Price and Income Elasticities of Crude Oil Demand: Cross Country Analysis

Hina Ashraf [1], Irfan Hussain Khan[2*], Amber Javaid[3], Muhammad Awais[3]

[1] PMAS University of Arid Agriculture Rawalpindi; [2] Government College University Faisalabad;
[3]Hajvery University Lahore
*Email: irfansial007@hotmail.com

Abstract

Volatility in crude oil price is the main issue in this era. Great volatility in price of crude oil affects the demand of oil directly and indirectly in developing countries because these countries are oil importing countries especially Pakistan, India and China. Crude oil therefore contributes to and thereby influences the GDP of the country as a source of energy. It is very critical and essential for any country to explore and produce gas to improve energy shortage, for some deliberate importance of gas because natural gas is very clean, cheap and sustainable source to produce energy within a country. This study aimed to analyze the price and income elasticities of crude oil demand in developing countries time series data used from the period of 1971-2014. ADF test was used to check the stationary of variables and it is seem that all variable are not stationary at level. ARDL used for co integration and all variables of the models have long run relation with dependent and explanatory variables. Price and income elasticities of crude oil demand were measured in short and long run for developing countries and it was concluded that long run elasticities of price and income were less inelastic or some cases like China was elastic than short run elasticities of price and income of crude oil demand. It was suggested that oil importer countries should explore the alternatives of oil within a country to fulfill the domestic demand.

Keywords: volatility, Elasticities, ARDL

Introduction

Crude oil has great influence on worldwide economies because it is considered a "flow good" as compared to other commodities e.g., agriculture and metal products (Taghizadeh-hesary and Yoshino, 2014). Oil is the most important physical commodity input and most imperative factor which affects the world economy because of this any variation in the oil prices brings a rapid change in all others macro-economic variables. Economies in the world depend on use of oil because it has major role in daily economic activities and development of economies. Oil is necessary for development with the passage of time oil demand increasing. Oil remains one of the most important inputs of production in all sectors especially industrial sector (Rapaport, 2013; Ansar and Asghar, 2013; Xiong and Wu, 2009).

It is emergent agreement that volatility in the price of crude oil is due to fluctuation in oil demand. In 2007-2008 there was a large increase in world was said to be the reason of fluctuations in price of oil, where as a results prices of oil gone down dramatically and had to face financial crises to the world because there was a great economic down fall. There is an argument that on international level the currency US dollar used as oil prices so exchange rate of dollar should affect the countries' crude oil demand that don't use US dollar for local dealing with change in rate of dollar (Hamilton, 2008).

Pakistan is an agrarian country it is not an oil producing country so to fill up supply-demand gap through import of oil. Most of fuel in Pakistan is used in industrial (to run heavy machines), transport and agriculture sector but ultimately consumers pay in the form of high food prices (Kiani, 2011). Change in oil prices (increase in prices) adversely affect developing economies (Pakistan) by

creating macroeconomic instability such as high inflation, depreciate exchange rate which influence trade balance, imports become more expensive and it increase budget deficit.

World is converting into global village, trade contribute significantly in this transformation and much more in development of the world economies, different nation interact each other to trade. Trade improves the level of income distribution, enhance choice availability, enhance the opportunities of technical capacities and motivate people to accelerate the change process. Trade and development go side by side, as it signifies the development process (Yasmin *et al.,* 2006).

Background of countries and oil consumption scenario
China
In the last 25 years the average annual GDP growth rate has been approximately 9.4% and today China is the second largest economy in the world after the U.S (Cheng *et al.,* 2007). In 2010, with export sector measures up to $1.435 trillion, China became the world's largest exporter. Although the fast economic growth, the income level per capita is still lower middle-income (The CIA World Fact Book, 2009). The energy demand in China has surged to fuel the fast expansion of the industrial and commercial sector as the economy is growing. China is the second largest consumer of energy products in the world behind United States.

In 2009, average oil demand of china remained 8 million barrel per day, while in 2000 it was 4.6 million barrel per day. It is expected that it would be 12.2 and 15 million barrel per day in 2020 and 2035 respectively. China's demand in 2010 was 40 percent for transport sector because gas and oil were main fuel in this sector, as population increase demand for transport and fuel increase so in 2035 demand will grow about 65 percent of total demand for transport sector. It is reported that per day import of oil in china is 8 million b/d in 2016, it was 6.7 in 2015 it is a huge jump. According to Standard Charted, in 2018 it could be 10 million per day; it is argued, that it is a huge amount of oil demand from China and could create supply shortage (Pritchard, 2016).

India
With its 1 billion inhabitants the main sectors of the Indian economy are village farming, modern agriculture, handicrafts, diversified manufacturing industries and the service sector. India has capitalized on its large educated population to become a major exporter of information technology services and software workers. Thus services are the major source of economic growth, accounting for 53.4 percent of GDP, with only one-third of Indian labor force.

India depends 80 percent of imported oil it also produce domestically about 700 kb/d. India is the fourth largest importer of oil and petroleum products after US, China and Japan, for domestic consumption imports required 77 percent since 2013- 2014 (Indian energy outlook, 2015). Fall of oil prices from 2014 impact every economy, it was 47 percent decline in oil prices as decline in inflation, in India food prices decrease as less transportation cost and reaches at 39.7 percent CPI and 14.3 percent WPI. In addition, CPI inflation rate at 6 percent in 2015 as expected 8 percent this year. Low oil price decrease the government expenditure in term of decreasing subsidies on fuel, kerosene and LPG that will help to reduce deficit (Indian Ministry of Petroleum and Natural Gas, 2015).

Pakistan
Pakistan met only 19.9 percent of oil demand from domestic production and 15.5 Mtoe import including petroleum and petroleum products during 2005-06 (Pakistan energy book, 2007). Pakistan is a nation of 170 million populations with 2.05 growth rate lowest user of energy. Large oil reserves were found in low population area due to less consumption of oil like Middle East and northern Europe (Gov Pakistan, 2010).

Imported crude oil and petroleum products are the main sources of energy for Pakistan. It ranks 33th among global consumers of oil. According to U.S. Energy Information Administration (EIA) the current crude oil production in Pakistan is 64,000 barrels per day (EIA 2012). This amount is not sufficient to fulfill the needs of the country which is 437,000 bbl/d. The production of crude oil in Pakistan has remained very low as compared to the demand (Kazim 2007). Pakistan heavily depends on the imported oil to fulfill its needs. Pakistan produced about 20 percent of its oil (Ghani 2007) and imports the rest. Mostly the demand for crude oil and petroleum products is met through imports mainly from Middle East countries (Saudi Arab is playing the leading role).

Proven reserves of crude oil in Pakistan are 247.5 million barrels. Pakistan's annual consumption of petroleum products is around 23 million tons. Indigenous crude oil meets only 16 percent of total requirements while 84 percent requirements are met through imports in the shape of crude oil and refined petroleum products. Pakistan now follows a market-based policy, in general, for the oil sector. OGRA is maintaining reserves equivalent to 20 days of petroleum demand and is making all efforts to enhance this capacity. Pakistan's petroleum consumption is about 22.9 million metric tons per annum. The overall trend of cheaper oil is likely to have deep implications for the Pakistan economy. The import of crude oil remained about 44.9 million barrels during FY14 as compared to 40.9 million barrels in the last period.

Objectives of Study:
➢ To measure the income elasticities for crude oil demand in short and long run.
➢ To estimate the price elasticities in long and short run for China, India and Pakistan.
➢ To recommend policies and suggestions according to the countries situations.

Literature review
Income and price elasticities of imports refer to the degree of responsiveness of imports to any slight change in the income and prices of imports. There are numerous studies, performed in order to measure the elasticities of crude oil demand but more are with energy demand rather crude oil with different macro-economic indicators. However, rare work has done on these three countries separately with India, China and Pakistan because majority of the work is done with country groups. In this section, some of them discussed to emphasize the significance of the analysis for different countries. In this chapter all studies have discussed that have previously done on relevant to this study to make consistent our results to these studies.

Difiglio (2014) examined why supply and price-inelastic demand of oil, reason oil price shocks. He concluded that there is not assure that great amount of worldwide emergency reserves and their effectiveness in protecting world economies. Premeditated oil stocks not been used in sufficient quantity can protect. Petroleum reserve used to protect the economy for following future supply disorder of oil.

In the same ground Phoumin (2014) study conducted on measuring elasticity of energy prices for East Asian countries. This study used time series data to investigate the patterns of price and income elasticity of energy demand. Applying a dynamic log-linear energy demand model, both short-run and long-run price and income elasticities were estimated by country. The study concluded that price elasticity is generally inelastic amongst all countries of studies. These findings support to the theory of price inelasticity of energy demand due to the assumption that energy remains a special commodity due to its nature of lack of substitution. Any shift from oil to other energy is difficult as it depends on equipment uses which are not easily to be replaced. As a result, a unit change in price may not induce equal change in quantity of demand. Although prices were inelastic, this study observed that price elasticity in developing counties is more sensitive than in

developed countries.

Yaprakli and Kaplan (2015) conducted a study on Turkish demand for crude oil import; this study was re examining of Turkish demand, 40 years time series data used from 1973-2013. Study measured price and income ealsticities with using structural break as dummy variable. Empirically study concluded that both price and income ealsticities are inelastic for crude oil demand in long run. The results measured with using dynamic OLS estimation, for examining elasticitiesco integration Maki (2012) was tested, introducing dummy to find external and internal crises effect and study found that in long run external shocks affect import of oil.

People switch over to substitute products in Pakistan like CNG and LPG, because it is difficult for people to continue buying expensive oil in the long run. Abdullah *et al.* (2015) analyzed the long and short run effects of crude oil price on crude oil import demand of Pakistan by employing time series data from 1981-2014. The long run relationship between crude oil price and crude oil import was tested by using Johansen and Juselius cointegration approach. The short run effect is analyzed by using error correction model. The analysis revealed significant long run negative impact of prices on crude oil import demand of Pakistan. However this study found insignificant effect of respective variable in short run. So, Pakistan should take various energy efficiency and demand side management measures like expanding and strengthening indigenous resource base, imports of advance technology, substituting imported crude oil by domestic crude oil and looking for alternative energy sources.

Kayum*et al.* 2016 examined the long-run price and income elasticity of import demand in Bangladesh over 1977-2015. This study uses a relatively recent cointegration test, the bounds test, based on the estimation of an unrestricted error-correction model. The result indicated that the short run and long run income elasticity of import demand was 1.18 and 1.54 respectively, suggesting a rise in import if income increases. The short run and long run price elasticity was -0.58, -0.73 respectively, which indicated that there is a fall in import if the price increases. The study recommended some policy suggestions for monetary authority as well as fiscal authority that by maintaining a relatively low level of inflation would be a better policy to retain the aggregate import in order to improve the trade balance.

Materials and Methods

In this study, economic variables are used oil import as demand of crude oil is as dependent variable and price of crude oil converted into domestic price and GDP growth as income of the each country as explanatory variables.

Similarly, the income elasticity of demand is a measure indicating the responsiveness or sensitivity of the quantity demanded of a good to a change in income, computed as the percentage change in quantity demanded divided by the percentage change in income (Mankiw,2006), The price elasticity of demand is a measure of how much the quantity demanded of a good responds to a change in the price of that good, computed as the percentage change in quantity demanded divided by the percentage change in price (Mankiw, 2006).

For price elasticity: $e_{price} = \dfrac{\dfrac{\Delta Q}{Q}}{\dfrac{\Delta price}{price}} = \dfrac{\Delta Q}{\Delta price} \times \dfrac{price}{Q}$; and

For income elasticity: $e_{income} = \dfrac{\dfrac{\Delta Q}{Q}}{\dfrac{\Delta income}{income}} = \dfrac{\Delta Q}{\Delta income} \times \dfrac{income}{Q}$,

where ΔQ, $\Delta price$, $\Delta income$ are the changes in quantity of demand, price and income respectively.

Data Sources
The data collection sources include:
Economic Survey of Pakistan (various issues), World Bank (WB), British, Petroleum (BP) and, Organization of Petroleum Exporting Countries (OPEC)

Description of variables
Literature stated that the crude oil consumption is a function of several other explanatory variables such as innovations and energy policies. Due to the fact that such variables are difficult to quantify we include only following variables that could affect crude oil consumption.

Model specification
The model used in this study based on previous papers Tsirimikos, 2011; Phoumin, 2014; Altinay, 2007; Ziramba, 2010; Sultan, 2010.
Functional form of the model is following:
$D_t = f(GDP, P_t)$
Where, D_t= crude oil import as oil demand, GDP= growth rate as income, P_t= Price of crude oil demand in domestic currency

Statistical Model

$$D_t = \alpha + \beta_1 Y_t + \beta_2 P_t + \varepsilon_t$$

Where,
α is constant β_1 and β_2 are coefficients of the variables income and price and expected signs for β_1 is positive and β_2 is negative. ε_t is disturbance term of the model. Basically this model is not used in the study to estimate the results, the model used in this study is extended to ARDL bound testing.

Results and Discussion
Auto Regressive Distributed Lag Model (ARDL) for short run and long run. Different software could be use in econometric estimation of variables but in this study E-views 9 (Econometric Views) used for all estimation because this model is in-build in E-views 9. Before any estimation or applying any technique there is compulsory to test the stationarity of variables because

in time series data most of the variables not stationary. So ADF test is applied to check the stationary of all variables and further preceded to ARDL Bound testing co integration approach.
Testing of stationarity

Table 1: Stationarity Test for India

Variables	Stationary at Level		Stationary at 1st difference		Results
	Intercept	Trend & Intercept	Intercept	Trend & Intercept	Difference
Ln imports of Oil	1.09	-1.90	-5.46	-5.58	*I(1)*
Ln GDP	-5.94	- 7.63	-8.46	-8.40	I(0)
Ln Price of Oil	-3.09	-4.37	-4.63	-4.96	I(0)

Source: Author's Calculation from time series data

Table 2: Stationarity Test for China

Variables	Stationary at Level		Stationary at 1st difference		Results
	Intercept	Trend & Intercept	Intercept	Trend & Intercept	Difference
Ln imports of Oil	-0.68	-1.73	-8.75	-6.09	*I(1)*
Ln GDP	-0.73	-0.93	-4.99	-4.44	*I(1)*
Ln Price of Oil	-3.62	-3.50	-5.51	-5.47	*I(0)*

Source: Author's Calculation from time series data

Table 3: Stationarity Test for Pakistan

Variables	Stationary at Level		Stationary at 1st difference		Results
	Intercept	Trend & Intercept	Intercept	Trend & Intercept	Difference
Ln imports of Oil	0.44	-1.47	-3.17	-3.76	*I(1)*
Ln GDP	-2.58	-4.15	-5.02	-4.96	*I(0)*
Ln Price of Oil	-0.78	-2.04	-6.01	-5.88	*I(1)*

Source: Author's Calculation from time series data

Diagnostic testing
Normality of Error Term
Histogram normality test is applied to check the normality of residual and frequency distribution. It isolates the arrangement range separation between its most extreme and least values into various equivalent lengths and showcases a check of the number of observations that fall onto every bin. Skewness used to measure symmetry of histogram.
Autocorrelation
Bruesch Godfrey test used to detect the problem of autocorrelation in the model.
H_0: No autocorrelation
H_1: There is problem of autocorrelation

ARDL bound testing

Table 4: Results of Bound tests (Co integration)

Country	F-stat	Significance (%)	Bound I(0)	Bound I(1)
Pakistan	4.59	10	3.07	4.03
		5	3.29	4.35
India	4.72	10	3.17	4.14
		5	3.79	4.43
China	6.59	10	4.19	5.06
		5	4.87	5.58

Source: Author's Calculation from time series data Significance at 5% and 10%

Descriptive statistics

The results of the descriptive summary statistics of the variable, used in the model of demand of crude oil shows spread of values (Akram, 2011). For detail of the values data is presented in below tables. All statistic summaries for China, India and Pakistan are given in table 5, 6, and 7.

Table 5: Descriptive Statistics Summary of China

Descriptive Stat	LIMP	LGDP	LDP
Mean	8.08	3.30	6.43
Median	8.02	3.21	5.92
Maximum	9.31	3.21	8.93
Minimum	6.76	1.03	4.86
Std. Deviation	0.72	0.77	1.23

Source: Author's Calculation from time series data (1971-2014)

Table 6: Descriptive Statistics Summary of India

Descriptive Stat	LIMP	LGDP	LDP
Mean	6.59	5.54	5.51
Median	6.31	5.83	5.56
Maximum	8.24	10.25	8.64
Minimum	5.50	-5.23	1.84
Std. Deviation	0.95	3.06	1.57

Source: Author's Calculation from time series data (1971-2014)

Table 7: Descriptive Analysis Summary of Pakistan

Descriptive Stat	IMP	GDP	DP
Mean	4.59	4.90	6.72
Median	4.42	4.83	6.20
Maximum	5.67	10.21	9.18
Minimum	4.06	1.01	4.63
Std. Deviation	0.37	2.10	1.38

Source: Author's Calculation from time series data (1971-2014)

Sort run and long run elasticities results

After confirmation of long run relationship between variables, we can estimate long and short run elasticities of price and income for crude oil. Previous empirical work and several studies have shown that price and income elasticities are significantly higher in the long-run than in the short-run. Both in the short-run and the long-run, the price elasticity of demand for crude oil is extremely low and specifically highly inelastic. Income elasticities are also found inelastic in the short-run but in the long-run are close to unity and in some cases significantly elastic. The following results show long and short run results of price and income elasticities for China, India and Pakistan.

Short run elasticities for China

Short run estimated equation for China as follows

$$LD_t = 26.93 + 1.02GDP_t - 0.18DP_t - 0.30DP_{t-1} + 0.26LD_{t-1}$$
$$- 0.46ECM_{t-1} + \varepsilon_t$$

The coefficient of ECM (-1) is -0.46 in the short run model, inferring that the deviation from the equilibrium in long term is corrected by around 46 percent every year. When the value of ECM (-1) is negative and statistically significant then we can further move to the explanation of the model because this is necessary for ARDL bound testing for co integration (Sultan, 2010)

Income Elasticity in Short Run

Moreover, result indicating that short run coefficient of GDP in equation (1) is 1.02 has positive sign indicating positive relation with import demand of oil. With 1 percent increase in GDP or income of China, lead to an increase in demand of oil by 1.02 percent by keeping the effect of price constant. P-value of GDP is 0.00 and that is also statistically significant. Demand of import is elastic with income change. Income elasticities indicate that crude oil is a normal good, since oil demand increases in line with an increase in income. Short-run income elasticities are higher than unity, indicating that crude oil demand grows at a greater rate than income and oil intensity has been rising over time (Tsirimikos, 2011).

Price Elasticity in Short Run

The coefficient price is -0.18 that has economically –ve and correct sign as demand and price function indicates that with price change demand will also change and has inverse relation (-ve), shows that import is inelastic to change in price of oil. P-value of price in short run is 0.04 that is statistically significant, and evidence of strong relation of import demand of oil and price of oil. .Results indicated that in short run demand is income elastic and price inelastic in China.

Goodness of fit of the Model

Table showing model's goodness of fit which is regressed for long run results for China. R^2 of China is 0.96, that indicating that there 96 percent variation in the model is due to explanatory variables that are price of oil and income of country (GDP) and remaining 4 percent is included in error term mean 4 percent is due to other factors that affect import demand of crude oil. Adjusted R-square value is 0-96 that is also show that 96 percent variation in the model is due to explanatory variables.

H_{oS} = Model is not good fitted in the short run

H_{1S} = Model is good fitted in the short run

F-stat is 143.16 with the probability value of 0.00 which is smaller than 0.05, so we reject the null hypothesis and accept the alternative hypothesis that overall model is good fitted. The value of Durbon Watson is 1.98 that is proof of no problem of serial correlation in the mode

Table 8: Results (Long Run) for China

Log of imports demand (dependent variable)				
Variable	Value of Coefficient	Standard Error	t-value	p-value
LGDP	2.20	0.99	2.23	0.03
LDP	-1.38	0.45	-3.02	0.00
C	58.23	25.54	2.28	0.02
R-Square	Adjusted R-square	F-statistics	Dubon-Watson Value	Prob (F-statistic)
0.96	0.96	143.16	1.98	0.00

Source: Author's Calculation from time series data

Short run elasticities for India

Short run results for normalized equation of India as follows

$$LDt = 0.07 + 0.16LD_{t-1} + 0.00LGDP_t + 0.06LGDP_{t-1} - 0.08LDP_t - 0.05LDP_{t-1}$$
$$- 0.24(ECM)_{t-1} + \varepsilon_t$$

The estimated coefficient of error correction mechanism for India is -0.24 and statistically significant at 1 percent level with appropriate negative sign. This result justifies the long run equilibrium relationship among dependent and independent variables. It indicates that the system tends to correct its previous period of disequilibrium by 24 percent a year. Results are presented in table 4.15.

Income Elasticity in Short Run

In short run, elasticity of GDP for India is 0.00. It is showing that in case of India demand of income is inelastic as its value is 0.00 which shows that there is no effect of income on demand when income of India increases in short run. P-value of GDP is 0.00 in short run indicating that there is statistically significant impact of GDP on dependant variable but the value of coefficient showing that income has no impact on oil demand in short run. In previous year 2013 the coefficient of GDP is 0.06 that is greater value than current year 2014 that is 0.00, means that in 2013 income elasticity is inelastic and demand is respondent in 2013 than 2014 when there is no effect of GDP on demand of oil. As with 1 percent increase in income of previous year increase the demand by 0.06 percent that is inelastic demand but income of previous year has some effect as compare to current year demand.

Price Elasticity in Short Run

Elasticity of price is -0.08 in the short run, which shows that import is inelastic with a small change in price in India. It is inelastic demand with respect to price means when price of oil changes the demand of oil not much respond for oil to increase or decrease in short run. It can be interpreted as 1 percent increase in price of oil will decrease demand of oil on average by 0.08 percent by keeping other variable impact on demand of import oil constant.In previous year 2013 price elasticity is -0.05 that is also inelastic and more than in 2014.The inelastic price in India could be explained by several reasons such as fuel subsidy by the state and lack of alternative mode of fuel substitution especially for the transportation sector. It is also theoretically and statistically significant impact on import demand of oil. Findings are consistent with the studies of Ghosh (2009) and Phoumin (2014).

Long run elasticities for India

Estimated results of long run equation for India as follows

$$LD_t = 1.58 - 0.96LDP_t + 0.07LGDP_t + \varepsilon_t$$

Price Elasticity in Long Run

Coefficient of price is -0.96, which revealed negative correlation between oil demand and oil price in case of India. Oil demand is more responsive to price changes in the long run, such as one percent increase in price level leads to 0.96 percent decrease in oil demand in long run by keeping the effect of GDP constant. In long run demand is less inelastic or closer to unity for India with respect to price. The results indicates that in the long run demand becomes more responsive to small change in price especially increase in price as with1 percent increase in price of oil the demand of oil is decreased by 0.96 percent. There must be cheap alternates of crude oil that helps the consumer to shift these substitutes when oil price increase.

Table 9: Results (Short Run) for India

Log of imports demand (dependent variable) Selected Model: ARDL(2, 2, 2)				
Variable	**Value of Coefficient**	**Standard Error**	**t-value**	**p-value**
C	0.07	0.16	0.47	0.63
D(D(-1))	0.16	0.06	1.00	0.32
D(LGDP)	0.00	0.00	0.41	0.68
D(LGDP(-1))	0.06	0.00	0.31	0.75
D(LDP)	-0.08	0.05	-2.77	0.03
D(LDP(-1))	-0.05	0.03	-1.48	0.14
ECM (-1)	-0.24	0.06	-4.00	0.02

Source: Author's Calculation from time series data

Long run elasticities for India

Estimated results of long run equation for India as follows

$$LD_t = 1.58 - 0.96LDP_t + 0.07LGDP_t + \varepsilon_t$$

All long run results for India are presented in table 4.16.

Price Elasticity in Long Run

Coefficient of price is -0.96 it is price elasticity of crude oil demand of India, which revealed negative correlation between oil demand and oil price in case of India. Oil demand is more responsive to price changes in the long run, such as one percent increase in price level decrease the oil demand in long run by 0.96 percent by keeping the effect of GDP constant. In long run demand is less inelastic or closer to unity for India with respect to price. The results indicates that in the long run demand becomes more responsive to small change in price especially increase in price as with1 percent increase in price of oil the demand of oil is decreased by 0.96 percent. The results indicated that demand is in elastic in long run bet relatively less inelastic as its value approaches to zero.

Income Elasticity in Long Run

Long run slope coefficient of GDP is 0.07 for India as obtained in table 4.16 which exhibits positive relation with oil demand. The probability value of GDP is 0.00, significant at five percent level of significance. This is highly significant with price, states that 1 percent increase in income of India on the average will enhance its oil demand by 0.07 percent in long run. In long run demand for

oil with respect to income is inelastic. It is concluded that demand for oil is less inelastic of price and inelastic demand of income. In case of India it seems that demand of oil demand is more responsive with price changes rather changes in income of that country; demand increase less than as income of country increases as its value is 0.07 that is less than 1 (Ghosh, 2009).

Goodness of Fit of Model

Goodness of fit for India is regressed and represented in table 10 R^2 of India is 0.99, that is very high and indicating that included independent variables in the mode has strong impact on import, mean that there is 99 percent variation in dependent variable(demand of oil) is due to explanatory variables (Price and GDP) and remaining 1 percent is due to other factors that are included in error term.

H_{oS} = Model is not good fitted in the short run

H_{1S} = Model is good fitted in the short run

F-stat is 480.99 with the probability value of 0.00 which is smaller than 0.05, so we reject the null hypothesis and accept the alternative hypothesis that overall model is good fitted. The value of Durbin Watson is 1.87 indicating there is no autocorrelation. The value is greater than the value of adjusted R-square so this is the evidence of no more spurious results.

Table 10: Results (Long Run) for India

Log of imports demand (dependent variable)				
Variable	Value of Coefficient	Standard Error	t-value	p-value
LGDP	0.07	0.02	3.18	0.00
LDP	-0.96	0.45	-2.13	0.03
C	1.58	1.85	0.85	0.39
R-Square	Adjusted R-square	F-statistics	Dubon-Watson Value	Prob (F-statistic)
0.99	0.98	480.99	1.87	0.00

Source: Author's Calculation from time series data

Short run elasticities for Pakistan

Normalized equation results for Pakistan as follows:

$$LD_t = 0.86 + 0.04GDP - 0.07DP - 0.17DP_{t-1} + 0.65LD_{t-1}$$
$$- 0.34ECM_{t-1} + \mu_t$$

Table shows estimated short run results, first column of the table shows name of all variables, second column shows the value of estimated coefficients, likewise standard error, t-statistics and probability values are shown in third, fourth and fifth column respectively.

Results of ECM for Pakistan show that there is a long run relationship between the variables as estimated by the error correction term, is an indication of quick recovery in oil demand after an economic crisis. The value of ECM (-1) is estimated as -0.34 which is significant with p-value 0.04 as there is 34 percent speed of adjustment in one year (Altinay, 2007; Zaramba, 2010; Phoumin, 2014 and Ghosh, 2009).

Income Elasticity in Short Run

Moreover, result indicating that short run elasticity of GDP is 0.04 that is economically and statistically significant. As, 1 percent increase in GDP then demand of oil increase by 0.01 percent by keeping the effect of price constant on dependent variable, points out that oil demand grows less

than income. In short run demand of oil is found inelastic for Pakistan Altinay (2007). In other words, the degree of responsiveness of oil demand to changes in income in the short run is very low.

Price Elasticity in Short Run

The error correction model shows that in short run, there is insignificant effect of crude oil prices on import demand of Pakistan. Elasticity of price is -0.07 and its probability value is 0.3 that is not significant statistically but significant economically. There is negative relation of price with demand of oil in the short run but has no effect on the demand of crude oil import. Results indicated that oil demand with previous year 2013 is -0.17, mean that previous year price has significant impact on current demand of oil. With 1 percent in previous year price the demand of oil in present year decreased by 0.17 that has a large decrease as compare to 2014 that is 0.07 and has no effect on demand. So the price of previous year in short has significant impact. The imported oil demand of previous year also has significant impact on current as the value of LIMP is indicating in equation that is 0.65 that is statistically significant with p-value of 0.00.

Long run estimated elasticities for Pakistan

The log run equation estimated with respect to the model as follows

$$LD_t = 2.49 - 0.30DP_t + 0.09LGDP_t + \mu_t$$

Long run estimated normalized equation for demand of oil shows that all variables have statistically and economically correct relation with dependant variable. Results for Pakistan illustrated in table 11. As estimated equation shows that there is a correlation between the variables of model as demand of oil, GDP and price of oil in Pakistan as earlier checked through the co integration model and expected for this study.

Price Elasticity in Long Run

The coefficient of price is -0.30, which shows negative relation of oil price with oil demand as theory states that price and demand have opposite relation as price increase demand for oil decrease and if price decrease demand increase. As crude oil is necessary and normal good in case of Pakistan thus with increase in oil price demand becomes lower (Jamali*et al*., 2011). Results indicates that when oil price increase by 1 percent and holding impact of other variables such as GDP constant or zero then on the average oil demand response negatively i.e. decrease by 0.30 percent in long run. Probability value of price is 0.00, which is highly significant (Ghosh, 2009).

Overall Significance of Model

Goodness of fit for Pakistan is represented in table 11. The value of R^2 for Pakistan in table is 0.89 that is indicatingthat89 percent variation in import demand of oil is due to explanatory variables(price of oil and GDP). Remaining 11 percent is due to other factors that affect import demand of oil that are included in error term.

H_{oS} = Model is not good fitted in the short run

H_{1S} = Model is good fitted in the short run

As F-statistics shows overall goodness of fit of the model, if F-statistics is significant with its p-value < 0.05, it is concluded that overall model is good fitted. The value of calculated F-statistics is 74.20 in table as explaining that model is good fitted at 1 percent level of significance as indicated with p-value0.00 that is less than 0.05. Durbin Watson value is 1.84 that is close to two (2). Therefore, there is an evidence of no autocorrelation; and there are no spurious results because Durbin Watson value is greater than R-Square and adjusted R-Square, as Gujrati (2009) stated that when R- square become greater that Durbin Watson value results are spurious and no more reliable.

Comparison of results with previous studies

Phoumin (2014) study concluded that price elasticity in developing counties is more sensitive than in developed countries. For income elasticity, this study also found that income has been very sensitive toward energy consumption, except in countries like India, China and Australia due to energy supply limitation in the cases of India and China. Cooper's (2003) results are quite consistent with the results of this study with some variations among the values of the results due to different data. Altinay (2007) found that the short-run and the long-run price elasticity in Turkey accounts for -0.10 and -0.18 respectively while income elasticity in the short-run and in the long-run is 0.64 and 0.61, and also used the same methodology ARDL bound testing as in this thesis is used

Table 11: Long Run Results of Pakistan

Log of imports demand (dependent variable)				
Variable	**Value of Coefficient**	**Standard Error**	**t-value**	**p-value**
LGDP	0.09	0.04	2.24	0.03
LDP	-0.30	0.05	-5.50	0.00
C	2.49	0.42	5.85	0.00
R-Square	**Adjusted R-square**	**F-statistics**	**Dubon-Watson Value**	**Prob (F-statistic)**
0.89	0.87	74.20	1.84	0.00

Source: Author's Calculation from time series data

Conclusion

This study empirically measured the price and income elasticity of oil demand for crude oil both in the short and long run this was the main objective of this study. Concluding the study, it was seen that upsurge in prices of oil both in country and outside the country reduce the demand of oil because these countries are oil importers. Income plays positive role with demand of oil when income increases in the country it respond positively to demand of oil and increase import of oil.

Regression analysis was carried out on data of 44 years from 1971–2014. This study used three countries China, India and Pakistan to testify the model used demand of crude oil as dependent and price of oil and income of each country. First, the stationarity analysis showed that some variables were stationary at first difference and some were on level. Co-integration analysis was carried out to check the long run relationships of variables, because all variables were not stationary at level. Results revealed that long run relationship do exist between variables, indicating that all variables have effect on each other in long run.

The optimal lag selection criterions of the model used in the study and were selected through AIC, SC and Hennan Quinn criterions. The study has employed Autoregressive Distributed Lag Model (ARDL) for the analysis of short run and long run elasticities.

The study concluded that price elasticity of oil demand for all countries was found as inelastic in short run but it is less inelastic in the long run, that demand act in response was not instant in short run but in the long it shows more responsiveness in the case of China. Income elasticity of oil demand is elastic in the long run and short run but more elastic demand of income in short run in case of China. India and Pakistan were also found income inelastic in long run but lower as short run, in case of India results of the study shown that there was no effects of income on demand in short run. Study concluded t 108 's demand was more responsive with change in

income of country but India shows more response with change in price especially increases in price in the long run and short run.

All objectives of has been achieved such as to measure the income elasticities for crude oil demand in long run and short run and to estimate price elasticities of crude oil demand in the long run and short run has been fulfilled.

This study also answered all research questions appropriately such as income has positive relation with demand of oil in the short and long run. Price has negative relation with demand in long and short run. The elasticities indicated that in short run demand is price, income inelastic in short run and in some cases income elastic demand in long run but inelastic in short run. All variables have economically correct relation with demand of oil.

Policy Suggestions

Crude oil remains a major import of developed and developing countries, especially industrialized economies like China as an emerging economy, India and Pakistan less developed economies. All the findings have some key implication for policy makers. It is concluded that demand is inelastic with income in short and long run except China, but less inelastic demand with price in long run. So, there are some policy suggestions for government to control import and produce alternate within a country, that country should not only rely on importing oil other substitute also explore. Some policies in this regard are as under:

- A large amount of petroleum is used in transport sector in these countries, government should impose high tariff rate on import of private small luxurious vehicles that are under used in high income population, it provide to generate income of country and also reduce these import.

- Substitute of oil should be found within a country to cope with increasing demand of oil, like gas, coal.

As this study is conducted in Pakistan, so few elements are necessary to bring light for elevation of Pakistan's economy. This study has analyzed that price effect is more than income on demand of oil in Pakistan so there must be some policies that helps the economy to come out from the increasing demand of oil that effect country's income.

References

Aaron, G. and S. Nabiyev. 2009. Oil price fluctuations and its effect on GDP growth: A case study of USA and Sweden. Bachelor Thesis within Economics. Jonkoping international business school. Jonkoping University.

Akram, M. 2011. Does Crude Oil Price Affect Economic Growth of India, Pakistan and Bangladesh? Economic D level Thesis. Hogskolan Dalarna.

Altinay, G. 2007. Short-run and long-run elasticities of import demand for crude oil in Turkey. Energy Policy.Vol 35: 5829–5835.

Alves, D. C. O. and R. L. S Bueno. 2003. Short-run, long-run and cross elasticities of gasoline demand in Brazil. Energy Economics.Vol 25. Pp 191–199.

De Vita, G., K. Endresen and L. C. Hunt. 2006. An empirical analysis of energy demand in Namibia. Energy Policy.Vol 34. Pp 3447–3463.

Dees, S., P. Karadeloglou, R. K. Kaufmann, M. Sanchez. 2007. Modelling the world oil market: assessment of a quarterly econometric model. Energy Policy.Vol35 :178–195.

Dickey, D. A. and W. A. Fuller. 1979. Distribution of the Estimation for Autoregressive Time Series with a Unit Root. Journal of the American Statistics Association.Vol 76(366): 427-431.

Difiglio, C. 2014. Oil, Economic Growth and Srategic Petroleum Stocks.U.S. Department of Energy. Energy Strategy Reviews. vol 5. pp 48-58.

Krichene, N. 2002. World crude oil and natural gas: a demand and supply model. Energy Economics.Vol 24. Pp 557–576.

Luft, G. 2006. The oil crises and its impact on the Air Cargo Industry.Institute for analysis of Global Security, Washington.

Mahmud, S. F. 2000. The energy demand in the manufacturing sector of Pakistan: some further results. Energy Economics.Vol 22. Pp 641–648.

Roubini, N. and B. Setser. 2004. The effect of the recent oil shocks on U.S and global economy.

Schryder, D. and G. Peersman. 2012. The U.S. Dollar Exchange Rate and the Demand for Oil. JEL Classification: C33, F31, Q41.

Yasmin, B and Z. Jehan.2006.Trade liberalization and Economic Development: Evidence from Pakistan. The Lahore Journal of economies: 19-34.

Ziramba, E. 2010. Price and income elasticities of crude oil import demand in South Africa: A cointegration analysis. Energy Policy.Vol 38(12): 7844-7849.