The null hypothesis for both tests is that there is no cointegration among the variables, while the alternative hypothesis states that there is a cointegration relationship among the variables.

4.3.3.1. Pedroni Test

Table (04): Pedroni Cointegration Test Result

Alternative hypothesis: common AR coefs. (within-dimension)				
	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	1.557864	0.0596	2.120802	0.0170
Panel rho-Statistic	1.157493	0.8765	1.035327	0.8497
Panel PP-Statistic	0.059802	0.5238	-0.220245	0.4128
Panel ADF-Statistic	-1.422515	0.0774	-1.653441	0.0491
Alternative hypothesis: individual AR coefs. (between-dimension)				
	Statistic	Prob.		
Group rho-Statistic	1.501771	0.9334		
Group PP-Statistic	-2.371021	0.0089		
Group ADF-Statistic	-2.370622	0.0089		

Source: Prepared by the researcher based on Eviews12 outputs.

From the previous table, we find that the results of most tests confirm the rejection of the null hypothesis of the Pedroni test at the 5% significance level, and the acceptance of the alternative hypothesis, which states that there is a cointegration relationship among the study variables.

4.4. Long-Term Relationship Estimation:

After confirming the existence of cointegration among the study variables, we proceed to estimate the **VECM model** using the **FMOLS method** developed by **Pedroni**, which is characterized by approximately **unbiased estimators** with **minimum variance**, and is therefore considered **consistent**.

Table (05): VECM Estimation Result Using the FMOLS Method

Dependent Variable: LGDP				
Method: Panel Fully Modified Least Squares (FMOLS)				
Date: 04/20/24 Time: 23:33				
Sample (adjusted): 1993 2022				
Periods included: 30				
Cross-sections included: 4				
Total panel (balanced) observations: 120				
Panel method: Pooled estimation				
Cointegrating equation deterministics: C				
Additional regressor deterministics: @TREND				
Coefficient covariance computed using sandwich method				
Long-run covariance estimates (Bartlett kernel, Newey-West fixed bandwidth)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LINF	-0.188644	0.067611	-2.790143	0.0062
LTCO	-1.197192	0.106757	-11.21413	0.0000
R-squared	0.907652	Mean dependent var		24.17836
Adjusted R-squared	0.903601	S.D. dependent var		1.386886
S.E. of regression	0.430602	Sum squared resid		21.13767
Long-run variance	0.489452			

Source: Prepared by the researcher based on Eviews12 outputs.

From the table, we observe that the estimators are statistically significant at the **5% significance level**. The **adjusted R-squared** reached **0.90**, meaning that **90%** of the variations in the dependent variable **LGDP** are explained by the variables **LINF** and **LTCO**, which is a strong explanatory power.

From an economic perspective, the coefficient of the inflation variable has a **negative sign**, which aligns with economic theory a one-unit increase in the inflation rate leads to a **0.18** decrease in economic growth. As for the unemployment rate, its coefficient also has a **negative sign**, which is also consistent with economic theory a one-unit increase in the unemployment rate results in a **1.19** unit decrease in economic growth.

5. Conclusion:

This study examines the relationship between inflation and economic growth in the Maghreb countries over the period 1990–2022. Empirical analysis reveals that inflation has a significant impact on economic growth in the region. Moderate levels of inflation may initially support growth by stimulating demand and investment, but beyond a certain threshold, high inflation becomes detrimental, weakening purchasing power, increasing uncertainty, and discouraging long-term investment.

Key findings include:

- The results of estimating static panel models and the comparison tests among them demonstrated that the **Fixed Effects Model** is the most appropriate, and therefore its estimators are the most suitable and statistically significant.
- According to the Fixed Effects Model, **inflation has a significant negative effect on economic growth**.
- The results of the **stationarity tests** for the panel time series variables showed that the study variables are non-stationary at level but become stationary at the first difference, indicating that they are **integrated of order one**.
- The **Pedroni cointegration test** confirmed the existence of a cointegration relationship among the study variables, allowing the use of the **FMOLS method**.
- The **FMOLS estimation results** proved that **inflation has a statistically significant negative effect on economic growth**, which is consistent with economic theories.

6. REFERENCES AND SOURCES:

1. Vikesh, G., & Subrina, H. (2004). Relationship between inflation and economic growth. Reserve Bank of Fiji, pp. 5–6.
2. Abdalla, S., Saed, K., Abdelkarim, G., & Ahmed, E. (2023). The effect of inflation rates on long-run economic growth in Arab countries. Arab Monetary Fund, p. 7.
3. Mostafa Ahmed Hamed Radwan, Essam Ahmed Al-Badri. The relationship between inflation and economic growth in Egypt during the period (1990–2021), Volume 14, Issue 1 – January 2023, p. 17.

4. Ben El-Ayeb Abdelaziz, Kebir Mouloud. (2021). The effect of inflation on economic growth in Algeria: An econometric study during the period (1980–2019). Forum for Economic Studies and Research, p. 101.
5. Iman Mohamed Abdel Latif. The relationship between inflation rates and the rate of economic growth – applied to the Egyptian case during the period (1961–2018), Journal of Studies, Volume 21, Issue 03, July 2020, p. 112.
6. Al-Aqoun Zahra, Al-Aqoun Om El-Kheir. (2021). A descriptive and analytical study of panel models. Algerian Journal of Economic Performance, Volume 01(06), pp. 98–113.
7. Mohamed Al-Oqba. (2015). Inflationary pressure factors in MENA countries: An econometric panel data study for the period (2000–2014), Dafatir Iqtisadiya Journal, Volume 07(02), pp. 12–24.
8. Abbas Khadija, Qacham Ismail. (2021). The effect of monetary policy on economic growth in Arab countries with reference to the case of Algeria using panel data analysis for the period 1980–2018, Journal of Economic Studies, Volume 12(02), pp. 155–177.

7. Appendices

Appendix 01:

Dependent Variable: LGDP Method: Panel Least Squares Date: 05/01/24 Time: 21:54 Sample: 1992 2022 Periods included: 31 Cross-sections included: 4 Total panel (balanced) observations: 124					Dependent Variable: LGDP Method: Panel Least Squares Date: 05/01/24 Time: 21:55 Sample: 1992 2022 Periods included: 31 Cross-sections included: 4 Total panel (balanced) observations: 124				
Variable	Coefficient	Std. Error	t-Statistic	Prob.	Variable	Coefficient	Std. Error	t-Statistic	Prob.
LINF	-0.605047	0.144806	-4.178335	0.0001	LINF	-0.110382	0.056411	-1.956751	0.0527
LTCO	1.377513	0.380279	3.622374	0.0004	LTCO	-1.301122	0.166005	-7.837834	0.0000
C	21.39461	0.946280	22.60918	0.0000	C	27.62065	0.417629	66.13687	0.0000
Root MSE 1.261542 R-squared 0.166296 Mean dependent var 24.15483 Adjusted R-squared 0.152516 S.D. dependent var 1.387248 S.E. of regression 1.277085 Akaike info criterion 3.350934 Sum squared resid 197.3446 Schwarz criterion 3.419167 Log likelihood -204.7579 Hannan-Quinn criter. 3.378652 F-statistic 12.06770 Durbin-Watson stat 0.133278 Prob(F-statistic) 0.000017					Effects Specification Cross-section fixed (dummy variables) Root MSE 0.414807 R-squared 0.909863 Mean dependent var 24.15483 Adjusted R-squared 0.906044 S.D. dependent var 1.387248 S.E. of regression 0.425222 Akaike info criterion 1.174769 Sum squared resid 21.33607 Schwarz criterion 1.311234 Log likelihood -66.83566 Hannan-Quinn criter. 1.230204 F-statistic 238.2248 Durbin-Watson stat 0.114029 Prob(F-statistic) 0.000000				

Dependent Variable: LGDP Method: Panel EGLS (Cross-section random effects) Date: 05/01/24 Time: 21:57 Sample: 1992 2022 Periods included: 31 Cross-sections included: 4 Total panel (balanced) observations: 124 Swamy and Arora estimator of component variances				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LINF	-0.115300	0.056327	-2.046956	0.0428
LTCO	-1.265465	0.165523	-7.645255	0.0000
C	27.53567	0.596021	46.19913	0.0000
Effects Specification				
		S.D.		Rho
Cross-section random		0.852960		0.8009
Idiosyncratic random		0.425222		0.1991
Weighted Statistics				
Root MSE	0.434429	R-squared		0.357529
Mean dependent var	2.154153	Adjusted R-squared		0.346910
S.D. dependent var	0.544190	S.E. of regression		0.439781
Sum of squared resid	99.48993	F-statistic		99.68739

Appendix 02:

Null Hypothesis: Unit root (common unit root process) Series: D(LGDP) Date: 05/01/24 Time: 19:42 Sample: 1992 2022 Exogenous variables: None User-specified lags: 1 Newey-West automatic bandwidth selection and Bartlett kernel Total (balanced) observations: 112 Cross-sections included: 4		
Method	Statistic	Prob.**
Levin, Lin & Chu t*	-4.84523	0.0000

Null Hypothesis: Unit root (common unit root process) Series: LGDP Date: 05/01/24 Time: 19:42 Sample: 1992 2022 Exogenous variables: None User-specified lags: 1 Newey-West automatic bandwidth selection and Bartlett kernel Total (balanced) observations: 116 Cross-sections included: 4		
Method	Statistic	Prob.**
Levin, Lin & Chu t*	4.25516	1.0000

I Hypothesis: Unit root (individual unit root process) Series: D(LGDP) Date: 05/01/24 Time: 19:48 Sample: 1992 2022 Exogenous variables: Individual effects User-specified lags: 1 Total (balanced) observations: 112 Cross-sections included: 4		
Method	Statistic	Prob.**
Pesaran and Shin W-stat	-3.75064	0.0001

Null Hypothesis: Unit root (individual unit root process) Series: LGDP Date: 05/01/24 Time: 19:46 Sample: 1992 2022 Exogenous variables: Individual effects User-specified lags: 1 Total (balanced) observations: 116 Cross-sections included: 4		
Method	Statistic	Prob.**
Im, Pesaran and Shin W-stat	0.42989	0.6664

Null Hypothesis: Unit root (common unit root process)
Series: D(LGDP)
Date: 05/01/24 Time: 19:44
Sample: 1992 2022
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 1
Total (balanced) observations: 108
Cross-sections included: 4

Method	Statistic	Prob.**
Breitung t-stat	-2.53330	0.0056

Null Hypothesis: Unit root (common unit root process)
Series: LGDP
Date: 05/01/24 Time: 19:43
Sample: 1992 2022
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 1
Total (balanced) observations: 112
Cross-sections included: 4

Method	Statistic	Prob.**
Breitung t-stat	-0.11252	0.4552

Null Hypothesis: Unit root (common unit root process)
Series: D(LINF)
Date: 05/01/24 Time: 21:23
Sample: 1992 2022
Exogenous variables: None
User-specified lags: 1
Newey-West automatic bandwidth selection and Bartlett kernel
Total (balanced) observations: 112
Cross-sections included: 4

Method	Statistic	Prob.**
Levin, Lin & Chu *	-9.14065	0.0000

Null Hypothesis: Unit root (common unit root process)
Series: LINF
Date: 05/01/24 Time: 21:29
Sample: 1992 2022
Exogenous variables: None
User-specified lags: 1
Newey-West automatic bandwidth selection and Bartlett kernel
Total (balanced) observations: 116
Cross-sections included: 4

Method	Statistic	Prob.**
Levin, Lin & Chu *	-0.88957	0.1868

Null Hypothesis: Unit root (common unit root process)
Series: D(LINF)
Date: 05/01/24 Time: 21:25
Sample: 1992 2022
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 1
Total (balanced) observations: 108
Cross-sections included: 4

Method	Statistic	Prob.**
Breitung t-stat	-0.89745	0.1847

Null Hypothesis: Unit root (common unit root process)
Series: LINF
Date: 05/01/24 Time: 21:25
Sample: 1992 2022
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 1
Total (balanced) observations: 112
Cross-sections included: 4

Method	Statistic	Prob.**
Breitung t-stat	1.31530	0.9058

Null Hypothesis: Unit root (individual unit root process)
Series: D(LINF)
Date: 05/01/24 Time: 21:27
Sample: 1992 2022
Exogenous variables: Individual effects
User-specified lags: 1
Total (balanced) observations: 112
Cross-sections included: 4

Method	Statistic	Prob.**
Im, Pesaran and Shin W-stat	-6.37651	0.0000

Null Hypothesis: Unit root (individual unit root process)
Series: LINF
Date: 05/01/24 Time: 21:26
Sample: 1992 2022
Exogenous variables: Individual effects
User-specified lags: 1
Total (balanced) observations: 116
Cross-sections included: 4

Method	Statistic	Prob.**
Im, Pesaran and Shin W-stat	-1.41316	0.0788

Null Hypothesis: Unit root (common unit root process)		
Series: D(LTCO)		
Date: 05/01/24 Time: 21:45		
Sample: 1992 2022		
Exogenous variables: None		
User-specified lags: 1		
Newey-West automatic bandwidth selection and Bartlett kernel		
Total (balanced) observations: 112		
Cross-sections included: 4		
Method	Statistic	Prob.**
Levin, Lin & Chu t*	-6.82572	0.0000

Null Hypothesis: Unit root (common unit root process)		
Series: LTCO		
Date: 05/01/24 Time: 21:44		
Sample: 1992 2022		
Exogenous variables: None		
User-specified lags: 1		
Newey-West automatic bandwidth selection and Bartlett kernel		
Total (balanced) observations: 116		
Cross-sections included: 4		
Method	Statistic	Prob.**
Levin, Lin & Chu t*	-0.25511	0.3993

Null Hypothesis: Unit root (common unit root process)		
Series: D(LTCO)		
Date: 05/01/24 Time: 21:47		
Sample: 1992 2022		
Exogenous variables: Individual effects, individual linear trends		
User-specified lags: 1		
Total (balanced) observations: 108		
Cross-sections included: 4		
Method	Statistic	Prob.**
Breitung t-stat	0.69530	0.7566

Null Hypothesis: Unit root (common unit root process)		
Series: LTCO		
Date: 05/01/24 Time: 21:46		
Sample: 1992 2022		
Exogenous variables: Individual effects, individual linear trends		
User-specified lags: 1		
Total (balanced) observations: 112		
Cross-sections included: 4		
Method	Statistic	Prob.**
Breitung t-stat	-0.47222	0.3184

Null Hypothesis: Unit root (individual unit root process)		
Series: D(LTCO)		
Date: 05/01/24 Time: 21:49		
Sample: 1992 2022		
Exogenous variables: Individual effects		
User-specified lags: 1		
Total (balanced) observations: 112		
Cross-sections included: 4		
Method	Statistic	Prob.**
Pesaran and Shin W-stat	-4.35043	0.0000

Null Hypothesis: Unit root (individual unit root process)		
Series: LTCO		
Date: 05/01/24 Time: 21:48		
Sample: 1992 2022		
Exogenous variables: Individual effects		
User-specified lags: 1		
Total (balanced) observations: 116		
Cross-sections included: 4		
Method	Statistic	Prob.**
Im, Pesaran and Shin W-stat	-0.09512	0.4621