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Environmental and Economical Evaluation of Liquified Natural Gas Vehicles Promotion Program in The City of Baghdad

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Abstract: *There is lack of a clear vision of the environmental impacts resulting from using the alternative Liquified Natural Gas (LPG) as a fuel for vehicles instead of the current diesel and gasoline in the city of Baghdad. Conversion to LPG is the installation of a second fuel system, including an LPG tank, a new electronic control unit and different fittings. Such modifications allow the vehicles to run on both fuels. LPG is preferred as it regarded a clean fuel that do not pollute the environment. This confirmed fact was an incentive for energy experts to explore new avenues, which make it an alternative to other hydrocarbons. The five air pollutants (SO2, NO2, NOx PM10 and CO) relationship and the LPG vehicles ratio will be analyzed by panel data analysis. RStudio programming language is used to do this analysis using a package called PLM. Results show that PM10 and CO is slightly significantly decreased with an increase in the LPG vehicles ratio. SO2 and NO2 reveal no statistically significant relationship with LPG vehicles' ratio. Nevertheless, inconsistent outcomes of the remaining pollutants indicate that the efficacy of implementing the LPG vehicles program seems to be different by city.*
Keywords: Natural Gas, Environment, air pollutants, Iraq, Baghdad.

1. INTRODUCTION

A range of converging pressures arising from population growth, the effects of three wars, climate change and invasion of vulnerable ecosystems have been put on Iraq's environment (World Bank, 2017). The whole world, including the Middle East area in which Iraq is situated, is experiencing substantial climate change. (Al-Maamary, 2016). In several countries, natural gas has been adopted as a transportation fuel for different reasons, the key drivers of which are economic benefits, environmental issues, energy stability and the availability of natural gas supplies. Ministry of oil in Iraq is looking forward to exploit Iraqi natural gas by involving national and international companies in different projects such as LPG vehicles program, which besides will help to decrease the environmental pollution of burning other type of fossil fuel like Diesel and Gasoline (UCS, 2014).

2. BACKGROUND OF THE RESEARCH

Iraq has significant gas reserves about 3.5 trillion cubic meters (BP, 2018), Typically found with oil in conjunction. Large reserves of gas remain unexploited. These gas reserves could either be marketed or used to provide a reliable and sustainable form of energy for the production of electricity, which could in turn, stimulate new domestic manufacturing industries. Tremendous amount of gas flaring over oil field sky in Iraq every year. The world bank estimates that Iraq is the world's second largest gas flaring country after Russia (World bank Data, 2016).The estimated amount of raw gas produced by Iraq is 2.8 Bcf/d, of which 1.7 Bcf/d is being flared (50- 60%) (IEI, 2019, p. 6). Iraq's major hydrocarbon resource makes it a key player in regional and global energy systems planning. Applications are chosen and the demand side plan needs to be modified depending on each component. When studying regional features, the characteristics of gas components in the south and the north could be a subject. While methane makes up the majority of the gas generated in the north, the gases released in the south contains a significant proportion of ethane as a raw resource for petrochemical products. Basically, the amount on the supply side is a deciding issue, thus the downstream industry plan must be created based on the amount of component that is readily available. If not, the demand and supply balance cannot be guaranteed, which will prevent Iraq from being rebuilt and developed. Thus, it is anticipated that a gas-powered petrochemical facility will be developed in the south.

Table 1. Gas components example

Notation of component	Name of component	common uses
Number of vehicles	233953	110091.2
Number of LPG vehicles	262	376.9789
Ratio of LPG vehicles (%)	0.08936	0.001067
SO_2	0.2043	0.427521
NO_2	0.09664	0.180543
NOx	0.06493	0.03488
CO	1.3066	1.895399
PM_{10}	219.9	52.46201

However, unless the volumes for both export and local consumption of the products are considered, the construction of a complex in the south might not have value. However, for Iraq's LPG production, it is covering the local market and Condensates are exported (averaging 4,200 tons per day) (IEI, 2019).

3. PROBLEM STATEMENT

The side effects of urbanization and industrialization, most significantly pollution, have come from the oil and gas sector. According to the World Health Organization, air pollution also triggers respiratory diseases, lung cancer and heart diseases. (Factsheet, 2008). Several studies have shown that the low quality of Iraqi fuel is the

key explanation for the high concentration of contaminants in the region. Diesel fuel produced in Iraq holds from 1 up to 2.5% Sulphur while 0.5% for gasoline of it accompanied with high quantity of toxic lead compounds (Al-Waeely, 2014) (Chaichan M. T., 2016). LPG is a good substitute fuel for gasoline and thus must be taken into account in the future of private transport, as it indicates a reduction in all emissions by comparing the emissions of the exhaust gasses of the same engine powered by petrol and LPG. Pollutants in LPG mode are reduced for NOx by 41% ,CO by 30 % ,CO2 by 10% (Tasic, 2011).

4. HYPOTHESIS

To conduct this study, the following three main hypotheses are considered based on research scope and objectives:

H1: The amount of air pollutants criteria as regulated by the United States Environmental Protection Agency (CAA, 1970) will be reduced by LPG These contaminants are a category of pollutants in the air that are responsible for acid rain, smog, and other health threats. **H1-A:** LPG vehicles will decrease the concentration rate of **SO2** in ambient air. **H1-B:** LPG vehicles will decrease the concentration rate of **NO2** in ambient air. **H1-C:** LPG vehicles will decrease the concentration rate of **NOx** in ambient air. **H1-D:** LPG vehicles will decrease the concentration rate of **CO** in ambient air. **H1-E:** LPG vehicles will decrease the concentration rate of **PM10** in ambient air

5. METHODOLOGY

In order to measure the success of the LPG vehicle policy, the level of concentration of air pollution should be measured in the cities where LPG vehicles have been implemented. Six cities from Jan 2015 to Dec 2019 are covered over a period of 60 months includes temperature as a control variable. A total of 360 cases were analyzed in the study (60 cases in each city). Data origins are as follows: Figures for the overall number of vehicles and LPG vehicles were attained from the Ministry of Oil Statistics; data on air emissions were obtained from the annual report published on the Iraqi Central Statistical Organization's website. The phrase 'panel or longitudinal data' refers to the pooling over many time periods of findings on a cross-section of households, states, companies, etc. By measuring a number of individuals or households and observing them over time, this can be done. A panel therefore has two dimensions, one unit for time series and the other for cross-section. These data sets provide a rich base for economic data. There has been a substantial increase in the availability of panel data in recent years, and the related research methods have also gained in versatility. The success of the policy means the degree to which the policy objective is accomplished, and the eventual objective of implementing LPG vehicles is to enhance air quality.

6. MODELING PANEL DATA

Assume we have N cross sectional observations measured in T time period the panel model would be in the following form:

$$\hat{y}_{it} = \hat{\beta}_{\circ(i)} + \sum_{j=1}^{K} \hat{\beta}_j x_{j(it)} + \varepsilon_{it} \quad i=1,2, ...N, t=1,2..T \quad (1)$$

Where:

$\hat{y}_{it}$: is the dependent variable for unit i at time t.

$\hat{\beta}_{\circ(i)}$: slope value

$x_{j(it)}$: The value of the explanatory variable j for unit i at time t.

ε_{it} : error term at unit i at time t.

7. Pooled Ordinary Least squares (POLS)

This model considers one of the simplest longitudinal data models in which all parameters are $\hat{\beta}_{\circ(i)}$, $\hat{\beta}_j$ constant for all time periods (neglects any time effect). By rewriting the equation 1 we obtain a pooled regression model by the following formula:

$$y_{it} = \hat{\beta}_{\circ} + \sum_{j=1}^{K} \hat{\beta}_j x_{j(it)} + \varepsilon_{it}, \; i=1,2,.....N, \; t=1,2.....T \quad (2)$$

Where: $\varepsilon_{it}= 0$, $var(\varepsilon_{it}) = \sigma^2_{\varepsilon}$ using least square method to calculate equations unknowns (Greene, 2003).

8. FIXED EFFECT MODEL (FEM)

The fixed effect model that assumes the existence of differences between the regions and assumes that they independently have their own intercept in each region when the intercept of each region remains constant over time.

$$y_{it} = \hat{\beta}_{\circ(i)} + \sum_{j=1}^{K} \hat{\beta}_j x_{j(it)} + \varepsilon_{it} \quad i=1,2,....N, \; t=1,2....T \quad (3)$$

Whereas: $\varepsilon_{it}= 0$, $var(\varepsilon_{it}) = \sigma^2_{\varepsilon}$, $\hat{\beta}_{\circ}$ is time invariant , Dummy variables is used (N-1) to avoid the case of perfect multicollinearity (Greene, 2003). This model is called Least square Dummy Variable model.

$$y_{it} = \alpha_1 + \sum_{d=2}^{N} \alpha_d D_d + \sum_{j=1}^{K} \hat{\beta}_j x_{j(it)} + \varepsilon_{it} \quad ,i=1,2,...N, \; t=1,2....T \quad (4)$$

Whereas: $\alpha_1 + \sum_{d=2}^{N} \alpha_d D_d$ represent the difference in the cross section for $\hat{\beta}_{\circ}$

9. RANDOM EFFECTS MODEL (REM)

Random effect models assist in controlling for unobserved heterogeneity when the heterogeneity is constant over time and not correlated with independent variables. This constant can be removed from longitudinal data through differencing, since taking a first difference will remove any time invariant components of the model. In this model

$$\hat{\beta}_{\circ(i)} = \mu + v_i \quad ,i =1,2,.....N, \; t=1,2.....T \quad (5)$$

By substitute in equation above

$$y_{it} = \mu + \sum_{j=1}^{K} \hat{\beta}_j x_{j(it)} + \varepsilon_{it} + v_i \quad i=1,2,...N, \; t=1,2...T \quad (6)$$

Whereas: v_i represents the error of measurement in i cross section. Sometimes this model called Error Components Model because there are two error terms $\varepsilon_{it}$and v_i Also: $E(\varepsilon_{it}) = 0$, $var(\varepsilon_{it})= \sigma^2_{\varepsilon}$, $E(v_i) = 0$, $var(v_i) = \sigma^2_v$ If we have compound error term : $w_{it} = v_i + \varepsilon_{it}$

Wheareas: $E(w_{it}) = 0$, var (w_{it}) = $\sigma^2_\varepsilon + \sigma^2_v$ However, even if the OLS estimator is consistent, it is inefficient relative to GLS. The inefficiency arises from the inefficient weighting of the estimators of the two least squares.

$$\text{cov}(w_{it}, w_{is}) = \quad \sigma_v^2 \neq 0 \, , t \neq s$$

10. ESTMATION MODEL PARAMETERS

Considering the LPG vehicles as an independent variable (y) and its effect on a number of dependent variables, the five pollutants SO_2, NO_X, NO_2, CO, PM_{10}, concentration rate in the ambient air, denoted as, (X_1-X_5) respectively, in six cities, these cities are as follow: Jadirya ,Waziriya, Andulus, Saidya ,Oil institute, Alkadumiya, during the period (Jan 2015- Dec 2019),(N*T=360).

$$\hat{y}_{it} = \hat{\beta}_{\circ(i)} + \sum_{j=1}^{5} \hat{\beta}_j \, x_{j(it)} \quad \text{,i=1,2,.....6, t=1,2.....60} \quad (7)$$

11. SELECTING THE APPROPRIATE MODEL FOR PANEL DATA

In order to choose the appropriate model between the three models there are two tests:

F-test

F-test is to advice whether to use fixed effects or pooled OLS and as follows:

$$F(N1, NT - N - K) = \frac{(R^2_{FEM} - R^2_{PM})/(N-1)}{(1 - R^2_{FEM})/(NT-N-K)} \quad (8)$$

Whereas: k is number of the estimated parameters, R_{FEM} , is the determination coefficient when using FEM and R_{PM} the determination coefficient when using POLS model comparing the result of the equation above with $F(\alpha, N-1, Nt-N-K)$ if P value is less or equal 0.05 FEM is appropriate (Greene, 2003).

Hausman Test

This analysis will use the Hausman Test to choose the acceptable

estimator between FE and RE models and analyze the findings based on our assumptions (Greene, 2003) . The null hypothesis of the Hausman test assumes, “The constant term and independent variables are not correlated." If the null hypothesis is rejected, the fixed effect model is selected; otherwise the random effect model is selected." (P-value < 0.05).

$$H = (\hat{\beta}_{FEM} - \hat{\beta}_{REM})' \, [\text{var}(\hat{\beta}_{FEM}) - \text{var}(\hat{\beta}_{REM})]^{-1} (\hat{\beta}_{FEM} - \hat{\beta}_{REM}) \quad (9)$$

12. RESULT AND ANALYSIS OF DATA

12.1. Descriptive analysis

There were 233,953 vehicles in each area on average, with 262 of these being LPG vehicles. The results from descriptive analysis are shown in Table. 2 below: The average monthly temperature was 31° C. The influence of humidity and temperature on engine combustion and pollution have been explored in many studies. (Lindhjem) (Yoon, 2012). The average PM10 is 219.9 µg/m3 with a range of 152 µg/m3 - 390 µg/m3. The concentration level of of air pollution in different cities are as follows: (see Table.3).

12.2. SO2

In the analysis of SO2, based on the results of the Hausman and F tests indicate that fixed effects model must be selected over the random effects models and pooled ordinary least square OLS (see Table.4). The percentage of LPG vehicles has no statistically significant impact on the level of SO2 concentration, according to the fixed effect model (p 0.05). Vehicles, however, display a substantial positive sign, suggesting that the quantity of vehicles affects the amount of SO2 concentration. The fixed effect model's conclusion is that adding one more car results in a 2.65e8 ppm increase in SO2. It also indicates a major relationship between SO2 and temperature. Please note that all concentrations are ppm for SO2, NO2, NOx, and CO, µg/m3 for PM10. Especially because of the transboundary air pollution problem, collaboration between neighbouring counties is imperious (De las Obras-Loscertales, 2013).

Table.2 Descriptive Analysis

Variable	Mean	SD	Min	Max
Number of vehicles	233953	110091.2	87796	459077
Number of LPG vehicles	262	376.9789	10	1000
Ratio of LPG vehicles (%)	0.08936	0.001067	0.00669	0.3707
SO_2	0.2043	0.427521	0.0030	1.41
NO_2	0.09664	0.180543	0.014	0.773
NOx	0.06493	0.03488	0.02	0.214
CO	1.3066	1.895399	0.27	7.028
PM_{10}	219.9	52.46201	152.0	390

Table. 3 Concentration rate of air pollutants in six cities in 2019

Variable	SO_2	NO_2	NOx	CO	PM_{10}
Jadirya	0.55	0.123	0.06	3.6	198
Waziriya	0.031	0.025	0.047	0.57	152
Andulus	0.022	0.0140	0.032	0.36	190
Saidya	0.03	0.03	0.055	0.34	209
Oil institute	0.038	0.059	0.027	0.495	152
Alkadumiya	0.003	0.034	0.04	0.27	210

ppm for SO2, NO2, NOx, and CO. µg/m3 for PM10

12.3. CO

LPG vehicles in Iraq are not being replaced by older diesel vehicles. As stated previously, due to incomplete combustion, an old engine is considered to release greater CO. The effect of the replacement of the old vehicles with newer LPG vehicles can therefore be viewed as having a greater impact than the pollution features of diesel and LPG.

Table. 4 SO2 Results

Variable (SO2)	Pooled OLS	Fixed effect	Random effect
Intercept	0.0065	0.02119***	0.0211***
Ratio of LPG vehicles	0.00004***	-0.00004*	$6.8e^{-7}$
Number of vehicles	$2.1e^{-9}$	$2.65e^{-8}$**	$2.87e^{-12}$
R-Squared		77.1	63.1
Adj. R-Squared	41.2		
F-statistic	26.3***	33.4***	
Hausman test			31.4***

*** p < 0.001; ** p< 0.05; * p <0.1

Table. 5 CO results

Variable (CO)	Pooled OLS	Fixed effect	Random effect
Intercept	2.1***	0.7443***	2.0023***
Ratio of LPG vehicles	− 0.00076***	−0.0064***	−0.0023***
Number of vehicles	3.2e−8**	1.43e−6***	1.66 e−8
R-Squared:		0.981313	0.506722
Adj. R-Squared	0.907990		
F-statistic:	72***	31.23***	
Hausman test			9.39**

*** p < 0.001; ** p< 0.05; * p <0.1

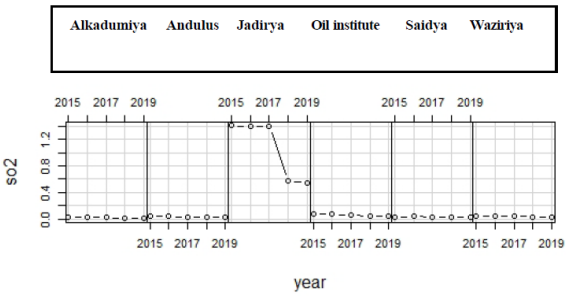

Fig. 1. SO_2 Concentration rate of the ambient air in six cities (2015–2019)

The number of new gasoline vehicles is greater than the number of new LPG vehicles. Therefore, we can assume that the replacement of old diesel vehicles with new LPG vehicles have led to a reduction in the amount of emissions associated with carbon and an increase in the quality of the environment. On the other side, the analysis result implies that an increase in one vehicle produces 1.43e−6 ppm of CO. Considering an average of more than two hundred thousand vehicles in each metropolitan area, traffic volume will have a very important effect on the amount of CO. In the winter, temperature can be related with fuel heating.

12.4. NOx

Once again, the Hausman test and F test demonstrate that the concept of a random effect is a suitable approach for NOx. The R Square of the model was 72.6 and the LPG ratio influenced the increment of the concentration level. Outcome is in line with the researches of (Kathuria, 2004) (Ravindra, 2006) They concluded that more NOx could be created by the higher combustion point of NGV(650°C) compared to (250°C) to that in diesel. Several explanations can be posited for this result. For instance, painting new buses and expanding the number of LPG fuelling stations could have an impact; these actions would emit gases primarily made up of VOCs, which are the primary substance in combination with NOx.

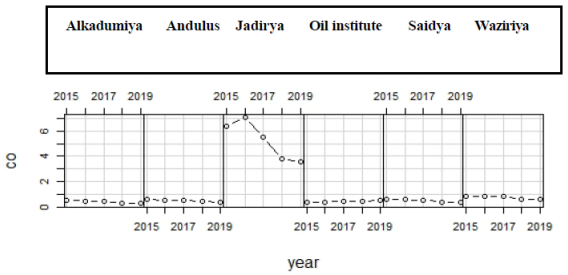

Fig 2. CO Concentration rate of the ambient air in six cities (2015–2019)

12.5. PM10

According to random effect model study, the LPG vehicle ratio has a negative effect on PM10 (see Table .7). The outcome suggests that a 1% rise in the ratio of LPG vehicles reduces PM10 by 0.3324 µg/m3. This is a major result, indicating a reduction in air pollution.

12.6. NO2

Again, the F test and Hausman test show that the fixed effect model is a suitable approach for NO2, The result shows no statistically significant relationship between the ratio of LPG vehicles and the level of concentration of NO2 in the air ($p < 0.05$). On the other side, vehicles have a positive and significant effect on NO2 Diesel cars produce a lot More nitrogen dioxide (NO2) within the emission of (NOx) they emit the share of NO2 (nitrogen dioxide) in the total (NOX) emissions reaches 60% for vehicles that runs with diesel but is significantly lower for automobiles using gasoline (0-30%) (Weiss).

13. RESULTS SUMMARY AND FURTHER ANALYSIS

Based on the outcomes of the present study model, the influence of LPG vehicles on SO2 and NO2 in ambient air does not comply with fuel exhaust emissions specification of the fuel. To clarify this discrepancy, more precise interpretation is required. To calculate the disturbance effect owed to the geographical difference, a random coefficient model (RCM) is adopted, which considers random variations in the LPG vehicle ratio slope in each zone. To deal with interrelated error terms in multivariate regression models, a seemingly unrelated regression (SUR) equation must be used, which considers the association between error terms and enhances the efficiency of the study (Baltagi, 1995). Although the

SUR, due to its supposition that each of the explanatory variable is independent, is identical to the ordinary least square (OLS), the distinction is that the SUR deliberates the association between terms of error. However, to make SUR more successful than OLS, each model has to include at least one different variable. If in all models, every explanatory variable is identical, SUR will generate the same result as OLS (Amemiya , 1985, p. 197). Analysis of the current study was carried out under the condition that the model had the equivalent explanatory variables, assuming that the dependent variables were associated. The outcomes of SUR and OLS can be considered to be the same. The outcomes of analysis of SUR are just the same as those of the pooled OLS. Hence in order to carry out a more in-depth evaluation, it is best using (RCM) the random coefficient model, which considers the local differentiation for each city, rather than to introduce the SUR model in addition. Several researches show that ambient air emissions are affected by the region's industrial construction and income. Several studies indicate that higher emissions in ambient air in the area are influenced by revenue and industrial structure. (Roca & Serrano, 2007) (Vennemo, 2009) (Akbostancı, 2009). According to these reports, the impact of the introduction of LPG vehicles is sufficiently disturbed by the revenue and the proportion of the manufacturing business in those cities.

Table. 6 NOx results

Variable (NOx)	Pooled OLS	Fixed effect	Random effect
Intercept	0.05883***	0.05845***	0.05770***
Ratio of LPG vehicles	0.00003*	0.00019***	0.00009***
Number of vehicles	−1.42e−9***	−1.55e−8	−1.55e−8
R-Squared:		74.00	72.5
Adj. R-Squared	70.17		
F-statistic:	87.69***	4.75***	
Hausman test			10.2**

*** p < 0.001; ** p< 0.05; * p <0.1

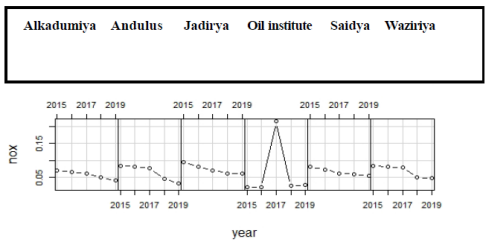

Fig. 3 NOx Concentration rate of the ambient air in six cities (2015–2019)

14. POLICY IMPLICATIONS AND CONCLUSIONS

This study explores the performance of the air quality improvement for LPG vehicles program in the city of Baghdad. After controlling for a number of variables, a panel data study has been carried out to evaluate the impact of the LPG vehicles. The outcome stated, overall, that

- PM10 and CO is slightly significantly decreased with an increase in the LPG vehicles ratio.
- SO2 and NO2 display no statistically significant relation with the proportion of LPG vehicles.
- NOx is increased slightly supporting the claim that increase due to the use of LPG vehicles.

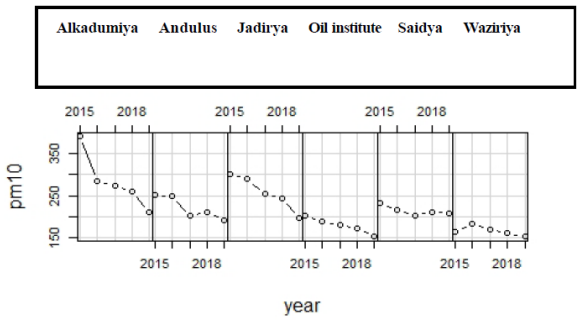

Fig. 4 PM10 Concentration rate of the ambient air in six cities (2015–2019)

Table .7 PM10 Results

Variable (PM10)	Pooled OLS	Fixed effect	Random effect
Intercept	155.4***	201.2***	165.6***
Ratio of LPG vehicles	−0.0575	−0.4032 *	−0.3324***
Number of vehicles	1.84e−6 *	−0.000019	9.6e−9
R-Squared:		63.32	61.53
Adj. R-Squared	46.97		
F-statistic:	42.5***	8.53***	
Hausman			7.32

*** p < 0.001; ** p< 0.05; * p <0.1

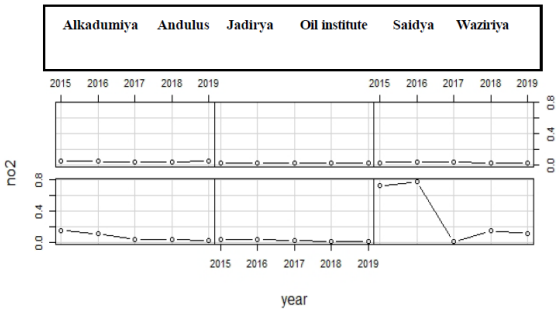

Fig. 5 NO2 Concentration rate of the ambient air in six cities (2015–2019)

Therefore, this study indicates that more vehicles need to be added to the LPG vehicle program to minimize both PM10 and CO concentration levels. Nevertheless, inconsistent outcomes of the remaining pollutants indicate that the efficacy of implementing the LPG vehicles program seems to be different by city. Previous studies also indicate that for many reasons, local enforcement of environmental policy is noteworthy.

Table. 8 NO2 Results

Variable (NO2)	Pooled OLS	Fixed effect	Random effect
Intercept	-8.071232	-22.84418	-9.104606
Ratio of LPG vehicles	0.092756	0.191248	0.068484
Number of vehicles	-0 .421095	-0.536763	-0.269394
R-Squared:		0.667307	0.488146
Adj. R-Squared	0.530706	0.463995	0.381510
F-statistic:	96.3***	43.3***	
Hausman test			8.2 **

*** p < 0.001; ** p< 0.05; * p <0.1

- Local area actions and facilities produce air pollutants emission, so the air pollution control program should be conducted on a limited scale. (Aall, 2007).
- Owing to political, geographical, and social disparities, both outside and inside the local region (Adger, Arnell, & Tompkins, 2005) , Choices relating to climate change should be taken in a distributed manner, for example by the local authorities or the private sector (Bond, 2010) . (Aall, 2007) stresses the local governments role in responding to combat climate change, and making and implementing the environmental policies are relevant.
- Gross Regional Domestic Product (GRDP) value of the perception is considered to be an integral precedent of the Kuznet Environmental Curve (EKC), that defines the connection between GDP and pollution. The per capita OF Gross Regional Domestic Product (GRDP) gap indicates that the pattern and the source of air pollution can be diverse across regions.

Moreover, it should be noticed that there is a variation between cities in the modal share of vehicles. Unfortunately, because monthly avg. data is not available in other six cities, these variances have not been integrated into the study model. Nevertheless, the results of the current research show that according to regional characteristics, the universal policy of adopting LPG vehicles has had a different impact on each area. Thus, when considering regional disparities in policy formulation and execution, a bottom-up strategy would be more successful than a top-down one. In the case of the introduction of LPG vehicles in Baghdad, the central government agreed to subsidize share of the purchase and fuel cost of the vehicles so as to encourage the LPG system of vehicles (Alluaibi, 2016). Sustainable development goals and clean energy have long been crucial issues worldwide. Moreover, recent rise of oil prices has contributed to larger efforts to discover alternative sources of energy. Both policies and technology that can minimize vehicle pollution whereas reducing traffic congestion and energy costs should be introduced to achieve sustainable economic growth in the transport sector (Bose, 2001). In this context, the distribution, supply and safety of natural gas are the most urgent issues concerning LPG vehicles (Tzeng, 2005). For boosting the air quality, the Iraqi government has introduced numerous policy instruments, together with the upgrading of air pollutant measurement systems, the acquisition of cleaner fuel supplies and the implementation of carbon trading. Without any shrinking the business economy, these policies should be wisely crafted to establish reciprocal synergy effects. While this research tried to monitor many variables as probable that could influence air quality, unregulated and hidden variables were inevitably overlooked. There may be major variables that have not been taken into the consideration, but the results of this research hopefully lead to the development in this area of a more robust model. Moreover, a complete picture of air pollution cannot be given by the study of individual pollutants. Thus, finding variables to reflect the complete image of air pollution is important. Some indices may help to understand these problems, such as statistical data for the patients who have from lung diseases and respiratory problems or the total costing of such patients over a given period.

Abbreviation

CNG: Compressed Natural Gas
CO: Carbon monoxide
EIA: Iraq Energy Institute **FE:** Fixed Effect
FEM: Fixed Effect Model
GLS: Generalized least squares
HC: Hydrocarbons
IEI: Iraq Energy Institute
INDC: Nationally Determined Contribution
LNG: Liquefied natural gas
LPG: Liquefied Petroleum gas
MPI : Multi-point injection systems
NGVs: Natural Gas Vehicles
NO2: Nitrogen Dioxide
NOx: Nitrogen oxides
OLS: Ordinary least squares
PLF: Premium leaded fuel
PM10: Particulate Matter
RCM: Random coefficient model
RE: Random Effect
REM: Random effect Model,
SO2: Sulfur dioxide
SUR: Seemingly unrelated regression
UNFCCC: United Nations Framework Convention on Climate Change
WHO: World Health Organization
VOC: Volatile organic compound

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