Impact of Energy Prices on Inflation in Pakistan

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Acronyms

ADF	Augmented Dickey Fuller
ARDL	Autoregressive Distributed Lag
CNG	Compressed Natural Gas
CPI	Consumer Price Index
ECM	Error Correction Model
ECT	Error Correction Term
HSD	High Speed Diesel
IFS	International Financial Statistics
IMF	International Monetary Fund
IPP	Independent Power Producers
LDO	Light Diesel Oil
LPG	Liquefied Petroleum Gas
KESC	Karachi Electric Supply Company
OMC	Oil Marketing Companies
PI	Price Index
PEPCO	Pakistan Electric Power Company
PSO	Pakistan State Oil
QTM	Quantity Theory of Money
WAPDA	Water and Power Regulatory Authority
SBP	State Bank of Pakistan
TOE	Tones of Oil Equivalent

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Abstract

We examine the impact of energy prices on inflation at aggregate and disaggregate level in Pakistan. The time span of the research is 2001:7-2011:7. The results suggest that energy prices have a significant influence upon inflation. The strongest influence on inflation comes from change in electricity prices followed by diesel, petrol and gas. The impact of change in kerosene prices on inflation is positive but statistically insignificant. This could be due to relative smaller share of the kerosene in the aggregate consumption basket.

CHAPTER 1

INTRODUCTION

Energy is a key determinant of economic development and prosperity of society, as it plays a crucial role in raising productivity and economic growth. Many economists including, Adam Smith considered land, labor and capital as main inputs for economic activity in the production processes. Since the industrial revolution, energy came to be recognized as a fourth major input for the production processes. The rapid escalation of energy prices, since 1970, has been a source of adverse impact on the world economy. Many macroeconomists are of the view that the rising trend of energy prices has been a major cause of economic fluctuations in terms of reduction in output, increasing inflation and unemployment both in developed and developing countries [(Brown and Yucel(2002), Hamilton(2005), Malik,(2007), Kiani(2011)]. Simply, an increase in the price of various energy-inputs (such as oil, electricity and natural gas) increases the cost of production and reduces productivity and output level, which ultimately raises the price level in the economy. Since 1999, increasing price level of oil encouraged the policy makers to reconsider their monetary and energy policies given high inflation and unemployment in the economies. This study seeks to examine the impact of energy prices on inflation in Pakistan.

Oil prices are a major determinant of global economic performance. An oil-price shock leads to a transfer of income from importing to exporting countries through a shift in the terms of trade (Brown and Yucel, 2002). The extent of direct effect of energy price shock depends on the share of cost of oil in the total production cost, on the price and availability of substitutes. There is a plethora of literature on oil price shocks and its impact on economic activity in developed economies. However, research on the subject for developing countries is scant. The reason could be lesser dependence on oil. Recently, the upsurge in economic activities has pushed up demand of oil in developing countries like India and China (Kumar, 2009). The adverse impact of consequent increase in price increase is more severe on oil importing countries because their economies are more reliant on imported oil and use energy inefficiently. Oil being an input to numerous production processes, generation of electricity and transportation, the adverse impact on general prices level is obvious — the increase in cost of production negatively influences employment and level of output.

The important strands of literature to examine the determinations of inflation can be segregated into demand and supply factors advocated respectively by monetarists and structuralists. The Monetarists view holds that "inflation is always and everywhere a monetary phenomenon". This proposition, based upon the Quantity Theory of Money (QTM), is owed to Friedman (1968, 1970 and 1971) and has been first tested empirically by Schwartz in 1973. The QTM states that "an increase in the money supply results in proportionate increases in the prices, assuming output and real money balances constant". For Pakistan numerous studies have found a positive relationship between money supply and inflation [Qayyum (2006), Khan and schimmelpfenning (2006), and Kemal (2006), Abbas (2009)]

The Structuralists are of the views that the supply side factors have been the source of rising cost such as wages, profits, exchange rate, food prices, external shock and taxes, etc. All these factors lead to increase in the overall price level [Balkrishnan (1992), Khan and Qasim (1996), Hasan *et al*.(1995)]. If the prices of these basic factors of production such as labor, capital and energy increases, it will increases the cost of production for which the producers have to adjust the prices of their final products to maintain their normal profit. Since 2003, the rising trend of various input prices such as oil and gas and electricity have been known as leading indicators of inflation in Pakistan.

1.1 Rationale for the study

In Pakistan, the impact of energy prices has been discussed by researchers but mainly in the context of the relationship with economic growth. These studies have primarily used crude oil prices as a proxy for energy prices and found a negative relationship with economic growth and positive relationship with price level [(Aqeel and Butt (2001); Siddiqui (2004); Khan (2008);Siddique and Haq(1999), Malik(2007), Kiani(2009), Syed(2010) Jamil and Ahmed (2010), Khan and Ahmad(2011)] Though the studies referred above are quite comprehensive but do not account for the prices of other components like electricity and natural gas.

Given that now electricity and gas constitutes a major share of total energy consumed in the country, it is important to examine the impact of energy prices by accounting for all energy components. As different component of energy are frequently substituted for one another e.g. gas for oil. Therefore, it is important to examine the impact change in price of individual energy components on inflation.

1.2 Objective of the Study

Given the gap in literature referred above, our study seeks to fill the gap of literature. The basic objective of the study is to:

> Examine the impact of energy prices on inflation. The impact will be examined at aggregated level as well as disaggregated by individual energy components including-Electricity, Natural Gas, Petrol, Diesel and Kerosene.

1.3 Organization of the Study

The study is organized as follows: chapter 2 presents an overview of Pakistan's energy sector. The current scenario and issues faced by energy (electricity, gas and petroleum product) sector are highlighted. Chapter 3 reviews the literature regarding the relationship of energy prices and inflation. Theoretical framework and empirical model of the study is discussed in chapter 4. Chapter 5 describes the data, construction of variables and econometric techniques. Chapter 6 reports and interprets the results of estimation. Chapter 7 concludes the study.

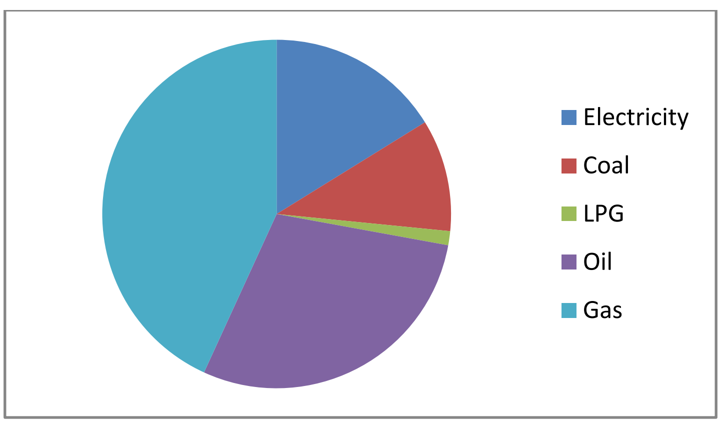
Chapter No 2

Overview of Energy Sector of Pakistan

2.1 Introduction:

The rising oil consumption and more or less static oil production in Pakistan have led to rising oil imports. Pakistan's energy requirements are fulfilled with more than 80% of energy resources through imports. The growth in economic activity demands higher energy consumption Indigenous resources of oil are not enough to quench energy thirst of the economy. The demand-supply gap of energy is main hazard to economic growth for Pakistan. Pakistan's total energy consumption was 63.1million tons of oil equivalent in 2009-2010, which consists mainly of gas, oil and electricity. The energy mix consumed by the country includes oil, gas, electricity, coal and LPG. The consumption mix of energy in 2011-12 is shown in the figure below.

Figure: 2.1 Consumption of Energy Mix (2011-12)



Source: Economic Survey of Pakistan, (2011-12)

The increase in international fuel prices reduces the economic activity and increases the domestic price level. The increase ultimately affects cost of production, transportation charges and accelerates price level. As a whole the effect of energy consumption remained negative due to the problem of circular debt and dependency on imported crude oil. The summary of energy consumption during last ten years has been shown in following tables.

Table: 2.1 Annual Energy Consumption

Years	Petroleum product		Natural Gas		Electricity	
	Tones (000)	Change in %	(mmcft)	Change in %	(Gwh)	Change in %
2001-02	16,960	-3.9	8,24,604	7.4	50,622	4.2
2002-03	16,452	-3.0	8,72,264	5.8	52,656	4.0
2003-04	13,421	-18.4	10,51,418	20.5	57,491	9.2
2004-05	14,671	9.3	11,61,043	10.4	61,327	6.7
2005-06	14,627	-0.3	12,23,385	5.4	67,603	10.2
2006-07	16,847	15.2	12,21,994	-0.1	72,712	7.6
2007-08	18,080	7.3	12,75,212	4.4	73,400	0.9
2008-09	17,911	-0.9	12,96,433	-0.5	70,371	-4.1
2009-10	19,132	6.8	12,77,821	0.66	74,348	5.7
2010-11	18,887	-1.3	12,40,671	-2.91	77,099	3.7

Source: Economic Survey of Pakistan (2011-12)

2.2 Electricity Sector:

Electricity is considered an important input to the production process. After 2007, the demand-supply gap of electricity has risen and since then, the increasing gap is due to rapid increase in demand, the problem of circular debt, the insufficient generation capacity, transmission and distribution losses and heavily oil-dependent electricity generation. After 2007, the gap between generation cost and tariff imposed was so large that it led the heavy losses (Malik, 2012). Table (2.2) supports this gap of generation cost and tariff. In 2011, demand-supply gap reached to 7000MW (Malik, 2012). To fill this gap, a huge investment is required to maintain the supply of power.

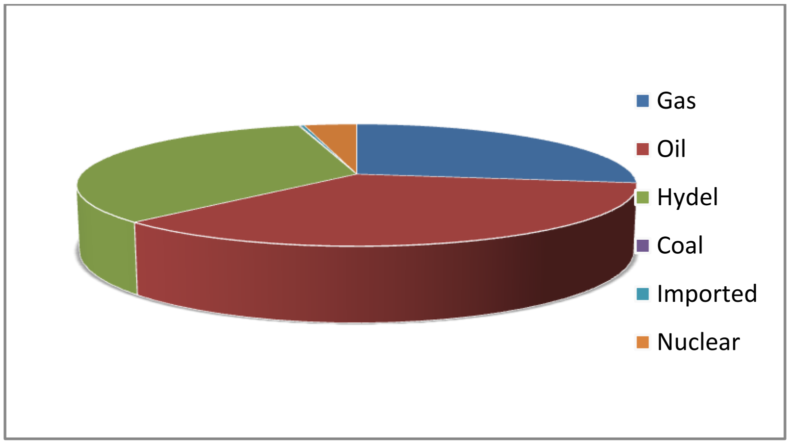
Table: 2.2 Average Cost and Sale Rate of Electricity

	2004-05	2005-06	2006-07	2007-08	2008-09
Units sold(KWh)	55278	62405	67480	66540	65244
Avg. Sale Rate (RS/KWh)	4.0	4.1	4.5	5.4	7.3
Avg. Cost (RS/KWh)	4.2	4.7	5.1	6.5	8.2
Excess Cost	0.2	0.7	0.6	1.1	1.0
Loss (Billion Rs.)	13	41	39	76	62
Cumulative loss (Billion Rs.)	13	54	92	168	230

Source: Pakistan Energy Year Book (2010), Malik, (2012)

It is the pricing policy of power consumption which could generate profits to increase supply and reduces cost effectively. During last five-six years, a significant part of electricity consumed is being produced using expensive imported furnace oil. A major source of electricity generation in Pakistan is thermal, which is 99.8 percent dependent on imported oil (Pakistan Economic Survey, 2010-2011). Two third of our electricity generation is thermal based. Oil (furnace and diesel) tops the list of fuels which are used for thermal electricity generation.

Figure: 2.2 Electricity Generation by Source



Source: Economic Survey of Pakistan, (2011-12)

Keeping in view the fact that 80% of oil demand is met from imports. It can be seen to what extent increase in oil prices would affect the cost of electricity generation. Due to depletion of natural gas resources, the share of natural gas based electricity generation is going down.

Table: 2.3 Electricity Generation (Thermal) by Fuels GWH

Items	2000-01	2006-07	2007-08	2008-09	2009-10	2010-11
Coal- % of total	241 0.5	136 0.21	136 0.21	113 0.17	139 0.20	131 0.20
Oil- % of total	26904 55	26449 41.59	29928 45.56	25513 39.41	35641 52.09	35847 55.07
Gas- % of total	21780 44.5	37006 58.19	35624 54.23	39108 60.41	32647 47.71	29118 44.73
Total	48925	63591	65688	64734	68427	65096

Source: Energy Year Book; Malik, (2012)

The motive behind the reduction in natural gas based electricity is to make gas available for domestic and industrial consumers (Economic Survey of Pakistan, various issues). The prevailing electricity crisis is one of the major causes of slowdown in economic activity. There is an annual loss of about 2% in GDP due to electricity shortage (Abbasi, 2011). The power crisis in the form of severe power outages ranging from eight to twelve hours has become the cause of reduction in large scale manufacturing production (LSM). There is 12-37 percent decline in industrial output due to this power crisis (Siddiqui *et al.* (2011).

2.2 Crude Oil and Petroleum Product Sector:

Pakistan has been facing an unprecedented energy crisis due to disturbed situation in Middle East and North Africa. This political turmoil has led to upward pressure on international oil prices. As a result, Pakistan is facing an escalation in oil import bill and a rise in power generation cost. Consequently, this energy crisis has led to inflationary pressures in the economy, increasing budget deficit and balance of payment problems and slowdown in the economic growth (Malik, 2007). The current demand-supply energy gap fostered reliance on the imported oil. According to the Ministry of Petroleum and Natural Resources (MPNR), the demand of petroleum products in the country is about 16 million tons out of which 82 percent is met through imports and the rest is fulfilled through indigenous resources (Pakistan Economic Survey, 2010-11).

The total supply of crude oil was 75.3 million barrels. In 2010-11, the major part (61%) of was imported and rest was extracted domestically. The average crude oil production was 66,032 barrels per day in 2011-12 as against 65,997 barrels per day last year. Petroleum products are produced from the processing of crude oil at petroleum refineries. Major part of petroleum products consists of motor spirit, kerosene, high speed diesel (HSD), light diesel oil (LDO) and furnace oil. The total import and export of petroleum products is shown in table (2.4).

Table:2.4 Import and Export of Petroleum Products

Imports		Exports	
Products	Quantity in million tones	Products	Quantity in million tones
100 Octane Aviation Fuel	0.80	Naphtha	0.79
High Speed Diesel	3.78	High speed diesel	0.12
High Sulphur Furnace Oil	5.60	Jet propellant (Aviation fuel) JP -1	0.64
Low Sulpher furnace Oil	1.06	Furnace oil	0.004
Motor spirit	1.13	Motor spirit	0.02
Total	12.37	Total	1.57

Source: Pakistan Economic Survey, (2010-11)

There are nine Oil Marketing Companies (OMCs) working in Pakistan. Pakistan State Oil (PSO) is the lead state owned company leading in Pakistan. It is engaged in import, storage, distribution and marketing of various petroleum products, including HSD, Fuel Oil, LDO, LPG and CNG etc. Initially, PSO was the only largest importer of finished products, but later on, Caltex and Shell also became the major oil importing companies (OMCs).

Pakistan's net oil imports are predicted to increase significantly in coming years as demand is growing faster than the production. The consumption of petroleum is expected to increase to around 26 million tones by the year 2017-18. The table (2.5) below gives the details regarding demand-supply forecasts of petroleum products.

Table: 2.5 Petroleum Products demand /Supply Forecast (in million tons)

	2006-07	2011-12	2016-17
Demand of petroleum products	17.5	22.4	28.4
Production of local refineries	11.0	12.4	13.2
Surplus Naphtha/ Motor Gasoline available for exports	1.0	1.3	1.5
Deficit: HSD and FO	8.4	11.3	16.6

Source: Economic Survey of Pakistan (2011-2012)

Natural Gas:

Natural gas is a dominant fuel in Pakistan accounting for 47% of primary energy demand as it offers the cheapest and a cleaner alternative source of energy (Pakistan Economic Survey, 2007). The importance of natural gas to the country is rapidly increasing. The government is making efforts to enhance gas production to fulfill the increasing energy demand. The balance recoverable natural gas reserves have been estimated at 24 trillion cubic Feet. The average production of natural gas has increased by 4.57% during FY 2011-12 (Economic Survey of Pakistan, various issues). It shows 4.6 percent increase in consumption of natural gas. Natural gas is used in general industry to prepare consumer items, to produce cement and to generate electricity. The consumption pattern of natural gas by main sector of economy is presented in table (2.6).

Table: (2.6) Consumption of Gas (billion Cft)

Years	Domestic	Power	Industrial	Transport (CNG)	Fertilizers
2001-02	144	315	151	7	178
2002-03	154	336	165	11	181
2003-04	155	470	193	16	185
2004-05	172	507	226	24	190
2005-06	171	492	279	39	198
2006-07	186	434	307	56	194
2007-08	204	430	323	72	200
2008-09	214	404	319	88	201
2009-10	219	367	334	99	220
2010-11	232	337	292	113	228

Source: Pakistan Economic Survey (2011-12)

Pakistan is the largest consumer of CNG in Asia. In recent years, Pakistan has faced a severe gas shortage. There has been a tremendous growth in consumption of natural gas by thermal power plants for electricity generation. This increasing demand-supply gap is due to a rapid increase in demand from domestic transport and power sector. Currently, more than 27 firms including BHP, OPI, PEL, MOL and OGDCL are engaged in exploration & production of new gas reserves.

Chapter 3

Review of Literature

3.1 Introduction

This chapter reviews the literature regarding the impact of energy prices on macroeconomic variables like inflation; economic activity etc. A number of studies suggest that an increase in energy prices negatively affects macroeconomic activities of oil importing countries by influencing supply and demand channels. It is argued that countries heavily dependent on energy are badly affected when there is an increase in international oil price. While discussing energy, the reason for emphasis upon oil is due to the fact that oil is quite often an input for generation of energy through other means e.g. thermal power. From the consumers' point of view, rise in oil prices causes energy bills to grow, whereas from the producers' standpoint, the firms bear an increase in unit costs [(Lescaroux and Mignon, 2008)]. Literature suggests six transmission channels through which energy prices may affect economic activity and the price level [Brown and Yucel, (2002, Hooker (1986), Jones *et al*. (2004), Tang *et al*., (2010)]. These channels include supply shock, wealth transfer, inflation, real balance, sector adjustment and the unexpected effects.

The most important channel is the supply shock i.e. increases in energy prices adversely influences the production and reduces actual output. Consequently, marginal costs of production increases and the growth of output and productivity are slowed [Rasche and Tatom (1977), Mork and Hall (1980), Jorgenson (1981), Bruno and Sachs, (1982), Lescaroux and Mignon, (2008) and Tang *et al*. (2010)]. It leads to reduction in output level and labor productivity. The decline in productivity growth negatively affects real wages and increases unemployment, reduces output ultimately leading to high price level [(Mankiw, 1997), (Black and Benzing (1991) Kumar, 2009, Chuku *et al*., 2010)].

As mentioned earlier, oil prices negatively affects macroeconomic activities of oil-importing countries through influencing demand-supply. Since 1970s, Oil price shock had adversely affected the economic performance of various economies due to their heavy dependence on imported oil [Hamilton (1983), Brown and Yucel (2002) for example, Burbidge and Harrison, 1984, Gisser and Goodwin, 1986, Mork 1989, Mork *et al*. 1994, Lee *et al*. 2001 and Cologni and Manera, 2008, Olbusoye and Oyaromade (2008), Aliyu (2009)]. The effects of oil price shock are different on oil importing and exporting nations. Some studies show that increase in oil prices deteriorates terms of trade for oil importing countries (Dohner, 1981 and Husain*et al.*, 2008). The increase affects real money balances as it increases money demand, increases interest rates and retard economic growth (Pierce and Enzler, 1974 and Mork, 1994, Hooker (2002) suggests that the reaction function of monetary authorities is the main driver of second-round effects of oil price shocks. The response of fiscal and monetary policy may not be neutral. In some economies the impact of oil price shock is more severe due to inappropriate reaction of monetary authorities. In oil exporting nations, the increase in oil price appreciates the exchange rate and GDP increase with the causality running from oil prices to GDP. [Al Mulali (2010) and Ito (2011), Hakro and Omezzine (2010].

Various studies have examined the consequences of increase in energy prices. Chishti and Mehmood (1991) find that an increase in energy prices leads to reduction in output and investment in capital goods. Khan and Qasim (1996) examine three kinds of inflation (overall inflation, food inflation and non- food inflation) and conclude that electricity prices play a crucial role in determining inflation.

As mentioned earlier, the increase in oil prices affect economic activity, inflation and other macroeconomic variables. The most visible impact of external oil price shock is through the supply side channel (decline in inputs to production process, reduction in output and increase

Table 3.1 Summary of Review of Literature			
Study	**Countries and Data**	**Variables**	**Conclusion**

in price level). Malik (2007, 2008) and Abbas (2009) find that crude oil prices negatively affect economic activity and cause an increase in prices through fluctuation in exchange rate and interest rate. Along with international oil price shock, global import food prices are also creating inflationary effects in Pakistan [(Syed (2010), Mohammad (2010), Khan and Ahmad (2011)].

In this chapter, we have reviewed the studies regarding the impact of energy prices on different economic variables. We did not come across any study for Pakistan in which the impact of energy on inflation has been examined at the aggregate level as well as at the disaggregate level by components of energy i.e. electricity, diesel, petrol, kerosene and gas. The comprehensive review of the above mentioned studies is presented in table (3.1).

	Span		
Jorgenson (1981)	United States (US) ; 1948-76	land , labor, capital, energy and other raw material	Higher Energy prices lead to dramatic decline in the Economic Growth
Bruno (1982)	UK manufacturing sector, A descriptive study	Inputs to Production Process (land , labor, capital, energy components and raw material)	Prices of inputs increase; there is decline in productivity, output, wages and capital formation. Employment level and profits also decrease.
Hamilton (1983)	US Economy; Data(1948-1974)	Crude oil prices and economic activity	US economy is more affected by oil prices shock because it is more dependent on imported oil.
Jorgenson (1984)	US Economy; A descriptive study	Energy (electrical and non electrical components) and other factors of productions	The adverse impact of change in input price other than electricity is more severe as compared to change in price of electricity.
Chishti and Mahmood (1991)	Pakistan; 1960-80	Energy inputs(electricity) and Non Energy inputs (labor, capital and raw material) of production process	Increase in energy prices lead to reduction in investment of capital goods with a passive impact on labor absorption.
Black and Benzing (1991)	United States (US); 1967-1987	Exchange rate, energy prices, unemployment, money supply, unemployment and inflation	Non monetary variables (energy prices, exchange rate and unemployment) are also main contributor of inflation.
Khan and Qasim (1996)	Pakistan; 1971-95	Overall inflation, food inflation and non food inflation, money supply, exchange rate	Electricity prices are major contributor to inflation.
Siddique and Haq (1999)	In case of Pakistan over the period 1971-97	Electricity , Gas and Petroleum Products	Kerosene and Electricity are substituted. And increase in petroleum prices positively affects demand for gas.
Abseysinghe (2001)	12 Open Economies; 1982Q1-2000Q2	International oil prices, economic activity and price level	The impact on economic activity depends upon the how energy intensive a country is.
Leblance and Chin (2004)	Five Developed Economies ; 1980-2002	International crude Oil prices and inflation	Inflationary effects of oil prices depend upon the country's energy intensity.
Cundo and Gracia (2004)	Asian Countries (Malaysia, South Korea, Philippines, Japan, Thailand; 1975Q1-2002Q2	Oil prices, economic growth and inflation	For oil exporting countries, the increase in oil prices appreciates currency (exchange rate falls) and vice versa.

Cologni and Menera (2005)	G-7 Countries (Canada, France, Germany, Italy, Japan, United Kingdom and United States) ; 1980Q1-2003Q4	Oil prices, Consumer price index(CPI), exchange rate, GDP, Money supply and interest rate	Oil price increases price level and reduces productivity (France and US). Sometimes the reaction of monetary authorities enhances the effect of external oil price shock (in case of Italy and Japan).
Malik (2007, 2008)	Pakistan ; 1979-2008	International oil prices and macroeconomic variables	An international oil prices shock raises the prices of petroleum products, transport cost and electricity prices etc, which ultimately cause inflation.
Olbusoye and Oyaromade (2008)	Nigeria (oil exporting nation); 1970-2003	Real output, expected inflation, real exchange rate, interest rate, money supply, oil prices (as external shock)	Expected inflation, CPI, exchange rate and petroleum prices are major determinants of inflation.
Khan and Ahmad (2008)	Pakistan ; 1970-2008	Demand function of energy components (electricity, gas and coal) is generated.	Long run: There is no relationship between Price level and demand for gas and electricity. Short run: Price level affects only electricity demand.
Heerdan (2008)	South Africa; 1980-2007	Electricity prices and consumer price index (CPI) and GDP	Electricity prices positively affect inflation and GDP.
Fayomi (2009)	Oil importing Nations (Turkey, Tunisians and Jordan) ; 1997Dec-2008Mar	Oil prices and stock market return	Oil prices do not have significant impact on stock market return.
Kumar (2009)	In case of India and study period is 1975Q1-2003Q3	World oil prices, industrial growth, inflation, real effective exchange rate, interest rate	Oil prices along interest rate (a monetary variable) declines industrial production.
Abbas (2009)	Pakistan; 1980-2007	Inflation, oil price shock, expected inflation, real GDP and crop productivity	Oil prices have significant effect on inflation via fluctuation in exchange rate.

Khan *et al.* (2009)	Pakistan; 1972-2006	Money supply, wheat support prices, import prices, interest rate, exchange rate	Wheat support prices — supply side variable and money supply and import prices — demand side variable) play significant role in increasing inflation.
Rehman (2010)	Pakistan and United Kingdom (UK) ; 1994-2009	Inflation, interest rate and exchange rate	Exchange rate and interest rate are inversely related and have positive effect on inflation.
Ali and Badar (2010)	A descriptive study in Pakistan	Electricity crisis and role of circular debt	Circular debt is the major cause of persistent energy crisis in Pakistan.
Mohammad (2010)	Pakistan ;1975-2008	World oil prices, GDP, export earnings, living standard of people, Balance of payment	Oil prices inversely hit macroeconomic variables (GDP, employment, trade balance) and positively affect inflation.
Al maulali (2010)	In case of Norway (oil exporting nation); 1975-2008	Oil prices, consumer price index (CPI), trade balances, foreign direct investment and employment.	CPI and oil prices positive affect exchange rate and other macroeconomic variables.
Syed(2010)	Pakistan;1980-2009	Crude oil prices, exchange rate, Consumption, foreign direct investment, Govt. spending and inflation	Oil prices are negatively related to GDP and positively to inflation.
Hakro and Omezzine (2010)	Oman ;1985-2008	International food and oil prices and Macroeconomic variables	Both food and oil price shock affect domestic economy through exchange rate channel.
Fezzani and Nartova (2011)	Iraq ;1969-2009	Oil prices and economic activity	Oil price shock positively affects exchange rate and economic growth.
Khan and Ahmad (2011)	Pakistan; 1990M1-2011M7	International food and oil prices and Macroeconomic variables	Oil price shock affects industrial output and inflation through fluctuation in exchange rate.
Eski *et al.* (2011)	OECD Countries; 1997M1-2008M12	Oil prices and industrial production	Causality exists from oil prices to industrial production in all OECD countries except France and US.
Ito (2011)	Russian Economy; 1994Q1-2009Q3	Oil price shock, inflation and exchange rate	Oil price shock depreciates exchange rate and enhances economic activity in oil exporting country.

Basher *et al.* (2011)	Pakistan; 1972-2010	Inflation, real income and import prices and other Macroeconomic variables	Inflation is mainly caused by money supply (demand side channel) and import prices (supply side channel).
Siddique *et al.* (2011)	(Sialkot, Gujarat, Gujranwala and Faisalabad) Pakistan ; 2011	Survey based data of power outage and industrial production	Electricity outage is the major cause of reduction in labor demand, increase in unemployment and reduction in industrial output.
Malik (2011)	Pakistan, A descriptive study	Major issues and performance of power sector due to severe load shedding	Governance crisis is the root cause of all problems in electricity sector.

Chapter No 4

Theoretical Framework

4.1 Introduction

In this chapter we specify the theoretical framework to empirically examine the impact of energy prices on inflation.

4.2 Theoretical Model

We assume that both the demand and supply side factors play an important role in determining the inflation. Following Moser (1995), we assume that there are two sectors in the economy namely: tradable sector and non-tradable sector. The prices of goods are determined in the following manner.

$$P = f(P^{T}, P^{NT}) \qquad (4.1)$$

The prices of tradable goods depend upon fluctuation in exchange rate and foreign prices whereas the prices of non-tradable goods are influenced by the disequilibrium in money market. Equation 4.1 can be written as:

$$P = P_{T}^{\beta} P_{NT}^{1-\beta} \qquad (4.2)$$

Where $0 < \beta < 1$

Taking log on both sides of the above expression, we have:

$$\log P = \log P_{T}^{\beta} + \log P_{NT}^{1-\beta} \qquad (4.3)$$

Equation 4.3 can be written as:

$$\log P = \beta \log P_{T} + (1-\beta) \log P_{NT} \qquad (4.4)$$

Where:

P_t= Price of traded goods

P_{NT} = Price of non-traded goods

β = Share of non tradable goods in total expenditures

Tradable goods can be represented in world market and domestically with the help of foreign prices(P^f) and exchange rate (e). Change in parity of the domestic currency vis-à-vis other currencies influences domestic price level, the depreciation increases the domestic price level of the tradable goods and vice versa. Moreover, the change in foreign price level also causes a corresponding change in the domestic price level. The purchasing power parity (PPP) theory states that the price of tradable goods is the function of exchange rate and foreign prices:

$$P_T = f(e, P^f) \qquad (4.5)$$

The oil prices, since early 70's have, played an important role in determining the price level of tradable goods. After the energy crisis of 1970's, a sharp upward increase in oil prices has affected the general prices of the oil importing countries. To capture the effect of oil prices, we re-specify the equation (4.5) as follows:

$$P_T = f\left(e, P^f, P^{oil}\right) \qquad (4.6)$$

The increase in oil price not only retards economic activity but also exerts inflationary pressure on the economy via adverse influence on the balance of payments and hence the exchange parity of net oil importers. Under the supply-side channel rising oil prices reduce accessibility of energy as a basic input to production. The output level and labor productivity declines, unemployment and inflation increase. Moreover the purchasing power partially shifts from oil-importing countries to the oil-exporting nations. This reduces aggregate demand in oil importing countries. An increase in oil prices is essentially considered as a tax imposed by oil exporting countries on oil importing nations. With the increase in oil prices the purchasing power increases in the oil exporting countries. Given the higher propensity to save of the rich, the overall increase in consumer demand in the oil exporting country is less than the decline in demand in oil importing country.

Many economists believe that the real balance affect is yet another channel through which oil prices may influence the economy. It is argued that an increase in oil price may increase money demand. If the monetary authority fails to meet the growing demand for money, the price level would rise without an increase in money supply, the real balances would decline and the real interest rate would go up, which would influence numerous sectors of the economy (Brown and Yucel, 2002).

The price of non traded goods is set in the money market. Demand for non traded goods is determined by the money market equilibrium. Money market equilibrium occurs when real money supply ($\frac{M^S}{P}$) is equal to real money demand ($\frac{M^D}{P}$).

$$P_{NT} = f(m_s, m_d) \qquad (4.7)$$

It is assumed that real money demand is the function of real income, observed inflation in period $_{t+1}$ and interest rate.

$$m_t^d = f(y_t, \pi_t, r_{t+1}) \qquad (4.8)$$

Where, y_t is the real income, π_t represents the expected inflation in period $_t$, structured in period $_{t-1}$, r_{t+1} is the interest rate expected in period $_{t+1}$, set according to anticipated change in exchange rate in period $_{t+1}$.

Money demand theory holds that, an increase in real income will enhance the demand for real money balances, whereas an increase in expected inflation would reduce the money demand (Moser, 1995). Based on adaptive expectation, the expected inflation in period $_t$ is considered to be equal to the following expression:

$$\pi_t = \theta(\Delta log P_{t-1}) + (1-\theta)\pi_{t-1} \qquad (4.9)$$

Where $\Delta logP_{t-1}$ and π_{t-1} are the actual inflation and the expected inflation in period $_{t-1}$ respectively. θ is assumed to be equal to one, thus the reduced form of the inflation equation will be:

$$\pi_t = (\Delta logP_{t-1}) \qquad (4.10)$$

The expected interest rate r_{t+1} rate formulates on basis of adaptive expectation and is regulated according to the expected exchange rate. Thus, the expected interest rate r_{t+1} in period $_{t-1}$ is based on the expected changes in exchange rate in period $_{t+1}$ and is equal to the observed interest rate in period $_t$.

$$E(r_{t+1}) = r_t \qquad (4.11)$$

Substituting equation (4.10) and (4.11) into (4.8) yields:

$$\mathrm{m_t^d} = \mathrm{f}(\mathrm{y_t},\ \Delta\mathrm{logP_{t-1}},\ \ \mathrm{r_t}) \qquad (4.12)$$

Thus the prices in non-tradable sector are a function of money supply, real income, expected inflation and the interest rate.

By substituting equation (4.12) into equation (4.7)

$$P_{NT} = f(m_s, y_t,\ \Delta logP_{t-1},\ \ r_t) \qquad (4.13)$$

The electricity and gas are part of the non traded goods. To capture the separate effect of electricity and gas prices, we augment the equation (4.13) as:

$$P_{NT} = f(m_s, y_t,\ \Delta logP_{t-1},\ \ r_t, P^{elec}, P^{gas}) \qquad (4.14)$$

We have the following functional form after substituting the values of P_T and P_{NT} from equation (4.6) and (4.14) into equation (4.1)

$$P = f(e, P^f, P^{oil}, m_s, y_t,\ \Delta logP_{t-1},\ \ r_t, P^{elec}, P^{gas}) \qquad (4.15)$$

Taking log of 4.15 on both sides yields:

$$logP = logf(e, P^f, P^{oil}, m_s, y_t,\ \Delta logP_{t-1},\ \ r_t, P^{elec}, P^{gas}) \qquad (4.16)$$

The log linear form of 4.16 is:

We import crude oil and use its refined form like diesel, petrol, kerosene, so to capture the impact of oil prices we substitute oil with its various refined forms because these prices directly hit inflation.

$$logP = \alpha_o + \alpha_1 loge + \alpha_2 logP^f + +\alpha_3 logm_s + \alpha_4 logy_t + \alpha_5 log\Delta logP_{t-1} + \alpha_6 logr_t + \alpha_7 logP^{die} + \alpha_8 logP^{pet} + \alpha_9 logP^{ker} + \alpha_{10} logP^{elec}, \alpha_{11} logP^{gas} + e_t \quad (4.17)$$

Where P^{die} stands for prices of diesel, P^{pet} for petrol prices, P^{ker} for kerosene prices, P^{elec} for electricity prices and P^{gas} for gas prices.

As CPI and expected CPI are likely to be strongly correlated, therefore we are dropping the variable of expected Prices from the final equation. Moreover money supply and interest rate, both are monetary policy tool, we only include money supply in the final equation. The final equation to be estimated is given as:

$$logCPI = \alpha_o + \alpha_1 logNEER + \alpha_2 logP^f + +\alpha_3 logm_s + \alpha_4 loggdp + \alpha_5 logP^{die} + \alpha_6 logP^{pet} + \alpha_7 logP^{ker} + \alpha_8 logP^{elec} + \alpha_9 logP^{gas} + e_t \quad (4.18)$$

Where:

P: Non-Energy Prices (i.e. CPI excluding energy items)

M_s : Money supply

y_t : Gross domestic product (GDP)

e_t: Nominal effective exchange rate

P_t^f: Foreign prices

P^{die}: Diesel Prices

P^{pet}: Petrol prices

P^{kero}: Kerosene prices

P^{elec}: Electricity prices

P^{gas}: Gas prices

Chapter No 5

Data Description and Econometric Techniques:

5.1 Introduction

This chapter describes the variables, data source and the econometric techniques used in this study. If all the variables have the different order of integration, then Autoregressive distributed Lag (ARDL) model to cointegration is employed by using monthly time series data over the period 2001-7 to 2011-7 (121 observations).

5.2 Data description and data source

To analyze the impact of energy prices (energy price index) on consumer price index (non energy price index), we will use five major components of energy i.e. electricity, diesel, petrol, gas and kerosene. To compute non energy CPI we have excluded the CPI of energy items from the gross CPI. The data span is 2001:7 to 2011:7. The variables used in this study are described below:

5.2.1 Consumer price index (CPI):

To estimate the impact of energy prices index on inflation, we have excluded the contribution of energy components to the aggregate CPI. The non energy CPI, thus computed, is our dependent variable. The data on price indices and weights assigned to each item has been taken from State Bank of Pakistan (SBP).

5.2.2 Energy Price Index:

Energy prices include the prices of electricity, gas and oil (diesel, petrol and kerosene oil). The energy price index has been developed on the basis of weights assigned to each item of energy in the CPI. To estimate the impact of energy price index on CPI (non energy price index), we have constructed the energy price index using the weights assigned to each component of energy in the aggregate CPI. Data on these variables has been obtained from SBP.

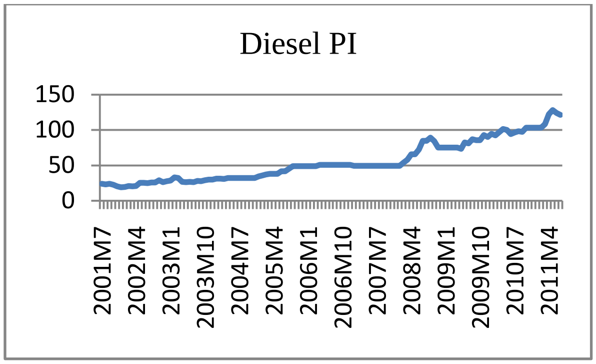
5.2.2.1 Construction of Price Index of Energy Components:

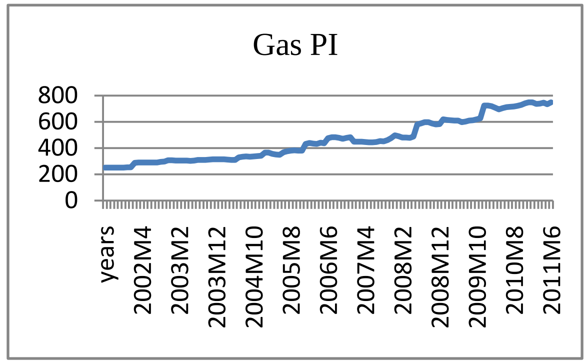
To compute price index (PI) of each energy component e.g. electricity Price index, we have used the data on price index and weight assigned to electricity in the aggregate CPI. To find the electricity (PI), the following formula has been applied.

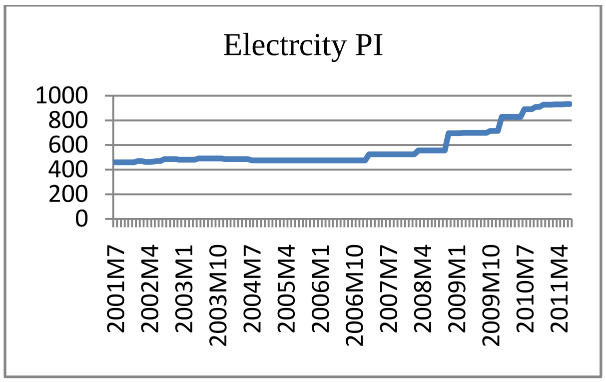
Electricity PI= [(weight assigned to electrcity) / (price index of electrcity)]*(100)

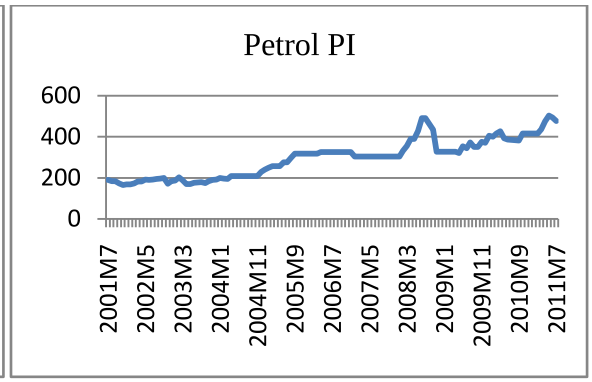
Using this formula, we have constructed index of electricity prices and subtracted this PI from the aggregate CPI. We have computed PI of all energy components i.e. Diesel PI, petrol PI, kerosene PI and gas PI. The sum of these price indices has been subtracted from the aggregate CPI to obtain the non-energy CPI, which is our dependent variable. The prices indices of energy components computed in the manner described earlier are plotted in figure (5.1).

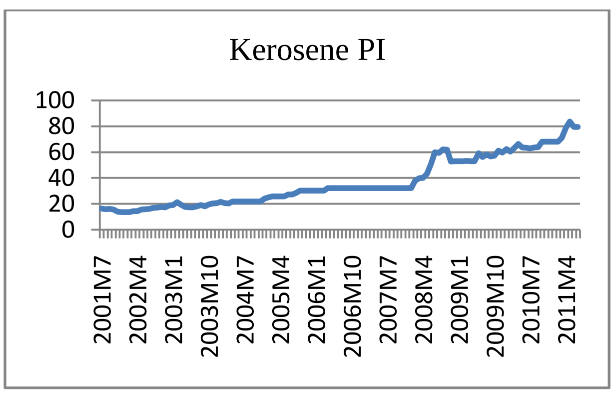
Figure:5.1 Price Indices of Different Energy Components

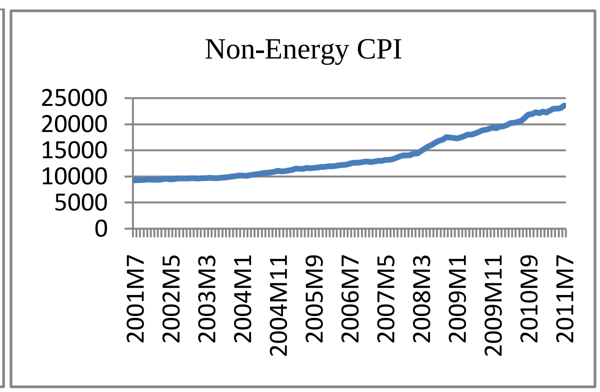












5.2.3 Money Supply (M2)

Money supply (M2) includes money in circulation and all time related deposits, saving deposits and non institutional money market. Data on money supply is from monthly statistical bulletin of State Bank of Pakistan (various issues)

5.2.4 Nominal Effective Exchange Rate

Nominal effective exchange rate is defined as the exchange rate of the local currency vis-à-vis other currencies weighted by their share in the country's international trade. Data on nominal effective exchange rate is from various issues of International Financial Statistics (IFS) a publication of International Monetary Fund (IMF).

5.2.5 Industrial production:

We are using industrial production as a proxy for real income due to non-availability of monthly data on real income. The data source of large scale manufacturing index (LSM) is International Financial Statistics (IFS).

5.2.6 Foreign prices

We use Consumer Price Index (CPI) of United States (US) as proxy for foreign prices. Data on US CPI has been collected from various issues of International Financial Statistics (IFS).

5.3 Statistical Properties of Data Series

The descriptive statistics and correlation matrix of energy components and rest of control variables (money supply, GDP, exchange rate and foreign prices) are given in table (5.1) and table (5.2), respectively.

Table: 5.1 Descriptive Statistics

Variables	Mean	Median	St. div	Max	Min
CPI(Non Energy CPI)	139.60	124.57	43.39	235.94	92.76
Diesel PI	0.55	0.49	0.29	1.28	0.19
Electricity PI	5.77	4.90	1.54	9.32	4.58
Foreign Prices	102.78	103.33	7.68	115.70	90.48
Gas PI	4.57	4.43	1.57	7.47	2.51
GDP	99.08	106.74	21.62	138.06	49.14
Kerosene PI	0.37	0.32	0.19	0.84	0.14
Petrol PI	2.95	3.029	0.93	5.03	1.65
NEER	91.47	97.39	17.79	117.27	61.53
MS	3575845	3405965	6295663	1518430	1430152

Table: 5.2 Correlation Matrix

.

Variables	CPI(Non Energy CPI)	GDP	FP	M2	NEER	Diesel PI	Electricity PI	Petrol PI	Gas PI	Kerosene PI
CPI(Non Energy CPI)	1	-	-	-	-	-	-	-	-	-
GDP	-0.671	1	-	-	-	-	-	-	-	-
FP	0.922	0.84	1	-	-	-	-	-	-	-
M2	0.97	0.80	0.97	1	-	-	-	-	-	-
NEER	-0.98	-0.71	-0.94	-0.97	1	-	-	-	-	-
Diesel PI	0.98	0.70	0.93	0.96	0.96	1	-	-	-	-
Electricity PI	0.94	0.49	0.76	0.86	0.88	0.91	1	-	-	-
Petrol PI	0.88	0.78	0.95	0.92	0.89	0.93	0.73	1	-	-
Gas PI	0.98	0.73	0.94	0.97	0.97	0.97	0.90	0.91	1	-
Kerosene PI	0.98	0.68	0.93	0.96	0.97	0.99	0.91	0.91	0.97	1

Table (5.2) shows that there exists high correlation between all variable. Highest correlation is observed between energy prices (Diesel, Kerosene and Gas prices) and Non Energy CPI.

5.4 Estimation Procedure:

The time series estimation requires the determination of order of integration of each data series. To determine the order of integration, we have used Augmented Dickey Fuller (ADF) and Phillip Perron (PP) test. If all the data series are stationary, the Ordinary Least Square (OLS) can be applied. To capture the long run relationship and the short run dynamics, we apply bound testing approach to cointegration within the framework of Autoregressive distributed lag (ARDL) model developed by Peseran *et al*. (2001). This technique has certain advantages, like it can be applied even if the sample size is small. Secondly, ARDL does not require the order of integration of all data series should be same. Thirdly, both the long run and short run coefficients are estimated together (Khan *et al*. 2005). Therefore, this approach is more appropriate for investigating the underlying relationship.

Now the econometric model for equation (4.18) within the framework of vector error correction model (VECM) can be written as

$$\begin{aligned}\Delta LCPI_t^{NE} &= \beta_0 + \sum_{i=1}^{p}\beta_{1i}\Delta LCPI_{t-i}^{NE} - \sum_{i=0}^{p}\beta_{2i}\Delta LGDP_{t-i} + \sum_{i=0}^{p}\beta_{3i}\Delta LFP_{t-i} + \sum_{i=0}^{p}\beta_{4i}\Delta LM2_{t-i} \\ &+ \sum_{i=0}^{p}\beta_{5i}\Delta LNEER_{t-i} + \sum_{i=0}^{p}\beta_{6i}\Delta LDIE_{t-i} + \sum_{i=0}^{p}\beta_{7i}\Delta LELE_{t-i} + \sum_{i=0}^{p}\beta_{8i}\Delta LPET_{t-i} + \sum_{i=0}^{p}\beta_{9i}\Delta LGAS_{t-i} \\ &+ \sum_{i=0}^{p}\beta_{10i}\Delta LKER + \delta_1 LCPI_{t-1}^{NE} + \delta_2 LGDP + \delta_3 LFP_{t-1} + \delta_4 LM2_{t-1} + \delta_5 LNEER_{t-1} + \delta_6 LDIE_{t-1} \\ &+ \delta_7 LELE_{t-1} + \delta_8 LPET_{t-1} + \delta_9 LGAS_{t-1} + \delta_{10} LKER_{t-1} + \mu_{1t} \quad ------- (5.1)\end{aligned}$$

Where $LDIE, LELE, LPET, LGAS, LKER$ stand for diesel price index, electricity price index, Petrol price index, gas price index and kerosene price index, respectively. All variables are in logarithmic form.

The estimation using ARDL requires selection of lag length of all the data series. Akiake Information Criterion (AIC) and Shawrtz Beysain Criterion (SBC) are the commonly used methods for lag selection. Pesaran and Shin (1999) suggest that SBC is a better method of lag selection. Therefore, we use Sharwts Baseian Criteria) for ARDL estimation. Next, the existence or otherwise of the long run relationship is examined by using F test. The computed values of F test are compared with the critical F-values provided by pesaran *et al*. (2001). These critical values consist of two sets i.e. lower bound and upper bound. If computed F-value is greater than the upper bound, it means that there exists long run relationship between the variables under considerations. If computed F-values lie between upper and lower bounds, then the values lie in the conclusive range.

We estimate the equation (4.18) using ARDL model specification and compare the computed F-values and tabulated F-values. If cointegration is confirmed, the long run coefficients are estimated using the reduced form of ARDL, where all differenced terms are assumed to zero. The final step using ARDL is the estimation of short run dynamics with error correction model

(ECM). ECM shows the speed of adjustment to equilibrium after the short run shock. We test the fairness of model using various diagnostics - serial correlation test, functional form test, normality test, Heteroscedasity and stability test, CUSUM and CUSUM square test.

5.5 Unit root test:

We employ augmented Dickey-Fuller (ADF) and Phillip Perron (PP) test on each data series. The general form of ADF is given by

$$\Delta y_t = \gamma_0 + \gamma_1 y_{t-1} + \gamma_2 \Delta y_{t-1} + \gamma_3 \Delta y_{t-1} + \cdots + \gamma_n \Delta y_{t-n} + \varepsilon_t$$

Where

Δ is the difference operator, y_t is the dependent variable and y_{t-1} is the lag value of the dependent variable. Phillip Perron (PP) test is developed on the basis of Augmented Dickey fuller (ADF). The functional form of PP is as follows

$$\Delta y_t = \gamma_0 + \gamma_1 y_{t-1} + \varepsilon_t$$

The basic difference between ADF and PP test is that the former one is used when data of some variables exhibit greater correlation while the latter one is used to make a correction to remove serial correlation in error terms ε_t .PP test is the modified form of ADF test with lesser restriction on error term. The results of ADF and PP are reported in table (5.3).

Table: 5.3 Results of Unit root test

Dependent variable: Non-Energy Consumer price index		
Variables	Augmented Dickey Fuller (ADF)	Phillips Perron (PP)

	Level	1st difference	Level	1st difference
CPI	3.46	-8.24**	2.78	-8.56**
GDP	-2.29	-3.42**	-2.18	-13.38**
FP	-0.58	-6.70**	-0.55	-5.02**
M2	-3.02**	-4.50**	-3.07**	-13.91**
NEER	0.68	-7.53**	0.73	-7.65**
Diesel	0.07	-10.09**	0.03	-10.07**
Electricity	0.93	-11.32**	1.37	-11.34**
Petrol	-0.48	-9.55**	-0.65	-9.49**
Gas	-0.47	-10.28**	-0.29	-11.59**
Kerosene	-0.19	-9.61**	0.13	-9.59**

Note. All variables are considered in log form. (**) denote the level of significance at 5%. Critical values are taken from Mackinnon (1991).

The results show that all the data series are stationery at 1st difference except money supply which is stationery at level in both cases. The two unit root test, that is ADF and PP yield the same results. The order of integration of all data series is the mixture of 1(0) and 1(1). This order of integration allows us to apply cointegration. Typically, cointegration approach in case mixed order of integration is Autoregressive Distributed Lag (ARDL). Here we have used ARDL.

Chapter No: 6

Results and Interpretations

6.1 Introduction:

This chapter describes the results obtained from estimation of equation (4.18). The equation has been estimated using Autoregressive Distributed Lag (ARDL) model. The first step is to select the optimal lag length of the explanatory variables. Sharwtz Baysien Criterion (SBC) has been used for optimal lag length. This criterion favors 8 lags as optimal. Given that the frequency of our data is monthly, this lag length seems appropriate. To specify the best fit model, we have followed the general to specific approach by eliminating the insignificant variables one by one. After determining the final specification of the model, we have used bound F test to test for long run relationship (Cointegration) among the variables. After confirming the existence of long run relationship, we have estimated the final model with both long and short run with ECM terms. Several diagonestic tests (Serial correlation, Normality test, Functional form, Cumulative Sum (CUSUM) and Cumulative Sum of square (CUSUM Square)) have been conducted.

6.2 Impact of Energy Prices on inflation:

We have estimated the impact of energy Prices on inflation at aggregate level. The following equation has been estimated to confirm the long run relationship among the variables of the equation (6.1).

$$\begin{aligned}\Delta LCPI_t^{NE} &= \beta_0 + \sum_{i=1}^{p}\beta_{1i}\Delta LCPI_{t-i}^{NE} - \sum_{i=0}^{p}\beta_{2i}\Delta LGDP_{t-i} + \sum_{i=0}^{p}\beta_{3i}\Delta LFP_{t-i} + \sum_{i=0}^{p}\beta_{4i}\Delta LM2_{t-i}\\ &+ \sum_{i=0}^{p}\beta_{5i}\Delta LNEER_{t-i} + \sum_{i=0}^{p}\beta_{6i}\Delta LDIE_{t-i} + \sum_{i=0}^{p}\beta_{7i}\Delta LELE_{t-i} + \sum_{i=0}^{p}\beta_{8i}\Delta LPET_{t-i} + \sum_{i=0}^{p}\beta_{9i}\Delta LGAS_{t-i}\\ &+ \sum_{i=0}^{p}\beta_{10i}\Delta LKER + \delta_1 LCPI_{t-1}^{NE} + \delta_2 LGDP + \delta_3 LFP_{t-1} + \delta_4 LM2_{t-1} + \delta_5 LNEER_{t-1} + \delta_6 LDIE_{t-1}\\ &+ \delta_7 LELE_{t-1} + \delta_8 LPET_{t-1} + \delta_9 LGAS_{t-1} + \delta_{10} LKER_{t-1} + \mu_{1t} \quad ------(6.1)\end{aligned}$$

The results obtained from estimation of equation are as follows. The results of bound F test are presented in table (6.I).

Table 6.1 Results of bound F test to Cointegration

Dependent variable	Computed F- values	Critical F-values Upper bound	Lower bound	Co-integration
Non energy PI	13.48	2.16	3.32	Yes

Note: level of significance is 5%

The computed F-value is greater than upper critical bound. Therefore, we reject the null hypothesis of no co-integration. We conclude that there exists long run relationship among non energy CPI, energy Price index (electricity, petrol, diesel, natural gas, and kerosene), money supply, nominal effective exchange rate (NEER), and GDP and foreign prices.

6.2.1 Long run relationship:

After establishing long run relationship among the variables, the following long run model is estimated to obtain the long run coefficients.

$$\Delta LCPI_t^{NE} = \beta_0 + \delta_2 LGDP + \delta_3 LFP_{t-1} + \delta_4 LM2_{t-1} + \delta_5 LNEER_{t-1} + \delta_6 LDIE_{t-1} + \delta_7 LELE_{t-1}$$
$$+ \delta_8 LPET_{t-1} + \delta_9 LGAS_{t-1} + \delta_{10} LKER_{t-1} + \mu_{1t} --------(6.2)$$

The long run coefficients are presented in table (6.2).

Table 6.2 Estimated Coefficients of Long Run Model

Dependent variable: Non-Energy CPI			
Variables	Coefficients	t -statistics	Probability
LGDP	0.03	0.03	0.98

LM2	0.09	3.08	0.00
LNEER	-0.46	-7.85	0.00
LFP	0.37	2.34	0.02
LDIE	0.27	4.73	0.00
LELE	0.43	6.52	0.00
LPET	0.15	6.62	0.00
LGAS	0.05	2.69	0.00
LKER	0.03	0.82	0.41

Note: LDIE, LELE, LPET, LGAS and LKER indicate diesel PI, Electricity, PI, petrol PI, gas PI and kerosene PI, respectively . Level of significance is 5%.

The results suggest that electricity PI positively influences inflation (non energy CPI). The coefficient of electricity PI indicates that a one percent increase in electricity PI will increase the non-energy CPI by some 0.43 percent on average in the long run. The reason that higher prices affect consumer prices in the long run is that electricity is an important factor in the production process. Firstly, higher electricity prices mean higher cost of energy for the producers resulting in higher overall cost of production. Due to increase in cost of production, output level goes down. Secondly, as electricity is a component of CPI so when electricity price increases, it leads to a direct increase in general CPI or an inflationary shock [Gordon (1997) and Hooker (2002))] which can be accompanied by second round effects through price-wage spiral. Thirdly, the extent of higher electricity prices depends on the share of electricity PI in total CPI.

As evident from above table (6.2) both diesel and petrol prices positively affect the CPI in long run, while the effects of kerosene prices are positive but statistically insignificant. Our results indicate that a one percent increase in the price of diesel leads to an increase in non-energy CPI by 0.27 percent while in case of petrol, a one percent increase in price leads to an increase in non-energy CPI by 0.15 percents in the long run. The positive influence of petrol and diesel prices on non energy CPI is in conformity with literature [(Barbidge and Harrison (1984), Mork

(1989), Hamilton (1996), Hooker (1996, 2002), Barsky and Kilian (2004), Tang *et al.* (2010) and

Table (6.3): Estimated Short Run Coefficients of ARDL model

many others]. The reason could be that now the monetary authorities are more concerned about controlling inflation. Another reason could be that due to competitive market, producers are not able to fully pass on the increase in oil prices. The long run coefficient of Gas shows that a one percent increase in gas prices increases non-energy CPI by 0.5 percent. The long run coefficient of gas is highly significant but is smaller as compared to other three components. The coefficient of Kerosene CPI shows that a one percent increase in kerosene PI leads to increase non-energy CPI by 0.3 percent but is statistically insignificant. The reason could the smaller weight of kerosene in the aggregate CPI and share of kerosene in total energy consumption mix. All the control variables i.e. foreign prices, money supply and exchange rate influences the non energy CPI. Foreign prices positively influence non-energy CPI. Table (6.2) shows that one percent increase in foreign prices increases non energy CPI by 0.37 percent. This shows that Pakistan's economy is sufficiently integrated with the global economy. Increase in money supply also influences the non-energy CPI, while the impact of exchange rate changes on CPI is negative.

6.2.2 Short Run Model:

The short run dynamics are obtained by estimating the following equation (6.3) of short run model.

$$\Delta LCPI_t^{NE} = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta LCPI_{t-i}^{NE} - \sum_{i=0}^{p} \beta_{2i} \Delta LGDP_{t-i} + \sum_{i=0}^{p} \beta_{3i} \Delta LFP_{t-i} + \sum_{i=0}^{p} \beta_{4i} \Delta LM2_{t-i}$$
$$+ \sum_{i=0}^{p} \beta_{5i} \Delta LNEER_{t-i} + \sum_{i=0}^{p} \beta_{6i} \Delta LDIE_{t-i} + \sum_{i=0}^{p} \beta_{7i} \Delta LELE_{t-i} + \sum_{i=0}^{p} \beta_{8i} \Delta LPET_{t-i} + \sum_{i=0}^{p} \beta_{9i} \Delta LGAS_{t-i}$$
$$+ \sum_{i=0}^{p} \beta_{10i} \Delta LKER + ECM(-1) - - - - - - - - (6.3)$$

variable	At level	1st lag	2nd lag	3rd lag	4th lag	5th lag	6th lag	7th lag	8th lag
LELE	---	0.13 (5.88)	0.096 (4.91)	0.221 (8.43)	0.117 (5.65)	0.14 (4.88)	0.14 (8.43)	0.114 (3.27)	---
LDIE	0.063 (11.25)	0.102 (4.63)	0.113 (7.77)	---	0.157 (3.41)	0.045 (2.74)	-0.060 (- 3.61)	---	
LPET	0.071 (3.19)	0.119 (5.27)	---	---	0.191 (9.82)	---	0.094 (4.928)	-0.165 (-5.22)	
LGAS	---	---	---	0.069 (3.66)	---	0.045 (2.19)	0.124 (5.37)	---	
LKER	0.197 (7.66)	0.227 (9.49)	---	---	0.186 (7.21)	0.164 (7.11)	---	0.191 (6.83)	0.075 (4.90)
LM2	0.088 (2.95)	0.226 (5.15)	0.229 (7.17)	0.061 (2.67)	---	---	---	-0.294 (-5.99)	
LFP	0.467 (2.49)	1.24 (6.58)	0.354 (2.04)	---	-1.22 (-5.66)	---	---	---	1.08 (4.51)
LGDP	-0.053 (-7.80)	---	---	---	---	-0.045 (-7.72)	-0.053 (-6.92)	---	-0.014 (-1.94)
LNEER	-0.510 (-11.2)	-.208 (4.21)	-0.548 (-8.41)	0.211 (4.33)	0.198 (3.33)	0.185 (3.02)	0.224 (4.27)	---	0.38 (5.79)
LCPI	---	0.183 2.63	---	---	---	-0.453 -4.86	-0.451 -4.645	---	
ECM(-1)	---	-0.547 (-12.21)	---	---	---	---	---	---	
C	2.76 (12.24)	---	---	---	---	---	---	---	
R-squared		0.86	Akeike Info,Criterion			-7.489	Durbin-Watson	1.85	
Adjusted R-Squared		0.69	Sharwz Baysian Criterion			-5.960			

The results of short run model are shown in table (6.3).

The results show that in short run coefficient of electricity PI indicates that a one percent increase in electricity PI tends to increase non-energy CPI by some 0.09 to 0.22 percent point at different lags and is highly significant. The increase in electricity prices has no immediate effects on non-energy CPI. Its effects start in the second month and continue until the eighth month with the stronger short run effects occurring in the fourth month. The short run effects are similar to long run effects. The short run coefficients show that the effect of increase in of prices of diesel and petrol leads to an inflation and continues upto six month. The only difference is that between short and long run coefficients is that the magnitude is smaller as compared to long run. The short run coefficients of kerosene prices indicate that increase in kerosene prices leads to increase non energy CPI upto ninth month. The corresponding short run coefficients of gas prices indicate that the effects of increase in Gas price start in fourth month and continue till the seventh month. The coefficient of error correction term (ECT) is -0.54 which indicates that if the long run equilibrium is disturbed by exogenous shock, it will take almost two months for the economy to reach new equilibrium.

6.2.3 Diagonestic test:

The results of various diagonestic tests applied on equation (6.1) are presented in table (6.4). The results show that there is no evidence of serial correlation, non normality and misspecification of functional form and heteroscedasticity.

Table (6.4) ARDL-VECM Model Diagonestic Tests

Results of Diagonestic Test:			
Serial Correlation	$\chi2(1)$=(0. 12)	Normality	$\chi2(2)$= (0.88)
Functional Form	$\chi2(1)$= (0.27)	Heteroscedasticity	$\chi2(1)$= (0.26)

The plots of CUSUM and CUSUM square stability tests are shown in figure (6.1) and figure (6.2) respectively. The figures indicate the stability of the coefficients as they lie within the bounds.

Figure (6.1)

Plot of Cumulative Sum of Recursive Residuals

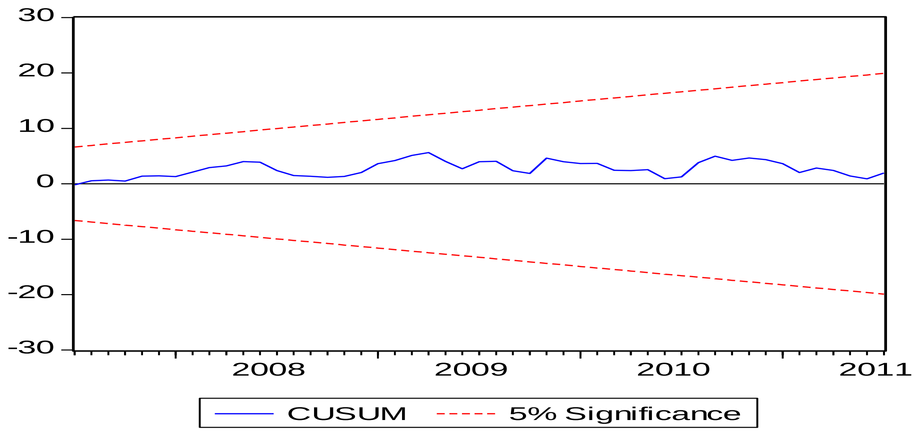
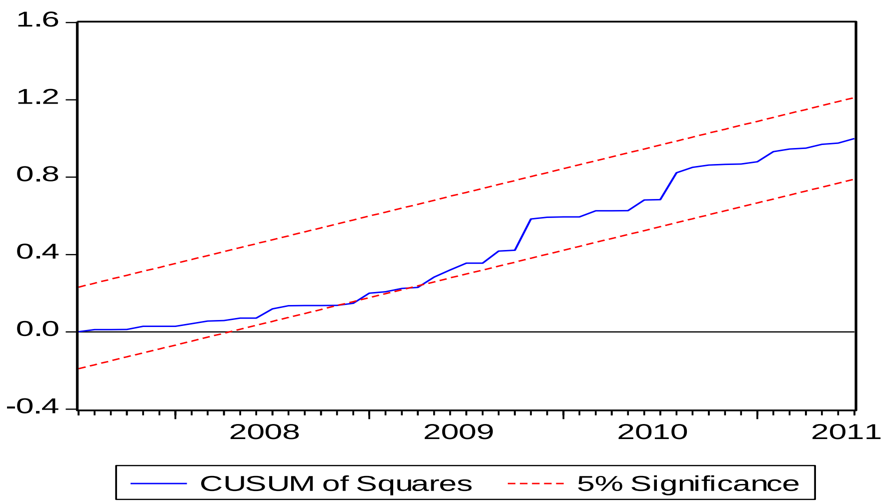


Figure (6.2)

Plot of Cumulative Sum of Squares of Recursive Residuals



6.3 Component Wise Analysis of Impact of Energy Prices on Inflation:

We have estimated the impact of individual energy components on inflation using the procedure described in the main text for estimating the impact of energy PI on non energy CPI[1]. The results are shown in Appendix B. To allow comparison between the coefficients obtained from aggregate and disaggregate analysis the long run coefficients from both types of analysis are shown in table 6.5

Table: 6.5 Comparison of long run coefficients at aggregate and disaggregated level

[1] The difference between the aggregate and disaggregate analysis that in the former case we have excluded all the energy components from the Consumer Price Index while in the latter case we excluded only the specific energy component from the consumer price index the impact of which on inflation is being investigated.

Dependent variable is non energy price index	Dependent variable: non -electricity price index, non-diesel price index, non-petrol price index, non-gas price index and non-kerosene price index, respectively					
Variables	Coefficients					
	Aggregate	Disaggregate				
GDP	0.003 (0.03)	-0.004 (-0.56)	-0.028 (-2.48)	-0.021 (-2.56)	-0.020 (-2.51)	-0.031 (-3.13)
Money supply	0.088 (3.08)	0.096 (4.98)	0.051 (2.96)	0.017 (1.06)	0.011 (60.8)	0.0478 (2.62)
Exchange rate	-0.460 (-7.86)	-0.115 (-5.56)	-0.036 (-2.64)	-0.258 (-4.13)	-0.163 (-6.29)	-0.156 (-2.76)
Foreign Prices	0.367 (2.34)	0.553 (5.16)	0.351 (4.08)	0.217 (3.03)	0.229 (4.29)	0.132 (1.67)
Electricity	0.429 (6.52)	0.465 (4.05)	---	---	---	---
Diesel	0.273 (4.73)	---	0.372 (4.72)	---	---	---
Petrol	0.145 (6.62)	---	---	0.178 (4.25)	---	---
Gas	0.051 (2.69)	---	---	---	0.123 (4.77)	---
Kerosene	0.027 (0.82)	---	---	---	---	0.091 (4.88)

Note: t-Statistics are in parenthesis and level of significance is 5%.

It is evident from the results shown in the table the difference between the results obtained from the aggregate and disaggregate analysis is negligible.

Chapter No 7

Summary and Conclusion

We set for ourselves the task of examining the impact of energy prices (electricity, diesel, petrol, kerosene and gas) on inflation in Pakistan. Though some studies have examined the effects of crude oil prices (a proxy of energy prices) on macroeconomic variables, none of these studies have examined the impact of energy prices both at aggregate and disaggregate. In Pakistan, the impact of energy prices has been discussed by researchers but mainly in the context of the relationship with economic growth but do not account for the impact of energy prices (electricity, natural gas etc) on inflation. As electricity and gas constitutes a major share of total energy consumed in the country, it is important to examine the impact of energy prices by accounting for all energy components. It is also important to examine the impact of change in price of individual energy components on inflation because different component of energy are frequently substituted for one another e.g. gas for oil.

The investigation of impact of energy prices and inflation is important because the rising trend of energy prices has been a major cause of reduction in output, inflation and both in developed and developing countries. We have estimated the impact of change in energy PI on non energy CPI using monthly data. The time span is 2001:7-2011:7. The individual impact of energy components on inflation has also been estimated in similar manner. The ARDL bound testing approach to co integration has been employed to find out the presence of long run relationship between energy prices and inflation. The results show that energy prices positively affect inflation. The magnitude of various energy components does vary. The major contributor to non energy CPI is electricity prices. The main reason is that electricity consumption dominates the energy consumption mix. This is evident from the weights assigned to the different components of energy PI e.g. electricity (4.37), diesel (0.17) etc. The next higher contributors are diesel, petrol and gas in that order. The impact of kerosene prices on inflation is insignificant. The primary reason is that share of kerosene in the energy consumption mix is very small. A disaggregated analysis of the impact of prices of energy components is broadly in conformity with the results discussed above except that the coefficients in the disaggregated analysis are larger.

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APPENDIX: A

Specification of ARDL model:

Following Pesaran *et al* (2001), the general form of the error correction model is given by:

$$Y_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i Y_{t-i} + \sum_{j=0}^{m} \beta_j X_{t-j} + u_t \quad (5.1)$$

or

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \cdots + \alpha_n Y_{t-n} + \beta_0 X_t + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \cdots + \beta_n X_{t-m} + u_t \quad (5.1)*$$

Where Y_t is dependent variable and X_t is independent variable

Here, β_0 denotes the impact of X_t on Y_t in short run and long run coefficients are estimated as

$$Y_t = Y_{t-1} = Y_{t-2} = \cdots = Y_{t-n} = Y_t^* \quad (a)$$

and

$$X_t = X_{t-1} = X_{t-2} = \cdots = X_{t-n} = X_t^* \quad (b)$$

Substituting (a) and (b) into equation (5.1), we have

$$Y_t^* = \alpha_0 + \alpha_1 Y_t^* + \alpha_2 Y_t^* + \cdots + \alpha_n Y_t^* + \beta_0 X_t^* + \beta_1 X_t^* + \beta_2 X_t^* + \cdots + \beta_n X_t^* + u_t$$

Resetting the terms, we obtain $Y_t^*(1 - \alpha_1 - \alpha_2 - \cdots - \alpha_n) = \alpha_0 + (\beta_0 + \beta_1 + \beta_2 + \cdots + \beta_n)X_t^* + u_t$

$$Y_t^* = \frac{\alpha_0}{(1-\alpha_1-\alpha_2-\cdots-\alpha_n)} + \frac{(\beta_0+\beta_1+\beta_2+\cdots+\beta_n)}{(1-\alpha_1-\alpha_2-\cdots-\alpha_n)} X_t^* + u_t$$

or

$$Y_t^* = A + B.X_t^* + u_t$$

The long run multiplier is given by $B = \frac{(\beta_0+\beta_1+\beta_2+\cdots+\beta_n)}{(1-\alpha_1-\alpha_2-\cdots-\alpha_n)}$.

Now we can use equation (5.1) to derive Error Correction Mechanism (ECM) as under;

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \cdots + \alpha_n Y_{t-n} + \beta_0 X_t + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \cdots + \beta_n X_{t-m} + \varepsilon_t$$

Y_t can be written as

$$Y_t = Y_t - Y_{t-1} + Y_{t-1}$$

$$Y_t = \Delta Y_t + Y_{t-1} \quad (c)$$

Likewise X_t can be written as

$$X_t = \Delta X_t + X_{t-1} \quad (d)$$

Substituting the value of X_t and Y_t from (c) and (d) into equation (5.1), we obtain

$$\Delta Y_t + Y_{t+1} = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \cdots + \alpha_n Y_{t-n} + \beta_0 \Delta X_t + \beta_0 X_{t+1} + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \cdots$$
$$+ \beta_n X_{t-m} + \varepsilon_t \quad (5.2)$$

Rearranging the values, we obtain:

$$\Delta Y_t = \alpha_0 + (\alpha_1 - 1)Y_{t-1} + \alpha_2 Y_{t-2} + \cdots + \alpha_n Y_{t-n} + \beta_0 \Delta X_t + \beta_0 X_{t-1} + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \cdots$$
$$+ \beta_n X_{t-m} + \varepsilon_t \quad (5.3)$$

Y_{t-1} can be written as

$$Y_{t-1} = Y_{t-1} - Y_{t-2} + Y_{t-2}$$

$$Y_{t-1} = \Delta Y_{t-1} + Y_{t-2} \quad (e)$$

Correspondingly X_{t-1} can be written as

$$X_{t-1} = \Delta X_{t-1} + X_{t-2} \quad (f)$$

Substituting, value of X_{t-1} and Y_{t-1} from (e) and (f) into equation (5.3)

$$\Delta Y_t = \alpha_0 + (\alpha_1 - 1)\Delta Y_{t-1} + (\alpha_1 - 1)Y_{t-2} + \alpha_2 Y_{t-2} + \cdots + \alpha_n Y_{t-n} + \beta_0 \Delta X_t + \beta_0 X_{t-1}$$
$$+ \beta_1 \Delta X_{t-1} + \beta_1 X_{t-2} + \beta_2 X_{t-2} + \cdots + \beta_n X_{t-m} + \varepsilon_t \quad (5.4)$$

Rearranging the terms with Y_{t-2} ,

$$\Delta Y_t = \alpha_0 + (\alpha_1 - 1)\Delta Y_{t-1} + \alpha_1 Y_{t-2} + (\alpha_2 - 1)Y_{t-2} + \cdots + \alpha_n Y_{t-n} + \beta_0 \Delta X_t + \beta_0 X_{t-1}$$
$$+ \beta_1 \Delta X_{t-1} + \beta_1 X_{t-2} + \beta_2 X_{t-2} + \cdots + \beta_n X_{t-m} + \varepsilon_t \quad (5.5)$$

Y_{t-2} can be written as

$$Y_{t-2} = Y_{t-2} - Y_{t-3} + Y_{t-3}$$

$$Y_{t-2} = \Delta Y_{t-2} + Y_{t-3} \quad (g)$$

Similarly X_{t-2} can be written as

$$X_{t-2} = \Delta X_{t-2} + X_{t-3} \quad (h)$$

Putting the value of X_{t-2} and Y_{t-2} from (g) and (h) into equation (5.5)

$$\Delta Y_t = \alpha_0 + (\alpha_1 - 1)\Delta Y_{t-1} + \alpha_1 Y_{t-2} + (\alpha_2 - 1)\Delta Y_{t-2} + (\alpha_2 - 1)Y_{t-3} + \cdots + \alpha_n Y_{t-n} + \beta_0 \Delta X_t$$
$$+ \beta_0 X_{t-1} + \beta_1 \Delta X_{t-1} + \beta_1 X_{t-2} + \beta_2 \Delta X_{t-2} + \beta_2 X_{t-3} + \cdots + \beta_n X_{t-m} + \varepsilon_t \quad (5.6)$$

The process of substitution continues in the same fashion up-till Y_{t-n} and X_{t-n}, we obtain

$$\Delta Y_t = \alpha_0 + (\alpha_1 - 1)\Delta Y_{t-1} + (\alpha_2 - 1)\Delta Y_{t-2} + \cdots + (\alpha_{n-1} - 1)\Delta Y_{t-n-1} + \beta_0 \Delta X_t + \beta_1 \Delta X_{t-1}$$
$$+ \beta_2 \Delta X_{t-2} + \cdots + \beta_{m-1} \Delta X_{t-n-1} + \alpha_1 Y_{t-2} + \alpha_2 Y_{t-3} + \cdots + \alpha_n Y_{t-(n+1)} + \beta_0 X_{t-1}$$
$$+ \beta_1 X_{t-2} + \beta_2 X_{t-3} + \cdots + \beta_n X_{t-(m+1)} + \varepsilon_t \; (5.7)$$

The long run takes the following form process takes the form as follows

$$Y_t = Y_{t-1} = Y_{t-2} = \cdots = Y_{t-n}$$

$$X_t = X_{t-1} = X_{t-2} = \cdots = X_{t-n}$$

Substituting the terms $X_{t-2}, X_{t-3}, \dots, X_{t-n}$ with X_{t-1} and $Y_{t-2}, Y_{t-3}, \dots, Y_{t-n}$ with Y_{t-1} in (5.7)

$$\Delta Y_t = \alpha_0 + (\alpha_1 - 1)\Delta Y_{t-1} + (\alpha_2 - 1)\Delta Y_{t-2} + \cdots + (\alpha_{n-1} - 1)\Delta Y_{t-n-1} + \beta_0 \Delta X_t + \beta_1 \Delta X_{t-1}$$
$$+ \beta_2 \Delta X_{t-2} + \cdots + \beta_{m-1} \Delta X_{t-n-1} + \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \cdots + \alpha_n Y_{t-1} + \beta_0 X_{t-1}$$
$$+ \beta_1 X_{t-1} + \beta_2 X_{t-1} + \cdots + \beta_n X_{t-1} + \varepsilon_t \quad (5.8)$$

Let $a_i = (\alpha_i - 1)$

$$\Delta Y_t = \alpha_0 + a_1 \Delta Y_{t-1} + a_2 \Delta Y_{t-2} + \cdots + a_{n-1} \Delta Y_{t-n-1} + \beta_0 \Delta X_t + \beta_1 \Delta X_{t-1} + \beta_2 \Delta X_{t-2} + \cdots$$
$$+ \beta_{m-1} \Delta X_{t-n-1} + \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \cdots + \alpha_n Y_{t-1} + \beta_0 X_{t-1} + \beta_1 X_{t-1} + \beta_2 X_{t-1}$$
$$+ \cdots + \beta_n X_{t-1} + \varepsilon_t \quad (5.9)$$

Applying summation, we obtain

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{n-1} a_i \Delta Y_{t-i} + \sum_{j=1}^{m-1} a_j \Delta X_{t-j} + (\alpha_1 + \alpha_2 + \cdots + \alpha_n - 1) Y_{t-1} + (\beta_0 + \beta_1 + \beta_2 + \cdots$$
$$+ \beta_n) X_{t-1} + \varepsilon_t \quad (5.10)$$

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{n-1} a_i \Delta Y_{t-i} + \sum_{j=1}^{m-1} a_j \Delta X_{t-j} + \gamma_1 Y_{t-1} + \gamma_2 X_{t-1} + \varepsilon_t \quad (5.10)$$

Where $\gamma_1 = (\alpha_1 + \alpha_2 + \cdots + \alpha_n - 1)$ and $\gamma_2 = \beta_0 + \beta_1 + \beta_2 + \cdots + \beta_n$

APPENDIX: B

Component Wise Analysis of Impact of Energy Prices on Inflation:

The Final equation for impact of electricity prices, diesel prices, petrol prices, gas prices and kerosene prices on inflation is estimated, respectively[1]. The results of F-bound test to cointegration are given below in tables.

Table B.1 Results of bound test to Cointegration

Dependent variable	Computed F- values	Critical F-values		Co-integration
		Upper bound	Lower bound	
Non Electricity PI	9.99	2.6	3.75	Yes
Non Diesel PI	9.82	2.6	3.75	Yes
Non Petrol PI	24.01	2.6	3.75	Yes
Non Kerosene PI	13.26	2.6	3.75	Yes
Non Natural Gas PI	35.98	2.6	3.75	Yes

Note: All F-values are significant at 5% level of significance

Table B-2 Impact of Electricity PI on Non-Electricity CPI

Estimated Coefficients of Long Run Model

Dependent variable: CPI excluding Electricity CPI			
Variables	Coefficients	t-statistics	Probability
LGDP	-0.04	-0.562	0.58
LM2	0.097	4.979	0.00
LNEER	-0.115	-5.557	0.00
LFP	0.554	5.163	0.00
LELE	0.466	4.054	0.00

Note: LELE, LGDP, LM_2, LNEER,.LFP indicate, Electricity PI, Gross Domestic Product, Money Supply, Exchange Rate and Foreign Prices respectively.
Level of significance is 5%

Table: B-3 Impact of Electricity PI on Non-Electricity CPI

Estimated Short Run Coefficients and Error Correction Term of ARDL model

Variables	Coefficient at level	1st lag	2nd lag	3rd lag	4th lag	5th lag	6th lag	7th lag	8th lag
LELE	---	0.421 (2.09)	0.231 (1.99)	---	---	---	0.336 (1.733)	---	---
LM2	0.066 (2.26)	---	---	---	---	---	0.0744 (2.33)	---	-0.064 (-1.59)
LFP	0.729 (4.031)	-0.402 (-2.215)	---	---	---	---	---	---	---
LGDP	-0.021 (-2.262)	---	-0.0143 (-1.844)	---	---	-0.0158 (-2.287)	-0.011 (-1.921)	---	---
LNEER	-0.198 (-4.495)	-0.100 (-1.672)	---	---	0.197 (3.104)	---	---	---	0.080 (1.687)
ECM(-1)	-0.1165 (3.45)	---	---	---	---	---	---	---	---
R-Squared		0.64	Akaike Info. criterion			-7.21	Durbin Watson		1.95
Adjusted R-Squared		0.54	Sharwts Baysian Criterion			-6.95			

Table B-4 Impact of Electricity PI on Non-Electricity CPI

ARDL-VECM Model Diagonestic Tests

Results of Diagonestic Test			
Serial Correlation	$\chi_2(1)=(0.610)$	Normality	$\chi_2(2)= (0.46)$
Functional Form	$\chi_2(1)= (0.51)$	Heteroscedasticity	$\chi_2(1)= (0.82)$

Impact of Electricity PI on Non-Electricity CPI

Figure B-1 Plot of Cumulative Sum of Recursive Residuals

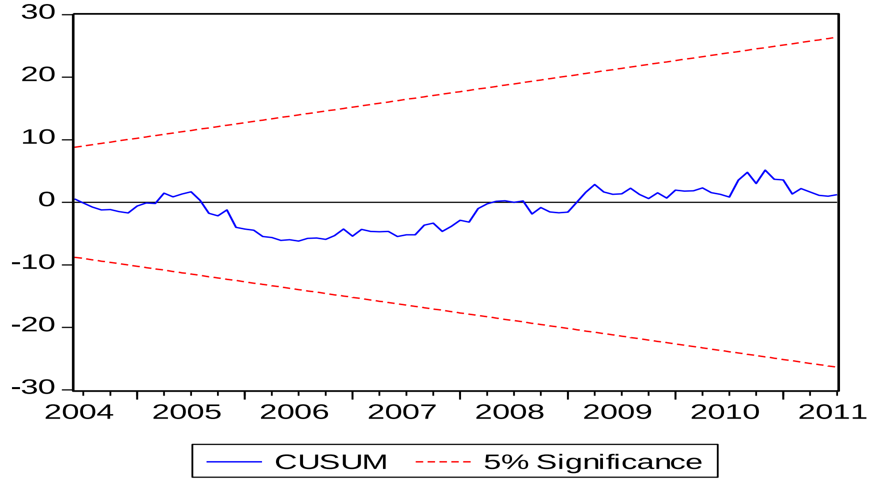
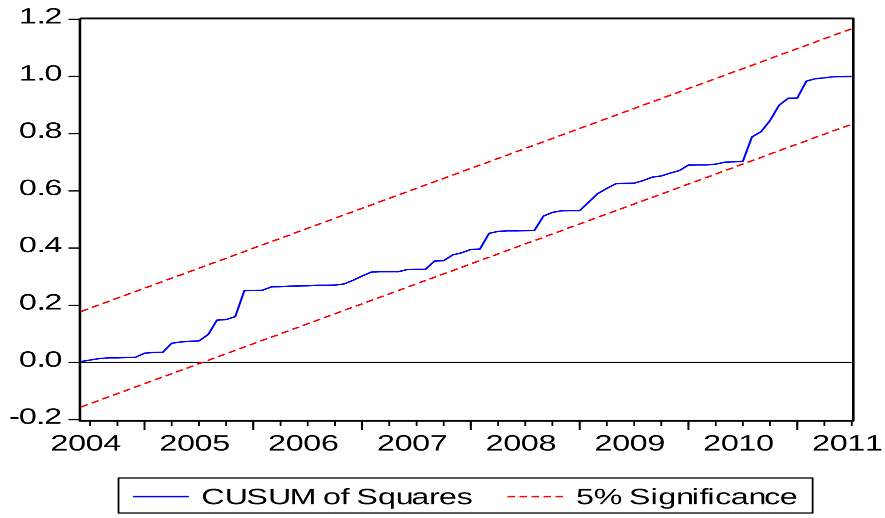


Figure B-2 Plot of Cumulative Sum of Squares of Recursive Residuals



Impact of Diesel PI on Non-Diesel CPI

Table B-5 Estimated Long Run Coefficients using ARDL Approach

Dependent variable: CPI excluding Diesel CPI			
Variables	Coefficients	t -statistics	Probability
LGDP	-0.028	-2.84	0.005
LM2	0.051	2.95	0.004
LNEER	-0.036	-2.64	0.009
LFP	0.550	0.88	0.379
LDIE	0.372	4.73	0.000

Note: LDIE, LGDP, LM_2, LNEER,.LFP indicate, Diesel PI, Gross Domestic Product, Money Supply, Exchange Rate and Foreign Prices respectively.
Level of significance is 5%.

Impact of Diesel PI on Non-Diesel CPI

Table B-6 Short Run Coefficients and Error Correction Term for ARDL Model

Variables	Coefficients at level	1st lag	2nd lag	3rd lag	4th lag	5th lag	6th lag	7th lag	8th lag
LDIE	---	0.237 (2.961)	0.135 (3.12)	---	---	---	---	0.117 (1.642)	---
LM2	0.299 (2.106)	---	---	---	---	---	0.108 (3.89)	---	-0.077 (-1.74)
LFP	0.729 (4.031)	0.402 (2.215)	---	---	---	---	---	---	---
LGDP	---	---	---	-0.0201 (-2.593)	---	---	---	0.0143 (2.175)	---
LNEER	-0.174 (-4.321)	0.100 (1.872)	---	---	-0.138 (-2.92)	---	-0.091 (-1.83)	---	0.080 (1.68)
ECM(-1)	-0.058 (2.57)	---	---	---	---	---	---	---	---
R-squared		0.58	Akaike info. Criterion			-7.24	Durbin Watson		2.05
Adjusted R-squared		0.54	Sharwtz baysian Criterion			-6.80			

Note: t values are in parenthesis. Level of significance is 5%.

Impact of diesel PI on Non-Diesel CPI
Table B-7 ARDL-VECM Model Diagonestic Tests

Results of Diagonestic Test			
Serial Correlation	$\chi_2(1)$=(0. 96)	Normality	$\chi_2(2)$= (0.658)
Functional Form	$\chi_2(1)$= (0.63)	Heteroscedasticity	$\chi_2(1)$= (0.95)

Figure B-3 Plot of Cumulative Sum of Recursive Residuals

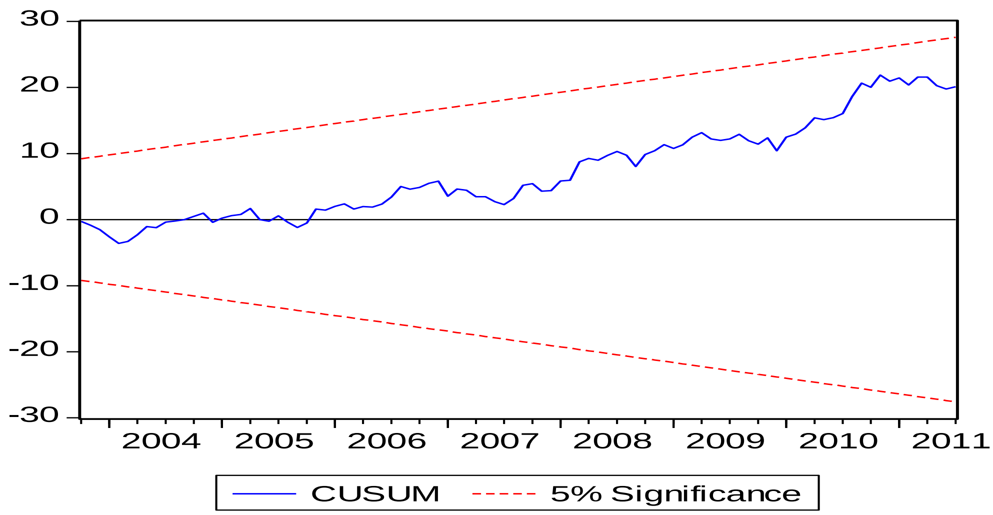
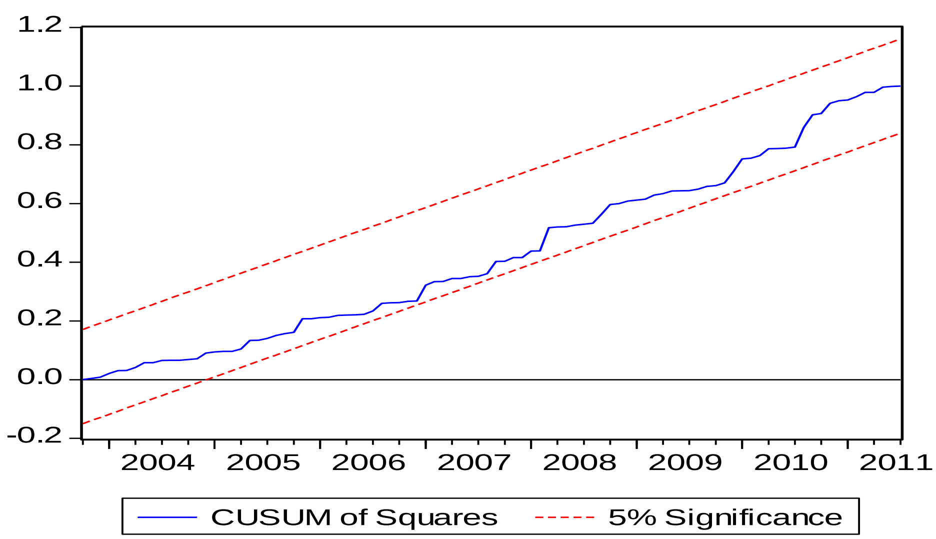


Figure B-4 Plot of Cumulative Sum of Squares of Recursive Residuals



Impact of Petrol Prices on Non Petrol CPI

Table B-8 Estimated Long Run Coefficients of ARDL Model

Dependent variable: CPI excluding Petrol CPI			
Variables	Coefficients	t -statistics	Probability
LGDP	-0.021	-2.556	0.012
LM2	0.017	1.059	0.292
LNEER	-0.258	-4.125	0.000
LFP	0.217	3.033	0.003
LPET	0.178	4.253	0.000

Note: LPET, LGDP, $LM_{2,}$ LNEER, LFP indicate, Petrol PI, Gross Domestic Product, Money Supply, Exchange Rate and Foreign Prices respectively.
Level of significance is 5%.

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Impact of Petrol Prices on Non Petrol CPI

Table B-9 Short Run Coefficients and Error Correction Term for ARDL Model

Variables	Coefficients at level	1st lag	2nd lag	3rd lag	4th lag	5th lag	6th lag	7th lag	8th lag
LPET	---	0.031 (2.64)	0.225 (1.99)	---	---	---	---		---
LM2		0.091 (2.87)	---	---	---	---	0.084 (2.38)	---	
LFP			---	---	---	---	---	---	---
LGDP	-0.029 (-3.12)	---	---	0.016 (2.03)	---	---	---		---
LNEER	-0.246 (-3.15)		---	---	0.133 (2.70)	---		---	
ECM(-1)	-0.071 (3.81)	---	---	---	---	---	---	---	---
R-squared		0.552	Akeike Info. Criterion			-7.22	Durbin Watson		2.06
Adjusted R-squared		0.48	Sharwtz Baysian Criterion			-6.82			

Note: t-values are in parenthesis.

Impact of Petrol Prices on Non Petrol CPI

Table B-10 ARDL-VECM Model Diagonestic Tests

Results of Diagonestic Test			
Serial Correlation	$\chi_2(1)=(0.76)$	Normality	$\chi_2(2)=(0.98)$
Functional Form	$\chi_2(1)=(0.51)$	Heteroscedasticity	$\chi_2(1)=(0.92)$

Figure B-5 Plot of Cumulative Sum of Recursive Residuals

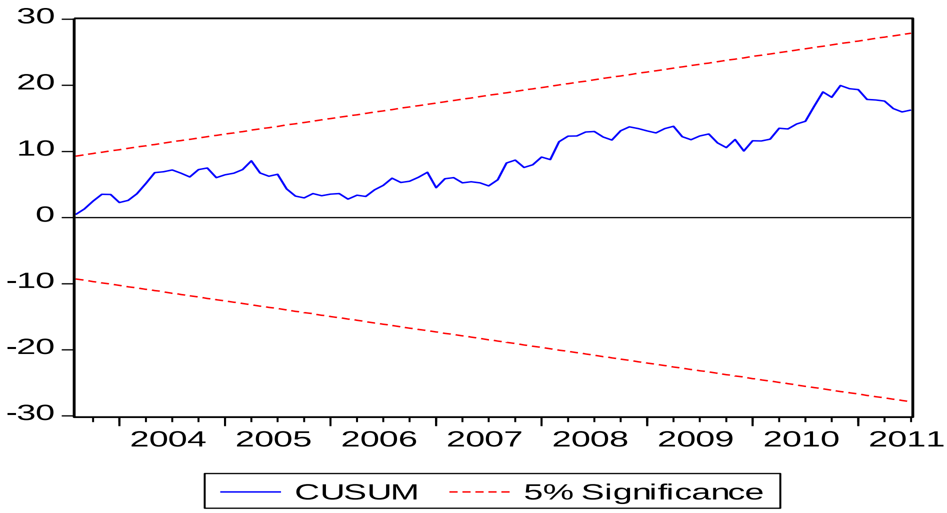
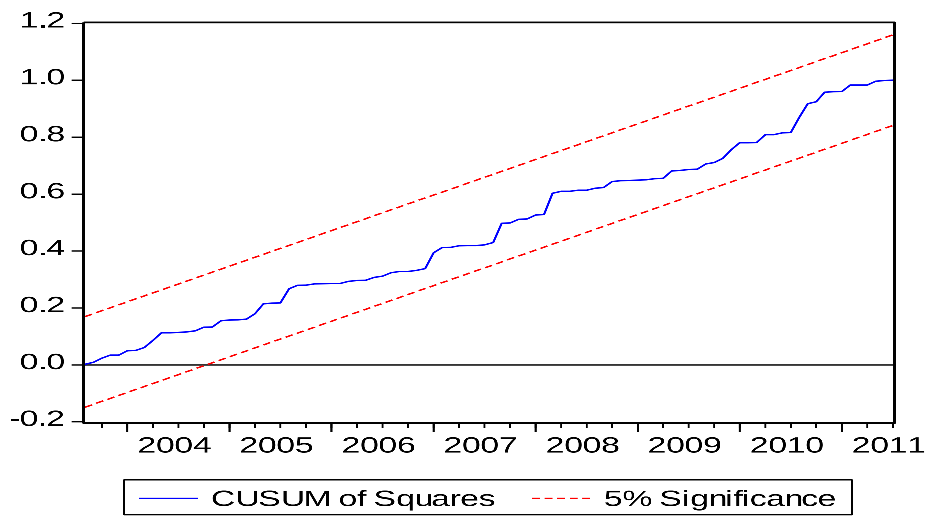


Figure B-6 Plot of Cumulative Sum of Squares of Recursive Residuals



Impact of Kerosene Prices on Non Kerosene Prices

Table B- 11 Estimated Coefficients of Long Run model

Dependent variable: CPI excluding Kerosene CPI			
Variables	Coefficients	T -statistics	Probability
LGDP	-0.030	-3.131	0.002
LM2	0.046	2.618	0.010
LNEER	-0.156	-2.784	0.006
LFP	0.132	1.667	0.099
LKER	0.011	1.147	0.254

Note: LKER, LGDP, $LM_{2,}$ LNEER,.LFP indicate, Kerosene PI, Gross Domestic Product, Money Supply, Exchange Rate and Foreign Prices respectively.
Level of significance is 5%.

Impact of Kerosene Prices on Non Kerosene Prices

Table: B-12 Short Run Coefficients and Error Correction Term for ARDL Model

Variables	Coefficients at level	1st lag	2nd lag	3rd lag	4th lag	5th lag	6th lag	7th lag	8TH lag
LKER	---	0.060 (3.89)	0.051 (3.36)	---	---	---	---	---	---
LM2	---	---	---	---	---	---	0.131 (3.89)	0.076 (1.94)	-0.114 (-2.82)
LFP	0.392 2.219	-0.327 (-1.79)	---	---	---	---	---	---	---
LGDP	-0.040 (-4.23)	---	---	0.02 (2.75)	---	---	---	0.020 (2.481)	---
LNEER	-0.169 (-3.50)	0.093 (1.78)	---	---	0.180 (3.67)	---	-0.106 (-2.18)	---	---
ECM(-1)	-0.062 (2.796)	---	---	---	---	---	---	---	
R –squared		0.69	Akieke Info. criterion			-7.301	Durbin Watson		2.15
Adjusted R-squared		0.54	Shawrtz baysian criterion			-6.815			

Note: t-values are in parenthesis

Impact of Kerosene Prices on Non- Kerosene CPI
Table B-13 ARDL-VECM Model Diagonestic Tests

Results of Diagonestic Test			
Serial Correlation	$\chi_2(1)$=(0.925)	Normality	$\chi_2(2)$= (0.71)
Functional Form	$\chi_2(1)$= (0.34)	Heteroscedasticity	$\chi_2(1)$= (0.98)

Figure B-7 Plot of Cumulative Sum of Recursive Residuals

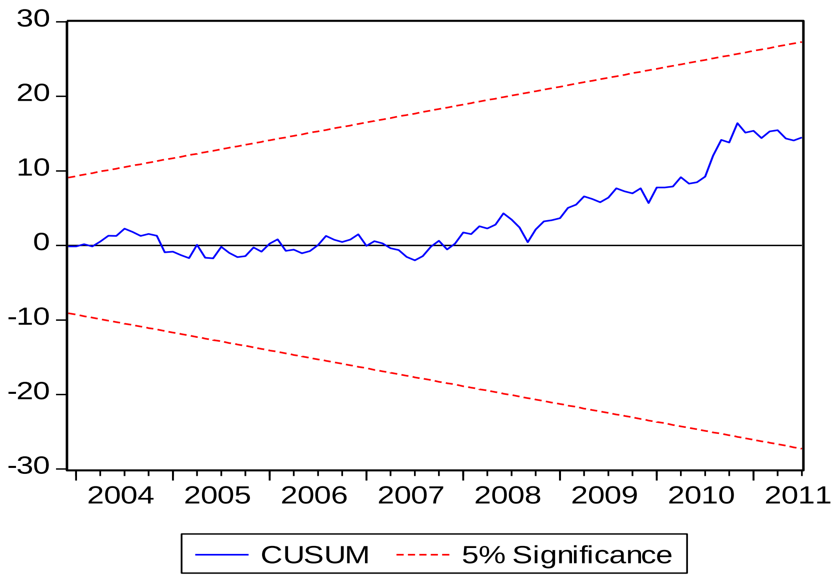
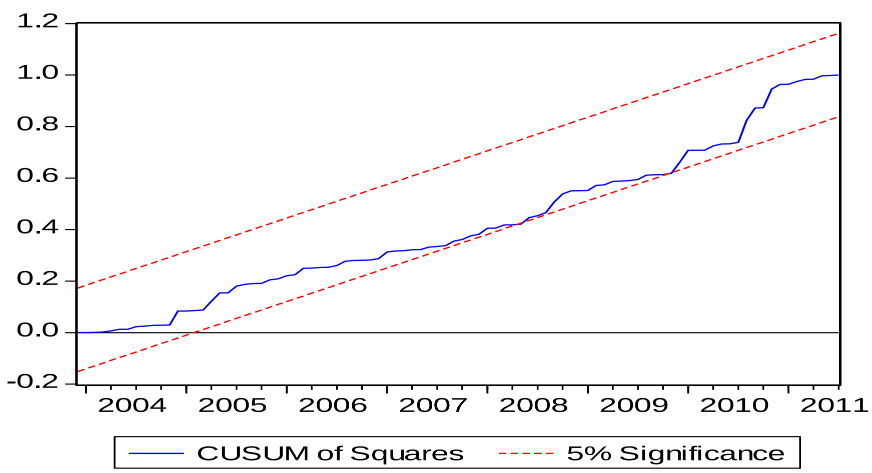


Figure B-8 Plot of Cumulative Sum of Squares of Recursive Residuals



Impact of Gas prices on Non Gas CPI

Table B-14 Long Run Coefficients of ARDL Approach

Dependent variable: CPI excluding Gas CPI			
Variables	Coefficients	t -statistics	Probability
LGDP	-0.021	-2.506	0.014
LM2	0.012	0.809	0.420
LNEER	-0.163	-6.288	0.000
LFP	0.229	4.299	0.000
LGAS	0.123	4.770	0.000

Note: LGAS, LGDP, LM_2, LNEER,.LFP indicate, Gas PI, Gross Domestic Product, Money Supply, Exchange Rate and Foreign Prices respectively. Level of significance is 5%.

Impact of Gas prices on Non Gas CPI

Table B- 15 Short Run Coefficients and Error Correction Term of ARDL Model

Variables	Coefficients at level	1st lag	2nd lag	3rd lag	4th lag	5th lag	6th lag	7th lag	8TH lag
LGAS	---			---	---	---	0.14 (2.42)	-0.03 (-3.11)	---
LM2	0.082 (2.538)	---	0.071 (2.29)	---	---	---	-0.071 (-2.242)		
LFP	0.449 3.272		---	---	---	---	---	---	---
LGDP	-0.031 (-2.99)	---	---	0.014 (1.673)	---	---	---		---
LNEER	-0.134 (-3.155)		---	---	0.14 (2.77)	---		---	---
ECM(-1)	-0.195 (2.57)	---	---	---	---	---	---	---	
R-squared		0.53	Akieke Info. Criterion			-7.24	Durbin Watson		1.84
Adjusted R-squared		0.46	Sharwtz Baysian criterion			-6.80			

Impact of Gas prices on Non Gas CPI

Table B- 15 ARDL-VECM Model Diagonestic Tests

Results of Diagonestic Tests			
Serial Correlation	$\chi 2(1)=(0.707)$	Normality	$\chi 2(2)=(0.56)$
Functional Form	$\chi 2(1)=(0.64)$	Heteroscedasticity	$\chi 2(1)=(0.82)$

Figure B-9 Plot of Cumulative Sum of Recursive Residuals

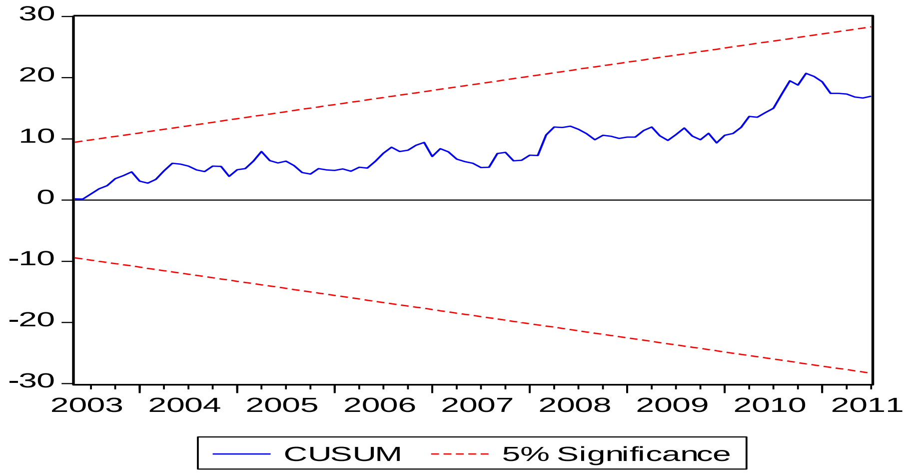


Figure B-10 Plot of Cumulative Sum of Squares of Recursive Residuals