

Determinants of economic growth in Algeria outside of hydrocarbon prices during the period 2000-2022

محددات النمو الاقتصادي في الجزائر خارج أسعار المحروقات خلال الفترة 2000-2022

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Abstract:

This paper seeks to identify the main determinants influencing economic growth in Algeria, excluding hydrocarbon prices during the period 2000-2022, using four different methods: regression, relative importance, general dominance analysis and random forest algorithm. The study results indicate that the Human Developing Index is the main determinant of the Algerian economic growth.

Keywords: Economic Growth, human development, Algeria

Jel Classification Codes : C52, C87, E32

ملخص:

تسعى هذه الورقة البحثية إلى التعرف على محددات النمو الاقتصادي في الجزائر خارج أسعار المحروقات وهذا في الفترة الممتدة من 2000-2022، باستعمال أربعة طرق مختلفة والمتمثلة في: الانحدار المعياري، طرق الأهمية النسبية، تحليل التحكم العام وخوارزمية الذكاء الاصطناعي المسماة الغابة العشوائية. تشير نتائج الدراسة إلى أن أهم محدد للنمو الاقتصادي في الجزائر خارج المحروقات يتمثل في مؤشر التنمية البشرية.

كلمات مفتاحية: النمو الاقتصادي ، التنمية البشرية، الجزائر

تصنيف JEL : C52, C87, E32

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1. INTRODUCTION

Economic growth is regarded as one of the core objectives of economic policy and a crucial measure of economic prosperity. Mankiw (2021) define economic growth as a fundamental concept that contributes to improving the standard of living, reducing poverty and creating employment opportunities.

Economic growth is generally measured by the rise in real Gross Domestic Product (GDP), with a sustained increase in real GDP serving as a key indicator of growth.

Two types of economic growth are distinguished: extensive growth and intensive growth. The extensive growth focuses on increasing the quantity of labor and/or technical capital, while the intensive growth involves enhance in the efficiency of production factors through technological innovation (Irmen, 2005).

After the 1929 crisis, the topic of economic growth and its key determinants became increasingly prominent, drawing significant interest from economists. The literature on this subject has been significantly enriched by two major theoretical frameworks: the neoclassical growth theory proposed by Solow (1956) and the endogenous growth theory, introduced by Romer and Lucas from the 1980s with further development of Grossman and Helpman in the 1990s.

According to the neoclassical theory, capital accumulation and technological progress are considered as key determinants of economic growth. This model regards technological progress as an exogenous factor that contributes to long-term growth with an unspecified origin.

However, the endogenous models attribute long-term growth through internal economic factors. They are generally divided into two categories. The first category focuses on human capital (education and skills) as main factor of economic growth, such as those developed by P. Romer (1989b) and R. Lucas (1988). Romer identified that technological innovation as well as research and development are significant contributors to economic growth. On the other hand, Lucas highlighted the importance of investments in education and worker skills, which boost productivity and consequently stimulate growth. In the second category, Grossman and Helpman (1994) emphasize the importance of research and development to determinate growth.

In this way, the primary distinction between the two models is that considers technological progress as an endogenous variable in the endogenous growth model. This creates a self-reinforcing cycle where technological progress stimulates economic growth, which then enhances technological progress.

Barro's working papers on economic growth determinants highlight several crucial factors influencing long-term economic development. He emphasizes the importance of human capital, particularly education, in enhancing productivity and fostering innovation (Barro, 1990).

Barro also stipulates that strong institutions play an essential role in creating a stable and attractive environment for investment (Barro, 1996).

Furthermore, effective economic policies and economic freedom, with less regulation and open markets, are crucial for promoting growth (Barro, 1991).

Additionally, he studied the impact of technological progress and demographic factors on economic growth and its long-term sustainability (Barro, 2001).

Moreover, economic growth is also affected by institutional factors, fiscal and monetary policies along with structural reforms. Policymakers primarily focus on sustainable economic growth that not only mitigates inequalities but also tackles the environmental issues caused by fast-paced growth expansion.

In order to identify determinants of economic growth, it is crucial to differentiate between developed and developing countries. According to Chirwa and Odhiambo (2016), physical capital and technological factors are the primary growth determinants in developed countries while in developing countries, natural resources, foreign aid, foreign direct investment, investment, reforms, and geographical and political factors play a key role in stimulating economic growth.

Algeria's economic growth has undergone through various phases, significantly impacted by national and international events, including oil crises, the socio-economic instability of the 1990s, and various reforms.

Hydrocarbon prices are considered as the main determinant of economic growth in Algeria as they represent the lion's share of the country's revenues. As a result of the Algerian economy's vulnerability to fluctuations in hydrocarbon prices, which lead to uncertainty in the economy, the authorities are compelled to implement measures to diversify the economy in order to eliminate the dependence to natural resources income.

The principal objective of our study is to define the determinants of economic growth in Algeria apart from hydrocarbon prices during the period from 2000 to 2022.

The main purpose of this study is to order the importance of the variables influencing economic growth in Algeria, excluding hydrocarbon prices. This constitutes our research problem which revolves around the following question:

- Among the study variables, what is the order of importance in terms of determining economic growth in Algeria?

Four methods were used to identify which independent variable impact the most the dependant variable. These are: regression, relative importance analysis, general dominance analysis and random forest algorithm.

2. LITERATURE REVIEW

Interest in economic growth has increasingly attracted the attention of Algerian researchers. This arises from the need of identify the main factors that are essential in determining the Algeria's economic growth.

In order to clearly structure the empirical literature review related to determinants of economic growth Algeria or in comparison with other countries, we have decided to present a concise table that includes important information such as the study period of the paper, the model used, and the main findings.

Table 1 offers an overview of a selected literature developed in favor of the determinants of economic growth in Algeria. The papers will be presented according to the alphabetical sequence.

Table 1. determinants of economic growth in Algeria

Paper	Study period	Model	Main findings
[1]	1985-2020	ARDL	Both export and import have positive impact on economic growth. Exchange rate does not have any effect on economic growth.
[2]	1979-2004	ARDL	The development of the Algerian financial sector does not have any impact on economic growth determination.
[7]	1980-2014	ARDL	The FDIs have a positive long term impact on economic growth determination.
[8]	1990-2021	VAR	Economic growth is slightly influenced by trade openness.
[9]	1990-2020	ARDL	The main determinants of growth are financial intermediation and oil prices. Inflation has a negative and significant effect on economic growth. Liquidity measured by M2/GDP does not impact growth.
[10]	1970-2016	Vecm	Oil revenues have a positive impact on the Algerian economy while investment spending has a negative effect.
[11]	2000-2015	VECM	Hydrocarbon exports are the key driver of long-term economic growth in Algeria, while investment and the non-hydrocarbon export sector show only a weak correlation with economic growth.
[14]	1997-2021	VAR	Human capital has significant impact on economic growth in Algeria
[17]	1980-2021	ARDL	While imports and exports contribute positively to long-term economic growth, the exchange rate has a detrimental effect. In the short term, exports affect economic growth, while imports and the exchange rate exert a negative influence.
[20]	1970-2017	ARDL	Public and private investments impact economic growth in long term. Private investment is significantly correlated to economic growth.
[21]	1979-2019	Regression	Foreign direct investments and financial development have an insignificant effect on economic growth.
[23]	2001-2016	Regression	The SME contributions have weak positive impact on economic growth in Algeria.

[27]	1970-2012	VAR	The FDIs do not impact the Algerian economic growth which contradicts the theory.
[28]	1980-2018	ARDL	Hydrocarbon exports and the payments balance have positive impact on economic growth.
[29]	1990-2018	ARDL	Domestic credit, deposit interest rate and money supply have positive effect on economic growth in short and long term.
[30]	1965-2010	Panel	Education has a positive and significant effect on economic growth.
[33]	1980-2006	Panel	Trade openness is not determinant factor of economic growth in Arab countries.
[34]	1992-2016	Regression	Export instability index has no significant correlation with economic growth. Prices fluctuations and quantities of exports do not effect Algerian economic growth.
[35]	1980-2014	Cobb Douglas function ARDL	Trade openness boosts economic growth in the short term, while it exerts a negative impact over the long term.
[36]	1990-2019	VECM model	Export diversification has positive, no significant affect on economic growth in Algeria.
[37]	1990-2016	Panel	The determinants of sustained economic growth are natural and geographical factors, human capital, trade openness and quality of governance.
[38]	2001-2015	Panel	The determinants of economic growth in Mena area are: government finale consumption expenditure, exports, domestic investment, labor force, tourism and financial development. The foreign direct investment has a negative impact.
[39]	1990-2017	ARDL	Exchange rate and trade balance are not economic growth determinants in Algeria
[40]	1990-2017	ARDL	The main determinants outside the Hydrocarbon sector that have a positive and significant impact on economic growth in Algeria are Human capital, trade openness and monetary mass.
[41]	1990-2014	Linear & Non-linear regression	Determinants of economic growth are total population, size of investment, total exports and final consumption.
[42]	1980-2017	ECM FMOLS	Investment expenses, management expenses, export, and import, loans directed to the private sector and oil prices have a positive impact on economic growth in long term.

			Investment expenditures, export, import, loans to the private sector and oil prices have a positive impact on economic growth in short term.
[43]	1990-2018	ARDL	Public expenditure, capital, human capital, Money Supply and Trade Openness have a significant impact on economic growth.
[44]	1970-2013	ARDL	The monetary stock (volume of money), consumption, exports, oil price, and local investigation have a positive significant impact on economic growth.

Source: Carried out by the author based on the cited articles

3. METHOD

To conduct this research, four different methods were selected to identify the determinants of economic growth in Algeria apart of hydrocarbon revenues by classifying the study variables from the most important determinant to the less important one. The methods are regression, relative importance, general dominance analysis and random forest algorithm.

The models include a dependent variable that we seek to explain, which is the economic growth rate represented by real Gross Domestic Product (**GDP**). The explanatory variables were selected according to the specifications of the Algerian economy. These include: Gross Fixed Capital Formation (**GFCF**), Government Expenditures (**GOVEXP**), Trade opening (**TRADEOPN**), Inflation (**INFL**) and Human Development Index (**HDI**). As mentioned in the introduction, the hydrocarbon prices are excluding from this study.

It should be noted that the data are annual and are collected from the World Development Indicators database (**WDI**) over the period **2000-2022**. The study was carried out using two software: **Eviews** and **R**.

3.1 Preliminary Study of the Model Variables

This step is essential for understanding the historical development of each variable. Table 2 illustrates the descriptive statistics results.

Table 2. Descriptive statistics

Date: 10/23/24 Time: 02:18 Sample: 2000 2022						
	GDP	GFCF	GOVEXP	HDI	INF	TRADEOPN
Mean	2.978261	33.07524	16.71007	0.657693	3.954887	56.78536
Median	3.100000	32.55504	16.96331	0.729927	3.961800	58.54828
Maximum	6.500000	43.38669	20.52447	1.374046	8.891451	65.00018
Minimum	-5.000000	20.67724	11.95145	-1.604278	0.339163	40.04836
Std. Dev.	2.238091	6.838454	2.747135	0.618791	1.995010	7.670009
Skewness	-1.843770	-0.066219	-0.288328	-2.109448	0.474291	-1.071164
Kurtosis	8.208137	1.693008	1.796247	8.786467	3.155819	2.920757
Jarque-Bera	39.02586	1.653861	1.707324	49.14552	0.885585	4.404357
Probability	0.000000	0.437390	0.425853	0.000000	0.642240	0.110562
Sum	68.50000	760.7305	384.3316	15.12693	90.96241	1306.063
Sum Sq. Dev.	110.1991	1028.818	166.0285	8.423841	87.56141	1294.239
Observations	23	23	23	23	23	23

Source: Carried out by the author using Eviews

Below are the results of the descriptive statistical analysis for the study variables.

1- Gross Domestic Product (GDP)

- The standard deviation and the arithmetic mean show a weak difference. Thus, the data is tightly clustered around the mean, with few outliers;
- According to the Skewnes coefficient, the left side is extended more than the right. This means that the distribution leans more to the left;
- According to the Kurtosis coefficient, the data has more outliers and a sharper peak than a normal distribution.

2- Gross Fixed Capital Formation (GFCF)

- A large difference between the **mean** and the **standard deviation** indicates that the data has considerable spread, with some outliers;
- The Skewnes coefficient indicates that the distribution is almost symmetrical;
- The Kurtosis coefficient stipulates that the data is more flat with fewer outliers.

3- Government Expenditures (GOVEXP)

- A significant gap between the **mean** and the **standard deviation** suggests that the data values are widely dispersed, with few outliers;
- The Skewnes coefficient indicates that the distribution is more concentrated on the left side;
- According to the Kurtosis coefficient, the data is more flat with few outliers (Platykurtic).

4- Human Development Index (HDI)

- The difference between standard deviation and arithmetic mean suggests that the data points are closely grouped around the mean, with low dispersion;
- The Skewnes coefficient illustrates that the left tail extends further than the right;
- The Kurtosis coefficient stipulates a leptokurtic where the data has a sharper peak than a normal distribution and more outliers.

5- Inflation (INFL)

- A small difference between the **mean** and the **standard deviation** indicates that the data values are tightly clustered around the mean, with few outliers;
- The Skewnes coefficient shows that fairly symmetrical distribution where the right tail is slightly extended than the left;
- The Kurtosis coefficient indicates a normal distribution.

6- Trade opening (TRADEOPN)

- A large difference between the **mean** and the **standard deviation** suggests that the data is highly dispersed where many data points lie far from the mean (outliers);
- The Skewnes coefficient indicates that left side has a longer tail compared to the right;
- The Kurtosis coefficient shows a normal distribution.

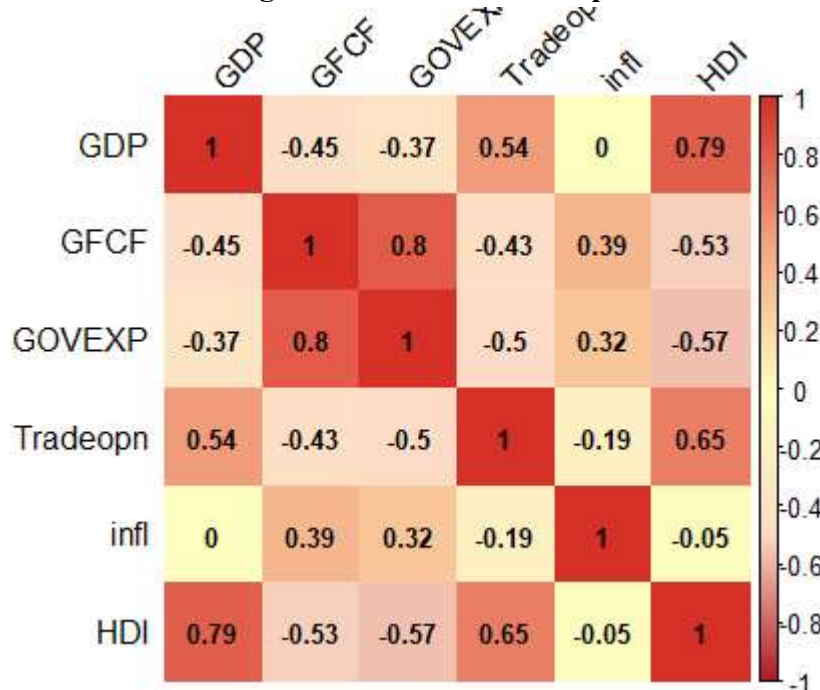
In conclusion, gross fixed capital formation and trade opening will be examined with caution.

3.2 Correlation Heatmap

Figure 1 shows a correlation matrix. The dark colors show a strong correlation while the light colors illustrate a weak correlation.

The results indicate a negative weak correlation between GDP and GFCF and GOVEXP while HDI has a strong positive correlation to GDP.

Fig.1. Correlation Heatmap



Source: Carried out by the author using R

4. RESULTS AND DISCUSSION

The objective of this paper is to classify the study explanatory variables (**GFCF**, **GOVEXP**, **TRADEOPN**, **INFL** and **HDI**) according to the degree of importance in terms of determining economic growth in Algeria, using four different methods: regression, relative importance, general dominance and random forest algorithm.

4.1. Regression

The first method used in the study was an extension of linear regression introduced by Gujarati (2019). The standardization process involves calculating the difference between each variable and its arithmetic mean, and then dividing by its standard deviation. After that, we proceed to estimate the parameters.

It is noteworthy that coefficients obtained from classical linear regression, the VCM model, or the ARDL model accurately reflect the true underlying relationships. For instance, in multiple regression, the highest coefficient is often seen as the main factor affecting the dependent variable. However, this interpretation may be unreliable, as it could result from potential issues in the model under consideration. This provides justification for the use of the methods outlined earlier.

Table 3 illustrates the results of the first method.

Table 3. Method 1 results

Residuals:				
Min	1Q	Median	3Q	Max
-1.37464	-0.39646	0.01329	0.32516	1.17975
Coefficients:				
	Estimate	Std. Error	t value	Pr(> t)
GFCF	-0.29184	0.23783	-1.227	0.23560
GOVEXP	0.32086	0.23776	1.349	0.19391
Tradeopn	0.07564	0.18478	0.409	0.68710
infl	0.07316	0.15182	0.482	0.63569
HDI	0.77623	0.20024	3.877	0.00111 **

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1				
Residual standard error: 0.6335 on 18 degrees of freedom				
Multiple R-squared: 0.6716, Adjusted R-squared: 0.5804				
F-statistic: 7.364 on 5 and 18 DF, p-value: 0.0006476				

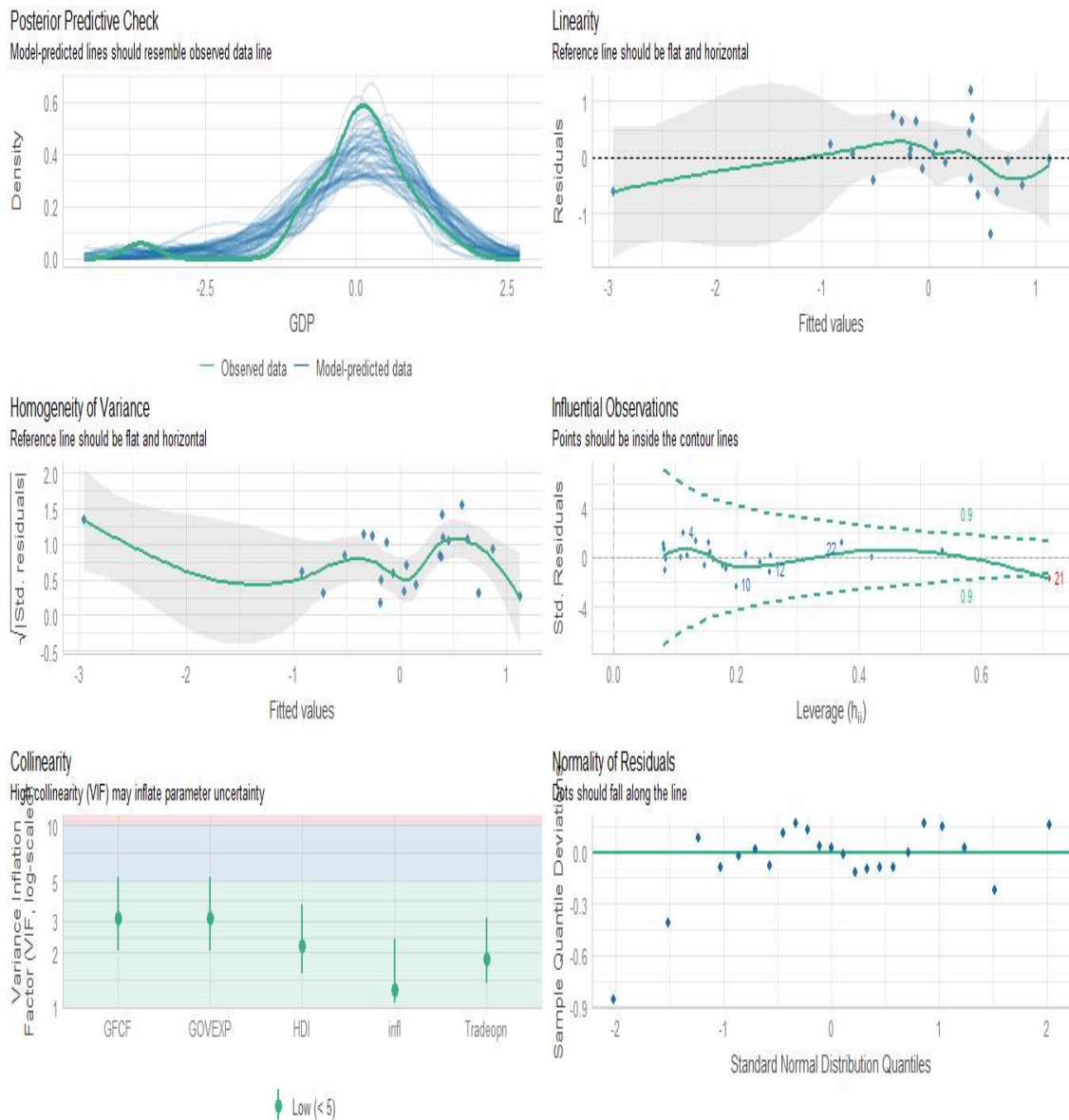
Source: Carried out by the author using R

According to the regression results, the Human Development Index (**HDI**) is identified as the main factor in determining economic growth in Algeria, followed by Government Expenditures (**GOVEXP**), Trade opening (**TRADEOPN**), Inflation (**INFL**), and Gross Fixed Capital Formation (**GFCF**), which has a negative impact.

$R^2=0.6716$, this indicates that 67.16% of the variation in the real GDP is explained by the independent variables of the study (GFCF, GOVEXP, TRADEOPN, INFL and HDI)

To guarantee that the model is devoid of any statistical problems, we have carried out the performance model check. (Figure 2)

Fig.2. Performance model check



Source: Carried out by the author using R

The graphs presented above indicate that:

- There is a convergence between the estimated model and the real data (Posterior predictive check). This indicates that the model accurately represents the behavior of the real data;
- Homogeneity of variance of residuals in this model (graph is almost flat and horizontal);
- Factor VIF is lower than 5 which means absence of multicollinearity issue;
- All data points lie within the confidence interval, indicating the absence of outliers. The last observation refers to the Corona virus pandemic (Observation 21).

4.2. Relative importance

The second method used in the study was introduced by Lindeman & al. (1980). Table 3 and Figure 2 illustrate the main findings.

Table 4. Method 2 results

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Response variable: GDP
Total response variance: 5.009051
Analysis based on 23 observations

5 Regressors:
GFCF GOVEXP Tradeopn infl HDI
Proportion of variance explained by model: 67.16%
Metrics are not normalized (rela=FALSE).

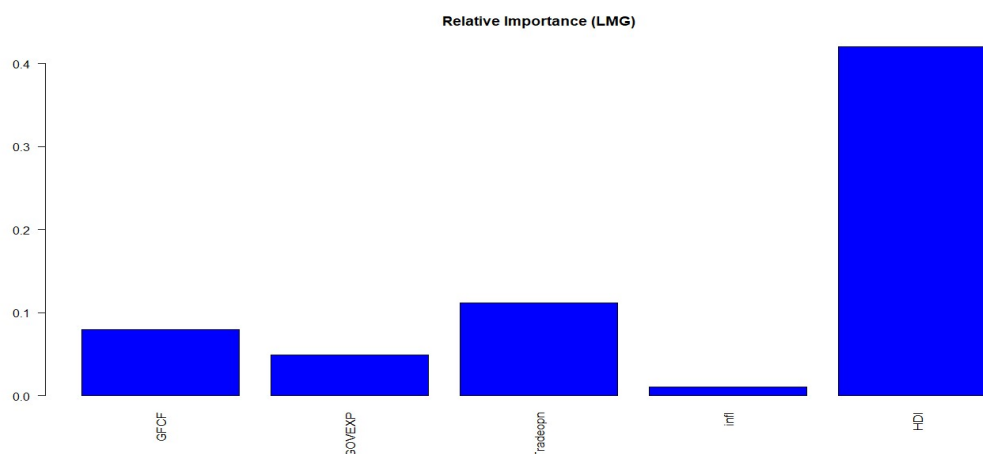
Relative importance metrics:

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	lmg	last	first	pratt
GFCF	0.07984336	0.027467799	2.028958e-01	0.1314567516
GOVEXP	0.04916021	0.033220620	1.342418e-01	-0.1175582486
Tradeopn	0.11225490	0.003057045	2.871677e-01	0.0405351063
infl	0.01032955	0.004236072	8.650916e-06	0.0002151841
HDI	0.42005785	0.274127372	6.318041e-01	0.6169970768

Source: Carried out by the author using R

Fig.3. Relative importance



Source: Carried out by the author using R

The relative importance method allowed us to rank the study's variables to identify their respective impact on economic growth determination. The test results show that the Human Development Index (**HDI**) is the key determinant of economic growth in Algeria, followed by Trade opening (**TRADEOPN**), the Gross Fixed Capital Formation (**GFCF**), Government Expenditures (**GOVEXP**), and Inflation (**INFL**).

4.3. Dominance analysis

The third method used in this study was introduced by Budescu (1993). Table 4 indicates the results of the dominance analysis test.

Table 5. Method 3 results

Overall Value: 0.6716459			
General Dominance Values:			
	General Dominance	Standardized	Ranks
GFCF	0.07984336	0.11887717	3
GOVEXP	0.04916021	0.07319365	4
Tradeopn	0.11225490	0.16713405	2
infl	0.01032955	0.01537946	5
HDI	0.42005785	0.62541566	1

Source: Carried out by the author using R

The findings from this method are consistent with those of the previous one. The test results indicate that the Human Development Index (**HDI**) is the main determinant of economic growth in Algeria. The ranking of the remaining variables is as follows: Trade opening (**TRADEOPN**), the Gross Fixed Capital Formation (**GFCF**), Government Expenditures (**GOVEXP**), and Inflation (**INFL**).

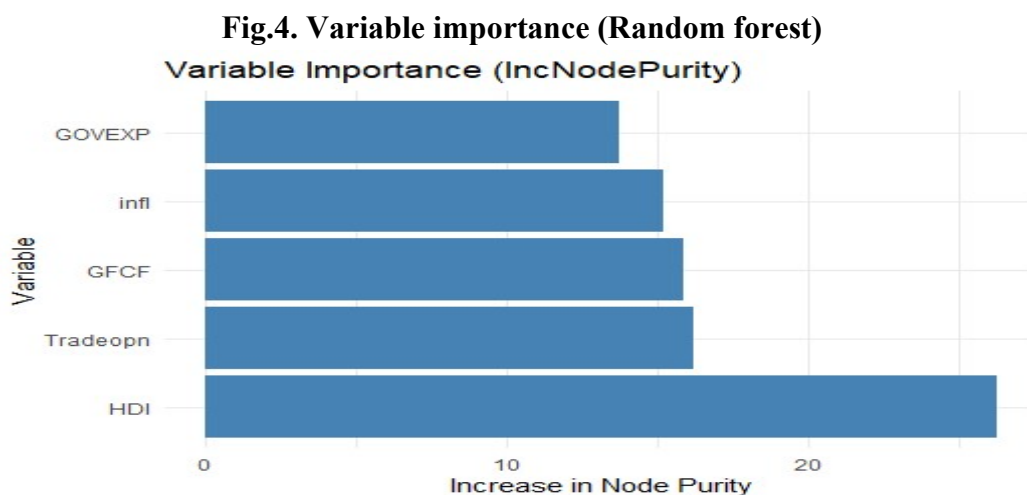
4.4. Random forest algorithm

The fourth method was reserved to an Artificial Intelligence method, specifically a machine learning algorithm method which is the random forest algorithm. This AI method was introduced by Breiman (2001) and Cutler & al. (2012). It is used in both classification and regression.

Table 6. Method 4 results

Type of random forest: regression		
Number of trees: 500		
No. of variables tried at each split: 1		
Mean of squared residuals: 4.768483		
% var explained: 0.48		
> importance(model_rf)		
	%IncMSE	IncNodePurity
GFCF	5.4146223	15.88204
GOVEXP	0.3449114	13.75116
Tradeopn	4.9470810	16.20451
infl	-2.9089315	15.19976
HDI	6.8464627	26.27319

Source: Carried out by the author using R



Source: Carried out by the author using R

The main findings of random forest algorithm method indicate that the Human Development Index (**HDI**) is the Algerian economic growth primary determinant, followed by the Gross Fixed Capital Formation (**GFCF**), Trade opening (**TRADEOPN**), Government Expenditures (**GOVEXP**), and Inflation (**INFL**), which has a negative effect.

5. CONCLUSION

In macroeconomics, understanding the determinants of economic growth is crucial in order to identify the key factors for long-term sustainable and maintained growth. As mentioned before, researchers from different schools of thought have contributed to the literature on economic growth.

Studies on economic growth determination in Algeria have caused a lot of ink to flow. In the current paper we assess the factors affecting economic growth in Algeria excluding hydrocarbon prices.

The main findings indicate that the Human Development Index (HDI) is seen as the key determinant of the Algerian economic growth. In addition, Trade opening (**TRADEOPN** and Gross Fixed Capital Formation (**GFCF**) have both a considerable impact on economic growth determination.

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