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Econometric study of energy consumption in road transport in Algeria between 1980 and 2020.

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Abstract: *The aim of this econometric study is to investigate energy consumption in the road transport sector in Algeria between 1980 and 2020, based on the ARDL model. Our aim was to identify the factors influencing energy consumption and assess their impact on this key sector of the economy. Variables such as the PARC vehicle fleet and fuel prices (PESS and PGAZ) were studied to identify important links and develop forecasting models.*

The main results showed significant coefficients for some variables, such as the car fleet (PARC), suggesting a positive influence on long-term energy consumption. As the number of vehicles increases, so does energy demand. In addition, model estimation (ECM) has highlighted the existence of a short-term adjustment towards long-term equilibrium, and confirms the importance of fuel prices as a factor influencing energy consumption in the transport sector. It is crucial to have these data in order to optimize and maintain sustainable energy use in the transport sector, thereby contributing to economic development and environmental protection.

Keywords: *Road transport; Energy consumption; Cointegration; ARDL model; Forecasting;*

Jel Classification Codes : *R40 ; C51 ; C53*

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1. Introduction :

In this article, an econometric study of energy consumption in road transport in Algeria is presented, using sustainable energy indicator modeling. Currently, Algeria is focusing on policies aimed at optimizing energy consumption and substituting relatively environmentally-friendly energy products. This is in line with Algeria's obligations to various established global protocols. Particular attention is being paid to energy-intensive sectors such as road transport. Major changes have marked final consumption in 2021, which plays a crucial role in economic and social development, with a 7.6% recovery i n consumption, from 13.5 M toe in 2020 to 14.5 M toe in 2021 (balance National energy, 2021).

In this article, we use a method for modeling energy consumption in the transportation sector, using the ARDL model. With this method, we can assess whether the variables considered as preliminary explanatory factors in energy consumption are adequate. Road transport is the main focus of this study, in order to assess fuel consumption in this sector. This choice is justified by the preponderant share of this sector in Algeria's energy consumption; the final consumption of petroleum products is mainly made up of gasoil (58%), petrol (21%) and LPG (20%) (balance National energy, 2022). Therefore, with a high proportion of gasoline and gasoil (79%), in this study, we will consider only freight transport, private vehicles and public transport. To better indicate the focus of our research, we pose the following main question**: What factors influence energy consumption in Algeria's road transport sector? And what is their effect on the economy?**

From this main question flow other subsidiary questions:

- Is there a significant relationship between the number of vehicles on the road and energy consumption in Algeria? Is the relationship short- or long-term?
- How do fluctuations in fuel prices affect energy consumption in Algeria's transport sector?

The chosen methodology is based on historical data on energy consumption, fuel prices, the vehicle fleet and the Algerian population over the period from 1980 to 2020, using the Auto-Regressive Distributed Lag (ARDL) model, and is based on the following two assumptions: The development of the vehicle fleet plays a key role in the growth of transport energy consumption over the long term, and fuel costs have a significant impact on its use in Algeria. Energy demand declines when fuel prices rise.

To answer these questions, we first review the main studies on the subject. Secondly, we study the segmentation of fuel demand and present the variables and studies of time-series stationarity, as well as the estimation of the ARDL model. Finally, we interpret the results and make recommendations.

2. Literature review on energy consumption

Economic studies of energy consumption in transport have been the subject of research for decades. The first studies analyzed fuel demand for road transport in the USA, taking into account factors such as distance travelled and fuel efficiency of passenger cars and trucks (Kouris, 1983), Energy consumption in transportation is a major concern, with road transport accounting for over 90% of energy consumption in this sector (T. Rokicki, G. Koszela, L. Ochnio, Kamil Wojtczuk, M. Ratajczak, Hubert Szczepaniuk, K. Michalsk, 2021), What's more, transport energy consumption accounts for around a third of total energy consumption in the EU (Rocco, Carmela, & Gennaro, 2014).

More recent research has examined the effect of direct increases in the transport sector, concluding that higher fuel prices have a negative impact on energy consumption, particularly in developing countries, while income growth leads to higher consumption (Kangni & Boya, 2021). Elżbieta Szaruga presents an approach to rationalizing road transport energy consumption towards sustainability. He concludes that the rationalization of road transport energy consumption is affected by drift and shocks, which desynchronizes the adjustment mechanism from equilibrium. Furthermore, he observed low sustainability between road transport energy consumption and GDP and high sustainability between road transport energy consumption and energy (Elżbieta, 2020). Econometric modeling integrated with input-output analysis has been used to assess the impacts of US energy policy on demand and supply, projectingeconomic activity and energy use from 1975 to 2000 and including production models for nine industrial sectors (Edward A & Dale, 1974).These studies paved the way for a wider body of research into energy demand in various sectors, including transport. The results inform policy decisions aimed at improving energy efficiency and reducing emissions in the transport sector.

Algeria's transport sector is a major energy consumer. According to the 2021 energy balance, Algeria's transport sector accounts for a third of total energy consumption, with the road transport sub-sector accounting for 95% of final energy consumption (balance National energy, 2021). The sector is heavily dependent on fossil fuels. Energy demand in Algeria is rising rapidly, and to meet these challenges, Algeria has embarked on an energy transition towards sustainable development. Road transport is a major contributor to greenhouse gas (GHG) emissions (Merzoug, 2022). This sector is therefore a major contributor to pollution in Algeria, with equivalent emissions of 14 million tonnes of CO_2, representing 46% of greenhouse gas emissions (UNDP, 2023).

3. Segmentation of fuel demand

Fuel demand is segmented according to two criteria: type of use and type of customer. The former can be subdivided into different segments based on transport type, fuel type and demand. It should be emphasized that only road transport is included in the study, as its fuel consumption is higher than that of the total energy business. Fueling is carried out both inside and outside the country for air and sea transport, which leads us to conclude that the data collected on the national territory are not faithful to reality. As far as rail transport is concerned, most of its consumption is electric, or very low compared with other modes. In road transport, there are three categories of fuel: Gasoline

(40%) and diesel (52%) account for the bulk of energy consumption, while LPG represents a small percentage in the transport sector (6%) (APRUE, 2019), which is negligible compared to the share of gasoline and diesel. Thus, we only rely on the mathematical representation of fuel and diesel

consumption in our analysis, as they represent a significant share of consumption. However, it should be stressed that LPG (Liquefied Petroleum Gas) offers undeniable economic and environmental benefits, as well as widespread availability in Algeria. Thus, increasing the use of this fuel could give Algeria the opportunity to benefit from its exports of petroleum products. In this respect, it would be wise to integrate it more widely into fuel consumption. Demand is subdivided into road demand, which comprises three categories: personal vehicles, public transport and road trucks. Two distinct sub- segments are identified for non-road demand: industry, where fuel is used as an additive, and agriculture, building construction and factories. In terms of segmentation according to customer type, we distinguish two categories of consumer: private individuals and businesses, for which we can distinguish two distinct categories of demand: The demand from individuals: Consisting of motorists who generally have small vehicles (passenger vehicles), and the demand from professionals which also includes passenger transport, heavy vehicles (goods transport) and large construction sites, agriculture and industry.

4. Presentation of variables and study of time series stationarity

4.1. Variable selection

4.1.1. Econometric study

The aim is to design a graphical representation of energy consumption in Algeria between 1980 and 2020, taking into account the various factors likely to influence it. Several factors were identified that could have an impact on the demand for these fuels. In order to achieve this, our model has included four essential variables, namely: the variable to be explained "**CET**" (energy consumption in the transport sector) and the explanatory variables "**Gasoline price**", "**Diesel price**" and "**Size of vehicle fleet**".

The price of gasoline (**PESS**) and diesel (**PGAZ**) (dinars per liter) has been chosen because they are the main factors with a direct impact on domestic consumption. When the price of a product rises, consumption becomes less affordable.

The model takes into account the size of the vehicle fleet (**Parc**), as fuel consumption is directly linked to its size. Indeed, the larger the fleet, the greater the consumption potential, which means that an increase in fleet size would lead to an increase in energy consumption. We would like to point out that this research work was carried out jointly with two master's students in quantitative economics whom we supervised, and whose theme was proposed by ourselves. This testifies to our close collaboration and shared responsibility throughout the process.

4.1.2. Data sources used

We used the economic information available on the official websites of the National Statistics Office (in French: Office National des Statistiques, ONS) and the Ministry of Energy and Mines for our study. The evaluation period runs from 1980 to 2020, with data presented for each year with 41 observations.

4.1.3. Model specification

The choice of model is an essential step, as it enables us to formulate a set of hypotheses to solve the problem. The development of an economic model is considered the starting point for empirical analysis, but economic theory is often used.

The first version of the model was set out using a mathematical expression that can be written as follows:

$$CET = f\ (\mathrm{PESS} + \mathrm{PGAZ} + \mathrm{PARC})$$

Economic theory and data aspects influence variable selection.

Once the economic model has been defined, it needs to be transformed into an econometric model. From the variables defined above, we obtain the following equation:

$$CET = \beta 0 + \beta 1\mathrm{PESS} + \beta 2\mathrm{PGAZ} + \beta 3\mathrm{PARC} + \varepsilon$$

This logarithmic form could be used to express the econometric model:

$$LogCET_t = \beta 0 + \beta 1 Log\mathrm{PESS}_t + \beta 2 Log\mathrm{PGAZ}_t + \beta 3 Log\mathrm{PARC}_t + \varepsilon_t$$

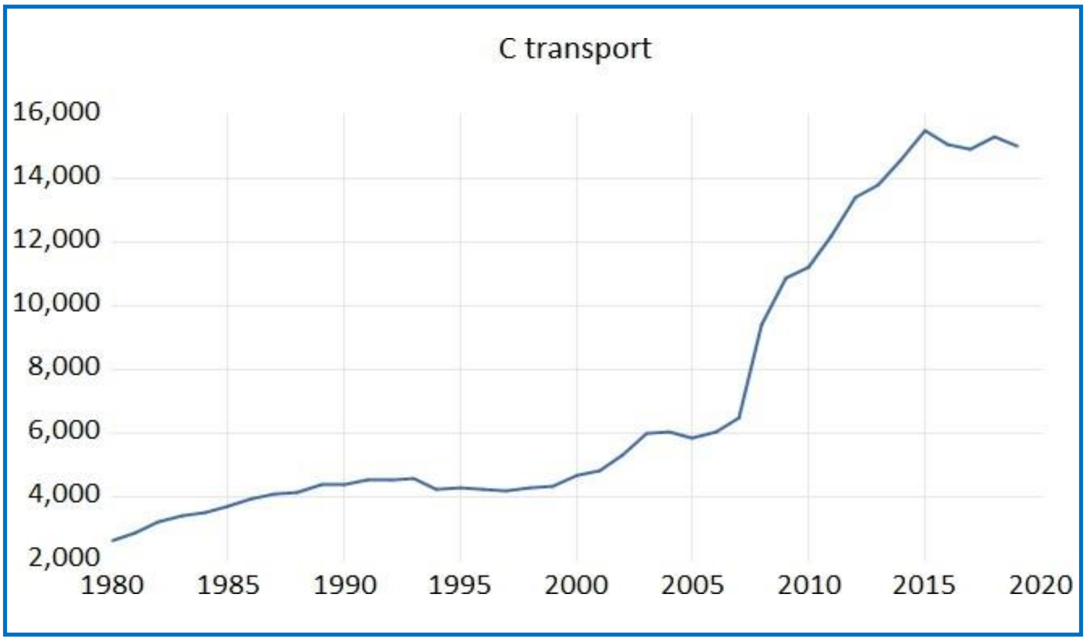
Thanks to the conversion of these variables into logarithmic series, we can refine the series and calculate the elasticity coefficients, which will enable us to interpret the results accurately. Logarithmic variable notation:

- $\boldsymbol{Log\ CETt}$: Logarithm of energy consumption in the transport sector.
- $\boldsymbol{Log\ PESSt}$: Logarithm of gasoline price.
- $\boldsymbol{log\ PGAZt}$: Logarithm of diesel price.
- $\boldsymbol{log\ PARt}$: Logarithm of fleet size.

4.2. Graphical representation of selected variables

With graphs, we can observe trends and patterns in the behavior of variables over time, improve our understanding of the data, facilitate the identification of trends and relationships, and make it easier to communicate results in a visually striking way.

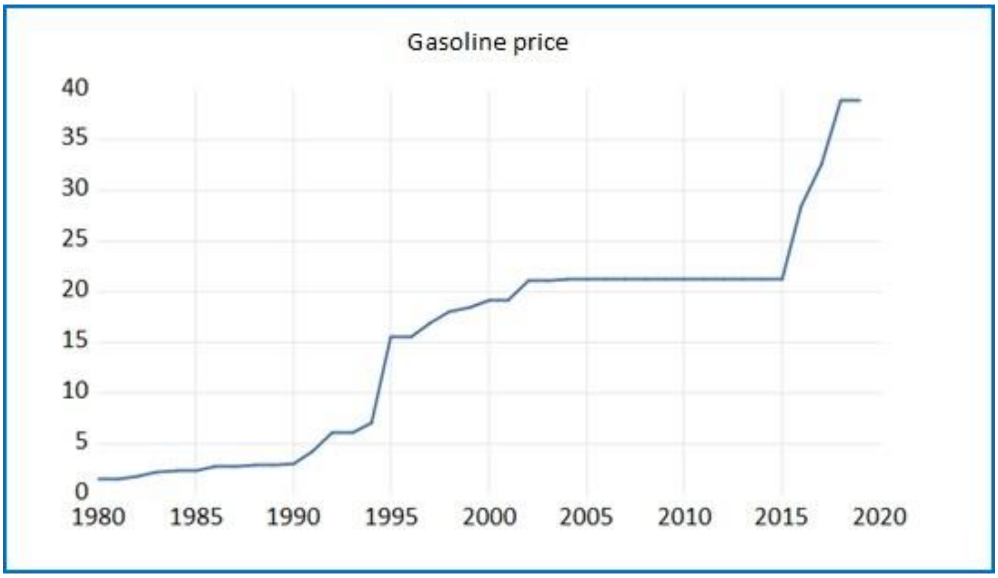
Graph (1): Evolution of CET from 1980-2020 :



Source: Realized by ourselves using Eviews12 software.

Analysis of the above graph reveals that the series shows an increasing trend, suggesting that the (CET) series is not stationary. To validate this result, the stationarity of this series must be verified by the DICKEY FULLER test performed by Eviews 12 software.

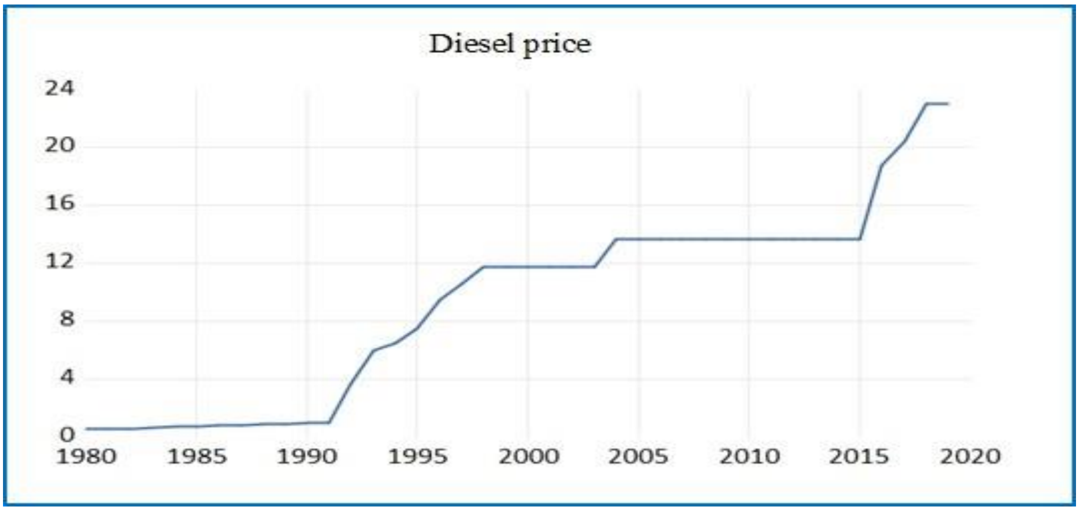
Graph (2): Evolution of gasoline prices in Algeria from 1980-2020 :



Source: Realized by ourselves using Eviews12 software.

The graph shows that the trend in the gasoline price variable is increasing from 1980 to 2004. The price of petrol in Algeria was stable between 2004 and 2015, at 21.20 DA. However, outside this period, a new upward trend is observed, indicating that this series is not stationary.

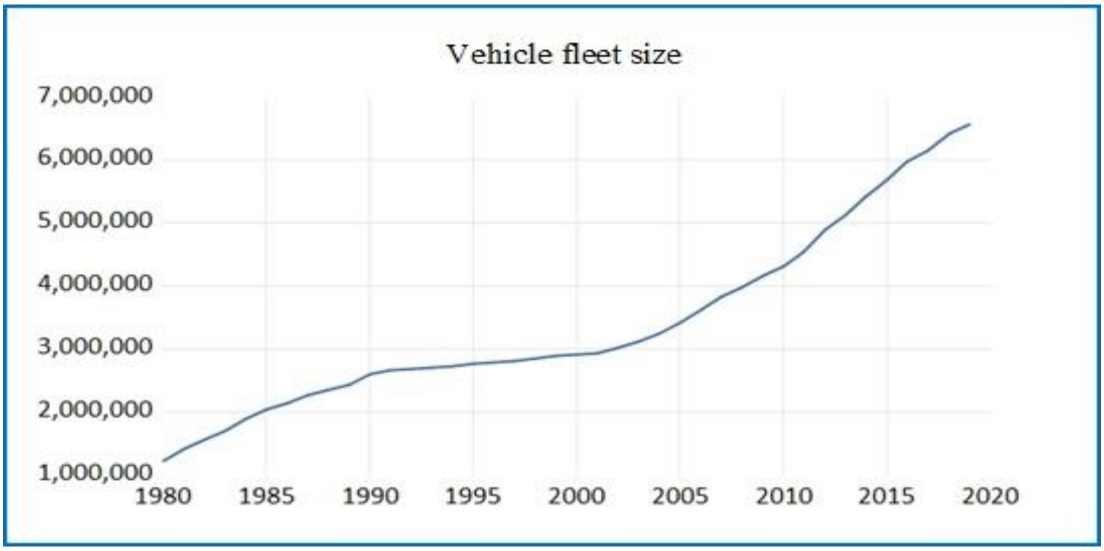
Graph (3): Evolution of diesel prices in Algeria from 1980-2020 :



Source: Realized by ourselves using Eviews12 software.

The graph shows an overall upward trend in the diesel price series, while recording two periods of price stability. The first period begins in 1998 and continues until 2003, when diesel prices remain stable for 6 years, at 11.75 DA. One year later, between 2004 and 2015, the second period begins with a slight increase in diesel prices, estimated at 13.70 DA. This gives us confidence that this series is not stationary.

Graph (4): Evolution of the size of the automobile fleet in Algeria from 1980-2020 :



Source: Realized by ourselves using Eviews12 software.

The graph showing the evolution of the vehicle fleet shows an upward trend. This suggests that the series isnot stationary.

4.3 Study of series stationarity

The ADF test (augmented by Dickey Fuller) is used to determine the stationarity of the selected variables and the number of lags, using the Akaike (AIC) and Schwarz (SC) information criteria. The ADF test can also be used to determine the type of non-stationary process, whether DS (stationary difference) or TS (stationary trend).

It is essential to go through this step when estimating series, to avoid fictitious regressions which could give significant but erroneous results. However, if there is no stationary series, differentiating it could make it stationary. The Augmented Dickey- Fuller (ADF) test is used to verify the existence of a unit root and establish the integration of the different series. The tests are performed with a threshold of 5% to determine whether the series are stationary or not.

- If the ADF is less than the critical value (or if the probability is less than 5%), then hypothesis H1 is accepted: the X series is stationary.
- If the ADF value is greater than or equal to the critical value (or if the probability is greater than or equal to 5%), then hypothesis H0 is validated: the X series is not stationary.

Table (1): Results of ADF stationarity tests

Variables	Teste de DICKEY-FULLER				Integration order
	Level estimation	Critical value 5%	Estimated 1st difference	Critical value 5%	
Log(CET)	1,992142	-1,95	-3,391135	-1,95	I (1)
Log(PARC)	2,001323	-1,95	-2,679892	-1,95	I (1)
Log(PESS)	2,371918	-1,95	-4,339713	-1,95	I (1)
Log(PGAZ)	0,444108	-1,95	-4,060482	-1,95	I (1)

Source: Based on Eviews12 software.

The variables expressed in levels all have ADF statistic values above the critical value at the 5% threshold. When expressed in levels, the series are not stationary. We have performed unit root tests on the difference variables to render them static.

It is preferable to use the differentiation method to obtain a stationary series, by applying the first difference to the series of four variables (CET, PESS, PGAZ, PARC). Indeed, the ADF value calculated for the first difference between the four series is lower than the tabulated ADF value a t the 5% threshold,suggesting that they are integrated according to order (1).

5. ARDL model estimation

Auto Régressive Distributed Lag/ARDL models are dynamic models. Temporal dynamics (adjustment lag, expectations, etc.) are taken into account to explain a variable (time series). This helps optimize forecasts and policy effectiveness (decision-making, actions, etc.).

This approach is used when small sample sizes are required to verify results. If the variables used are of order (1), order (0) or order (Mixed), it can be implemented.Once the stability and integration requirements have been verified, it is essential to define an optimal ARDL model, which gives statistically significant results using a sufficient number of parameters and meets the criteria of no errorautocorrelation, heteroskedasticity and error normality.

It is essential to verify the existence of a unit root (Dickey-Fuller test) and to determine the order of integration before performing the cointegration test. The order of integration of each variable in the ARDL- based cointegration test must be less than 1.

Table (2): Stationarity test results

	In level			In difference			
Variables	**Model**	**ADF**	**Critical value**	**Model**	**ADF**	**Critical value**	**Conclusion**
CET	M1	1,99	-1,95	M1	-3,39	-1,95	I (1) at the threshold of 5%
PARC	M1	2,00	-1,95	M1	-2,67	-1,95	I (1) at the threshold of 5%
PESS	M1	2,37	-1,95	M1	-4,33	-1,95	I (1) at the threshold of 5%
PGAZ	M1	0,44	-1,95	M1	-4,06	-1,95	I (1) at the threshold of 5%

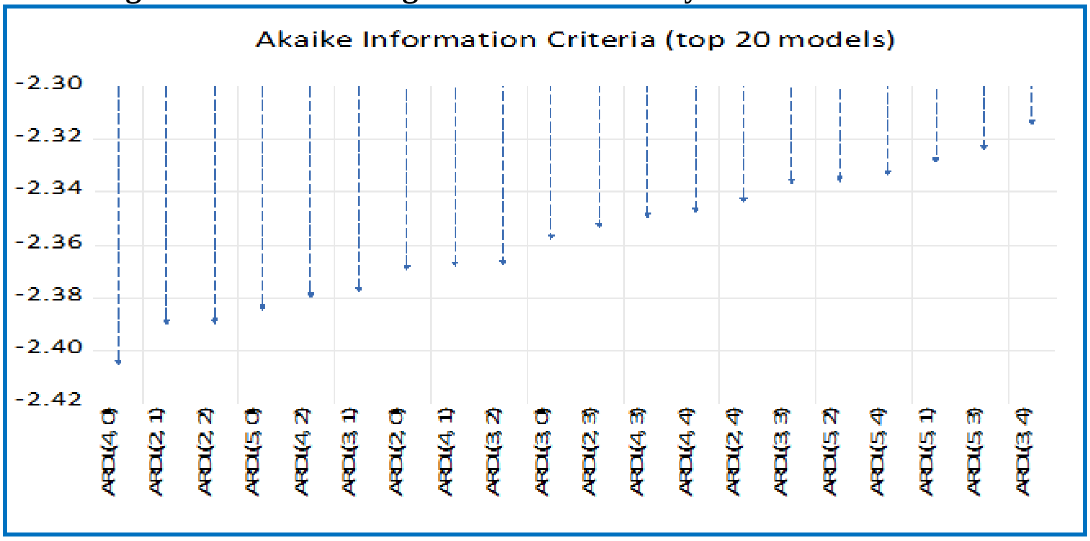
Source: Realized by ourselves from results obtained from Eviews 12 software.

The series have first-order integration, as shown in the graph above. Indeed, the Dickey Fuller unit root analysis performed on the level series reveals that all these series are not level stationary. In other words, these results confirm the stationarity of the variables (CET, PARC, PESS, PGAZ) when differentiated once, meaning that they are first-order integrated.

5.1. Determining the number of delays

The Akaike Information Criterion (AIC) will be used in our series to select the most suitable ARDL model, the one that offers statistically significant results with the minimum number of parameters. Here are the results obtained:

Figure 01: Determining the number of delays in the ARDL model



Source: Based on ARDL model results in Eviews12.

From the analysis to evaluate the number of delays, it appears that the Akaike Information Criterion (AIC) isthe most appropriate model. Thus, the model corresponding to an ARDL (4,0) model is the ideal choice, asit minimizes the AIC criterion.

5.2. Bounds-test and estimation of the long-term relationship

The variables are integrated in the same order by the cointegration test, while the estimation of the relationship allows us to determine whether the residuals are stationary. Thanks to linear combination, it is possible to convert the series into a stationary series in order to check whether the regression on non- stationary variables is correct.

Table (3):Results of the cointegration test (Bounds Test)

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	**2.978584**	10%	3.02	3.51
k	1	5%	3.62	4.16
		2.5%	4.18	4.79
		1%	4.94	5.58
			Finite Sample:	
Actual Sample Size	36		n=40	
		10%	3.21	3.73
		5%	**2.337**	**2.823**
		1%	5.593	6.333

Source: Realized by ourselves from results obtained from Eviews 12 software.

The results of the bounds-inclusive cointegration test show that the series analyzed have a long-term relationship (cointegration) at the threshold level of (5%). The value of the F statistic is above the upper bound (2.978584 > 2.823), thus rejecting the H0 assumption that there is no long-term relationship, and affirming that there is a cointegrating relationship between the different variables.

Table (4): Estimation results for the long-term relationship

Levels Equation Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(PARC)	1.619288	0.098648	16.41484	0.0000
C	-15.47318	1.380390	-11.20928	0.0000
EC = LOG(CET) - (1.6193*LOG(PARC) - 15.4732)				

Source: Results obtained from Eviews 12 software.

The long-term equation can be rewritten using normalization with respect to the LOG (CET) variable: LOG(CET) = (1.6193*LOG(PARC) - 15.4732)
When normalized, these results demonstrate that there is a statistical and economic correlation between transportation energy consumption (TEC) and the logarithm of the vehicle fleet (PARC) variable.

According to the statistical framework, these results can be interpreted as follows:

- All other things being equal, the coefficient of 1.6193 suggests that a 1% increase in the vehiclefleet is associated with a 1.6193% increase in energy consumption in the transport sector over the long term. The elasticity of energy consumption in relation to the vehicle fleet is represented bythis coefficient.

- The intercept of the equation is the constant -15.4732. It represents the amount of energy consumed when the vehicle fleet is zero (which is rarely realistic in this context). However, it shouldbe stressed that this value does not necessarily make direct economic sense.

5.3. ECM model estimation

By using differential variables, an ECM model can represent the short-term dynamic relationship.

Table (5): ECM model estimation results

ARDL Error Correction Régression
Dependent Variable: DLOG(CET)
Selected Model: ARDL (4, 0)
Case 2: Restricted Constant and No Trend
Date: 05/22/23 Time: 23:56
Sample: 1980 2020
Included observations: 36

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(CET(-1))	0.627631	0.178802	3.510204	0.0015
DLOG(CET(-2))	0.250513	0.200154	1.251602	0.2211
DLOG(CET(-3))	0.321718	0.180749	1.779920	0.0859
LOG(PGAZ)	-0.040105	0.022711	-1.765874	0.0883
LOG(PESS)	-0.005075	0.021037	-0.241246	0.8111
CointEq(-1)*	-0.583993	0.188738	-3.094191	0.0044

R-squared	0.584372	Mean dependent var	0.041457
Adjusted R-squared	0.246768	S.D. dependent var	0.072568
S.E. of regression	0.062981	Akaike info criterion	-2.540963
Sum squared resid	0.118997	Schwarz criterion	-2.277043
Log likelihood	51.73734	Hannan-Quinn criter.	-2.448848
Durbin-Watson stat	2.002362		

Source: Results obtained from Eviews 12 software.

The variable D marks the first distinction between the variables studied. In addition, the one-period lagged residual from the long-term equilibrium equation is called CointEq (-1). The estimate of this coefficient, which determines how close the CET variable is to its long-term target value, is (-0.583993), which represents 58% for our ARDL model, suggesting a relatively rapid adjustment to the long-term target.

6. Interpretation of results and model validation

Sign analysis of the coefficients of the CET equation in the long and short term is used to interpret these results. With this in mind, the coefficient of 1.619288 obtained from the long-term estimate suggests that the more vehicles on the roads, the greater the demand for fuel and other energy sources for transport. This can be explained by a number of factors, such as increased mobility, population growth, urbanizationor the level of economic development.

With regard to the coefficients -0.040 (LOG PGAZ) and -0.0050 (LOG PESS), it is suggested that a rise in gas and petrol prices leads to a proportional fall in energy consumption in the transport sector. This implies that when there is an increase in the price of fuels (natural gas and gasoline), consumers may consider reducing their use of these fuels and turning to other, less costly and more energy-intensive alternatives. As a result, energy consumption in the transport sector may fall. In addition, the coefficient of determination (R2) is 0.58%, which means that the goodness-of-fit is correct. On the economic side, this implies that the model's independent variables, such as LOG(PGAZ) and LOG(PESS), play an important role in explaining a significant proportion of the variation in total energy consumption in the transport sector in Algeria. In particular, these variables reflect almost (58.44%) of the variation observed in total energy consumption in this area.

7. Model validation

There are various methods for assessing model reliability. Three tests were chosen for this study: the auto- correlation test, the heteroscedasticity test and the stability test. The results of these tests are presented in the table below. It is important to note that for all the tests performed, the calculated probability exceeds the 5% threshold. The results obtained are therefore considered acceptable.

7.1. Autocorrelation test

The autocorrelation test is used to determine whether errors are auto-correlated.

Table (6): Auto-correlation test results

Breusch-Godfrey Serial Correlation LM Test:			
Null hypothesis: No serial correlation at up to 2 lags			
F-statistic	0.570533	Prob. F(2,26)	**0.5721**
Obs*R-squared	1.513513	Prob. Chi-Square(2)	0.4692

Source : Autocorrelation test based on Eviews 12 results.

The data in the table clearly show that the residuals are not auto correlated, since the probability associated with the F statistic is 0.57, which exceeds the 5% threshold. It is therefore possible to verify that the hypothesis that the residuals are not auto correlated is validated.

7.2. Heteroscedasticity test

This is an essential test, since it reveals not only heteroscedasticity, but also poor model particularization. Homoscedasticity can be observed when the distribution of residuals is homogeneous over all predicted values. Clearly, this is a desired characteristic, because if the residuals correspond correctly to measurement errors, there's no reason why the distribution of these residuals should vary according to the predicted values.

Table (7): Results of the heteroskedasticity test

Heteroskedasticity Test: ARCH			
F-statistic	0.047055	Prob. F(1,33)	**0.8296**
Obs*R-squared	0.049836	Prob. Chi-Square(1)	0.8233

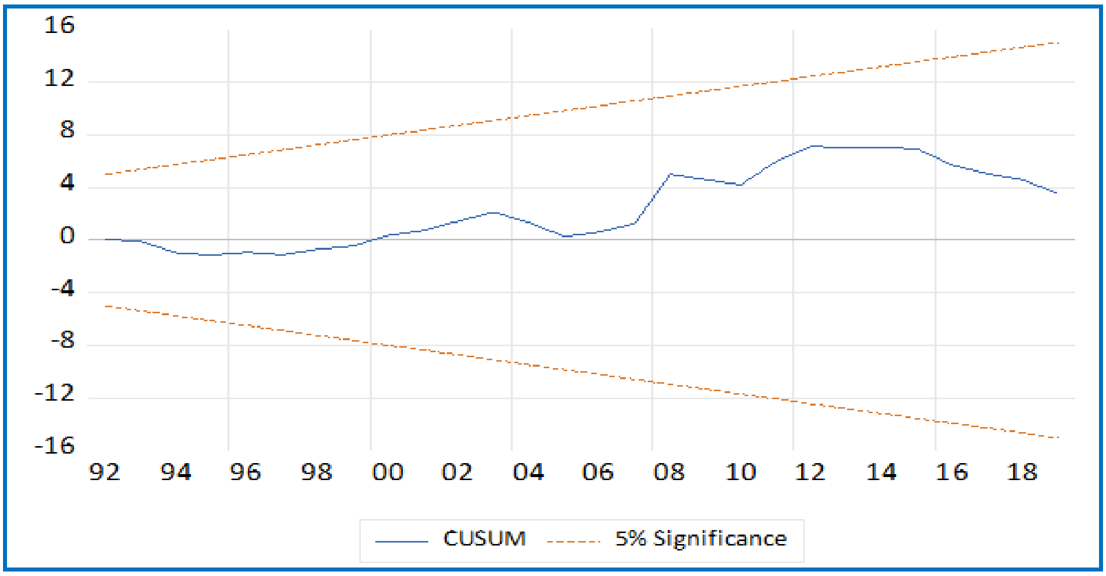
Source : Heteroskedasticity test based on Eviews 12 results.

From the data in the previous table, we can see that the F-statistic probability is 0.82, which exceeds 0.05. This is the absence of heteroscedasticity and homoscedastic residuals. This indicates the absence of heteroscedasticity and homoscedastic residuals. We can confirm the validation of the ARDL model based on what has been mentioned above and the results of previous tests. The model is considered significant.

7.3. Stability test

The CUSUM stability test is used to assess the stability of an econometric model over time. It is usually used to identify structural breaks or changes in the relationship between variables over time.

Graph (5): CUSUM stability test results



Source: Results obtained from Eviews 12 software.

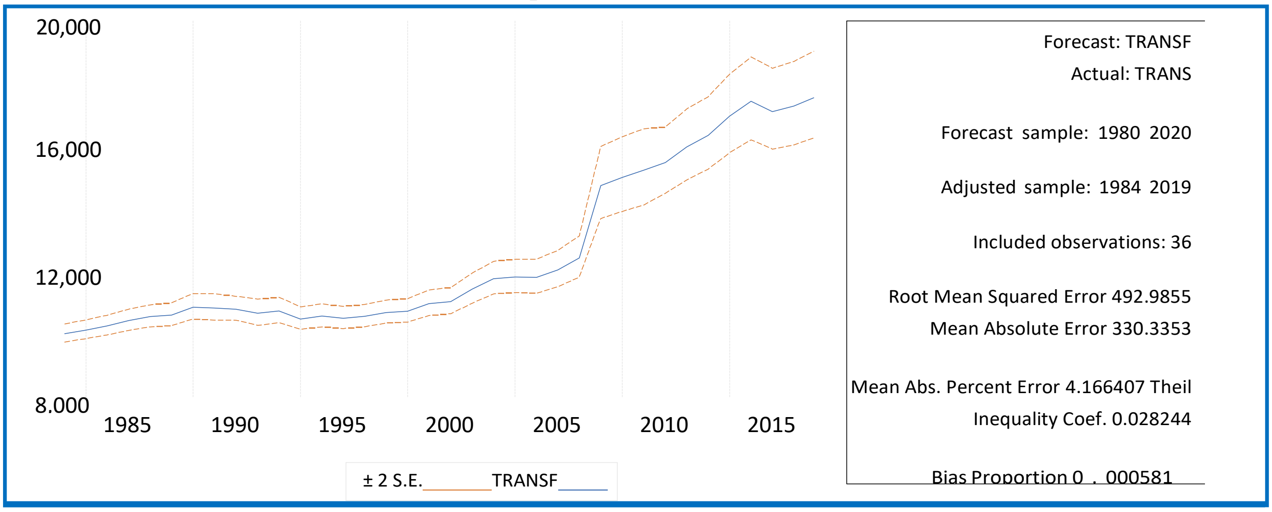
Analysis of the results of the CUSUM test leads to the conclusion that the estimated model is stable throughout the period.

We adopt the zero hypothesis for each of these tests. Our model is thus statistically validated. The ARDL (4,0) model calculation is clearly defined.

8. Forecast based on the selected model

One of the essential aims of econometrics is to forecast. Once we have verified our model, we can make a forecast based on the chosen model. Forecasting offers the possibility of evaluating the future impact on variables. The result of the pre-version is shown below.

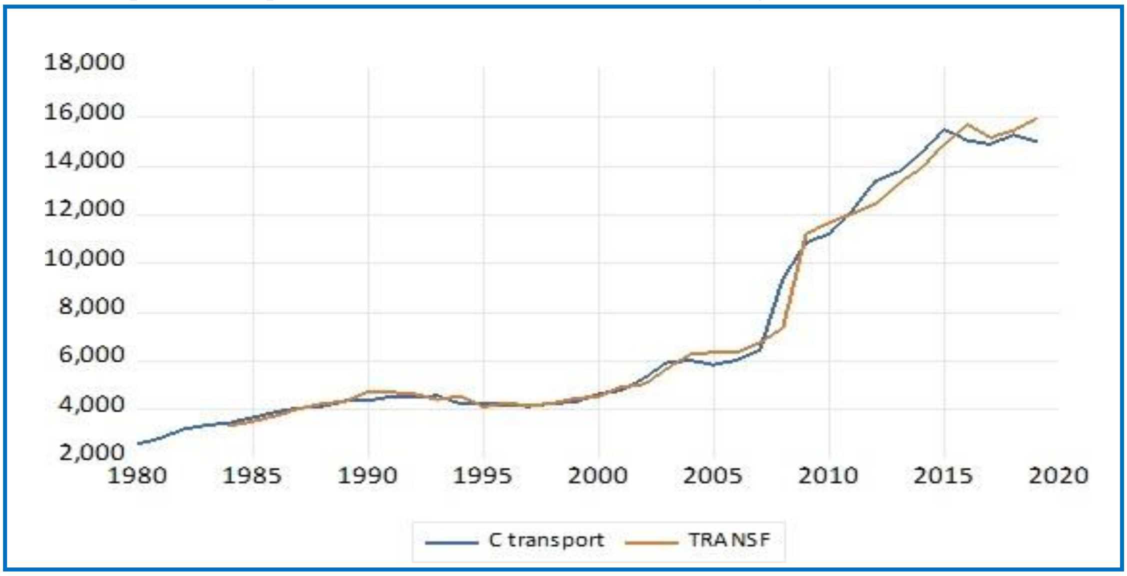
Graph (6): Forecast results



Source: Results obtained from Eviews 12 software.

Once this estimation has been carried out on the sample, we need to check that Theil's coefficient of inequality, which always oscillates between 0 and 1, is close to 0 in order to ensure perfect prediction and success. The Theil inequality coefficient is 0.02, which corresponds to a low proportion variance (0.0005 in our situation). The forecast is therefore satisfactory in terms of Theil's coefficient of inequality.

Graph (7): Comparison between observed CTRANS and adjusted CTRANSF



Source: Results obtained from Eviews 12 software.

From the example presented, it can be concluded that the appropriate model is reliable, as there is a small margin of error between the appropriate model and the observation, implying that our model can be used for forecasting.

9. Conclusion:

In this study, we carried out an econometric evaluation of energy consumption in the transport sector between 1980 and 2020. We carried out several tests, including the evaluation of an ARDL process.

Firstly, the stationarity of our series was checked using the Dickey Fuller unit root test (ADF). Our series are not stationary in level, which led to the use of differentiation to make them stationary. Following differentiation, the series became stationary at the first difference.

In order to assess the reliability of our model, we have chosen to carry out three specific tests: the autocorrelation test, the variance homoscedasticity test and the stability test (CUSUM). This shows that the model is relatively stable over time, based on the recursive residuals. Furthermore, analysis of the short- and long-term relationship revealed a positive correlation between the CET variable and the PARC variable, which corresponds to the car fleet. However, the variable CET is negatively related to the fuel price variables PESS and PGAZ.

The comparison between the observed CTRANS and the adjusted CTRANSF shows that the chosen model perfectly matches the data. It can therefore be used as a forecasting tool or for economic analysis.

The econometric study of energy consumption in the transport sector in Algeria, using the ARDL model over the period 1980-2020, revealed several key elements and provided valuable information on the factors influencing energy consumption and their economic consequences.

The data studied revealed the trends and characteristics of energy consumption in the road transport sector over the period studied, using descriptive analysis. Factors such as vehicle fleet, fuel prices (PESS, PGAZ) were identified as determinants of energy consumption.

Using the ARDL model, it was possible to evaluate the model parameters and examine the correlation between energy consumption and explanatory factors. Significant coefficients were observed for certain variables, such as the number of cars on the road (PARC), suggesting a positive influence on energy consumption.

on long-term energy consumption. As the number of vehicles increases, so does energy demand. This highlights the importance of implementing environmentally-friendly transport policies, such as improving public transport and promoting energy-efficient vehicles.

In addition, the model evaluation (ECM) highlighted the presence of a short-term adjustment towards the final equilibrium. We have confirmed that fuel costs play an essential role in the impact o f energy consumption in the transport sector. Energy consumption falls when fuel prices rise, suggesting that economic incentives can play a key role in promoting more energy-efficient modes of transport.

It is important to consider economic incentives, such as fuel pricing policy, to influence energy consumption decisions in road transport, as these results demonstrate. To encourage more sustainable and energy- efficient modes of transport, incentives such as taxes on polluting fuels or subsidies for energy-efficient vehicles could play a key role.

In addition, our findings underline the importance of effective fleet management in Algeria. Energy demand is rising due to the constant expansion of the vehicle fleet, which calls for special attention to encourage the use of more environmentally-friendly vehicles and recharging infrastructures for electric vehicles.

Environmental policies play a crucial role in promoting sustainable development and economic growth while addressing urgent environmental challenges. These policies can be categorized according to their objectives, timetables and implementation mechanisms. Regulatory policies have a significant impact on sustainability and economic growth, with technological innovation as a key driver. Environmental policies. To improve environmental sustainability and economic prosperity, policymakers must adopt integrated frameworks, invest in green technologies, strengthen international agreements and balance economic development and environmental protection. This multidimensional approach is essential to effectively address global environmental challenges.

Recent studies have examined the impact of energy efficiency and decarbonization policies on energy consumption in road transport. In Algeria, government policies have contributed to declining trends in energy consumption by cars and trucks, despite increased demand for transport. Moreover, the interaction between transport energy policies and the sustainable development goals is difficult to achieve and full reconciliation is not always possible. Recent studies also highlight the urgent need for an energy transition in the road transport sector in Algeria, which is heavily dependent on fossil fuels and contributes significantly to pollution and energy consumption. These studies show that LPG/C consumption is influenced by factors such as oil prices and GDP (Bouakline & Jemah, 2024). Scenario analyses suggest that the implementation of alternative fuels and technologies could potentially reduce energy consumption by 35% and CO2 emissions by 43% by 2050 (Bencheikh & Settou, 2021). In addition, the built environment and socio-economic factors play a crucial role in the energy demand of commuting. Higher density and age of respondents can reduce energy consumption, while car ownership and travel frequency increase. This underlines the importance of comprehensive policies on vehicle technology, fuel alternatives, urban planning and socio-economic factors to achieve sustainable transport and energy transition in Algeria.

Like many other nations, Algeria has developed a strategy to ensure a transition to a clean and sustainable energy future. Thus, 500,000 vehicles per year have been transferred to LPG, with the goal of reaching one million vehicles by 2023. It should be noted that in 2020, 400,000 vehicles were converted to LPG. In the same vein, a recent decision has been taken to phase out super-lead petrol from 1 July 2021, which is considered to be extremely harmful to the environment.

Other recommendations may also be taken into account, such as :

- Encourage the implementation of policies aimed at reducing dependence on fossil fuels in the transport sector. This can be achieved by promoting the use of electric cars and investing inrecharging infrastructure.
- Introduce actions to optimize energy efficiency in road transport. This includes awareness-raising campaigns to encourage economical driving and regular car maintenance. Strict regulations on CO2 emissions and fuel consumption standards can also be introduced to encourage the adoption of more efficient technologies.
- Encourage investment in sustainable, high-performance transportation infrastructure. This can include expanding public transport networks, improving rail and metro systems, and creating bicycle paths and pedestrian zones. These actions can reduce the use of personal vehicles and promote more environmentally-friendly means of transport.

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