Scientific Research Bulletins | *Volume:12 / N°:01(2024), p 319-340*

The evolution of sales of liquefied gas LPG/c fuels in Algeria until 2021

تطور مبيعات وقود الغاز المسال في الجزائر إلى غاية 2021

Redouane Ait Kaci Azzou[1], Mohamed Imad Oussedik[2]

[1]Phd, Centre universitaire Tipaza, aitkaciazzou.redouane@cu-tipaza.dz
[2]Phd, Centre universitaire Tipaza, oussedik.imad@cu-tipaza.dz

Received: 06-02-2024 *Accepted: 01-04-2024*

Abstract:

This study aims to examine the sales evolution of liquefied gas (LPG/C) fuels in Algeria by analyzing variables considered to influence this evolution. The approach employed in volvesco integration through an autoregressive model withst aggereddelay, known as ARDL (AutoRegressive Distributed Lags). The results obtained reveal a positive and significant equilibrium relation ship between the demand for LPG/C and the converted vehicle fleet, economic growth (GDP), and the average gasoline price. Additionally, a négative and significant relationship is observed between the demand for LPG/C and its price.

Keywords: liquefied gas fuels LPG/c; ARDL; GDP; vehicle fleet;.
JEL ClassificationCodes:C51, Q2, O13.

ملخص:

يتضمن هذا العمل دراسة تطور مبيعات وقود الغاز المسال LPG/c في الجزائر من خلال متغيرات يفترض أنها تحدد هذا التطور، وذلك باستخدام نموذج الانحدار الذاتي للإبطاء الزمني الموزع.

وتشير النتائج التي تم الحصول عليها إلى وجود علاقة توازنية معنوية موجبة بين الطلب على غاز البترول المسال وأسطول المركبات المحولة، والناتج الداخلي الخام ومتوسط سعر البنزين، وكذلك وجود علاقة معنوية سلبية بين الطلب على الغاز الطبيعي المسال وسعره.

كلمات مفتاحية: وقود الغاز المسال LPG/c، نموذج الانحدار الذاتي للإبطاء الزمني الموزع ، الناتج الداخلي الخام، أسطول المركبات، البنزين.

تصنيفات JEL: C51، Q2، O13

***Redouane Ait Kaci Azzou*:,*e-mail:*redouane7282C@yahoo.fr**

1. INTRODUCTION

The carburetors play a crucial role in conserving various fuel types, such as gasoline, gasoil, and LPG/C, which are integral components of crudepetroleumproducts. As significant contributors to the energy sector, automobiles holdconsiderable importance in terms of production, investments, and financial impact, representingeither profit or growth.

Within the environmental engineering framework, specificindustrialentities in Algeria have raisedconcerns about the use of certain components (petrol), prompting a decision to transition to LPG carburetors as a solution to addresseconomic and environmental challenges. However, variousfactors, including economic, technological, or others, may influence thisdecision.

During the fallseason, the global demand for LPG as an alternative carburetor has not witnessed a significant increase, as consumers are drawntowards automobiles that align with various advancements. Against thisbackdrop and considering these diverse advancements, the research question at the core of thisstudyisarticulated as follows:What are the underlying principles governing the demand for LPG/C in Algeria?

The main research question encompassesseveralassociatedsecondaryquestions:

1. In Algeria, can the LPG/C license be utilized for major carburetors of class?
2. What are the distinctions in the fundamental substitution of LPG/C in Algeria?

The responses to these questions are derived through the examination of the following hypotheses:

1. The popularization of LPG/C in Algeria will be facilitated through the implementation of incentivizing fiscal measures and public normalization, achieved by establishing sector connections in education, transportation, and automotive technology control.
2. The adoption of LPG/C in Algeria aims to mitigate the reliance on gasoline content.

2. The development of the LPG/c in Algeria:

The LPG/C carburetor, known by the commercial name SIRGHAZ (NAFTAL SPA brand name), is characterized by low fuel consumption and is linked to proprietary technology.
During autumn, the demand for LPG/C as an alternative carburetor in the country, particularly in Algeria, has not experienced a decline. This is attributed to the appeal of this fuel type, especially in the realm of larger automobiles, which offer multiple advantages.

The National Agency for the Promotion and Rationalization of Energy Use (APRUE), through the PROP-AIR program, plans the conversion of 56,000 detailed vehicles to LPG/C and 9,385 separate motor vehicles. Additionally, there are ongoing conversion projects for 150,000 LPG/C vehicles within public administrations. This includes the establishment of 800 private conversion enterprises, the creation of 7 training centers, and the development of a reserve infrastructure.

2.1 Advantages of LPG/c :

The LPG/C presents advancements in various domains, including but not limited to:

2.1.1 Advanced techniques:

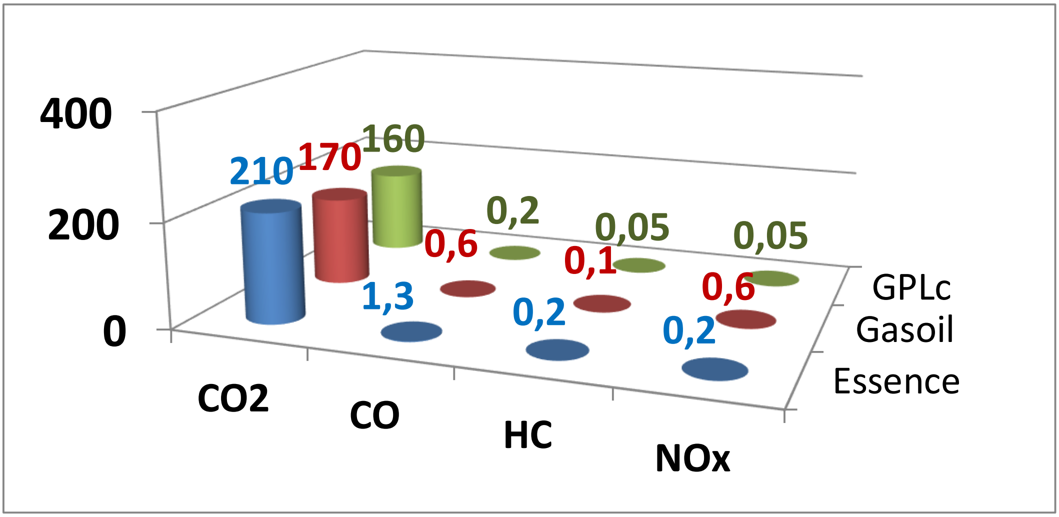
The LPG/C represents a carburetor of superior quality applicable to all classes of carburetors. The homogeneity, high calorific content, and octane consumption of LPG/C ensure a more comprehensive motor combustion when compared to essential oil or gas oil, thereby providing a more efficient energy supply. Increased autonomy is achieved through bicarburation (utilizing both gasoline and LPG).

LPG is a proprietary, cost-effective, and environmentally friendly carburetor, comprising 20% butane (C_4H_{10}) and 80% propane (C_3H_8) (František, Kristián, & Vladimír, 2019). Furthermore, a notable distinction in energy consumption lies in the properties of LPG, characterized by a high flame rate of 95%.(Suyabodha, 2017)

2.1.2 The ecological advantages and security features:

The LPG/C carburetor represents an environment allyconscious alternative among carburetors. Distinguished by itscolor and absence of impurities, such as benzene, it exemplifies an eco-friendly option. Notably, the carburetor's superior environment al characteristics are evident in bothits appearance and composition. The visualrepresentation of theseattributesisillustrated in the accompanying graphbelow, highlighting the reduced environmental impact and cleanlinessassociatedwith the LPG/C carburetor, especially when compared to traditional carburet or sutilizing gasoline and diesel (essence and gasoil).

Figure 1:Comparison of carburetoremissions (in g/km)



Source: APRUE

Upon observation of Graph 1, we analyze the LPG/C carburetor's capacity to emit significant quantities of carbon dioxide (CO_2), carbon monoxide (CO), hydrocarbon impurities (HC), nitrogen oxides (NOX), and other substances, including gas oil.

It is essential to note that vehicles utilizing traditional fuels such as gasoline or diesel emit substantial amounts of nitrogen oxides, which act as ozone-depleting agents and contribute to indoor toxins and carcinogenic pollutants. These emissions include gases such as formaldehydes and aromatics. In contrast, vehicles powered by the LPG/C carburetor demonstrate a notable reduction in hydrocarbon polycondensers, known to be associated with severe health issues, particularly in areas with high levels of pollution and in environments with a rapid accumulation of waste and contaminants.

2.1.3 Economicadvances:

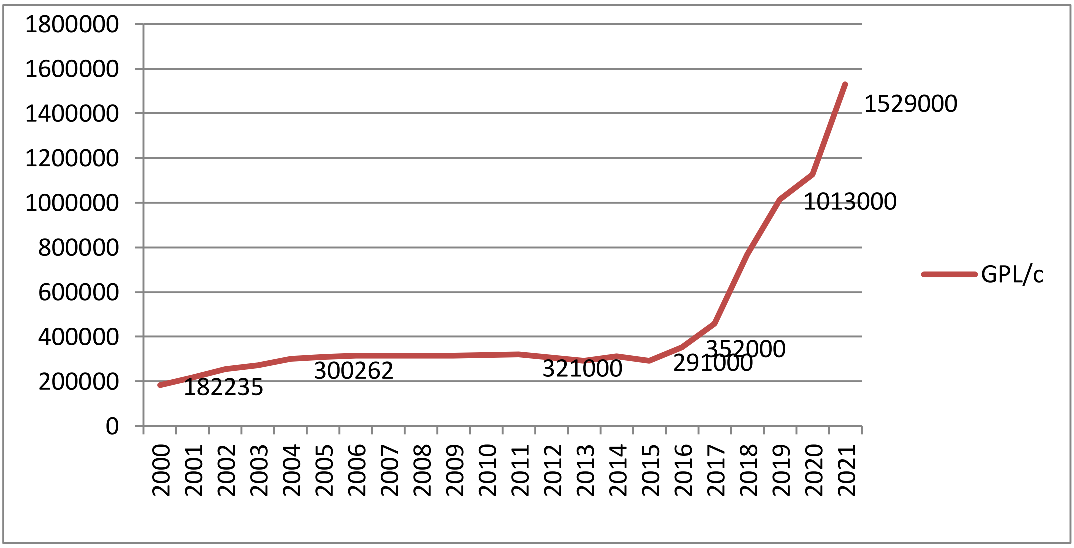
The promotion of LPG/C in Algeria facilitates the adjustment of essential oil and gas quantities for export. Remarkably, high-quality carburetors command a higher price on the international market compared to LPG/C, resulting in significant economic gains. These gains, in turn, contribute substantially to the implementation of conversion kits.

It is noteworthy that engines operating with LPG/C on motor panels (Bruce, Yuhan, L, Yat-Shing, Wai-Chun, & Edward, 2020) also enable the regulator to manage the carburetor control phenomenon. This is particularly relevant in areas beyond the limits of the Wilayas, controlling the import and retrieval of associated components.

3. Analyze the demand for carburetors in Algeria:

The demand for LPG/C in Algeria has experienced a notable increase in recentyears, particularly with in the public transportation sector. This surge can beattributed to its competitive pricing in comparison to traditional carburetors on the market, positioningit as a higher-quality alternative.

Figure 2:Development of the LPG/c (TM) vent



Source : Naftal

The analysis of Figure 2, depicting the evolution of LPG/C sales from 2000 to 2021, enables the identification of distinct trends acrossvariousperiods, including:

- ✓ **Period(2000-2011):**

During this initial period, LPG/C consumption is in fluenced by macroeconomic factors, including the composition of the automobile fleet (tourist vehicles), investment patterns in the cruiseindustry, and overall economic activity.

- ✓ **Period (2011-2015):**

This period is marked by challenges in LPG/C sales, influenced by disruptions in refueling, the slowdown in vehicle conversion due to supplyconstraintsin LPG/C kits. The interruptions in sales are addressed to enhance innovation, allowing for service station improvements and optimizing the overall LPG infrastructure.

- ✓ **Period (2015-2021):**

During this period, there is a notable shift in the demand for LPG/C, increasing from 291,000 tons in 2015 to 1,52,900 tons in 2021, reflecting a capacity expansion of 425%. However, it is important to acknowledge the impact of the six-month period corresponding to the exceptionalcircumstancesduring Covid-19 pandemic, causing a significant disruption in LPG/C consumption trends.

This disruption can be attributed, in part, to the adjustment in carburetor prices that took effect on January 1, 2016, following the primary LPG/C price set in 2015 (9 DA/liter) and subsequent adjustments. Additionally, the video conversion program to LPG/C, incorporating both modern and older technologies, is a crucial aspect of the strategy aiming to convert over 1,000,000 vehicles by Horizon 2030.

4. Analysis of the LPG/Cdemande in Algeria:

The primary objective of this research is to ascertain the demande of LPG/C in Algeria employing the ARDL (Auto regressive Distributed Lag). To add ressour research question, wewill commence with an examination of the stationarity of the selected series in the first section. In the second section, we will proceed with the estimation of our ARDL model and interpretation of the results. Finally, to validate the robustness of our model, wewill test for auto correlation and heteroscedasticity of errors. Additionally, we will employ stability tests (CUSUM, CUSUMQ) based on the recursive regression of residuals to assess the stability of ourmodels.

4.1 Presentation of the data sets and station selection:

Adhering to this analytic al method, the economic model encompasses a specific set of variables deemed pertinent. The principlesemployed in the economic model a number of explicative variables, encom passing perturbations and parameters.

4.1.1 Selection of ExplanatoryVariables:

In the presentre search, we aimed to system atically choose the exogenous variables that exhibit a direct correlation with the demand for LPG/C. This selection process was grounded in the accessibility of data from ONS and NAFTAL.

The slected variables include:
- The price of LPG/C
- The converted automobile fleet
- The price of gasoline
- Gross Domestic Product (GDP)
- Disposable house hold in come.

- A number of adjustments have been implemented in relation to the variables using logarithms to mitigate the impact of variance (avoiding non-stationarity in variance and potential trends). This transformation helps minimize the influence of temporal effects on the series and diminishes the dependence on the previous values of the series, resulting in a stationary series.
- Subsequent to these modifications, we proceed to outline the applications utilized for the various data sets:

- LLPG/C: Logarithm of the demand for LPG/C;
- Lparconvertis: Logarithm of the converted automobile fleet;
- LprixLPG/C: Logarithm of the price of LPG/C;
- Lprixes: Logarithm of the price of gasoline;
- LRDM: Logarithm of disposable household income;
- LPIB: Logarithm of Gross Domestic Product.

4.1.2 Application of the race unit test ADF:

In this section, itis imperative to operate empirical approachon the economic series. This test aims to identify the presence of non-stationary elements in a time series and ascertain their representation type:

- TS (Trend Stationnary):refers to a natural deterministic process. To induce stationarity, the Ordinary Least Squares (MCO) method is applied to model new cars.
- DS (Differency Stationnary):refersto a natural algorithmic process. To restore stationarity, various difference filters are employed.

The implementation of the Augmented Dickey-Fuller (ADF) unit root test necessitated adjusting the lag order to examine different types of series in the regression line. Subsequently, the maximum lag order was determined considering the influence of explanatory variables on the variable under scrutiny.

To determine the number of lags in the ADF tests, we opted for automaticselectionwithin the Eviews 12 software.

4.1.2.1 Application of the ADF Unit Root Test on the LPG/C series

One of the preliminary steps associated with stationarity involves subjecting the given data to a comprehensive testing application using a general model encom passing all relevant variables. This procedure is crucial for computing properties pertinent to this series, akin to the model in reference [3].

The hypothesis tests will focus on evaluating whether the LPG/C series is stationary (indicating a minimal presence of a unit root) in comparison to the alternative hypothesis suggesting non-stationarity.

The estimation of the Ordinary Least Squares (MCO) model [3] is applied to this series, yielding the following results:

Table1: Test ADF: M [3] for the LPG/c series

Null Hypothesis: LGPLC has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.976456	0.5916
Test critical values:	1% level	-4.273277	
	5% level	-3.557759	
	10% level	-3.212361	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGPLC)
Method: Least Squares
Date: 05/06/23 Time: 22:21
Sample (adjusted): 1990 2021
Included observations: 32 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGPLC(-1)	-0.130490	0.066022	-1.976456	0.0592
D(LGPLC(-1))	0.495075	0.192145	2.576563	0.0163
D(LGPLC(-2))	-0.070115	0.213447	-0.328490	0.7453
D(LGPLC(-3))	0.166318	0.187915	0.885068	0.3846
D(LGPLC(-4))	-0.092307	0.097877	-0.943097	0.3547
C	1.386313	0.656626	2.111269	0.0449
@TREND("1985")	0.013023	0.007807	1.667951	0.1078

Source:Eviews 12

Note that the LPG/C series follows a DS car process, and the ADF test statistic is (-1.97), exceeding the critical value of the 5% threshold (-3.55).

Conversely, the T-statistic value for the trend is greater than (1.66), while the critical value (5%) is 2.81. This leads to the rejection of the null hypothesis, H0: trend = 0. Consequently, we reject the notion of a trend in the model. When utilizing model [2], the model is constant and devoid of any discernible trend. The resulting outcomes are as follows:

Table 2: ADF test : M [2] for the LPG /c series

Null Hypothesis: LGPLC has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.429907	0.8930
Test critical values:	1% level	-3.632900	
	5% level	-2.948404	
	10% level	-2.612874	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGPLC)
Method: Least Squares
Date: 05/06/23 Time: 22:26
Sample (adjusted): 1987 2021
Included observations: 35 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGPLC(-1)	-0.010175	0.023668	-0.429907	0.6701
D(LGPLC(-1))	0.350067	0.068850	5.084477	0.0000
C	0.208708	0.289990	0.719709	0.4769

R-squared	0.554975	Mean dependent var	0.172418
Adjusted R-squared	0.527161	S.D. dependent var	0.237547
S.E. of regression	0.163345	Akaike info criterion	-0.704086
Sum squared resid	0.853812	Schwarz criterion	-0.570771

Source:Eviews 12

Note that the LPG/C series follows a DS car process, and the ADF test statistic is (-0.42), exceeding the critical value at 5% (-2.94).

The outcomes presented in model [2] reveal that the constant ADF statistic, recorded at (0.71), is lower than the critical 5% value of (2.56), thus indicating non-rejection of the null hypothesis. Subsequently, when establishing model [1], a model without a constant and devoid of any discernible trend, the following results are obtained:

Table3:ADF test: M [1] for the LLPG/c series

Null Hypothesis: LGPLC has a unit root
Exogenous: None
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		2.699600	0.9977
Test critical values:	1% level	-2.632688	
	5% level	-1.950687	
	10% level	-1.611059	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGPLC)
Method: Least Squares
Date: 05/06/23 Time: 22:33
Sample (adjusted): 1987 2021
Included observations: 35 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGPLC(-1)	0.006762	0.002505	2.699600	0.0109
D(LGPLC(-1))	0.378544	0.055932	6.767943	0.0000

R-squared	0.547771	Mean dependent var	0.172418
Adjusted R-squared	0.534067	S.D. dependent var	0.237547
S.E. of regression	0.162148	Akaike info criterion	-0.745172
Sum squared resid	0.867633	Schwarz criterion	-0.656295
[illegible]	[illegible]	[illegible]	[illegible]

Source:Eviews 12

Note that the LPG/C series follows a DS car process, and the ADF test statisticis 2.69%, surpassing the critical value of -1.95. This indicates non-stationarity and suggests the presence of a unit root from the previousmonth. In preparation for the advanced use of the ADF test for stationarity, the difference is computed and presented in the table:

Table 4:ADF test: M [1] for the differentLPG/c series

Null Hypothesis: D(LGPLC) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.03650	0.0000
Test critical values:	1% level	-2.632688	
	5% level	-1.950687	
	10% level	-1.611059	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGPLC,2)
Method: Least Squares
Date: 05/06/23 Time: 22:43
Sample (adjusted): 1987 2021
Included observations: 35 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LGPLC(-1))	-0.562410	0.056037	-10.03650	0.0000

R-squared	0.737793	Mean dependent var	-0.067131
Adjusted R-squared	0.737793	S.D. dependent var	0.344696
S.E. of regression	0.176506	Akaike info criterion	-0.602772
Sum squared resid	1.059244	Schwarz criterion	-0.558334
Log likelihood	11.54852	Hannan-Quinn criter.	-0.587432
Durbin-Watson stat	1.558843		

Source:Eviews 12

The LPG/C seriesexhibitsstationarity, as indicated by the ADF statistic currently standing at (-10.03), surpassing the critical value of -1.95 at the 5% significance level. In contrast, the LPG/C series, originally featuring a unit root, undergoes a transformation, thereby achieving stationarity.

4.1.2.2 Presentation of ADF Test Results for the RemainingSeries:

The unit root testing strategyis applied to other series (Lparconvertis, LprixLPG c, Lprixes, LRDM, LPIB). The corresponding results are presented in the providedtable:

Table5:Results of station tests (Test ADF)

Variables	Level ADF test						Differential ADF test	
	T statistic	Model 3		Model 2		Model 1	Model 1 Or Model 2	Order ofintegration
		TADF	Ttrend	TADF	Tconst	TADF	TADF	
Lparconvertis	T computed	-2,39	2,44	-0,52	0,99	5,59	**-13,21**	I(1)
	T computed	-3,55	2,81	-2,94	2,56	-1,95	-1,95	
LprixLPGc	T computed	-3,06	-0,28	**-5,19**	5,53	-	-	I(0)
	T computed	-3,55	2,81	-2,94	2,56	-1,95	-1,95	
Lprixes	T computed	-2,34	1,49	-1,87	2,89	-	**-4,39**	I(1)
	T computed	-3,55	2,81	-2,94	2,56	-1,95	-2,94	
LRDM	T computed	-0,26	-0,51	**-4,70**	4,91	-	-	I(0)
	T computed	-3,55	2,81	-2,94	2,56	-1,95	-1,95	
LPIB	T computed	0,37	-0,91	-2,80	3,50	-	**-4,96**	I(1)
	Ttabulated	-3,52	2,81	-2,92	2,56	-1.94	-2,92	

Source : Logiciel Eviews 12

The outcomes of the ADF unit root tests, applied to various series, reveal that the four variables—LPG c, Lparconvertis, Lprixes, and LPIB—exhibit integrated behavior, indicative of a differencing process (DS). These variables, distinct from other stationary and non-stationary versions, have built-in integration and are novel in their nature. In contrast, variables such as LprixLPG c and LRDM exhibit zero or few non-zero components (indicating a presence of local trends), rendering them suitable for integration up to order 2.

However, it is imperative to refrain from applying diverse conditions in the ARDL-type model, as it may lead to difficulties in executing and testing long-term relations when incorporating variables without differences.

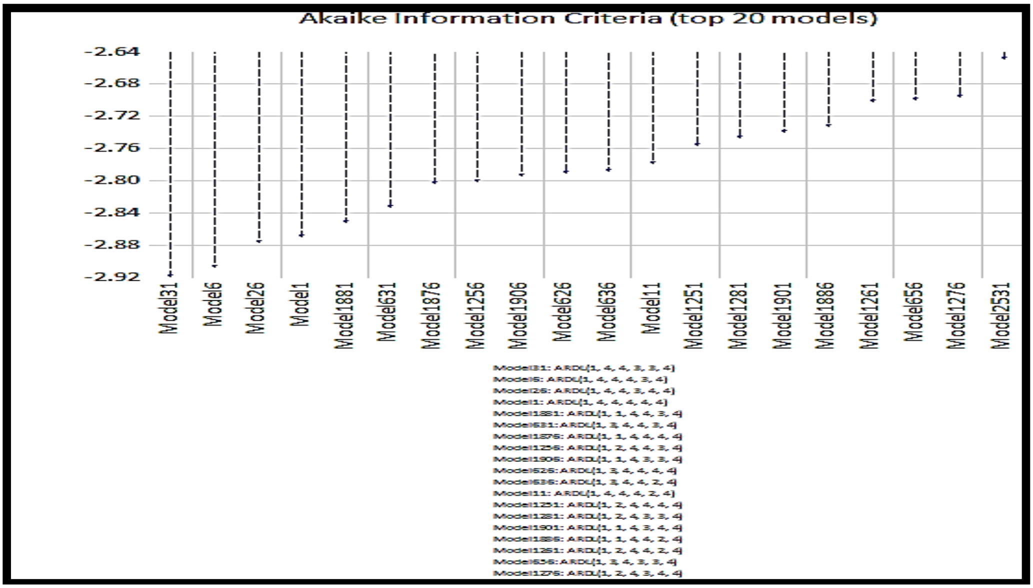
4.2 MultivariateAnalysis of Data Series :

Weconsistentlyemploy the ARDL model to assess compliance with the LPG/C requirement and conduct the "Bounds test" for the cointegration test. Consequently, itis essential to determine the number of lags in the ARDL model whenspecifying the dimensions of the models.

4.2.1 Determination of the Optimal Number of Lags :

To determine the most appropriate model selection among alternative options, we consistently refer to the information provided by Akaike to choose the optimal ARDL model. The results of the optimal ARDL model were selected from 20 different model susing Eviews 12, including ARDL (1,4,4,3,3,4), which corresponds to the highest AIC value.

Figure 03: Akaike Information Criterion



Source:Eviews 12

4.2.2 Estimation of ARDL model:

Once the optimal number of lags is determined for the ARDL model, weassess the ARDL model that willlater serve as the basis for the Bounds test, in order to validate the présence or absence of a cointegration relationship in the long term. The outcomes of the ARDL model estimates are delineated in Table 6.

Table 6: Estimation of ARDL Model (1, 4, 4, 3, 3, 4)

Dependent Variable: LGPLC
Method: ARDL
Date: 05/15/23 Time: 18:15
Sample (adjusted): 1989 2021
Included observations: 33 after adjustments
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): LPARCONVERTIS LPIB LPRIXES LPRIXGPLC LRDM
Fixed regressors: C
Number of models evalulated: 3125
Selected Model: ARDL(1, 4, 4, 3, 3, 4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LGPLC(-1)	-0.449777	0.306899	-1.465556	0.1809
LPARCONVERTIS	-0.660141	0.461945	-1.429049	0.1909
LPARCONVERTIS(-1)	0.410493	0.650815	0.630737	0.5458
LPARCONVERTIS(-2)	-0.162946	0.410631	-0.396819	0.7019
LPARCONVERTIS(-3)	0.393811	0.267967	1.469623	0.1799
LPARCONVERTIS(-4)	-0.167769	0.104391	-1.607121	0.1467
LPIB	0.539693	0.267694	2.016082	0.0785
LPIB(-1)	0.475789	0.244754	1.943943	0.0878
LPIB(-2)	0.772935	0.250025	3.091438	0.0149
LPIB(-3)	0.542121	0.244045	2.221401	0.0571
LPIB(-4)	0.546763	0.251857	2.170925	0.0617
LPRIXES	0.580390	0.263724	2.200746	0.0589
LPRIXES(-1)	1.104153	0.271408	4.068239	0.0036
LPRIXES(-2)	1.748619	0.499465	3.500986	0.0081
LPRIXES(-3)	0.635272	0.316461	2.007422	0.0796
LPRIXGPLC	-0.743679	0.212774	-3.495163	0.0081
LPRIXGPLC(-1)	-1.087705	0.249220	-4.364432	0.0024
LPRIXGPLC(-2)	-0.441431	0.231911	-1.903448	0.0935
LPRIXGPLC(-3)	-0.321730	0.178441	-1.803012	0.1090
LRDM	0.005525	0.455672	0.012125	0.9906
LRDM(-1)	-1.523856	0.594061	-2.565152	0.0334
LRDM(-2)	-1.422550	0.487323	-2.919113	0.0193
LRDM(-3)	-0.155216	0.420215	-0.369373	0.7214
LRDM(-4)	0.837001	0.375827	2.227090	0.0566
C	2.503057	1.608132	1.556500	0.1582

Source:Eviews 12

Subsequent to this model, we proceed through the next stage, indicatingwhether the variables form part of a long-term relationship. To ascertain this, we employ the ARDL Bounds test to test for the presence of a long-term relationship.

It is noteworthy that the results of the "Bounds test" procedure reveal that the Fisher statistic (F = 8.24) surpasses the critical input value at the 5% significance level, confirming the existence of a long-term relationship between the LPG/C requirements and other components in thisstudy.

Table 7:Pesaranco-integration test results

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	8.244471	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15
Actual Sample Size	33		Finite Sample: n=35	
		10%	2.331	3.417
		5%	2.804	4.013
		1%	3.9	5.419
			Finite Sample: n=30	
		10%	2.407	3.517
		5%	2.91	4.193
		1%	4.134	5.761

Source:Eviews 12

4.2.3 Estimation of the long-termrelationshipbetween the ARDL model:

Having confirmed the presence of a long-term relationship between the variables, our primary focus shifts to the estimation of this relationship. The results of the model estimation conducted using the Views 12 software are presented in Table 06.

In Figure 04, the CUSUM test results are depicted, indicating the stability of all model parameters at specific intervals. The speeds of the cars remain consistently stable within the specified bounds, maintaining stability at the 5% significance level.

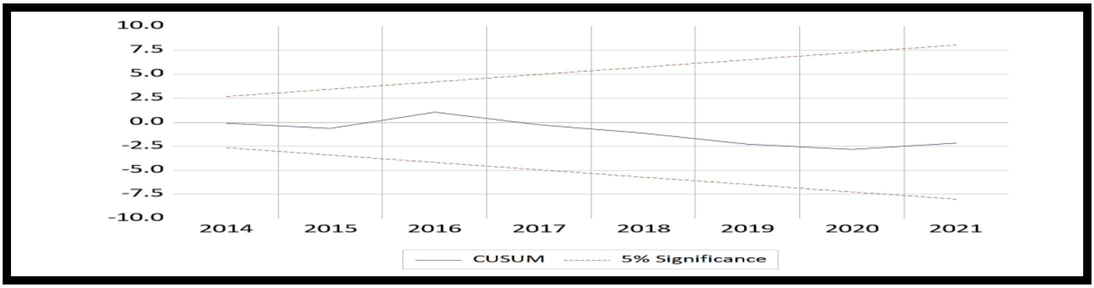


Figure 4: Cumulative Sum of Cars (CUSUMQ)

Source:Eviews 12

Figure 04 simultaneously presents the représentation of the cumulative sum of squared residuals. The data indicates that this sum remains entirely stable, as the statistic is situated within the bounds of the notarized screens.

Table 08: Estimation of the Long-Term Relationship:

Levels Equation Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LPARCONVERTIS	1.128676	0.197350	5.719158	0.0005
LPIB	1.984651	0.344777	5.756339	0.0004
LPRIXES	2.806247	0.327494	8.568855	0.0000
LPRIXGPLC	-1.789617	0.290702	-6.156188	0.0003
LRDM	-1.558237	0.242797	-6.417864	0.0002
C	1.726512	1.057056	1.633321	0.1410

Source:Eviews 12

In Table 08, we observe constants alongside parameters that define the long-term relationship between economic and statistical points.

With an elasticity of -1.78 per month at the 5% significance level, the constants indicate a negative relationship between LPG/C demand and its price. Essentially, a 1% increase in LPG/C price results in a decrease of 1.78 units in LPG/C demand. This inverse relationship can be explained by the principles of supply and demand: an increase in price prompts a smaller quantity demanded, and vice versa. In this context, we assume that essentials for LPG/C serve as substitutes, and if the price increases, the demand for these substitutes becomes more reasonable.

Further, in our analysis, selecting a higher quality carburetor, such as Sirghaz, like unleaded petrol, might lead to a negative impact on LPG/C demand. This effect could be explained by the notion that if the vehicle has an advanced operating system, it necessitates the use of a higher-quality carburetor like Sirghaz, similar to unleaded petrol.

4.2.3 Estimation of the Relationship in the Short Term with the ARDL Model:

Table 09: Estimation of the Short-Term Relationship:

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LPARCONVERTIS)	-0.660141	0.160978	-4.100829	0.0034
D(LPARCONVERTIS(-1))	-0.063096	0.127009	-0.496783	0.6327
D(LPARCONVERTIS(-2))	-0.226042	0.098862	-2.286430	0.0516
D(LPARCONVERTIS(-3))	0.167769	0.047256	3.550176	0.0075
D(LPIB)	0.539693	0.097863	5.514782	0.0006
D(LPIB(-1))	-1.861820	0.197496	-9.427107	0.0000
D(LPIB(-2))	-1.088885	0.171484	-6.349781	0.0002
D(LPIB(-3))	-0.546763	0.127819	-4.277638	0.0027
D(LPRIXES)	0.580390	0.094976	6.110942	0.0003
D(LPRIXES(-1))	-2.383890	0.326335	-7.305036	0.0001
D(LPRIXES(-2))	-0.635272	0.157164	-4.042089	0.0037
D(LPRIXGPLC)	-0.743679	0.091674	-8.112192	0.0000
D(LPRIXGPLC(-1))	0.763162	0.138092	5.526482	0.0006
D(LPRIXGPLC(-2))	0.321730	0.078005	4.124474	0.0033
D(LRDM)	0.005525	0.246078	0.022452	0.9826
D(LRDM(-1))	0.740766	0.226913	3.264534	0.0114
D(LRDM(-2))	-0.681785	0.179648	-3.795108	0.0053
D(LRDM(-3))	-0.837001	0.198615	-4.214186	0.0029
CointEq(-1)*	-1.449777	0.144262	-10.04962	0.0000

R-squared	0.972654	Mean dependent var	0.143116
Adjusted R-squared	0.937496	S.D. dependent var	0.161960
S.E. of regression	0.040491	Akaike info criterion	-3.281396
Sum squared resid	0.022954	Schwarz criterion	-2.419770
Log likelihood	73.14303	Hannan-Quinn criter.	-2.991485
Durbin-Watson stat	1.796058		

Source:Eviews 12

The term "cointEq (-1)" corresponds to a correction mechanism due to long-term equilibration. The coefficient is estimated to be negative (-1.449777) with a significant value (Probability=0.00), indicating the presence of a correction mechanism and the absence of a relationship with long-term (cointegration) variables.

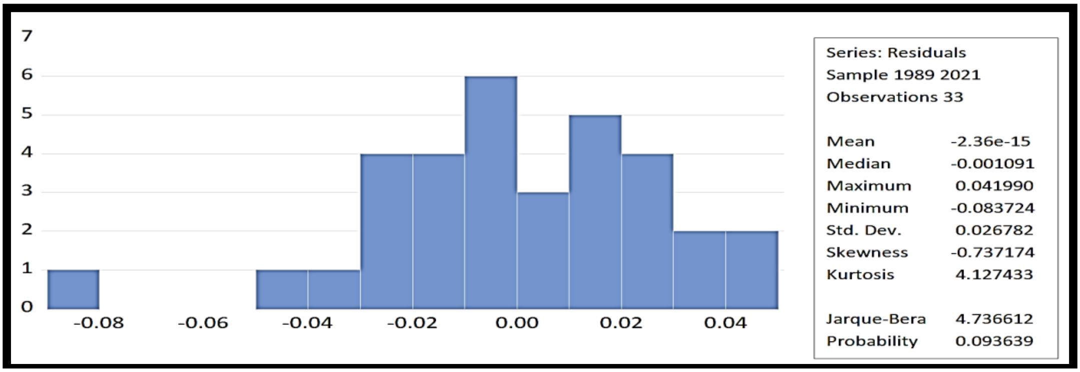
4.3 ResidualsTesting:

These statistical tests aim to ensure the quality of the residuals, maintaining homoscedasticity, autocorrelation, and normality.

4.3.1 Normalization Test of Residuals:

To assess the normality of various series, multiple tests were conducted, with the Jarque-Bera test being the most relevant. The test results reveal a p-value associated with the Jarque-Bera statistic higher than 5%, confirming the normality of the residuals.

Figure 5: Result of the Normal Residency Test.



Source : Eviews 12

4.3.2 HomoscedasticityTest:

Conducting a homoscedasticity test is crucial as it identifies not only heteroscedasticity but also a misspecification of the model. Homoscedasticity is observedwhen the dispersion of residualsisuniformacross the entirespectrum of predicted values. It is clear that this is a desirable property because if the residuals accurately reflect measurement errors, thereis no reason for the dispersion of these residuals to vary with predicted values.

Table 10:Resultsfrom Homoscedasticity Tests

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	0.818115	Prob. F(24,8)	0.6716
Obs*R-squared	23.44682	Prob. Chi-Square(24)	0.4936
Scaled explained SS	2.154735	Prob. Chi-Square(24)	1.0000

Source:Eviews 12

Following the Breusch-Pagan-Godfrey test, we accept the null hypothesis of homoscedasticity at the 5% significance level, as the p-value exceeds 0.05. Hence, the obtained estimates are considered optimal.

4.3.3 Autocorrelation Test:

Subsequent to the homoscedasticity test, we proceed to verify that the model does not exhibit autocorrelation. Table 11 presents the results of the Breusch-Godfrey autocorrelation test.

The outcomes of this test affirm the absence of autocorrelation in the error term, as the test probability exceeds 5%. Therefore, we do not reject the null hypothesis (absence of auto correlation errors).

Table 11:ResultsfromAutocorrelation Test

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	2.121817	Prob. F(2,6)	0.2010
Obs*R-squared	13.67092	Prob. Chi-Square(2)	0.0011

Source:Eviews 12

4.4 Model Stability Test:

To assess the stability of our model, we employ the CUSUM and CUSUMQ tests proposed by Brown, Durbin, and Evans (1975). The CUSUM test is founded on the sum of residuals, illustrating the cumulative sum of residuals along with 5% critical lines. Model parameters are considered unstable if the curve falls outside the critical zone between the two lines and stable if it resides within.

5. CONCLUSION:

LPG/C (or Sirghaz) stands as one of the subsidized gasoline substitution products in Algeria, supported by public authorities. It aims to gain larger market shares to mitigate the gasoline import bill. Algeria adopts a strategy aligning environmental protection with economic profitability, given Sirghaz's ecological properties and national availability.

The estimation results reveal a high determination coefficient (R^2) around 99.98%, signifying that 99% of the equilibrium differential is explained by the model variables, indicating its overall effectiveness. The CUSUM SQ test, based on recursive residuals, suggests the model's relative stability over time.

Furthermore, the long-term relationship estimation indicates a positive and significant equilibrium association between LPG/C demand and the converted vehicle fleet, economic growth (GDP), and the average price of species. However, a negative and significant relationship is observed between LPG/C demand and its price.

In conclusion, any increase in gasoline price and the converted vehicle fleet is anticipated to result in an upsurge in LPG/C demand. Nonetheless, for a successful transition from gasoline to LPG/C, we stress the importance of two recommendations:

- Ensuring a sufficient, reliable, and continuous supply of LPG/C conversion kits to achieve a qualitative and quantitative leap, following the example of other countries like Turkey, South Korea, Italy, and Poland.

- Promoting the widespread adoption of LPG/C through motivating measures, particularly fiscal incentives, and public standardization with the active participation of related sectors such as education and automobile technical inspection.

6. Bibliography List:

Bruce, o., Yuhan, H., L, Z., Yat-Shing, Y., Wai-Chun, M., & Edward, F. (2020, 05 10). Simulation of energie faults and their impact on emissions and vehicle performance for a liquified petroleum gaz taxi. *Science of the total environment* .

https://www.aprue.org.dz/index.php/fr/programmes/realisations. (s.d.). *https://www.aprue.org.dz/index.php/fr/programmes/realisations*. Consulté le 07 21, 2023, sur Agence Nationale de la promotion et de la rationalisation de l'utulisation de l'energie.

Suyabodha, A. (2017). Comparison the rate of energy consumption between gasoline 95 and lpg in spark lgnotion under real driving condition. *Energy Procedia* , pp. 164-171.