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**ON FUEL SUBSIDIES FOR TRANSPORTATION  
SECTOR IN KUWAIT**

**Mohamed Nagy Eltony**

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## Abstract

The aim of this study is to estimate the demand for oil products in the transportation sector in Kuwait using time series data for the period 1975-2005. The results indicate that the demand for motor gasoline is inelastic with respect to price and income in the short and long run. The demand has a short run elasticity approaching unity when it comes to the average fuel economy of the fleet of automobiles, which indicates a rapid response to global changes in the automobiles' technology. Furthermore, the results reveal that diesel fuel consumption is price and income inelastic in the short run but exceeds unit elasticity in the long run. As for the case of aviation fuel, the demand is inelastic with respect to the price in the short run but it exceeds unit elasticity with respect to the number of flights landed at Kuwait airport, which indicates that the level of activity is more important explanatory variable of the demand for aviation fuel than its own price. The Simulation of the estimated model under various scenarios regarding energy prices revealed that there are definite long run advantages to introducing fuel prices adjustment upward. There is a great potential for energy conservation and fuel efficiency gains in the transportation sector. The moderate, the extreme and the complete removal of subsidies scenarios showed that the transportation sector will observe a decline of in the range of 3 % to 6 % from the baseline scenario. The size of fleet of automobiles and improvements in technical fuel efficiency will contribute significantly in that direction. Finally, for the result under no price subsidies, fuel prices for the transportation sector will be the highest prices among all the scenarios and the total energy demand will be lower than the baseline scenario by about 6 % in 2015.

**JEL Classification:** D04

**Keywords:** Fuel subsidies, Transport, Kuwait

## ملخص

الهدف من هذه الدراسة هو تقدير الطلب على منتجات النفط في قطاع النقل في الكويت باستخدام بيانات سلسلة زمنية للفترة 1975-2005. وتشير النتائج إلى أن الطلب على وقود المحركات غير مرن في ما يتعلق بالسعر والدخل على المدى القصير والطويل. الطلب لديه مرونة على المدى القصير تقترب من الوحدة عندما يتعلق الأمر بالاقتصاد في استهلاك الوقود المتوسط لأسطول من السيارات، مما يدل على الاستجابة السريعة للتغيرات العالمية في مجال التكنولوجيا وصناعة السيارات. وعلاوة على ذلك، فإن النتائج تكشف عن أن استهلاك وقود الديزل غير مرن في السعر والدخل في المدى القصير ولكن يتجاوز مرونة الوحدة في المدى البعيد. أما بالنسبة لقضية وقود الطائرات، والطلب الغير مرن فيما يتعلق بالسعر على المدى القصير ولكنه تجاوز مرونة الوحدة فيما يتعلق بعدد الرحلات الجوية التي هبطت في مطار الكويت، مما يدل على أن مستوى النشاط هو متغير أكثر أهمية ويفسر الطلب على وقود الطائرات والسعر الخاص بها. كشفت المحاكاة للنموذج المقدر وفقا لسيئاريوهات مختلفة بشأن أسعار الطاقة بأن هناك مزايا المدى الطويل لتقديم أسعار الوقود بالزيادة. هناك امكانات كبيرة للحفاظ على الطاقة ومكاسب الكفاءة في استهلاك الوقود في قطاع النقل. وأظهرت سيناريوهات الإعانات المعتدل، و المدفع والإزالة الكاملة إلى أن قطاع النقل سوف يلحظ انخفاضا بنسبة تتراوح بين 3% و 6% من سيناريو خط الأساس. وإن حجم أسطول السيارات والتحسينات في كفاءة الوقود التقنية تساهم بشكل كبير في هذا الاتجاه. أخيرا، لكانت النتيجة تحت دعم الأسعار، وارتفاع أسعار الوقود في قطاع النقل تكون أعلى الأسعار بين السيناريوهات كافة، وإجمالي الطلب على الطاقة سوف تكون أقل من السيناريو الأساسي بنحو 6% في عام 2015.

## **1. Introduction**

Kuwait is experiencing rapid growth in domestic energy demand. It will soon face serious economic pressures as oil exports decline, unless Kuwait can shift away from oil and gas dependence to other energy resources. Transportation sector in Kuwait is considered one of the key energy consuming sectors. For example, Kuwait is a small country but with huge road system and one of the highest stock of automobiles per capita in the world. In fact, United Nations Statistics estimates that Kuwaiti vehicles traveled more than 300 billion kilometres in 2007. To put this in perspective, that's about 390,215 (almost 400,000) return trips from the Earth to the moon. In 2009, roughly one-third of all the energy at end-use consumption in Kuwait was used by the transportation sector. And 99.9% of all energy used for road transportation in 2007 came from refined oil products, mainly motor gasoline fuel.

The transport sector in Kuwait comprises of two distinct modes, namely, road and air transportation. However, each mode of transportation tends to consume different types of oil refined product. For example, motor gasoline and diesel fuel are used on the road transportation mode, whereas aviation fuel (jet fuel) is used in the air transportation mode. Because of the non-existence of inter-fuel substitution between the different modes of transportation, each mode would be examined independently. However, the road mode alone accounted for about 90% of the total energy requirements of the transportation sector in year 2005. In the light of its importance, road transportation is accorded the greatest attention.

Domestic energy prices have been declining in real terms since 1975. For example, the nominal price of premium gasoline at the pump in 2005 is set by the government at 80 fils per litre (about 25 cent US per litre) however, in real terms; it costs only about 22 fils per litre today when compared with its level in 1980. In other words, there is no real price incentive for motorist to conserve on their use of fuels. Furthermore, while the nominal price at the pump for a litre of premium gasoline is 80 fils, the costs of producing it has been estimated to be around 180 to 200 fils which means there is a subsidy of about 120 – 140 fils per litre of motor gasoline sold domestically.

In recent years, the Kuwaiti government has considered measures to reduce inefficiency and waste in energy consumption by key sectors especially by the transportation sector. In that direction, the government has privatized gasoline retail outlets. On a different front, environmental concerns have pressed the authorities to convert all the gasoline outlets to sell only unleaded gasoline in an effort to reduce the emission of harmful gases by the fleet of automobiles. Furthermore, due to massive traffic congestion, the government is looking into restricting automobile registration to only the five years old model automobiles in an effort to reduce number of automobiles on the roads and improving technical fuel efficiency of the fleet. Government is also looking into restricting the issuing new driving licenses to only certain professions for vast expatriate labor force. Moreover, the municipality of Kuwait city is seriously considering building a new and reliable transit system such as an underground (Metro) transit system.

Decision makers are also considering raising the price of domestic oil products. One of the key elements of these measures that currently under discussion is the complete or partial removal of price subsidies for the fuel for the road transportation. This study attempts to estimate the demand for fuels in the transportation sector in Kuwait. Furthermore, the estimated models are simulated under various scenarios to assess the possible impacts of alternative pricing structure options and forecast future energy demand by the transportation sector especially for the case of complete removal of fuel price subsidies. These forecasts will provide the policy-makers with valuable information upon which they can set effective energy pricing policies.

## 2. Road Transportation Demand for Fuel

### 2.1 Road Transportation Demand for Gasoline

The energy consumption in the road transport mode covers both private and commercial vehicles. Private vehicles are assumed to consume mainly motor gasoline, while commercial vehicles are assumed to consume both motor gasoline and diesel fuel. Moreover, medium and heavy vehicles such as large trucks and buses also consume diesel fuel.

Few studies have estimated the gasoline demand in GCC countries. Most of these studies have either failed to recognize all the ways in which consumers can react to gasoline price changes or have implemented pre-1990s data which did not provide good estimates of prices elasticities, Al-Sahlawi, (1978), Al-Faris (1993) Eltony (1996). Some models attempted to estimate the components of Gasoline demand using aggregated data, Gallini (1983) and Dahl (1983). The problem with these models is that they do not identify the relationship between the household decisions on vehicle holdings and on usage. These two decisions are likely to be dependent; the use of the vehicle depends on its type of the vehicle chosen depends on its expected use. Since these two decisions are made within the household, household data should be used for estimating the various components of gasoline demand.

The model presented here is of the investment-utilization type and has its theoretical basis in the household production literature, Becker (1965), Lancaster (1966) and Pollack and Wachter (1975). The demand for gasoline in the framework of the household is perceived to depend on their joint decision making behavior regarding (i) the average number of cars per household, (ii) number of miles driven per car in the household and (iii) the frequency of replacement of old cars with new ones. The model assumes that the household is a utility maximizing agent, making a joint decision about these three factors. In particular, the basic identity for aggregate gasoline demand is given by,

$$AG = MS * S * E \quad (1)$$

Where: MS = miles driven per car

S = total automobiles in the fleet

E = average fuel economy of the fleet

Moreover, following the convention of earlier models,(e.g., Eltony 1993 & 1997) the household demand for gasoline is modeled as the outcome of utility-maximization, conditional on the vehicle choice, Becker (1965) and Pollick and Wachter (1975). The solution of such a model yields the gasoline demand per automobile (GS):

$$GS = g(Pg/e, YH) * E \quad (2)$$

Where: Pg/e = price of gasoline per mile, which is the outcome of the price of gasoline per gallon divided by the fuel efficiency;

E = miles per gallon or 1/e.

YH = household disposable income.

The equation for the stock of automobiles per household is given by:

$$S/H = g[ Pn, Pg, (S/H)_{t-1}, YH] \quad (3)$$

Where: S/H = stock of automobiles per household.

Pn = price of new automobiles.

Pg = price of gasoline per gallon.

Furthermore, the new car sales per household given by:

$$NR/H = f(P_n, P_g/e, YH) \quad (4)$$

Where NR/H = new car sales per household. Previous studies, i.e., Dahl (1983), Gallini (1983) and Eltony (1993 & 1997) have assumed a log-linear functional form and some demographic variable has been included. The estimated equations in log-linear form are as follow:

\* Gasoline Demand per automobile:

$$\ln GS = \beta_0 + \beta_1 \ln PGDP + \beta_2 \ln E + \beta_3 \ln P_g + \beta_4 \ln AH \quad (5)$$

\* Stock of automobiles:

$$\ln S = \beta_0 + \beta_1 \ln PGDP + \beta_2 \ln P_g + \beta_3 \ln AH \quad (6)$$

\* New automobiles sales:

$$\ln NR = \beta_0 + \beta_1 \ln PGDP + \beta_2 \ln P_n \quad (7)$$

Where:  $\ln PGDP$ : real per capita disposable income

$\ln P_g$ : real price of gasoline per gallon

$\ln AH$ : average number of vehicles per household

$\ln P_n$ : real average price of new automobiles.

The data pertaining to these variables are available except for the Average fuel economy of the fleet (E). A time series for this variable is constructed by defining the fuel economy of the fleet as the harmonic mean of the fuel economy of the new cars, EN and the fuel economy of the last year's stock, UC. The relationship can be expressed as follows:

$$E = EN \cdot (NR/S) + E_{t-1} \cdot (UC/S) \quad (8)$$

Furthermore, the relationship between new cars ratio, NR/S, and used cars, UC/S, can be determined as follows.

$$NR/S + UC/S = 1$$

$$\text{Or } S = NR + UC \quad (9)$$

Which simply states that adding used cars, UC, and new cars, NR, gives the current stock of automobiles in the fleet, S. Therefore, the proportions of new car and used cars sales, over the fleet, can be determined by the following equation:

$$NR/S = NR/(NR + UC) \text{ and}$$

$$UC/S = UC/(NR + UC) = 1 - NR/S \quad (10)$$

The fuel economy of new cars, EN, in equation (8) is the weighted average of the technical fuel economy of various types cars with the interior volume (the size) being the proportion of the corresponding types of cars sold, i.e.,

$$EN = \frac{\sum_j (EN_j \times N_j)}{NR} \quad (11)$$

Where  $EN_j$  = technical fuel economy for the j-th size class of cars;

$N_j/NR$  = ratio of j size cars sold to total new cars sales.

While the data on the technical fuel economy for the j-th size class of automobiles is available, a time series data on various type of automobiles sold in Kuwait is not available.

The study uses the USA data assuming that composition of new cars by the interior volume (the size) in Kuwait is approximately comparable to those of the USA.

Since the decisions are made jointly, the model has been estimated simultaneously using the Generalized Least Squares method and date set for all the variables for the period 1975-2005. The main source of the data utilized was the Annual Statistical Abstract of the Ministry of Planning. Finally, the parameters obtained from the above model are substituted in the identity (1) in order to reach an estimate of the aggregate demand, AG, for gasoline in the road transport sector.

### *The Empirical Results*

The general observation of examining the transportation demand data for energy in Kuwait is that the values of consumption tend to rise over the time period of investigation. Because of this trended nature of the data, their values through time do not remain constant. It was shown by Engle and Granger (1986) that if a time series is not stationary, that is, the mean and the variance increase over time, there always exists the possibility that spurious regression will result, causing the long run equilibrium to be invalid. In recent years, the cointegration and error correcting techniques has been utilized as a method of resolving this problem. After conducting the unit root tests for all the variables and the Augmented Dick-fuller test for cointegration, it was confirmed that almost all the variables utilized in the model are stationary and thus we proceed to the next step of estimating both the short-run and the long-run elasticities of demand.

The estimated results corresponding to the demand for gasoline per car equation are presented below. Income and price are the conventional variables in a typical demand function with an expected sign of income to be positive and of price to be negative. LAH, number of cars per household, car is expected to take a negative sign because; the larger the number of cars per family is the less will be the usage of each car. Similarly, LE, the average fuel efficiency, is also expected to take a negative sign. This is because more efficient cars are expected to consume less energy.

$$\text{LnGS} = 1.281 + 0.0301 \text{LnPGDP} - 0.8944 \text{LnE} - 0.0405 \text{LnPg} - 0.8577 \text{LnAH} \quad (12)$$

(3.55)                      (1.94)                      (-7.22)                      (-1.55)                      (-17.3)\*

$$R^2\text{-Adj.} = 0.98 \quad \text{S.E.R} = 0.02 \quad \text{D.W.} = 2.1439$$

\*t-statistic in parenthesis.

The equation seems to fit the data reasonably well. All the coefficients have the correct signs and are statistically significant. The coefficient corresponding to the price variable is quite small. However, this not surprising given the fact that the public transit system is not very popular in Kuwait given the harsh summer heat and therefore the demand for gasoline by private cars is expected to be price inelastic. The demand is income inelastic as well with a short run elasticity of about 0.03. This is because the expenditure on gasoline accounts for a small Percentage of household income. These results are in line with earlier findings by Eltony (1995, 1996 & 1997). Furthermore, gasoline demand per car is inelastic for changes in the average number of cars per household. However, it has a negative sign indicative of the fact that as the number of cars per household increases the utilization of each car declines. Finally, the demand has a near unit elasticity when it comes to changes in technology, as is reflected in the average fuel economy of the fleet of automobiles.

The results corresponding to the household decision regarding car holdings are presented below. The stock of cars (S) equation is modeled as a function of the real price of new cars (LnPn), real per capita disposable income (LnPGDP), and average number of vehicles per household (LnAH).



$$\ln S = 15.2353 + 0.00404 \ln PGDP - 0.1913 \ln P_n + 0.8045 \ln AH \quad (13)$$

(8.93)      (1.52)                      (-1.63)                      (13.36)

$$R^2 \text{ Adj.} = 0.97 \quad \text{S.E.R} = 0.03 \quad \text{D.W.} = 1.5514$$

The equation fits the data reasonably well. All the coefficients have the correct signs and are statistically significant. The average number of cars per household is near unit elasticity while the income and the price of new cars are inelastic and relatively small. This mainly reflects the need in the Kuwaiti household for more than one car as each car may be utilised for different purposes.

The estimated equation corresponding to new car sales ( $\ln NR$ ) is presented below. The estimated model in log-linear functional form is as follows:

$$\ln Nr = 11.592 + 0.2275 \ln PGDP - 0.2845 \ln P_n \quad (14)$$

(13.8)      (1.75)                      (-1.75)

$$R^2\text{-Adj.} = 0.72 \quad \text{S.E.R} = 0.11 \quad \text{D.W.} = 1.2791$$

The equation seems to fit the data reasonably well. All the coefficients have the correct signs and are statistically significant. The coefficient of the price of new cars variable is negative as expected. However, the size of the coefficient is small which means that the demand for new cars is inelastic to changes in its real prices. This may be due to automobile market structure. In Kuwait, the market is largely dominated by a few dealers each specialising in one automobile brand name, i.e. Ford, Nissan, GM, Honda, Toyota, Mercedes ... etc. Thus, the demand for new cars is price inelastic in the short-run, with an elasticity of 0.28. Also, the demand for new cars is income inelastic in the short run, with an elasticity of about 0.23.

## 2.2 Road Transportation - Diesel Fuel

Historically, diesel fuel is consumed by commercial and industrial vehicles, i.e., buses, trucks and heavy load vehicles. However, it also includes diesel consumed in marine by fishing boats as disaggregated data is not available for each use. The consumption of diesel fuel in the road and marine sub-sector ( $\ln DS$ ) is modeled as a function of real GDP generated by the commercial and the non-oil industrial sectors, ( $\ln RGDP$ ), real price of diesel, ( $\ln Pd$ ), and the lagged dependent variable. Income and price variables are the usual variables which obviously belong to a demand function. The use of a lagged variable makes it a partial adjustment type model reflecting the fact that demand for diesel is a derived demand by the vehicles and other diesel using equipment. This means that the demand for diesel cannot adjust instantly in response to a change in explanatory variable. The estimated equation is as follows:

$$\ln DS = 0.2971 + 0.1164 \ln RGDP - 0.06199 \ln Pd + 0.8468 \ln DS_{t-1} \quad (15)$$

(0.768)      (1.64)                      (-2.75)                      (14.65)

$$R^2\text{-Adj.} = 0.95 \quad \text{S.E.R} = 0.02 \quad \text{D.W.} = 2.0116$$

The equation seems to fit the data reasonably well. All the coefficients have the correct signs and are statistically significant except for the intercept term. The coefficient on the price variable is negative as expected. However, the size of the coefficient is small. Thus, the demand for diesel is price inelastic in the short-run, with an elasticity of only 0.062. The long-run price elasticity of demand for diesel is about 0.41 which is also inelastic<sup>1</sup>. Also, the demand is income inelastic in the short run and in long run with. It gives about 0.12 short run elasticity and about 0.76 in the long-run.

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<sup>1</sup> The formula for calculating long-run elasticity is  $b_j/(1 - b_3)$ .

It should be mentioned here that, since this equation lagged dependent variable, it may be argued that DW is not an appropriate test-statistic, since DW-statistic is biased towards two or biased towards accepting the null-hypothesis of no autocorrelation in such a situation. The Durbin h-statistics has been recommended to test for AR(1) disturbances. However, Inder (1984) showed that the DW-test is generally more powerful than the Durbin h-statistic in such cases. Inder (1986) also showed that the critical values of non-stochastic X matrix are valid in regression equations with lagged dependent variable. In the estimated model, both DW and h-statistic were compared and were found to be in agreement with each other; hence only the DW-statistic is reported.

### 3. Air Transportation

The consumption of aviation fuel is modeled as a system of equations. First, the demand for aviation fuels (lnDAV), is modeled as a function of number of flights landed at Kuwait Airport (lnAIR) and the real price of aviation fuel (lnPav) which is set by the international market. Second, the number of flights (Lair) is modeled as a function of number of passengers (lnNPAIR) and an index representing the changes in the price of airline travel (lnPair). Real per capita disposable income was also used but was found insignificant and therefore was dropped from the estimated equation. The two equations were estimated simultaneously using the Generalized Least Squares method of estimation. The estimated equations are as follow:

$$\ln\text{DAV} = -1.925 + 0.9275 \ln\text{AIR} - 0.08911 \ln\text{Pav} \quad (16)$$

(-0.51)      (2.48)                      (-2.33)

$$R^2\text{-Adj.} = 0.83 \quad \text{S.E.R} = 0.05 \quad \text{D.W.} = 2.5693$$

$$\ln\text{AIR} = 10.339 + 0.0602 \ln\text{NPAIR} - 0.2339 \ln\text{Pair} \quad (17)$$

(25.16)      (1.65)                      (-1.97)

$$R^2\text{-Adj.} = 0.72 \quad \text{S.E.R} = 0.08 \quad \text{D.W.} = 2.1029$$

The system of equations seems to fit the data reasonably well. All the coefficients have the correct signs and are statistically significant. The coefficients on the price variables are negative as expected.

### 4. The Simulation of the Model

The ex ante projection simulation of the model's endogenous variables beyond the estimation period is the concern of this section. The models are simulated under different assumptions to evaluate their sensitivity to a variety of pricing policy options, Intrilligator (1978). The ex ante projection simulation covers the period 2005-2015. Three scenarios were utilized to solicit the models' response to long run changes in the key policy variables. The three scenarios are:

#### 4.1 The Baseline Scenario

The baseline scenario serves as a benchmark for the remaining scenarios and it projects current trends and directions. For the most part, the baseline scenario represents the situation when the current conditions, the status quo, continue. It also gives a long run projection of existing conditions regarding domestic energy consumption of oil products, natural gas and electricity, but with conservative economic rates of growth. A simple set of assumptions is utilised to measure the changes in the key exogenous variables with no changes in current domestic energy prices. The assumptions are:

- 1- An annual growth rate of 2% for the real Gross Domestic Production (GDP) which is adapted by the Five-Year Economic Development Plan, Ministry of Planning. This growth rate is remarkably low when compared with the 1970s. However, it is not lower than historical levels that prevailed during the 1980s and most of the 1990s.
- 2- An annual growth rate of 3.5% for the Kuwaiti population, which is in line with historical rates. Furthermore, an annual growth rate of 3.9% for total population. These rates are also adopted by the Five-Year Economic Development Plan, Ministry of Planning (2008).
- 3- All current domestic nominal oil products prices to remain constant throughout the forecast period.
- 4- An improvement in technical fuel efficiency of automobiles of 1% annually, which is adopted by the International Energy Agency (2005) for the Middle East and Gulf regions.
- 5- An annual inflation rate of about 1.5% in response to the expected slower inflation rates worldwide.
- 6- All other exogenous variables are assumed to grow at their historical growth rates (1975-2005, i.e., geometric growth rates).

#### ***4.2 The Moderate Scenario***

This scenario aims at determining consumption when domestic oil product nominal prices double, i.e., increase by 100%. Essentially the same set of assumptions that were used for the baseline scenario is utilized. The major exception is that all domestic nominal oil products prices are assumed to increase by 100% immediately in 2005 and then remain constant throughout the forecast period.

#### ***4.3 The Extreme Scenario***

This scenario elicits the model's response to a deliberate shock of a 200% increase in oil product nominal prices. The same set of assumptions that was applied to the moderate scenario is also applied to this scenario, with the only exception that all domestic nominal oil product prices are assumed to upsurge immediately by 200% in 2005 and remain constant throughout the forecast period.

#### ***4.4 The Complete Removal of Fuel Price Subsidies Scenario***

The aim of this scenario is to examine the response of the various transport modes to changes in the fuel prices under the assumption of the total removal of energy prices' subsidies. This exercise is timely and very useful in gaining an understanding of the economic consequences associated with the implementation of full market based economy.

The same set of assumptions implemented for the baseline scenario is also utilized here, with the exception that all domestic fuel prices are in line with oil products international prices. It is troublesome to conduct this simulation while international price for a barrel of oil has exceeded \$100 and the litre of Gasoline at the pump in the USA is selling for more than one dollar. Nevertheless, the simulation path here involves an immediate prices change substantially upwards for in 2005 followed by stabilization throughout the forecast period. The aim is to remove the subsidies and reflect the international value of energy consumption.

### **5. Simulation Results**

#### ***5.1 Baseline Scenario***

The baseline scenario projects that the demand for fuels by the transportation sector will grow but at slightly lower than historical rates. This is mainly due to the anticipated improvements in technical fuel efficiency embedded in new automobiles, which is explicitly modelled in the gasoline demand model. For example, in the gasoline per vehicle equation, gasoline

consumption is directly influenced by the changes in the average fuel economy of the stock of cars. Meanwhile, in the stock of cars equation, the stock of cars is also directly influenced by the improvements in the technical fuel efficiency of new sales of cars as they improve the average fuel economy of the entire fleet. Thus, the growth rate of transportation demand is projected to be around 2.3%, where most of the growth in demand comes from the consumption of gasoline in the road transportation mode. Meanwhile, consumption of diesel is expected to decline as the share of vehicles using diesel fuel is predicted to decline. Table 1 below gives the simulation results for all scenarios.

Therefore, if the current fuel price structure continued that will cause the real prices for fuel to decline over time, and despite the slower growth rate of GDP, the oil products consumption by the transportation sector will continue growing for years to come. In other words, under the assumption of the baseline scenario, there will be little incentive for energy conservation or energy efficiency.

### ***5.2 Moderate Scenario***

Under the assumption of this scenario of the simulation of the model predicts that, despite higher fuel prices, the transportation sector's consumption will continue to increase from 25.9 mboe in 2005 to about 32.1 mboe in 2015, which will grow by a growth rate of about 2 % annually. Nevertheless, the consumption of gasoline on the road alone is predicted to grow by about 3.1 % annually while diesel consumption will decline at -1.3 annually. Thus, if the nominal prices of oil products immediately doubled, the rate of growth in transport sector demand for energy will be reduced significantly from its level in 2005 and will induce consumers to conserve on their consumption of oil products.

### ***5.3 Extreme Scenario***

Under this scenario, the transport sector consumption is projected to increase in the year 2015 to reach about 31.7 mboe from its level in 2005 of about 25.9 mboe at an annual growth rate of about 1.8 %. However, the transport sector's consumption is lower by about 5 % and 2 % than the baseline and the moderate scenarios respectively. Most of the reduction in demand will come from the road transportation mode; meanwhile diesel consumption on the road is projected to decline by -1.3 % annually. Thus, if the nominal prices of oil products immediately trebled, the rate of growth in transportation sector demand for fuel will be reduced substantially from its level in 2005.

### ***5.4 Complete Removal of Fuel Price Subsidies Scenario***

Generally, the result of this scenario is the most severe results among all scenarios conducted. The transportation sector consumption is projected to increase in the year 2015 to reach about 31.3 mboe from its level in 2005 of about 25.9 mboe at an annual growth rate of about 1.7 %. However, the transport sector's consumption is lower by about 6 % and 3 % than the baseline and the moderate scenarios respectively. Most of the reduction in demand will come from the road transportation mode, where diesel consumption on the road is projected to decline by -1.32 % annually while aviation fuel is expected to decline by about -1.2 % annually.

## **6. Conclusions and Policy Implication**

The demand for gasoline in road transportation is both price and income inelastic in the short run. Furthermore, gasoline demand per automobile is inelastic for changes in the average number of cars per household. However, it has a negative sign indicative of the fact that as the number of cars per household increases the utilization of each car declines. Moreover, the gasoline demand elasticity approaches unity in response to changes in the technology, i.e., fuel efficiency of the vehicle, as it has been manifested in the average fuel economy of the fleet of automobiles. Furthermore, the demand for diesel fuel in road transportation is also inelastic with respect to own price in both the short-run and the long run. Also, the demand

for diesel fuel is income inelastic in the short run and in long run as it is typically consumed by heavy trucks and construction machines and equipments.

The demand for aviation fuel is also inelastic with respect to its own price in the short run. However, the demand for aviation fuel is almost unit elasticity with respect to the number of flights landed in Kuwait airport. This indicates that the demand for aviation fuel, as derived demand, is more responsive to changes in the level of activities at Kuwait Airport than the price of aviation fuel.

The results of the model simulation based on the four scenarios address several important issues. With nominal oil products' prices remaining unchanged and inflation and economic growth continuing their expanding trend (i.e., baseline scenario), the demand for oil products by the transportation sector is expected to grow by about 2.3 % by the year 2015. For the most part, it appears that a lower than historical average economic growth rate, in the short run, may not be enough to reduce the consumption of fuel by the transportation sector in Kuwait. The high real per capita income, the affluent living standards and the large stock of automobiles contribute to excessive fuel consumption patterns.

The results also revealed that there are definite long run advantages to introducing an oil products prices adjustment upward. There is a great potential for energy conservation and fuel efficiency gains by the transportation sector. The moderate, the extreme and the complete removal of subsidies scenarios showed that the transportation sector will observe a decline of in the range of 3 % to 6 % from the baseline scenario. The size of fleet of automobiles and improvements in technical fuel efficiency will contribute significantly in that direction.

Finally, as the prices of all types of fuels increased substantially to reflect energy prices without the subsidies, the growth rate in aggregate energy consumption will be definitely lower than all other scenarios. The results of this scenario, under no price subsidies, fuel prices for the transportation sector will be the highest prices among all the scenarios. Furthermore, the total energy demand will be lower than the baseline scenario by about 6 % in 2015.

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**Table 1: Simulation Results of Transport Sector Fuel Demand (mboe)**

Scenarios	Mode of Transport	1995	2000	2005	2010	2015	Growth Rate %
<b>Baseline</b>	<b>Road</b>						
	Gasoline	11.490	13.689	17.801	21.688	25.297	3.25
	Diesel	3.692	4.399	4.310	4.246	4.219	- 0.19
	<b>Air</b>						
	Aviation Fuel	3.218	3.833	3.832	3.750	3.682	-0.36
	<b>Total</b>	18.400	21.921	25.943	31.478	33.198	2.27
<b>Moderate</b>	<b>Road</b>						
	Gasoline	11.490	13.689	17.801	21.334	24.884	3.09
	Diesel	3.692	4.399	4.310	3.794	3.751	-1.25
	<b>Air</b>						
	Aviation Fuel	3.218	3.833	3.832	3.561	3.496	-1.96
	<b>Total</b>	18.400	21.921	25.943	28.689	32.121	2.56
<b>Extreme</b>	<b>Road</b>						
	Gasoline	11.490	13.689	17.801	21.087	24.595	2.98
	Diesel	3.692	4.399	4.310	3.793	3.741	-1.28
	<b>Air</b>						
	Aviation Fuel	3.218	3.833	3.832	3.432	3.370	-1.16
	<b>Total</b>	18.400	21.921	25.943	28.312	31.706	1.84
<b>Removal of Subsidies</b>	<b>Road</b>						
	Gasoline	11.490	13.689	17.801	20.743	24.194	2.83
	Diesel	3.692	4.399	4.310	3.767	3.731	-1.32
	<b>Air</b>						
	Aviation Fuel	3.218	3.833	3.832	3.432	3.370	-1.16
	<b>Total</b>	18.400	21.921	25.943	27.942	31.295	1.72