

How to Cite:

Saouli, Y. (2025). Study of the reality of economic diversification in Algeria for the period 2000-2022, using the Herfindahl-Hirschman index. *International Journal of Economic Perspectives*, 19(4), 1494–1506. Retrieved from <https://ijeponline.org/index.php/journal/article/view/937>

Study of the reality of economic diversification in Algeria for the period 2000-2022, using the Herfindahl-Hirschman index

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Abstract--This study aims to shed light on the path of economic diversification during the period 2000-2022, based on the Herfindahl-Hirschman coefficient, by measuring the extent of national economic diversification of macroeconomic indicators that reflect economic performance, namely "gross domestic product, export and import structure, public budgets revenues, and gross fixed capital formation." The study concluded that Algeria still relies heavily on oil revenues and that the embodied diversification policy has not yielded the desired result despite the efforts made by Algeria to diversify its economy. It is necessary to develop a comprehensive national program to stimulate economic sectors. The agricultural sector is proposed as a potential avenue for diversifying the Algerian economy. Utilizing the implications of the research include specific recommendations, notably that one sector should not be maintained by international innovation and technology.

Keywords--Economic diversification, the Herfindahl-Hirschman index; gross domestic product, Economic sectors, Algerian economy.
JEL classification codes: C50, O41, Q01, C32.

1. Introduction

Algeria is the largest oil-exporting nation in Africa and possesses a fast-expanding economy. The nation employs a resource-based growth strategy centered on the production and exportation of oil. Due to the fluctuations in global oil prices and the inconsistent growth of Algeria's economy, the nation has squandered several opportunities to escape underdevelopment, despite its abundant natural and human resources. It has relied solely on its substantial crude oil reserves as the

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Submitted: 20 February 2025, Revised: 20 March 2025, Accepted: 21 April 2025

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primary source of revenue, propelling a homogenous economy for years despite the substantial developmental obstacles it encounters. Unfortunately, the oil resources are being misallocated and a significant portion of it has engaged in rent-seeking and bureaucratic inefficiency prevalent in Algeria administrative system. GDP does not represent the distribution of wealth.

2. Principles of economic diversification

The matter of economic diversification is crucial for many nations, particularly oil-exporting countries reliant on oil revenues. This singular dependence renders their economies susceptible to external shocks from declining oil prices in global markets, directly affecting their financial and economic conditions. Consequently, these nations are compelled to explore alternative economic sectors that facilitate diversification, thereby reducing their reliance on a sole sector, enhancing their income sources, and promoting greater stability.

2-1 Definition of economic diversification

Economic diversity is defined in several ways, contingent upon the standpoint from which it is analyzed. We state the subsequent:

Diversification entails diminishing reliance on a singular resource and advancing towards the fortification of the industrial and agricultural economic foundation, as well as establishing a production base. This entails developing a robust economic sector that progresses toward self-sufficiency across several domains. (Zohra & Metarref, 2021)

Economic diversification entails diminishing reliance on the oil industry and its earnings by fostering the non-oil economy, non-oil exports, and other revenue streams, while decreasing the public sector's influence and augmenting the private sector's involvement in development. (Sabah & Shamam, 2017)

Economic diversification refers to efforts aimed at enhancing the contribution of productive sectors to the gross domestic product, broadening export markets, and stimulating tax revenues within a given economy to mitigate risks associated with reliance on a single sector, particularly in rentier economies. Diversification generally signifies that a country should manufacture and export a broad spectrum of goods and services; hence, economic diversification encompasses: (Bitat & Djellit, 2022)

2-2 Diversification of production

occurs through the proportional contribution of several economic sectors to national output and income generation. Nonetheless, the diversification of production inherently leads to a relative augmentation of industrial activity within the entire economy, since it serves as the foundation of every economy and the nexus connecting diverse sectors.

2-2-1 Export diversification

The approach seeks to enhance and expand exports by offering material and in-kind incentives to investors, therefore improving the competitiveness of domestic products in international markets. Thus, economic diversification is a multifaceted and advantageous process including the diversification of output and the enhancement of exports.

Diverse forms of diversification can also be categorized based on their respective

directions. (boualleg, ait-yahia, & mechir, 2022)

2-2-2 Vertical diversification:

The utilization of the outputs from one activity, such as raw copper, as inputs for another activity, such as electrical wires, enhances the product's added value through the use of local or imported resources, referred to as forward and backward linkages.

2-2-3 Horizontal diversification:

It generates novel potential for goods in sectors such as mining, energy, and agriculture. Lateral diversification: It is venturing into a new domain by developing novel items that are unconnected to current offerings and aimed at new markets.

2-2-4 Comprehensive diversification

Production facilities aim to broaden their existing product range while simultaneously entering and penetrating new markets.

2-2-5 Geographical diversification

This entails entering new geographical regions (exporting products) and adjusting to alterations in the new production landscape.

2-2-6 Financial diversification

Diversification is a strategy designed to mitigate investment risks by allocating capital across many investing activities that are unlikely to decline simultaneously. Financial diversification may also encompass investments in several locations to mitigate the impact of economic downturns.

2-3 Indicators of measuring economic diversification

Economic diversity is assessed by many statistical indicators, which differ in their effectiveness and appropriateness for measuring objectives. Certain indicators rely on assessing dispersion (the coefficient of variation), analyzing concentration characteristics (such as the Gini index), or evaluating diversity.

2-3-1 Herfindahl-Hirschman coefficient

Abbreviated as (H H I), it is the most often employed metric for assessing diversification in the composition of a phenomena, emphasizing the structural changes that have transpired within its components. This coefficient is extensively utilized to assess economic diversity, since the index is defined by the following formula: (guerrouf, 2020)

$$H = \frac{\sqrt{\sum_{i=1}^N \left(\frac{x_i}{x}\right)^2} - \sqrt{\frac{1}{N}}}{1 - \sqrt{\frac{1}{N}}}$$

Where:

N: number of activities,

X_i : value of the variable in activity i ,

x : total value of the variable in all activities.

The Herfindahl-Hirschman coefficient runs from zero to one ($0 \leq H \leq 1$). If it is 0, there exists entire variety in the economy, meaning the distribution of activities is

uniform, corresponding equally to the aggregate output of all activities. If it equals one, the level of diversification is zero, indicating that output is concentrated in a single economic activity, with all other activities contributing no share to the gross domestic product. Elevated Herfindahl coefficient values indicate the economy's inadequacy in evenly dividing its activity throughout a diverse array of sectors or goods, hence potentially confining itself to a limited few.

2-3-2 Gini index (López-Cálix, Diop, & Walkenhorst, 2010)

The Gini coefficient is insensitive to the quantity of observations. The value of the index is unaffected by alterations in the number of sectors within the sample. The Baron equation is used for every nation and year. The sample is organized by export lines, indexed by k in ascending order of trade value x , ensuring that $XK < XK+1$ for cumulative export shares, where

Cumulative shares in the number of export lines are represented as kn/n . Therefore, the Baron formula for the Gini coefficient is:

$$G = \left| \sum_{K=1}^n ((\chi_K - \chi_{K-1})(2K - 1)/n) \right|$$

The weight assigned to each product line in the Gini coefficient is determined by its rank rather than its absolute value, making the Gini coefficient a function that is more responsive to rank alterations than to changes in export share.

2-3-3 Ogive indicator

The Ogive index quantifies the variability of evenly distributed export shares among commodities, articulated as follows: (Ali, Jeffrey, & Paul B, 1971)(Siegel, 1991, p. 11)

$$\text{Orgive} = \sum_n^N \frac{(x_n - \frac{1}{n})^2}{\frac{1}{n}}$$

Where:

N : is the total number of export products taken into account, and $1/N$ is assumed to be the "ideal" share of exports revenues for each product, X : is the actual share of commodity n in total exports.

3- Analysis of the development of economic diversification and sustainable development during the period 2000 – 2022

3-1 Analysis of the evolution of the Herfindahl-Hirschman index in Algeria during the pe-riod (2000 – 2022)

Algeria aims to identify new alternative sources to enhance the national economy and pursue sustainable development. To achieve this objective, it is essential to analyze the composition of the economic diversification index by evaluating the index based on the contribution of productive sectors to the gross domestic product. It has been computed based on the subsequent relationship:

Numerical application:

Calculating the value of the Herfindahl-Hirschman coefficient for the year 2000 (value in billion Algerian dinars):

$$HHI_{2000} = \sqrt{\frac{(156.2/381.3)^2 + (98.5/381.3)^2 + (89.2/381.3)^2 + (76.7/381.3)^2 + (56.3/381.3)^2}{1 - \sqrt{1/5}}}$$

$$HHI_{2000} = 0,065$$

Calculating the value of the Herfindahl-Hirschman coefficient for the year 2022 (value in billion Algerian dinars):

$$HHI_{2022} = \frac{(256.2 / 645.3)^2 + (167.24 / 645.3)^2 + (134.24 / 645.3)^2 + (145.24 / 645.3)^2 + (125.24 / 645.3)^2 - \sqrt{1/5}}{1 - \sqrt{1/5}}$$

$$HHI_{2022} = 0.097$$

Table N°(01) : Shows the development of the economic diversification index in Algeria during the period (2000 - 2022)

Years	2000	2001	2002	2003	2004	2005	2006
HHI	0.196	0.149	0.139	0.162	0.185	0.259	0.253
Years	2007	2008	2009	2010	2011	2012	2013
HHI	0.244	0.275	0.132	0.168	0.194	0.177	0.139
Years	2014	2015	2016	2017	2018	2019	2020
HHI	0.119	0.095	0.093	0.086	0.091	0.087	0.089
Years	2021	2022					
HHI	0.09	0.097					

Source: Prepared by the researcher based on Microsoft Excel (WBG, 2024)

The table above indicates that the economic diversification index was estimated at 0.196 in 2000, reflecting an enhancement in economic diversification (a reduction in the Herfindahl-Hirschman index) in Algeria for that year. This index experienced a notable rise to 0.253 in 2006, followed by a decline in 2008 to an estimated value of 0.275, which signifies an increase in the degree of economic diversification. Subsequently, the index exhibited an upward trajectory until 2010, reaching a value of 0.168, signifying a reduction in economic diversification in Algeria from 2012 to 2014. This period marked the inception of development projects encapsulated in the economic recovery support program, which sought to bolster productivity initiated by the agricultural sector. Algeria additionally settled debts, with the supplemental package to bolster growth (2000 to 2022).

3-2 Examination of the progression of the GDP per capita index in Algeria from (2000 to 2022)

The GDP per capita metric was employed to represent the economic aspect of sustainable development. The subsequent graphic will depict the evolution of this indicator.

Table N°(02) :Shows the development of the economic diversification index in Algeria during the period (2000 - 2022)

Years	2000	2001	2002	2003	2004	2005	2006
GDP	1780,37	1904,21	1945,19	2292,31	2827,22	3248,09	3681,29
Years	2007	2008	2009	2010	2011	2012	2013
GDP	4192,66	5217,99	4270,85	4958,25	5974,57	6096,09	6044,67
Years	2014	2015	2016	2017	2018	2019	2020
GDP	6164,64	4741,49	4481,08	4615,86	4640,31	4530,1	3794,40
Years	2021	2022					

Years	2000	2001	2002	2003	2004	2005	2006
GDP	4216,25	5023,25					

Source: Prepared by the researcher based on Microsoft Excel (WBG, 2024)

Shows the development of per capita GDP during the period (2000 - 2022)

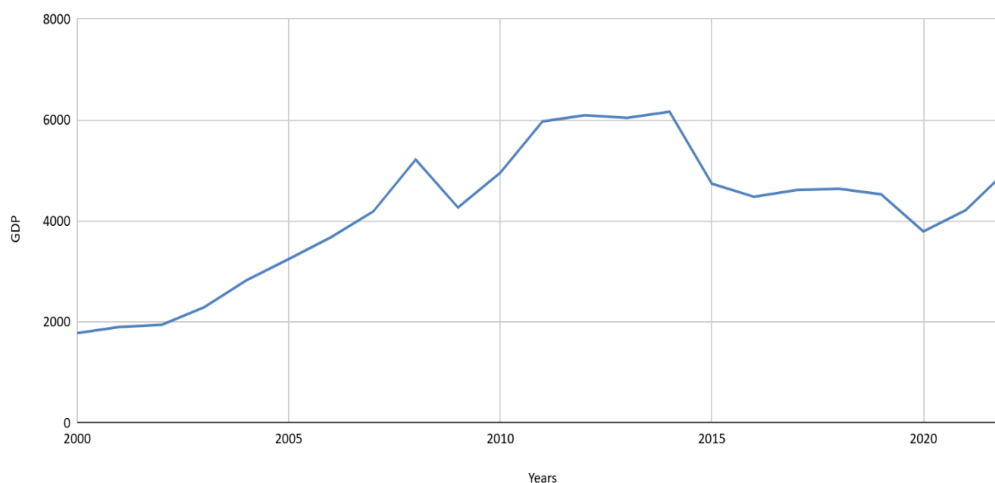


Fig N°(01): Shows the development of per capita GDP during the period (2000 - 2022)

Source: Prepared by the researcher based on World Bank data.

The figure indicates a decline in the per capita GDP index by 2292.31 billion Algerian dinars in 2003, followed by an upward trend. This was succeeded by another decline in 2009, with a value of 4270.82 billion Algerian dinars. The per capita GDP then experienced a continuous increase until 2012, reaching 6096.09 billion Algerian dinars, before resuming a downward trajectory until 2022.

3-3 Analysis of the reality of economic diversification in Algeria during the period (2000 - 2022)

3-3-1 Measuring economic diversification during the period (2000 - 2022)

Economic diversification is a multifaceted process that encompasses variations across all measures of the national economy, including GDP composition, exports, imports, government revenues, and gross fixed capital creation. Consequently, we choose to examine these comprehensive variables utilizing the Herfindahl-Hirschman Index for the period from (2000 - 2022).

➤ Measuring Diversity in the Structure of GDP (2000 - 2022)

Table No. 3 illustrates variations in the hydrocarbon sector's contribution to gross domestic product, with the percentage of hydrocarbon added value declining to 14.0 in 2002 from 19.5 in 2000. This is because to the diminished demand for hydrocarbons resulting from the global Corona epidemic, along with the plummet in pricing within international markets, leading to a 40.7% drop in the gross product during this period. In 2021, it experienced robust growth of 10.3% in volume following an extraordinary historical contraction of 10.2% over more than two decades, attributed to the resurgence in global oil demand, which resulted in

a rise in oil prices; the average price of Algerian crude oil increased from \$42.07 per barrel in 2020 to \$72.75 per barrel in 2022. The agriculture industry is experiencing upheaval because to a notable and historic drop in 2022. The volume saw a negative growth rate of 1.1%, mostly because to adverse meteorological circumstances resulting from a drought, compounded by rising agricultural input prices and stringent import regulations.

Table N°(03) : Relative change in the contribution of productive sectors to the gross domestic product

Years	2000 2001	2002 2003	2004 2005	2006 2007	2008 2009	2010 2011	2012 2013	2014 2015	2016 2017	2018 2019	2020 2021	2022
Fuels	11.0	12.3	10.6	16.2	21.5	14.0	17.3	14.0	17.3	19.6	22.2	21.5
Agriculture	09.1	11.2	08.8	10.8	13	14.1	12.2	14.1	12.2	11.8	11.8	13
Industry	3.3	4.6	5.5	5.4	5.8	6.3	5.6	6.3	5.6	5.5	5.4	5.8
Construction and Public Works	10.1	11.8	11.7	11.5	12.3	13.0	11.8	13.0	11.8	11.7	11.5	12.3
Services outside the Public Administration	18.2	27.6	27.4	26.8	24.4	26.2	27.6	26.2	27.6	27.4	26.8	24.4
Public Administration Services	11.3	13.5	14.3	13.7	13.8	18.3	17.5	18.3	117.5	16.3	14.7	15.8

Source: Prepared by the researcher based on the annual reports of the Bank of Algeria (BCA, 2024)

Based on reading the results of the Herfindahl-Hirschman index during the period (2000-2022), calculated and shown in Figure (3), based on the rule that states that the closer this index is to 0, the more it indicates economic diversification, and the closer it is to 1, the more it indicates the absence of economic diversification, i.e. the presence of economic concentration. We note that its value is close to zero, but in reality, it does not reflect the reality of the existence of economic diversification, because the decline in the value of this index is due to the collapse of oil prices, which reached \$40 per barrel in 2015, which was reflected in the value of the output of the hydrocarbon sector, and thus there is no real economic diversification.

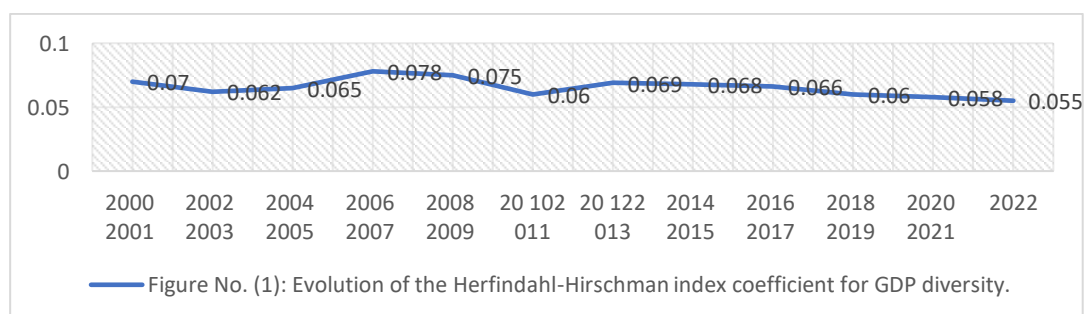


Fig N°(02): Evolution of the Herfindahl-Hirschman GDP Diversity Index coefficient.

Source: Prepared by the researcher based on the annual reports of the Bank of Algeria (BCA, 2024)

➤ **Measuring Export Diversification (2000-2022)**

Table No. 2 illustrates that energy materials constitute over 90% of Algeria's exports over the whole research period. Notwithstanding the reduction in hydrocarbon exports between 2019 and 2020, following a decrease in oil prices from \$44.64 per barrel in 2019 to \$42.08 per barrel in 2020, a fall of 70.34%, the average price of a barrel of Brent increased by 22.72% in 2021, reaching \$47.72. The rise in oil prices, along with the augmentation of exported amounts in tons of oil equivalent in 2021, resulted in an escalation of hydrocarbon exports from \$20.02 billion in 2020 to \$34.06 billion in 2021, reflecting an increase of \$14.04 billion. This illustrates the Algerian economy's significant reliance on the oil sector as a catalyst for economic activity.

Table N°(04) : Composition of exports by type of products

Unit: Millions of US dollars

Years	2000 2001	2002 2003	2004 2005	2006 2007	2008 2009	2010 2011	2012 2013	2014 2015	2016 2017	2018 2019	2020 2021	2022
Foodstuffs	341.0	372.3	360.6	376.2	321.5	384.0	417.3	414.0	417.3	419.6	422.2	521.5
Energy	19354.1	19871.2	20568.8	21650.8	21563	27918,0	32205	38697	32254	20315	35053,00	43765
Raw materials	43	46,4	55,9	54,7	58	63	56	63	84,4	73,5	182,00	192.3
Semi-finished products	710.1	781.8	712.7	811.5	812.3	919,0	865	1726	1485	1387	3480,0	4192.3
Agricultural equipment	0	0	0	0	0	0	0	0	0	0	0	0
Industrial equipment	71.3	73.5	74.3	83.7	93.8	98.3	97.5	88.3	117.5	86.3	174.7	15.8
Consumer goods	13	13,5	15	15	16	16.5	17	17	18,0	20	37,0	79,0
Other	1,1	0	1	1	0	0	1,5	2	2	2,5	3	4

Source: Annual reports of the National Bank of Algeria (BCA, 2024)

The progression of the Herfindahl-Hirschman coefficient for export diversification corroborates the earlier findings, indicating that the coefficient remains elevated and near one, albeit its decline during the research period. The little decline is attributed to the reduction in international oil prices, resulting in a diminished value of oil imports rather than a diversification of the export structure.

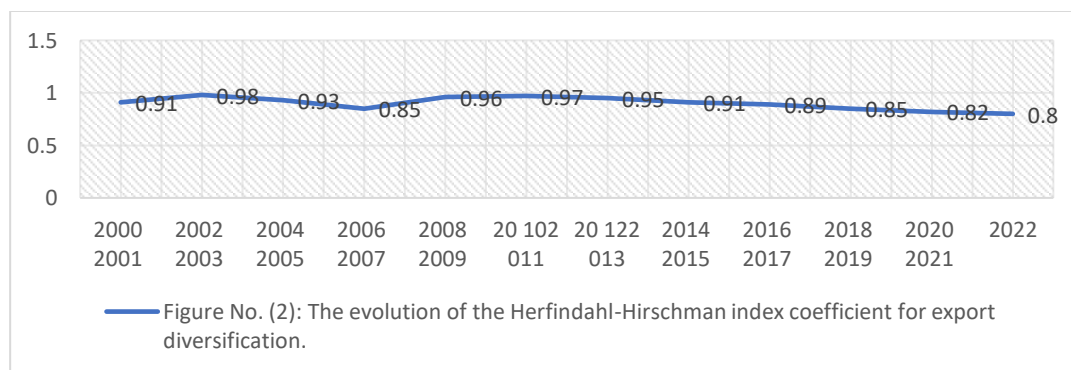


Fig N°(03): The evolution of the Herfindahl-Hirschman index coefficient for export diversification.

Source: Prepared by the researcher based on the annual reports of the Bank of Algeria (BCA, 2024)

➤ **Measuring the diversification of imports (2000-2022)**

In the context of Algerian imports, industrial equipment predominates, comprising 30 to 36% despite a persistent decline throughout the study period. This is succeeded by semi-finished products at 27%, followed by consumer goods, which fluctuate between 19 and 24%. Agricultural equipment occupies the lowest position at 1%. Consequently, the overall import structure remains stable from 2000 to 2022.

Table N°(04) : Composition of imports by type of products Unit Million US dollars

Years	2000 2001	2002 2003	2004 2005	2006 2007	2008 2009	2010 2011	2012 2013	2014 2015	2016 2017	2018 2019	2020 2021	2022
Foodstuffs	4644	7159	5875	6079	8523	6667	7644	8159	7875	8079	8723	9867
Energy	1049	757	1054	1569	790	413	1349	957	1254	1869	990	613
Raw materials	1011	914	1180	1166	2199	1402	1911	1614	1480	1466	3199	5402
Semi-finished products	7640	9668	9962	10173	5644	5213	9640	10668	10962	10473	7644	9213
Agricultural equipment	327	427	359	465	198	147	427	527	459	565	188	347
Industrial equipment	9545	9624	11809	10568	7797	8858	10545	12624	14809	13568	8797	9858
Consumer goods	5954	7212	7014	7159	5617	6498	7954	9212	7914	8159	5817	7498
Other	2716	2159	2299	3046	1543	1398	3716	3159	4299	4046	2543	2398

Source: Annual reports of the National Bank of Algeria (BCA, 2024)

The evolution of the Herfindahl-Hirschman coefficient for revenue diversification indicates the findings from the revenue structure analysis, revealing a stable coefficient value of approximately 0.1, which signifies a deficiency in revenue diversification.

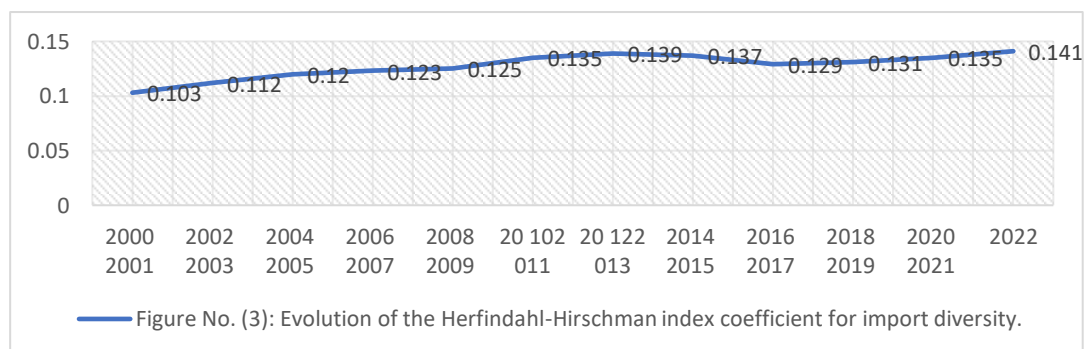


Fig N°(04): Evolution of the Herfindahl-Hirschman index coefficient for import diversity

Source: Prepared by the researcher based on the annual reports of the Bank of Algeria (BCA, 2024)

Assessment of the variety in the composition of government revenues (2000-2022): Analysis of the trajectory of public revenue proceeds and oil taxation growth during the study period reveals a congruent pattern. The apex of public revenue proceeds reached 6826.8 in 2018, following a landmark accord between

independent oil producers and OPEC members to cur-tail oil supply by approximately 1.8 million barrels, coinciding with the year in which oil taxation attained its zenith. It is observed that oil taxes have had a declining trend during the 2014 oil crisis, attributable to the decrease in oil prices. We observe a sustained enhance-ment in regular taxation revenues, peaking in 2022, primarily attributable to the implementa-tion of increases on certain taxes, fees, and licenses in accordance with the Finance Law of 2016, aimed at substituting regular taxation with oil taxation.

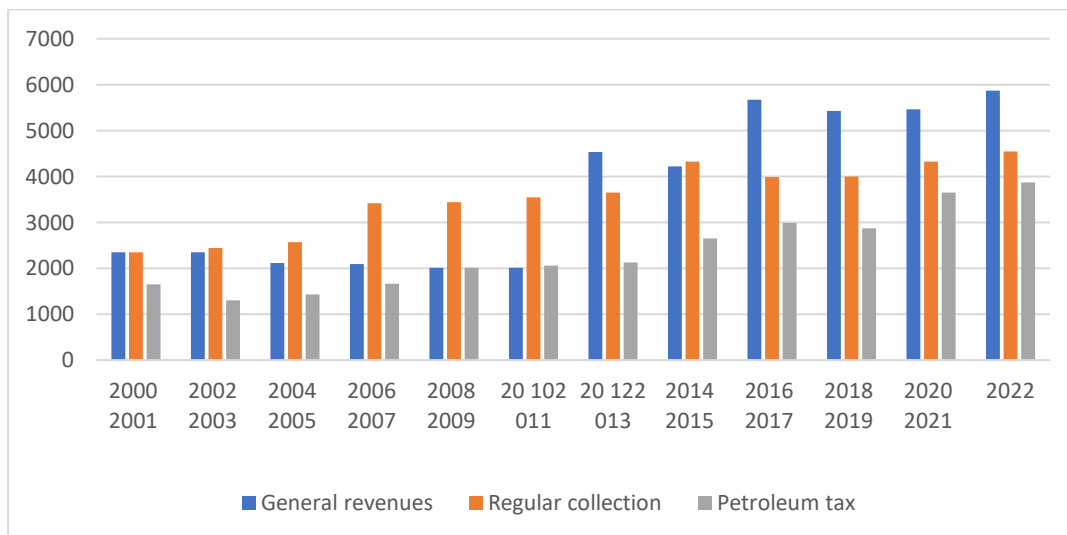


Fig N°(05): Development of public revenues of the public treasury (2000-2022)

Source: Prepared by the researcher based on the annual reports of the Bank of Algeria (BCA, 2024)

Analysis of the Herfindahl-Hirschman index findings for public revenue diversification from 2000 to 2022 reveals considerable fluctuations, including a notable decline to 0.03 in 2018. This reflects the significant variability in revenues, mostly attributed to the decline in oil income and the rise in tax revenues. A decline in oil revenue compels the government to implement increased tax burdens to offset the shortfall, while non-tax revenues are little.

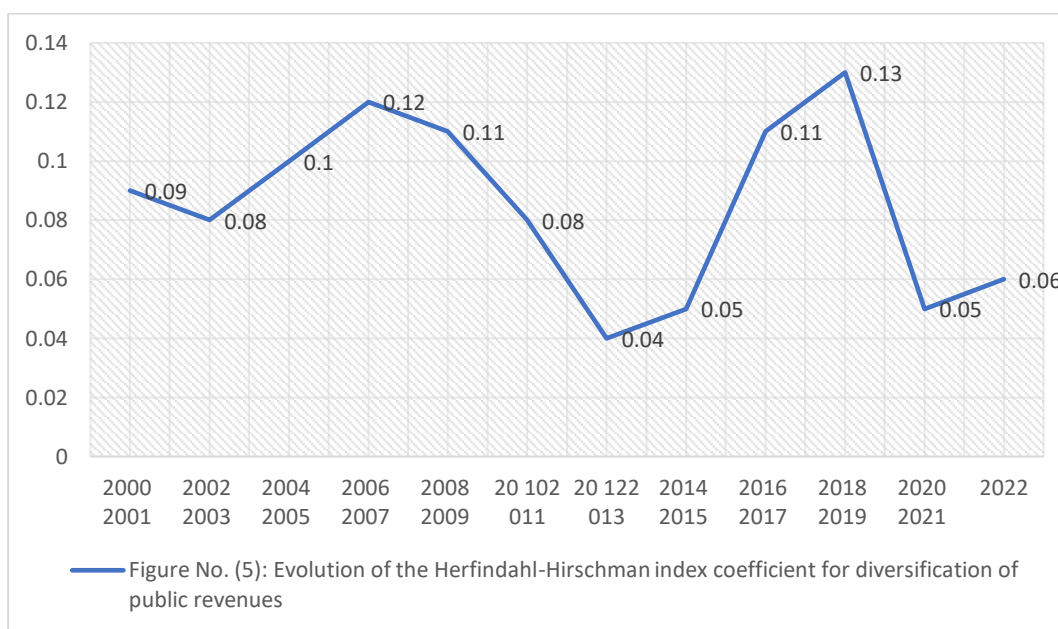


Fig N°(06): Evolution of the Herfindahl-Hirschman index coefficient for diversification of public revenues

Source: Prepared by the researcher based on the annual reports of the Bank of Algeria (BCA, 2024)

➤ **Assessing diversification in fixed capital formation**

Analyzing the allocation of fixed capital formation between the accumulation of gross fixed funds and variations in inventory levels reveals that they progress in a similar direction and nearly in the same ratio, indicating a constrained diversification in fixed capital aimed at augmenting expenditures on fixed assets.

Table N°(04) : Distribution of the gross accumulation of fixed assets Unit: billion DZD

Years	2000 2001	2002 2003	2004 2005	2006 2007	2008 2009	2010 2011	2012 2013	2014 2015	2016 2017	2018 2019	2020 2021	2022
Gross accumulation of fixed capital	5684	5179	5073	6049	6723	6867	7044	8159	7544,3	7689,1	8623,6	9467,4
Change in inventory level	1089,7	797,7	1034,4	1519,6	791,4	453,7	1369	977,8	1284,4	1849,9	993,3	753,9

Source: National Bureau of Statistics report (ons, 2024)

The Herfindahl coefficient of diversification in gross fixed capital formation exhibited a consistent rise from 2000 to 2022, increasing from 0.53 in 2016 to 0.99 in 2022, reflecting a steady average growth rate of 0.09% annually. This trend unequivocally indicates the lack of substantial economic diversification in

the allocation of gross fixed capital formation, as illustrated in Figure No. 7.

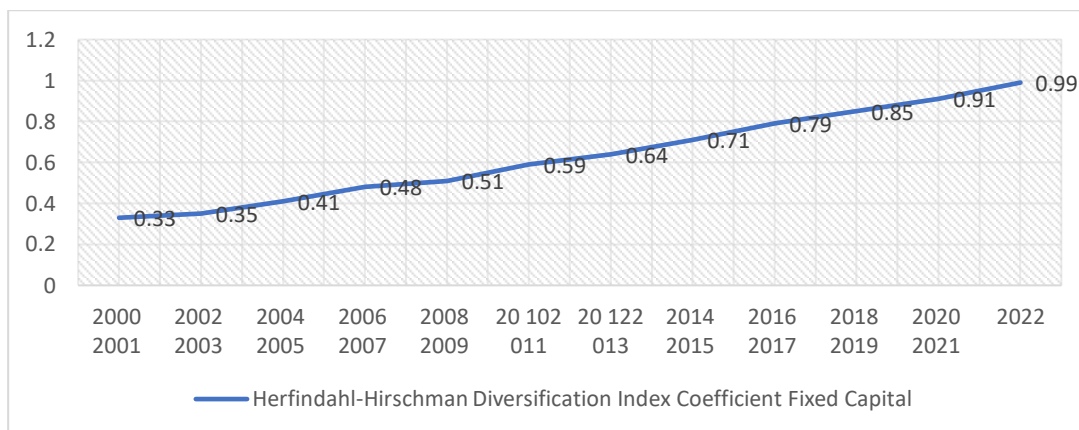


Fig N°(06): Herfindahl-Hirschman Diversification Index Coefficient Fixed Capital

Source: Prepared by the researcher based on data from the reports of the National Bank of Algeria. (BCA, 2024)

4. Conclusion

This paper examines the extent to which the Algerian government has implemented the new growth model and achieved economic diversification by analyzing the Herfindahl-Hirschman coefficient across five macroeconomic variables: gross domestic product, export and import structure, public revenues, and gross fixed capital formation. The findings indicate that Algeria continues to experience insufficient economic diversification, with the hydrocarbon sector dominating production and exports, thereby rendering development dependent on oil revenues. Consequently, it is imperative to reassess the framework upon which this model was established and realign it with the nation's actual capabilities, particularly leveraging the potential of its youth, especially researchers and educated individuals. To attain economic diversity, the government must consider:

- Seeking to use energy income to facilitate economic changes.
- Utilizing the experiences of successful nations in the management of oil earnings.
- Transitioning to the use of renewable energy sources.
- Enhancing the financial dimension through the activation of financial markets.
- Reviewing the currency rate policy and implementing a system aligned with the investment strategy, particularly with tourist investment.
- The agricultural sector is proposed as a potential avenue for diversifying the Algerian economy. Utilizing the implications of the research include specific recommendations, notably that one sector should not be maintained by international innovation and technology.

The matter of economic diversification is crucial for many nations, particularly oil-exporting countries reliant on oil revenues. This singular dependence renders their economies susceptible to external shocks from declining oil prices in global

markets, directly affecting their financial and economic conditions. Consequently, these nations are compelled to explore alternative economic sectors that Facilitate diversification, thereby reducing their reliance on a sole sector, enhancing their income sources, and promoting greater stability.

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