Analyzing Energy Demand in Transport Sector of Pakistan

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بسم الله الرحمن الرحيم

Allah will exalt in degree those of you who believe and those who have been granted knowledge.

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Dedicated to my

Beloved Father & Mother

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Abdul Hafeez

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LIST OF ABBREVIATIONS

AIDS	Almost Ideal Demand System
ARDL	Autoregressive Distributed Lag
ARIMA	Autoregressive Integrated Moving Average
CNG	Compressed Natural Gas
GCC	Gulf Cooperation Council
GoP	Government of Pakistan
GDP	Gross Domestic Product
HSD	High Speed Diesel
HSFO	High Sulphur Furnace Oil
KG	Kilogram
KM	Kilo Meter
LA-AIDS	Linear Approximation to Almost Ideal Demand System
LNG	Liquid Natural Gas
LPG	Liquefied Petroleum Gas
LRG	Liquefied Refinery Gases
MMcft	Million Cubic Feet
MMSCF	Million Standard Cubic Feet
NGL	Natural Gas Liquids
PAM	Partial Adjustment Model

Abstract:

Fuel demand in transport sector is not only the issue of developing countries but also the developed countries as well. Transport sector is one of the major users of petroleum products in Pakistan. The purpose/objective of the study is to calculate the price and income/expenditure elasticities of petroleum products demand in the transport sector of Pakistan: Petrol, Diesel and Compressed Natural Gas (CNG). We have used monthly data from July 2005 to June 2014 by applying LA-AIDS approach developed by Deaton and Muellbauer (1980a, b) to calculate the elasticities of fuel demand for Transport sector of Pakistan. All own-price elasticities are negative and significant at 5% level. The own-price elasticity of Petrol, Diesel and CNG are -0.62, -0.61 and -0.77, respectively. All cross price elasticities are positive which indicates that all fuels are substitutes of each other. Petrol is close substitutes with Diesel and CNG. The sign of expenditure elasticity for all fuels are positive which suggests that all fuels are placed in the category of normal goods.

Chapter 1

Introduction

In this chapter we are going to discuss the background of our study, Own Price, Cross Price and Income/Expenditure elasticites, Brief overview of Transport sector of Pakistan consumption of different types of petroleum products in Transport sector of Pakistan. At the end we have discussed the significance of study and our research objectives.

1.1 Background

Socioeconomic development of a country is dependent on the efficient transportation structure. An efficient transport system allied with modern infrastructure is an important economic factor for development of a country. The key means of transportation in Pakistan includes: roads and highways, railways, rivers, canals, seaports, and air transport etc. According to economic survey of Pakistan 2012-13, theTransport sector consumes approximately 90 percent of the imported petroleum products and their prices are continuously increases. The increasing trend in demand and price of Petroleum products has diverted the people's attention towards inter-fuel substitution. Therefore the conversion of vehicles to diesel fuel engine and compressed natural gas (CNG) engine is a common practice (Ahmed and

Kemal, 2001). But now-a-days due to shortage and unavailability of CNG, people are reverting to petroleum products again. For the review of price policies to control petroleum consumption, the important consideration is to analyze the responses of total fuel consumption to changes in fuel price and these policies can be analyzed by computing the price and expenditure elasticities of demand for petroleum products (Mehrara and Ahmadi, 2011).

There are many studies conducted around the world on analysis of Petroleum products. However, with the passage of time means and modes of transportation has increased which not only lead to increase the pollution only but the consumption of petroleum products specifically. This increase in oil consumption around the world has increased the interest of oil producing countries to forecast this consumption. Whereas, the countries relying heavily on petroleum products are also interested to assess their future consumption in order to maintain their balance of payment (Sterner & Dahl, 1992).

1.2 Price & Income Elasticities:

Price and income elasticities are provide basic information for forecasting and policy making. Short-term shock adjustment can be accessed via short-term elasticities, whereas, long-term shock adjustment can be accessed via long-run elasticities results.

Elasticity basically measures the fluctuation in quantity demand or quantity supply due to change in price. It has the following types;

1.2.1 Price elasticity of demand:

Response of quantity demand of goods to change in price is recognized as price elasticity of demand. It is the friction of percentage change in quantity demanded to percentage change in price.If the elasticity is less than 1, demand of that good is inelastic. If the elasticity is greater than 1, demand of the good is elastic.

1.2.2 Cross Price Elasticity of Demand

It is the response of quantity demanded of one good change as a change in the price of another good. It is the friction of percentage change in quantity demanded of good i to percentage change in price of good j. Cross price elasticity is positive or negative, it depends on the two goods that are substitutes or complements. Substitutes are goods that are used in place of one another. An increase in the price of good i encourages the people to use good j. Because the price of good i and the quantity demanded of good j moves in the same direction, in this scenario the cross-price elasticity is positive. On the other hand, compliments are those goods which are used together. The cross price elasticity is negative, which indicates that an increase in the price of good i reduce the quantity demanded for good j.

1.2.3 Income/Expenditure elasticity of demand:

Response of quantity demand of goods to change in income is attributed as income/expenditure elasticity of demand. It is the friction of percentage change in quantity demanded to percentage change in income.

Most of the goods are considered as normal goods. As income increases it will raises the quantity demanded of that good. The normal goods have positive income elasticities because quantity demanded and income moves in the same direction. Some goods are considered as inferior goods, when income increases, the quantity demanded will decreases. The inferior goods have negative income elasticities, because quantity demanded and income move in opposite direction. Income elasticities may vary among normal goods.Food and clothes fall in less income elastic category because consumer can't forgo goods and clothes for other items. Luxury items fall in high income elastic category where he can make compromise on its purchase. (Mankiew, 2004)

1.3 Transport Sector of Pakistan

Pakistan is blessed with matchless geographic premises having strength and challenges for its existence in the region. The connectivity of roads, coastal lines and air routes are blessed with the favorable climate. Pakistan offers the most effective, economical and viable transit routes during the year which is connected with Central Asian and other neighboring countries. According to World Bank report, the low performance of the transport sector is affecting GDP by 5%. Moreover due to limited/disorganized access from agricultural farms to markets, shortage of cold storage facilities and old transportation services, about thirty percent of agriculture output is wasted during transit. Government of Pakistan is committed to develop modern transport and logistics sector that will help in the development of our economy. Government of Pakistan have set the target to bring down the transportation cost, its safety and efficient link between rural and urban area's markets, link between provinces, roads network and connectivity with regional countries via road network of international standards. Landscape of Pakistan is consists of hilly mountain, agriculture lands and desert spread all around the country. These roads offer unproblematic and well-organized way of transportation. In Pakistan, roads network have essential importance for the movement of people and goods, it joins the country, helps in economic growth and decreasing poverty. There are approximately 263,775 kms of total roads network exist in Pakistan and out of which about 70 percent are cemented. This roads network is the backbone of the Pakistan's economy as it bears about 96 % of national goods transport and about 92 % of passenger transport across the country. Some details regarding road network in Pakistan is as follows; length of Pakistan National Highways and Motorways is 9,324 kms and 2,280 kms respectively. There are 262 kms of Strategic roads and 100 kms of Expressways are exists in Pakistan. The other roads network includes provincial highways and roads under respective provincial administration, Cantonment Boards, Municipal Corporations, Local Development Authorities, etc. Distribution of roads in provinces of Pakistan is as follows: Punjab 40.9%, Sindh 30.9%, Khyber Pakhtunkhwa 16.3%, Balochistan 11.3% and Azad Jammu & Kashmir 0.6%. (Pakistan Economic Survey 2013-14, 2014-15). Total length of roads since 1990-91 is reported in Table-1.1:

Table-1.1 Length of Roads

LENGTH OF ROADS (In Kilometers)			
Year	Total	High Type	Low Type
1990-91	170,823	86,839	83,984
1991-92	182,709	95,374	87,335
1992-93	189,321	99,083	90,238
1993-94	196,817	104,001	92,816
1994-95	207,645	111,307	96,338
1995-96	218,345	118,428	99,917
1996-97	229,595	126,117	103,478
1997-98	240,885	133,462	107,423
1998-99	247,484	137,352	110,132
1999-00	248,340	138,200	110,140
2000-01	249,972	144,652	105,320
2001-02	251,661	148,877	102,784
2002-03	252,168	153,225	98,943
2003-04	256,070	158,543	97,527
2004-05	258,214	162,841	95,373
2005-06	259,021	167,530	91,491
2006-07	259,189	172,827	86,362
2007-08	258,350	174,320	84,030
2008-09	258,350	176,589	81,761
2009-10	260,760	180,910	79,850
2010-11	259,463	180,866	78,597
2011-12	261,595	181,940	79,655
2012-13	263,415	182,900	80,515
2013-14	263,755	184,120	79,635
2014-15	263,942	185,063	78,879

Source: National Transport Research Center

Total Number of Registered Motor Vehicles since 2005 is reported in Table-1.2 below:

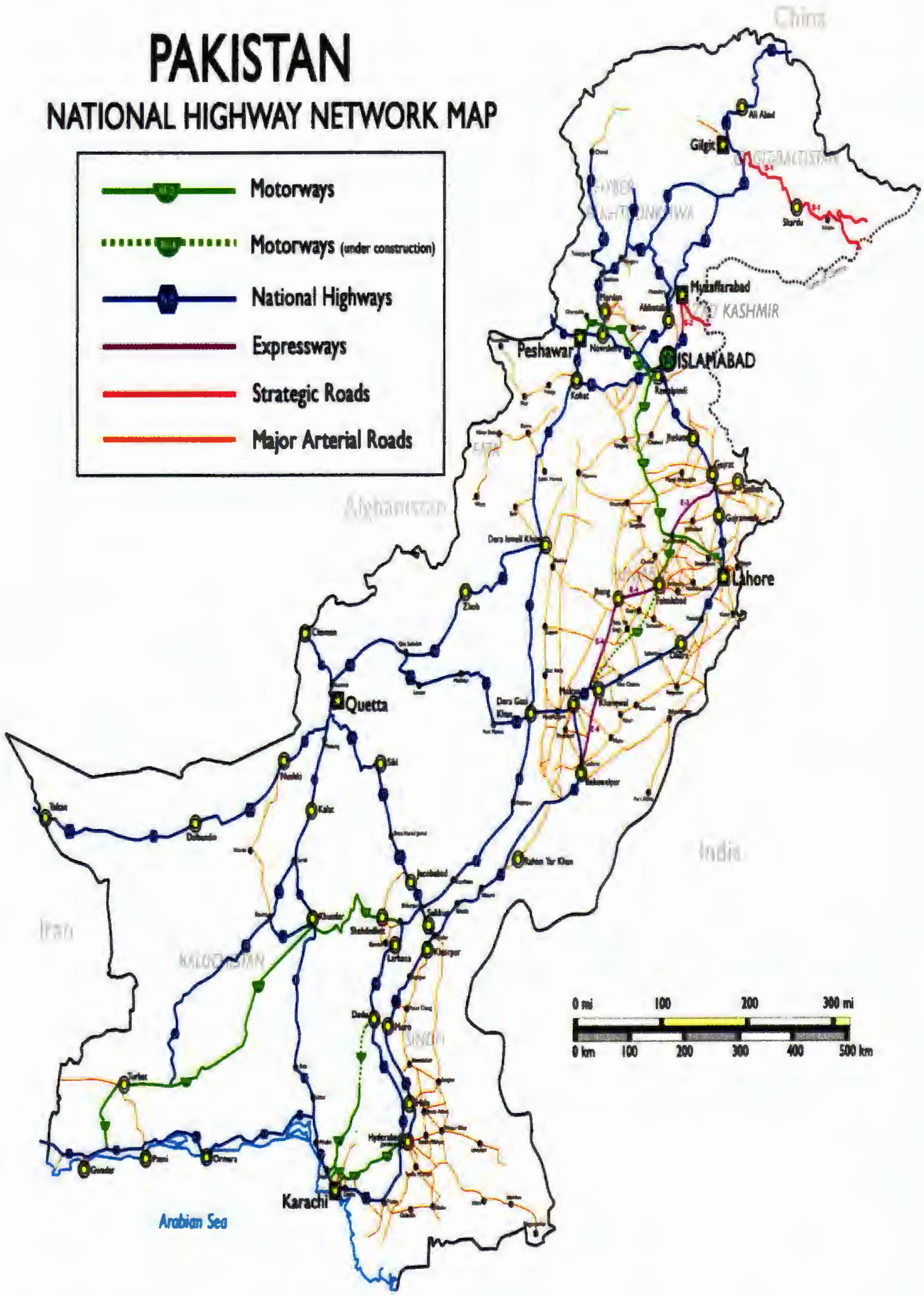
Table-1.2 Number of Registered Motor Vehicles

Number of Registered Motor Vehicles								
								(In 000 Nos.)
Year	**Motor Cars, jeeps & station wagons**	**Motor Cabs/ taxis**	**Buses**	**Trucks**	**Motor Cycles 2 Wheels**	**Motor Cycles/ Motor Rickshaws 3 Wheels**	**Others**	**Total**
2005	1318.5	91.9	168.7	182.5	2649.9	101.1	861.9	5374.5
2006	1372.2	105.4	175.6	190.0	2757.8	136.4	896.0	5633.4
2007	1440.8	103.4	184.4	199.4	2895.7	143.2	940.9	5907.8
2008	1549.9	104.4	187.4	202.6	3039.8	156.1	961.6	6201.8
2009	1657.9	106.5	195.2	210.9	3215.6	167.9	1005.4	6559.4
2010	1726.3	122.9	198.8	216.1	4305.1	201.8	1081.9	7852.9
2011	1881.6	124.7	202.5	225.1	5781.9	266.4	1178.9	9661.1
2012	2094.3	143.9	215.4	240.9	7500.1	323.2	1270.8	11788.6
2013	2281.1	145.2	220.3	247.2	9064.5	378.0	1334.3	13670.6
2014	2400.7	145.4	223.6	251.3	10341.3	429.3	1376.4	15168.0

Source: Economic Survey of Pakistan 2014-15

From the above table, we can see that large numbers of vehicles are registered since 2005 and these numbers are increasing from year to year resulting the increase in the use of petroleum products.

Figure-1.1 Road Map of Pakistan



Source: www.mapsofworld.com/pakistan/road-map.html

Transport sector is one of the major users of petroleum products. Due to massive local demand for oil, every year a huge quantity of crude oil is imported. During fiscal year 2012 the imports was 47,104 thousand barrels of crude oil, whereas the total production by oil companies in Pakistan is 24,573 thousand barrels of crude oil. On the other hand, 11, 507 thousand tonnes were imported while 8,395 thousand tonnes of petroleum were produced by oil companies in Pakistan. In 2012 import bill of petroleum products is US $ 10,292 million. This import bill includes three types of petroleum products, High Sulphur Furnace Oil (HSFO) having share of 48%, High Speed Diesel (HSD) having share of 32% and Petrol (Motor Spirit) having share of 16% percent. HSFO is imported from UAE, Saudi Arabia and Kuwait. HSD is imported from Kuwait. On the other hand, Petrol is imported from UAE, Oman and France in the sharing ratio of 72%, 12% and 10% respectively.

Since 2001-2002, there is decreasing trend in consumption of petroleum products which suggests that there is shift in composition of annual energy consumption from petroleum products to other energy sources due to volatile oil prices. Since FY-2003, there is 27% increase in oil import bill every year. In FY-2011, the oil bill was US$12 billion. During FY 2012 the import bill of the petroleum products raised to US $ 15.2 billion. We can say that the total quantity of 19.2 million metric tons of Petroleum products was imported. Moreover, between July-2012 to March-2013, the import of petroleum products is decreased. The main reason of this decline is due to fall of prices of petroleum products internationally and also decline in consumption of petroleum products in the country. The share of petroleum products in total energy consumption is shown in Table-1.3.

In FY2013, usage of oil in transport sector is stagnant. The main reason is that most of the transport has used oil and there is negligible shift towards CNG while use of oil in household declined which showed that the households has used more CNG in transport as compared to Oil.

Table-1.3 Supply and Consumption of Oil / Petroleum Products

Fiscal Year	Supplies (Growth Rates %)				Consumption	
	Oil		Petroleum Products		Oil/Petroleum Products	
	Crude	Local	Imports	Production	Total	Transport
2001-02	-1.00	10.01	-10.03	8.29	-3.90	47.28
2002-03	1.02	1.13	-6.49	0.62	-3.00	49.13
2003-04	9.88	-3.55	-38.72	7.22	-18.42	63.07
2004-05	6.00	6.60	9.79	7.54	9.31	61.51
2005-06	3.90	-0.76	5.87	0.23	-0.30	55.77
2006-07	-4.49	2.84	38.63	-1.75	15.18	47.38
2007-08	6.95	4.01	8.34	4.27	7.32	51.90
2008-09	-4.31	-6.13	10.52	-8.61	-0.94	49.34
2009-10	-14.54	-1.36	12.07	-8.47	6.81	46.32
2010-11	-3.34	1.41	10.67	-0.94	-1.28	47.08
2011-12	-8.19	2.21	-6.98	-5.79	-1.10	49.61
2012-13					-10.04	49.57

Source: Economic Survey of Pakistan 2012-13

During the last few years, CNG Industry has experienced remarkable growth. Pakistan is one of the top CNG user country of the world about3 million CNG Vehicles running across the country and more than 3,395 CNG stations are operational in the country. The reason is that the price of CNG is comparatively less than petrol & diesel price.

The consumption of gas by transport sector since 2001-02 is presented in Table-1.4;

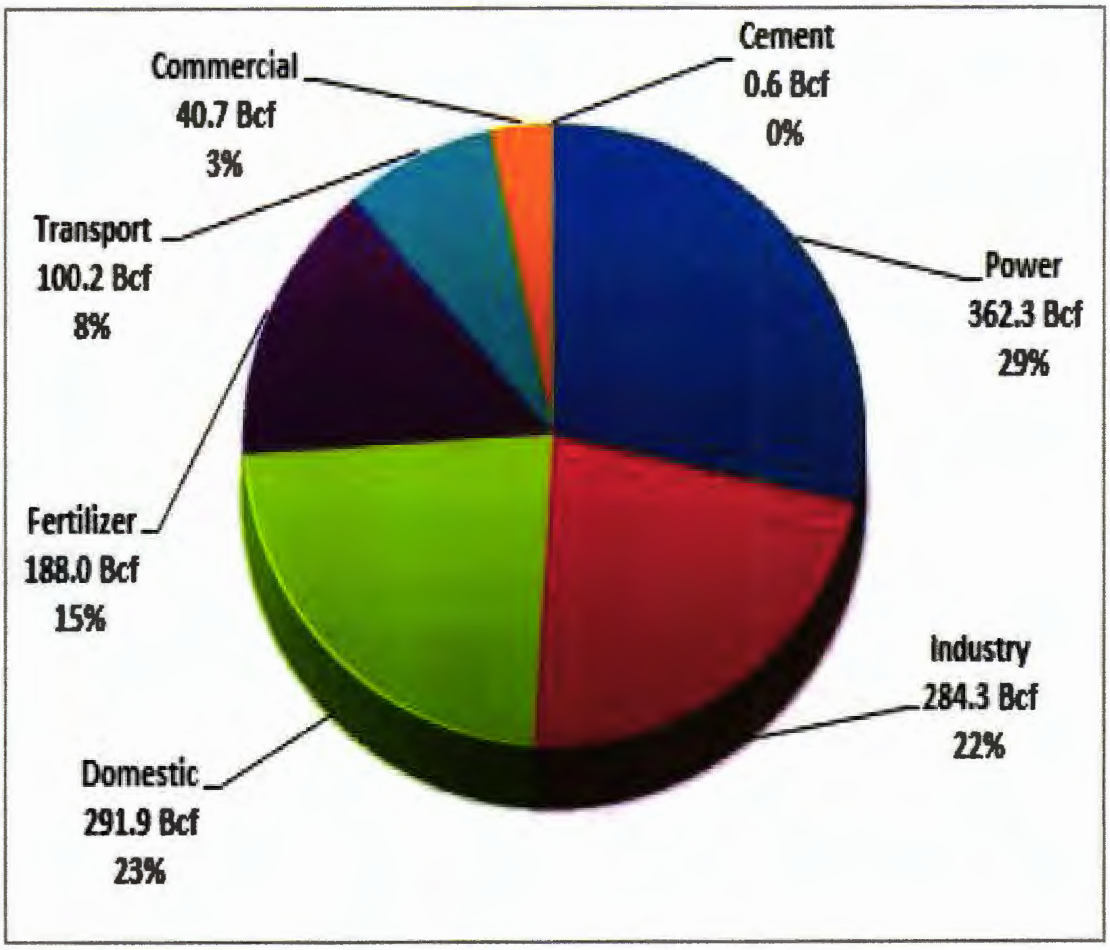
Table-1.4: Consumption CNG in Transport Sector Shares and Growth rates

Fiscal Year	Share (%)	Growth (%)
2001-02	0.9	66.6
2002-03	1.3	53.6
2003-04	1.5	40.1
2004-05	2.1	54.1
2005-06	3.2	59.1
2006-07	4.6	45.2
2007-08	5.6	27.6
2008-09	7.0	22.5
2009-10	7.7	12.2
2010-11	9.1	14.2
2011-12	9.2	5.3
2012-13	8.2	-16.12
2013-14	7.0	

Source: Economic Survey of Pakistan 2012-13 & 2013-14

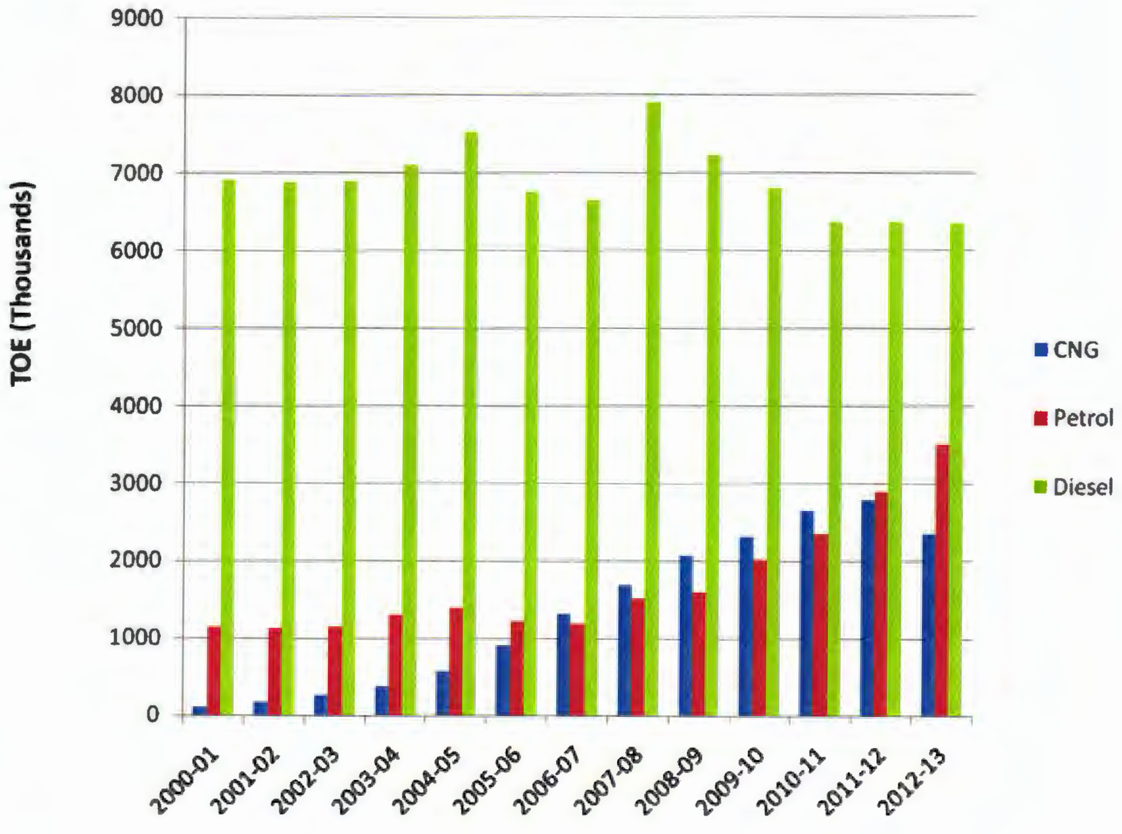
During 2011-12, transport sector has showed positive growth in gas consumption by about 5.3 percent. However, there was a negative growth of 16 percent has been reported in transport sector during 9 months (July2012 to March 2013). At the end of FY-2013, use of CNG as a fuel increased in transport as fuel, but due to shortage of gas supply the Govt. has agreed for supply of CNG on alternate days/hours which reduced the share of gas consumption in transport sector (Pakistan Energy Year Book 2012-2013& Pakistan Economic Survey 2012-13, 2013-14).

Figure-1.2 Sector wise Gas Consumption FY 2013



Source: Energy Year Book 2013

Figure- 1.3 CNG, Petrol & Diesel Consumption 2000-01 to 2012-13



Soruce: Ministry of Petroleum and Natural Resources, GoP

On the basis of above discussion, we can conclude that Transport sector is one of the major users of petroleum products. Because of huge oil demand, a large quantity of crude oil is imported every year results in increase of extra burden on the import's bill of the country. During FY 2012-13 19.2 million metric tons of petroleum products were imported and an amount US $ 15.2 billion was paid in shape of import bill of petroleum products. Due to declining prices of petroleum products around the world during July-2012 to March-201, 0.53 percent negative growth was witnessed in imports of petroleum products. On the other hand there is positive growth in transport sector is witnessed in respect of gas consumption from 2001-02 to 2005-06 but it was decreased to 5.3 percent in year 2011-12 due to shortage and load management in gas sector. During July 2012 to March 2013 this growth is further decreased and becomes negative 16 % due to shortage of gas supply to transport sector.

1.4 Significance of the Study:

The researchers have used different techniques to estimate fuel demand around the world and for Pakistan few studies have been conducted to drive food demand as well as fuel demand by using annual data. There is no other study attempts to estimate fuel demand elasticities separately for transport sector of Pakistan before this study by using most recent monthly data. As we know that in Pakistan prices of fuels products are changed on monthly basis or in past these prices were changed two or three times during a single month which have put some extra effect on consumption of petroleum products. We are using monthly data from July-2005 to June-2014, in order to capture these rapid changes takes place during this time period due to changes in price of petroleum products.

1.5 Research Question

Research question for our study is as follows;

What are the price and income/expenditure elasticities of demand for petroleum products used in the transport sector of Pakistan?

1.6 Hypothesis of the study

To answer the above question we have derive following Hypothesis for our study:

Own Price Elasticities

Ho: Own Price Elasticites for all fuels used in Transport sector are Negative

H1: Own Price Elasticites for all fuels used in Transport sector are Positive

Cross Price Elasticities

Ho: Cross Price Elasticites for all fuels used in Transport sector are Positive

H1: Cross Price Elasticities for all fuels used in Transport sector are Negative

Income/Expenditure Elasticities

Ho: Income/Expenditure Elasticites for all fuels used in Transport sector are Positive

H1: Income/Expenditure Elasticites for all fuels used in Transport sector are Negative

1.7 Objectives of the Study

To address the above research question and hypothesis, we have used Linear Approximation to Almost Ideal Demand System (LA-AIDS)[1] model in this study to trace out the price and income elasticities of petrol, diesel and CNG by using monthly data, from July 2005 to June 2014. The data used in this study is limited to the petroleum products used in roads transport only. Petroleum products used in the residue of the modes of transportations are not included in this study. LA-AIDS model is robust in nature and parsimonious considering the number of parameters. Furthermore, LA-AIDS model output are in linear form which can further used in estimating and testing procedure of econometric methods. Similarly LA-AIDS model parameters can also be used for estimating uncompensated price and expenditure elasticities (Mehrara and Ahmadi, 2011). This study helps to improve consumer behavior in Pakistan towards petroleum products utilization in transport sector.

This study is organized as follows. After introduction, the review of studies is provided in chapter 2. The econometric methodologies, data and its sources are discussed in chapter 3. Estimation and results are discussed in chapter 4. Conclusion and Policy recommendations are discussed in chapter 5.

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[1] Deaton and Muellbauer (1980),

Chapter 2

The Review of Literature

Fuel demand in transport sector is not only the issue of developing countries but also the developed countries as well. Colossal research has been conducted around the world on this issue. To estimate fuel demand, researchers have used different econometrics techniques on monthly, quarterly and on yearly data to address the issues. We have addressed some of the studies in our research work.

2.1 Studies used Almost Ideal Demand System (AIDS) & Linear Approximation to Almost Ideal Demand System (LA-AIDS) approach

Almost Ideal Demand System (AIDS) model has been applied in most of the existing studies to derive demand for different products such as Mehrara and Ahmadi (2011) has used the Linear Approximation to Almost Ideal Demand System (LA-AIDS) to estimate the price and income elasticities for the fuel used in the transport sector of Iran. They have used data of gasoline, automotive gas oil and Liquefied Petroleum Gas (LPG) for the years 1997-2008. Results of their study showed that all own-price elasticities are negative and significant at the 5% level. The own-price elasticity for gas oil, gasoline and LPG were -0.22, -1.01 and -3.58, respectively. The resultscategorized the gasoline and gas oil as normal goods and LPG as inferior good.Moreover, Iootty et al. (2009) investigated the demand for transport fuels in Brazil for the period 1970-2005. They have used LA-AIDS model to estimate the price and income elasticities for gasoline, compressed natural gas (CNG), ethanol and diesel. They have estimated the price and income elasticities by using seemingly unrelated regression and vector error correction model. The results of the study showed that the ethanoland CNG are substitutes with gasoline. Their study further showed that gasoline, ethanol and diesel isfalls under normal goods category. Gasoline, ethanol and diesel are expenditure elastic. CNG is estimated as an inferior good.However, Gebreegziabher et al. (2010) conducted a study in which they considered fuels such as Wood, Dung, Charcoal, Kerosene and Electricity. They have used a dataset of 350 urban households in Tigrai city of northern Ethiopia. They have estimated own price, price ofrelated good and household income/expenditure elasticities by applying an almost-ideal demand system. The results for price elasticities showed thatthe firewood, charcoal and kerosene are price inelastic and their own price elasticity is less than one. Price Elasticity of electricity demand is negative. On the other hand, Income elasticities for all the fuel goods are positive, which suggests that no fuel is considered as inferior goods.For Spain Oladosu (2003) used the Almost Ideal Demand System (AIDS) to derive vehicle-fuel allocation in multi-vehicle households. He has used surveys data collected in years 1988, 1991, and 1994. The results of this study show that Own-price elasticities for all vehicles are close to 1. Similarly, Labandeira et al. (2006), conducted a study by using modified form of the AIDS model i.e. Quadratic-AIDS. They have estimated price and income elasticities of household energy goods by using Spanish household expenditure surveys for the years 1973 to 1995. The finding depicted that the price elasticity of car fuels ranged between -0.11 and -0.058, while income elasticity was between 1.36 and 1.79. On the other hand, in another study conducted by Labeaga and Lopez Nicolas (1997) a flexible Almost Ideal Demand System (AIDS) is used to derive price and income elasticities for gasoline for Span. They used Spanish panel data and found that the price and income elasticities for gasoline are -0.536 and 0.429 respectively.Similarly Curtis and Stanley (2015) have analyses the residential energy demand system by using variants Almost Ideal Demand System model for Ireland. They have used annual data from 1970 to 2013 to trace out the demand for solid fuels, oil, gas and electricity with the aim to derive long run price and expenditure elasticities. The results of the study showed thatall own price elasticities for fuels are negative and lies between -0.05 and -0.23.The cross-price elasticity for solidfuels as there is change in the prices of gas and electricity are 0.2 and 0.3 respectively. The results further revealed that the residential energy products are price inelastic. The demand for Oil and gas are most responsive to price changes. On the other hand solid fuels and electricity are not responsive to price changes. Also the solid fuels are substitute for gas and electricity.

On the other hand, some authors have estimated elasticities by using AIDS approach on different commodities such as Ezedinma et al. (2006) have used AIDS model in their study, which is based on micro level data on urban household food consumption and expenditure for the year 1999 and 2000 in three Nigerian cities. They have used the data of different types of meat and meat products,such as beef, mutton/goat, chicken, fish, eggs, and milk. The results of their study point out that urban demand for meat products will continue to increase as income rises.However, Hui-Shung (Christie) et al. (2002) have used non-linear Almost Ideal Demand System modelto ascertain the competitive position of Australian cotton in the Japan's cotton market. They have used the data of valuesand volumes of cotton imports to Japan from the major cotton suppliers, theUSA, Australia, and all others countries during the years from 1972 to 1998. They found that the USA had a strongmarket position in Japan's cotton market and Australia needs to improve its cost competitiveness andquality in order to establish its position in Japan's cotton market. Moreover, Hwang (2000) predicted demand elasticities for meat products for Taiwan. For this purpose he used data ranging from 1970-1998 and LA-AIDS model as econometric methodology. From the results he concluded that poultry, meat and seafood are price inelastic. Similar study was made by Ahmet & Mehmet (2009) for Turkey in which they estimated price elasticity of twelve product groups by using AIDS. To establish conclusive outcome they used twelve month price index data. On the basis of the deduced results they concluded price elasticities were in line with AIDS model parameter results. For Pakistan, Ahmed et al. (2013) estimated demand system for six composite goods; food, tobacco and beverages,textile and footwear, transport and communication, rent and housing, fuel and lighting and miscellaneous using Almost Ideal Demand System. They also analyzed the welfare implications of tax reforms that replace the existing tax structureby uniform taxes on all goods. They used pooled time series and cross sectional data for the years 1984-2008, taken from theHousehold Integrated Economic Survey (HIES). The results of the study showed that the estimated demand system met all the theoretical restrictions. The results further elaborated that all the expenditure elasticities are positive and all theown-price elasticities are negative with reasonable magnitudes. All the six composite goods have negative own-priceuncompensated elasticities measured around the mean. Similarly, Mdafri & Brorsen (1993) estimated the demand for poultry and fishery products for the region of Morocco. For this purpose they incorporated AIDS model and annual data ranging from 1969 to 1985. From the results they found that poultry and beef products are elastic. On the basis of the econometric results they deduced that beef and fish can be considered as normal goods whereas, mutton as luxury good. They results also showed that people prefer mutton over other meat products.

2.2 Studies Used Other Techniques

There are number of other studies on estimating price and income elasticities of fuels demand around the world by using other techniques; For Australia, Samimi (1995) did a study for Australia in which he assessed the impact of price and income on fuel demand for road transport. For this purpose he used co-integration and error correction technique. On the basis of the econometric results he found that income elasticity in short-run is about 0.25 whereas, for long it was 0.52. Moreover, they found that price elasticity is about -0.12. Similarly, Eltony and Al-Mutairi (1995) estimated petrol demand for Kuwait. For this purpose they used co-integration technique and error correction model. They incorporated petrol per capita consumption in their model, petrol price and per capita income of the people. Their data was ranging from 1970 to 1989. From the results they deduced that income is having significant effect on petrol demand as compared to price effect. They found that in short-run price elasticity is -0.37 whereas, in long-run this effect is -0.46. From the results they also found that short-run and long-run income elasticity is 0.47 and 0.92 respectively. Similarly, Al-faris (1997) made a study for six Gulf Cooperation Council (GCC) countries. In this study he used partial adjustment model to assess the demand for oil and oil products. He used time series data of annual basis ranging from 1970 to 1991. On the basis of the results he concluded that in short-run price and income effects are inelastic. According to him short-run and long-run elasticities of fuel price is 0.14 and 0.13 respectively for all the six GCC countries. To check the transport fuel demand for Taiwan and Korea a study was made by Banaszak et al. (1999). They used partial adjustment model (PAM) and for this purpose they used yearly data ranging from 1973 to 1992. On the basis of the results they found that in short-run fuel demand price is inelastic. Akhani (1999) did a study to estimate the fuel demand for roads, railways and air ways. For this purpose he used Ordinary Least Square method. He incorporated annual data ranging from 1974 to 1995. On the basis of the results he concluded that income and price elasticities are relatively low for gasoline, whereas, income elasticity for diesel was higher. Ramanathan (1999) did a study for India in which he used co-integration and error correction model as econometric technique. He was interested to check the relationship among petrol consumption, petrol prices and GDP. For this purpose he used data ranging from 1972 to 1993. On the basis of the results he found that in short-run and in long-run income elasticity is 1.18 and 2.68 respectively. According to him income effect is significant than price effect. He also found from the results that petrol demand is price inelastic because of low gasoline consumption and steady economic growth in India. Similarly Cheung and Thomson (2004) made a study for China. They were intending to find the income elasticities of gasoline demand. For this purpose they used annual data ranging from 1997 to 2008. From the results they found that price elasticities of gasoline lies between -0.497 and -0.196. They also found that income elasticities of gasoline lies between 1.01 and 1.05.

However Eidger and Akar (2007) did a simulation study for 2005 to 2020. Their area of investigation was Turkey. For this purpose they used historical data ranging from 1950 to 2004 and incorporated ARIMA and seasonal ARIMA as methodologies. Their simulation study result shows that energy demand of Turkey will increase from 2005 to 2020. They also concluded on the basis of their findings that fossil fuels would play a crucial role in economic growth of the country. However, Zheng et al. (2008) made a study for Australia. They used quarterly time series data of petrol consumption in their study. Their data was ranging from 1977 to 2006 on the basis of the historical data they did simulation study to assess the petrol demand for automobile sector in Australia from 2007 to 2020. For this purpose they used a set of different models e.g. single exponential smoothing model, liner trend model, exponential trend model and quadratic trend model, Holt's liner model, ARIMA model etc. Their study provided an analysis of future demand of oil products in Australia. A similar study was made by Breunig and Murphy (2007) for Australia. They also want to check the impact of prices on Australia's petrol demand. On the basis of the results they found that in short-run demand of oil product would not affect due to a small decrease in oil prices. However, in long-run they found a symmetrical increase and decrease of oil demand response to price. Zaman et al. (2011) made a study for Pakistan. They used error correction model and granger causality test. In this study they examined the impact of oil consumption in all sectors and their effect on economic growth during the period 1972 to 2008. For this purpose they incorporated time series techniques. From the results they found that transport, industry and power generation sectors are major oil consumer whereas, these sectors's contribution in economic growth is also significant. However, in this regard economic growth contribution of government, household and agricultural sector is insignificant.Boshoff (2011) did a study for South Africa in which he tried to investigate the price and income elasticities of petroleum products. For this purpose he used Autoregressive Distributed Lag (ARDL) model. He used two quarterly data sets, one data set ranging from 1982 to 2010 and other data set ranging from 1998 to 2010. From the results they found that long-run price and income elasticities are -0.44 and 0.67 for data set one. However for data set two short-run price and income elasticities are -0.59 and 0.82 respectively. He also concluded that gasoline demand is more price and income sensitive. Tanghavee and Hajiani (2014) did a study for Iran. Purpose of their study was to find out the price and income elasticities of Petroleum products. For this purpose they incorporated error correction model (ECM) and static & dynamic models. They used the data from 1976 to 2010. On the basis of the results they deduced that short run price elasticity was -0.1538 whereas, income elasticity was 0.2273. They also found that in intermediate run price elasticity was -0.1618 and income elasticity was 0.4636. Whereas their long-run results depicted -0.3612 price elasticity and 0.7284 as income elasticity.Lin and Lea (2013) did a study for USA.

They used monthly data ranging from 1990 to 2012. Basic purpose of their study was to investigate the impact of change in gasoline price on consumer's price elasticity of gasoline demand. On the basis of the results they found that consumers would be less elastic if volatility of gasoline prices is medium or high. They also deduced from their results that increased volatility prices would decrease the consumer's demand for gasoline at intermediate run. Moreover, they found that increased volatility of gasoline prices would lessen consumer response to change in prices of gasoline. Sterner and Dahl, (1992) did a study in which they employed partial adjustment model (PAM) to estimate elasticities and forecasting petroleum products for transport sector. Reason for using PAM is that it completely responds to any shock. They used OECD data ranging from 1960 to 1985. On the basis of their results they concluded that in short-run income elasticity were in between 0.15 to 0.55 whereas, price elasticity was in between -0.1 to -0.3.Similarly Birol and Guerer (1993) also employed PAM model to assess the fuel demand which comprised of diesel and petrol. They made their study for six developing countries. They employed historic data ranging from 1971 to 1990. They considered three different scenarios. In first scenario they considered low price of fuel and high GDP growth, in second scenario they took base price of oil and GDP growth, whereas in third scenario they considered high fuel prices and low GDP growth. On the basis of their results they found that under all the scenarios fuel consumption would increase significantly. Similarly for Indonesia, Suleiman (2009) have used annual time series data from 1973 to 2007 by incorporating the structural time series model (STSM) and unrestricted error correction model (UECM) to derive gasoline and diesel demand for the transportation sector of Indonesia and make a forecast of per capita consumption of the total products up to year 2030. The results from both models showed that the demand for petroleum products is price inelastic.The estimated long-run price elasticity is - 0.19 in the STSM and is - 0.16 in the UECM. However, long-run income elasticity is 0.97 when using the STSM and is 0.88 under the UECM which showed that in the long run the total petroleum products are income elastic.

In the light of above literature review, we conclude that the researcher have used different techniques to estimate fuel demand around the world and for Pakistan few studies have been conducted to drive food demand as well as fuel demand by using annual data. There is no other study attempts to estimate fuel demand elasticities separately for transport sector of Pakistan before this study by using most recent monthly data. As we know that in Pakistan prices of fuels products are changed on monthly basis or in past these prices were changed two or three times during a single month which have put some extra effect on consumption of petroleum products. We are using monthly data from July-2005 to June-2014, in order to capture these rapid changes takes place during this time period due to changes in price of petroleum products.

Chapter 3

Data, Variables and Econometric Methodologies

In this chapter we have discussed the data used in our study, rang of the data, source of the data, description of variables and econometric methodologies used to estimate the results.

3.1 Data:

Annual data do not provide the actual position that what happened during that year as in Pakistan Petroleum Prices is changing during a year for many times. We will use monthly data in order to capture those rapid changes during a year. In this study, monthly data from July 2005 to June 2014 is used to estimate demand elasticities of three major petroleum products used in the transport sector of Pakistan. For this purpose, time series data on the consumption share of petrol, diesel and CNG and their prices is used in this analysis. The relevant data on all variables is taken from Pakistan Energy Year Book (2005 to 2013), Monthly Statistical Bulletin issued by Pakistan Bureau of Statistics (2005 to 2014), Directorate General of Oil&Directorate General of Gas under Ministry of Petroleum & Natural Resources Government of Pakistan Islamabad.

3.2 Variables:

Following variables are used in this study;

Compressed Natural Gas (CNG):

Compressed natural gas (CNG) isan alternate to Petrol (gasoline), Diesel and LPG. It is safer than other fuels, because natural gas is lighter than air and dissolves quickly when released. In Pakistan CNG is sold in Rs/KG. The unit for CNG is MMSCF.

Petrol (Gasoline):

Petrol (Gasoline) is available in liquid form and mostly used in light transport like Cars, Vans and Motor cycle etc. In Pakistan Petrol is sold in Rs/liters. The unit for petrol is Million tons.

Diesel:

Diesel is mostly used in diesel engines and in heavy transport like Buses, Trucks, long vehicles etc. In Pakistan Diesel is sold in Rs/liters. The unit for petrol is Million tons.

The descriptive statistics of the series used in this analysis, i.e. the natural log of the prices and the consumption share of Petrol, Diesel, and CNG are reported in table-3.1;

Table-3.1: Descriptive Statistics

Variables	Mean	Median	Maximum	Minimum	Std. Error
LOG(Petrol Price)	1.863	1.838	2.054	1.69	0.114
LOG(Diesel Price)	1.819	1.842	2.280	1.502	0.193
LOG(CNG Price)	1.69	1.71	1.96	1.453	0.144
Cons Of Petrol	2.215	2.225	2.585	1.90	0.187
Cons Of Diesel	2.777	2.781	2.951	2.579	0.072
Cons of CNG	3.824	3.884	4.0346	3.416	0.159

Source: Author's construction, Petrol (Million Tons), Diesel (Million tons), CNG (MMSCF)

The table 3.1 shows that during the period 2005 to 2014, the mean value of CNG is 3.824 which indicated that during this time period, the consumption of CNG is more than other fuels i.e. Petrol and Diesel as their mean values are 2.215 and 2.277 respectively which shows clear dependence of transport sector on CNG due to its cheaper price.

3.3 Econometric Methodologies

We are using the following econometric methodologies for our analysis.

3.3.1 Unit Root Test

First we check stationarity of data used in our study. Stationary data have the property of uncorrelated error term and have constant variance. In the absence of this property data is considered to be unit root. To make it stationary we perform unit root test.

In time series analysis unit root test has widely been used to check the stationarity of the data. For this purpose numbers of unit root tests have been introduced in econometric literature like Phillip-Perron (PP) unit root test, Dickey Fuller (DF) GLS test, Augmented Dickey Fuller (ADF) test, Ng Perron test etc.

We are using Augmented Dickey Fuller and Phillips-Perron unit root testing approaches for our study. ADF test was established by Dickey & Fuller. The general form of the test is as follows:

$$\Delta Yt = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha_i \sum_{t=1}^{m} \Delta Y_{t-i} + \varepsilon_t \quad (3.1)$$

ε is error term whereas, Δ is difference operator.

$$\Delta Y_{t-1} = (Y_{t-1} - Y_{t-2}), \qquad \Delta Y_{t-2} = (Y_{t-2} - Y_{t-3})$$

The null hypothesis in this regard is $\delta = 0$ for unit root and $\delta < 0$ for stationarity. The calculated values of δ are checked with τ critical values from Fuller's table. If the calculated value is less than critical value then variable is said to be stationary or otherwise (Gujrati 2003).

The other unit root test we are using for our study is Phillips-Perron (PP) unit root test. This test was developed by Phillips and Perron during 1984. PP test is non-parametric in nature. As compared to ADF test, PP test ignores any serial correlation in the test regression. General form of the PP test is as follows:

$$\Delta Y_t = \alpha_1 t + \theta Y_{t-1} + u_t \quad (3.2)$$

Where u_t is I(0) and may be heteroskedastic. The null hypothesis in this case is that θ=0. The PP tests correct for any serial correlation and heteroskedasticity in the errors u_t of the test regression by directly modifying the test statistics.

The Phillips-Perron (PP) unit root tests differ from the ADF tests in a way that how PP unit root tests deals with serial correlation and heteroskedasticity in the errors terms. Beside this PP test is independent of lag length selection (Virmani, 2004).

3.3.2 Johansen Cointegration Test:

Johansen cointegration test is applied to check the cointegration between the series. This test provides two different statistics i.e. the Maximum Eigen value and the Trace statistic. These statistics showed the number of hypothesized cointegrating equations for the variables used in analysis. When estimated value the Maximum Eigen value and the Trace statistic is greater than its tabulated value, we reject the hypothesis of No cointegration at 1%, 5% or 10%. Then we could say that there are at least one cointegrating relations between the variables.

3.3.3 Theoretical Background of the Linear Approximation of the Almost Ideal Demand System (LA-AIDS)

We will calculate the fuel demand elasticities for Transport Sector of Pakistan by using Linear Approximation of the Almost Ideal Demand System (LA-AIDS) model developed by Deaton and Muellbauer (1980a, b).

During last 20/30 years, there was shift in consumer demand analysis towards system approaches. These demand system are comprises of several algebraic expressions such as the linear and quadratic expenditure systems, the Working model, the Rotterdam model, Translog models and the Almost Ideal Demand System (AIDS) are used. But the AIDS and Rotterdam models have got more attention of researchers to estimate the demand analysis. The AIDS, developed by Angus Deaton and John

Muellbauer in the late 1970s was the step forward in demand system analysis. Alston and Chalfant (1993) point out that, since the AIDS was introduced, it was mostlyused by agricultural economists, but now it is the popular system than allother demand systems.

Many authors[2] have given following reasons that differs the AIDS model from other models;

i. It is simple to estimate and interpret.

ii. It satisfies the axioms of choice.

iii. It is obtain from a particular cost function and also match with a preference structure, which is suitable for welfare analysis.

iv. Homogeneity and symmetry restrictions are easily tested or imposed.

v. This model provides an arbitrary first-order approximation to any demand system.

Therefore this technique is more feasible to estimate as compared to other systems.

3.3.3.1 Theoretical background of AIDS model

According toDeaton and Meulbauer (1980), the general form of AIDS model can be written as:

$$W_{it} = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_{jt} + \beta_i ln\left(\frac{X_t}{P_t}\right) + \mu_{it} \quad i=1.....n \qquad (3.3)$$

Where W_{it} is the budget/expenditure share of ith good,

[2]Deaton and Muellbauer (1980), Alston and Chalfant (1993), Eales and Unnevehr (1994), Glewwe (2001), Buse (1994)

P_{jt} is the nominal price of the j[th] good,

$\ln X_t$ is total expenditure

μ_{it} is the error term s

$\ln P_t$ is the translog price index and defined by

$$\ln P_t = \alpha_0 + \sum_{k=1}^{n} \alpha_k \ln p_{kt} + \frac{1}{2}\sum_{j=1}^{n}\sum_{k=1}^{n} \gamma_{jk} \ln p_{jt} \ln p_{kt} \qquad t=1.....t \qquad (3.4)$$

In the above equation j and k are variables. This price index made the system non-linear, resulting in complicated estimation process. To avoid this issue, Deaton and Muellbauer (1980) suggested Stones's Price Index.

3.3.3.2 Linearization of AIDS

As described above, the main difference between the AIDS and LA-AIDS is specification of the price index. Many authors have examined the relationship between linear and nonlinear specifications of AIDS. In these studies, Monte Carlo analysis was used to show that the use of differential functional forms of the index in the LA-AIDS givesthe results that can be compare with the AIDS model (Asche and Wessels, 1997).

Deaton and Meulbauer (1980) have suggested the Stone's (1953) price index that replaced the translog price index. It is defined as:

$$\log P = \sum_{i=1}^{n} w_{i,t} \log p_{i,t} \qquad (3.5)$$

Where, $w_{i,t}$ is the share of expenditure on good ***i*** in time period ***t***.

Eales and Unnevehr (1988) identified a simultaneity problem while substituting Stone's price index in place of translog price index and found that w_{it}which is used as dependent variable in LA-AIDS equation. They suggested to use the lagged share ($w_{i,t-1}$) for Equation 3.5.

Replacement of equation 3.5 with the lagged shares into Equation 3.4gives the LA-AIDS model as:

$$w_{it} = \alpha_i + \sum_{j}^{n} \gamma_{ij} \ln P_{jt} + \beta_i (LnX - \sum_{t=1}^{n} w_{i,t-1} \log p_{i,t}) + \mu_{i,t} \ldots\ldots\ldots\ldots\ldots\ldots(3.6)$$

Equation 3.6 can be applied to the empirical data to calculate the required elasticities.

3.3.3.3 Price and Expenditure Elasticities

Price and Expenditure elasticities can be calculated by using the Equations 3.7 and 3.8 respectively[3]:

$$e_{i,t} = e_{it} + \overline{w} + \widehat{\beta}\left(\frac{\overline{w}_j}{\overline{w}_t}\right) = -\delta + \frac{\widehat{\gamma}_{it}}{\overline{w}_t} + \overline{w}_j \quad \text{I, J=1,2....N} \qquad (3.7)$$

$$e_{i,t} = -\delta + \frac{\widehat{\gamma}_{it}}{\overline{w}_t} - \widehat{\beta}_t\left(\frac{\overline{w}_j}{\overline{w}_i}\right) \qquad (3.8)$$

Where δ=1 for i=j and δ=0 otherwise

$\overline{w}_t$ is the expenditure shares whereas, $\widehat{\beta}_t$ and $\widehat{\gamma}_{it}$ are Restricted Seemingly Unrelated Regression (RSUR) parameter estimates for the LA-AIDS model.

[3] See more Jung (2000)

The formula used to calculate the expenditure elasticities can be written as:

$$\eta_i = 1 + (\frac{\widehat{\beta}_t}{\overline{w}_i}) \qquad (3.9)$$

3.4 LA-AIDS Model for Transport Sector of Pakistan

In the light of theoretical specifications, a LA-AIDS model for transport sector of Pakistan for different categories of fuel (Petrol, Diesel & CNG) is written as;

$$w_0 = \alpha_0 + \gamma_{00} \ln P_0 + \gamma_{0D} \ln P_D + \gamma_{0C} \ln P_C + \beta_O (LnX - \sum_{i=1}^{n} w_{O,t-1} \log p_{O,t}) + \mu_{i,t} \text{..................} (3.10)$$

$$w_D = \alpha_D + \gamma_{D0} \ln P_O + \gamma_{DD} \ln P_D + \gamma_{DC} \ln P_C + \beta_D (LnX - \sum_{i=1}^{n} w_{D,t-1} \log p_{D,t}) + \mu_{i,t} \text{..................} (3.11)$$

$$w_C = \alpha_C + \gamma_{C0} \ln P_O + \gamma_{CC} \ln P_C + \gamma_{CD} \ln P_D + \beta_C (LnX - \sum_{i=1}^{n} w_{C,t-1} \log p_{C,t}) + \mu_{i,t} \text{..................} (3.12)$$

Where W_O, W_D, W_C is the consumption share of Petrol, Diesel and CNG respectively, whereas P_O, $P_{D,}$, P_C is the price Petrol, Diesel and CNG respectively, LnX is the total expenditure in all fuels, $w_{O,t-1}, w_{D,t-1} and w_{C,t-1}$ is the share of expenditure of Petrol, Diesel and CNG respectively and μ_{it} is error term.

3.4.1 Price and Expenditure Elasticities

Price eleasticities for all fuels are calculated by using the following equation:

$$e_{i,t} = -\delta + \frac{\widehat{\gamma}_{it}}{\overline{w}_t} + \overline{w}_j \qquad \text{................} (3.13)$$

Whereas, expenditure eleasticities for all fuels are calculated by using the following equation:

$$\eta_i = 1 + (\frac{\hat{\beta}_i}{\bar{w}_i}) \qquad \text{..................} (3.14)$$

In this chapter we have discussed the unit root test to check the stationarity of the variables used in our study. To check the Cointegration, we have discussed Johansen Cointegration Tests. After that we have discussed theoretical back ground of the Linear Approximation of the Almost Ideal Demand System (LA-AIDS) model. The LA-AIDS is a popular system than all other demand systems used to derive demand. For theoretical back ground of the model we have derived the equations for Petrol, Diesel and CNG used in Transport sector of Pakistan. We have also described the Own price, cross Price and Income/Expenditure Elasticities for Transport sector of Pakistan.

Chapter 4

ESTIMATIONS, RESULTS AND ANALYSES

In previous section we have discussed Unit Root, Johansen Cointegration Tests and Linear Approximation of the Almost Ideal Demand System (LA-AIDS) modelin detail. Before the estimation of LA-AIDS model, first we check the stationarity of the variables used in this analysis by using Unit Root Test alongwith existence of Cointegration among the series by using Johansen Cointegration Test.

4.1 Unit Root Test Results:

Before incorporating LA-AIDS model testing approach we test stationarity of each variable of the study. All the variables for LA-AIDS approach must be stationary either at level or at first difference. Bound testing approach necessitate all the variables to be integrated of I(0) or I(1) or of both nature for computation of F-statistics. One must not be worried whether the variables are integrated of order zero or one. But the condition which binds the researcher applying unit root test is that none of the variable used in the study has to be integrated of order two. So in order to look that none of the variable is integrated of order (2) we apply unit root test. Variables integrated of level (2) in bound testing procedure would yield spurious results.

To check the order of integration of each variable we incorporated Augmented Dickey Fuller (ADF) and Phillips Perron (PP) unit root tests. The results of both the tests are reflected in table 4.1.

Table.4.1 Unit Root Test Results

Variables	ADF test statistics		PP test statistics		5% Level of Significance
	Levels	First Differences	Levels	First Differences	
Cons(Petrol)	-0.111105	-17.12153*	-0.484659	-23.86486*	I(1)
Cons(Diesel)	-0.946863	-7.839785*	-8.449334	-32.86770*	I(1)
Cons(CNG)	-3.226491	-8.466669*	-2.752248	-11.54606*	I(1)
L_nP(petrol)	-1.334259	-7.650109*	-1.152759	-7.425872*	I(1)
L_nP(Diesel)	-0.569378*	-14.50323*	-1.218994	-14.40701*	I(1)
L_nP(CNG)	-1.34539	-11.26406*	-1.300755	-10.37555*	I(1)
***Significance at 5% level**					

The unit root test for all the variables used in the study are estimated at intercept. The results in table-4.1 reveal that none of the variable of our study is integrated of order 2. From the results we conclude that all variables are stationary at 5% significance level. Similarly, PP test also shows that all the variables are stationary at 5% significance level. All the variables of our study are integrated of order I(1). Graphs of unit root test are as follows;

Figure-4.3 Consumption of Petrol

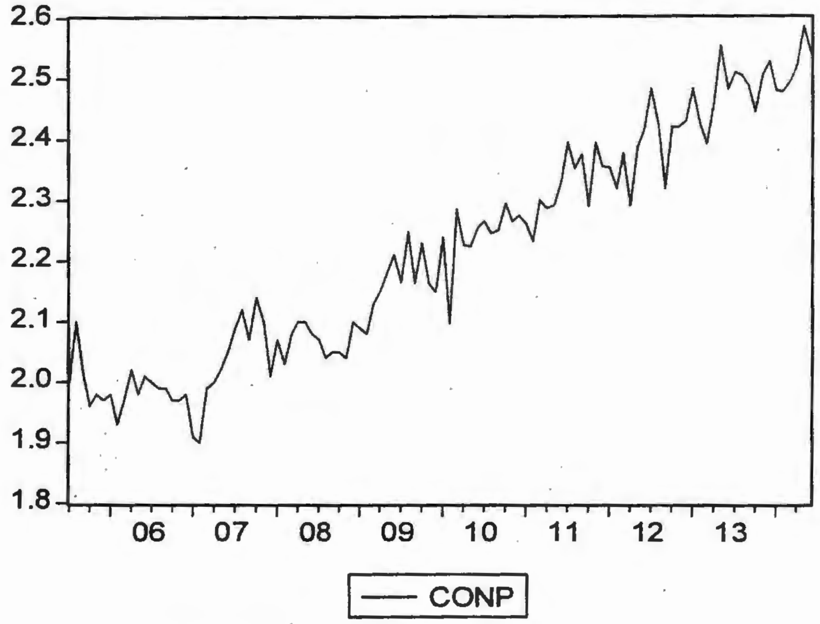


Figure-4.4 Price of Petrol

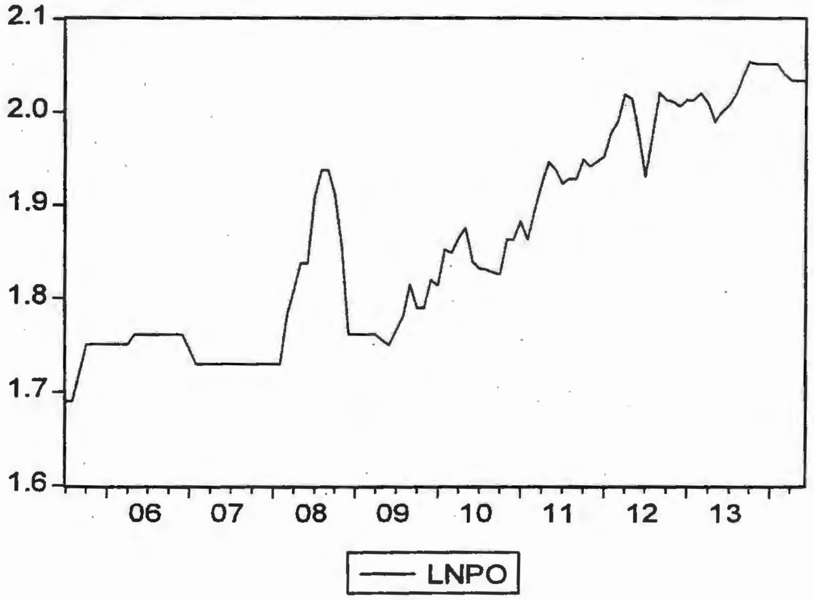


Figure-4.5 Consumption of CNG

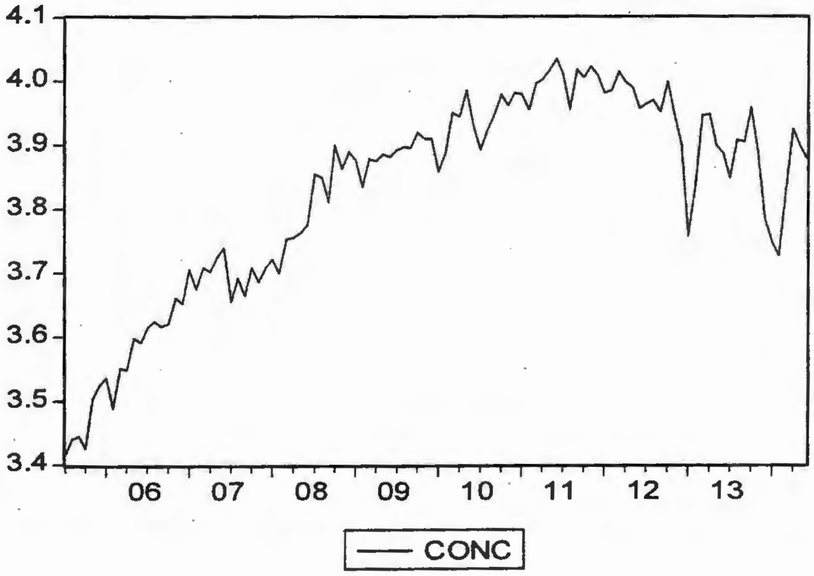
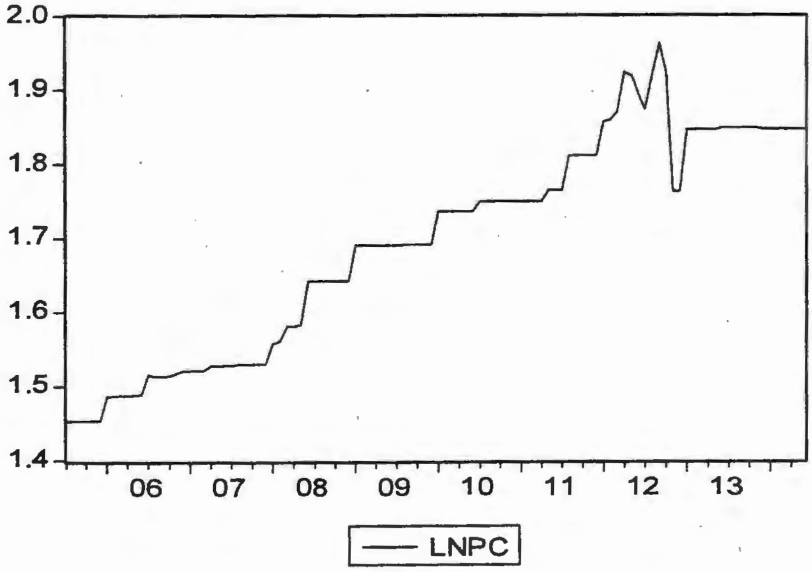


Figure-4.6 Price of CNG



4.2 Johansen Cointegration Test:

The Johansen cointegration test is applied to check the cointegration among series. The results of Johansen Cointegration Test are shownin Table-4.2below;

Table-4.2 Johansen Cointegration Test Results

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.420699	120.6197	95.75366	0.0004
At most 1	0.233625	64.38857	69.81889	0.1256
At most 2	0.183644	36.98195	47.85613	0.3484
At most 3	0.103784	16.08276	29.79707	0.7064
At most 4	0.043751	4.796680	15.49471	0.8300
At most 5	0.001831	0.188784	3.841466	0.6639

Trace test indicates 1 cointegratingeqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.420699	56.23114	40.07757	0.0004
At most 1	0.233625	27.40662	33.87687	0.2422
At most 2	0.183644	20.89919	27.58434	0.2824
At most 3	0.103784	11.28608	21.13162	0.6188
At most 4	0.043751	4.607896	14.26460	0.7903
At most 5	0.001831	0.188784	3.841466	0.6639

Max-eigenvalue test indicates 1 cointegratingeqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

From the results reported in table 4.2, we can deduce that the trace statistics value is greater than critical value at 5% level so we reject the null hypothesis of no cointegration between the series. On the other hand the Max-Eigen statisticsis greater than critical value at 5% level so we also reject the null hypothesis of no cointegration between the series. Therefore we can conclude that there exist only one cointegration vector.

4.3 Estimation and Results of LA-AIDS Model

After confirming that all the variables are stationary at order one and the series have cointegration so we can apply LA-AIDS approach which is next step of our estimation. The parameters used in LA-AIDS model are estimated by using Zellner's Generalized Least Square method for seemingly unrelated regression (SUR) in STATA. Consumption of petrol, diesel and CNG are dependent variables whereas, prices of petrol, diesel and CNG are independent variables. The results in all three cases are appearing in Table-4.3 below;

Table 4.3: Seemingly Unrelated Regression Results

	Coef.	Std. Err	T	P>|t|	[95% Conf. Interval]	
i- Consumption of Petrol						
LnPO	-0.623	0.005	-125.46	0.000	-0.633	-0.613
LnPD	0.381	0.005	74.45	0.000	0.371	0.391
LnPC	0.225	0.005	44.69	0.000	0.215	0.235
LnXoP	1.000	0.0003	2822.58	0.000	0.999	1.000
R^2	0.999					
F-stat	2.20e+06					
ii-Consumption of Diesel						
LnPO	0.377	0.004	76.76	0.000	0.367	0.386
LnPD	-0.619	0.005	-122.03	0.000	-0.629	-0.609
LnPC	0.225	0.004	45.22	0.000	0.216	0.235
LnXdP	1.000	0.0003	2515.41	0.000	0.999	1.001
R^2	0.999					
F-Stat	1.59e+06					
iii-Consumption of CNG						
LnPO	0.373	0.004	79.17	0.000	0.363	0.382
LnPD	0.381	0.004	81.90	0.000	0.372	0.391
LnPC	-0.770	0.004	-159.96	0.000	-0.780	-0.761
LnXcP	0.997	0.0008	1126.97	0.000	0.995	0.999
R^2	0.999					
F-Stat	486244.42					

4.3.1 Explanation of estimated Parameters

Now we explain the results appearing the table 4.3 in detail for all types of Fuels i.e. Petrol, Diesel & CNG;

Case # 1: For Petrol

Refer to table-4.3(i), the estimated results for Petrol indicates that if there is increase of 1 percent in the price of Petrol, the consumption of petrol is decreased by 6.2%. On the other hand, 1 percent increase in the Diesel price put increasing effect on the consumption of Petrol by 3.8%. On the other hand if CNG price increased by 1 percent, the consumption of petrol is increased by 2.2%. The coefficient of R-square is 99% which depicts that the model is feasible and the variables are good enough to demonstrate the change in electricity fuel consumption in transport sector. Value of F-statistic presents the combined significance of all other variables used in the model. It demonstrates that while explaining the dependent variable, at least one independent variable was not zero.

Case # 02: For Diesel

Refer to table-4.3(ii), the results for Diesel indicate that if there is increase of 1 percent in the price of Diesel, the consumption of petrol is increased by 3.8%. On the other hand, 1 percent increase in the Diesel price put decreasing effect on the consumption of Diesel by 6.2%. While CNG price increased by 1 percent the consumption of Diesel is increased by 2.2%. The coefficient of R-square is 99%

which depicts that the model is feasible and the variables are good enough to demonstrate the change in electricity fuel consumption in transport sector.Value of F-statistic presents the combined significance of all other variables used in the model. It demonstrates that while explaining the dependent variable, at least one independent variable was not zero.

Case # 03: For CNG

Refer to the table-4.3(iii), results indicates that if there is increase of 1 percent in CNG price, the consumption of petrol is increased by 3.7%. On the other hand, 1 percent increase in the Diesel price put increasing effect on CNG consumption by 3.8%. While CNG price increased by 1 percent the consumption of CNG is decreased by 7.7%. The coefficient of R-square is 99% which depicts that the model is feasible and the variables are good enough to demonstrate the change in electricity fuel consumption in transport sector.Value of F-statistic presents the combined significance of all other variables used in the model. It demonstrates that while explaining the dependent variable, at least one independent variable was not zero.

4.4 Price Elasticities of all Fuels

In table-4.4 price elasticities of all fuels are reported at the mean values of the budget shares:

Table-4.4: Price Elasticities of all fuels

		Petrol	Diesel	CNG
ε_{1j}	**Petrol**	-0.623	0.377	0.373
ε_{2j}	**Diesel**	0.381	-0.619	0.382
ε_{3j}	**CNG**	0.225	0.225	-0.770

All own-price elasticities are negative and inelastic. Own-price elasticities of all fuel are significant at the 5 percent level. The own price elasticity for CNG is -0.770, indicating that CNG consumption is sensitive to prices. It means that when the price of CNG is increased by 1% the demand for CNG will decrease by 7.7%. Diesel is the most price inelastic, implying that Diesel consumption is not sensitive to its price. When increase in 1% in the diesel prices the consumption of diesel decreased by 6.2%. Own price elasticity of Petrol is -0.623 indicating that when the price of petrol is increased by 1% the demand for petrol will decrease by 6.2%.

Cross price elasticities measure the responsiveness of demand for one fuel to changes in the price of other fuel.The results of Cross price elasticities are negative, positive or zero. When the goods are complements, the increase of the price of one good leads to a decrease in the quantity demanded of another good. Similarly, when the goods are substitutes, the increase of the price of one good leads to a increase in the quantity demanded of another good. On the other hand, when the goods are unrelated, the increase of the price of one good does not have any effect on the quantity demanded of another good. From the above results, all cross price elasticities are positive which indicates that all fuels are substitutes of each other. Petrol is close substitutes with Diesel and CNG.

4.5 Expenditure Elasticities of all Fuels

In table-4.5 expenditure elasticities of all fuels are reported at the mean values of the budget shares:

Table-4.5: Expenditures Elasticities of all fuels

η_1	**Petrol**	1.000
η_2	**Diesel**	1.000
η_3	**CNG**	0.997

The results of Expenditure elasticities for all the fuels are shown in Table 4.5. The sign of expenditure elasticity for all fuels are positive which suggests that all fuels are placed in the category of normal goods. In other words, if income increases, the demand for all fuels will be increased. These results indicates that only CNG has less than unit income elasticity and is placed in the category of normal good and also income elasticities for Petrol and Diesel are greater than unit and are placed in the category of luxury goods. Expenditure elasticities shows that total expenditure on petrol increases by 1% the demand for petrol will also increase by 1%. Similarly when total expenditure on diesel and CNG increases by 1% then demand for diesel and CNG will also increases by 1% for each product.

From the above discussion it is depicted all own price elasticities are negative, all cross price elasticities are positive and the sign of expenditure elasticity for all fuels are positive.These results clearly showed that we do not reject the null hypothesis for all types of elasticities derived from LA-AIDS model for transport sector of Pakistan.

Chapter 5

Conclusion and Policy Recommendations

Transport sector is one of the major users of petroleum products in Pakistan.The purpose/objective of the study is to calculate the price and income/expenditure elasticities of petroleum products demand in the transport sector of Pakistan. We have used monthly data of Petrol, Diesel & CNG ranging from July 2005 to June 2014. Previous studies have used month, quarterly & annual data to estimate the elasticities of fuel demand. The authors around the world have used different time series techniques such as, ARIMA, PAM, AIDS, LA-AIDS, Co-integration, ECM, OLS method etc to calculate the fuel demand. In Pakistan, some authors have used HIES data to calculate food demand and also fuel demand but there is one other study by Ahmed& Kemal (2001),so far to calculate elasticities for transport sector by using annual data from 1972 to 2000. In our study, we have used monthly data from July 2005 to June 2014 by applying LA-AIDS approach developed by Deaton and Muellbauer (1980a, b) to calculate the elasticities of fuel demand for Transport sector of Pakistan. Previous research showed that LA-AIDS model has the ability to fulfill the desired theoretical properties of demand.

Furthermore, the equations derived from this model are linear in parameter, which allows researchers to use different econometric methods/techniques for estimation.

We have calculated the Price and Income/expenditure elasticities by using parameters of the LA-AIDS model. The result shows that all own price elasticities are negative and significant. The income elasticity for all fuels has positive sign which imply that all fuels are normal goods. We can say that, income rises, the demand for all fuels will also be increases. These results indicates that only CNG has less than unit income elasticity and is placed in the category of normal good and also income elasticities for Petrol and Diesel are more than unit and are luxury goods.

On the basis of our analysis, this study will provide following recommendations for a sustainable energy policy for transport sector of Pakistan;

i. Undertake research and development in Oil and Gas sector to increase oil and gas production which helps to reduce import of Petroleum products,
ii. Use of renewable energy resources and promoting alternative sources of energy.
iii. Implementation of advanced energy technologies to reduce fuel consumption.

iv. The Universities/higher education institutes would include the Transport Economics as a course at undergraduate and graduate level in order to familiarizes the student in the field of Transport Economics. This will help students to research in this field of study.

For future research, it is recommended that the researcher would collect data of fuel consumption, prices of fuel, number of registered vehicles on provincialbasis and calculate the elasticities for each province separately. On the other hand, the researcher can use data of LPG and Jet fuel prices and consumption in their research to investigate the demand for Jet fuel and LPG in transport sector of Pakistan.

Overall, this study helps us to understand the behavior of people to choose petroleum products in the transport sector of Pakistan.

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