A Standard Study on the Impact of Economic Diversification on the Economic Growth Rate in Algeria Using the ARDL Model for the Period 1990-2021.

دراسة قياسية لتأثير التنويع الاقتصادي على معدل النمو الاقتصادي في الجزائر باستخدام نموذج الانحدار الذاتي للفجوات الموزعة المتباطئة للفترة 1990-2021

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Abstract:

The study aims to measure the impact of economic diversification on the economic growth pursued by economic policy, adopting several models of economic diversification from the Growth Poles model in 1968 to the Economic Diversification Perspectives 2030 model. This is particularly relevant as the Algerian economy is characterized by its rentier nature and seeks to reduce its dependence on oil resources.

Through empirical analysis using the E-VIEWS software to measure the impact of economic diversification from 1990 to 2021 on economic growth, we found a negative short-term effect of diversification on economic growth. Economic growth in Algeria remains contingent on oil revenues, given the absence of productive sectors generating value-added, such as the manufacturing sector.

Key words: Economic diversification, Herfindahl-Hirschman index, economic growth, gross domestic product (GDP), petroleum rent.

الملخص: *تهدف الدراسة لقياس أثر التنويع في الاقتصاد على معدل النمو الاقتصادي الذي تسعى اليه السياسة الاقتصادية من خلال تبني عدة نماذج للتنويع الاقتصادي انطلاقا من نموذج أقطاب النمو في 1968 ووصولا الى نموذج التنويع الاقتصادي آفاق 2030، خاصة أن الاقتصاد الجزائري ريعي بطابعه ويسعى لتقليل تبعيته لمورد النقمة الاقتصادية.*

ومن خلال الدراسة القياسية باستعمال برنامج E-views لقياس مدى تأثير التنويع الاقتصادي للفترة الممتدة 1990 الى 2021 على معدل النمو الاقتصادي، توصلنا الى سلبية التأثير للتنويع على النمو الاقتصادي في المدى القصير، ويبقى معدل النمو الاقتصادي في الجزائر مرهون بعائدات النفط، في ظل غياب القطاعات المنتجة المدرة للقيمة المضافة كقطاع الصناعة المعملية.

الكلمات المفتاحية: التنويع الاقتصادي، مؤشر هيرفندال-هيرشمان، النمو الاقتصادي، الناتج المحلي الخام، الريع البترولي.

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1. INTRODUCTION

Oil has significantly influenced the economic development trajectory of the Algerian economy, particularly due to the marked increase in oil prices in recent years. As a result, the significance of economic diversification has diminished in the view of current economic policies, leading to disruptions in the productive system. This has ultimately resulted in the Algerian economy becoming a "rentier par excellence" as the need for economic diversification was not perceived as urgent until the oil prices collapsed in mid-2014, So the reliance on oil as a unique resource whose prices are connected with the global markets and its remaining as a subject to sharp fluctuations from time to time threatens the stability and security of the national economy, this is why it was necessary to adopt a permanent strategy for the sake of the economic growth that is based on diverse, permanent and continuous sources in order to create income and bring in hard currency, which depends on diversifying the raw domestic product and creating added value.

In this context, Algeria like the other oil-exporting rentier countries sought to pursue a strategy of economic diversification that aims to restructure the Algerian economy again through involving all the alternative economic sectors in the development track, and the bets of our national economy have crystallized between its rentier reality that contributed to disrupting the productive system outside hydrocarbons to a large extent, and its aspiration to reform, revivify and diversify the economic activity, where it was shown through the new economic model in Algeria,

So, based on this view, we have set out to carry an analytical study of the reality of economic diversification procedure since the collapse of the socialist system and the transition towards adopting the market economy, where we wanted to cover a large scope of time series data, and our choice fell on the period extending from 1990 to 2021, in which we have recorded the inconsistency of the relationship between the economic diversification and the economic growth in Algeria. In this context, we have concentrated on understanding how the positive and negative variables in the economic diversification index affect the economic growth.

In addition, since the gross domestic product is considered one of the used indices in the economic literature to measure the economic growth, it is reflected in the successive increase in the annual growth rate of the domestic product, which positively affects the living standard of the individual and society. In this context, economic theory concentrated on studying the relationship between the economic growth and the variables controlling it through setting economic models represented by rates that have an explanatory capacity for the direction and nature of the relationship between growth and the variables that explain and control it. Therefore, we have focused in this study on the effectual relationship of diversification in the economic activity as an explanatory variable (independent) in the economic growth function (raw domestic product).

Study Problem

How much does adopting economic diversification model affect the growth of the Algerian economy?

Based on the main question, we formulate the following sub-questions:

1- Is there actual economic diversification in the Algerian economy that contributes to increasing the economic growth rate?

2- Does economic growth and development in Algeria solely depend on financing from petroleum rent revenues?"

Based on the questions raised, we have formulated the following hypotheses:

1. At a 5% significance level, the economic diversification model did not have a significant impact on achieving economic growth in Algeria, and the relationship between them is weak
2. At a significance level of 5%, the economic growth rate in Algeria is significantly associated with the dependence on petroleum rent for development."

The significance of the study: lies in analyzing the extent to which economic growth in Algeria

is linked to rentier income and extractive industries, given the limited economic diversification primarily based on the effective contribution of manufacturing industries in creating diversified gross domestic product and adding value outside the hydrocarbon sector. This facilitates entry into global markets with manufactured products, thereby generating income in hard currency and mitigating risks associated with unstable economic development.

The aim of the study: is to emphasize the necessity of adopting an economic model for economic diversification based on supporting productive activity in sectors and branches of the producing industry. It also aims to encourage small, medium, and emerging enterprises to develop local industries, contributing to diversified production, export diversification, and substitution of imports. Diversifying sources of national income enables the enhancement of the economic growth rate and the achievement of genuine economic development independent of the hydrocarbon sector.

Study methodology: In this study, we relied on presenting a theoretical perspective to understand the relationship between economic diversification and economic growth. As for the empirical aspect, we adopted an econometric study to assess the degree of impact exerted by economic diversification programs in Algeria on achieving economic growth.

2. Theoretical and experimental literatures:

Both theoretical and empirical studies have emphasized a distinct correlation between economic diversification and growth, employing linear models to analyze the impact of economic diversification on growth. There is a wealth of literature providing compelling arguments regarding the influential relationship between economic diversification and the attainment of economic growth. This study aims to evaluate these arguments in the context of the Algerian economy.

Hvidt[(1)]**,** confirms in his study of the impact of the economic diversification on realizing the economic growth in the Arab Gulf Cooperation Council countries that rely on the petroleum rents, that standard and future ways of the economic diversification efforts in the running development plans and the future national visions that the governments of the Gulf Cooperation Council countries have published confirm that diversification efforts gave weak results, and the Arab Gulf economies still connected with the hydrocarbons, and diversification has waved in reverse manner with each retreat that the achieved income from the oil and gas revenues had witnessed.

As Akram Esanov [(2)] points out in his study on the negative relationship between economic growth and weak diversification of exports, he indicates that the success of diversification basically relies on producing a large share of the gross domestic product in the manufacturing, services, and agricultural sectors, and to preserve the economic growth in the long term, as it must achieve specialization and sustaining productivity growth in these sectors. Therefore, rentier countries perform poorly in these sectors that give value added because their economies are highly relying on the extractive sector to generate foreign exchange revenues that rely especially on the natural resources exports, and which restrains the industry productivity and blocks the economic diversification's way in it. And these economies still highly influenced by the different external shocks due to the negative effect of exaggerated variations in the commodity prices.

A study conducted by Maliki Samir [(3)] records that the diversification was tested in the economic growth for the period extending between (1980-2015), where the study revealed that the integration between the growth and economic diversification in Algeria has a negative character. As there is a retreat in the economic growth and a low level of the economic diversification due to the dominance of the oil and gas sector, in light of the witnessed retreat in the laboratory industry sector and the disinclination to invest in it.

It's also confirmed by the studies of Cadot [(4)]**,** Naudé**,** and Rossouw [(5)] that the relationship between diversification and wealth formation has an opposite effect, and there is a negative relationship between the profusion of natural resources, growth and diversification. Studies have

also indicated that the diversification of exports leads to higher per capita growth of the gross domestic product and employment. Likewise, development financing relies on the availability of capital resting on exports of incipient products. Also, development is witnessing a negative stream with the inconstancy of energy prices in international markets.

In a study conducted by Agosin[(6)]**,** it is mentioned that economies with a diversified structural form of exports are capable of registering a consistently higher growth rate than those whose exports are highly limited to only a few products, like the case of the national economy, which adopts up to 95% of exports of energy materials. The effect is often negative on the slowing growth in the regression periods, when international market fluctuations occur in economies whose exports highly rely on one product or few products, where Agosin emphasizes that emerging countries have logged economic growth according to the advantages presented in their manufactured, value-added products that create income when exported, which are based on presenting new productive thoughts and distinctive and competitive technological content. And effectively, it has been noticed that dynamic Asian economies have much higher investment rates than those of Latin American and Caribbean countries. The strength of investment can also be linked to the growth and diversification of exports: the more the economy is diversified, the greater the probability for profitable investment opportunities, which reflects positively on creating fortune and growing the domestic product in turn.

Algowear Almestneer [(7)] has investigated several factors that could be relevant to achieving the limit of crude oil as a principal source of income, which relies on it to create economic diversification and take a step towards diversifying the Saudi economy through encouraging the non-oil sectors and the commerce openness and depending in the non- oil exports in outputting the raw domestic product.

Also, a study conducted by Heiko [(8)] had confirmed the non-linear relationship that existed between export diversification and economic growth, especially in developing countries. It also showed that lot of East Asian economies, like China, Korea, Malaysia, Taiwan, and Thailand, which have relatively low levels of export concentration, have realized a full success in boosting the percentage of economic growth. Moreover, the study underlined that many of the countries that have underperformed growth in the past four decades were from the sub-Saharan and African countries with a highly focused sector.

Houfi [(9)] confirms that economic growth reflects the augmentation in the gross domestic product, which is defined as the total market value of goods and services that are produced in a given period in which all the economic sectors take a part. Therefore, the economic growth is the result of the total increases, in other words, it is the value added which all these sectors have realized, the researcher adds, confirming that economic diversification has a positive effect on economic growth, just in the long term, and economic growth responds equally to positive and negative changes in economic diversification. However, diversification in oil-exporting economies is still affected by oil revenues.

A study conducted by Looney [(10)] also confirms that in the literature related to economic diversification, it is clear that dealing with diversification is nothing else than the establishment of a manufacturing industry. While it is much broader than just the creation of manufacturing industries, industrialization also requires the process of creating service industries like tourism, financial services, insurance, banking, real estate services, transportation, restaurants, repair and maintenance services, etc. Thus, the concepts of vertical diversification and industrialization become synonymous, as it becomes clear that the target of diversification is to decrease risks via creating a varied set of income sources, and industrialization in its broadest sense is the process of creating these varied sources of income.

According to Hirschman [(11)], he considers that the reinforcement of the backward and forward links in the industry will lead to the development of the branches and the industrial sector as a whole and then the rest of the economic sectors, which will witness dynamism by showing intermediate and manufactured goods, that is reflected in a remarkable growth in the domestic product.

There are two models of economic growth commonly found in the literature: the model of Solow [(12)], and the model of Romer [(13)], where the Solow model which is used in our study predicts that economies will meet in a state of stable balance in the long term, also growth will not be affected by any policy measures. But according to the external variables like technology,

The Romer model was not the appropriate for our case, especially for the Algerian economy, which heavily depends on oil revenues and not on high-level technology and high quality of education, which are considered the focus of the Romer model. And according to Solow, growth in developing economies needs focusing on the specialization, division of labor, and freedom of foreign trade, where growth is an interconnected, integrated and compatible process with a positive mutual effect, where the growth of a given sector leads to the growth in the rest of economic sectors, which confirms the positive effect of economic diversification on the economic growth.

As El Khatib sees it [(14)], technological development has a restricted effect on the growth of countries that rely on a single resource, such as Algeria, as it is a country that imports technology and highly qualified workers, while investment is limited in research and development. Accordingly, to study the effect of diversification on economic growth, we have employed the expanded neoclassical model that is based on the production service that relies on the employment of production factors of capital and labor. Knowing that the capital is collected from oil revenues.

It is noteworthy that all studies emphasize the importance of economic diversification in fostering economic growth. However, our study will diminish the significance of this for the Algerian economy in light of successive economic developments aimed at reducing oil dependency.

3. The oil indignation's reverberations on the Algerian economy:

Algeria ranks fifth in the world in natural gas reserves, and the fourteen in oil reserves, and it is the second largest exporter of natural gas in the world, and the third largest exporter of oil in Africa, where this fossil energy realizes massive financial revenues for the Algerian economy. So, our national economy relies on 60% of petroleum collections to finance economic development, and oil exports represent about 95% of Algeria's total exports. While fuel production occupies approximately 40% of the raw domestic product, [(15)] , and the rentier nature of the Algerian economy is openly seen via the reading of the macroeconomic indicators of the Algerian economy:

Table 1. Development of Some Macroeconomic Indicators in the Algerian Economy 1990-2021.

Inclusive Indicators	1990	2021
Oil exports/Total exports	96.12%	88.58%
Oil revenues/Total state revenues	53.4%	36%
Petroleum raw domestic product/ Gross domestic product	35.59%	23.10%
Employment in the industrial sector/Total workforce	15.5%	12.5%
Employment in the petroleum sector/Total workforce	1.22%	1.4%
Domestic product for the laboratory industry sector/ Gross domestic product	14.15%	5.8%

Domestic product for the private sector/Gross domestic product	48%	74%
Stock of the trade balance	35,261 million Algerian dinars	153.40 million Algerian dinars
Stock of the state's public budget	16,000 million Algerian dinars	1, 589,600 million Algerian dinars

***Source**: Prepared by researchers relying on the annual reports of economic and financial developments of the Bank of Algeria.*

The indignation's supplier has been burdened with its reverberations on the national economy because of sequential universal oil shocks, and this is shown in the following:

1- The relative contribution of oil sector exports declined softly from 96.12% in 1990 to 88.58% in 2021, estimated at 7.54 percentage points, with the retreat of oil revenues and the serious decrease in oil export revenues, where oil export income has retreated by almost half ,since 2014, and in the midst of the raise and the big diversity of the Algerian import bill, where the value of imports overrode exports, and the latter covered only within the limits of 71%, also, the trade balance has known a clear deficit since that period.

2- The relative contribution of the oil sector to the gross domestic product decreased for the same period, estimated at 12.49 %, whereas the operating ratio in the sector has not known an evident evolution. So, the increase registered for the period studied was very modest, amounting to 0.18 %.

3- Also, the contribution of the petroleum collection to the state's total revenues has decreased for the same period of study, which is estimated at 17.4 %, and the retreat of the fossil energy incomes was reflected in the state treasury's negative reliance on the general budget, which has been suffering from a deficit since the oil crisis in 2014.

4- The clear retreat of the contribution of the laboratory industry sector in creating the raw domestic product, which is estimated at 8.7 %, where the decrease percentage approaches the half.

5- Whereas the relative contribution of the private sector specialized in creating wealth has raised by 26 percentage points for the same period mentioned.

6- The government resorted to the resource control fund whose resources declined between 2014 and 2015 by an estimated 33% within a year, to confront the large deficit registered in public revenues and to strive to meet public expenditures.

The decrease in Algeria's hard currency incomes, and this is what affected in a direct and heavy manner the major balances of the Algerian economy, prompted the government to adopt austerity policy in public expenditures, in the Finance and Public Budget Law since 2014

Taking into account the above, economic diversification is considered a major challenge that less developed countries face. It is a vital demand that is sought by oil-producing and exporting countries, which have long been captive to the fluctuations and instability that prices of this commodity have witnessed in international markets. It also fulfills the desire to realize a greater number of the income principle sources in the relevant economy, and pursues to decrease the reliance on rentier returns and surpluses as a main driver of economic growth(16) . All of this would boost the real abilities of the economy within global competitiveness, and this is through increasing the productive capacity of various sectors, even if they are not highly competitive. Besides this, the elevation with the contribution of productive sectors to the gross domestic product, diversifying the structure of exports outside the fuel sector, and activating the role of tax collection to expand public budget revenues, and so there are multiple economic alternatives to replace the single resource(17)**.**

4. The history of economic diversification in Algeria:

Through a careful reading of the history of economic events in Algeria, it is noted that the economic diversification model was adopted in Algeria in two stages:

First stage: Algeria's experience in adopting an import-substitute manufacturing strategy: The manufacturing industries model: Debernis Industries industrialisantes:

After gaining independence, Algeria adopted the model of manufactured industries inspired by the French economist De Bernis. The aim was to establish an economic diversification model focused on substituting imports with industrial equipment. These industrial facilities play a crucial role in the development of other transformative industries, as well as the agricultural sector. Consequently, the national economy achieves economic diversification across all sectors. And in a more optimistic view, if the saying is true, the industrial sector will provide investment goods, consumer goods and intermediate goods for industry, which will substitute the imported products and fulfill the national demand.(18) , Choosing this approach Algeria aimed to achieve the following goals:

- Setting up strong industrial poles that lead the heavy laboratory industry. These industrial clusters were distributed throughout all the national territory.
- Gradual substitution of "old" imports (capital goods) that were depended on during the colonialism through guaranteeing the principal conditions for continuing their manufacturing process.
- Supplying and providing the equipment and all the necessary inputs for developing agriculture that provides the major inputs for the food industry(19) .

The vertical integration policy that was implemented regarding the planned economy led to the appearance of large industrial complexes, which are supposed to realize economies of scale and use advanced capital-intensive techniques, thus making the industry the active engine of economic growth. Whereas, the great size of companies and the industrial concentration did not lead to the long-awaited economies of scale, which made the industrial sector sink into a vicious cycle of a deep and costly crisis. And with the failure of the privatization of big companies which raised the difficulties of the Algerian industrial sector more and more and made it more brittle, where the industrial sector decreased in a continuously manner in production in all branches of activity, except the energy and fuel sectors, which knew an increase, and within ten years from 1989-1999, industrial production decreased by more than 25%, whereas oil and gas grew by 22%.

In view of this, the reliance of Algeria on revenue from fossil energy rent exports in financing economic development, improving social conditions, and increasing the purchasing power has had a negative impact on the development path, and what made matters worse was the failure of the planned socialist approach. Of course, under the weight of sequential oil crises from 1986 to 2014, the Algerian economy witnessed repeated shocks because of the retreat in the oil prices, which had long been subject to the control of international markets. Where the adopted development path has reached an impasse and the failure of using external investment (oil exports revenue) and the extractive industry in financing, the internal investment (manufactured industries) has been proven(20).

Then, the adoption of the imported technology in developing heavy and then light industries without controlling their technical knowledge, acquiring it, and working to imitate it led to the existence of a weak industrial fabric with outdated and completely obsolete technology, where the manufacturing industry no longer contributed in creating of the raw domestic product except by 5% by the year 2014, also, economic diversification in Algeria has retreated notably from 1990 to 2021.

And this appears evidently to us the failure of the industrialization strategy to substitute imports, that starts with capital goods (heavy industry) and then consumer, intermediate, and semi-manufactured goods (light industry).

Since 1990, Algeria has abandoned the socialist economic model in favor of a market economy and concurrently embraced trade liberalization, resulting in the highest values of imports and a negative balance in the trade account. This is primarily attributed to two main factors: the weakness of the industrial sector where the industrial sector that had presented 18% of the gross domestic product in 1982, now it occupies only 6% in 2004, and this percentage has remained constant until today, from the year 2000 until 2020, and the decline in oil prices, the state budget recording negative balances emphasized the necessity to reconsider economic revitalization and explore mechanisms for economic recovery. This has reinstated the challenge of economic diversification.

The most significant negative point is considered as the exaggerated reliance of the national economy on the fuel sector, where the oil sector has dominated the economy from the early 1970s to today, and the numbers registered during the last decade shows us the extent of the economy's link with this sector that provides 40% of the gross domestic product, 97% of the value of exports, and 40% of revenues that finance the state's public treasury.

These numbers shows the extent of the weakness of economy in its developmental reliance on the fuel sector, which reliance on it may lead to a given degree of economic growth, but it does not lead to achieve the economic development. Whereas the other negative aspect is the retreat of the manufacturing sector, which has become at its lowest levels since the early the industrialization stage and has also become disabled to fulfill national needs, in the light of the heavy import bill, mainly the food commodities(21).

The diversification of the industrial sector is shown as a determined necessity, where it is the only sector that participates in creating and diversifying of fortune and solves social problems like the unemployment, also, paying attention to this sector guarantees the economic growth to higher levels than it is now between 2% and 5%. In this view, it became openly clear the ineluctability of adopting the industrialization strategy to substitute imports which are based on valuing the role of light manufacturing industry and encouraging the production of consumer goods of widely used so as to fulfill the essential needs of the Algerian economy, then the heavy ones, in other words the capital goods(22).

Second stage: The new economic model in Algeria 2016-2030:

In the view of the policy of diversifying the Algerian economy, the Algerian government has notarized the new economic growth model in 2016, which sought to realize a growth rate of up to 5.6% outside the fuel sector between 2020-2030. This increases the per capita share of the raw domestic product for the next decade, and the announced model revolved around three main axes, which are represented in:

- **First stage: 2016-2019:** which is represented in sending and launching a new development policy, which aims to gradually grow the added value of various economic sectors.
- **Second stage: 2020-2025:** where this stage was called the transitional stage, during which the economy makes up for the overall balance through addressing various indicators and macroeconomic variables.
- **Third stage: 2026-2030:** is the stage of stability, during which the Algerian economy will have addressed most of the macro-balancing indicators and realized the big balances, and throughout the mentioned stages, the following targets must be realized for the sake of diversifying the national economy:

- Realizing an important raise in the raw domestic product per capita by 3.2 times.
- Multiplying the industrial sector's participation in creating the benefit and the raw domestic product to 10% by the end of 2030.
- Modernization the agricultural sector within the mentioned period, which participates in realizing the food security, and working on raising the contribution of this sector in the national product and total national exports.
- The energy transition, which is the most significant desired target of the new economic model that seeks to decrease the growth level of internal energy consumption by half, and limit the extraction process to what is really necessary for the development path, which means adopting a policy for energy efficiency through evolving the alternative and diverse renewable energies to realize the energy security.
- Diversifying exports outside the fuel sector, by creating sectoral dynamism and this is by evolving and growing the different new sectors and branches with high added value, as well as advancing and boosting the current sectors for the sake of decreasing the excessive and total reliance on the fuel sector and creating new resources to expand sources of income.
- Enhancing and encouraging investment outside the oil sector by improving the productivity of public investment, and boosting the private investment and the foreign direct investment, mainly in the industrial sector, where this has a positive effect on increasing the economic growth rate. This will be done by embodying a new national system for investment and enhancing the partnership between the public and private sectors via creating and qualifying small and medium enterprises.
- The need to minimize the difference between exports and imports through working on accelerating the pace of exports growth of different goods and services outside the fuel sector. And thus, working on improving the position of the trade balance and the balance of payments starting in 2020, and this will only be possible by limiting the flow of imports and substituting them locally.
- Reviewing the principle law for doing business "Doing Business" through reviewing the mechanisms of investment financing by continuing reforming the banking system and evolving the capital market.
- Reviewing the industrial policy in Algeria through working on speeding the pace of the growth of the industrial sector, as well as reorganizing and managing industrial real estate and incorporating it regionally, by reviewing the tasks of the national agency for real estate brokerage and control, and preparing a new program for distributing the industrial zones[(23)].

5. Calculating the Herfindahl-Hirschman economic diversification index for the Algerian economy 1990-2021:

The Herfindahl-Hirschman Index is considered the most widely used indicator for measuring economic diversification, the coefficient adoption of measuring the composition, structure and the diversity extent of a number of variables, which are gross domestic product, public revenues, exports, imports, employment and capital accumulation. Accordingly, this factor is widely applied to measure economic diversification in a given sector[(24)] **.**

The Herfindahl-Hirschman index is known by the following formula.

$$HH=\frac{\sqrt{\sum_{i=1}^{i=N}(\frac{xi}{X})2}-\sqrt{\frac{1}{N}}}{1-\sqrt{\frac{1}{N}}}$$

Where (N) is considered the number of activities, (xi) is the value of the variable in the activity (i),

(x) is the global value of the variable in all the activities, as the value of the Herfindahl-Hirschman coefficient ranges between zero and one, which means $0\leq H\leq .1$

0=H means that there is an entire diversity in the economy and the shares of activities are equal.

H=1 means a complete absence of diversification and the dominance of a single economic sector.

$(0.5\leq H \leq 1)$ is a proof of the economy's weakness in distributing activities in an equal and balanced manner over a large number of sectors or products, and it is restricted to a few of them.

A study was carried out to measure the degree of economic diversification in Algeria starting from the evolution of the structure and composition of six variables, which are: gross domestic product, exports, imports, government revenues, employment, public revenues, and the total creation of the fixed capital, where each single diversification that is registered in these variables reflects the degree of diversification which is registered in the national economy.

Table2. Herfindahl-Hirschman (H-H) Composite Index for Economic Diversification Calculation in Algeria for the Period 1990-2021

Price per Barrel US Dollar	The composite Herfindahl-Hirschman	(H-H) for public revenue diversification	(H-H) for fixed capital diversification	(H-H) for labour force diversification	(H-H) for diversifying (GDP)	(H-H) for export diversification	(H-H) for import diversification	Year
23.76	0,33332	0,00482	0,63382	0,15585	0,07424	0,93804	0,19319	1990
20.04	0,32052	0,13160	0,42184	0,17132	0,10160	0,95042	0,14636	1991
19.32	0,34138	0,10861	0,58563	0,18827	0,07938	0,93395	0,15249	1992
17.01	0,37522	0,06197	0,87833	0,15931	0,07145	0,92420	0,15611	1993
15.86	0,33982	0,08073	0,59145	0,16790	0,08587	0,94491	0,16806	1994
17.02	0,32654	0,05254	0,55045	0,16790	0,11399	0,92077	0,15363	1995
20.64	0,41893	0,10398	0,98384	0,16790	0,17031	0,89639	0,19116	1996
19.11	0,45028	0,09006	0,95221	0,34759	0,18375	0,94173	0,18637	1997
12.76	0,39531	0,15893	0,80675	0,10634	0,17685	0,94407	0,17892	1998
17.9	0,36721	0,06667	0,73353	0,10995	0,16685	0,94399	0,18227	1999
28.66	0,46279	0,32568	0,76669	0,35351	0,19657	0,95551	0,17879	2000
24.46	0,35101	0,12702	0,45859	0,21655	0,18347	0,94581	0,17462	2001
24.99	0,32961	0,08073	0,43415	0,16447	0,16852	0,93839	0,19139	2002
28.85	0,34858	0,16346	0,38044	0,21491	0,18840	0,95633	0,18797	2003
38.26	0,33929	0,19492	0,27630	0.2000	0,19820	0,96120	0,20512	2004
54.57	0,35753	0,31288	0,19492	0,21161	0,23175	0,96851	0,22552	2005
65.16	0,37729	0,32568	0,31715	0,19833	0,23958	0,96523	0,21778	2006
72.44	0,36487	0,30218	0,30432	0,22637	0,22545	0,96433	0,16654	2007

96.94	0,38988	0,37208	0,34053	0,23612	0,24736	0,96121	0,18195	2008
61.74	0,35504	0,11783	0,42184	0,23450	0,17685	0,96195	0,21724	2009
79.61	0,37410	0,12243	0,60500	0,22637	0,19820	0,95709	0,13550	2010
111.26	0,37831	0,16346	0,49087	0,26649	0,22069	0,95469	0,17366	2011
111.63	0,38169	0,29573	0,37208	0,31148	0,20467	0,95386	0,15229	2012
108.56	0,34205	0,06668	0,37208	0,27906	0,21432	0,94743	0,17275	2013
98.97	0,34059	0,03832	0,40948	0,30537	0,20467	0,93438	0,15132	2014
52.32	0,35069	0,00482	0,48284	0,29923	0,24736	0,91161	0,15832	2015
43.64	0,37675	0,10629	0,52280	0,30690	0,24581	0,90483	0,16386	2016
54.13	0,35951	0,05726	0,53469	0,27436	0,23176	0,91249	0,14648	2017
71.34	0,36241	0,08540	0,54652	0,30537	0,19332	0,89367	0,15018	2018
64.3	0,35472	0,03356	0,55635	0,30230	0,19658	0,88678	0,15274	2019
41.96	0,38948	0,10398	0,74462	0,28996	0,22228	0,84932	0,12675	2020
77.76	0,37471	0,09238	0,72482	0,28530	0,18347	0,82418	0,13811	2021

Source: *calculated by the researchers based on data from the annual economic and monetary reports of the Bank of Algeria.*

Through Table2, it is clear that the oil sector still maintains its position as a primary source of state revenues and a fundamental component in commodity exports. Exports show a distinct concentration, as the index records increasing values approaching unity. The diversification is apparent in the structure of imports, where the value of the diversification index decreases. However, as a positive point, there is a noticeable change in the structure of gross domestic product (GDP), with a decreasing value for the diversification index in GDP.

We can also highlight the significant leap made by non-oil revenue in government treasury financing. All these indicators reflect some structural changes, albeit slight, in the Algerian economy. They primarily signify the gradual occurrence of economic diversification. Therefore, it is necessary to measure the degree of diversification using quantitative indicators to understand the depth or superficiality of the changes occurring in the national economy. This includes assessing the impact of diversifying the economic base on economic growth in Algeria.

Considering that economic growth is measured by the rate of change in Gross Domestic Product (GDP) at constant prices, an increase in the degree of diversification is accompanied by a positive, continuous, and increasing rise in the economic growth rate. Given that diversification is a multidimensional phenomenon measured by the Composite Diversification Index, this study aimed to establish a link between the Composite Diversification Index and the real GDP growth rate. The goal was to measure the impact of the economic diversification strategy pursued in Algeria on achieving economic growth. The study also connected economic growth with the variable of accumulated fixed capital, primarily derived from petroleum rent and linked to changes in the price of a barrel of oil in US dollars. Additionally, it considered the variable of labor force employment. The study aimed to assess the most influential variable in the growth of gross domestic product.

6. The empirical study on the impact of economic diversification, fixed capital, and labor force on the economic growth rate in Algeria

We will first introduce the time series under study as follows:

1. Model specification and Data sample

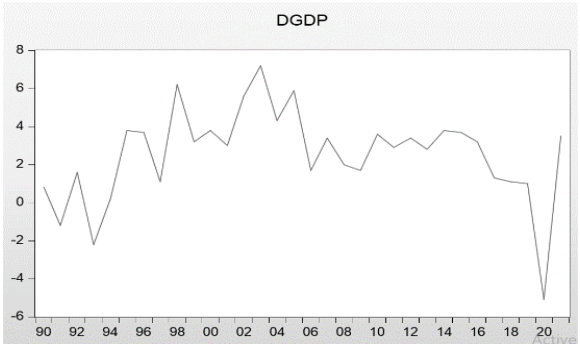
Table 3.Data Sample

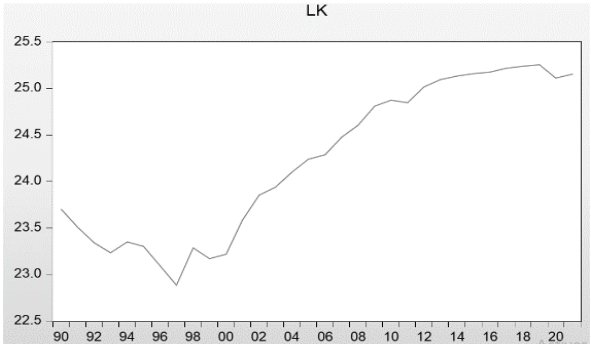
years	HH	DG DP	Capital Algerian Dinar	Labor L	years	H-H	GD DP	Labor L	Capital Algerian Dinar
1990	0,333	0,8	19620924010	6402241	**2006**	0,377	1,7	10155998	35312156752
1991	0,320	-1,2	16152772981	6668923	**2007**	0,364	3,4	10324354	42669470024
1992	0,341	1,6	13691728559	6922168	**2008**	0,389	2	10482036	48342831556
1993	0,375	-2,2	12291943650	7216939	**2009**	0,355	1,7	10629401	59386738231
1994	0,339	0,2	13796383291	7512992	**2010**	0,374	3,6	10912087	63525508759
1995	0,326	3,8	13156449678	7780127	**2011**	0,378	2,9	10675639	61639180982
1996	0,418	3,7	10652662233	8043670	**2012**	0,381	3,4	11356926	73000995403
1997	0,450	1,1	8674689074	8264429	**2013**	0,342	2,8	11876807	79198241018
1998	0,395	6,2	12990789774	8489529	**2014**	0,340	3,8	11489980	82236676681
1999	0,367	3,2	11533030023	8713359	**2015**	0,350	3,7	11813561	84285420602
2000	0,462	3,8	12120028652	8932727	**2016**	0,376	3,2	12032169	85574685011
2001	0,351	3	17475781503	9159728	**2017**	0,359	1,3	12184474	89347823673
2002	0,329	5,6	22813394818	9373599	**2018**	0,362	1,1	12330675	91131491104
2003	0,348	7,2	24851050271	9578796	**2019**	0,354	1	12500369	92900699818
2004	0,339	4,3	29217767026	9779482	**2020**	0,389	-5,1	12102616	80475979861
2005	0,357	5,9	33697991041	9975538	**2021**	0,374	3,5	12398078	83742143000

Source: *prepared by the researcher based on data from the annual economic and monetary reports of the Bank of Algeria, the statistical bulletins of the National Office of Statistics*

Table 4. Definition of the Variables

Variable	Metric
variations (DGDP)	Variation in percentage of the Gross Domestic Product (GDP)
Capital (K)	Measured in millions of constant (Year) Dollars
Labor force (L)	Measured in millions.
Composed Diversification measure (HH)	Author's calculations





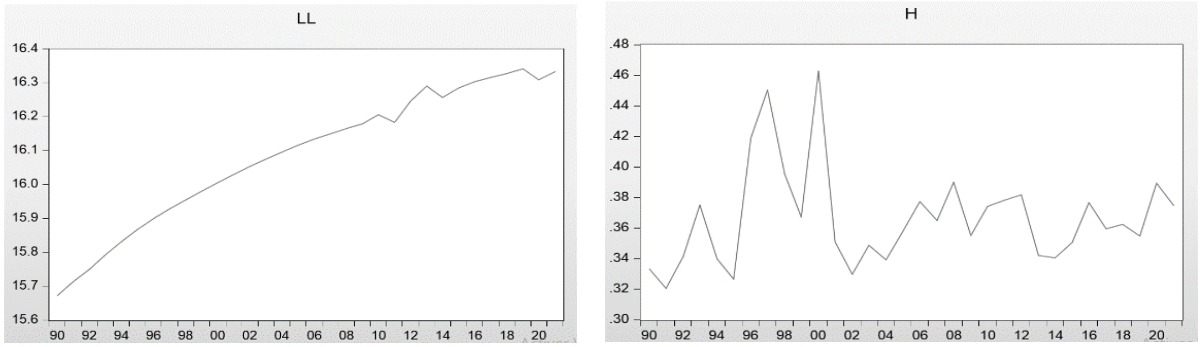


Fig.1. The Evolution of the Study Variables

Source: *Statistical outputs from Eviews 10 program.*

From the figure, it is observed that the gross domestic product (GDP) variable exhibits clear volatility, and the same applies to the composite diversification index. However, the utilization of capital and labor shows a growing trend. This is attributed to the nature of the Algerian economy, characterized by economic diversification weakness. Economic growth relies on oil revenue returns, as well as the strength of the labor force,

The modesty of the diversification index can be attributed to the volatility of gross domestic product (GDP), which is influenced by fluctuations in sectors that generate value-added, such as manufacturing and agriculture. Given the limited contribution of diversification to economic growth, the Algerian economy relies on utilizing capital acquired from oil revenues and labor to achieve current economic growth.

2. Empirical Results and Analysis

Pesaran, Shin, & Smith stated that the autoregressive distributed lag (ARDL) bounds testing approach can be applied irrespective of the order of integration of the time series, i.e. whether the underlying variables are I(0), I(1) or fractionally integrated. The only condition for applicability of this technique is that the series should not be integrated of order 2 [I (2)]. Additionally, this method has superior small sample properties compared to conventional cointegration techniques like the Engle-Granger test or Johansen's method, which require larger sample sizes for the results to be reliable. Therefore, the ARDL approach is more appropriate given the small sample size (with each time series spanning 31 observations) used in this study[(25)] .

Since most previous studies have viewed the relationship between (HH) and (DGDP) as linear, we estimate a non-linear (logarithmic) specification for this relationship due to the following advantages:

-Taking the logarithm of the variables generally makes time series variance stationary;

-Estimating a logarithmic relationship allows interpreting important elasticities in our study, which depend on growth rates of the variables.

-The computed statistic for the RESET (Ramsey) test was suitable for the functional form;

-The linear formulation was estimated but it suffered from several statistical issues in addition to most explanatory variables being insignificant in the long-run relationship. This required moving to the logarithmic specification.

-Additionally, adding the oil price variable improved the statistical results of the model estimation, especially the coefficient of determination value, indicating the role of this variable in enhancing the model's goodness of fit.

Accordingly, the Logarithm is introduced to the following series:

LNL: Logarithm of **Labor force (LL)**; LNK: Logarithm of **Capital (LK).**

3. Unit Root Tests for Stationarity

It is advisable to use multiple unit root tests to properly assess the stationarity and order of integration of the time series data being analyzed(26) .suggested applying more than one type of unit root test for robust conclusions about the integration order. Popular unit root tests include the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller) and the Phillips-Perron (PP) test**;** many studies report the results from both the ADF and PP tests. We can have greater confidence in the true integration order of the variables if the ADF and PP tests yield identical results.

This paper reports the results from two unit root tests ADF, PP. To conduct these tests appropriately, one must select the optimum lag length(27) .recommended using the Schwarz Information Criterion for the lag selection. The unit root test results are presented in Table X to shed light on the stationarity properties and order of integration of the time series under analysis.

Table 5. ADF Stationarity Tests

	Lag	At level			At First difference			Order
		C	C & T	None	C	C & T	None	
DGDP	**0**	3.92472- (0.0052)	3.86658-	2.31308-		-		**I(0)**
H	**0**	4.15543- (0.0029)	4.07846-	0.10563-		-		**I(0)**
LK	**1**	2.11515-	0.45175-	1.599183	3.70378-	3.51800-	3.1080- (0.003)	**I(1)**
LL	**3**	3.51117- (0.0152)	1.30367-	1.143401		-		**I(0)**

***Source**: Statistical outputs from Eviews 10 program.*

Table 6. PP Stationarity Tests

	Lag	*At level*			*At First difference*			*Order*
		C	C & T	None	C	C & T	None	
Dgdp	***0***	3.92472- *(0.0052)*	3.86658-	2.31308-		-		**I(0)**
H	***0***	4.15543- *(0.0029)*	4.07846-	0.10563-		-		**I(0)**
LK	***1***	-0.16324	2.55371-	1.548587	4.59263-	4.48283-	4.1854- *(0.000)*	**I(1)**
LL	***3***	5.69214- *(0.000)*	1.47732-	5.497010		-		**I(0)**

***Source:** Statistical outputs from Eviews 10 program.*

Tables clearly shows that some of the variables are stationary at level I (0), while others were found to be stationary at first difference I (1). Therefore, the bounds test of co-integration can be applied to determine the long-term relationship among the estimated variables.

Table7. ARDL Bounds Test for Cointegration

Variables	F– Statistics	Cointegration
DGDP, H, LK, LL	7.17 ***	Cointegration
Critical value	Lower Bound	Upper Bound
1%	4.614	5.966
5%	3.272	4.306
10%	2.676	3.586

*Note. *** Statistical significance at 1% level; ** Statistical significance at 5% level; * Statistical significance at 10% level. The lag length k=3 was selected based on (AIC, SC, HQ values). The number of regressors is 3.*

Source: *Statistical outputs from Eviews 10 program.*

The results provide evidence for a long-run equilibrium relationship between economic growth, economic diversification (H), labor force (L), and capital (K) in the context analyzed. This is supported by the calculated F-statistic value of 7.17 exceeding the critical upper bound values at all standard levels of significance. Such a result confirms the existence of cointegration between the variables .

Having established cointegration, the next stage involved investigating the marginal impacts of economic diversification and the other explanatory factors on economic growth in the system. These marginal effects show the quantitative influence of each variable on economic growth. The estimated marginal impacts from the model are presented in Table 8. This sheds light on the precise role played by diversification alongside other determinants in affecting the economy's growth rate over the study period.

Table 8. Linear Regression Model Between Variables

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
H	-46.55770	12.38649	-3.758748	0.0010
LL	16.64140	5.664482	2.937850	0.0072
LK	-4.288817	1.197845	-3.580444	0.0015
C	-144.8188	63.97273	-2.263758	0.0329

EC = DGDP - (-46.5577*H + 16.6414*LL -4.2888*LK -144.8188)

Source: *Statistical outputs from Eviews 10 program.*

4. Bounds Test of Co-Integration and ARDL Estimation Results

The results of the ARDL bounds testing approach are shown in Table 9

Table 9. Estimated long Run Coefficients

Dependent variable: DGDP		
Variables	**Coefficients**	**p-value**
Adjusted error term	-0.94	0.000
H	-0.46	0.001
LK	-4.28	0.001
LL	16.64	0.007
R-squared = 0.52 , ARDL(1,1,0,1) regression		

Source: *Statistical outputs from Eviews 10 program.*

The short-term dynamics revealed no statistically significant relationship between economic growth and the explanatory factors in the model. However, the long-run evidence indicates a negative and significant impact of the Herfindahl index (implying a positive effect from higher degrees of economic diversification) on Algeria's economic growth. This aligns with past research of [(28)]on this topic. The estimated long-run coefficients on capital and labor force were also significant at the 5% level, the quantitative results imply that a 1% increase in economic diversification levels, as measured by a decline in the Herfindahl index, would stimulate a 46% rise in Algeria's economic growth rate. Equivalently, a 1% decrease in diversification is associated with a 46% drop in growth. This highlights the favorable effect of diversification on the Algerian economy over the long run .

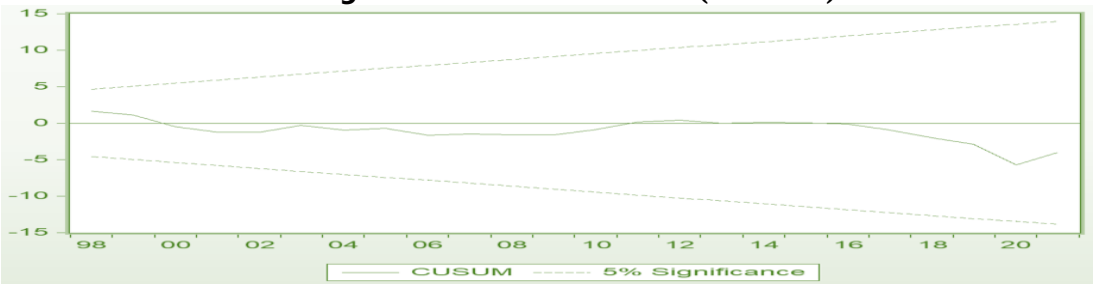
The capital and labor force variables were also found to have significant positive impacts on economic growth in the long run, as expected in economic theory. But the role of diversification stands out as a crucial determinant.

5. Diagnostic Tests

After obtaining the ARDL model estimates, diagnostic tests were conducted to evaluate the adequacy of the dynamic specification. The results from these diagnostic tests are presented in Table 10 and were found to be quite satisfactory. Specifically, the Lagrange Multiplier (LM) and Regression Specification Error Test (Reset) were used to test for serial correlation and heteroscedasticity issues respectively. The null hypotheses of no serial correlation and no heteroscedasticity could not be rejected at the 5% significance level, indicating the ARDL model does not suffer from these problems.

Furthermore, the stability of the ARDL model was assessed by examining recursive residuals using the Cumulative Sum (CUSUM) test. As Figure 2 shows, the CUSUM statistic stays within the upper and lower critical bounds. This provides evidence supporting coefficient estimate stability and the adequacy of the overall dynamic specification of the estimated ARDL model in capturing the time series properties.

Fig.2. The Cumulative Sum (CUSUM) Test



Source: *Statistical outputs from Eviews 10 program.*

The battery of tests applied post-estimation give the model a clean bill of health regarding serial
correlation, heteroscedasticity, structural stability and other diagnostics - bolstering confidence in relying on the ARDL results for analysis and inference.

Table 10. Diagnostic Tests of the ARDL Model

F-Bounds test	ECM	LM test	Reset test	Cusum test
7.17	-0.94 (0.000)	0.148 (0.8630)	0.0064 (0.9369)	Stable**

Note. Numbers inside the parentheses are the p-values.

Source: *Statistical outputs from Eviews 10 program.*

7. RESULTS AND DISCUSSION

Through the presented study, we have arrived at several results, which are summarized as follows:

1. The economic diversification index in Algeria recorded a value of less than 0.5, indicating a lack of diversification in Algeria concerning the composite diversification index.

2. As for the partial indicators, we did not observe diversification for exports; instead, they were concentrated solely in oil exports. Conversely, the imports diversification index recorded a high value. Gross Domestic Product (GDP) exhibited weak diversification. Regarding the labor force, there was concentration in the services sector. As for the capital diversification index, Algeria continues to rely on oil revenues to fund development, without reaching a level of diversification in national income sources.

3. Through the empirical study, we recorded the weak impact of economic diversification in achieving economic growth in Algeria. This result reflects the economic diversification's weakness.

4. Hence, the impact of economic diversification in the short term remains weak. This confirms the

delay in diversification in the industrial sector, which creates added value, while economic activity is concentrated in services.

5. In the short term, achieving the growth rate of the Algerian economy depends on the utilization of rentier capital from oil and gas exports, and it has not reached a level incentivized by economic diversification.

6. In the long term, and with the continuation of economic reforms along with achieving higher levels of economic diversification, the national economy can raise the economic growth rate through the growth of value-added sectors: manufacturing and agriculture.

8. CONCLUSION

The study provided a comprehensive analysis to measure the causal relationship between economic diversification, using the Herfindahl-Hirschman Index (HHI), and economic growth. Additionally, we incorporated two other variables, rentier capital and workforce strength, to deepen the investigation into their roles in achieving economic growth in Algeria. The study concluded that economic growth in Algeria still primarily relies on rentier capital, while the contribution of economic diversification to achieving high growth rates remains weak. The national economy has not reached an acceptable level of economic diversification capable of driving the required economic growth.

Therefore, in the long term, it is imperative to activate an economic diversification model that focuses on developing the manufacturing industry. This would enable the Algerian economy to achieve higher growth rates, moving away from dependence on rentier resources.

* Developing a competitive fabric of small and medium enterprises (SMEs) that embrace innovation and diversification in the industrial sector is crucial. Emphasis should be placed on light industries, particularly those involving manufacturing processes, to ensure diversification of exports beyond the hydrocarbon sector.
*Investment in human resources should be a priority, driving industrial development through the enhancement of knowledge and technological capabilities.

*Focusing on industrial branches where the national economy demonstrates a competitive advantage is essential. The emphasis should be on developing these sectors to create a diversified and competitive industrial landscape.

*Concentrating on industrial branches where the national economy exhibits a competitive edge and actively working on their enhancement is vital. This approach ensures the creation of a diversified and competitive industrial framework.

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10. Appendices

1. Unit root test

Null Hypothesis: DGDP has a unit root
Exogenous: Constant
Lag Length: 0 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.924723	0.0052
Test critical values:	1% level	-3.661661	
	5% level	-2.960411	
	10% level	-2.619160	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DGDP)
Method: Least Squares
Date: 11/29/23 Time: 12:35
Sample (adjusted): 1991 2021
Included observations: 31 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DGDP(-1)	-0.687975	0.175293	-3.924723	0.0005
C	1.807035	0.612004	2.952653	0.0062

Null Hypothesis: LK has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.115156	0.5170
Test critical values:	1% level	-4.296729	
	5% level	-3.568379	
	10% level	-3.218382	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LK)
Method: Least Squares
Date: 11/29/23 Time: 12:38
Sample (adjusted): 1992 2021
Included observations: 30 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LK(-1)	-0.213612	0.100991	-2.115156	0.0442
D(LK(-1))	0.201375	0.172778	1.165510	0.2544
C	4.893833	2.297625	2.129952	0.0428
@TREND("1990")	0.019608	0.009464	2.071994	0.0483

Null Hypothesis: D(LK) has a unit root
Exogenous: None
Lag Length: 1 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.108002	0.0031
Test critical values:	1% level	-2.647120	
	5% level	-1.952910	
	10% level	-1.610011	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LK,2)
Method: Least Squares
Date: 11/29/23 Time: 12:39
Sample (adjusted): 1993 2021
Included observations: 29 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LK(-1))	-0.705614	0.227032	-3.108002	0.0044
D(LK(-1),2)	-0.082164	0.188567	-0.435725	0.6665

Null Hypothesis: LL has a unit root
Exogenous: Constant
Lag Length: 3 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.511174	0.0152
Test critical values:	1% level	-3.689194	
	5% level	-2.971853	
	10% level	-2.625121	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LL)
Method: Least Squares
Date: 11/29/23 Time: 12:41
Sample (adjusted): 1994 2021
Included observations: 28 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LL(-1)	-0.112140	0.031938	-3.511174	0.0019
D(LL(-1))	-0.517908	0.187473	-2.762578	0.0111
D(LL(-2))	-0.556378	0.220914	-2.518525	0.0192
D(LL(-3))	-0.029268	0.224424	-0.130413	0.8974
C	1.850364	0.524141	3.530281	0.0018

Null Hypothesis: H has a unit root
Exogenous: Constant
Lag Length: 0 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.155430	0.0029
Test critical values:	1% level	-3.661661	
	5% level	-2.960411	
	10% level	-2.619160	

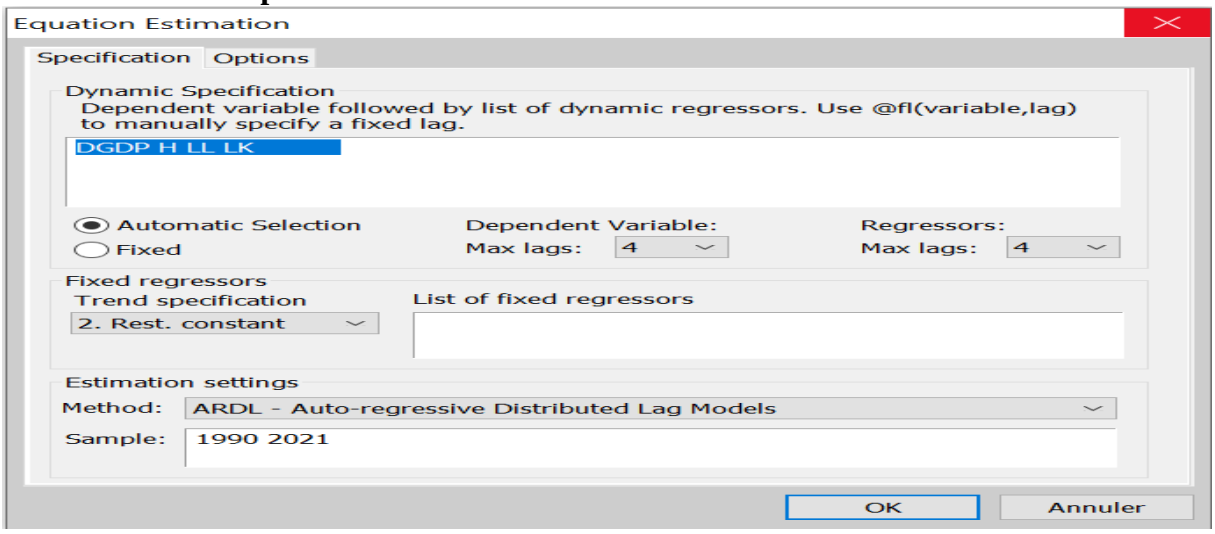
*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(H)
Method: Least Squares
Date: 11/29/23 Time: 12:43
Sample (adjusted): 1991 2021
Included observations: 31 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
H(-1)	-0.729530	0.175561	-4.155430	0.0003
C	0.268548	0.064555	4.160009	0.0003

2. ARDL estimation

a. Model specification



Dependent Variable: DGDP
Method: ARDL
Date: 10/15/23 Time: 16:21
Sample (adjusted): 1991 2021
Included observations: 31 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Schwarz criterion (SIC)
Dynamic regressors (4 lags, automatic): H LL LK
Fixed regressors: C
Number of models evalulated: 500
Selected Model: ARDL(1, 1, 0, 1)
Note: final equation sample is larger than selection sample
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
DGDP(-1)	0.057925	0.138648	0.417782	0.6798
H	-9.044091	8.193908	-1.103758	0.2806
H(-1)	-34.81676	8.238515	-4.226096	0.0003
LL	15.67745	6.193564	2.531248	0.0183
LK	6.292422	3.136547	2.006162	0.0562
LK(-1)	-10.33281	2.767666	-3.733401	0.0010
C	-136.4302	66.34365	-2.056417	0.0508

R-squared	0.515803	Mean dependent var	2.587097
Adjusted R-squared	0.394754	S.D. dependent var	2.463026
S.E. of regression	1.916174	Akaike info criterion	4.334218
Sum squared resid	88.12138	Schwarz criterion	4.658022
Log likelihood	-60.18038	Hannan-Quinn criter.	4.439770
F-statistic	4.261098	Durbin-Watson stat	1.824941
Prob(F-statistic)	0.004640		

b. Bound test

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	7.173888	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66

ARDL Error Correction Regression
Dependent Variable: D(DGDP)
Selected Model: ARDL(1, 1, 0, 1)
Case 2: Restricted Constant and No Trend
Date: 11/29/23 Time: 12:52
Sample: 1990 2021
Included observations: 31

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(H)	-9.044091	9.971634	-0.906982	0.3734
D(LK)	6.292422	2.404999	2.616393	0.0151
CointEq(-1)*	-0.942075	0.145630	-6.468978	0.0000

R-squared	0.649219	Mean dependent var	0.087097
Adjusted R-squared	0.624163	S.D. dependent var	2.893757
S.E. of regression	1.774033	Akaike info criterion	4.076153
Sum squared resid	88.12138	Schwarz criterion	4.214926
Log likelihood	-60.18038	Hannan-Quinn criter.	4.121390
Durbin-Watson stat	1.824941		

c. Residual diagnostics

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.528500	Prob. F(4,20)	0.7161
Obs*R-squared	2.963462	Prob. Chi-Square(4)	0.5640

Heteroskedasticity Test: ARCH

F-statistic	0.214609	Prob. F(1,28)	0.6468
Obs*R-squared	0.228190	Prob. Chi-Square(1)	0.6329

d. Model stability

Ramsey RESET Test
Equation: ARDL_FINAL
Specification: DGDP DGDP(-1) H H(-1) LL LK LK(-1) C
Omitted Variables: Powers of fitted values from 2 to 5

	Value	df	Probability
F-statistic	0.102023	(4, 20)	0.9805

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	1.762126	4	0.440532
Restricted SSR	88.12138	24	3.671724
Unrestricted SSR	86.35925	20	4.317963

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