ENERGY TRANSITION, ECONOMIC GROWTH AND ENVIRONNEMTAL SUSTAINABILITY IN ALGERIA

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Received: 25/03/2022/ **Accepted**: 16/06/2022 / **Published**: 06/07/2022
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ABSTRACT

This article aims to empirically analyze the relationship between energy transition, economic growth and CO2 emissions in Algeria, over the period of 1980-2018, using simultaneous equations model. The empirical results reveal that human capital, physical capital stock per capita, energy transition and oil prices stimulate real GDP per capita. Likewise, real GDP per capita positively affects CO2 emissions; however the latter are negatively linked to energy transition and exports. Therefore, increasing the share of renewable energy to fossil fuels consumption is one of the suitable strategies to stimulate economic growth and improve environmental sustainability.

KEYWORDS:

Energy transition, Economic growth, Environmental sustainability, Algeria.

JEL CLASSIFICATION: C30, C51, 011

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الانتقال الطاقوي، النمو الاقتصادي و الاستدامة البيئية في الجزائر

ملخص

تهدف هذه الورقة البحثية إلى تحليل العلاقة ما بين الانتقال الطاقوي، النمو الاقتصادي، وانبعاث غاز ثاني أكسيد الكاربون في الجزائر خلال الفترة ما بين 1980-2018.أظهرت النتائج المتحصل عليها من خلال تقدير نموذج المعادلات الآنية أن ناتج الدخل الفردي الحقيقي يتأثر ايجابيا برأس المال البشري، رأس المال المادي، مؤشر الانتقال الطاقوي، وسعر البترول، كما أظهرت النتائج أن انبعاث ثاني أكسيد الكاربون لها علاقة طردية مع ناتج الدخل الفردي الحقيقي وعلاقة عكسية مع مؤشر الانتقال الطاقوي، وعليه فإن الرفع من استهلاك الطاقات المتجددة يعتبر من أحسن الآليات لتحفيز النمو الاقتصادي والوصول إلى استدامة بيئية.

كلمات مفتاحيه:

الانتقال الطاقوي، النمو الاقتصادي، الاستدامة البيئية، الجزائر

تصنيف جال : C30, C51, 011

TRANSITION ÉNERGÉTIQUE, COROISSANCE ÉCONOMIQUE ET DURABILITÉ ENVIRONNEMENTALE EN ALGÉRIE

RÉSUMÉ

L'objet de cet article est d'analyser empiriquement la relation entre la transition énergétique, la croissance économique et les émissions de CO2 en Algérie en utilisant le modèle à équations simultanées, duant la période 1980-2018. Les résultats d'estimation montrent que le capital humain, le stock de capital physique par tête, l'indice de la transition énergétique et les prix du pétrole stimulent le PIB par tête. En revanche, les résultats obtenus confirment que la croissance du PIB par tête conduit à la hausse des émissions de CO2, tandis que celles-ci sont influencées négativement par l'indice de la transition énergétique et les exportations. Par conséquent, la promotion de la consommation des énergies renouvelables est l'une des meilleures stratégies qui permet aussi bien de stimuler la croissance économique que d'améliorer la durabilité environnementale.

MOTS CLÉS

Transition Energétique, Croissance Economique, Durabilité Environnementale, Algérie.

CLASSIFICATION JEL: C30, C51, 011

INTRODUCTION

In Algeria, the hydrocarbon sector plays an important role in the economy. Indeed, Algeria's gas and oil reserves are estimated at 4.51 trillion cubic meters and 12.2 billion oil barrels, respectively (Belaid and Youssef, 2017). The energy industry contributed to more than 20% of the GDP, 41% of the fiscal revenues, and 9% of the exports earnings (WB, 2019). Moreover, 76% of the total crude oil and 86% of the natural gas exports are destined to Europe countries, especially Spain, Italy and France (Grigorjeva, 2016). Therefore, Algeria's economy is suffering from the negative effects of external shocks; like oil prices crash of 1986 and that of 2015, financial crisis of 2008…etc. (Lopez-Calix and Touqeer, 2016; Benameur et al., 2020).

Otherwise, demographic expansion, economic activities and lifestyle change in Algeria led to increase rapidly the domestic energy consumption (Bouznit and Pablo-Romero, 2016). For instance, the total final energy consumption increased by 32% between 2010 and 2014, while the main increase was observed in the residential electricity consumption sector (IEA, 2017). Therefore, electricity demand is expected to be doubled by 2030 (Nachmany et al., 2015). Furthermore, fossil fuel production has had a downward trend during the last decade. This situation can be explained by the disadvantageous doing business in Algeria leading to hinder foreigner companies to invest in the hydrocarbon sector (US-EIA, 2016). Consequently, Algeria's government finds it difficult to conclude new corporation contracts with foreigner oil companies. For instance, among 31 international tenders in 2014, only four licences have been attributed to the petroleum foreigner companies (US-EIA, 2016).

Nevertheless, an increase in fossil energy consumption leads to rise greatly emission of greenhouse gas (GHG) in the air causing the atmospheric pollution, which, in turn, accentuates climate change phenomenon (Kasman and Duman, 2015; Omri, 2013; Campo-Robledo and Olivares, 2013; Saboori and Sulaiman, 2013). In this context, Algeria is vulnerable to the multiform effects of climate change, because the yearly average rainfall was decreased by more than 30% over the past decades causing several disastrous effects on the biodiversity (Bouznit and Pablo-Romero, 2016; Bouznit et al., 2022). Moreover, World Bank classifies Algeria among the poorest countries in terms of water sources with only 500 m^3 per person per year, knowing that the World Bank's threshold is fixed at 1000 m^3 per capita per year (NCP-Algeria, 2019).

In view to fight climate change, Algeria signed the Paris agreement in 2015 by committing to reduce carbon emissions by 7% by 2030, which represents the amount of 348 MtCO2. Consequently, the turning point of the total emissions is expected to be reached by 2024. However, if the developed countries grant financial helps and technology to Algeria, GHG emissions can be reduced by 22% by 2030. For doing so, Algeria adopted in 2015 the updated version of the national program of renewable energy and energy efficiency (NPREEE). The latter establishes the suitable measures and programs to be implemented during the period 2015-2030 in energy, forests, housing, transport, industry and waste sectors. These actions and measures aim three objectives; energy transition and energy efficiency, climate change mitigation and sustainable development. Therefore, the share of renewable electricity in total electricity consumption is expected to be 27% by 2030. Nevertheless, Algeria finds it difficult to promote renewable energy (RnE). In 2021, the statistics of the World Economic Forum on energy transition reveal that Algeria is classified 79th among 115 countries, while the first county in the world is Sweden, and Qatar, Morocco, and Tunisia are ranked 53rd, 66th and 88th, respectively (WEF, 2021).

According to Diji (2019), the energy transition is the process of shifting from the use of polluting fossil energy to renewable energy causing long-term economic and environmental structural changes. In this sense, numerous studies note that RnE plays a positive role on economic growth in developing countries (Arora and Shi, 2016; Gorus and Aydin, 2019; Pablo-Romero and Sanchez-Braza, 2017). Moreover, there is a widely consensus in the literature that economic growth and fossil energy use are the main sources of environmental degradation. Therefore, the new challenge facing Algeria in the coming year is to fight climate change without negatively impacting economic growth. To the author's knowledge, no study has highlighted this issue in Algeria. This paper aims to provide suitable recommendations to policymakers to establish an energy policy based on the balance between economic growth and environmental sustainability. For doing so, we will analyze the relationship between energy transition, economic growth and CO2 emissions in Algeria over the period of 1980-2018. The rest of this paper is structured as follows. The section 1 is devoted to the literature review. The Algeria's energy transition strategy and the methodology are presented in section 2 and section 3, respectively. The used data, results and discussion are given in section 4. The main conclusions are reported in the conclusion section.

1- LITERATURE REVIEW

In the extant literature, there is widely consensus that climate change directly and indirectly undermines the economy (Rezai et al., 2018; Fankhauser and Tol, 2005; Dell et al., 2008). In this context, Kasman and Duman (2015) and Omri (2013) argue that greenhouse gas emission is strongly linked to fossil fuels consumption. Recently, similar results are obtained in a large number of studies examining the effects of transition from fossil fuels to RnE on economic growth and environmental sustainability. Among them, the study by Mohsin et al. (2021) finds that energy consumption positively correlated to economic growth, whilst renewable energy negatively affects CO2 emission. The authors also validated the feedback hypothesis between renewable energy consumption and economic growth in developing Asian economies. Moreover, Pablo-Romero and Sanchez-Braza (2017) supported the residential Energy-Environmental Kuznets Curve hypothesis for the EU-28 countries. Likewise, Bouznit and Pablo-Romero (2016) further validated the EKC hypothesis for Algeria; however the turning point will be reached for a very high GDP per capita value, meaning that an increase in economic growth leads to raise CO2 emissions. With respect to the southern and northern Mediterranean countries, the study by Belaid and Zrelli (2019) confirms that non-renewable electricity consumption increases CO2 emissions, while renewable electricity consumption reduces them. On the other hand, Chen et al. (2022) empirically analyzed a nonlinear relationship between renewable and non-renewable energy consumption, income and CO2 emission using a dynamic panel threshold model. Author's findings show that CO2 emission tends to decrease only when the renewable energy consumption of the countries surpassed a certain threshold. For the OECD countries, Khan et al. (2022) further found that increasing energy transition leads to improve the environmental sustainability; while the economic growth tends to decrease. In contrast, the effect of RnE consumption on CO2 emission was found either positive or insignificant in some previous studies. In this sense, Apergis et al. (2010)obtain a significant and positive causality relationship between RnE consumption and CO2 emission in 19 developed and developing countries. Menyah and Wolde-Rafeal (2010) further noted that if RnE consumption doesn't reach a certain level, its contribution to reduce CO2 emission will be insignificant.

2- ENERGY TRANSITION STRATEGY OF ALGERIA

It is worth noting that Algeria's energy transition strategy has evolved over time. First, the law n° 99-09 defines the conditions and means needed to implement the national policy of energy management. The latter seeks to rationalize the energy use by optimizing the energy consumption from the production and transformation to the final consumption, developthe electricity generation from renewable sources (solar, geothermal and wind, and the hydroelectricity). It also intends to reduce the negative effectsof energy consumption onthe environment by decreasing greenhouse gas emissions in the residential areas. Meanwhile, the law n° 04-09 aims to promote the use of renewable energy in order to protect the environment, mitigate climate change by reducing the greenhouse gas emissions.

Given that the energy transition targets require financial resources to meetthem, Algeria, via the law n° 09-09 published in 2009, created the National Fund for Renewable Energy (NFRE), and allocated 0.5% of Oil royalties to its budget. Otherwise, the complementary finance law n° 11-11of 2011 has fixed the new feeto be taken from oil royalties to finance the budget of the NFRE; it became 1% instead of 0.5%. Moreover, the executive decree n°13-218, published in June 2013, aims to promote the investment in all fields of renewable energy by granting premiums for the costs of diversification of electricity generation from renewable sources. Therefore, investors have the legal guarantees for selling, at a price more than the whole production costs, the all electricity produced from the renewable sources.

Further, Algeria launched the pilot version of the national program to develop renewable energy and energy efficiency(NPDREEE) in 2011, while the final version was adopted in 2015. This program defines the suitable actions and incentive measures to be implemented, in the middle and long run, to success the energy transition and mitigate climate change. For doing so, the electricity generated using renewable sources and energy efficiency practices will be promoted. In that context, the regulatory framework was updated, it became more suitable to attract and increase the governmental and private investments in the renewable energy sector (Bouznit et al, 2020). Indeed, as Algeria has one of the most important solar deposits in the world, with more than 3,000 hours of sunshine per year and 5 kWh of daily energy received on a horizontal surface in most part of the country (Ghezloun, et al., 2015**)**, the solar photovoltaic is chosen to be the main source to generate the renewable electricity necessary to reach the mix energy. The contribution of the solar and wind inelectricity production is expected to be 27% and 3% respectively by 2030. To achieve this objective; the amount of 22000 MW is envisagedto be gradually produced by 2030, with 12000MW should be reserved to meet the domesticelectricity demand and 10000MW will be destined to the export (Bouznit et al., 2020). Moreover, Algeria established a set of measures and programs to protect and develop the forests in order to enhance the absorption of CO2 emitted in the air (i.e. forestation, reforestation, fighting the forest fires…etc.) (Bouznit et al., 2022). A further detail, Table 1 summarizes the different targets of the national program of renewable energy and energy efficiency of Algeria.

Table 1: Targets of Algerian's national program of renewable energy and energy efficiency

	Electric Power (MW)		
	1ststep (2015-2020)	**2ed step (2021-2030)**	**Total**
Solar photovoltaic	3000	10575	13575
Wind power	1010	4000	5010
Solar thermal	-	2000	2000
Biomass	360	640	1000
Cogeneration	150	250	400
Geothermal	05	10	15
Total	4525MW	17475MW	22000MW

Source: Algeria's INDC (2015)

It should be noted that the transition from the fossil energy to the renewable energy would be very important for Algeria to better cope with global warming. In this context, the amount of natural gas to be saved is estimated at more than 300 billion m^3, which represent 8 times of domestic consumption in 2014, leading to reduce carbon emissions by 348 MtCO2 equivalents by 2030 (Bouznit et al. 2020, Sahnoune and Imessad, 2017). For that reason, Algeria committed to increase renewable energy production. The latter has been doubled between 2000 and 2020, however its share in total electricity generation remains very weak, it remains less than 1% of the total electricity generation (Bouznit et al, 2022). Moreover, according to International Renewable Energy Agency report, over the period 2015-2020, Algeria produced only 410 MW from solar photovoltaic and

10MW from wind power, representing growth rates of 13.7% and 0.99%, respectively (IRENA, 2020, Bouznit et al., 2020).

Despite that the NPDREEE was very ambitious; its objectives have been further revised in 2020. the national program of energy transition (NPET), adopted in 2020, was built on four pillars: preserving the fossil energy sources, change the model of energy production and consumption, protecting the environment, reaching the sustainable development, and mastering the costs of renewable energy production. The priority will be given to develop electricity generation from the solar and promote energy efficiency practices. The electricity to be generated, using only the solar photovoltaic, is fixed at 16000MW by 2035, including 15000MW should be produced in the solar power stations connected to the national electrical grid(CEREFE, 2020). However, the remaining 1000 MW is to be generated independently. In addition, the NPET also aims to change consumer behaviour of citizens by establishing a set of incentive measures to rationalize electricity consumption, reduce energy losses and improve energy savings (the electricity losses are estimated at 20%) (Belaid and Abderrahmani, 2013; Bouznit and Pablo-Romero, 2016). Likewise, using the new energy-efficient technologies to reduce electricity consumption in the higher consumer energy sectors (energy-efficient machines, thermal insulation in constructing building, LED lamps, and solar air conditioning system ...etc.) (CEREFE, 2020; Bouznit et al., 2020).

3- METHODOLOGY

As mentioned above, this study analyzes the relationship between energy transition, economic growth and environmental sustainability for Algeria using annual data from 1980 to 2018. According to endogenous growth theories, economic growth, measured as real GDP per capita, is considered to be a function of physical capital and human capital (Lucas, 1988, Romer, 1986, Mankiew et al., 1992; Benhabib and Spiegel, 1994). Moreover, the economic growth model will be extended to include a set of control variables namely; crude oil prices (Van et al.,2019; Akinsola and Odhiambo, 2020, energy transition

(Taghizadeh-Hesary and Rasoulinezhad, 2020), and imports and exports of goods and services (Bouznit at al., 2018). Likewise, the environmental degradation, measured as the amount of CO2 emitted into the air, is also supposed to be linked to economic growth, energy consumption, and imports and exports of goods and services (Panayotou, 1993; Al-Mulali et al., 2015; Bouznit and Pablo-Romero, 2016; Khan et al, 2022). However, the share of renewable energy to fossil energy consumption will be used as a proxy of energy transition.

The equations [1] and [2] are interlinked, because economic growth is considered endogenous variable in the first sub equation and exogenous variable in the second sub equation. In this context, the simultaneous equations system is suitable model to examine the direct and indirect interaction between the studied variables (Omri, 2013, Bourbonnais, 2015, Liu et al.,2019).This model can be expressed as follows:

$$LnGDPC_t = C_1 + \beta_1 LnK_t + \beta_2 LnH_t + \beta_3 LnET_t + \beta_4 LnOP_t + \beta_5 LnImp_t + \beta_6 LnExp_t + \beta_7 D_{1994} + \varepsilon_{1t} \quad [1]$$

$$LnCO2_t = C_2 + \beta_8 LnGDPC_t + \beta_9 LnET_t + \beta_{10} LnImp_t + \beta_{11} LnExp_t + \varepsilon_{2t} [2]$$

where, *Ln* is the natural logarithm.*GDPC* is the real gross domestic product per capita at constant 2017 national prices.*CO2* is the variable referring to carbon dioxide emissions per capita. *ET* is the transition energy measured as the share of renewable energy to fossil energy consumption. The explanatory variables *K, H, OP, Imp* and *Exp* are stock of physical capital per capita, human capital, crude oil prices, imports of goods and services, exports of goods and services respectively. Finally,C_1, $C_2, C_3, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8, \beta_9, \beta_{10}$ and $\beta_{11}$are the parameters to be estimated, while ε_{1t} andε_{2t} are white noise errors terms. The dummy variable$D_1994$is included in the economic growth equation to capture the structural change when Algeria had adopted the structural adjustment plan in 1994. The used data are annually figures covering the period of 1980-2018.

Otherwise, the identification test reveals that the equation [1] is exactly identified, whilst the equation [2] is over-identified. In this case, the 2SLS is the most common method used to estimate the simultaneous equations system (Bourbonnais, 2015; Greene, 2002). Nevertheless, the 3SLS is also used to deal with serial correlation and heteroskedasticity problems (Bourbonnais, 2015; Wooldridge, 2010).

4- RESULTS AND DISCUSSION

4.1- Used data

It's worth noting that the used data are collected from four databases namely,Global Carbon Project, Pen World Table 10.0, U.S. Energy Information Agency (EIA) and Word Development Indicators (WDI) of the World Bank. All the studied variables are observed during the period from 1980 to 2018. A further detail, Table 2 reports the definition of the selected variables and data sources, while descriptive statistics of the used data are given in Table 3.

Table 2. Definition of selected variables and data sources

Variables	Symbol	Measure	Data source
CO2 emissions	CO2	CO2 emissions per capita (in million tons per year)	Global Carbon Project
Physical Capital stock	K	Physical capital stock per capita at constant 2017 national prices (2017US$)	Pen World Table 10.0
Real GDP per capita	GDPC	*GDP* is the real gross domestic product per capita at constant 2017 national prices	Pen World Table 10.0
Human capital	H	Human capital index, based on years of schooling and returns to education	Pen World Table 10.0
Share of RnE in Fossil Energy	ET	the share of RnE to fossil energy consumption	US-EIA
Crudes Oil prices	OP	Crudes oil prices at $2018	BP Statistical
Imports Exports	Imp Exp	The country's exports and imports measured as a share of GDP (in %).	WDI World Bank

Source: Elaborated by the author

Table 3. Descriptive statistics of used data

Variable	Obs	Mean	Std. Dev.	Min	Max
CO2	39	3.15	0.40	1.91	3.89
GDP	39	9389.87	1226.93	7564.58	11480.88
K	39	291260.4	95999.69	166473	477278
H	39	1.78	0.31	1.25	2.34
ET	39	0.003	0.002	0.0007	0.0089
Imp	39	26.79	4.408172	18.41	36.52
Exp	39	30.44	9.363155	12.85	48.81
OP	39	42.34	29.97736	12.71	111.66

Source. Elaborated by the author

4.2- Results and discussion

The estimated results are shown in Table 4. Columns A and B show the results obtained using 3SLS, while those obtained using 2SLS are reported in columns C and D. The signs and the values of estimated parameters using 3SLS are equivalent to those obtained using 2SLS. Therefore, the findings of the paper aren't sensitive to the used estimating methods. Indeed, the estimated coefficients with respect to physical capital stock per capita and human capital, in columns A and C, appear with a positive sign and statically significant at 5% and 1%, receptively. Therefore, real GDP per capita is positively linked to physical capital stock per capita and human capital, implying that an increase by 1% in K and H leads to raise real GDP per capita by 0.43%(or 0.55%) and 0.20%(or 0.17%), respectively. Likewise, the dummy variable D_1994 appears with a negative sign and significant at 1%; thereby the structural adjustment negatively impacted the economic growth. These results are in line with the extant literature analysing the determinants of economic growth. In this context, endogenous growth theories argue that technological progress and human capital, mainly accumulated from education, and their positive externalities are necessary to sustain and faster growth rate (Romer, 1986; Lucas, 1988; Barro, 1991; Benhabib et Spiegel, 1994, Bouznit et al., 2015, Pablo-Romero et al., 2016). Lucas (1988) noted that human capital is the engine of the economic growth in the long run. Similarly, Romer (1986) further showed that improving human capital is necessary to enhance innovation activities, which, in turn, stimulate growth rate. Moreover, high level of human capital helps to absorb technological progress and physical capital from the abroad leading to increase economic growth (Romer, 1990, Bouznit et al. 2015). Nevertheless, imports and exports of goods and services don't have any effect on economic growth of Algeria during the studied period, because their estimated coefficients aren't statistically significant.

The obtained results also indicate that economic growth is positively related to energy transition. If the latter increase by 1%, the real GDP per capita is expected to be increased by 0.05%. Otherwise, the estimated coefficient with respect to oil prices is positive and significant at 1%. This result is consistent with previous studies which showed that economic growth of oil exporting countries is strongly linked to the variation of crude oil prices (Benramdane, 2017;Van et al.,2019). Regarding Algeria, fossil fuels revenues remain the main factor to maintain macroeconomic equilibrium, achieve numerous of development plans, improve wellbeing and people's quality of life, and also increase the economic growth rate. Indeed, as oil prices experienced a strong upward during the 1970s, gross fixed capital formation in numerous industries had experienced also a great increase especially in heavy industry and hydrocarbon sector. Between 1973 and 1977, 61% of GDP were devoted for promoting the industrial sector, 5% for agriculture sector, and 34% of GDP in view to build the heavy infrastructures. Consequently, the gross fixed capital formation in the industrial sector in 1977 was five times more than that recorded in 1967, it moved from 7.56 billion DZD to 44.4 billion DZD (Palloix, 1980).Likewise, the unemployment rate was very weak, it was estimated at 3.2% in 1979 (Chantal, 1979). However, the crude oil price experienced a strong decrease in 1986; it fell from $28 to $16 per barrel, leading to multidimensional economic crisis. Between 1985 and 1989, the annual rate growth was estimated at1.33%. The public investment has had a strong downward trend; however, the unemployment rate and the inflation rate have had a strong upward trend. Consequently, the purchasing power was dropped rapidly and the shortage of the consumer products during the period 1987-1997.

According to Bouyacoub (1997) and Bank of Algeria (2022), the external debt-service of Algeria was more than 80% of export revenues in 1993. Thus, the statistics provided by the World Bank reveal that growth rate of Algeria's GDP was negative over the period 1993-1995. For instance, the growth rates were (-2.10%) in 1993 and (-0.89%) in 1994. Meanwhile, the unemployment rate reached the record levels; it was 23% in 1993, 24% in 1994, and 27% in 1995. In addition, the inflation rate surpassed the threshold of 29% in 1994. This situation pushed Algeria to adopt in April 1994 the structural adjustment plan (SAP) concluded with IMF,leading to decrease the national currency value by 40%, reduce heavily the public expenditures, privatised the governmental enterprises, and open the external trade to the private enterprises. Moreover, the increase in crude oil price at the beginning of the 2000s, where the annual price reached $120 in 2012, it allowed for Algeria to get its macroeconomic equilibrium and adopt three development plans over the period from 2001 to 2015. Algeria invested $7 billion, $150 billion and $286 billion during the periods of 2001-2004, 2005-2009 and 2010-2014, respectively.

Table 4. Estimation results

	3SLS		2SLS	
	A	B	C	D
	$LnGDDP$	$LnCO2$	$LnGDP$	$LnCO2$
$LnGDP$	-	0.971***	-	0.97***
	-	(4.11)	-	(3.83)
lnK	0.433**	-	0.55**	-
	(2.00)	-	(2.09)	-
LnH	0.208***	-	0.17***	-
	(4.73)	-	(3.16)	-
$LnET$	0.051***	-0.06*	0.050***	-0.06*
	(3.94)	(-1.77)	(3.30)	(-1.65)
$LnOP$	0.078***	-	0.07*	-
	(2.52)	-	(1.91)	-
$LnImp$	0.040	-0.098	0.03	-0.09
	(0.80)	(-0.68)	(0.53)	(-0.64)
$LnExp$	-0.021	-0.191***	0.005	-0.19***

	(-0.37)	(-3.34)	(0.08)	(-3.12)
D_1994	-0.090***	-	-0.10***	-
	(-2.59)	-	(2.33)	-
C	4.385**	-7.126***	3.07	-
	(1.90)	(-3.50)	(1.08)	-
Obs.	39	39	39	39
RMSE	.036	.1095	0.04	0.11
F-stat (p-value)	-	-	49.70(0.00)	6.26(0.00)
chi2 (p-value)	438.71(0.00)	28.72(0.00)	-	-

Notes: t-value in brackets. ***, ** and *indicate significance at the 1%, 5% and 10% level respectively

Source: Elaborated by the author using Stata Software

With respect to the obtained results of equation [2], the estimated coefficient of real GDP per capita is positive and significant at 1%, implying that an increase by 1% in real GDE per capita, the CO2 emissions will also be increased by 0.97%. This result is consistent with the extant literature showing that environmental degradation is strongly linked to the level of the country's economic development taking the form of an inverted U curve, called Environmental Kuznets Curve (EKC) (Panayotou, 1993; Stern, 2014; Al-Mulali et al., 2015; Bouznit and Pablo-Romero, 2016). According to Panayotou (1993), the EKC hypothesis states that as income increases, emissions also increase until some threshold level of income is reached, after which emissions begin to decline.

Additionally, the results also show that the elasticity of the energy transition is negative and statically significant, being equal to 0.06. This means a 0.06% decrease in CO2 emissions due to a 1% per capita increase in energy transition. The low elasticity related to ET can be explained by the fact that the use of renewable energy in Algeria is not quite sufficient, because its share is less than 1% in the total electricity consumption (Bouznit et al., 2020).Therefore, increasing the share of renewable energy to fossil energy consumption will be one of the solutions to reduce CO2 emissions without negatively impacting economic growth. This result is in line with that obtained in Belaid and Zrelli (2019)who found a positive long run relationship between RnE and CO2 emission for the Mediterranean countries. These authors show that 1% an increase in RnE leads to decrease carbon emission by 0.003%. In addition, the fossil fuels revenues vulnerability hinders Algeria to reach the sustainable development goals (SDGs). To avoid this problem, promoting renewable energy and energy efficiency and investing in low-carbon technologies constitute an opportunity for Algeria to conciliate economic growth and environmental suitability.

Likewise, the estimated equation 2, the coefficient associated with export variable appears negative and significant at 1%, implying the good and service exports reduce CO2 emissions. According to Bouznit and Pablo-Romero (2016), the negative effect of export can be explained bythe structure of the Algeria's economy, which is strongly linked to exports of gross fuelsand the large rate of deindustrialization, which led to a rapid decrease in the share of manufacturing in gross value added, from 17% in 1970 to less than 5% in 2010.

CONCLUSION

It's worth noting that energy transition is a complex process, and it will be achieved at a long period. Further, the promotion of the renewable energy sources in electricity generation requires an appropriated regulatory framework and suitable incentives measures. In this context, Algeria's INDC commitments for achieving energy transition and mitigating climate change are very ambitious; however, the expected targets have not yet been achieved.

In this paper the relationship between energy transition, economic growth and environmental sustainability is analyzed for Algeria over the period 1980-2018. For doing so, the simultaneous equations model was employed to estimate the effects of energy transition, and a set of explanatory variables, on real GDP per capita and CO2 emissions per capita. The obtained results indicate that real GDP per capita is positively affected by energy transition, human capital and stock of physical capital per capita, and oil prices. Therefore, the transition from fossil energy to renewable energy is necessary for Algeria to sustain economic growth. Otherwise, the results further show that real GDP per capita has a positive effect on CO2 emissions, while the latter are negatively impacted by transition energy and exports of goods and services. Therefore, increasing renewable energy consumption and adopting a suitable energy efficiency policy will be one of the good ways to improve environmental sustainability without negatively affecting economic growth.

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