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# Income and Price Elasticities of Demand for Imported Crude Oil in Pakistan

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**Abstract**

*This study aims at the estimation of price and income elasticities of demand for imported crude oil and establishment of long run and short run relationship between crude-oil consumption and economic growth for Pakistan. Annual data on quantities of imported crude oil from various sources have been utilized for the analysis purpose. Johansen co-integration and Vector Error Correction Mechanism (VECM) techniques have been employed. The finding shows positive income elasticity for imported crude oil for long run implying that the imported crude oil is a normal good. The price elasticity of quantity demand for imported crude oil is statistically significant and has correct sign. Similarly in other model which uses real price of imported crude oil, the price elasticity without dummies has positive sign and contrary to the theoretical expectations. Present study suggests that in Pakistan, imports of crude oil can be boosted by increasing the income levels in order to increase the output of the industries using crude oil through suitable policy measures.*

**JEL Classification:** K32, L11, F32, F39, O40

**Keywords:** Energy, Price, Imported Crude Oil, Demand, Income, Growth, GDP.

## 1. Introduction

Energy is one of the most important inputs in modern production process. Some forms and sources of energy include thermal energy, hydro energy, solar energy, wind energy and the atomic energy. Energy is the main factor accountable for growth and industrialization of any economy. It provides impetus for maintaining sustainability in economic advancement. The provision of energy is vital and all

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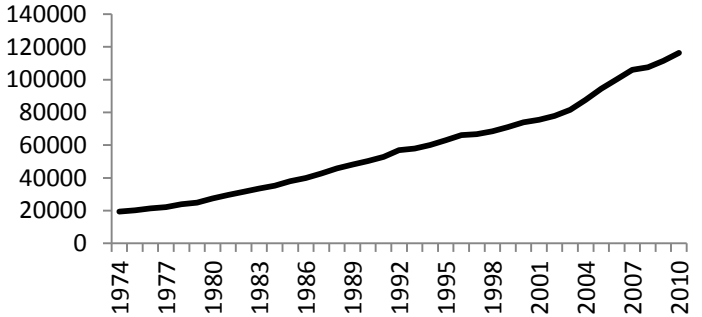
lives on earth directly or indirectly require it. Energy consumption and economic development of a country are interrelated [see Al-Yousef (2005),Ghosh (2009) and Royfaizal (2008)]. Like other energy sources, crude oil is very key source of energy among others and thus it has important significance in the world market. It is used to make different goods like diesel fuel, chemicals, fertilizers and pesticides etc. Without crude oil our life is like a stop dead. So the dependence on imported crude oil has increased over the time and it also contributes to persistent budget and trade deficits [see Kiani (2011)].

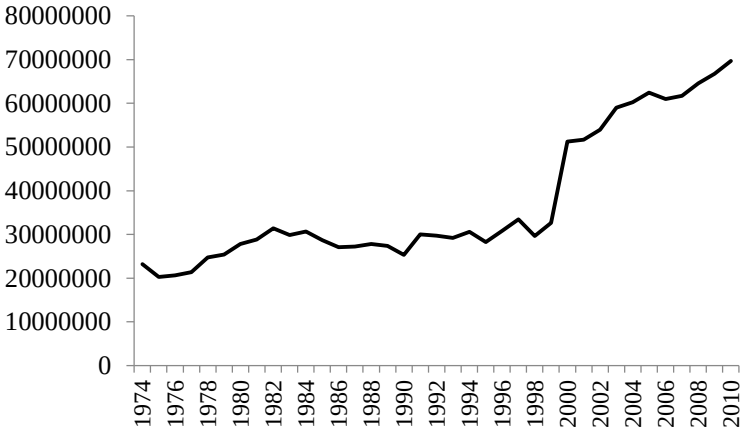
Maintenance of crude oil reserves through local exploration as well as through imports is crucial in order to achieve idealized output particularly by manufacturing sector. Those reserves ensure availability of crude oil as per need for different purposes. Oil is used by automobiles also for transportation including transportation of goods from farm to market; one place to the other and also of labor force itself as some populations are residing far away from their work place and thus they depend on transportation in order to reach their work place. Many production processes use oil based plastic as raw material. The dependence on oil as one the main energy input is significant.

**Figure 1: Trend of GDP (Constant, 2000 US$)**




The share of oil prices in national income has some implications for an economy. Economies of different countries are mainly depending on oil. The provisions of products and services would be much difficult if oil supply is interrupted. Oil has been a crucial source of energy for the world as a whole and it would enjoy this status for many decades until substitutes for oil are explored. Oil is used for space heating and for power generation in the world along with transportation. In United States and Canada, 2/3 of oil is used for transportation (Peter 1996).

**Figure 2: Trend of Quantity Imported Crude Oil (Constant)**




Like other developing countries, energy demand is increasing due to expansion in Pakistan's economy thus putting an upward pressure on demand for inadequate energy recourses particularly oil, natural gas and hydal resources. In past two decades, Pakistan has been facing an unexpected energy disaster due to large difference between demand and supply. Domestic production is not sufficient for fulfilling the requirements of country's energy needs. Currently, energy demand exceeds its supply thus increasing the dependency of the economy on imported crude oil. Share of oil consumption was 32% of country's total energy use in 2005-06 [State Bank of Pakistan, 2006]. Crude oil was imported having worth equal to $2.85 billion in the first eight month of financial year 2010 as compared to $2.29 billion last year. [Pakistan Bureau of Statistics, various issues]. Figure 1 and Figure 2 show the behavior of real GDP and quantity of imported crude oil over the time in Pakistan, respectively.

Demand for crude oil is affected by various factors including prices of crude oil itself, prices of substitutes, GDP etc. Then the variation in demand for crude oil is not same due to change in those factors. Demand is affected by different extents. Elasticities are often a well-located way to sum up the responsiveness of demand to different factors such as own price, income etc. Elasticity of demand due to own price provides information about proportionate change in quantity of a commodity due to proportionate variation in its price. Similarly, income elasticity indicates how much proportionate change in income (GDP) of a country leads to how much proportionate change in quantity demanded of imported crude oil. Demand elasticity

of energy due to price is normally inelastic and income elasticity is either unity or inelastic (Altinay 2007).

Elasticities of demand have special importance for policy purposes especially for a country's finance minister. Price elasticity of demand provides basis for government intervention to impose price ceiling or price floor. The rate of foreign exchange is also considered on the basis of elasticity of imports and exports of a country. Similarly, income elasticity of demand has also a special importance. Elasticity of demand due to income is positive; greater than zero but less than one and greater than one for normal, necessity and luxury goods, respectively. It is in this context that present study increases the literature by focusing on the estimation of income and price elasticities of imported crude oil, which has been an ignored research area. The estimation of income and price elasticities has much theoretical and policy level implications for an economy like Pakistan.

Only knowledge understanding of demand side is not sufficient. Supply side is equally important. When someone looks on the supply side of energy in Pakistan, one notes that the foremost sources of supply of energy in Pakistan are: natural gas (41%), oil (29%), hydro (12.7%), coal (12%) and nuclear power (1%)[1]. Since the late 1980s, Pakistan has faced less progress regarding exploration of new oil reserves. Pakistan had proven oil reserves of 300 million barrels as of January 2006 (Oil and Gas Journal, 2006). Pakistan is forced to import oil in order to meet local needs of oil. Crude oil and its related products have been imported in order to meet energy needs among others. In November 2006, consumption of oil was about 350 thousand barrels (EIA 2006; World Bank 2006). Transport sector, power generation sector and industrial sector, respectively are the three major consumers of the petroleum products in Pakistan [Economic Survey of Pakistan, various issues].

Pakistan like other developing countries is also an energy demanding country. Oil is imported in large quantities by Pakistan in order to fulfill its energy requirements. The net consumption of imported oil in 1995-1996 constitutes 44 percent of total energy consumption (Aqeel *et.al* 2001). Like most of other developing countries, expenditures on imports of crude are significant in Pakistan. So it is very crucial to determine whether there is positive relationship between consumption of imported crude oil and economic growth or other way round in order to find justification and rationale for huge expenditures incurred on imports of crude.

[1] Pakistan Economic Survey, (various issues).

Present study aims to estimate the price and income elasticities of demand for imported crude oil and to establish long run and short run relationship between crude-oil consumption and economic growth for Pakistan.

Remainder of the paper is organized as follows: Review of important studies is presented in Section 2. Theoretical framework is given in Section 3. Data and estimation is presented in Section 4. Section 5 reports results and discussion. Conclusion and policy recommendations are given in Section 6.

## 1. Review of Literature

Crude oil has been one of the major sources of energy not only in present time period but in past also. Its use is multidimensional. Sometimes, it is used as raw material for the production of some goods particularly for the production of petroleum products. Due to its significant importance for different sectors of the economy, the issue of crude oil has been investigated both theoretically and empirically in different directions. The review of some of the important studies conducted so far is presented in following lines:

Al-Faris (1996) estimated the income and price elasticities (IPEs) of oil products in Gulf Cooperative Countries (GCC). The partial adjustment model was used for the estimation, covering the period 1970-1991. The standard price and income elasticities (PIEs), respectively were -0.28 and 0.26. One of major results was that great disparity in elasticities among fuels across different countries was noticed.

Ramanathan (1999) used estimated elasticities of gasoline demand in India by utilizing data from 1972 to 1994. Gasoline consumption was expressed to depend upon real income and prices. Long-run (LR) income elasticity of gasoline demand was 2.682 and the price elasticity was -0.319. The LR elasticities were found to be greater as compared to SR elasticities. The results showed that gasoline demand in LR and SR is inelastic to gasoline price changes. The result also showed low LR price elasticity for India.

Krichene (2002) estimated crude oil and natural gas model by utilizing data from 1970 to 2006. The study examined the relationship between demand and supply for oil and gas. It was found that monetary policy shocks influence oil and gas market and oil and gas demand can be affected by interest and exchange rates. In SR, price elasticity of oil was 0.01 for the period of 1970 to 2006 and -0.02 for the period of 1984 to 2006. It was also concluded that SR price inelasticity was a key cause for high instability of price oil and gas.

Gately and Huntington (2002) examined the energy and oil demand relationship by estimating LR PIEs for panel of 96 countries by using data from 1971 to 1997. Estimated LR income elasticity for energy and oil demand was 0.59 and 0.55, respectively and LR price elasticities were -0.24 and -0.60, respectively for OECD countries. For Non-OECD countries, income elasticities for oil and energy demand were 0.44 and 0.53, respectively.

Al-Yousef (2005) examined the growth of oil demand in selected Asian countries by using data 1982- 2002. The study analyzed the connection between GDP, price of oil and imports of crude oil imports. The demand-function was estimated by utilizing co-integration and ECM techniques. ARDL model was also employed in order to forecast crude oil consumption for the period from 2006 to 2010. Results showed that GDP and Price were vital series in affecting demand for oil but elasticities of demand were low. It was found that GDP growth was an essential factor in the increase or decrease of crude oil demand in Asian countries when the estimated model was used to forecast crude oil demand. China had the largest demand for crude oil while Pakistan remained the last among the countries in the analysis.

Altinay (2007) estimated the SR and the LR elasticities of crude oil demand in Turkey by using ARDL estimation technique to Co-integration. Findings revealed that LR Co-integration association existed between dependent and independent series. LR coefficients were found by using a LR static solution of the estimated ARDL model, and the SR dynamics were found by ECM. Findings revealed that the IPEs of import demand for crude oil were inelastic.

Ghosh (2009) examined import demand for crude oil and economic growth in India using data ranging between 1970 to 2006. Autoregressive Distributed Lag (ARDL) and Co-integration approaches were used. The findings based on past data showed that LR income elasticity of ICO was 1.97 % which showed insignificant estimates for both LR and SR elasticities. It was showed that decrease in LR ICO would not influence future economic growth on the basis of findings.

Royfaizal (2008) studied the connection between crude oil consumption and economic growth using quarterly data from 1992-2006. ARDL model was used for establishment of connection among QICO, GDP and the price of imported crude oil in Japan. Results showed that long-term IPEs of ICO demand in Japan were 1.35 and -0.08, respectively. Whereas the SR IPEs of crude oil demand in Japan were 1.78 and -0.06, respectively based on sampled period. SR elasticity for both

variables was greater than LR elasticity. Study concluded that drop in crude oil demand does not influence forthcoming economic growth and LR price in Japan.

Ziramba (2010) used the Co-integration technique to determine the PIEs of ICO demand in South Africa by utilizing data from 1980 to 2006. The SR crude oil import demand elasticities were found through ECM technique. The LR PIEs of import demand for crude oil were 0.429 and -0.147, respectively.

Kiani (2011) examined the effect of higher oil prices on Pakistan's economy using the data from 1990-2008. The study found that increased oil price led to inflation and higher budget deficit. The same cause exchange rate to depreciate due to which imports become more expensive. It is also found that increased oil price had influenced adversely the household's daily consumption pattern. It was also explored that changed real crude oil price had positive impact on real GDP and the same has opposite influence upon many other factors.

The above lines show that different studies both theoretically and empirically have tried to analyze the energy demand in different aspects but many areas are still unexplored yet. It is in this context present study aims to increase the literature in this area by estimating income and price elasticities of demand for imported crude oil in Pakistan.

## 2. Theoretical Framework

Energy demand models are basically developed from the Marshallian theory of demand. Explanatory variables of these models incorporate the price of energy and the income. These models can also be extended to include other relevant variables depending on the features and nature of the kind of energy demand. However, as a matter of fact the case of crude oil is much dissimilar to other kinds of energy inputs. One distinction is that of the nature of demand for crude oil. Demand for crude oil is derived demand as it is not directly used rather its use facilitates the production process of other goods and services. Secondly, Crude oil is primary or intermediate good but not final goods.

The representative model used in this study for consumption of crude oil includes the determinants responsible for changes in total demand for imported crude oil, actual price of crude oil, and the real GDP as proxy of income. Price is an important determinant to influence the decision regarding quantity of imported crude oil. Generally price of crude oil is reported in terms of nominal US dollars. Though in some kinds of analysis nominal price is used as one of the explanatory variables but

sometimes in other type of analysis real price of crude oil in domestic currency is used as an explanatory variable. For this purpose, the domestic currency real price of oil is calculated by dividing the nominal price in US by the relevant price index (GDP Deflator) and multiplying by the exchange rate.

Present study estimates two different models due to the assumption of purchasing power parity hypothesis (Salvatore 2007). So based upon this assumption exchange rate changes are expected to be more or less proportional to the domestic inflation rate. In such cases, nominal price of crude oil in US dollars and real price in domestic currency are supposed to be nearly equal to each other. Thus the first model uses the real price of oil in domestic currency. While second model utilizes the nominal price of crude oil in US dollars with the purpose to capture the direct influence of the nominal price movements on the import demand for oil. Consequently elasticities acquired from first and second model can be compared for fruitful implications.

Smuggling of petroleum products into Pakistan from Iranian border has increased during near past possibly due to constant raise in petroleum prices. Loss faced by Pakistani government in the form of loss in tax revenue per annum due to smuggling of petroleum product is estimated to about Rs. 5 to Rs. 6 billion.[1] Baluchistan and Sindh were the main markets for the smuggled products but, during the last two years, the same has expanded to Punjab and the Khyber PakhtoonKhawa provinces also.[2]

Due to availability of reliable data issues, the present study implicitly assumes that the share of smuggled petroleum products remains unchanged throughout the sample period. Thus first model that incorporates real price of oil in domestic currency takes the following form:

$$\ln X_t = \delta_0 + \delta_1 \ln RP_t + \delta_2 \ln Y_t + \delta_3 D2_t + \delta_4 D3_t + \delta_5 D5_t + \varepsilon_t \qquad (1)$$

where X is the quantity of imported crude oil; RP is the real price of oil measured in Pakistani Rupee and Y is the real GDP at Constant 2000 US$. $\varepsilon_t$ is the error term.

Second model by incorporating nominal price of imported crude oil in US dollars is specified as:

[1] http://paktribune.com/articles/Iranian-petrol-a-hot-commodity-in-Pakistan-162821.html
[2] http://paktribune.com

$$\ln Q_t = \theta_0 + \theta_1 \ln P_t + \theta_2 \ln Y_t + \theta_3 D1_t + \theta_4 D2_t + \theta_5 D3_t + \theta_6 D4_t + \theta_7 D6_t + \mu_t \quad (2)$$

Where, P is the nominal price of the crude oil in US dollars and μ is the error term.

Present study uses following six dummy variables in total (as shown above for model 1 and model 2) to capture the effect of different shocks: D1 is the dummy variable for exchange rate permanent shock; D2 is the dummy variable for gulf war one time shock; D3 is dummy variable for flood effect permanent shock; D4 is dummy variable for Pervez Musharaf's military take over in1999; D5 is dummy variable for earthquake for permanent shock and D6 is dummy variable for earthquake for one time shock.

The expected signs for coefficients in equation (1) are such that $(\delta_1, \delta_3, \delta_4, \delta_5) < 0$, & $\delta_2 > 0$ ; and the expected signs for coefficients in Eq. (2) are such that $(\theta_1, \theta_3, \theta_4, \theta_5, \theta_6, \theta_7) < 0 \,\&\, \theta_2 > 0$.

## 3. Data and Estimation

The study uses annual time series data on dependent variable (Quantity of Imported Crude Oil) and independent variables: Nominal price of imported crude oil, Real Price of Imported Crude Oil and income (Real GDP at Constant 2000US $) for Pakistan. The period of analysis is from 1974 to 2010. Annual data on quantities of imported crude oil are obtained from Hydrocarbon Development Institute of Pakistan Energy Year Book (various issues) and Index Mundi website: http://www.indexmundi.com. Data on nominal prices of Crude Oil in are collected from Illinois Oil & Gas Association (IOGA) Website: www.ioga.com. The data on exchange rate and Real Income (Real GDP at Constant 2000US $) have been taken from World Development Indicators (2011), a publication of World Bank. The data on GDP deflator (used for the construction of real price) have been obtained from International Financial Statistics (2011).

Quantity of imported crude oil is measured in barrels. Nominal prices of Imported Crude Oil are taken in US$. Real prices of Imported Crude Oil are taken in Pakistani Rupee. Real Income (Real GDP at Constant 2000 US $) has been taken in million US$.

The real price of imported crude oil in Pakistani rupees has been found by the following formula:

$$\text{Real prices of imported crude oil} = \frac{NPOUS\$ * ER(Rupee/US\$)}{GDPDeflator} \qquad (3)$$

where
$NPOUS\$$ is nominal price of oil in US dollars and
$ER(Rupee/US\$)$ is exchange rate (Pakistani Rupee divided by US$)

The choice of a suitable estimation technique depends totally on the analysis of properties of the data set. Time series properties of the data have been checked through the application of Augmented Dickey Fuller (ADF) test (1981). Lag length has been selected on the basis of Akaike Information Criterion (AIC). Johansen co-integration technique (Johansen and Juselius, 1990) has been employed in order to have a look on the long-run dynamics of the both models. Similarly, the study uses Vector Error Correction Mechanism (VECM) to check Short-run Dynamics of both the models.

## 4. Results and Discussion

First of all we determine the order of integration of all the variables. Table1 reports the results of unit roots with level as well as first difference. The application of ADF tests indicates that the dependent variable and included explanatory variables are non-stationary. Furthermore, the first differences of all the variables are stationary. In other words, all the variables are integrated of order one i.e. I(1).

**Table 1: Results of Augmented Dickey-Fuller Test with Trend and Intercept**

| Variables | Level | 1st Difference | Conclusion |
|---|---|---|---|
| LnQ | -0.0098 | -6.1471* | I(1) |
| LnY | -2.2839 | -4.2381* | I(1) |
| LnNP | -1.3384 | -5.9744* | I(1) |
| LnRP | -1.7011 | -6.6643* | I(1) |

*Note:* Significant at 1% level.*

Lag length has been selected on the basis of Akaike Information Criterion. Results of the selected lag lengths for both the models (Equations 1 & 2) on the basis of AIC by using VAR are reported in Table 2.

As a next step, the study proceeds for co-integration developed by (Johansen and Juselius, 1990). Table 3 shows the result of Trace Test and Max Eigen Value test for

both the models that have effect on quantity demand of imported crude oil but without using dummy variables.

**Table 2: Results of AIC for Lag Selection**

| LAG | Akaike Information Criterion (AIC) | |
|---|---|---|
| | **Model 1** | **Model 2** |
| **0** | -3.7339 | -4.2220 |
| **1** | -11.9944* | -12.0575* |
| **2** | -11.7635 | -11.8126 |
| **3** | -11.6197 | -11.6950 |
| **4** | -11.9063 | -11.9385 |
| **5** | -11.7735 | -11.8898 |
| **6** | -11.8810 | -11.8785 |

*Note: * Shows Lag length based on AIC.*

The results of Trace Test and Maximum Eigen Value Test for both the models without dummies show long run relationship, based on p-value of the first hypothesis ($H_o$ =0). In this case the p-value is less than 5% significance level. So null hypothesis is rejected. However, in case of other two hypothesis ($H_o$ =1 and $H_o$ =2), the null hypothesis are accepted. Equations 4 and 5 show results of both the models.

After initially findings the relationship among the model variables, we now show the long-run estimates of the coefficients of the model.

$$lnQ = -147.061 + 32.081lnY - 20.36lnNP \quad (4)$$
S.E (47.54) (11.19) (10.95)

$$lnQ = 22.50 - 3.251lnY + 3.912lnRP \quad (5)$$
S.E (5.603) (1.259) (1.621)

The results of both Equations (4 and 5) show that the variables are statistically significant but their elasticities are very high. In Equation 4, the intercept is negative. The signs of the variables are opposite as compared to our expectation in Equation 5. This situation seems to be problematic. It is established that there are many economic and non-economic factors that intervene the relationship between

the variables. We incorporate the dummy variables in both models in order to deal with the instrumental biases. In order to check the possible impact of dummy variables on demand of imported crude oil. Results of Johansen Co-integration for model 1 and model 2 by using different dummies are reported in Table 4.

Results of Trace and Maximum Eigen Value tests show that first null hypothesis ($H_o$=0) is rejected on basis of P-value that is less than 5%. It implies that there is no co-integrated equation among the variables. While in case of other two hypothesis ($H_o$ =1 and $H_o$ =2), the null hypothesis are accepted. It implies that there exists long-run connection between quantity of imported crude oil, income and prices.

**Table 3: Johansen Co-Integration Results for Model 1 & 2 (Without Dummies)**

| **Hypothesis** | **Trace Test** | | **Maximum Eigen Value** | |
|---|---|---|---|---|
| | **Model 1** | **Model 2** | **Model 1** | **Model 2** |
| $H_o$=0 | 40.24<br>(0.013)** | 42.97<br>(0.006)* | 25.43<br>(0.018)** | 26.63<br>(0.011)** |
| $H_o$=1 | 14.81160<br>(0.237)*** | 16.34568<br>(0.159)*** | 11.11918<br>(0.243)*** | 12.96<br>(0.137)*** |
| $H_o$=2 | 3.69<br>(0.460)*** | 3.38<br>(0.512)*** | 3.69<br>(0.460)*** | 3.38<br>(0.512)*** |

*Note: *, ** and *** represent the rejection of null hypothesis at 1%, 5% and 10% significance level, respectively.*

**Table 4: Johansen Co-Integration Results for Model 1 & 2 (With Dummies)**

| **Hypothesis** | **Trace Test** | | **Maximum Eigen value** | |
|---|---|---|---|---|
| | **Model 1** | **Model 2** | **Model 1** | **Model 2** |
| $H_o$=0 | 33.38332<br>(0.0027)* | 40.36825<br>(0.0002)* | 24.56126<br>(0.0043)* | 25.90888<br>(0.0024)* |
| $H_o$=1 | 12.32090<br>(0.1737)*** | 14.45937<br>(0.0216)** | 8.917590<br>(0.1238)*** | 14.15860<br>(0.0148)** |
| $H_o$=2 | 0.004474<br>(0.9559)*** | 0.300767<br>(0.6449)*** | 0.004474<br>(0.9559)*** | 0.300767<br>(0.6449)*** |

*Note: *, ** and *** represent the rejection of null hypothesis at 1%, 5% and 10% significance level, respectively. P values are given in parentheses. Model 1 uses D2, D3 and D5, dummy variables while model 2 uses D1, D2, D3, D4 and D6, dummy variables.*

Trace and Maximum Eigen Value tests demonstrate long run relationship between quantity of imported crude oil (Q), income (Y) and prices of imported crude oil (P). So both models are long-run model. Model 1 having nominal price of imported crude as an explanatory variable uses d2, d3 d5 as dummy variables.

$$lnQ = 1.683lnY - 1.993lnNP \quad (6)$$

S.E (0.321) (1.071)
T ratios 5.23* 1.86**
Note: * Represents 5% significance level. ** Represents 10% significance level.

Results shown in Equation (6) depict positive relationship between Q and Y. When income increases, the demand and consumption of imported crude oil increase. As production of crude oil is medium In Pakistan, so in order to fulfill gap between demand and supply of oil, country depends on imports of oil. There is inverse relationship between prices and demand for imported crude oil i.e. when prices increase, demand for import of oil decrease.

Results reported in Equation (6) show that elasticities of demand for imported crude oil with respect to income and price are inelastic and statistically significant. The income and price elasticities in long-run are 1.993 and -1.683, respectively. It implies that 1% increase in income leads to 1.993% increase in quantity of imported crude oil and with 1% increase in nominal price of imported crude oil measured in US $, quantity of imported crude oil decreases by -1.683. Model 2 having real price of imported crude as an explanatory variable uses d1, d2, d3, d4 and d6 as dummy variables (as described earlier).

$$LnQ = (1.614304)lnY - (0.790598)lnRP \quad (7)$$

S.E (0.104) (0.422)
T-ratios (15.51)* (1.87)**

Note: * shows 5% significance level and ** shows 10% significance level.

It is clear from Equation 5 that the results of normalized co-integrated equation depict correct signs of coefficients are as per the economic theory and the same are significant. In long run, the determinants of imported crude oil are income and prices. We determine the individual commodity like crude oil rather than the whole import in Pakistan. There are many other factors that influence the demand for imported crude oil. Therefore, study incorporates different dummy variables in order to check their impact on the demand for imported crude oil.

Results of income and real prices elasticities of imported crude oil are reported in Equation 5. Results show that these elasticities are inelastic and are statistically significant. In the long-run, income and real price elasticities are 1.614 and -0.791, respectively. It means that 1% increase in income leads to 1.614% increase in quantity of imported crude oil and 1% increase in real prices in US $ leads to -

0.791% decrease in quantity of imported crude oil. When the variables have long run association i.e. they are co integrated then the dynamics of short run behavior of variables are checked by using some suitable technique like Vector Error Correction Model (VECM). VECM represents the lagged first difference of endogenous variables and also the lagged co-integrated equation. VECM model convert the variable into fist difference automatically. We can estimate the VECM by using VAR.

Present study uses three endogenous variables and four dummies to check their impact. Long run dynamics are checked using Johanson co integration technique. For the purpose of estimation of error correction model, 2 lag period for each variable are used. VECM uses lagged variables because the dynamics process may take a number of periods.

The results of short run dynamics of Model 1 using vector error correction model are shown in Table 5. Values of short run coefficients are reported along with their standard errors (shown in round brackets) and the t-statistics (in square brackets).

**Table 5: VECM Results (Model 1)**

| **Variable** | **D(LNQ)** | **D(LNNP)** | **D(LNY)** |
|---|---|---|---|
| Speed of adjustment(ECT) | `0.057220<br>(0.02850)<br>[2.00785] | 0.044014<br>(0.08306)<br>[0.52992] | 0.021246<br>(0.00528)<br>[4.02186] |
| D(LNQ(-1)) | -0.19762<br>(0.20911)<br>[-0.94504] | -0.158382<br>(0.60947)<br>[-0.25987] | -0.048161<br>(0.03876)<br>[-1.24241] |
| D(LNQ(-2)) | -0.119521<br>(0.18578)<br>[-0.64335] | -0.026518<br>(0.54146)<br>[-0.04898] | -0.016418<br>(0.03444)<br>[-0.47674] |
| D(LNNP(-1)) | -0.119521<br>(0.07861)<br>[1.62046] | -0.028993<br>(0.20899)<br>[-0.13873] | 0.011412<br>(0.01329)<br>[0.85856] |
| D(LNNP(-2)) | -0.043455<br>(0.07861)<br>[-0.55279] | -0.108953<br>(0.22911)<br>[-0.47554] | 0.007009<br>(0.01457)<br>[-0.48099] |
| D(LNY(-1)) | -0.757609<br>(0.98559)<br>[-0.76837] | 2.2318116<br>(1.87369)<br>[1.19113] | 0.009565<br>(0.18278)<br>[0.05233] |

*Continued on next page*

**(continued) Table 5: VECM Results (Model 1)**

| | | | |
|---|---|---|---|
| D(LNY(-2)) | -1.256195<br>(0.98599)<br>[-1.30638] | -3.174288<br>(2.8026)<br>[-1.13264] | -0.012537<br>(0.17825)<br>[0.07033] |

*Note: * Showing significance level. Standard Errors are in parenthesis while T-ratios are reported in brackets.*

Table 6 exhibits short run vector error correction model results of model 2. The value of speed of adjustment term is -0.056 with t-statistics equal to 2.03. This value shows how much time the economy would require in order to reach at the long run equilibrium.

**Table 6: VECM Results (Model 2)**

| **Variable** | **D(LNQ)** | **D(LNRP)** | **D(LNY)** |
|---|---|---|---|
| Speed of adjustment(ECT) | -0.056235*<br>(0.02764)<br>[ 2.03443] | -0.019137<br>(0.07768)<br>[0.24635] | -0.020261*<br>(0.00515)<br>[ 3.93132] |
| D(LNQ(-1)) | -0.213588<br>(0.21820)<br>[-0.97885] | 0.316846<br>(0.61322)<br>[ 0.51669] | -0.047629<br>(0.04068)<br>[-1.17074] |
| D(LNQ(-2)) | -0.145332<br>(0.19313)<br>[-0.75252] | 0.123302<br>(0.54275)<br>[ 0.22718] | -0.020621<br>(0.03601)<br>[-0.57269] |
| D(LNRP(-1)) | 0.112032<br>(0.07489)<br>[ 1.49590] | -0.226950<br>(0.21047)<br>[-1.07824] | 0.008013<br>(0.01587)<br>[ 0.10141] |
| D(LNRP(-2)) | -0.025268<br>(0.08511)<br>[-0.29688] | -0.281322<br>(0.23920)<br>[-1.17612] | -0.003709<br>(0.01587)<br>[-0.23375] |
| D(LNY(-1)) | -0.696148<br>(0.98360)<br>[-0.70775] | 3.021856<br>(2.76425)<br>[ 1.09319] | 0.018598<br>(0.18339)<br>[ 0.10141] |
| D(LNY(-2)) | -1.349628*<br>(0.97523)<br>[-1.38391] | -1.520860<br>(2.74060)<br>[-0.55494] | -0.015155<br>(0.18185)<br>[-0.08333] |

## 5. Conclusions

In this study income and price elasticities of demand for imported crude oil in Pakistan have been estimated by using annual time series data for the period 1974 to 2010. Model 1 and model 2 are estimated with and without dummy variables in order to capture their effect on demand for imported crude oil. We apply Johansen co-integration with dummies and without dummies and there are exclusive effects of dummies on demand for imported crude oil. The estimated signs of variables are robust. The variables are cointegrated with the use of instrumental cointegration technique based on Johansen and Juselius approach. We found positive income elasticity for long run. Though its sign is according to theory but its magnitude is very high.

The income elasticity in long-run from estimation of 2nd model which uses the real prices of imported crude oil and the dummy variables is statistically significant and its sign is according to the theory. It implies that the imported crude oil is a normal good and its quantity demanded increases with the increases in income in Pakistan. The price elasticity of quantity demand for imported crude oil of 1st model which uses nominal prices without using dummy variables is statistically significant and has correct sign. Similarly in the second model which uses real price of imported crude oil, the price elasticity without dummies has positive sign and contrary to the theoretical expectations. This implies that the demand for imported crude oil is affected not by its price rather due to other factors (i.e. "All other things being"). The dummies for structural breaks also show significant impact. Similarly, the price elasticity in long run obtained from estimation of model 1 and model 2 using dummy variables is statistically significant and according to theory.

The results of long run income and price elasticities are in line with, found by other studies done for different countries like Altinay (2007) found the income and price elasticities as 0.61 and 0.18, respectively for Turkey. The same values for South Africa are 0.429 and -0.14, respectively (Ziramba, 2010). Similarly, Gately and Huntington (2002) countries the estimated the long-run income elasticities of demand for oil as 0.56 and 0.53, respectively for OECD countries and non-OECD results and price elasticities in long run is (-0.64) and (-0.18), respectively for the same countries.

The co-efficient of Error Correction Term (ECT) shows the speed of adjustment for model 1 and model 2 i.e. how much it will take for convergence to long-run equilibrium to take place.

The findings of this study have some useful implications for policymakers related to import of crude oil in Pakistan. Present study suggests on basis of positive value of income elasticity imported crude oil is a normal good and an increase in the income (GDP) level can have a positive impact on production levels of goods and services in different sectors of the economy in Pakistan. The income elasticity less than unity for both short run and the long run suggests that oil demand grows less than income e.g. if economy grows by 5% per annum, demand for imported oil will grow by less than 5% annually, hence oil intensity will decline, provided that price does not change. Price elasticity of demand for imported crude oil suggests the authorities to define a band within which the price of imported crude oil can fluctuate i.e. to set minimum and maximum prices of imported crude oil.

## References

Al-Faris, AR (1996). Demand for Oil Products in the GCC Countries. *Working Paper, 9608*, Economic Research Forum.

Altinay, G., (2007). Short-run and long-run elasticities of import demand for crude oil in Turkey. *Energy Policy*, 35, 5829-35.

Al-Yousef, N. A., (2005). Modeling and Forecasting the demand for Crude Oil in Asian Countries" 25th USAEE/ IAEE North American Conference September 18 – 21, Omni Interlocken Resort, Denver, CO, USA.

Aqeel, A. & Butt, M. S., (2001).The relationship between energy consumption and economic growth in Pakistan. *Asia-Pacific Development Journal*, 8(2), 101-109.

Dickey, D. A. and W. A. Fuller (1981).Likelihood Ratio Statistics For Autoregressive Time Series With a Unit Root, *Journal of the American Statistical Association,* 49, 1057-1072.

EIA (2006). U.S. Energy Information Administration- EIA- Independent Statistics and Analysis.

Gately, D., and Huntington, H.G., (2002).The Asymmetric Effects of Changes in Price and Income on Energy and Oil Demand. *The Energy Journal*, 23, 19-55.

Ghosh, S. (2009). Import demand of crude oil and economic growth: Evidence from India. *Energy Policy*, 37(2), 699-702.

Illinois Oil & Gas Association (IOGA) Website: www.ioga.com

Index Mundi website: http://www.indexmundi.com.

International Financial Statistics (2011). International Monetary Fund, Washington D.C.

Johansen,S., Juselius, K.(1990).Maximum likelihood estimation and inferences on cointegration—with applications to the demand for money. *International Journal of Business and Social Science*, 2(17), 209-216.

Kiani, A. (2011). Impact of High Oil Prices on Pakistan's Economic Growth. *International Journal of Business and Social Sciences*, 2(17), 209-216.

Krichene, N. (2002). "World Crude Oil and Natural Gas: a Demand and Supply Model", *Energy Economics*, 24, 557-576

Peter R. B., (1996). Pakistan: A Country Study. Federal Research Division Library of Congress. DIANE Publishing, pp.186.

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.

Roy faizal, R.C., (2008). Crude Oil Consumption and Economic Growth: Empirical Evidence from Japan. Department of Economics, Faculty of Economics and Management, University Putra Malaysia.

State Bank of Pakistan (2006). Annual report. State Bank of Pakistan

World Bank, (2006), *World Development Indicators 2006*, Washington, DC.

Ziramba, E., (2010). Price and Income Elasticities of Crude Oil Import Demand in South Africa: A Co-integration Analysis. *Energy Policy*, 38, 7844–7849.