An Empirical Analysis of Gasoline Demand in Kuwait: A Cointegration Analysis

Osama Alfalah and Barrak Algharabi

Abstract

The objective of this paper was to investigate the determinants of gasoline demand in Kuwait and to assess their impact on consumption. We used the Standard Demand Equation (SDE), the Cointegration Techniques, and the Error Correction Model (ECM) on annual time-series data for Kuwait from 1972 to 2018. We obtained a price elasticity of -0.341 in the long-run, while the short-run price elasticity was insignificant, indicating that changes in prices had minimal or no effect on gasoline consumption in Kuwait. This may be at least in part due to consumers shifting their consumption from a higher grade of gasoline to a less expensive grade when prices changed. We also found that the income elasticity is 0.175 in the short-run and 0.234 in the long-run, indicating that income will be more effective in changing consumption in the long-run. We conclude that reducing gasoline subsidies could result in substantial governmental savings, but this may have an inequitable impact on low-income Kuwaitis.

Keywords: Time-Series Models, Price Policy, Energy, Subsidies, Energy and the Macroeconomy, Government Pricing and Policy, Economic Development, Public Policy, Consumer Economics.

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1. Introduction

Subsidies in Kuwait lower energy prices to very low levels, making consumption extraordinarily high. However, the Kuwait authorities intend to rationalize energy consumption through reform plans, especially for petroleum products. Subsidies consumed 17.6% of the state's annual budget in 2019 (KWD 3,967 million, equivalent to USD 13,092 million), with 48% of those subsidies going to the energy sector (Kuwait News Agency, 2019).

In September 2016, the Kuwait National Petroleum Company (KNPC) increased the prices of the three types of gasoline used in Kuwait: Premium 91 increased from 0.060 KWD to 0.085 KWD per liter (41%); Super 95 increased from 0.065 KD to 0.105 KD per liter (61%); and Ultra 98 increased from 0.090 KWD to 0.165 KWD per liter (83%)[1]. The goal of adjusting the rates is to shift the demand from Super 95 and Ultra 98 to Premium 91. Two years after the implementation of this plan, the consumption pattern in the domestic market changed significantly for each type of gasoline. The total gasoline consumption of Premium 91 rose from 16% in 2016 to 62% in 2018, which was at the expense of a reduction in the consumption of Super 95 from 81% in 2016 to just 37% in 2018, and a reduction in the consumption of Ultra 98 from 2% to 1% over the same period (KNPC, 2019). This change in use is expected to positively affect the budget in Kuwait because the previous consumption of Super 95 was forcing the Kuwaiti government to import Super 95 at international prices and sell it locally at subsidized prices. Figure 1 shows the consumption of three types of gasoline in Kuwait in the previous 25 years, and it is clear that the price change implemented in September 2016 has significantly shifted the consumption in Kuwait from Super 95 and Ultra 98 to Premium 91.

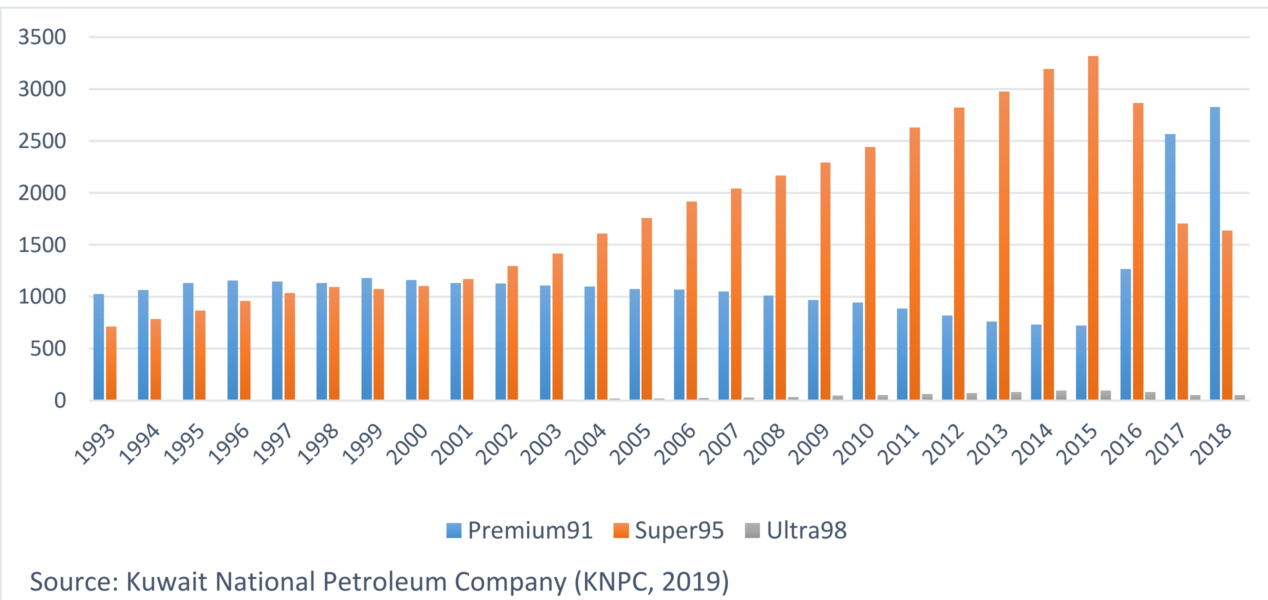

Figure 1. Gasoline Consumption in Kuwait from 1993 to 2018 (in millions of liters)

1 The exchange rate between the Kuwaiti dinar and the US dollar in May 2019 is: 1 KWD = $3.28 USD

History of Gasoline Prices in Kuwait

The prices of petroleum products sold in the local market in Kuwait during the 1960s were equal to the prices in international markets. This was partly because of the low prices of crude oil in the world markets, and partly because petroleum products were sold on a commercial basis in the local Kuwait markets. Local price adjustments were introduced in the late 1960s when the metric system was adopted for all products, instead of imperial oil gallons. The prices of products in the local market were held constant by the government until 1972 when their levels were increased to match the increases in the export prices of crude oil and its derivatives, and to cover the continuous increase in the costs of distribution and marketing to local consumers. In April 1975 this increase was canceled, and prices returned to their previous levels until the early 1980s, leading to petroleum products in Kuwait being sold for far less than the same products on the global market. The actual cost of petroleum products, especially gasoline, fell continuously as a result of inflation in the prices of goods and services. The real rate of these products in 1980 was less than half that of 1970. This encouraged an increase in demand due to the lack of economic incentive to reduce consumption.

The costs of distribution in the domestic market have risen continuously so that the price of selling products, such as gasoline, is less than the cost of distribution (i.e., the oil used in the production of these derivatives is given free of charge, which is a waste of oil wealth). In order to correct this situation, the prices of gasoline were increased in April 1982 by 0.025 KWD per liter for all types of gasoline, becoming 0.040 KWD and 0.050 KWD for Premium 91 and Super 95, respectively. In August 1999 the prices were raised from the level prevailing since 1982, and prices increased by 0.02 KWD for Premium 91 (50%), 0.015 KWD for Super 95 (30%), and 0.030 KWD for Ultra 98 (50%), respectively[2]. The final increase in gasoline prices in Kuwait was in September 2016 and was associated with the fall of global oil prices which affected the Kuwaiti budget significantly. Figure 2 shows the movement of the gasoline prices in Kuwait since 1965 and shows that changing the prices in Kuwait is not a common event as they are not linked to international prices.

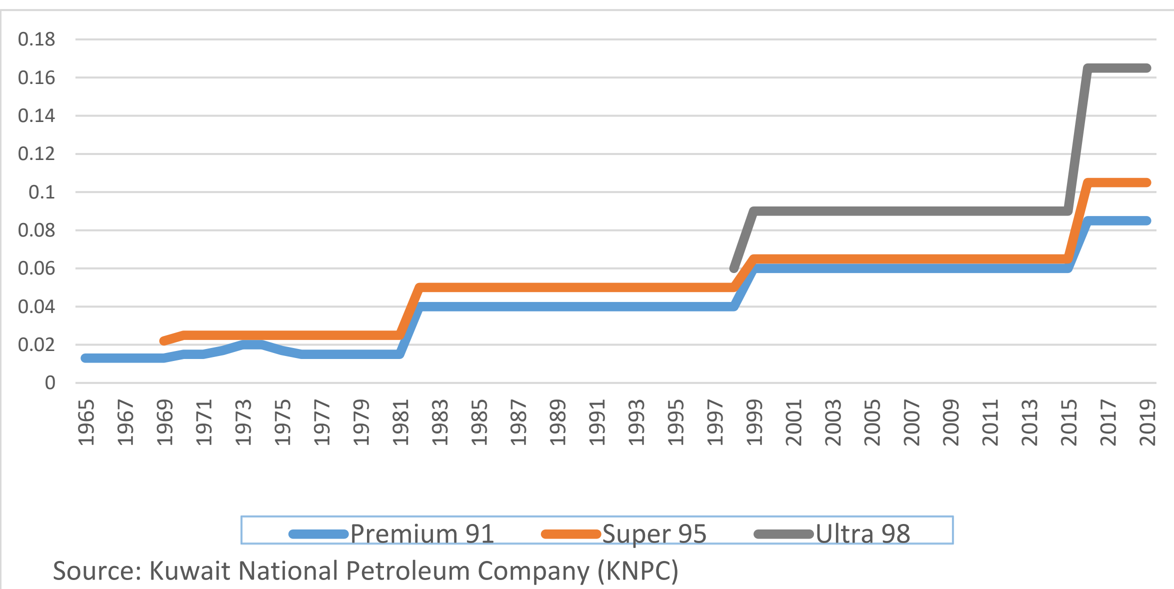

Figure 2: Gasoline Prices in Kuwait from 1965 to 2019 (in Kuwaiti Dinars per liter)

[2] Ultra 98 was introduced to the local market in September 1998 (KNPC)

This paper studies consumption patterns when gasoline prices change and examines how the government can direct consumer behavior towards the use of different types of gasoline or the reduction of the total amount consumed. Therefore, this paper will focus on identifying the most critical factors affecting the consumption of gasoline in Kuwait, especially price and income elasticities of demand. Knowing the elasticity of consumer demand is one of the essential elements of economic reform decisions and thus policymaking becomes more realistic and less harmful to the economy in general and the consumer welfare in particular. The remainder of the paper is organized as follows: Section two is a literature review; Section three provides the methodology; Section four presents the data and its resources; Section five shows the results for estimating the elasticity of demand for gasoline in Kuwait; Section six provides road map recommendation; and Section seven presents concluding remarks.

2. Literature Review

Several studies have attempted to find a better way to apply subsidy reform by analyzing the price and income elasticities of demand in different regions and at different times. Bentzen (1994) estimated the demand for gasoline in Denmark from 1948 to 1991 by using Cointegration Analysis and the Error Correction Model (ECM). Bentzen used two different equations to analyze gasoline consumption: the first used price and income and the second used price and the number of vehicles in the country. The first test showed long run elasticity of price as -0.84 and short run as -0.27; and found income elasticities of 1.33 in the long run and 0.44 in the short run. The second model showed price elasticities of -0.41 in the long run and -0.32 in the short run, and elasticities for vehicles per capita were 1.04 in the long run and 0.89 in the short run. The ECM value of the adjustment coefficient was 67%, indicating that gasoline demand adjusts quickly if consumption deviates from the long run level of demand.

Eltony and Al-Mutairi (1995) estimated the demand for gasoline in Kuwait using Cointegration Analysis and ECM. They covered the period from 1970 to 1989 by employing annual time-series data using a simple model suggested by Dahl and Sterner (1991). They found that Kuwaiti consumers were inelastic with respect to price in the short run (-0.37) and the long run (-0.46), and inelastic with respect to income in the short run (0.47). However, the latter was elastic in the long run (0.919) which suggests that demand response to income changes in the long run is higher than in the short run. Ramanathan (1999) examined the relationship between gasoline demand, national income and price of gasoline in India from 1972 to 1994, again using Cointegration Analysis and ECM. He found that the price elasticity was -0.209 in the short run and -0.319 in the long run, while income elasticity was 1.178 in the short run and 2.682 in the long run.

Cheung and Thomson (2004) used Cointegration Analysis and ECM to study the demand for gasoline in China between 1980 to 1999. They found that the demand for gasoline was relatively inelastic in relation to price change, both in the short run (-0.194) and long run (-0.56), while the elasticity for income was 1.64 in the short run and 0.97 in the long run. In addition, ECM has shown that gasoline consumption adjusts towards its long run equilibrium level at a moderate speed, with about 32% of adjustment taking place within the first year. Wadud et al. (2009) applied Cointegration Analysis and ECM to estimate gasoline demand in the United States using annual time-series data for the period of 1949 to 2004. Their findings were consistent with previous studies, but slightly lower, where price elasticities were -0.065 in the short run and -0.102 in the long run, while income elasticities were 0.473 for the short run and 0.565 for the long run. Finally, ECM has shown that gasoline consumption adjusts towards its long run equilibrium level quite quickly with about 78% of the adjustment taking place within the first year. Park and Zhao (2010) estimated the time-varying price and income elasticities of US gasoline demand from 1976 to 2008 using a time-varying cointegrating regression. They found that price elasticity increased rapidly during the late

1970s and then decreased until 1987. The ECM shows that any deviation from the long run equilibrium is corrected quickly.

Baranzini and Weber (2013) investigated the determinants of gasoline demand in Switzerland over the period 1970 to 2008 by using Cointegration Analysis and ECM. They found that price elasticity was -0.09 in the short run and -0.34 in the long run, while income elasticity was 0.025 in the short run and 0.673 in the long run. Additionally, they found that the adjustment speed to the long run equilibrium was 27% within the first year. Finally, Davis (2014) examined global fuel subsidies using World Bank data. He applied a statistical analysis, rather than using regression models, to emphasize that pricing fuels below cost is inefficient because it leads to overconsumption. The study emphasized that consumption tends to be high in countries where gasoline is subsidized, like Kuwait, Saudi Arabia, the United Arab Emirates (UAE) and Venezuela. For example, gasoline consumption in Venezuela is 40% higher than in any other country in Latin America and is more than three times the regional average. According to Davis, subsidies create Deadweight Loss (DWL) by enabling transactions in which the buyer's willingness to pay is below the opportunity cost. The total deadweight loss depends on the elasticity for each country: the more elastic the demand, the larger the deadweight loss from pricing below the cost. Davis found that the deadweight loss resulting from gasoline subsidies in 2012 was around USD 20 billion globally. Venezuela, for example, is at the top of the list with USD 7.8 billion deadweight loss, Saudi Arabia is USD 5.2 billion, Indonesia is USD 2.2 billion, Iran is USD 2.0 billion, Egypt is USD 0.7 billion, and Kuwait is USD 0.5 billion. Table 1 presents a summary of the reviewed studies.

Table 1 A Comparison of Gasoline Elasticities through Various Studies

			Short-Run Elasticities		Long-Run Elasticities		
Study	**Country**	**Period**	**Price**	**Income**	**Price**	**Income**	**Speed of Adjustment**
Present Study	Kuwait	1972 - 2018	0.054	0.18	-0.34	0.23	46%
Bentzen (1994)	Denmark	1948 - 1991	-0.27	0.44	-0.84	1.33	67%
Eltony and Al-Mutairi (1995)	Kuwait	1970 - 1989	-0.37	0.47	-0.46	0.919	52%
Ramanathan (1999)	India	1972 - 1994	-0.209	1.18	-0.319	2.68	28%
Cheung and Thomson (2004)	China	1980 - 1999	-0.194	1.64	-0.56	0.97	32%
Wadud et al. (2009)	U.S.	1949 - 2004	-0.065	0.47	-0.102	0.565	78%
Baranzini and Weber (2013)	Switzerland	1970 - 2008	-0.09	0.025	-0.34	0.673	27%

2. Methodology

In this paper we use several methods, starting with Cointegration Analysis, which is a method to examine the existence of a long run relationship between two or more variables. We also use the Error Correction Model (ECM), which is a technique that helps in understanding the difference between the short run and long run elasticities and helps to find the expected equilibrium in the long run. Alongside these, we incorporate the Standard Demand Equation (SDE) to create a solid and useful equation that will explain the relationship between consumption, gasoline prices, and income. Finally, the Price-Gap approach is used to detect the expected impact of subsidy removal and finding the most effective subsidy reform plan. This method focuses on end-use energy consumption subsidies and quantifies the gap between world energy prices and domestic (subsidized) end-user prices. Each method is examined in more detail in the following section.

As a starting point, we incorporate the SDE method, and follow Eltony and Al-Mutairi (1995), Ramanathan (1999), Cheung and Thomson (2004), Wadud et al. (2009) and Baranzini and Weber (2013) in applying the SDE on the cointegration analysis. This starts with the following simple equation:

$$\boldsymbol{g_t = \beta_0 y_t^{\beta_1} p_t^{\beta_2} + \varepsilon_t} \tag{1}$$

where g denotes gasoline demand of Kuwaiti consumers at time t, β_0 denotes a constant, y is Kuwait real GDP per capita at time t, β_1 is the income elasticity of gasoline demand, p is the real price of gasoline in Kuwait at time t, β_2 is the price elasticity of gasoline demand, and ε is the error term. By taking the logarithm of both sides of the equation, we obtain the following equation:

$$\boldsymbol{\log(g_t) = \beta_0 + \beta_1 \log(y_t) + \beta_2 \log(p_t) + \varepsilon_t} \tag{2}$$

We can estimate this equation by using OLS regression with robust standard errors to obtain the long run income and price elasticities by β_1 and β_2, respectively. Baltagi and Griffin (1984) have shown, using Monte Carlo simulations, that OLS estimation is the preferred model to other estimations (such as fixed effects and random effects). This is especially true if the estimation is aiming to show long run elasticities. We will also obtain, using equation (2), the error term to use for the ECM model in the following equation:

$$\boldsymbol{\Delta\log(g_t) = \beta_0 + \beta_1 \Delta\log(y_{t-i}) + \beta_2 \Delta\log(p_{t-i}) + \beta_3 \Delta\log(g_{t-1}) + \beta_4 ECT_{t-1} + \varepsilon_t} \tag{3}$$

where Δ is the difference operator; β_1 and β_2 are the short run income and price elasticities, respectively, and ECT refers to the error correction term derived from the long run cointegration relationship via the Johansen Maximum Likelihood procedure, where β_4 represents the speed of adjustment toward long run equilibrium. The equation used for ECT is as follows:

$$\boldsymbol{ECT_t = log(g_t) - \beta_0 - \beta_1\, log(y_t) - \beta_2 log(p_t)} \tag{4}$$

The final test, the price-gap approach, could help in finding the impact size of any reform and presenting a reform plan for the gasoline pricing in Kuwait. This approach has several advantages. Firstly, it has been used in a good number of papers that studied subsidies, as it has the advantage of both theoretical and analytical simplicity (Birol and Keppler, 1999; Koplow, 2009; Liu and Li, 2011; Lin and Jiang, 2011; Jiang and Tan, 2013; Griffiths, 2017; Von Moltke et al., 2017). Secondly, this approach captures the subsidies on the end use of energy. The majority of Kuwaiti energy subsidies, like the three types of gasoline, are in the form of end-user subsidies which are based on the idea that subsidies to consumers lower the end-user prices of energy products and thus lead to more consumption than would occur in their absence. On the other hand, the price-gap approach has some limitations in that it requires accurate data on world reference prices, domestic taxes, and transport costs, all of which can pose difficulties. In addition, the price-gap approach identifies only static effects in that it compares given situations with and without subsidies, holding all other things equal (Birol and Keppler, 1999 and Davis, 2014)

To apply the price-gap analysis, we first determine the consumer price (which is the gasoline price paid by the consumers in Kuwait) and the reference price (which is the price that is linked to the global prices). We compute the price gap as follows:

$$\boldsymbol{Price\ Gap = Reference\ Price - Consumer\ Price} \quad (5)$$

We then estimate the impact of the price gap on energy consumption, where the effect of the removal of the subsidies depends on the functional form of the inverse demand function. The methodology described in Birol and Keppler (1999) is adopted in this paper, as we use the constant elasticity of the inverse demand function. The advantage of this is that the demand elasticity stays constant along a range of possible values and the parameters are easy to estimate with limited data. A constant-elasticity inverse demand function for calculating the price change impact on Kuwaiti gasoline consumption starts with the following form:

$$\Delta \boldsymbol{q} = \Delta \boldsymbol{p}^{\boldsymbol{\varepsilon}} \quad (6)$$

where Δq is the change consumption quantity, Δp is the change in price, and ε is the long run price elasticity of gasoline demand (note that $\Delta q = Q_1 - Q_0$ is the impact on the consumption after changing the price). By taking the logarithm of both sides, we will reach:

$$\boldsymbol{log}\Delta(\boldsymbol{Q}) = \boldsymbol{\varepsilon} \times \boldsymbol{log}(\Delta \boldsymbol{p}) \quad (7)$$

$$\boldsymbol{logQ_1} - \boldsymbol{logQ_0} = \boldsymbol{\varepsilon} \times (\boldsymbol{logp_1} - \boldsymbol{logp_0}) \quad (8)$$

$$\boldsymbol{logQ_1} = \boldsymbol{\varepsilon} \times (\boldsymbol{logp_1} - \boldsymbol{logp_0}) + \boldsymbol{logQ_0} \quad (9)$$

where Q_1 and p_1 are the quantity and price after the removal of the subsidies, respectively, and Q_0 and p_0 are the quantity and price before the removal of the subsidies, respectively. Intuition would suggest that price changes will generate large quantity changes if the absolute price elasticity to demand is higher, and vice versa.

According to an International Monetary Fund (IMF) report from 2014, defining the suitable reference price to establish the cost of subsidies is often a challenge, especially for products that are not easily traded such as electricity. Likewise, for broadly traded products, such as gasoline, the appropriate reference price has to be chosen carefully. For example, in oil-producing countries, the relevant reference price is the international price, because the country would incur an opportunity cost if it simply sold the gasoline at the domestic production cost.

4 Data

The data used for the estimation in this paper covers the period from 1972 to 2018, a period of time which represents significant changes in the economy of Kuwait and includes several global shocks that the country experienced. Data have been obtained from various resources. Macroeconomic variables such as Gross Domestic Product (GDP), GDP growth, and CPI were obtained from the World Bank Development Indicators. Data regarding gasoline consumption and gasoline prices in Kuwait were obtained from the Kuwait National Petroleum Company (KNPC) and the Ministry of Oil in Kuwait. Kuwait population data was extracted from the Public Authority for Civil Information (PACI) and from the Kuwait Central Statistical Bureau (CSB).

Summary Statistics

Consumers in Kuwait use three main types of gasoline: Premium 91; Super 95; and Ultra 98. This is based on the octane grade, and the higher the figure, the better the quality. It should be noted here that from 1972 to 1998, Kuwaiti consumers had only two types of gasoline to consume, Premium 91 and Super 95. However, in 1998, a new type of gasoline was introduced: Ultra 98 as a special type of gasoline aimed at owners of luxury cars. While Figure 1 in the first section shows the consumption of each type of gasoline in Kuwait, Figure 3 shows the percentage growth in each type of gasoline, which reflects the increasing/decreasing size of demand every year. It is evident that the price change in September 2016 cause a significant shift in consumers' preferences for Premium 91, not only from Super 95 but also from Ultra 98. This shift was aimed at reducing the cost of supporting Super 95. However, the total consumption for all types of gasoline has not changed significantly.

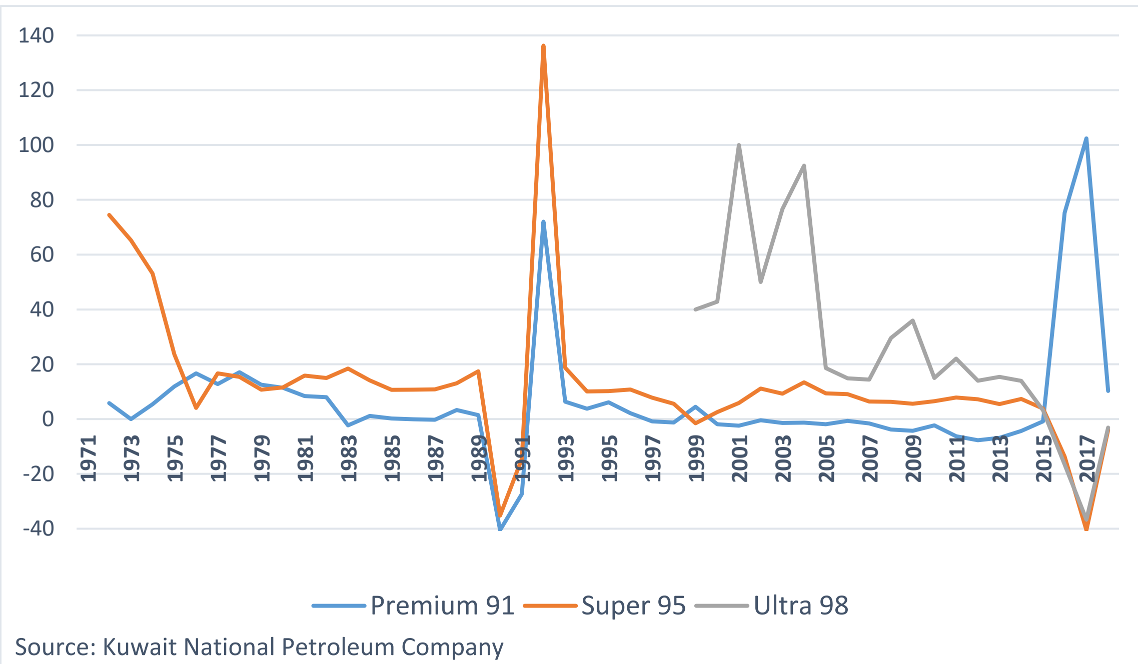

Figure 3 Percentage Change in Consumption of Gasoline in Kuwait from 1972 to 2018

Table 2 presents the summary statistics for the main variables used in this paper, where we divided the covered period to three periods: from 1977 to 1989; from 1994 to 2006; and from 2007 to 2018. There are two reasons behind this separation in this table; firstly, to control for the Iraqi invasion of Kuwait from 1990 to 1991 and its consequences (which extend to the 1993 dataset) and secondly, to differentiate consumption behavior among different generations as the nature of social and material life in Kuwait changes from decade to decade. However, the regression analysis applied in this paper uses the data for the whole period.

Table 2 Summary Statistics for the Consumption of Gasoline Per Capita and Per Capita Income.

Period	*Consumption Per Capita (Lit/Y)*				*Real GDP Per Capita (USD/Y)*			
	Mean	*Max*	*Min*	*SD*	*Mean*	*Max*	*Min*	*SD*
1977 to 1989	853	952	715	63	24,700	41,800	15,500	8,800
1994 to 2006	992	1020	944	23	24,800	40,700	17,100	6,700
2007 to 2018	958	981	916	19	33,000	46,800	20,600	9,100

Source: Author's calculations. Consumption is per liter, and income is in USD

We can observe two important points from Table 2. First, the average consumption per capita of gasoline in Kuwait has not always increased over time, with the mean of the 1994 to 2006 period higher than the mean of the 2007 to 2018 period even though the real income of Kuwaiti consumers has increased from decade to decade. As our results will demonstrate, the decrease between 2007 and 2018 can be attributed at least in part to the government's decision to increase prices. This indicates that consumption is something that the government can control with the right policy. Second, the volatility of gasoline consumption per capita is getting lower over time (SD = 189 in the last decade), which indicates that the consumption behavior of Kuwaiti consumers is becoming more predictable. This is despite the fact that income fluctuations were higher in the last decade (SD = 91) than in previous decades.

5. Empirical results

The econometric models considered in this paper for estimating gasoline demand were quite similar to previous papers that applied tests on other countries or other time periods (i.e., Elnoty and Al-Mutairi 1995; Ramanathan 1999; and Cheung and Thomson 2004). All the mentioned papers applied Cointegration Analysis, which involves several steps. The first step is to choose the number of lags for the Augmented Dicky-Fuller (ADF) test, which can be done by using the Vector Autoregressive Model (VAR). According to Stock and Watson (2015), in practice, selecting the number of lags requires a balance between a low number of lags which might omit potential valuable information and a high number of lags which might introduce additional estimation error into the forecast. For the lag selection, we will be following the Bayes Information Criterion (BIC) (also known as the Schwarz Information Criterion (SIC)), the Akaike Information Criterion (AIC), and the Hannan–Quinn Information Criterion (HQ) by using the following models:

$$\boldsymbol{BIC(K) = ln\frac{RSS(K)}{T} + K\frac{\ln(T)}{T}} \tag{10}$$

$$\boldsymbol{AIC(K) = ln\frac{RSS\ (K)}{T} + K\frac{\ln(2)}{T}} \tag{11}$$

$$\boldsymbol{HQ(K) = T \times ln\frac{RSS\ (K)}{T} + 2 \times K \times \ln(lnT)} \tag{12}$$

where K is the number of model parameters, RSS is the residual sum of squares that result from the statistical model, and T is the number of observations. We can choose the number of lags by testing a couple of models with different lags. The model with the lowest value of BIC, AIC or HQ is the preferred model.

Table 3 presents our results for the lag selection criteria, which show that all types of tests indicate that one lag is the preferable choice for our model.

Table 3 VAR Lag Order Selection

Lag	*AIC*	*BIC*	*HQ*
0	-5.388191	-5.260224	-5.342278
1	-8.621466*	-8.109601*	-8.437813*
2	-8.336584	-7.44082	-8.015191
3	-8.063836	-6.784173	-7.604704

Source: Author's Calculations.

The second step is to check for the stationary (unit root) of all variables, in its levels, the first difference and the second difference, by using the ADF test. To do so, we start by:

$$\boldsymbol{Y_t = \alpha + \beta X_t + \mu_t} \tag{13}$$

And then obtain the error terms:

$$\boldsymbol{\hat{\mu}_t = Y_t - \hat{\alpha} - \hat{\beta} X_t} \tag{14}$$

Finally, we estimate the ADF by the following equation:

$$\Delta\boldsymbol{\hat{\mu}_t = \phi\hat{\mu}_{t-1} + \sum_{i=1}^{\rho} b_i}\Delta\boldsymbol{\hat{\mu}_{t-i} + \varepsilon_t} \tag{15}$$

Where ρ is the preselected order of lags for the residuals.

Table 4 presents the test results for each variable. All variables at the level form are not statically significant, which means that the null hypothesis that variables at the level form are non-stationary cannot be rejected. However, the second difference outputs are statistically significant for all variables, meaning that we can reject the null hypothesis that all variables at the second difference form are non-stationary (that is, variables are denoted as I(2), as their second differences are stationary).

Table 4 Testing for the Stationary of Variables Using the ADF Test

Variable	*Level Form*	*First Difference Form*	*Second Difference Form*
Per Capita Gasoline Consumption	-1.004	-1.337	-2.793*
Real Per Capita GDP	-2.212	-5.789***	-10.427***
Real Gasoline Price	-1.665	-6.516***	-10.365***
Residuals from long run equation	-1.886	-3.947***	-5.376***

Source: Author's Calculations.
****,**,*: Statistically significant at 1%, 5% and 10%, respectively.*

The third step is to estimate the cointegration relationship shown in equation (2) and apply the Engle and Granger (1987) test for the long run relationship among variables. The residual ε_t has been found to be non-stationary at the level form, while it was stationary at the first difference levels, indicating that it is stationary I(1) and that the above cointegration relationship among the variables exists (Table 4).

Furthermore, the results from equation (2) indicate that the estimated long run coefficients of real per capita GDP and real price of gasoline are 0.234 and -0.341, respectively. Both estimates are statically significant at 1%. The long run income elasticity implies that a 10% increase in the real income for Kuwaiti consumers would increase gasoline consumption by 2.34%, while the long run price elasticity implies that a 10% increase in the price of gasoline would result in a decrease in gasoline consumption of 3.41%.

Once the cointegration relationship is found, the fourth and final step is the construction of the ECM model, which estimates short run behavior in terms of gasoline consumption. In addition, cointegrating variables are expected to restore themselves to their long run equilibrium whenever there is a drift. The ECM is estimated using equation (3), where the results indicate that the short run coefficients for real per capita GDP and real price of gasoline are 0.175 and 0.054, respectively. However, the elasticity of gasoline price to demand is not statically significant, while the income elasticity to demand is significant at 1%. Short run income elasticity implies that a 10% increase in real income for Kuwaiti consumers would increase gasoline consumption by 1.75% in the short run. Finally, the coefficient of the residual used in equation (3) represents the speed of adjustment toward long run equilibrium. Its value is estimated as 0.458 and it is statically significant at 1%, signifying that gasoline consumption adjusts toward its long run equilibrium levels at a relatively moderate speed, with about 45.8% of the adjustment occurring within the first year. Table 5 summarizes the short run and long run results.

Table 5 Short and Long-Run Elasticities of Gasoline Demand in Kuwait

Dependent Variable	Price Elasticity		Income Elasticity	
	Short Run	*Long Run*	*Short Run*	*Long Run*
Consumption	0.0537 (0.7984)	-0.3409*** (-4.5134)	0.1749*** (3.0395)	0.2336*** (3.4245)

Source: Author's Calculations.

*Standard Errors in Parenthesis; ***,**,*: Statistically significant at 1%, 5% and 10% respectively*

The results found in this paper are consistent with previous literature in several ways. Firstly, the price elasticity seems to be inelastic in the short run and long run, which means that the impact of price change on consumption is not large (Eltony and Al-Mutairi, 1995; Ramanathan, 1999; Wadud et al., 2009; Baranzini and Weber, 2013). Secondly, the long run elasticities are higher than the short run, indicating that the impact of price or income changes are much higher in the long run (Bentzen, 1994; Eltony and Al-Mutairi, 1995; Ramanathan, 1999; Wadud et al., 2009; Baranzini and Weber, 2013).

The final test that we applied in this paper is the price-gap approach, which has been widely used in previous studies, such as IEA (2012), IMF (2013), Davis (2014), and Plante (2014). We estimated the impact of linking the local prices to the international prices (that is, the impact of Kuwaiti consumers paying international prices in the local market). We started with equation (5) to measure the price gap between Kuwaiti prices and the international price. According to the Global Petroleum Price (2019), the average price of gasoline around the world in 2018 was 1.15 USD per liter, while the average prices for gasoline in Kuwait in the same period was 0.34 USD per liter. This makes the price gap between Kuwaiti prices and international prices equivalent to 0.81 USD per liter (price gap = 1.15 – 0.34). We then followed the 1999 IEA study by employing equations (6) through (9) to find that, in the long run, gasoline consumption would fall from 45,110 million liters to 29,985 million liters if prices were increased to USD 1.15. Table 6 summarizes the price-gap results.

Table 6 Size and Impact of Gasoline Subsidies in Kuwait (USD in 2019)

Consumer Prices	*International Prices*	*Rate of Subsidies*	*Gasoline Saving from Subsidy Removal*
$0.34	$1.15	70.3%	33.5%

Source: Author's Calculations Based on KNPC and Global Petroleum Price data

Based on the results shown in Table 6, we can see that Kuwait may benefit greatly from the liberalization of gasoline prices in two ways, both by reducing pressure on the annual budget and by reducing the amount of exhaust emissions created by the high consumption of gasoline annually. This is mainly due to the fact that the Kuwaiti consumer pays only 30% of the international price. It should be noted here that the gasoline prices in Kuwait are still among the lowest around the world. Table 7 shows gasoline prices in selected countries.

Table 7 Lowest and Highest Gasoline Prices Around the World (USD per liter)

Lowest Prices		*Highest Prices*	
Country	**Price**	**Country**	**Price**
Venezuela	0.01	Greece	1.71
Sudan	0.13	Denmark	1.73
Iran	0.29	Netherlands	1.76
Kuwait	0.34	Iceland	1.77
Algeria	0.35	Barbados	1.78
Nigeria	0.4	Norway	1.86
Egypt	0.43	Wallis and Futuna Islands	1.89
Qatar	0.43	Monaco	1.98
Turkmenistan	0.43	Hong Kong	2.11
Azerbaijan	0.47	Zimbabwe	3.34

Source: Global Petroleum Price database, February 18, 2019.

6. Policy Recommendations

The estimations of the price elasticity of gasoline demand set out above suggest that Kuwait could benefit from undertaking a subsidy reform. Subsidies can be thought of as negative taxes. Taxes are used to discourage negative externalities or discourage a specific action/behavior (Christiansen and Smith 2012). Subsidies serve the opposite role where they can be used to encourage positive externalities or to encourage a specific behavior (McKenzie 2005). Removing or reducing the current subsidy on a product (such as gasoline) would be similar to the idea of introducing a tax to that specific product. Thus, the principles of taxation apply to that scenario, so it is essential to keep them in mind from a policy perspective.

Denison and Facer (2005) delineate the core principles of tax systems: equity, adequacy of revenues, economic neutrality, transparency and accountability, and ease of administration. Our findings indicate that the demand for gasoline in Kuwait is inelastic, which is in line with the findings of the literature. These findings highly relate to the economic neutrality principle. Economic neutrality means that the tax system should introduce the lowest amount of distortions possible. If the plan is to apply economic neutrality and tax efficiency, we should tax the more inelastic goods because this will help to structure a tax system that minimizes the deadweight loss (Ramsey 1927). The rationale behind this is that when taxing an inelastic good, people will not have much flexibility to switch to other goods or products, as is the case with elastic goods (Hoffer and Shughart 2018). This means that reducing the subsidies on gasoline in Kuwait, given the fact that its demand is inelastic, is a logical decision under the economic neutrality grounds.

On the other hand, taxing gasoline could violate the equity principle. Equity here refers to both horizontal equity and vertical equity. Under the horizontal equity principle, people at the same level of income are supposed to have a similar tax bill. However, when we remove the subsidies from gasoline, the burden that will fall on the consumer is determined by the consumption choices of each household. In other words, it would be difficult to achieve the horizontal equity in this scenario. The literature also reflects that the tax burden of excise taxes (or selective taxes on specific products like cigarettes, gasoline, and alcoholic beverages) is higher on individuals with lower incomes relative to ones with high incomes (Colman and Remler 2008, Hoffer and Shughart 2018). This indicates that the nature of such taxes is regressive, which violates the vertical equity principle, which entails that people at different income levels should pay different taxes. This could require the Kuwaiti government to consider compensating those with low levels of income.

The adequacy of revenue principle is relevant where the potential reforms in the Kuwaiti economy and budget are all trying to increase the Kuwaiti revenues (or decrease its expenditures) and diversify the Kuwaiti economy. The Kuwaiti economy is dependent on oil (Al-Mutairi et al. 2020). When the price of oil started to decrease recently, the Kuwaiti national budget went from running annual surpluses to ongoing deficits. Reducing the subsidies on gasoline could be one of many reforms that when taken together could help in reaching a balance in the Kuwaiti budget. Table 8 reflects forecasts of the expected effects of the decrease in the gasoline subsidy in Kuwait.

Table 8 Forecasts of Expected Savings of Three Different Scenarios of Gasoline Subsidy Decreases

Forecasts	Average gas price in Kuwait Today	Kuwait's new price	International gas price	Gas Consumption in 2018	Elasticity	Gas consumption after accounting for elasticity	Total Savings in USD
Increase gas prices by 5%	0.34	0.357	1.15	4,500,000,000	0.3409	4,423,297,500.00	$137,325,082.50
Increase gas prices by 10%	0.34	0.374	1.15	4,500,000,000	0.3409	4,346,595,000.00	$272,042,280.00
Increase gas prices by 15%	0.34	0.391	1.15	4,500,000,000	0.3409	4,269,892,500.00	$404,151,592.50

Source: Author's calculations based on KNPC and global petroleum data and the elasticities found in this paper

To put these number in perspective, the total costs of subsidies on the Kuwaiti government in 2018 was 3.73 billion KWD (around 11.9 billion USD). Thus, the savings based on the proposed gasoline subsidies decreases will not be the sole change that will fix the issues of Kuwaiti budget. However, if the Kuwaiti government starts to gradually fix the Kuwaiti economy by taking small steps towards reducing subsidies on other services (e. g. water and electricity), this could assist in combating the deficit issue. They also need to find new streams of revenues to make the Kuwaiti budget less dependent on oil and less vulnerable to the fluctuations in the oil barrel price. However, the subsidies' reform plan will not work without a good communication strategy and high level of strategy.

7. Conclusion

Energy consumption in Kuwait is one of the highest in the world and has not achieved any efficiency during the past two decades; this is mainly due to high energy subsidies that encourage excessive consumption and careless behavior. According to Ministry of Finance (2019), Kuwait's energy subsidies account for about 48% of the total subsidies in the country, which accounted for 8.4% of the total GDP in 2018. Total subsidies in Kuwait cost about USD 13.092 billion in 2018, and this number is expected to grow by 7.4% every year.

The government of Kuwait has taken some steps to reduce the burden of subsidies, starting with historical increases in gasoline prices through history such as those in 1972, 1975, 1982, 1999, and 2016. These changes aimed for the same purpose, which was to reduce the sharp and sustained increase in domestic consumption of petroleum products in Kuwait. Another action the government of Kuwait has taken on gasoline use is developing the public transportation infrastructure to provide a viable substitute for personal automobile use as much as possible. However, personal automobile use is still the primary transportation method in Kuwait, because public transportation is still inefficient, and people can easily afford cars.

The long run and short run price and income elasticities of gasoline demand in Kuwait have been estimated in this paper using the cointegration analysis and the ECM covering the period from 1972 to 2018 with annual time-series data. The results have shown relatively low income elasticity in the short run (0.1749) and the long run (0.2336) indicating that income change has a higher impact in the long run. Also, the price elasticity was inelastic in the long run (-0.3409) while it was insignificant in the short run, meaning that price change has little to no effect for gasoline consumption in Kuwait. The ECM was found to be significant with an adjustment coefficient of 0.458, indicating that if gasoline demand drifts away from its long run equilibrium level it then restores itself to the long run equilibrium at a relatively moderate speed, with about 45.8% of the adjustment occurring within the first year.

The elasticities obtained in this paper provide valuable policy implications. The higher long run income elasticities compared to the short run income elasticities indicate that the response of gasoline demand to income will be greater in the long run. The insignificant short run price elasticity may indicate that price changes will not cause a change in gasoline consumption in the short run, but rather the consumers will change their consumption behavior in the long run. Nevertheless, this change might be also limited because price elasticity is still low in the long run. Increasing the price of gasoline may be considered as one policy option in Kuwait. However, the empirical results of this paper indicate a low price elasticity, meaning that the over-pricing of gasoline as a policy instrument in itself is not likely to be very effective. However, it could be part of a wider comprehensive reform of the energy sector in Kuwait. If nothing else, it reduces subsidy spending, even if there is no decrease in consumption.

One recommendation for future studies is to divide the sample into three subsets: 1972 to 1989; 1994 to 2005; and 2006 to 2018 (as we did in Table 3). Dividing the data in such a way would avoid the possible structural breaks during the long period and would control for the significant changes in the dataset during and after the period of Iraq's invasion of Kuwait. Additionally, this division would allow for study of the different consumption behavior in each generation, which is most likely not the same over the past 46 years. However, this division would be much better if it used monthly or quarterly data, because it will increase the degree of freedom in the econometric model. Another recommendation for future studies is to incorporate the semiparametric regression into Kuwaiti data, which would give a broader view of elasticities over time and in different levels of income and price.

References

1. Al-Mutairi, A., Al-Abduljader, S., & Naser, K. (2020). Determinants of inflation in Kuwait. *Journal of Developing Areas*, *54*(3).

2. Baltagi, B. H., & Griffin, J. M. (1984). Short and long run effects in pooled models. *International Economic Review*, 631-645.

3. Baranzini, A., & Weber, S. (2013). Elasticities of gasoline demand in Switzerland. *Energy Policy*, *63*, 674-680.

4. Bentzen, J. (1994). An empirical analysis of gasoline demand in Denmark using cointegration techniques. *Energy Economics*, *16*(2), 139-143.

5. Birol, F., & Keppler, J. H. (1999). IEA World Energy Outlook 1998; IEA-Weltenergieprognose 1998. ET, Energiewirtschaftliche Tagesfragen, 49.

6. Birol, F., & Keppler, J. H. (1999). World energy outlook. Looking at energy subsidies: getting the prices right. 1999 insights.

7. Charap, M. J., da Silva, M. A. R., & Rodriguez, M. P. C. (2013). *Energy subsidies and energy consumption: A cross-country analysis* (No. 13-112). International Monetary Fund.

8. Cheung, K. Y., & Thomson, E. (2004). The demand for gasoline in China: A cointegration analysis. *Journal of Applied Statistics*, *31*(5), 533-544.

9. Christiansen, V., & Smith, S. (2012). Externality-correcting taxes and regulation. *The Scandinavian Journal of Economics*, *114*(2), 358-383.

10. Colman, G. J., & Remler, D. K. (2008). Vertical equity consequences of very high cigarette tax increases: If the poor are the ones smoking, how could cigarette tax increases be progressive? *Journal of Policy Analysis and Management: The Journal of the Association for Public Policy Analysis and Management*, *27*(2), 376-400.

11. Dahl, C., & Sterner, T. (1991). Analysing gasoline demand elasticities: A survey. *Energy Economics*, *13*(3), 203-210.

12. Davis, L. W. (2014). The economic cost of global fuel subsidies. *American Economic Review*, *104*(5), 581-85.

13. Denison, D., & Facer, R. L. (2005). Interstate tax coordination: Lessons from the International Fuel Tax Agreement. *National Tax Journal*, *58*(3), 591-603.

14. Eltony, M. N., & Al-Mutairi, N. H. (1995). Demand for gasoline in Kuwait: An empirical analysis using cointegration techniques. *Energy Economics*, *17*(3), 249-253.

15. Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: Representation, estimation, and testing. *Econometrica: Journal of the Econometric Society*, 251-276.

16. Griffiths, S. (2017). A review and assessment of energy policy in the Middle East and North Africa region. *Energy Policy*, *102*, 249-269.

17. Hoffer, A. J., & Shughart, W. F. (2018). The theory and practice of selective consumption taxation. In *For Your Own Good: Taxes, Paternalism, and Fiscal Discrimination in the Twenty-First Century.* Arlington, VA: Mercatus Center at George Mason University.

18. Jiang, Z., & Tan, J. (2013). How the removal of energy subsidy affects general price in China: A study based on input–output model. *Energy Policy*, *63*, 599-606.

19. Koplow, D. (2009). *Measuring Energy Subsidies Using the Price-Gap Approach.* International Institute for Sustainable Development (IISD), Winnipeg, Manitoba, Canada. http://www.iisd.org/pdf/2009/bali_2_copenhagen_ff_subsidies_pricegap.pdf.

20. Kuwait National Petroleum Company (2019). KNPC History. Viewed January 15 2019, < https://www.knpc.com/en/about-us/knpc-in-history>.

21. Kuwait News Agency (2018). Energy. Viewed January 15 2019, < https://www.kuna.net.kw/ArticleDetails.aspx?id=2744205>.

22. Lin, B., & Jiang, Z. (2011). Estimates of energy subsidies in China and impact of energy subsidy reform. *Energy Economics*, *33*(2), 273-283.

23. Liu, W., & Li, H. (2011). Improving energy consumption structure: A comprehensive assessment of fossil energy subsidies reform in China. *Energy policy*, *39*(7), 4134-4143.

24. McKenzie, K. J. (2005). Tax subsidies for R&D in Canadian Provinces. *Canadian Public Policy/Analyse de Politiques*, 29-44.

25. Park, S. Y., & Zhao, G. (2010). An estimation of US gasoline demand: A smooth time-varying cointegration approach. *Energy Economics*, *32*(1), 110-120.

26. Plante, M. (2014). How should monetary policy respond to changes in the relative price of oil? Considering supply and demand shocks. Journal of Economic Dynamics and Control, 44, 1-19.

27. Ramanathan, R. (1998). *Introductory econometrics with applications*. Harcourt Brace College Publishers.

28. Ramanathan, R. (1999). Short-and long-run elasticities of gasoline demand in India: An empirical analysis using cointegration techniques. *Energy Economics*, *21*(4), 321-330.

29. Ramsey, F. P. (1927). A contribution to the theory of taxation. *The Economic Journal, 37*(145), 47-61.

30. Stock, J. H., & Watson, M. W. (2015). Introduction to econometrics 3rd ed.

31. Von Moltke, A., McKee, C., Morgan, T., & Töpfer, K. (2017). *Energy subsidies: Lessons learned in assessing their impact and designing policy reforms*. Routledge.

32. Wadud, Z., Graham, D. J., & Noland, R. B. (2009). A cointegration analysis of gasoline demand in the United States. *Applied Economics*, *41*(26), 3327-3336.