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Demand for Oil Products in OPEC Countries: A Panel Cointegration Analysis

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ABSTRACT: The increasing consumption of oil-refined products on OPEC countries will have its impact on the availability of oil exports. The goal of this paper is to examine the determinants of oil refined products' consumption for a panel consisting of 7 OPEC countries, namely, Algeria, Kuwait, Libya, Qatar, Saudi Arabia, United Emirates and Iran for the period of 1980–2010, by employing the recently developed panel data unit root tests and panel data cointegration techniques. Furthermore, conditional on finding cointegration, the paper extends the literature by employing the Pedroni Panel Fully Modified Ordinary Least Squares (FMOLS) Dynamic OLS (DOLS) procedure to generate. The study estimates the demand for Gasoline, Kerosene and Diesel**.** An attempt is also made to assess the impact of this demand on the future availability of OPEC oil exports.

Keywords: OPEC; Demand for Gasoline; Kerosene; Diesel; Cointegration; panel data
JEL Classifications: C33; Q41; Q43

1. Introduction

OPEC, the Organization of Petroleum Exporting Countries, consists of the major oil-producing countries and counts for 58% of total world crude oil exports[1] in 2008. Major OPEC countries have become the world's fastest growing consumers of oil (average growth 4.0% between 1980-2010 and account for 18.6 % of world total petroleum consumption). Having OPEC countries as important consumers of oil will affect the volume of their oil exports to the world, hence affecting their oil revenue; also, the decline of the availability of oil to the rest of the world will be reflected in the price of oil. The goal of this paper is to estimate the income and price elasticities for the consumption of oil-products of a panel consisting of 7 OPEC countries, namely Algeria, Kuwait, Libya, Qatar, Saudi Arabia, the United Arab Emirates and Iran for the period 1980–2010. Estimation of income and price elasticities is essential for forecasting the demand for oil-products, and for projecting the required capacity to meet future domestic consumption. In addition, it has significant policy implications or these countries, because their low domestic prices for oil products are subsidized by their governments Knowledge of the income and price elasticities gives policy-makers a guideline for the levels to which oil products prices should be increased in order to reduce domestic consumption and conserve energy.

The contribution of this study to the existing literature on demand for energy is twofold. The first contribution is to estimate income and price elasticities of two oil products; Gasoline, and Kerosene, and income elasticity only for Distillates, Residuals and Total products for OPEC countries[2]. There is a large literature modeling OPEC behavior as oil-producing and exporting countries, which includes analysis of the oil-pricing policy of OPEC as an organization and also for its member countries, but relatively few studies have examined the demand for energy within these countries; and of those studies that have modeled the demand for energy in OPEC countries, one study which focuses on total energy-consumption, Al-Janabi (1979) estimates total energy consumption for OPEC countries. Other studies focuses on oil-products by some members of the OPEC within other regional groups: studies such as, Eltony (1994), Al Faris (1997), Narayan and Smyth (2007); while

[1] www.eia.doe.org
[2] There is no price available for Distillates, Residuals and Total products, since they represent total of other products. (Definitions are given in Appendix one)

others concentrated within a single country (see e.g. Al-Mutairi and Elton, 1995; Al-Sahlawi, 1988, 1997; Ahmadian et al., 2007).

The second contribution is the study-estimate relationship by using a heterogeneous panel co-integration framework as developed by Pedroni (1999, 2004) that takes into accounts the time-series properties of the data. Many studies have found that panel-based tests have higher power than tests based on individual series. However, few studies have estimated income and price elasticities for energy within a panel framework. Narayan and Smyth (2007), for example, used panel co-integration analysis of the demand for oil in the Middle East without analyzing the demand for oil-products. Other studies, though, have examined the time-series properties of the data, have concentrated on the relationship between economic growth and energy- consumption (Mehrara 2007; for oil-exporting countries, Al-Iriani (2006) used panel data for member countries of the Gulf Cooperation Council (GCC); Lee (2005) applied panel data to developing countries. Other studies on energy consumption that used panel data did not study time-series properties (Seale et al., 1991; Rothman et al., 1994; Brenton, 1997).

This paper is organized as follows. Section II provides a review of the consumption for oil products in OPEC countries, and discusses the empirical methodology to be employed in subsequent sections. Section III pools data for six OPEC members' countries over the 1980-2010 period. This section also applies recently developed panel unit root tests to the relevant variables to determine if they are stationary and a panel (and group) cointegration test developed by Pedroni (1999a, 2004) is used to determine whether there is a stable long-term relationship among the relevant panel regressors of the demand function. In addition, it proceeds to estimate the demand function via a "group-mean" panel fully modified Ordinary Least Squares (FMOLS) estimator developed by Pedroni (1999b; 2001) which not only generates consistent estimates of the parameters in relatively small samples, but also controls for potential endogeneity of the regressors and serial correlation. This study thus represents an important contribution to the existing literature on the complementarity hypothesis because it addresses the important question of spurious correlation among the variables in the pooled (stacked) model. The last section summarizes the chapter's major findings and offers some policy prescriptions.

2. Consumption of Refined Products in OPEC Members

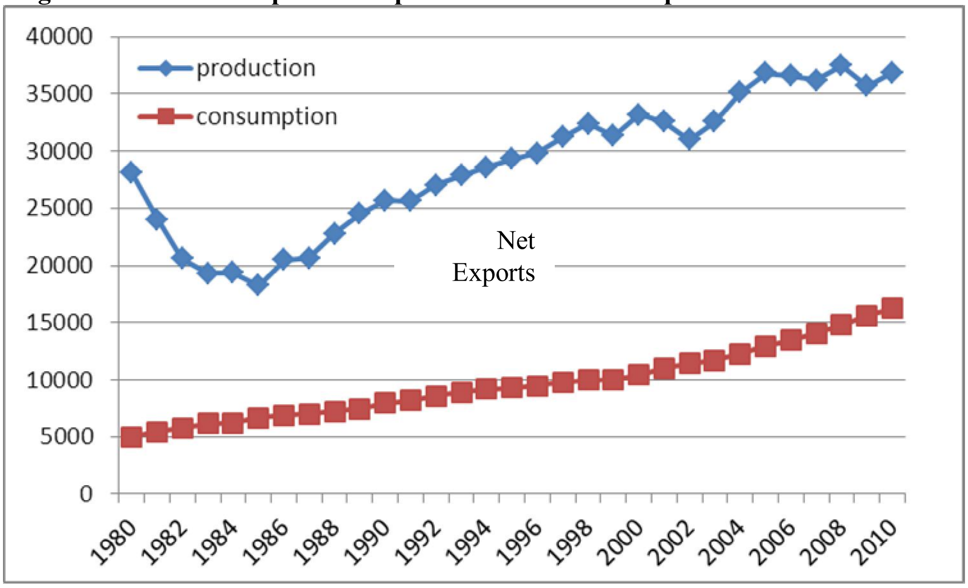
The OPEC countries long recognized for the production and export of oil have become one of the world's fastest growing consumers of oil. The emergence of OPEC as an important consumer of oil is having a significant effect on the availability of oil exports to the rest of the world, because with increased domestic demand, oil supplies available for export are reduced. Table 1 shows the fast growth of consumption of refined petroleum products in OPEC countries for the period 1980-2010.

Table 1. OPEC Consumption for total Refined Products thousand barrel/day: 1980-2010.

	1980	1985	1990	1995	**2000**	**2005**	**2010**
ALGERIA	107.4	158.3	187.4	172.7	187.7	245.9	337.7
ANGOLA	23.6	38.7	40.6	41.7	52.7	85.2	110.0
ECUADOR	69.9	77.1	86.5	104.9	120.1	153.4	220.0
I.R.IRAN	562.5	812.3	1,002.1	1,140.8	1,189.1	1479.2	1775.0
IRAQ	192.3	289.6	338.1	404.4	472.4	511.3	565.6
KUWAIT	57.0	101.7	65.2	117.6	152.9	248.7	260.4
S.P. LIBYAN A.J.	97.9	120.8	142.5	196.4	201.7	229.5	299.0
NIGERIA	161.8	178.1	160.4	187.4	213.7	257.5	258.7
QATAR	6.1	10.5	13.2	17.2	23.6	60.1	116.3
SAUDI ARABIA	403.3	637.9	647.2	723.6	901.6	1175.2	1435.7
UNITED ARAB EMIRATES	62.7	101.9	120.0	135.7	144.5	204.3	238.2
VENEZUELA	395.7	387.4	399.5	415.9	485.9	505.6	675.4
OPEC	2192.1	2958.3	3188.7	3658.3	4145.9	5170.8	6291.9
Source: OPEC secretariat.							

During those years total consumption of petroleum products increased from over 2,509 thousand bbl/day in 1980 to 8,115 thousand bbl/day in 2010. The overall growth rate for the whole period is 4.0 % annually (figure 1). While the growth rate for the period 1980-1999 averaged 3.2% annually, it has increased to 4.5% for the period 2000-2010. In OPEC countries, the prices of refined products are subsidized by government, which has an effect on domestic consumption.

Figure 1. Total OPEC petroleum production and consumption 1980-2010



For each country in particular we found out the following[3]; **Saudi Arabia,** the largest producer and exporter of Crude oil among OPEC countries, is the sixth consumer of petroleum in the world in 2010 at 2650 thousand barrel per day, particularly in the area of transportation fuels. Domestic consumption growth has been affected by the economic boom due to historically high oil prices and large fuel subsidies. **Iran** is OPEC's second-largest producer and exporter after Saudi Arabia, and in 2010 was the fourth-largest exporter of crude oil in the world after Saudi Arabia, Russia, and the United Arab Emirates. Natural gas accounts for half of Iran's total domestic energy consumption, while the remaining half is predominately oil consumption.

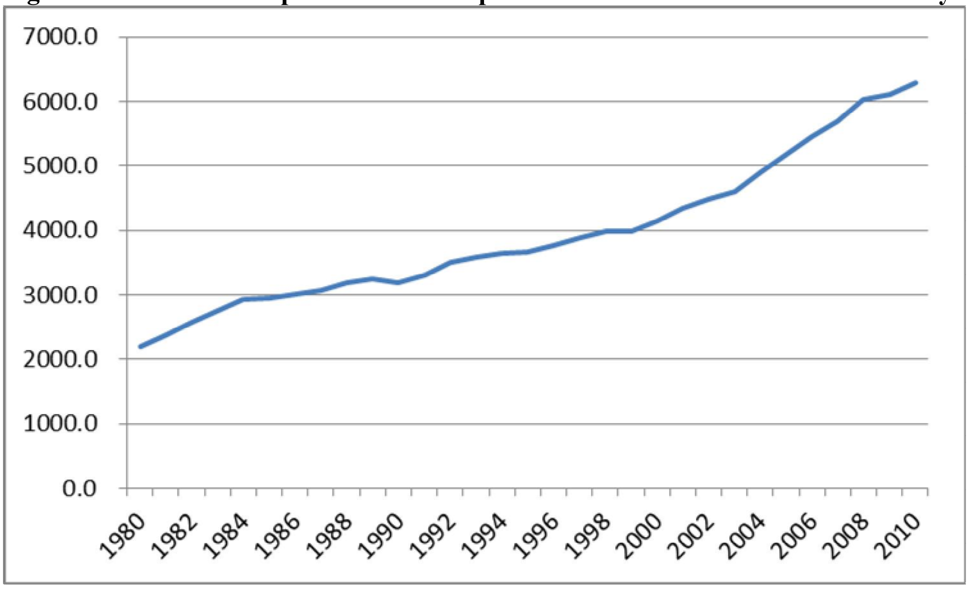
In 2010, the **UAE** produced 3.096 million barrels per day (bbl/d) of total oil liquids, of which 2.57 million bbl/d was crude oil and 356,000 bbl/d was natural gas liquids (NGLs). The UAE's domestic oil consumption averaged only 545,000 bbl/d in 2010, and the majority of oil production was exported to Asian countries. **Kuwait** is one of the world's top exporters of oil, with about 2.124 million barrels per day exported in 2009. Kuwait's economy is heavily dependent on oil export revenues which account for roughly 90 percent of total export earnings. In 2010, Kuwait's total oil production approximated 2.496 million barrels per day (bbl/d). **Qatar** was the 15th largest crude oil exporter in the world in 2008. In 2009, Qatar consumed approximately 135.39 bbl/d of petroleum. Qatar's oil product consumption is expected to grow by nearly 11 percent annually[4] from 2010 through 2015. Qatar's increased petroleum consumption rates are due to its growing economy, and through 2015, to its use of LPG as feedstock for petrochemical plants. **Libya** holds the largest proven oil reserves in Africa. Libya's energy consumption is predominated by oil which constitutes 74 percent while gas is the remaining 26 percent. With domestic consumption of 264,000 bbl/d in 2009, Libya has estimated net exports (including all liquids) of 1,525 thousand bbl/d. Most of Libyan oil exports[5] are sold to European countries. In 2009, **Algeria** produced a total of 2.13 million barrels per day (bbl/d) of oil liquids, of which 1.33 million bbl/d was crude oil. Algeria was the 4th largest crude oil producer in Africa after Nigeria, Angola, and Libya and the largest total oil liquids producer on the

[3] Source: Energy information Administration. www.eia.doe.gov
[4] FACTS Global Energy forecasts in International energy administration.
[5] the *Global Trade Atlas*

continent. Algeria is an important oil exporter and its estimated net oil exports (including all liquids) reached 1.8 Million bbl/d in 2009, including 1.33 million bbl/d of crude oil

Most OPEC members benefited from the increase in oil prices in the seventies and in recent years. As oil prices surged in the seventies, OPEC members benefited from increased revenue. Large oil- producers such as Iran, Kuwait, Qatar, Saudi Arabia, the UAE and Venezuela, benefited directly in the form of higher export earnings. Economic developments in these countries have been accompanied by an increase in oil consumption. Even in the second half of the 1980s and 1990s when economic growth was slower, energy consumption, mainly oil, continued to grow at a fast rate fuelled by low domestic prices. Since 2003 consumption of oil products increased by average of 4.3 percent, total oil products consumption reached a level of 6291.9 thousand barrel per day, which constitutes 20 percent of OPEC total oil production (figure 2).

Figure 2. OPEC consumption of Total oil products 1980-2010 thousand Barrel /day



When petroleum is refined, there are four main categories under which it is classified. Gasoline, the main refined product which is used for transportation, Kerosene which is used for jet fuel and as a heating fuel, Distillate oils, which includes Diesel, and finally residual oils, which include different types of fuel oil and others.

3. Model Specification and Data

Consumption function is treated in the literature as a positive function of real income or real income per capita and a negative function of own price (see the studies reviewed in Dahl, 1994, OPEC countries went through structural changes affected by four periods of world oil market from 1974-1982 OPEC dominated the world oil market and had a large influence on crude oil prices, from 1983-1986 OPEC not only lost control over oil prices but also market share from 1997-2000 OPEC used formula pricing that is connected to market oil price, and from 2000-2008 OPEC was affected by speculation and increased demand. These changes have affected the economy of OPEC countries and thereafter local demand for oil products. So the model which is going to be used should include a dummy variable reflecting these structural changes.

On the other hand, recent literature has found that GDP is one of the key macroeconomic variables that bear the impact of shocks, reflecting structural changes in the economy (see, for instance, Smyth and Inder, 2004; Narayan, (2007). Therefore, following the standard convention in these studies the demand for oil can be written as follows:

$$C_{it} = f(Y_{it}, P_{it}) \qquad (1)$$

where the per capita real demand for oil (Ct) is a function of per capita real income (Yt) and the real price of oil (Pt). In logarithmic form the model is as follows:

$$\ln C_{it} = \beta_0 + \beta_1 \ln Y_{it} + \ln P_{it} + e \qquad (2)$$

The term e_t is the error term bounded with the classical statistical properties. Using subscript 'i' in Eq. (2) represent a panel by depicting each of the OPEC countries in the sample.

Data: we consider annual data for 7 OPEC members (Algeria (1), Kuwait (2), Libya (3), Qatar (4), Saudi Arabia (5), United Emirates (6), and Iran (7) covering the 1980-2010 period. Source of data are, OPEC secretariat for Gasoline, kerosene distillate, residual and total consumption and domestic prices for each country. Gross demotic product (GDP) in National currency, Country's population and IMF exchange rate (us dollar) comes from International financial statistics (IFS)/ International Monetary Fund (IMF). Since GDP and refined products prices are reported in National currency, converting to USA dollar were made. Moreover, GDP and consumption were obtained for each country.

3.1. Panel Unit Root Tests

Im, Pesaran and Shin (2003) have proposed a panel unit root test statistic, t_{IPS}, which is applicable to heterogeneous cross-sectional panels and given as follows:

$$T_{IPS} = \frac{\sqrt{N}\left(\bar{t} - E\left[t_i \middle| \rho_i = 0\right]\right)}{\sqrt{\mathrm{var}\left[t_i \middle| \rho_i = 0\right]}}, N(0,1) \qquad (3)$$

where N is the number of countries, $\bar{t} = N^{-1}\sum_{i=1}^{N} t_i$ is the mean of the computed Augmented Dickey Fuller (ADF) statistics for individual countries included in the panel, ρ_i is the autoregressive root, $E\left[t_i \middle| \rho_i = 0\right]$ and $\sqrt{Var\left[t_i \middle| \rho_i = 0\right]}$ denote, respectively, the moments of mean and variance obtained from Monte Carlo simulation.

The ADF Fisher panel unit root test proposed by Maddala and Wu (1999) combines the p-values of the test statistic for a unit root in each cross-sectional unit. The Fisher test is nonparametric and distributed as a chi-squared variable with two degrees of freedom. The test statistic is given as:

$$\lambda = -2\sum_{i=1}^{N} \log_e \pi_i \qquad (4)$$

where π_i is the p-value of the test statistic in unit i. The test is superior compared to the IPS test (Maddala and Wu (1999)); its advantage is that its value does not depend on different lag lengths in the individual ADF regressions.

Breitung (2000) studies the local power of *LLC* and *IPS* tests statistics versus a sequence of local alternatives. He finds that both tests suffer for a dramatic loss of power if individual specific trends are included. This is due to the bias correction that also removes the mean under the sequence of local alternatives.

3.2 Panel cointegration tests

Once the order of stationary has been defined, we would apply Pedroni's cointegration test methodology. Indeed, like the IPS and MW panel unit root, the panel cointegration tests proposed by Pedroni (1999) also take heterogeneity into account by using specific parameters which are allowed to vary across individual members of the sample. Since it is illogical to assume that vectors of cointegration are the same for individual countries in the panel, taking into account heterogeneity is ssential in the analysis of panel data.

The implementation of Pedroni's cointegration test requires estimating first the following long run relationship:

$$y_{it} = \alpha_i + \delta_i t + \beta_{1i} x_{1,it} + ... + \beta_M x_{M,it} + \varepsilon_{it} \qquad (5)$$

$$for \quad i = 1,...,N; t = 1,...,T; m = 1,...,M$$

Where *N* refers to the numbers of individual members in the panel; *T* refers to the number of observation over time; *M* refers to the number of exogenous variables. The structure of estimated residuals is follows:

$$\hat{\varepsilon}_{it} = \hat{\rho}_i \hat{\varepsilon}_{it-1} + \hat{u}_{it}. \qquad (6)$$

Pedroni (1999) has shown that there are seven different statistics for this test. They are panel-statistic, panel statistic, panel PP-statistic, Panel ADF-statistic, group-statistic, group PP-statistic, and group ADF-statistic. The first four statistics are known as panel cointegration statistics and are based on the within approach. The last three statistics are group panel cointegration statistics and are based on the between approach. In the presence of cointegrating relationship, the residuals are expected to be stationary. The panel *v*- test is a one sided test with the null of no cointegration being rejected when the test has a large positive value. The other statistics reject the null hypothesis of no cointegration when they have large negative value.

The finite sample distribution for the seven statistics has been tabulated by Pedroni via Monte Carlo simulations. The calculated statistic tests must be smaller than the tabulated critical value to reject the null hypothesis of absence of cointegration.

3.3 Panel cointegration estimation

Although Pedroni's methodology allows us to test the presence of cointegration, it could not provide estimation of a long-run relationship. Kao (1999) analyzed the proprieties of the OLS estimator[6] and found that the bias-corrected OLS estimator does not improve over the OLS estimator in general. These results suggest that alternatives, such as the FMOLS estimator or the DOLS estimator may be more promising in cointegrated panel regressions. However, Kao and Chiang (2000) showed that both the OLS and Fully Modified OLS (FMOLS) exhibit small sample bias and that the DOLS estimator appears to outperform both estimators[7].

In this paper, we consider two estimators with error correction: Fully Modified OLS (FMOLS), and dynamic OLS (DOLS) to empirically examine the demand for gasoline in OPEC countries.

The Fully Modified OLS (FMOLS) and Dynamic OLS (DOLS) methodologies are proposed by Kao and Chiang (2000) to estimate the long-run cointegration vector, for non-stationary panels. These estimators correct the standard pooled OLS for serial correlation and endogeneity of regressors that are normally present in long-run relationship.

Let us consider the following fixed effect panel regression:

$$y_{it} = \alpha_i + x_{it}\beta + u_{it}, i = ,.....,N, t = 1,....,T, \qquad (7)$$

where y_{it} is a matrix (1,1), β is a vector of slopes $(k,1)$ dimension, α is individual fixed effect, u_{it} are the stationary disturbance terms. It is assumed that $x_{it}(k,1)$ vector are integrated processes of order one for all i, where:

$$x_{it} = x_{it-1} + \varepsilon_{it} \qquad (8)$$

Under these specifications, (Eq. 8) describes a system of cointegrated regressions, i.e. is cointegrated with x_{it}. By examining the limiting distribution of the FMOLS and DOLS estimators in co-integrated regressions, Kao and Chiang (2000) show that they are asymptotically normal. The FMOLS estimator is constructed by making corrections for endogeneity and serial correlation to the OLS estimator and is defined as:

$$\hat{\beta}_{FM} = \left[\sum_{i=1}^{N}\sum_{t=1}^{T}\left(x_{it} - \bar{x}_i\right)'\right]^{-1}\left[\sum_{i=1}^{N}\left(\sum_{t=1}^{T}(x_{it} - \bar{x}_i)\hat{y}_{it}^{+} + T\hat{\Delta}_{\varepsilon\mu}^{+}\right)\right], \qquad (9)$$

where $\hat{\Delta}_{\varepsilon\mu}^{+}$ is the serial correlation correction term and $\hat{y}_{it}^{+}$ is the transformed variable of y_{it} to achieve the endogeneity correction. The serial correlation and the endogeneity can also be corrected by using DOLS estimator. The DOLS is an extension of Stock and Watson's (1993) estimator. In order to obtain an unbiased estimator of the long-run parameters, DOLS estimator uses parametric adjustment

[6] Following proprieties are examining by Chen et al. (1999): the finite sample proprieties of the OLS estimator, the t-statistic, the bias-corrected OLS estimator, and the bias-corrected t-statistic

[7] See Kao and Chiang (2000) for more discussions on the advantages of these estimators

to the errors by including the past and the future values of the differenced I(1) regressors. The dynamic OLS estimator is obtained from the following equation:

$$y_{it} = \alpha_i + x_{it}\beta + \sum_{j=q_1}^{j=q_2} c_{ij}\Delta x_{i,t+j} + v_{it}. \qquad (10)$$

where c_{ij} is the coefficient of a lead or lag of first differenced explanatory variables. The estimated coefficient of DOLS is given by:

$$\hat{\beta}_{DOLS} = \sum_{i=1}^{N}\left(\sum_{i=1}^{T} z_{it} z_{it}^{'}\right)^{-1}\left(\sum_{t=1}^{T} z_{it}\hat{y}_{it}^{+}\right) \qquad (11)$$

where $z_{it} = \lfloor x_{it} - \bar{x}_i, \Delta x_{i,t-q}, ..., \Delta x_{i,t+q} \rfloor$ is $2(q+1)\times 1$ vector of regressors

4. Empirical Findings

Cointegration analysis is the appropriate technique to investigate the long-run relationship between consumption. income and price when the time series included in the study are not stationary. Hence, before applying the cointegration technique, the first step is to investigate the stationarity properties of the variables. The power of standard time-series unit root tests may be quite low given the sample sizes and time spans. Therefore, we adopt the recently developed panel unit root tests suggested by Im, Pesaran and Shin (2003) (IPS), the Fisher-ADF proposed by Maddala and Wu (1999) and Breitung (2000) to test for the presence of a unit root in the panel data series.

The second step is to test for the existence of a long-run relationship between consumption of refined products, GDP and domestic real prices. The Pedroni panel cointegration test, which takes into account heterogeneity by using specific parameters, is applied in this study to examine the long-run relationship. Finally, on finding cointegration in the second step, we estimate the coefficients of consumption of refined oil products by using panel fully modified ordinary least squares (FMOLS) method. The Im, Pesaran and Shin W-stat (IPS), the Fisher ADF and PP - Fisher Chi-square panel unit root test results for both levels and first differences of consumption (C_{it}) of Gasoline, Diesel, Kerosene. Income (Y_{it}) and domestic prices for each product (P_{it}) are reported in Table 2. The panel tests include a constant.

Table 2. Panel Unit Root Test Results

	level			First difference		
Series	Im, Pesaran and Shin W-stat (IPS)	ADF - Fisher Chi-square	PP - Fisher Chi-square	Im, Pesaran and Shin W-stat (IPS)	ADF - Fisher Chi-square	PP - Fisher Chi-square
$\ln C_{it}^{gasoline}$	3.6357[0.999]	3.1515[0.998]	4.3099[0.993]	-5.0598[0.000]	54.936[0.000]	129.93[0.000]
$\ln P_{it}^{gasoline}$	0.9199 [0.821]	12.0545[0.601]	18.770[0.173]	-4.0610[0.000]	43.795[0.000]	97.917[0.000]
$\ln C_{it}^{Diesel}$	3.5011[0.999]	6.1621[0.962]	12.356[0.577]	5.7325[0.000]	60.582[0.000]	98.561[0.000]
$\ln P_{it}^{Diesel}$	3.1733[0.999]	2.3321[0.999]	2.2463[0.999]	-7.0545[0.000]	74.492[0.000]	132.53[0.000]
$\ln C_{it}^{Kerosene}$	0.4150[0.660]	12.897[0.534]	28.566[0.012]	-7.0724[0.000]	74.282[0.000]	153.82[0.000]
$\ln P_{it}^{Kerosene}$	1.7488[0.959]	6.4293[0.954]	9.475[0.799]	-6.9885[0.000]	74.394[0.000]	135.42[0.000]
$\ln Y_{it}$	5.7535[1.000]	0.7852[1.000]	0.7082[1.000]	-5.4519[0.000]	56.774[0.000]	103.77[0.000]
Total products	6.5141[1.000]	1.1385[1.000]	0.6892[1.000]	-3.1903[0.000]	36.944[0.000]	71.132[0.000]

Note: Im, Pesaran and Shin W-stat, ADF - Fisher Chi-square, Null: Unit root (assumes individual unit root process). ** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Table 2 presents the results of the panel unit root test. Through the estimation, we find that all variables are I (1). All of the test results show that we are unable to reject the null at the %1 level for all the variables at the level but we reject the null for the first difference of each of these variables. Under the difference form, all variables reject the unit root null hypothesis. which indicate, that the series in the panel are integrated of order one.

4.1. Panel Cointegration

Given that each variable is integrated of order one, the tests suggested by Pedroni (1995, 1999, 2000) are employed for panel cointegration in this study. These tests extend the Engle and Granger (1987) two-step strategy to panels and rely on the ADF and PP principles. Pedroni (1995, 1999, 2000) has proposed seven test statistics for cointegration in a panel context. Four of the statistics developed by Pedroni (1995, 1999), called panel cointegration statistics, are pooled within-dimension based statistics. The other three statistics developed by Pedroni (2000), called group-mean panel cointegration statistics, are between-dimension panel statistics.

The null hypothesis of no cointegration against the alternative of cointegration is tested using the seven statistics. Rejection of the null hypothesis means that the variables are cointegrated. The results of Pedroni panel cointegration test based on seven test statistics are tabulated in Table 3.

Table 3. Pedroni's panel cointegration test for Gasoline, Diesel, Kerosene demand results $\ln C_{it}, \ln Y_{it}, \ln P_{it}$ wth intercept and deterministic trend and lag length selection based on SIC.

	Gasoline	Diesel	Kerosene	Total products
Panel Statistics	1 lag	1 lag	1 lag	1 lag
Panel v –Statistic	5.2885[0.000]	4.02329[0.000]	1.702212[0.044]	3.17307[0.000]
Panel ρ – Statistic	-0.95593[0.169]	-1.97943[0.023]	-0.67115[0.251]	-2.1919[0.014]
Panel PP Statistic	-2.61753[0.004]	-3.54054[0.000]	-1.71256[0.043]	-3.55649[0.000]
Panel ADF Statistic	-0.6675[0.252]	-2.86457[0.002]	-0.47002[0.319]	-2.24748[0.012]
Group Statistics				
Group ρ - statistic	0.0349[0.514]	-0.23562[0.406]	0.43659[0.668]	0.15547[0.561]
Group PP Statistic	-2.5351[0.005]	-4.10130[0.000]	-1.65660[0.048]	-1.77479[0.038]
Group ADF Statistic	-1.4217[0.077]	-2.78347[0.002]	-0.32943[0.370]	-1.13412[0.128]

Note: Probability values in parenthesis. All test statistics are asymptotically normally distributed.

The results show that the null hypothesis of no cointegration is rejected by Panel v –Statistic, Panel PP Statistic, Group PP Statistic and Group ADF Statistic for Gasoline and by all the test except Group ρ - statistic for Diesel and by Panel v –Statistic , Panel PP Statistic, Group PP Statistic for Kerosene. Therefore, these panel cointegration tests point to the existence of a long-run relationship between consumption of three refined products, the income and the domestic real price**.**

4.2. Panel FMOLS and dynamic OLS (DOLS) Estimates

Given that our variables are cointegrated, the next step is estimation of the long-run relationship. The OLS estimator is a biased and inconsistent estimator when applied to cointegrated panels. Therefore, estimation of the long-run relationship using FMOLS approach suggested by Pedroni (2000, 2001, 2004) and dynamic OLS (DOLS) is done. The FMOLS estimator not only generates consistent estimates of the β parameters in small samples, but it also controls for the likely endogeneity of the regressors and serial correlation.

We can see from the Table 4 that the estimated coefficient of the income (Y_{it}) is positive and statistically significant and for Gasoline as a group (FMOLS) is equal to.53, (DOLS) is equal to 0.57 for the group, for price is low and not significant For Diesel FMOLS) equal 0.08, (DOLS) is equal to 0.05 for the group, and significant for the group however most of the individual members not significant this can be explained by the definition of Distillate which was used as an estimate for consumption of Diesel where Distillate though it has diesel includes other products of oil, for Kerosene FMOLS) equal 0.78, (DOLS) equal 0.73 for the group. while the coefficient for domestic price is negative and not significant for Gasoline (FMOLS) equal -0.12, (DOLS) equal -0.12 for the group. For Diesel (FMOLS) equal 0.07, (DOLS) equal 0.03 for the group and is not significant. For the Kerosene (FMOLS) equal -0.11, (DOLS) equal -0.33 for the group and is not significant.

These findings provide strong evidence that income was a positive effect on consumption and the price has negative effect and has low elasticities for the three products. The income result that though has less than one, it has more effect on consumption than the price. However, price should be higher to have more effect on consumption. For the OPEC products, the terms Distillates used as an estimate for Diesel but it seems that Diesel should be used as a separate product not to be included with other products to be able to analyze it.

Table 4. Panel FMOLS, DOLS Estimates for consumption of Gasoline, Diesel, Kerosene and total products.

			Gasoline		Diesel		Kerosene		Total Products	
			FMOLS	DOLS	FMOLS	DOLS	FMOLS	DOLS	FMOLS	DOLS
			Coefficient		Coefficient		Coefficient		Coefficient	
1	Algeria	LY	0.22**	0.24**	0.22	0.30**	2.09**	1.87**	0.57**	0.56**
		LP	0.02	0.02	-0.00	0.04	-0.60	-0.55		
2	Kuwait	LY	0.31**	0.39**	0.89	1.98	2.25	2.44	0.44**	0.47**
		LP	0.33	0.01	0.28	0.37	-0.79	-0.87		
3	Libya	LY	0.73	0.85**	0.09	0.31	0.59	2.35	0.58**	0.61**
		LP	-0.25**	-0.08	-0.16**	-0.36**	1.40	3.05		
4	Qatar	LY	0.35**	0.31**	1.08**	0.93**	1.67**	1.55**	0.76**	0.69**
		LP	0.79	1.15	0.15	-0.02	0.56	0.81		
5	Saudi Arabia	LY	0.56**	0.55**	0.06	0.35**	0.94**	1.54**	0.55**	0.58**
		LP	-0.36**	-0.28**	0.17	0.13	-0.76**	-0.96**		
6	United Arab Emirates	LY	0.64**	0.69**	0.29	0.23	1.90	2.38**	0.40**	0.37**
		LP	0.30	0.10	0.25	0.22	0.06	-0.20		
7	Iran	LY	0.87**	0.93**	0.26	0.19	1.01**	2.46**	0.40**	0.35**
		LP	-0.64**	-0.65**	-0.21**	-0.13**	-0.25	-0.01		
Group										
	Income	LY	0.53**	0.57**	0.08**	0.05**	0.78**	0.73**	0.53**	0.52**
	Price	LP	-0.12	-0.12	0.07	0.03	-0.11	-0.33		

Note: ** indicating significance at the 5%.

4. Conclusions

This paper investigates the long-run relationship between the consumption of three refined products, per capita income and domestic prices for a panel of 7 OPEC members over the period 1980–2007 by using recently developed panel data unit root tests and Pedroni panel data cointegration techniques. The IPS, ADF-fisher, and PP - Fisher Chi-square panel unit root test results show that the series in the panel are integrated of order one.

The estimated coefficient of income (Y_{it}) is positive and statistically significant for (FMOLS) and (DOLS) estimation, while the coefficient for domestic price is negative and not significant for (FMOLS), and (DOLS) estimation for the group. All the elasticities are less than one; however Gasoline and Kerosene income elasticities are higher than price elasticities while Diesel elasticities are low and significant for the group while for individual income elasticities were significant for Algeria and Qatar, while price elasticities were significant for Libya and Iran only.

These finding indicate that policy maker should raise prices of refined products to influence consumption, as the paper indicated that already one country of OPEC (Indonesia) has left the organization in 2008, because of the decline in its exports of crude oil and there is a chance that it will be followed by other members. The subsidized products prices are affecting the consumption of such products. If these countries are to continue their current pricing policy they should at least build more refineries to meet the increasing consumption. Also increase their public transportation use.

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Appendix (1). Definition of oil products used

Gasoline: a mixture of relatively volatile hydrocarbons, with or without small quantities of additives, that have been blended to form a fuel suitable for use in internal combustion engines; includes gasoline used in aviation.

Kerosene: medium hydrocarbon distillates in the 150° to 280° C distillation range and used as a heating fuel as well as for certain types of internal combustion engines; includes jet fuel, which is a fuel of naphtha or of kerosene type, suitable for commercial or military purposes in aircraft turbine engines.

Distillates: middle distillate type of hydrocarbons; includes products similar to number one and number two heating oils and diesel fuels. These products are used for space heating, diesel engine fuel and electrical power generation.

Residual fuel oil: fuels obtained as liquid still bottoms from the distillation of crude used alone or in blends with heavy liquids from other refinery process operations. These are used for the generation of electric power, space heating, vessel bunkering and various industrial purposes.