Long and Short-Term Effects of Fiscal Policy on Economic Diversification in Algeria during the Period 2000-2020

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Abstract:

The study aimed to analyze the long and short-term effects of fiscal policy on economic diversification in Algeria during the period 2000-2020, using the Herfindahl-Hirschman index as a dependent variable and public expenditures and revenues as independent variables, using the ARDL model.

The results of the bounds test showed a long-term equilibrium relationship between fiscal policy and economic diversification, as well as a significant negative long-term effect of public expenditures on the Herfindahl-Hirschman index. Specifically, a 1% increase in public expenditures resulted in a 0.001% decrease in the Herfindahl-Hirschman index. The study also found a positive effect of public revenues on the Herfindahl-Hirschman index, with a 1% increase in public revenues resulting in a 0.0001% increase in the index.

Keywords: Fiscal policy, economic diversification, Algeria, ARDL model.

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Introduction:

The economy has witnessed many developments and transformations in recent times that have attracted the attention of many researchers and economists to the field of economic diversification, which has occupied a prominent place in economic thought. Economic diversification is considered one of the solutions that countries, especially oil-producing ones, are seeking. This is due to the fact that the economies of oil-producing countries remain vulnerable

to shocks that occur in the global oil markets, which negatively affect the progress of their economies.

Algeria is among the rentier countries that have been affected by the decline in oil prices in the global markets, which requires the search for other sources of income, away from the sole resource, in order to maintain the stability of its economy and move towards diversifying the production and industrial base of the country to avoid the disruption that occurs during oil shocks. This has made economic diversification a necessary policy to be considered as one of the paths to exit from oil dependence and isolate the national economy from excessive reliance on the hydrocarbon sector.

Fiscal policy is one of the policies through which the economy can be driven away from the oil sector. It is considered a tool for the state to influence the level of economic activity through the use of its tools, which include both public revenues and public expenditures, by adopting development programs such as the structural adjustment program and other means that ensure the achievement of objectives, and given the significant role that fiscal policy plays in promoting economic diversification for countries.

The objective of this study is to confirm the existence of a long-term equilibrium relationship between fiscal policy and economic diversification in Algeria during the specified period, and to determine whether there is an effect between these variables. The importance of the study lies in shedding light on some theoretical concepts and highlighting the relationship between fiscal policy and economic diversification in Algeria during the period 2000-2020.

Based on aforementioned, and considering that fiscal policy is one of the most important policies that the government relies on to influence the level of economic activity, and given that economic diversification has become a necessary requirement that all advanced and developing countries, especially oil-producing ones, seek to achieve, it was necessary to investigate the effectiveness of fiscal policy in achieving economic diversification.

To reach a conclusion on this issue, the following problem was posed:

What is the nature of the relationship between fiscal policy and economic diversification in Algeria during the period 2000-2020?

1.Previous Studies:

There have been many applied studies that attempt to explain the impact of fiscal policy on economic diversification and analyze the relationship between them. For example, (Ogbole, Sonny, & Isaac, 2011) found that there is a difference in the effectiveness of fiscal policy on economic growth during and after regulatory periods, and concluded that fiscal policy affects economic growth. (Bitrus Nakah , 2013) Addressed the Dutch disease phenomenon and economic diversification, and found differences in the characteristics of advanced and developing

countries, especially when talking about the development index. In addition, revenue increases lead to an increase in spending rather than diversification. In a (United Nations, 2016) that discussed information on concepts and theories related to economic diversification, guidance and guidelines were provided on how to deal with the latter at the national level. The paper indicated that there is a need for a more rigorous process for planning and implementing policies that target economic diversification, and for conducting more studies on each region and sector to support parties from developing countries in their economic diversification initiative. (Kolawle & Eleanya, 2018) Confirmed through testing the existence of a long-term relationship between fiscal policy indicators and economic diversification, as well as a positive relationship between economic diversification index and petroleum profit tax, capital expenditures, and financial freedom. (Ha-Joon & Amir , 2020) Proposed an alternative model for managing resource revenues that is more suitable for the context of commodity-dependent developing countries when analyzing the shift from financial stability to economic diversification. The approach adopted consists of gradually expanding investments in productivity-enhancing assets, as the researchers formulated the challenge of resource-based development with the aim of promoting productive diversification. The management of resource wealth lacks a comprehensive vision for managing resource revenues for the purpose of structural transformation of production.

2. Theoretical literature on fiscal policy

Given the great importance of fiscal policy in economic analysis, as it aims to adjust economic imbalances by relying on some of its tools, including both public expenditures and revenues, in order to achieve desired goals, this section will shed light on some concepts related to fiscal policy.

2.1 Definition of Fiscal Policy

Fiscal policy is characterized by multiple and diverse concepts. (Abu Al-Saud, 2004, p. 174) Defined fiscal policy as "One of the means relied upon by the government to influence the path of economic activity with the aim of addressing the fluctuations that affect the national economy and reaching the desired level of national income." (Koueidry & Frustrated, 2021, p. 977) Viewed it as a set of measures adopted by government agencies to adjust the size of public expenditures or tax revenues in order to achieve set goals. From (Qasimuri, 2021, p. 21) point of view, fiscal policy is the government's use of its expenditures and revenues to achieve economic, social, and even political goals within its beliefs and available resources, taking into account its level of progress and economic growth. According to (Mokhtari, 2011, p. 135), fiscal policy is a planned program by the state, implemented using its spending programs and administrative resources to achieve desired effects and attempt to avoid undesirable effects on the entire level of economic and even political activity, in order to achieve the goals of society.

2.2 Financial Policy Tools

Financial policy tools consist of government revenues and expenditures, which enable it to influence aggregate demand in the economy.

2.2.1 Public Expenditures:

Public expenditure refers to an economic or monetary amount issued by the state or any public legal person with the aim of achieving a public benefit (Ahmad Al-Dabbash & Majeed Nasser, 2018, p. 539).

2.2.2 Public Revenues:

It is defined as the income that the state obtains from various sources and is usually in cash, with the aim of covering its public expenditures (Khalf Falyh, 2008, p. 335).

3. The Relationship between Financial Policy and Economic Diversification

The relationship between financial policy and economic diversification can be explained by clarifying the impact of each financial policy tool on economic diversification, which is represented by all public expenditures and revenues.

3.1 Impact of Public Expenditures

Government spending can have an impact on the level of economic diversification, through the government's focus on encouraging the contribution of economic sectors and reducing excessive reliance on a single resource. This can be achieved by targeting aggregate demand through directing investment spending towards supporting productive sectors outside the oil sector, particularly the industrial, agricultural, and tourism sectors. It is recognized that an increase in government spending in these sectors leads to an increase in capital formation, which in turn improves productivity. In addition, human capital is activated, which is considered the main pillar in the production process, as a result of directing consumption spending and spending on basic services, which works to distribute human energies to all different economic sectors (Rahal & Brika, 2017, p. 104). This is because public spending policy is one of the means used by the government to direct the economy, by determining and prioritizing government spending priorities. The importance of the latter is particularly important in a period that necessitated economic diversification, given its contribution to developing production and promoting exports. It is worth noting that the production process of any country is based on two main factors, which are as follows (Zaghasho & Dahan, 2017, p. 76):

3.1.1 National Production Capacity:

Refers to the physical factors of production, including natural, material, and human resources of a country.

3.1.2 Actual Demand:

The contribution of government spending to diversifying production is evident through its positive impact on the demand for consumer goods and investment goods. This is achieved by maximizing the utilization of available economic resources, and since government spending represents a large share of actual demand, its importance increases through increased government intervention in the economy, thereby creating a direct impact on the volume and type of production.

Investment spending helps to create tangible capital assets and leads to the availability of major infrastructure such as roads, railways, and communication systems. Infrastructure investment is typically the responsibility of the government due to the characteristics it provides that the private sector cannot. These characteristics include stability, indivisibility, and non-substitutability, which make it difficult to separate capital assets. These investments are also not easily replaceable.

Social expenditures, on the other hand, involve the production of goods and services used to achieve social goals, such as education and health. This contributes to the development of human capital, which directly leads to increased production and upgrading. Social expenditures in cash form are reflected in the social assistance provided by the government to low-income earners, which redistributes income among different segments of society. This, in turn, increases their consumption capacity, leading to an increase in actual demand and, consequently, an increase in production and its type.

Since economic diversification requires a change in the export structure, production diversification alone is not enough. This indicates that the economy is not capable of global competition and is only able to adapt its production activities domestically. However, government spending policies contribute to achieving economic diversification by diversifying exports, starting from tax spending (tax privileges), which is reflected in the government's program to provide financial assistance through tax measures instead of direct general spending. This aims to stimulate a certain category of investors to increase their product supply by exempting them from taxes to develop and diversify their products. This leads to diversification of exports outside the hydrocarbon sector.

The government has many financial capabilities to support local and foreign investors to develop and diversify exports. To achieve this, the Algerian government has adopted export subsidies, which are directly provided to some exporters to support them in facing foreign competition. This allows for the diversification of exports. The government also encourages foreign direct investment by providing many means, including tax exemptions and investment opportunities in sensitive sectors. The Algerian government has provided a wide range of opportunities for foreign investment, including the oil sector, industry, especially the food and mechanical industries,

electronics, agriculture, public works, and telecommunications. In addition to this, the government provides subsidies to private institutions that produce export goods to expand their production capacity and enable them to have modern production equipment. All of this stimulates national production and upgrades it to increase its ability to compete globally (Zaghasho & Dahan, 2017, pp. 76-77).

3.2 Impact of Public Revenues

The impact of public revenues on economic diversification is evident through tax systems, which are also a tool of fiscal policy, as they affect investment, which is considered the most important variable in achieving economic diversification. The impact of taxes on investment is manifested through their effect on the rate of profit, where the investment tendency increases as the opportunities for profit increase. The negative impact of taxes on profits by reducing their rates results in a reduction in investments. Its impact is particularly evident in modern investments, where taxes prevent the use of modern investment methods. In addition, the negative impact of taxes on consumption by reducing demand for products due to their high prices leads to a reduction in investments, except in cases where the state provides subsidies to prevent an increase in prices of consumer goods. The impact of taxes on production may lead large project owners to double their production to compensate for the tax cut, but this depends on the flexibility of demand for their products.

In contrast, the positive impact of reducing taxes on profits and granting exemptions on reinvested profits leads to an increase in profits and, consequently, an increase in investments (Rahal & Brika, 2017, p. 105).

4. Standard Modeling of the Relationship between Fiscal Policy and Economic Diversification in Algeria:

In this section, we will discuss the study of the relationship between fiscal policy and its impact on economic diversification in Algeria during the period from 2000 to 2020.

4.1 Introduction of Study Variables

To test the nature of the relationship between fiscal policy, represented by both revenues and expenditures, and economic diversification, and to answer the research question, Algeria was chosen as the country of study. Annual data from 2000 to 2020 was collected from the National Office of Statistics, available on the website: http://www.ons.dz, and the Bank of Algeria, available on the website: http://www.banc-of-algeria.dz. The variables used in the study are as follows:

4.1.1 Independent Variables:

Represented by fiscal policy tools, as follows:

- Public Expenditures: represented by the symbol (PE).
- Public Revenues: represented by the symbol (GR).

4.1.2 Dependent Variable:

Represented by the Herfindahl-Hirschman Index (HHI), which is symbolized by the symbol HHI. Its value is between 0 and 1, and it is calculated according to the following formula (Elhannani, Boussalem , & Benbouziane, 2018, p. 58):

$$\mathbf{HHI} = \frac{\sqrt{\sum_{i=1}^{N}(x_i/X)^2} - \sqrt{1/N}}{1 - \sqrt{1/N}}$$

Where: n is the number of sectors; x_i is the value of the variable in sector i; X is the total value of the variable in all sectors.

4.2 Study of Time Series Stability

Testing the stability of time series is of great importance in applied studies that rely on time series data to avoid misleading and false conclusions and analyses. There are many tests that reveal the properties of time series, including the Augmented Dickey-Fuller test, which is the most widespread. These tests allow us to determine the degree of stability of time series and to determine their integration order (Qasim & Abban, 2016, p. 24).

The results of Appendix 1 showed that the calculated t-values for the three models (with a constant, with a constant and trend, without a constant and trend) were less than the tabulated t-values at a significance level of 5% for the study variables (public expenditures (PE), public revenues (GR), Herfindahl-Hirschman Index (HHI)). Therefore, the null hypothesis, which states (the time series is non-stationary), is accepted, and the alternative hypothesis, which states (the time series is stationary), is rejected. To make the series stationary, first-order differences had to be introduced. The results showed that the series had stabilized at the first difference, indicating that the series did not contain a unit root, i.e., the integration order of the series is I(1). In this case, the condition of non-stationarity of the second-degree time series is met, and therefore, the ARDL model can be applied.

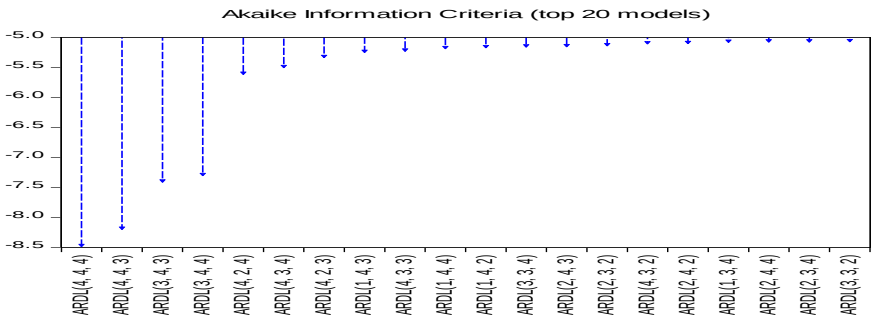
4.3 Estimating the Study Model

Before estimating the appropriate model, several steps must be taken to ensure that the model is valid for the study. The following presents the results in subsequent stages:

4.3.1 Optimal Lag Test for the Model:

In this stage, the AIC criterion is used to determine the appropriate model for the study. As shown in Figure (01), the optimal model for this study is ARDL(4.4.4), based on the lowest AIC value.

Figure 1: Results of Lag Test According to AIC Criterion



Source: Prepared by researchers using Eviews software

4.3.2Model Diagnosis:

After identifying the appropriate model for the study, this step involves ensuring the quality of the ARDL model by using several diagnostic tests to determine whether the model is valid for the study or not.

-Breusch-Godfrey Serial Correlation LM Test:

The results of the Breusch-Godfrey Serial Correlation LM Test for residuals, as shown in Table (01), indicate that the probability value of the Fisher statistic is not significant (Prob>0.05=0.6243). Therefore, the null hypothesis, which states (no serial correlation between residuals), is accepted, and the alternative hypothesis (serial correlation between residuals) is rejected at a significance level of 5%.

Table 1: Breusch-Godfrey Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.448729	Prob. F(1,1)	0.6243
Obs*R-squared	5.265579	Prob. Chi-Square(1)	0.0218

Source: Prepared by researchers using Eviews software.

-The results of the Heteroskedasticity Tests ARCH:

As shown in Table (2), indicate that the calculated F-value (0.010299) is greater than the significance level at 5% with a probability of (0.9206). This means that the null hypothesis (residuals have homoscedasticity) is accepted.

Table 2: Heteroskedasticity Tests ARCH

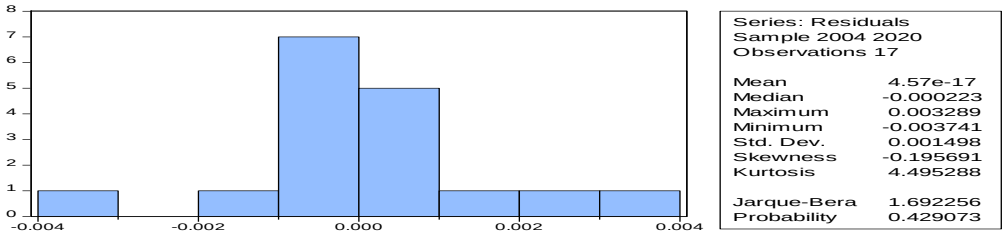
Heteroskedasticity Test: ARCH			
F-statistic	0.010299	Prob. F(1,14)	0.9206
Obs*R-squared	0.011762	Prob. Chi-Square(1)	0.9136

Source: Prepared by researchers using Eviews software.

-Jarque-Bera Normality Test:

Based on Figure (3) below, the probability value of the test (brop=0.429073) is greater than 0.05, indicating that the null hypothesis, which states that errors are normally distributed in the model, is accepted.

Figure 3: Jarque-Bera Normality Test



Source: Prepared by researchers using Eviews software.

-Ramsey Reset Test for Model Adequacy:

The results shown in Table (3) indicate that the calculated Fisher value is (13.39359) with a probability of (0.1698), which is greater than the significance level at 5%. Therefore, the null hypothesis (indicating the validity of the functional form used in the model) is accepted, indicating stability in the model used in the study. Thus, it has been confirmed that the estimated model is free from measurement problems, and therefore, the model is valid.

Table 3: Ramsey Reset Test for Model Adequacy

Ramsey RESET Test	
Equation: UNTITLED	
Specification : HHI HHI (-1) HHI (-2) HHI (-3) HHI (-4) PE PE (-1) PE (-2) PE (	

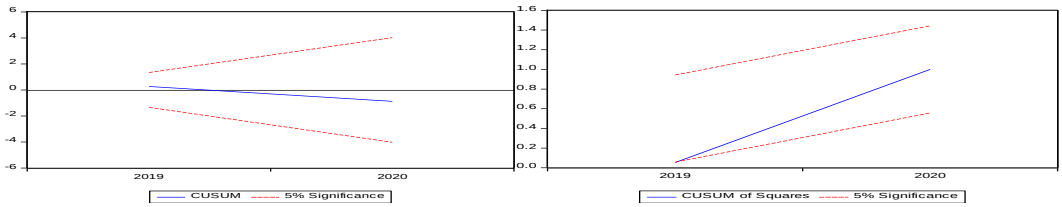
-3) PE(-4) GR GR(-1) GR(-2) GR(-3) GR(-4) C			
Omitted Variables: Squares of fitted values			
	Value	**Df**	**Probability**
t-statistic	3.659725	1	0.1698
F-statistic	13.39359	(1, 1)	0.1698

Source: Prepared by researchers using Eviews software.

-Structural Stability Test:

As observed from Figure (4) below, the estimated coefficients of the model are structurally stable over the study period. The cusum and cusum of squares tests for the model fall within the critical bounds at a 5% significance level, indicating consistency and stability in the relationship between fiscal policy, long-term and short-term economic diversification. Therefore, it can be concluded that the model is stable overall.

Figure 4: Structural Stability Tests



Source: Eviews software outputs.

4.3.3 Bounds Test:

To confirm the presence of a cointegrating relationship between the study variables, the bounds test for cointegration is used. As observed from the results in Table (4), the F-statistic value for the bounds test (49.03663) is greater than the upper and lower bounds at various significance levels of 5%, 10%, 1%, and 2.5%. This indicates the acceptance of the null hypothesis, which states the existence of a long-term equilibrium relationship between fiscal policy and economic diversification.

Table 4: Bounds Test

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)

4			Asymptotic: n=1000	
F-statistic	49.03663	10%	2.63	3.35
k	2	5%	3.1	3.87
		2.5%	3.55	4.38
		1%	4.13	5

Source: Prepared by researchers using Eviews software.

4.3.4 Estimation of Long-Term Parameters and Error Correction Parameter:

The aim of this step is to obtain the long-term parameters and the error correction parameter. The results can be analyzed from the annexes (02, 03) as follows:

-Interpretation of Short-Term Relationship:

From the results in Annex (02), it can be observed that the error correction parameter CointEq is negative (-0.795380) and significant at a 5% confidence level. This confirms the results of the bounds test, indicating the existence of a long-term relationship between the independent variables (public expenditure (PE) and general revenue (GR)) and the dependent variable (Herfindahl-Hirschman Index (HHI)). The negative value indicates short-term convergence of the model and also suggests a quick adjustment from the short-term to the long-term to reach equilibrium. Moreover, the deviations and imbalances in the previous year are corrected in the current year. Therefore, 79% of short-term errors can be corrected in the long-term within the number of lag periods. In case of a shock effect on the model due to changes in the variables (public expenditure and general revenue), the Herfindahl-Hirschman Index, which represents economic diversification, takes about one year and three months (1/0.79=1.265) to correct the imbalances in the short-term and return to its equilibrium value.

-Interpretation of Long-Term Parameters:

The estimation equation for the long-term model is as follows:

$$\boldsymbol{HHI_t = -0.0001PE_t + 0.0001GR_t + 0.3699}$$

It is evident from the above equation and the results in Annex (03) that there is a significant negative long-term effect at a 5% confidence level for the impact of public expenditure and the Herfindahl-Hirschman Index. This means that a 1% increase in public expenditure results in a 0.001% decrease in the value of the Herfindahl-Hirschman Index. This is consistent with economic theory, indicating that a decrease in the economic diversification index reflects an increase in the degree of diversification in the country. The impact of public expenditure on production diversification is reflected through the effects of national productive capacity and

actual demand. Public expenditure contributes to national production diversification by targeting actual demand through investment spending, directed towards supporting non-oil sectors such as agriculture and tourism. The increase in public expenditure in these sectors leads to an increase in capital formation, which in turn improves production capacity (Badroni, 2022, p. 144).

Regarding the impact of general revenue on economic diversification, a positive relationship was found, represented by a significant effect. This means that a 1% increase in general revenue results in a 0.0001% increase in the value of the Herfindahl-Hirschman Index. This finding is not consistent with economic theory. The impact of general revenue on economic diversification is reflected through tax systems, which are also a tool of fiscal policy, affecting investment, which is considered the most important variable in achieving economic diversification. The impact of tax systems on investment is manifested through their effect on the rate of return, where the investment propensity increases as the opportunities for profit increase.

It was also observed that the determination coefficient value (R^2) was high, estimated at 0.99, indicating a high explanatory power. This means that fiscal policy explains economic diversification by approximately 99%. Therefore, economic diversification was explained by fiscal policy tools (public expenditure and general revenue) through their previous and recent values, while the remaining percentage is attributed to other variables not included in the model (see Annex (4)).

Conclusion

After conducting a study on the long-term relationship between fiscal policy and economic diversification using the ARDL model during the period 2000-2020, estimating and analyzing its results to answer the study problem, which falls under the title "What is the nature of the relationship between fiscal policy and economic diversification in Algeria during the period 2000-2020?", the study reached a number of results that can be mentioned in the following points:

- The results of the bounds test confirmed the existence of a long-term equilibrium relationship between fiscal policy and economic diversification.
- There is a significant negative long-term effect of public expenditure on the Herfindahl-Hirschman Index, meaning that a 1% increase in public expenditure results in a 0.001% decrease in the value of the Herfindahl-Hirschman Index. This means that a decrease in the economic diversification index reflects an increase in the degree of diversification in the country.
- There is also a positive relationship, represented by a significant effect, between general revenue and the Herfindahl-Hirschman Index, where a 1% increase in general revenue

results in a 0.0001% increase in the value of the Herfindahl-Hirschman Index. This confirms the validity of the third hypothesis.

- The results of the structural stability test showed that there is consistency and stability in the relationship between fiscal policy and economic diversification in the long and short term.
- Fiscal policy contributes to the impact on economic diversification through government spending policy, which has a positive impact on the demand for consumer and investment goods, as well as diversifying exports through tax incentives.
- The effectiveness of fiscal policy is also evident through general revenue, which also affects investment by influencing the rate of return, where the investment propensity increases as the opportunities for profit increase.

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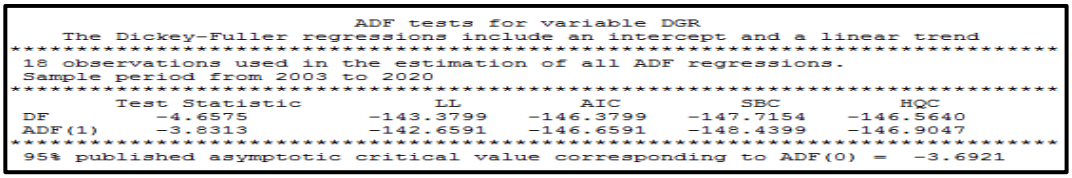
6. Annexes:

Annex 1: Time series stationarity



```
                    ADF tests for variable DGR
   The Dickey-Fuller regressions include an intercept and a linear trend
*******************************************************************************
18 observations used in the estimation of all ADF regressions.
Sample period from 2003 to 2020
*******************************************************************************
        Test Statistic          LL          AIC          SBC          HQC
DF          -4.6575      -143.3799    -146.3799    -147.7154    -146.5640
ADF(1)      -3.8313      -142.6591    -146.6591    -148.4399    -146.9047
*******************************************************************************
95% published asymptotic critical value corresponding to ADF(0) =   -3.6921
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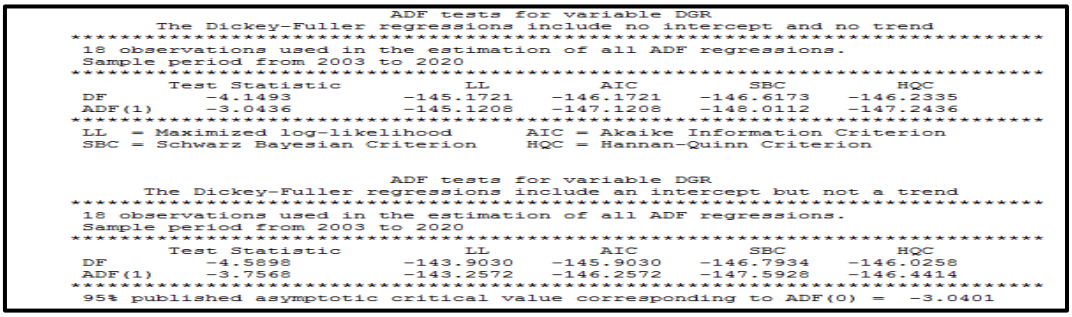

```
                    ADF tests for variable DGR
      The Dickey-Fuller regressions include no intercept and no trend
*******************************************************************************
18 observations used in the estimation of all ADF regressions.
Sample period from 2003 to 2020
*******************************************************************************
        Test Statistic          LL          AIC          SBC          HQC
DF          -4.1493      -145.1721    -146.1721    -146.6173    -146.2335
ADF(1)      -3.0436      -145.1208    -147.1208    -148.0112    -147.2436
*******************************************************************************
LL  = Maximized log-likelihood      AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion    HQC = Hannan-Quinn Criterion

                    ADF tests for variable DGR
      The Dickey-Fuller regressions include an intercept but not a trend
*******************************************************************************
18 observations used in the estimation of all ADF regressions.
Sample period from 2003 to 2020
*******************************************************************************
        Test Statistic          LL          AIC          SBC          HQC
DF          -4.5898      -143.9030    -145.9030    -146.7934    -146.0258
ADF(1)      -3.7568      -143.2572    -146.2572    -147.5928    -146.4414
*******************************************************************************
95% published asymptotic critical value corresponding to ADF(0) =   -3.0401
```

ADF tests for variable DPE
The Dickey-Fuller regressions include no intercept and no trend
18 observations used in the estimation of all ADF regressions.
Sample period from 2003 to 2020

Test Statistic	LL	AIC	SBC	HQC
DF -3.5771	-143.8138	-144.8138	-145.2590	-144.8752
ADF(1) -2.7558	-143.7937	-145.7937	-146.6840	-145.9164

LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

ADF tests for variable DPE
The Dickey-Fuller regressions include an intercept but not a trend
18 observations used in the estimation of all ADF regressions.
Sample period from 2003 to 2020

Test Statistic	LL	AIC	SBC	HQC
DF -4.7071	-141.0101	-143.0101	-143.9005	-143.1329
ADF(1) -4.7726	-138.9576	-141.9576	-143.2931	-142.1417

95% published asymptotic critical value corresponding to ADF(0) = -3.0401

ADF tests for variable DPE
The Dickey-Fuller regressions include an intercept and a linear trend
18 observations used in the estimation of all ADF regressions.
Sample period from 2003 to 2020

Test Statistic	LL	AIC	SBC	HQC
DF -4.5821	-140.7933	-143.7933	-145.1289	-143.9775
ADF(1) -4.6456	-138.7101	-142.7101	-144.4908	-142.9556

95% published asymptotic critical value corresponding to ADF(0) = -3.6921

ADF tests for variable DHHI
The Dickey-Fuller regressions include an intercept and a linear trend
18 observations used in the estimation of all ADF regressions.
Sample period from 2003 to 2020

Test Statistic	LL	AIC	SBC	HQC
DF -4.6989	32.2002	29.2002	27.8646	29.0160
ADF(1) -3.5140	32.3872	28.3872	26.6065	28.1417

95% published asymptotic critical value corresponding to ADF(0) = -3.6921

ADF tests for variable DHHI
The Dickey-Fuller regressions include no intercept and no trend
18 observations used in the estimation of all ADF regressions.
Sample period from 2003 to 2020

Test Statistic	LL	AIC	SBC	HQC
DF -4.8351	31.8329	30.8329	30.3877	30.7715
ADF(1) -3.5966	31.9693	29.9693	29.0789	29.8465

LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

ADF tests for variable DHHI
The Dickey-Fuller regressions include an intercept but not a trend
18 observations used in the estimation of all ADF regressions.
Sample period from 2003 to 2020

Test Statistic	LL	AIC	SBC	HQC
DF -4.7059	31.8743	29.8743	28.9839	29.7515
ADF(1) -3.5013	32.0405	29.0405	27.7049	28.8563

95% published asymptotic critical value corresponding to ADF(0) = -3.0401

Annex 2: Short-term relationship estimation

ARDL Error Correction Regression
Dependent Variable: D(HHI)
Selected Model: ARDL(4, 4, 4)
Case 2: Restricted Constant and No Trend
Date: 04/06/23 Time: 00:29
Sample: 2000 2020
Included observations: 17

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(HHI(-1))	-0.591657	0.056670	-10.44041	0.0090
D(HHI(-2))	0.471514	0.035828	13.16038	0.0057
D(HHI(-3))	-0.210932	0.021948	-9.610374	0.0107
D(PE)	-6.16E-05	2.64E-06	-23.29726	0.0018
D(PE(-1))	4.13E-06	2.13E-06	1.940386	0.1919
D(PE(-2))	-2.21E-05	2.64E-06	-8.371677	0.0140
D(PE(-3))	-9.46E-05	4.98E-06	-18.97919	0.0028
D(GR)	5.19E-05	1.51E-06	34.27510	0.0009
D(GR(-1))	-5.05E-05	2.09E-06	-24.18727	0.0017
D(GR(-2))	-8.19E-05	4.79E-06	-17.11537	0.0034
D(GR(-3))	-4.79E-06	1.76E-06	-2.719869	0.1128
CointEq(-1)*	-0.795380	0.035918	-22.14422	0.0020

Annex 3: Long-term relationship estimation

ARDL Long Run Form and Bounds Test
Dependent Variable: D(HHI)
Selected Model: ARDL(4, 4, 4)
Case 2: Restricted Constant and No Trend
Date: 04/06/23 Time: 00:29
Sample: 2000 2020
Included observations: 17

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.294199	0.039328	7.480573	0.0174
HHI(-1)*	-0.795380	0.099108	-8.025393	0.0152
PE(-1)	-8.58E-05	1.59E-05	-5.407433	0.0325
GR(-1)	0.000108	2.42E-05	4.446305	0.0470
D(HHI(-1))	-0.591657	0.164907	-3.587821	0.0697
D(HHI(-2))	0.471514	0.073479	6.417023	0.0234
D(HHI(-3))	-0.210932	0.091183	-2.313287	0.1468
D(PE)	-6.16E-05	1.42E-05	-4.333469	0.0493
D(PE(-1))	4.13E-06	1.06E-05	0.387915	0.7355
D(PE(-2))	-2.21E-05	7.27E-06	-3.046957	0.0929
D(PE(-3))	-9.46E-05	1.45E-05	-6.522548	0.0227
D(GR)	5.19E-05	7.01E-06	7.405457	0.0178
D(GR(-1))	-5.05E-05	7.89E-06	-6.401967	0.0235
D(GR(-2))	-8.19E-05	1.33E-05	-6.159012	0.0254
D(GR(-3))	-4.79E-06	4.79E-06	-1.000372	0.4225

* p-value incompatible with t-Bounds distribution.

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PE	-0.000108	2.13E-05	-5.058289	0.0369
GR	0.000135	3.28E-05	4.129068	0.0540
C	0.369885	0.020162	18.34603	0.0030

EC = HHI - (-0.0001*PE + 0.0001*GR + 0.3699)

Annex 4: Estimated model

Dependent Variable: HHI
Method: ARDL
Date: 04/06/23 Time: 00:28
Sample (adjusted): 2004 2020
Included observations: 17 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): PE GR
Fixed regressors: C
Number of models evalulated: 100
Selected Model: ARDL(4, 4, 4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
HHI(-1)	-0.387036	0.170087	-2.275525	0.1507
HHI(-2)	1.063171	0.164591	6.459474	0.0231
HHI(-3)	-0.682446	0.087825	-7.770480	0.0162
HHI(-4)	0.210932	0.091183	2.313287	0.1468
PE	-6.16E-05	1.42E-05	-4.333469	0.0493
PE(-1)	-2.00E-05	1.12E-05	-1.781946	0.2167
PE(-2)	-2.63E-05	7.59E-06	-3.458677	0.0744
PE(-3)	-7.24E-05	1.34E-05	-5.402921	0.0326
PE(-4)	9.46E-05	1.45E-05	6.522548	0.0227
GR	5.19E-05	7.01E-06	7.405457	0.0178
GR(-1)	5.34E-06	1.11E-05	0.482657	0.6770
GR(-2)	-3.14E-05	8.65E-06	-3.630953	0.0682
GR(-3)	7.71E-05	9.88E-06	7.804037	0.0160
GR(-4)	4.79E-06	4.79E-06	1.000372	0.4225
C	0.294199	0.039328	7.480573	0.0174

R-squared	0.999443	Mean dependent var	0.342718
Adjusted R-squared	0.995546	S.D. dependent var	0.063480
S.E. of regression	0.004237	Akaike info criterion	-8.465464
Sum squared resid	3.59E-05	Schwarz criterion	-7.730276
Log likelihood	86.95644	Hannan-Quinn criter.	-8.392385
F-statistic	256.4413	Durbin-Watson stat	2.409243
Prob(F-statistic)	0.003891		