In The Name Of Allah, The Most Beneficent, The Most Merciful.

# Long run and Short run Effects of Electricity Prices on Inflation in Pakistan: An Aggregate and Disaggregate Analysis

BY


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**Registration No. 01/M.Phil-ETS/PIDE/2012**


***A Dissertation Submitted to the Pakistan Institute of Development Economics, Islamabad, in partial fulfillment of the requirements of the Degree of Master of Philosophy in Econometrics***

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***Dedicated to my parents and advisor***

## *Acknowledgement*

*First and foremost to my best friend, my Allah, the most loving and merciful, who created the universe with beauty and perfection and gave me the ability to ponder and refine my thinking. I offer my humblest feelings and thanks to the prophet Muhammad (peace be upon him), who is forever the source of guidance and knowledge for the humanity as a whole.*

*There is a debt of gratitude I can not repay to my adviser, Dr. Abdul Qayyum for his superb guidance and encouragement during the whole course of research. His wise counseling has always stimulated my mind and makes me truly understand what this manuscript is all about.*

*It is hard to express my feelings for my family, all my accomplishments whether large or small, are possible because of my parent's love, support and constant prayers. I thank my brother* ***Shahid****, sisters* ***Rahat*** *and* ***Nuzhat*** *for their love and care for me. I have missed them all during the years I have spent at university away from home.*

**ANAM ALAMDAR**

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# ABSTRACT

In this study we examine the effect of electricity prices on inflation at aggregate and disaggregate level in case of Pakistan. In this study we take aggregate electricity prices and check its impact on overall inflation, food, non food and core inflation in Pakistan and then take sectoral electricity prices (Industrial, Commercial, Agricultural and Domestic) and check its impact on overall inflation, food, non food and core inflation. Augumented Dickey Fuller (1979), Zivot and Andrews(1992) unit root test with structural break and Johansen Maximum Likelihood method of Cointegration(1988) are used to test the unit root, unit root with structural break and to find out the long run and short run relationship between the variables by taking the data from 1971 to 2013 in case of Pakistan. This study shows the mix effect of electricity prices on inflation. As at aggregate level the electricity prices effect the overall inflation, food and non-food inflation positively but insignificantly in the long run and have no impact in the short run. But in the case of core inflation, electricity prices have positive and significant impact both in the long and short run. But at the sectoral level of electricity prices we have found interesting results. At disaggregate level the domestic electricity prices effect the overall inflation, food and non-food inflation negatively in the long run as well as in the short run. But it has positive impact on core inflation in the long run but has insignificant impact and have no impact in the short run. The industrial sector electricity prices effect the overall inflation, food and non-food inflation negatively in the long run but positively in the short run. But in the short run the increase in the industrial electrical prices have also a great impact on inflation, food and non-food inflation. But industrial electricity prices effect the core inflation positively in the long run and have no impact in the short run. The commercial and agricultural electricity prices affect all types of inflation positively both in the long run as well as in the short run. So overall impact of electricity prices on all types of inflation is mixed as positive and negative but the dominant impact of electricity prices on inflation is positive both in the long as well as in the short run. And we found that the most dominant effect of increasing in the electricity prices at aggregate and disaggregate level is on the core inflation.

# CHAPTER 1

# INTRODUCTION

Many economists are of the view that rising trend in the energy prices has been a major cause of economics fluctuations in term of reduction in output, increasing inflation and unemployment both in developed and developing countries (Brown and Yucel 2002, Hamilton 1983, Malik 2007 and Kiani, 2009). Simply, an increase in the prices of various energy-components such as oil, electricity and gas, increase the cost of production and reduces productivity and output level, which ultimately raises the price level in the economy. Among all sources of energy; electricity is very important source of power generation. "Electricity is the cheapest and cleanest source of energy" Khagram (2004). When energy components are disaggregated, it is seen that electricity is the highest quality energy component and its share in the energy consumption increases rapidly (Khan and Ahmad, 2009).

In Pakistan the rise in oil prices is pushing the electricity tariffs at a very high rate. The main sources of electricity generation are thermal, hydro and nuclear power plants. The thermal power plants account for 68%, hydro power plant accounts for 30% and the nuclear power plant accounts for only 2% (Looney, 2007). This has led to a huge generation cost, which in turn has adversely affected the economy over the past 8 years. The electricity generation is heavily oil dependent as 99.8% dependence of oil-based thermal power plants is on imported oil (Government of Pakistan, 2010-2011). As a result, the manufacturing cost and inflation are at the rising trend (Looney, 2007).

On the other hand, the prices of electricity are increasing at a very high rate over the past many years. As in 2013 the prices of electricity have been increased by Rs 5.89 for the units consumed up to 201 to 300 units of electricity, Rs 3.67 hike has been observed for the units consumed up to 301-700 while Rs 2.93 have been increased on using more than 700 units of electricity (Government of Pakistan, 2013). Furthermore, National Electric Power Regulatory Authority (2014) has announced that Rs 2 per unit will be charged on consuming 1-50 units, Rs 5.79 for 51-100 units, Rs 8.11 for 101-200 units, Rs 14 for 201-300 units, Rs 16 for 301-700 units and Rs 18 will be charged on using more than 700 units. So the increase in prices and continued crisis in electricity are destroying the national income, per capita income and inflation as well.

The determinants 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 preposition is based on the Quantity Theory of Money (QTM); is owed to Friedman (1968, 1970 and 1971) and was empirically tested by Schwartz in 1973. The QTM states that “an increase in the money supply results in proportionate increase in the prices, assuming output and real money balances constant”. There are numerous studies in the case of Pakistan which shows that there is positive relationship between money supply and inflation (Qayyum, (2006), Khan and Schimmelpfenning (2006), Kemal (2006), Abbas (2009) and Ali, 1996).

The Structuralists are of the view that the supply side factors such as wages, exchange rate, food prices, external shocks, import prices, wheat support prices and taxes etc are the main reasons of rising cost. All these factors are the indicators to increase the overall price level (Balkrishnan, (1992), Bilquees (1988), Hasan et al. (1995) and Khan and Qasim (1996).

If the prices of labor, capital and energy which are the basic factors of production are increasing, it will affect the cost of production then the producers have to adjust the prices of the final products in order to maintain their normal profit.

Cost push inflation is a type of inflation which is occurred if the prices of raw material increases which will affect the prices of final product. Cost push inflation's factors activate through the supply side of the economy by increasing the unit cost of production, so that the slimming down in GDP can create inflation (Gaomab II, 1998). In cost push inflation the prices are pushed up by increasing the cost of production and this rise in cost are passed along to the consumer in the form of higher prices.

As electricity is a component of CPI so when electricity price increases; it leads a direct increase in the general CPI or an inflationary shock (Gordon, 1997 and Hooker, 2002). As the weight of CPI food is 34.83% and non-food is 65.17%. The weight of Housing, Water, Gas, Electricity and other fuel items is 29.41% in the CPI. The weight of Electricity in the non-food items is 4.40% (Government of Pakistan 2012-2013). The climb up in the electricity prices also causes a positive impact on inflation. The increase in the prices of electricity also effects the industrial production. The increase in the prices of electricity with the shortage of electricity has cost push inflation in the economy. The higher prices directly influence not only the poor people of the country but also rich community. But the major impact is on the poor people. Obviously, all over the world not only in the developing countries policies are formulated and implemented for the welfare of the poor community of the world.

Hike in prices also worsens the balance of payment situation of the country. It raises not only private expenditure but also public expenditure effecting consumer price index (CPI) to increase. All these aspects lead to bring the country to the poverty fence.

In brevity, it is very important to examine the impact of the prices of electricity on inflation in Pakistan where the electricity prices are rapidly increasing and effecting the inflation.

## 1.1 Objectives of the Study

The prices of electricity in commercial, agricultural, domestic and industrial sectors are rapidly increasing; as a result it will also affect the inflation of the country. So the objectives of this study are as following:

- The first objective of the study is to find the effect of electricity prices on inflation at aggregate and disaggregate level.
- To find out the impact of sectoral electricity prices on inflation (at aggregate and disaggregate level).
- Another objective is to find the Long run and Short run impact of electricity prices and sectoral electricity prices on inflation at aggregate and disaggregate level by using the cointegration and Dynamic Error Correction method.

## 1.2 Hypotheses

Following are the hypotheses which are being used to test.

- Electricity prices have no impact on aggregate inflation.

  $\mathbf{H^A_0}$: $P^{Ele} = 0$

- Electricity prices have no impact on food-inflation.

  $\mathbf{H^B_0}$: $P^{Ele} = 0$

- Electricity prices have no impact on non food-inflation.

  $\mathbf{H^C_0}$: $P^{Ele} = 0$

- Electricity prices have no impact on core inflation.

  $\mathbf{H^D_0}$: $P^{Ele} = 0$

- Sectoral Electricity prices have no impact on aggregate inflation.

  **$H^{E}_{0}$:** $P^{Ele} = 0$

- Sectoral Electricity prices have no impact on food-inflation.

  **$H^{F}_{0}$:** $P^{Ele} = 0$

- Sectoral Electricity prices have no impact on non food-inflation.

  **$H^{G}_{0}$:** $P^{Ele} = 0$

- Sectoral Electricity prices have no impact on core inflation.

  **$H^{H}_{0}$:** $P^{Ele} = 0$

### 1.3 Methodology

There are different models which are used to find out the determinants of inflation. We assume that both demand and supply side factors play an important role in determining the inflation. Moser(1995) proposed a model which contained both supply and demand side factors, we simplify our model as $\log P = \log f(e, P^{f}, m_{s}, y_{t}, P^{Ele})$ by using the annual data from 1970 to 2013. First of all the stationarity of the variables is being tested by using the Augmented Dickey Fuller (1979) unit root test. In order to check out the stationarity of the data set in the presence of structural break, Zivot and Andrews (1992) test of unit root with structural break is used. For the long run and short run analysis, Johansen Maximum Likelihood Method of cointegration(1988) has being applied. In order to check that whether there exists the short run relationship between the variables, Error Correction Model (ECM) is estimated.

### 1.4 Data Sources

Annual data has been used in the following study starting from 1971 to 2013 on all the variables instead of core inflation on which we have data from 1991 to 2013. The sources of the data on different variables are World Development Indicator (WDI), Pakistan Economic Survey (Various Issues), International Financial Statistics (IFS) a publication of International Monetary Fund (IMF) and Water and Power Development Authority (WAPDA).

### 1.5 Plan of the Study

The study is organized as in the following way that Chapter 2 is on the salient features of electricity sector in Pakistan, Chapter 3 is about the literature review at national and international level, Chapter 4 explains the methodology which contains the information about the data sources, Augumented Dickey Fuller test, Zivot and Andrews test and Johansen Maximum Likelihood method. Chapter 5 is on the results and discussion. Finally Chapter 6 illustrates the conclusion and policy recommendation.

# Chapter 2

## SALIENT FEATURES OF ELECTRICITY SECTOR IN PAKISTAN

### 2.1. Introduction

During 1947, the installed capacity of power generation was only 60 MW for a population of 31.5 million, with a per capita consumption of 4.5 units. However in 1970 the installed capacity rose from 636 MW to 1331 MW in 1975. In the period of 1980, the system capacity touches 3000 MW, and thereafter it rapidly grew to over 8000 MW by 1990-91 (Government of Pakistan, 2008). But during the current years there is a huge gap is existed between the electricity demand and supply. As the demand is increasing day by day whereas supply of electricity is going to be short due to different major issues like transmission and distribution losses, circular debt, higher input cost for the production of electricity etc. This chapter consists of section 2.2 is on production of electricity, section 2.3 is on electricity generation, transmission and distribution, section 2.4 is on prices of electricity and section 2.5 consists of conclusion.

### 2.2. Production of Electricity

Electricity is considered as an important input in the production process. Electricity production is measured at terminals of all alternator sets in a station. In addition to hydropower, coil, oil, gas and nuclear power generation, it covers generation by geothermal, solar, wind and tide wave energy as well as that from explosive renewable and waste. Production of electricity includes the output of electricity plants that are designed to produce electricity only as well as combined heat and power plants. The total electricity production during 2005 was 88.42TWh. And the electricity production by sources (2014) is:

- Fossil fuel: 14,635MW-64.2% of total electricity production (oil-35.2% + gas-29%)
- Hydro: 6,611MW-29% of total

- Nuclear: 1,322MW-5.8% of total

There are four major sources of electricity production in country which are as following:

- ➢ WAPDA(Water and Power Development Authority)
- ➢ KESC(Karachi Electric Supply Company)
- ➢ IPPs(Independent Power Projects)
- ➢ PAEC(Pakistan Atomic Energy Commission)

### 2.3. Electricity Generation, Transmission and Distribution

In Pakistan electricity is generated, transmitted and distributed to the end users through WAPDA (Water and Power Development Authority) except Karachi. KESC (Karachi Electric Supply Company) provides the electricity to Karachi and its suburbs. In late 1990s the competition was introduced in electricity sector with the development of IPPs. Since there are 16 independent power producers (IPPs) that contributes about one third of electricity generation in the country.

There is only one electricity transmission company

- ➢ PEPCO(Pakistan Electric Power Company)

Pakistan Electric Power Company (PEPCO) produces it own thermal generation plants and purchases electricity from various IPPs and Pakistan Atomic Energy Commission (PAEC) (Jamil and Ahmad, 2010).

PEPCO transmits the electricity to the DISCOs. There are eight electricity distribution companies which are as following:

- GEPCO (Gujranwala Electric Supply Company)
- FESCO (Faisalabad Electric Supply Company)
- LESCO (Lahore Electric Supply Company)
- MESCO (Multan Electric Supply Company)

- IESCO (Islamabad Electric Supply Company)
- PESCO (Peshawar Electric Supply Company)
- HESCO (Hyderabad Electric Supply Company). HESCO is further divided into
    - HESCO (Hyderabad Electric Supply Company)
    - SEPCO (Sukkur Electric Supply Company)
- QESCO (Quetta Electric Supply Company)

After 2007, the demand-supply gap of electricity has risen and since then, the increasing gap is due to rapid increase in the 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 (A) supports this gap of generation cost and tariff. In 2011, the demand supply gap reached to 7000MW (Malik, 2012). To fill this gap, a huge investment is required to maintain the supply of power.

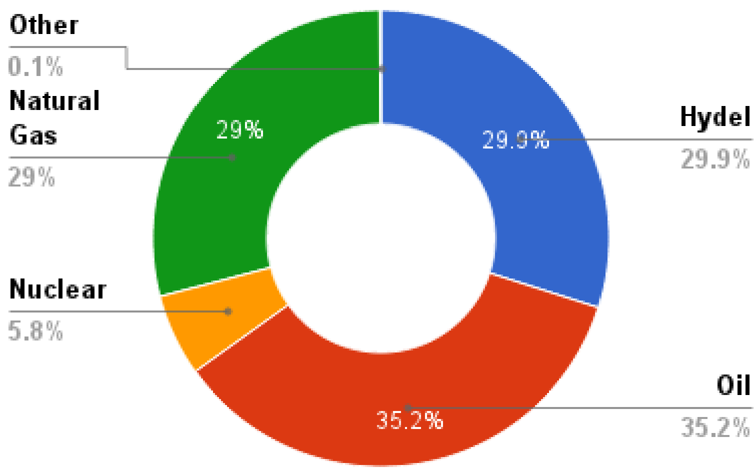
**Table (A): Average Cost and Sale Rate of Electricity**

| | 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 the last five to six years, a significant part of electricity generation in Pakistan is thermal, which is 99.8% depend on imported oil (Pakistan Economics 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 2.1: Pakistan Electricity Generation by Sources**




**Source:** "Pakistan Energy Year Book", Hydrocarbon Development Institute of Pakistan, 2012.

### 2.4. Electricity Prices

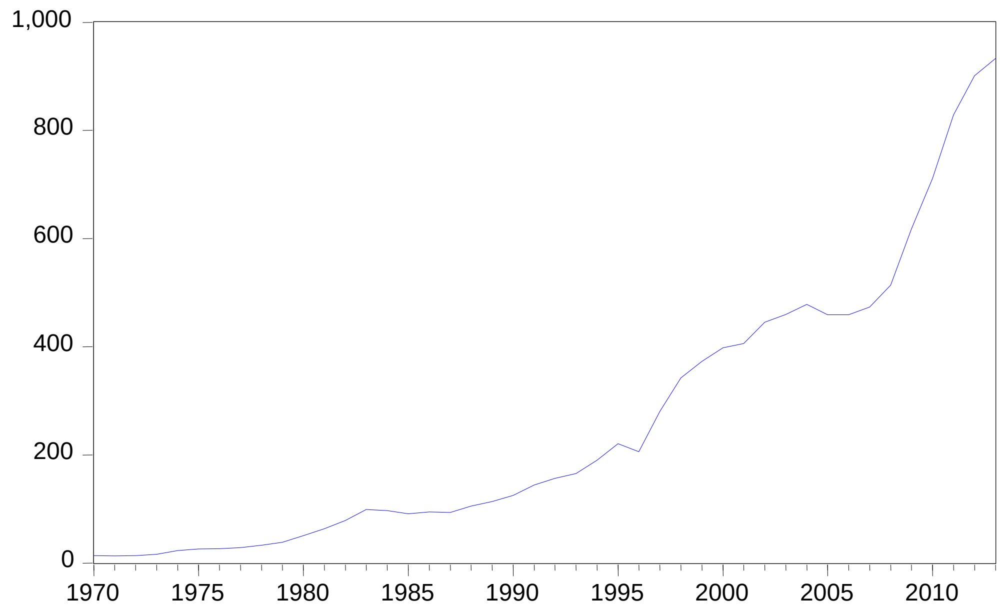
Pakistan went through an extraordinary period of having surplus electricity from the late 1990s to 2004-05. But since then, the country has been facing an acute shortage of electricity.

The present crisis started in 2006-07 with a gradual widening in the demand and supply gap of electricity. Since then this gap grown and has assumed proportions which are considered to be the worst of all such power crisis that Pakistan has faced since its inception. The electric power deficit had crossed the level of 500 MW at many points during the year 2011. At one stage in the month of May, 2011 this shortfall had surpassed 7000MW (Malik, 2012).

This gap between supply and demand is causing the continuous rise in the prices of electricity. A major reason of this gap is the huge increase in the household electricity consumption (Khan and Qayyum, 2009). There are different reasons of this gap, one of which is electricity tariffs were below cost recovery level. The previous military government did not allow the rise in electricity prices in the line with the steep rise in the international oil prices for obvious political reasons. In fact, tariffs were frozen at a very low rate between 2003 to 2007. The cost of electricity generation rose but unfortunately, notified tariffs were not sufficient enough to cover the higher cost (Malik, 2012).

Last year the government had started increasing the power tariffs to cover the cost. In the last two years more than 90% increase in tariffs has been taken place. The overall expected average cost of service to the end consumer in 2010-11 was Rs 9.73/kWh, higher by about 1.57% over the year 2009-10. The average cost that a consumer was expected to pay during 2010-11 was Rs 7.78/kWh. The same was Rs 6.85/kWh at the end of 2009-10. The overall expected increase in the different consumer categories range between 12 to 19 percent (Rana, 2011). One more change made in the tariff structure includes the implementation of GST for electricity consumption of more than 100 units.

**Figure 2.2**: Graph of Total Electricity Average Sale Prices (p/kWh)




One important feature of electricity sector in Pakistan is that demand is exceeding above the maximum generation capacity, whereas the institutions capacity for policy planning, development and implementation remains low. This drawback of institutions policy causes delay in investment, poor transmission and distribution network, heavy losses due to this poor transmission and distribution system, electricity theft and inefficient use of electricity. Such type of performance of electricity sector is badly affecting the domestic, industrial, agricultural and commercial sector in the country. Thus the government has come up with the solutions and encourages the domestic and foreign investors to invest in the electricity sector and also encourage constructing the new dams and alternative sources of electricity production as well as renewable sources of electricity.

## 2.5. Concluding Remarks

This chapter deals with the electricity production and the generation, transmission and distribution and also describes about the electricity generation, transmission and distribution companies. Then it describes about the rising trends in the electricity prices and also discusses the causes of this increase in prices and finally it describes about the effect of this rise in the prices on the country.

# CHAPTER 3

# LITERATURE REVIEW

## 3.1 Introduction

This chapter represents the review of literature associated to the inflation and energy prices. This chapter further divided into subsections as subsection 3.2 reviews the literature from international studies, subsection 3.3 reviews evidence in the case of Pakistan, subsection 3.4 shows the significance of the study and subsection 3.5 is on conclusion.

## 3.2 International Literature

Internationally, there are many studies on the subject of energy prices and inflation, especially in the case of oil prices and inflation. Thoresen (1981) studied the impact of oil prices on inflation. This study shows that an increase in the prices of oil will cause to increase in the standard of living of the oil exporting countries and cause to decrease of 20% in the standard of living of oil importing countries. In the short run the increase in the oil prices would not result in the compensation of wages as a result the rise in prices cause the high inflation. If the measure is taken to save the energy, then that will further reduce the standard of living of the people of oil importing countries. So in the short run to control the inflation the standard of living of the oil importing countries would be reduced and in the long run the use of alternative sources of energy would increase the productivity and again increase the standard of living of the people and in the long run the use of alternative sources of energy would not cause the inflation. So the industrial countries used the energy for the production process more efficiently then the rise in oil price will be compensated in a few years.

Thoresen (1983) showed that inflation is controlled by energy prices. This is the case study of Norway and Sweden. The high inflation which is experienced by the world during the past years could be reduced if the countries will become energy independent and oil importing countries would reduce energy dependency. The reduction in energy dependency on average by half could reduce the inflation by 30%. But this reduction in inflation is more beneficial for the oil exporting countries than oil importing countries. This study concluded that the inflation can be easily controlled, if the prices of domestically produced energy follow the national price index. It is suggested that if all the alternative sources of the energy is produced by utilizing all the economic benefits then it would be great competitive to the imported energy.

Brown et al (1995) studied the relationship between oil price and inflation in case of U.S. economy. The quarterly data is used from 1970 to 1994. The impulse response function which is based on VAR model is used to check that how major shocks of oil move through the major channels of the economy to effect the inflation. The results of this study show that Monetary shocks have persistent effects on real GDP and price level. Shocks to federal fund rates also have small and temporary effects on price level. The results of impulse response function show that the real oil price shocks lead to transitory effects on real GDP, the federal fund rates, the spread between the short term and long term interest rates. The oil price shocks have permanent effect on nominal GDP and price level. Money supply shows a long delayed but permanent oil price shock. The change in the price level is permanent and grows with the time. Thus this study concluded that over the longer term the velocity is stable but money supply is increasing. This finding suggests that during the estimation period, monetary policy generally accommodated the inflationary pressure of oil price shock.

Moser (1995) determine the inflation in Nigeria. In this study the dominant factors which are influencing the inflation are found. The time series annual data is used from 1960 to 1993.The OLS estimation technique is used for the estimation of data set. An error correction model of the inflation process is developed based on money market equilibrium condition The results of this study show that the increase in the GDP causes decrease in the inflation similarly increase in the rainfall also causes decrease in the inflation while the import prices, interest rate and expected inflation have insignificant impact on inflation. There is positive relationship between money supply and inflation. Thus the finding of this study concludes that the fiscal and monetary policies have a great influence on inflation in Nigeria whereas the agro climatic conditions were also found to be a great factor of influence on inflation.

Humpage and Pelz (2002) determine the relationship between energy price shocks effect on core price measures. In this article the author uses the monthly data of Cleveland from 1980:1 to 2010:12. To analyze the impact of energy price shocks effect on three core price measures, the recursive VAR model is used. The blocked exogeniety test is used to test the casual relationship between the variables. The impulse response functions are showing the response of negative energy prices to positive energy-price shocks and positive energy prices to negative energy-price shocks. The results suggest that positive energy price shocks have small significant effects on all three core price measures but negative energy price shocks have not significant effect on these core price measures. So the relative energy price changes do not disturb the inflation which is provided by the standard core price measures.

Heerden et al (2008) find the higher electricity prices effects on South African exchange rate and Economy. This study concluded that the effect of increase in the electricity prices on CPI and therefore on the exchange rate is very small. As the South African Reserve bank warned against the inflationary effect due to the higher increase in the prices of electricity but such significant results are not found in this study. When the prices of electricity increases it will negatively affect the economy, as a result the production of many industries in the short run decreases and even in the long run many industries are worse off. Some industries enjoy the benefits of exemption of an increase in prices of electricity, whereas some other industries and final consumers have to face this exemption. Poor group of people is affected most than the other groups because the rise in the prices of electricity. Some industries such as Iron and Steel are highly dependent on electricity, as their major input cost depends on electricity prices. So the increase in the electricity prices would affect the cost and competitiveness of these industries in the world and also exports because these industries are highly export driven. So this study suggested that an equitable policy of price distribution is necessary.

Charles at al (2011) finds the implications of rising commodity prices for inflation and monetary policy. The quarterly data is used from 1959 to 2008 for Chicago. For the estimation of the model, VAR technique is used to test the three hypotheses which are purposed by this study. This study influenced of a credible inflation-fighting central bank by comparing responses of core inflation and the monetary policy instrument in the pre- and post-Volcker periods. The results of this study show that the policy dependency on energy and commodity prices is not surprising but in fact the share of firms cost for energy and other commodities is falling over the time. This study concluded that oil price increases would slow down the economy without any policy rate increase. Because when the energy and commodity prices were lead to the broader increase in inflation then more substantial policy rate would be justified. But here by assuming that there is high degree of central bank credibility, so there is no reason for such expectations to develop.

Imrahim (2011) examines the oil price pass through into consumer price inflation for Malaysia by using the augmented Philips curve. This study mainly focused on the oil price relation to the aggregate consumer price index and different components of consumer price index as food price index, rent, fuel and power price index, transportation and communication price index and medical care and health price index in the short-run and in the long-run. The annual data is taken from 1972 to 2009. To test the long-run relationship Johansen and Juselious (1990) method is used. The results indicate that there exist the long-run relationship between oil prices and CPI but significant long-run relationship exists between oil prices and consumer prices in the case of FPI equation. There also exists the significant long-run relationship between real output and CPI and FPI. In order to confirm the long-run relationship between variables the dynamic ordinary least square (DOLS) method which is suggested by Stock and Watson is also applied which gives the results that there exists the significant long-run relationship between oil prices and FPI. So these results indicate that the FPI does not remain neutral with the variations in the oil prices. There also exist short-run effects of oil prices on CPI, FPI, rent, fuel and power price index and transportation and communication price index. It is also found that there are short-run inflationary asymmetric effects of positive and negative oil price changes on food price inflation only. Thus this study concluded that the effect of changes in oil prices is mainly on the food prices which is a cause affect poor households and raise Malaysia's import bills of food items. So the attention should be paid to the food sector by increasing domestic food supply and by cutting the bringing costs of food products to the market.

## 3.3 Literature in Context of Pakistan

Bilquees `(1988) determines the possible factors which effect the inflation in Pakistan by analyzing the hypotheses of monetarists and structuralists. The results of this study strongly support the debate between the monetarists and structuralisms' to understand the factors which are responsible for inflation. The monetarist's view that inflation is always and everywhere a monetary phenomenon and it can be controlled by the money supply. But according to this study in case of Pakistan there is a need to give consideration of structural factors to clearly identify the determinants of inflation. The higher imports prices and shortage in the commodity producing sector have impact on rate of inflation and decline in output generates the expectations of higher inflation. After examining the two hypotheses, the study concludes that in addition to monetary factors, the structural factors peculiar to the economy of Pakistan also have to be considered for a better understanding of this phenomenon.

Ali (1996) has analyzed the trend in the recent inflation in Pakistan by applying both monetary and real theories. This study concluded that the choice of monetary or structural theory to determine the inflation depends on the interest of researcher but from the policy point of view the monetary analysis to control inflation has an edge and it is easy to control inflation through monetary management rather than to regulate the various elements of costs which go into the formulation of prices under the real theory.

Khan and Qasim (1996) measure the inflation in Pakistan at aggregate and at disaggregate level. At the disaggregate level it measures the food and non-food inflation in Pakistan. This study takes the time series data from 1971-72 to 1994-95.To test the stationarity of the variables, the DF, ADF and CRDW tests are used which conclude that all the variables are integrated of the same order I(1).To test the long run relationship, Cointegration test is applied. The result of this study suggests that the money supply plays a strong role in the accelerating inflation in Pakistan. This study concludes that there is a need of tightening of fiscal policy. The government adjusted prices such as support price of wheat and electricity are also a cause of increase in inflation. Thus fiscal policy, commodity producing sector and moderation in raising the government administered prices are the keys to success in reducing the current inflation from double digit to single digit.

Qayyum (2006) has studied the money, inflation and growth in Pakistan. In this study the data is used from 1960 to 2005.This study supports the Monetarists preposition that “inflation is always and everywhere a monetary phenomenon”. The result of this study shows that at first round effect increase in money supply effects the GDP growth and in the second round effect the growth in the money supply effects the inflation. Thus result shows that there is one to one relationship between the growth rate of money supply and the rate of inflation. This study concluded that money supply growth is the main indicator of inflation in the Pakistan during the study period. Thus inflation is a monetary phenomenon in Pakistan. This study also suggested that the tight monetary policy should be adopted in order to control the inflation in Pakistan.

Kemal (2006) checks the hypothesis that “whether the inflation in Pakistan is a monetary phenomenon”. He uses the quarterly data from 1975:Q1 to 2004:Q4. Johansen Co- integration technique is used to check the long run relationship and for the short run dynamics, the vector error correction model (VECM) is used. Impulse response function is used to check the time path of the variables. The results of the study show that there exists the long run relationship between the inflation and money supply and significant but negative relationship between inflation and income. In the short run the impact of inflation on money supply is not instantly but it effects inflation after the lag of three quarters. This study concluded that QTM holds in the long-run which is concluded that inflation is a monetary phenomenon. And it is concluded that if shocks appeared in any of the three variables, the system does not converge to equilibrium for long period.

Khan and Schimmelpfenning (2006) examine the factors which are useful to explain and forecast inflation in Pakistan. The monthly data is used from January 1998 to June 2005. The short run and long run relationship have been examined between the variables and for the short run relationship, in the short run equation the monthly dummies and Islamic calendar control variables (Riazzuddin and Khan, 2005) are also included. The results of the short run model indicate that the money supply had great influence on inflation, likewise GDP growth and wheat support price matter and at some extent nominal effective exchange rate also effect inflation. For the long run relationship VECM is used and shows that there exists the long run relationship between the CPI and private sector credit growth only. For the inflation forecasting, leading indicator approach is used and the leading indicators are private sector credit growth and broad money growth. This study concluded that the monetary growth affects inflation with a lag of around 12 months. It is also concluded that the State bank of Pakistan has the capability to implement its own monetary policy which is consistent with the need of domestic economy. It is also suggested that this monetary policy has to be forward looking to achieve its inflation targets.

Khan and Gill (2007) studied the impact of supple of money on food and general price level in the case of Pakistan by using annual data from 1975 to 2007. In this study WPI general, WPI food, CPI general, CPI food, GDP deflator and SPI are used as indicators of inflation and M1, M2, M3 are used as explanatory variables. The findings of this study show that M1 has affect both CPI general and food but effect is greater on CPI general. M2 only effects CPI general and

M3 has negative effect on both CPI general and food but effect is greater on CPI general. All the forms of money supply have no effect on WPI food but M1 and M2 have positive effect on WPI general and M3 has negative effect on it. The M1 and M2 positively affected the GDP deflator but the effect of M1 is more than three times greater as compare to M2 but M3 has negative effect on GDP deflator. The effect in the case of SPI is same as in the case of GDP deflator. Thus the study concluded that as M1 effects all the form of inflation, so if the increase in money supply is not accompanied by increase in output, it will cause the increase in inflation. So this study negates the non productive government policy of borrowing which results the increase in inflation of food and general items.

Khan and Gill (2010) measure the determinants of inflation by using the data 1970 to 2007 in the case of Pakistan. Four price indicators CPI, SPI, WPI and GDP deflator are used to measure the inflation. The OLS method is used to estimate the model and the result shows that budget deficit does not affect all the four indicators of inflation in the long run. This finding also matches with the findings of Ackay et al (2003 for Turkey) and Jones and Khilji (1988 for Pakistan) that budget deficit has insignificant impact on CPI. The support prices of rice, sugar-cane and wheat collectively affect all the indicators of inflation positively in the short run, whereas in the long run wheat support price independently affects the GDP deflator. The exchange rate depreciation also has positive effect on all indicators. The money supply has only affect the WPI but has insignificant affect on CPI, SPI and GDP deflator. Expectation effect has also affected all the indicators.

In the study of Kemal et al (2011), they determine the food prices in case of Pakistan. They take the annual data from 1970 to 2008 to determine the demand and supply side factors which effect the food inflation. They develop a model which incorporates both demand and supply side factors and analysis the long run and short run relationship by using ARDL approach. This study shows that the supply side factors i.e subsidies and world food prices effect the inflation both in the short run as well as in the long run but the effect of subsidies in the long run is very small. Whereas the demand side factors as money supply has the very significant impact on food inflation in the short run as well as in the long run. This study does not incorporate the political economy side variables which effect the food inflation such as smuggling. Thus this study concluded that the money supply is the most important and significant variable which effect the food inflation. Whereas the subsidies are also causing the decline in the food inflation but their long run effect is very small.

Bashir et al (2011) determines the inflation in Pakistan. The time series data is used from 1972 to 2010 on annual basis. To test the long run relationship between the variables Johansen Co integration approach is used and for short run analysis VECM approach is used. The causality between the variables is also tested by using Engle Granger two step procedures. The findings of this study show that in the long run the CPI is positively influenced by money supply, gross domestic product, imports and government expenditures, where as government revenues and exports are negatively associated with CPI but exports are insignificant. In the short run the CPI of current year is enhanced by the involvement of last year CPI and two years before government revenues. The results of Granger causality test show that there is uni-directional relationship between M2 to government expenditure, Imports and Exports then Government revenue to M2, CPI, government expenditure and Exports. Then uni-directional relationship exists GDP to M2, government expenditures, Exports and Imports. Then uni-directional relationship between CPI to Imports, Exports and uni-directional relationship exists between government expenditures to CPI and Exports. And the bi-directional relationship is found from CPI to money supply and GDP, CPI to imports and government expenditures and imports and government revenue. Thus this study concluded that the money supply, government expenditures, government revenues and GDP are playing the significant effect on CPI. Thus it is suggested that GDP, government expenditures and imports should not increase much higher as these will increase the price level which is not in favor of any economy.

Haider et al (2013) determines the energy inflation in Pakistan. The data is taken from 1973 to 2012 on annual bases. For the estimation of the model the OLS, GLS and GMM methods are used. For the long run relationship both tests of cointegration are used. There exists the long run relationship between the variables. The results shows that broad money, oil prices, exchange rate, text revenue as a ratio of value added to manufacturing sector and adaptive expectations of inflation are all have significant impact on energy inflation. The dummy variable of 2008 has significant but negative impact on energy inflation. Energy import gap ratio has positive sign but it has insignificant impact on energy inflation. Thus this study concluded that there is pro-cyclical behavior is observed from the monetary and fiscal authorities to the energy supply side. This pro-cyclical behavior along with the world oil price shocks and exchange rate depreciation put upward pressure on energy inflation. The government heavy reliance on the indirect taxes from the energy items, the approximately 60% of energy inflation is because of inflation expectation and the circular debt all of these are causing the prices to go up. So there is a need to take some steps such as there should be roadmaps outlined for the authorities and rules defined for all the entities so that the ultimate goals can be achieved.

## 3.4 Significance of the Study

Internationally, studies regarding the effect of energy prices on inflation have been carried out, specifically to find the effect of oil prices on inflation but seldom study is done which particularly deals with effects of electricity prices on inflation. In Pakistan, there are studies which deal with the energy consumption and growth (Siddiqui, 2004), electricity consumption and growth (Jamil and Ahmad, 2010) and energy inflation (Haider, Ahmed and Jawed, 2013). But to my best knowledge, only one paper so far has been reported the use of electricity prices as a variable to find its effect on non-food inflation (Khan and Qasim,1996). In this paper the author has taken annual data from 1971-72 to 1994-95, which is short data span for time series analysis. The stationarity of the data set is tested by using the DF and ADF tests which suggested that all variables are integrated of order I(1) but no unit root test with structural break is applied to address the breaks in the data set. The cointegration relationship between the variables has been tested by using the simple OLS technique. There is a need to adopt the modern approach to find out the long run and short run relationship between the variables. So there exists a gap in the literature to find the effect of electricity prices on inflation at aggregate and disaggregate level, so the following study is a small attempt to fill this gap.

## 3.5 Concluding Remarks

The main findings of the reviewed literature at the international level is that different studies have been conducted which show the impact of energy prices i.e oil prices on inflation. These studies used different econometric techniques i.e VAR, impulse response function and Johansen and Juselious (1990) method of cointegration. These studies concluded that increase in the energy prices cause inflation.

At the national level most of the studies address the factors which effect the inflation by analyzing the hypothesis of monetarists and structuralists. These studies find the impact of different factors which effect the inflation by adopting different econometric techniques. There is only one study on energy inflation which included the energy prices i.e oil prices and find out its effect on the inflation in case of Pakistan. There is another study which takes electricity prices and find out its effect on non-food inflation. So there exists a gap in the literature to find the impact of electricity prices on inflation at aggregate and disaggregate level so the following study is an attempt in this direction.

# Chapter 4

## METHODOLOGY

### 4.1. Introduction

In this chapter we analyze the theoretical and empirical models to find the relationship between the electricity prices and inflation. The methodology is explained by dividing into two parts (i) the economic model and (ii) econometrics methodology. The annual data is used in this study from 1970 to 2013. To obtain the long run relationship three step procedure (Qayyum, 2002) is used. In the very first step to test the unit root of the data set ADF test will be used. To test the unit root of the data set in the presence of structural break Zivot & Andrews (1992) structural break unit root test will be used. In the second step to test the long run relationship Johnson & Juselius approach of Cointegration (1988) will be used. And finally error correction mechanism is used to obtain the short run relationship. The details of the procedure are given below:

### 4.2. Specification of Model

We assume that both demand and supply side factors play an important role in determining the inflation. Moser (1995) assumes that there are two sectors trade able and non-trade able which are used to determine the general price level of goods. So the prices are determine in the following way

$$P = f(P^{T}, P^{NT}) \qquad \dots\dots\dots\dots\dots\dots\dots\dots (1)$$

Prices of trade able goods depend upon the fluctuations in the exchange rate and foreign prices, where as the prices of non-trade able goods depend upon the fluctuations in the money market.

$$P^{g} = P_{T}^{\beta} \, P_{NT}^{1-\beta} \qquad \dots\dots\dots\dots\dots\dots\dots\dots (2)$$

By taking log:

$$logP^g = \beta \log P_T + (1 - \beta)logP_{NT} \ldots\ldots\ldots\ldots (3)$$

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:

$$P_T = f(e, P^f) \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Both an increase in the exchange rate (in domestic currency terms) and an increase in foreign prices will lead to an increase in the overall price level. The price of non tradable goods ($P_{NT}$) is assumed to be set in the money market, where demand for non tradable goods is assumed, for simplicity, to move in line with the overall demand in the economy (Moser 1995). As a result, the price of non tradable goods is determined by the money market equilibrium condition, real money supply ($M_s/P$) equals real money demand ($m_d$), which gives the following equation for non tradable goods prices:

$$logP_{NT} = \log(m_s, m_d) \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Where $M_S$ represents the nominal stock of money, $m_d$ is the demand for real money balances, and $m_s$ represents real money supply, β in equation (3) is a scale factor representing the relationship between economy-wide demand and demand for non tradable goods. The demand for real money balances ($m_d$) is assumed to be a function of real income, inflationary expectations, and foreign interest rates:

$$m_t^d = f(y_t, \pi_t, r_{t+1}) \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Where, $y_t$ is the real income, $\pi_t$ represents the expected inflation in period t, structured in period t – 1, $r_{t+1}$ is the nominal expected interest rate 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:

$$\pi_t = \theta(\Delta logP_{t-1}) + (1-\theta)\pi_{t-1} \quad \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Where $\Delta \log P_{t-1}$ and $\pi_{t-1}$ 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:

$$\pi_t = (\Delta logP_{t-1}) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

The expected interest rate $r_{t+1}$ 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.

$$E(r_{t+1}) = r_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (9)$$

Substituting equation (9) and (8) into (6) yields:

$$m_t^d = f(y_t, \Delta logP_{t-1}, r_t) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

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

By substituting equation (10) into equation (5):

$$logP_{NT} = \log(m_t^s, y_t, \Delta logP_{t-1}, r_t) \quad \ldots\ldots\ldots\ldots \quad (11)$$

The electricity prices are part of the non traded goods. To capture the separate effect of electricity prices, we augment the equation (11) as:

$$logP_{NT} = \log(m_t^s, \mathrm{y_t}, \Delta \mathrm{logP_{t-1}}, \mathrm{r_t}, \mathrm{P_t^{ele}}) \quad \ldots\ldots\ldots\ldots (12)$$

Where $m_t^s$, $\Delta logP_{t-1}$, $y_t$, $r_t$ and $P_t^{ele}$ are real stock of money supply, expected inflation, real income, interest rate and prices of electricity.

Now we have the following functional form after substituting the values of $P_T$ and $P_{NT}$ into equation (1).

$$logP = logf(e_t, P_t^f, m_t^s, y_t, \Delta logP_{t-1}, r_t, P_t^{ele}) \;\ldots\ldots\; (13)$$

As CPI and expected CPI are likely to be strongly correlated, therefore we are dropping the variable of expected Prices from the final equation. And money supply and interest rate both are monetary variables so we are just taking the money supply in the final model. The final equation to be estimated is given as:

$$logP = logf(e_t, P_t^f, m_t^s, y_t, P_t^{ele}) \qquad \ldots\ldots\ldots\ldots\ldots \;(14)$$

$P$: Overall inflation (% change in CPI)

$m_t^s$: Money supply

$y_t$: Gross domestic product (GDP)

$e_t$: Nominal effective exchange rate

$P_t^f$: Foreign prices

$P_t^{ele}$: Electricity Prices

### 4.2.1. *Economic Methodology*

As the purpose of this study is to determine the effect of electricity prices on inflation at aggregate and disaggregate level. So equation (14) can be further modified in the form of multivariate economic models as following:

$$logP_t = logf(e_t, P_t^f, m_t, y_t, P_t^{ele}, D_t) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (a)$$

Where

$logP_t$ : inflation which is taken as the percentage change in the CPI(it is also disaggregated into overall, food, non-food and core inflation).

$loge_t$ : log of nominal effective exchange rate.

$logP_t^f$ : log of foreign Prices as US CPI is taken as the proxy of foreign prices.

$logm_t$ : log of money supply

$logy_t$ : log of real income as log of real GDP is taken as a proxy to measure it.

$logP_t^{ele}$ : log of Electricity prices(which is also segregated into industrial, agricultural, commercial and domestic sector).

$D_t$ : dummy variable to capture the shock into inflation.

### *4.2.2. Construction of VAR*

For further analysis of this study we need to construct an econometrics model. First of all the vector autoregressive model (VAR) is needed to construct for the model (a) in the following equation.

$$Z_t = \mu + \sum_{i=1}^{m} A_i Z_{t-i} + \gamma D_t + V_t \quad \ldots\ldots\ldots\ldots.. (b)$$

Where $Z_t$ contains all n variables of the model and $V_t$ is a vector of random errors that are normally distributed with zero mean and constant variance $(0, \delta^2)$. The order of $Z_t$ matrix is (k x 1) and it contains variables (i.e. $P_t$, $m_t$, $e_t$, $y_t$, $P_t^f$, $P_t^{ele}$) for aggregate electricity prices impact on overall inflation and it has order of (6 x1). For the impact of disaggregate electricity prices on inflation the order $Z_t$ is (9 x1) and it contains the variables (i.e $P_t$, $m_t$, $e_t$, $y_t$, $P_t^f$, $P_t^{com}$, $P_t^{agr}$, $P_t^{ind}$, $P_t^{dom}$ ) and similarly the order of $Z_t$ is (9 x1) for food, non-food and core inflation. It is also assumed that this matrix is a matrix of non-stationary variables. $D_t$ is a matrix of dummy variables which are taken as exogenously. $\mu$ is constant and $V_t \sim N(0, \sigma^2)$ which is the vector of error terms.

### *4.2.3. Dynamics Models*

By assuming that variables are non stationary and there exists the long run relationship among the variables, we specify dynamic ECM model as:

$$\Delta Y_t = \mu + \gamma t + \sum_{i=1}^{p} \Gamma_i \Delta Y_{t-i} + \Pi ECM_{t-1} + u_t \text{..................(4i)}$$

$$\therefore u_t \sim N(0, \sigma^2)$$

Where, $Y_t$ is vector of variables (i.e. $P_t$, $m^s_t$, $e_t$, $y_t$, $P^f_t$, $P^{ele}$) a (6x1) vector of integrated of order one I(1) taken as endogenous variables(assumed).

In equation (i), $\Pi = \alpha \beta'$ and $\alpha$ is speed of adjustment parameter of matrix and $\beta'$ is matrix of long run coefficients. Theoretically the coefficient of speed of adjustment parameter must be negative and significant to confirm that a long run relationship can be obtained. $\Pi ECM_{t-1}$ must be integrated of order zero I (0) and negative for having long run cointegration relationship. $\sum_{i=1}^{p} \Gamma_i \Delta Y_{t-i}$; this term indicates short run part. $\gamma$ is the coefficient of time trend of model, $\mu$ and $u_t$ are intercept and error term of the model respectively that are normally distributed as zero mean and constant variance.

The value of $\Pi$ indicates that with how much speed the model is converge towards equilibrium or we can say that error is correcting with speed of the $\Pi$. Its value also confirms our long run relationship.

So following are four ECM models of overall inflation and three major components of inflation of Pakistan (Food, Non-food and Core inflation), these will be estimated for finding the results of our study:

## i. Overall Inflation and Electricity Prices:

$\Delta P_t = \alpha_0 + \textit{trend} + \Pi_1 ECM_{t-1} + \sum_{i=1}^{m} \alpha_{1i} \Delta P_{t-i} + \sum_{i=1}^{n} \alpha_{2i} \Delta Lm^s_{t-i} + \sum_{i=1}^{o} \alpha_{3i} \Delta Le_{t-i} + \sum_{i=1}^{p} \alpha_{4i} \Delta Ly_{t-i} + \sum_{i=1}^{q} \alpha_{5i} \Delta LP^f_{t-i} + \sum_{i=1}^{q} \alpha_{6i} \Delta LP^{ind}_{t-i} + \sum_{i=1}^{q} \alpha_{7i} \Delta LP^{agr}_{t-i} + \sum_{i=1}^{q} \alpha_{8i} \Delta LP^{dom}_{t-i} + \sum_{i=1}^{q} \alpha_{9i} \Delta LP^{com}_{t-i} + \mu_{0t}$ …………………………… (ii)

Here is the dynamic model for overall inflation and disaggregate electricity prices. Where the expected relationship between variables could be, $\alpha_0 \lesseqgtr 0$, $\alpha_{1i} > 0, \alpha_{2i} > 0, \alpha_{3i} > 0, \alpha_{4i} < 0, \alpha_{5i} > 0, \alpha_{6i} > 0, \alpha_{7i} > 0, \alpha_{8i} > 0, \alpha_{9i} > 0$ and $\Pi_1 < 0$. $\mu_{0t}$ error term of the dynamic model normally distributed as $(0,\sigma^2)$.

## ii. Food Price Inflation and Electricity Prices:

$\Delta P_t^{Food} = \beta_0 + \textit{trend} + \Pi_2 ECM_{t-1} + \sum_{i=1}^{m} \beta_{1i} \Delta P^{Food}_{t-i} + \sum_{i=1}^{n} \beta_{2i} \Delta Lm^s_{t-i} + \sum_{i=1}^{o} \beta_{3i} \Delta Le_{t-i} + \sum_{i=1}^{p} \beta_{4i} \Delta Ly_{t-i} + \sum_{i=1}^{q} \beta_{5i} \Delta LP^f_{t-i} + \sum_{i=1}^{q} \beta_{6i} \Delta LP^{ind}_{t-i} + \sum_{i=1}^{q} \beta_{7i} \Delta LP^{agr}_{t-i} + \sum_{i=1}^{q} \beta_{8i} \Delta LP^{dom}_{t-i} + \sum_{i=1}^{q} \beta_{9i} \Delta LP^{com}_{t-i} + \mu_{0t}$ ………………………...(iii)

The second dynamic model for food price inflation and disaggregate electricity prices is given above. So the expected relationship between the variables could be, $\beta_0 \lesseqgtr 0$, $\beta_{1i} > 0, \beta_{2i} > 0, \beta_{3i} > 0, \beta_{4i} < 0, \beta_{5i} > 0, \beta_{6i} > 0, \beta_{7i} > 0, \beta_{8i} > 0, \beta_{9i} > 0$ and $\Pi_2 < 0$. $\mu_{0t}$ error term of the dynamic model normally distributed as $(0,\sigma^2)$.

## iii. Non-Food Price Inflation and Electricity Prices:

$\Delta P_t^{Non\text{-}Food} = \delta_0 + trend + \Pi_3 ECM_{t-1} + \sum_{i=1}^{m} \delta_{1i} \Delta P^{Non\text{-}Food}{}_{t-i} + \sum_{i=1}^{n} \delta_{2i} \Delta Lm^s{}_{t-i} + \sum_{i=1}^{o} \delta_{3i} \Delta Le_{t-i} + \sum_{i=1}^{p} \delta_{4i} \Delta Ly_{t-i} + \sum_{i=1}^{q} \delta_{5i} \Delta LP^f{}_{t-i} + \sum_{i=1}^{q} \delta_{6i} \Delta LP^{ind}{}_{t-i} + \sum_{i=1}^{q} \delta_{7i} \Delta LP^{agr}{}_{t-I} + \sum_{i=1}^{q} \delta_{8i} \Delta LP^{dom}{}_{t-i} + \sum_{i=1}^{q} \delta_{9i} \Delta LP^{com}{}_{t-I} + \mu_{0t}$ ……………………………….(iv)

Dynamic model for Non-Food price inflation and electricity prices will be estimated as above. Whereas anticipated relationship between variables might be, $\delta_0 \lesseqgtr 0$, $\delta_{1i} > 0$, $\delta_{2i} > 0$, $\delta_{3i} > 0$, $\delta_{4i} < 0$, $\delta_{5i} > 0$, $\delta_{6i} > 0$, $\delta_{7i} > 0$, $\delta_{8i} > 0$, $\delta_{9i} > 0$ and $\Pi_3 < 0$. $\mu_{0t}$ error term of the dynamic model normally distributed as $(0, \sigma^2)$.

## iv. Core Price Inflation and Electricity Prices:

$\Delta P^{Core}{}_t = \lambda_0 + trend + \Pi_4 ECM_{t-1} + \sum_{i=1}^{m} \lambda_{1i} \Delta P^{Core}{}_{t-i} + \sum_{i=1}^{n} \lambda_{2i} \Delta Lm^s{}_{t-i} + \sum_{i=1}^{o} \lambda_{3i} \Delta Le_{t-i} + \sum_{i=1}^{p} \lambda_{4i} \Delta Ly_{t-i} + \sum_{i=1}^{q} \lambda_{5i} \Delta LP^f{}_{t-i} + \sum_{i=1}^{q} \lambda_{6i} \Delta LP^{ind}{}_{t-i} + \sum_{i=1}^{q} \lambda_{7i} \Delta LP^{agr}{}_{t-i} + \sum_{i=1}^{q} \lambda_{8i} \Delta LP^{dom}{}_{t-i} + \sum_{i=1}^{q} \lambda_{9i} \Delta LP^{com}{}_{t-i} + \mu_{0t}$ ……………………………….(4.8)

Finally, the dynamic model for Core price inflation and disaggregate electricity prices will be estimated as above. While the possible relationship between variables can be, $\lambda_0 \lesseqgtr 0$, $\lambda_{1i} > 0$, $\lambda_{2i} > 0$, $\lambda_{3i} > 0$, $\lambda_{4i} < 0$, $\lambda_{5i} > 0$, , $\lambda_{6i} > 0$, $\lambda_{7i} > 0$, $\lambda_{8i} > 0$, $\lambda_{9i} > 0$ and $\Pi_4 < 0$. $\mu_{0t}$ error term of the dynamic model normally distributed as $(0, \sigma^2)$.

In above four dynamic models; *α's, β's, δ's* and *λ's* are short run coefficients of variables in each model. $\Pi_1$, $\Pi_2$, $\Pi_3$, and $\Pi_4$ are coefficients of $ECM_{t-1}$ of all four models respectively.

## 4.3. Econometrics Methodology

For checking the long-run and short-run effects of electricity prices on aggregate and disaggregate inflation we use the following method.

- **Three Steps Method**
  - Unit root test
  - Johansen Maximumlikelihood Cointegration test
  - Dynamic model

**Step 1: ADF (Unit Root Test):**

The regression results are no more valid if the variables are non-stationary. So pre-testing of the order of unit root of the variables is necessary to avoid the spurious results. For the analysis of cointegration, it is assumed that all the variables are integrated of the same order. Dickey and Fuller (1979, 1981) provide one of the commonly used test known as augmented Dickey-Fuller (ADF) test of detecting whether the time series are of stationary or not. This test is the augmented form of Dickey Fuller as sometimes Dickey Fuller regression models suffer from the problem of autocorrelation in the error terms. In this case ADF is used instead of DF test.

Consider the time series variables follow the random walk:

$$Z_t = Z_{t-1} + \epsilon_t \quad \ldots\ldots\ldots\ldots (1)$$

Its mean that all the past information is available.

The dickey fuller unit root concept is illustrated through autoregressive process i.e.

$Z_t = Z_{t-1} + \epsilon_t$ …… AR(1)

Here the unit root test hypothesis is:

$\boldsymbol{H_0} : \boldsymbol{\varphi} = \mathbf{1}$ (i.e. the data is non-stationary)

$\boldsymbol{H_1} : \boldsymbol{\varphi} < \mathbf{1}$ (i.e. the data is not non- stationary)

This test statistics doesn't follow normal distribution so the critical values for the test have calculated through Monte Carlo simulation. For the Augmented dickey fuller test we need following process:

By adding and subtracting $Z_{t-1}$ on right hand side: we get following equation:

$$Z_t = \rho Z_{t-1} + Z_{t-1} - Z_{t-1} + \epsilon_t$$

$$Z_t - Z_{t-1} = \rho Z_{t-1} - Z_{t-1} + \epsilon_t$$

$$\Delta Z_t = (\rho - 1) Z_{t-1} + \epsilon_t \quad \ldots.. \quad (2)$$

∴Δ is the difference operator

Where (ρ-1) can be equal to φ, if ρ =1 so equation (2) has the unit root, so root of equation is φ = 0.

The augmented dickey fuller test can be formulated in three cases such as:

**1.** When the time series is flat or have no trend and potentially slow turning around zero then it can be expressed as:

$$\Delta Z_t = \gamma Z_{t-1} + \delta_1 \Delta Z_{t-1} + \delta_2 \Delta Z_{t-2} + \delta_3 \Delta Z_{t-3} + \cdots + \delta_p \Delta Z_{t-p} + \epsilon_t \qquad \therefore \gamma = (\rho - 1)$$

$\epsilon_t$ is normally distributed with 0 mean and constant variance.

Where, $Z_t$ denotes the time series variable to be tested, used in model. t is time period, Δ is first difference and $\gamma$ is root of equation. The numbers of augmented lags (p) determined by dropping the last lag until we get significant lags. The standard t test does not follow the normal distribution and it is skewed to the left with a long, left hand tail. So McKinnon (1991, 1996) provide the critical values to test following hypothesis. ADF hypothesis follows the left hand tailed test.

**H$_0$: $\gamma$ = 0** (i.e. the data is non-stationary)

$$\begin{cases} \text{if } \rho = 0 \text{ then, if } \rho = 1 \text{ then} \\ \gamma = (\rho - 1) = 0 - 1 = -1 < 0 \\ \gamma = (\rho - 1) = 1 - 1 = 0 \end{cases}$$

**H$_1$: $\gamma$ < 0** (i.e. the data is not non-stationary)

**2.** When the time series is flat but potentially slow turning around non-zero value, it can be expressed as follows by including intercept α but no time trend.

$$\Delta Z_t = \alpha + \gamma Z_{t-1} + \delta_1 \Delta Z_{t-1} + \delta_2 \Delta Z_{t-2} + \delta_3 \Delta Z_{t-3} + \cdots + \delta_p \Delta Z_{t-p} + \epsilon_t$$

Again, the numbers of augmented lags (p) determined by the dropping the last lag until we get significant lags. Hypothesis is left tailed so:

**H$_0$: $\gamma$ = 0** (i.e. the data is non-stationary)

**H$_1$: $\gamma$ < 0** (i.e. the data is not non- stationary)

3. If the time series data has trend in it and move along the trend line (either upward or downward) and potentially slow turning around the trend line so it can be showed as follows:

$$\Delta Z_t = \alpha + \beta t + \gamma Z_{t-1} + \delta_1 \Delta Z_{t-1} + \delta_2 \Delta Z_{t-2} + \delta_3 \Delta Z_{t-3} + \cdots + \delta_p \Delta Z_{t-p} + \epsilon_t$$

Where, βt is deterministic trend term in model. In this equation there are intercept and trend term in it. Now the hypothesis will test that whether the data is trend stationary or not.

**$H_0$: $\gamma$ = 0** (i.e. the data needs to be differenced to make it stationary)

**$H_1$: $\gamma$ < 0** (i.e. the data is trend stationary and needs to be analyzed by means of using a time trend in the regression model instead of differencing the data).

In this study we will use time series variables, the macroeconomic variables mostly have trend in it and have structure breaks in the data, such as; electricity prices and inflation shocks. So for testing the unit root in the presence of break in the data set it will give biased results, so Perron (1989) proposed the test for adding the known break or exogenous break in the ADF test. In (1998) Clemente, Montaries, and Reyes extended Perron (1989) structural break unit root test with two exogenous structural break. In (1992) Zivot & Andrews proposed a unit root test for single endogenous structure break in the data set.

**Zivot & Andrews Unit Root Test (1992)**

ZA test has developed to test the null hypothesis of unit root with one structure break. This test endogenously selects the structure break from the data. Three models have developed to test the stationary properties of the variables in the presence of structural break point.

**i.** One-time change in variables at level form.

**ii.** One-time change in the slope of the trend component i.e. function, and

**iii.** One-time changes both in intercept and trend function of the variables to be used for empirical propose.

ZA test following three models to check the one-time endogenous structural break;

$$\Delta X_t = a + \beta t + \varphi X_{t-1} + \gamma DU_t + \sum_{j=1}^{k} d_j \Delta X_{t-j} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots \text{(A)}$$

$$\Delta X_t = b + \beta t + \varphi X_{t-1} + nDT_t + \sum_{j=1}^{k} d_j \Delta X_{t-j} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots \text{(B)}$$

$$\Delta X_t = c + \beta t + \varphi X_{t-1} + nDT_t + \gamma DU_t + \sum_{j=1}^{k} d_j \Delta X_{t-j} + \varepsilon_t \ldots\ldots \text{(C)}$$

$DU_t$ is a dummy variable which shows the level shift and $DT_t$ is a dummy variable which shows the trend shift and TB is the break point.

$$DU_t = \begin{cases} 1 & if\ t > TB \\ & and \\ 0 & otherwise \end{cases}$$

$$DT_t = \begin{cases} t - TB & if\ t > TB \\ & and \\ 0 & otherwise \end{cases}$$

The null hypothesis for these three models;

**$H_0$:** $\varphi = 0$ ; series is non stationary with one structure break.

**$H_a$:** $\varphi < 0$ ; series is not non-stationary with one structure break

The t test is used to test these hypotheses, and it is left tail test. Zivot and Andrews test consider every break point independently and run regression for every possible break date sequentially. Among all these break dates the test selects that break date which minimizes the one sided t-statistics. According to the Zivot and Andrews, the presence of the end points cause the asymptotic distribution of the statistics to diverges towards infinity. Therefore there is a need to choose some region that does not include end points of the sample. Thus Zivot and Andrews suggest the 15% trimming of the end points of the sample set.

**Step 2: Johansen and Jusilious Maximumlikelihood Method of Cointegration**

If the combination of two non stationary variables generates linear combination, so they are called cointegrated. Engle and Granger (1987) proposed the two step Cointegration test also known as residual based test. But this test cannot estimate more than two variables, so Johansen & Juselius (1992) presented the Maximum likelihood test for estimating more than one Cointegration vector. Let us assume that the vector of variables Z has the following representation, it is general form of long run CI relationship.

$$Z_t = \mu + \sum_{i=1}^{m} A_i Z_{t-i} + \gamma D_t + V_t$$

In this we can estimate the Cointegration relation as follows:

$P_t = a_0 + a_1 m^s_t + a_2 e_t + a_3 y_t + a_4 P^f_t + a_5 P^{ind} + a_6 P^{agr} + a_7 P^{dom} + a_8 P^{com} + \mu_t$

As this equation is explained before, Where $Z_t$ contains all n variables; it is a vector of non-stationary variables and $\Delta Z_t = (1 - B)Z_t$ is a vector of stationary variables. $V_t$ is a vector of random errors. This model can also be represented in the form of dynamic error correction model ECM as:

$$\Delta Z_t = \sum_{k=1}^{i-1} \Gamma_k \Delta Z_{t-k} + \Pi Z_{t-1} + \mu + \theta D_t + v_t$$

$\therefore v_t \sim N(0, \sigma^2)$

Where k = 1, 2, 3,……, i-1 is the lag length. $\Gamma_k = -(I - A_1 - A_2 - A_3 \ldots . A_k)$ is the coefficient of the short run dynamic relationship and $\Pi = -(I - A_1 - A_2 - A_3 \ldots . A_k)$ is a matrix of long run coefficients of order (k x k). The no. of cointegration vectors are determined by the rank of Π matrix.

Where, Π = αβ', it can be illustrated through matrices form:

$$= \begin{bmatrix} \alpha_{11} & \cdots & \alpha_{n1} \\ \vdots & \ddots & \vdots \\ \alpha_{1m} & \cdots & \alpha_{nm} \end{bmatrix} \begin{bmatrix} \beta_{11} & \cdots & \beta_{n1} \\ \vdots & \ddots & \vdots \\ \beta_{1m} & \cdots & \beta_{nm} \end{bmatrix} \begin{matrix} z_{t-1} \\ \vdots \\ z_{t-i} \end{matrix}$$

↓ ↓

$$= \quad \alpha \quad \beta'$$

Where, α is speed of adjustment parameter of matrix and β' is matrix of long run coefficients.

Let Π = αβ' so;

$$= \begin{bmatrix} \Pi_{11} & \cdots & \Pi_{n1} \\ \vdots & \ddots & \vdots \\ \Pi_{1m} & \cdots & \Pi_{nm} \end{bmatrix}$$ ……….. Speed of adjustment & LR coefficients in Π matrix.

The μ, vector of constant is further decomposed into $\mu = \mu_1 + \delta_1 t + \mu_2 + \delta_2 t$, where $\mu_1 + \delta_1 t$ are the constant and trend term in the long run cointegration equation and $\mu_2 + \delta_2 t$ are the drift and trend term in the short run vector autoregressive model (VAR).

So in general form VECM can be illustrated as follows:

$\Delta Z_t = A_0 + \Pi Z_{t-1} + A_1\Delta Z_{t-1} + \ldots\ldots\ldots\ldots + A_p\Delta Z_{t-p} + \mu_t$ …….. (VECM)

Where, $\Pi Z_{t-1}$ is long run error correction term and $A_1\Delta Z_{t-1} + \ldots\ldots\ldots\ldots + A_p\Delta Z_{t-p}$ is short run VAR (p) at first difference.

$\Pi Z_{t-1}$ must be integrated of order zero I (0) and negative for having long run Cointegration relationship.

The equation of Maximumlikelihood fuction is as following

$$L\ (\alpha, \beta, \Lambda)\ =\ |\Lambda|^{-T/2} exp\left\{\frac{-1}{2}\sum_{t=1}^{T}(R_{0t} + \alpha\beta' R_{kt})' \Lambda^{-1}(R_{0t}\ + \alpha\beta R_{kt})\right\}$$

Where $R_{0t}$ is obtaining by first regressing the $\Delta Z_t$ on the lagged differences which giving the residuals $R_{0t}$ and then regressing $Z_{t-k}$ on the lagged differences giving the residuals $R_{kt}$.

In Johnson's and Juselius determines the number of cointegration relationship on the bases of rank of Π matrix. Two test statistics have used to find the rank of Π matrix such as

- **i.** Maximum Eigen Value Test and
- **ii.** Trace Test
- **i.** **Maximum Eigen Value Test:** It tests whether the no. of Eigen values are statistically different from zero. The null and alternative hypothesis are:

**$H_0$:** rank (Π) = r

**$H_a$:** rank (Π) = r+1 ∴r = rank, r = 0,1,2……k

**Test statistics:** $\boldsymbol{\lambda_{max(r,r+1)}\ =\ -Tln(1-\lambda_{r+1})}$ for r = 0,1……k-1

With T: The number of observations, λ: The Eigen values of the matrix Π, K: number of variables, r: rank of matrix Π. It will compare with the critical values provided by the Johansen & Juselius (1992). If the λ maximum calculated is less than the critical value so $H_0$ will not be rejected.

- **ii.** **Trace test:** It tests whether the trace of Π matrix significantly increased by adding Eigen values. This test considers the null hypothesis of r or less cointegrating vectors against the alternative of more than r cointegrating vectors. Null and alternative hypothesis:

**$H_0$:** rank k (Π) = 0 < r < k k is full rank

**$H_A$:** rank k (Π) > r

**Test statistics:** $\boldsymbol{\lambda_{trace(r)} = -T\sum_{i=r+1}^{k} log(1-\hat{\lambda_i})}$

$\hat{\lambda_i}$ are eigen values of Π matrix which are arranged into descending order.

From Maximum Eigen Value test and Trace test it is clear that $\boldsymbol{\lambda_{trace}}$ is joint test as compared to $\boldsymbol{\lambda_{max}}$.The critical values for both test are provided by Johansen and Juselius (1990). These test statistics are asymptotically distributed as $\boldsymbol{\chi^2}$ with r (k-r) degree of freedom.

As Π matrix consists of Π = αβ, where β is a matrix of long run coefficients. The statistical significance of long run parameters of β matrix is tested by Likelihood ratio (LR) test. This test has chi-square distribution and it can be calculated by applying zero restriction on the estimated parameters of the individual variables.

Johansen and Juselius (1990) allow the imposition of linear economic restrictions (such as homogeneity, proportionality) on the coefficients of α and β matrix. The restrictions apply equally to all vectors. The hypothesis can be formulated as:

$H_0: \beta = J\theta$

Where J is (k × h) matrix of known restrictions and θ is (s × r) matrix of restrictions on the individual values of the eigen vectors. The test statistics is

$$LR = -T\sum_{i=1}^{r} \ln\frac{(\mathbf{1}-\hat{\boldsymbol{\lambda}_i})}{(\mathbf{1}-\boldsymbol{\lambda}_i^*)}$$

$\hat{\boldsymbol{\lambda}_i}$ are the eigenvalues of the restricted model. LR is $\chi^2$distributed with r × (k-s) degrees of freedom. (k-s) is the number of rows over which restrictions are imposed.

For multiple cointegrating vectors, it is necessary to impose restrictions based on economic arguments to obtain long-run structural relationships. Davidson (1998) provides the general rule for identifying unique cointegration vector span. Accordingly, the restricted cointegrating vector has at least one variable unique to it that would always be helpful in identifying the relationships. After determining the rank of $\Pi$ matrices, or number of cointegrating vectors, we will run our dynamic model given in equation (4i).

### Step 3: Dynamic Error Correction Model

The residuals of long-run cointegrating vectors are used as an important determinant of error correction model (ECM). These residuals are also known as disequilibrium estimates or error correction terms. They measure the divergence from long run equilibrium and provide speed of adjustment information towards equilibrium. The four short run dynamic error correction models of overall inflation including three major sectors of Food, Non-Food and Core inflation are explained above in section 4.2.3 will be estimated through ordinary least square (OLS) method.

## 4.4. Diagnostic Tests

The preferred dynamic model satisfies the number of diagnostic tests. For example, Godfrey Lagrange Multiplier (LM) (1978) test is used to test the null hypothesis of serial correlation in the residual term of error correction model. Then to check the autocorrelation conditional heteroskedasticity (ARCH) in the residuals, Engle's (1982) LM test is used to ensure that there is constant variance in the residual series. For testing the normality of the residual of the model Jorque Bera (JB) test is used. Stability of the estimated parameters of the model is examined by utilizing the Cumulative Sum of Recursive Residuals (CUSUM) and Cumulative Sum of Squares of Residuals (CUSUMSQ) test [Brown, Durbin and Evans (1975)] is implied to ensure that the mean and variance of the model is stable.

## 4.5. Data Sources

For the estimation of the above described models we need data on the variables. Nine variables are used for the analysis of the following study. Annual data has been taken since 1970 to 2013 on all variables instead of core inflation data, which is taken from 1990 to 2013. The description of variables and data sources is as following:

### 4.5.1 Inflation

The percentage change in CPI is termed as inflation. Year on year inflation is the percent change of an index (CPI, WPI or SPI) in a given month over the index in the same month of the last year. It is computed as follows:

$$\pi_t = \left(\frac{I_t}{I_{t-12}} - 1\right) \times 100$$

The data on overall inflation is taken from World Development Indicator (WDI) on the base of (2005= 100).

### 4.5.2 Food Inflation

Annual % growth of CPI food, beverage and tobacco is used as a proxy to measure the food inflation [Khan and Qasim(1996), Kemal et al (2011), Bashir et al (2011)]. The data on food inflation is taken from Pakistan Economics Survey (Various Issues). By using splicing method data is converted on the base (2007-08 = 100).

### 4.5.3 Non-Food Inflation

Non-food inflation is measured by using the following formula $P_{nf} = P_g - \beta P_f/(1 - \beta)$.[ Khan and Qasim(1996)]. Where β is the weight of CPI food in overall CPI, $P_g$ is overall CPI and $P_f$ is food CPI. The data on non-food inflation is taken from Pakistan Economics Survey (Various Issues). By using splicing method data is converted on the base (2007-08 = 100).

### 4.5.4 Core Inflation

Core inflation is the persistent component of inflation which excludes the volatile and controlled prices. Core inflation is measured by two methods

i. Non-food, Non-Energy inflation (NFNE); it is measured by excluding the non-food and energy items (kerosene oil, patrol, diesel, electricity, CNG and natural gas) from the overall CPI basket.

ii. The second method to measure core inflation is 20% trimmed mean inflation method in which all the items are arranged into ascending order according to changes in their price indices. Then 10% of the items at the top of the list (corresponding to cumulative weight of 90% or more) and 10% of the items from the bottom of the list (corresponding to cumulative weight of 10% or less) are excluded from the overall inflation as it is considered that 20% of the items show extreme changes. Then the weighted mean of the changes in price indices of the rest of the items is core inflation.

The data on core inflation (NFNE inflation) is taken from Pakistan Economics Survey (Various Issues) with base (2000-01 = 100).

### 4.5.5 Money Supply (M2)

Money supply (M2) includes money in circulation and all time related deposits, saving deposits and foreign currency deposits of resident sectors other than the central government. Data on money supply is from World development Indicator (WDI).

### 4.5.6 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).

#### 4.5.7 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 World Development Indicator (WDI).

#### 4.5.8 Gross Domestic Product

The data on real gross domestic product (GDP) is available at current local currency and it is taken from World Development Indicator (WDI).

#### 4.5.9 Electricity Prices

The data on electricity prices is measured in paisa per kilowatt hour (paisa/Kwh). The data on overall electricity prices and sectoral electricity prices is taken from Water and Power Development Authority (WAPDA).

## 4.6. Concluding Remarks

In this chapter we have described the theoretical model and then econometrics model. We have also comprehensively described the methodology which we imply for the estimation of the variables in the next chapter. Finally we describe the brief description about the variables used in the study, their time span and sources of the data set.

# Chapter 5

# RESULT AND DISCUSSION

## 5.1 Introduction

In the last chapter we have discussed our theoretical and econometric methodology along with the brief description of the data set. Now in the preceding chapter we are going to use the above described methodology to analyze our data set for all the four models. This chapter deals with the finding of our study results and brief discussion on the results as well. This includes the results of unit root by Augmented Dickey Fuller test (1979) and unit root with structural break test by Zivot & Andrews (1992). The results of Maximum Likelihood Method of cointegration (Johansen, 1988) and dynamic models are also included. With the help of these results we can conclude the final results of the study.

## 5.2 Results of Unit root Test

All the independent variables are transformed into logarithmic form before applying the unit root test. The data is transformed into logarithmic form in order to reduce the impact of outliers and smooth the data set (Maddala, 1992). Then Augmented Dickey Fuller test and Zivot and Andrews test have been applied on all the eight independent and four dependent variables. Before applying the unit root tests, the graphs of the series have been plotted to examine the pattern of the data set which are shown in the following figures. From the graphs it can be seen that there is an increasing trend in the data set, as graphs trended upward as time passes. Thus time trend is included in the model. These graphs also show that data is not fluctuating around the zero mean level so intercept term is also incorporated in the model. These are the assumptions to check that whether the data is stationary or not.

**Figure 5.1 Inflation in Pakistan**

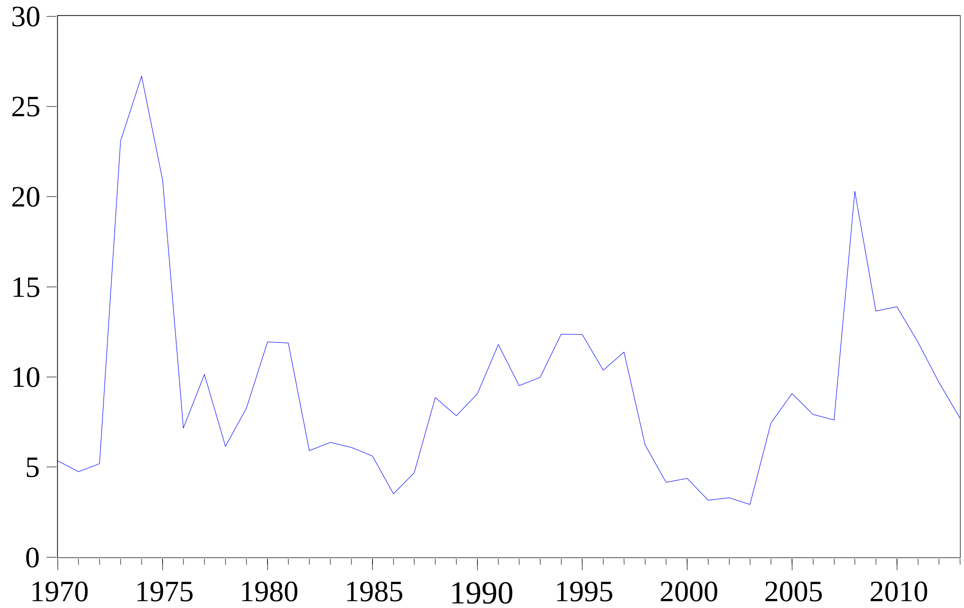



**Figure 5.2 Food Inflation of Pakistan**

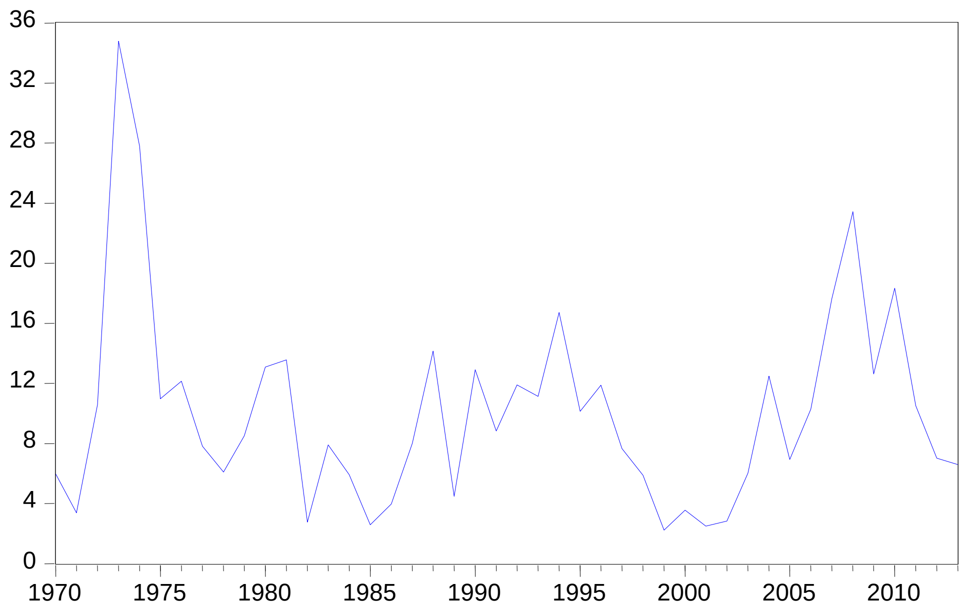


**Figure 5.3 Non-Food Inflation of Pakistan**

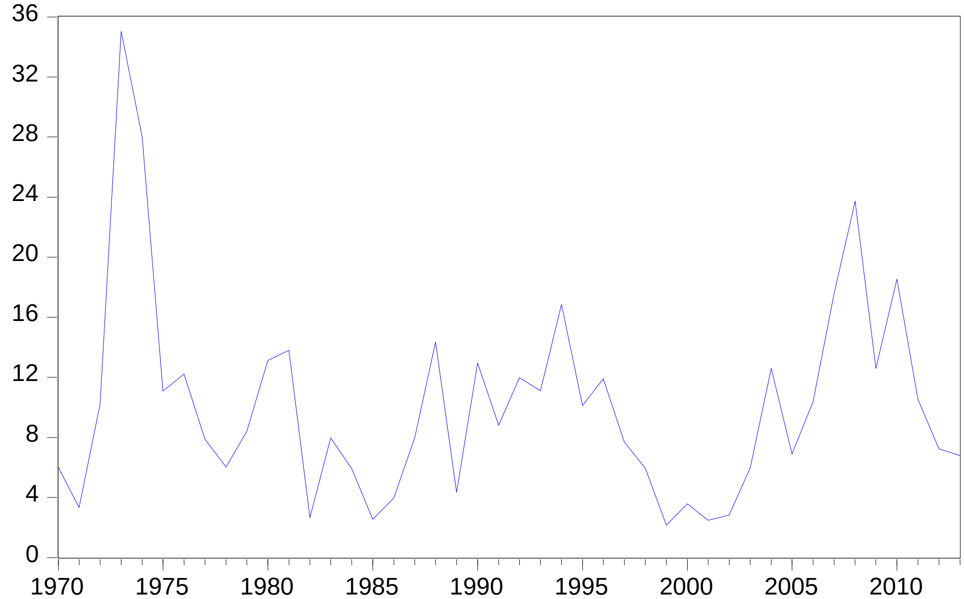



**Figure 5.4 Core Inflation of Pakistan**

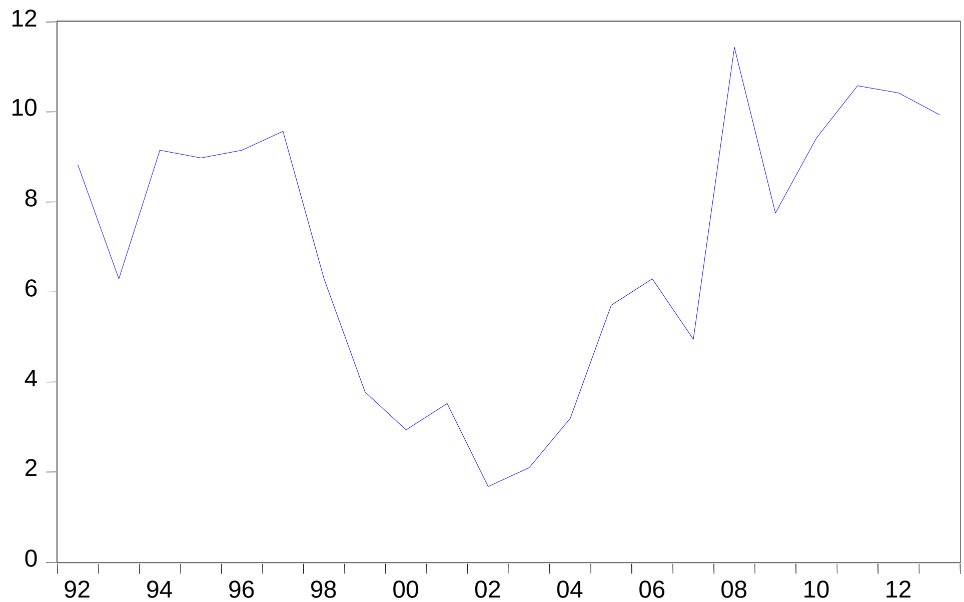


**Figure 5.5 Money Supply (M2) of Pakistan**

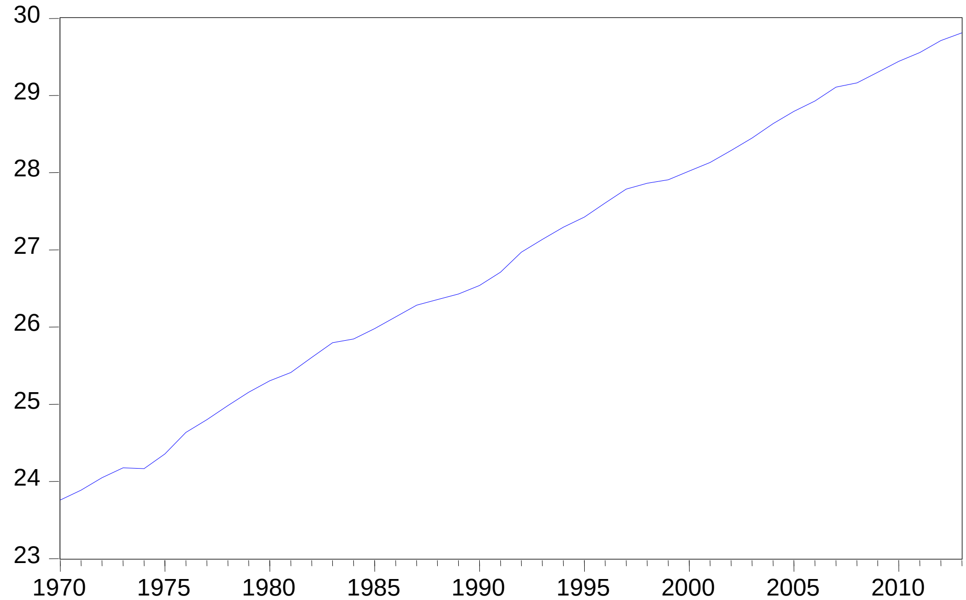



**Figure 5.6 Gross Domestic Product (GDP) of Pakistan**

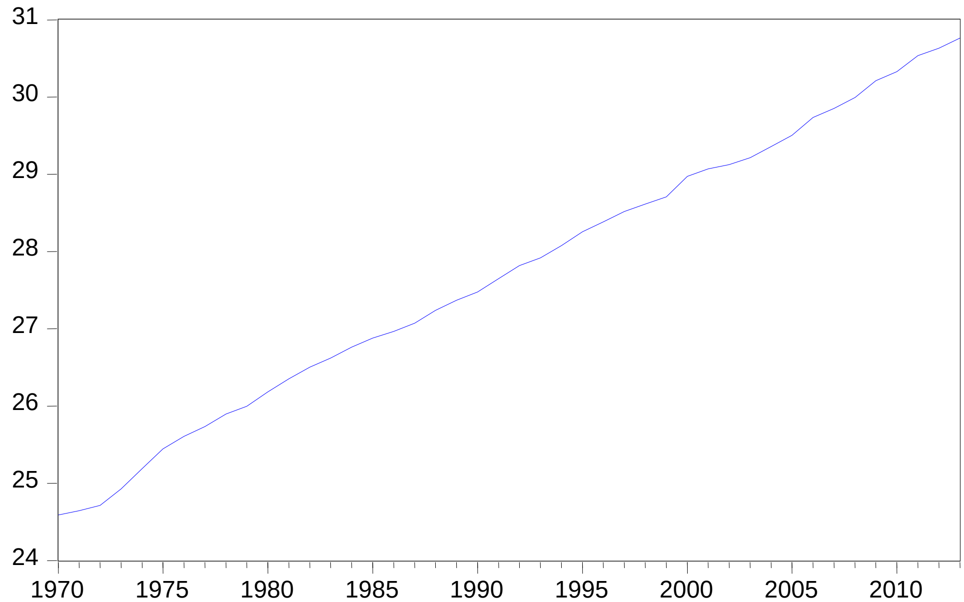


**Figure 5.7 Foreign Prices**

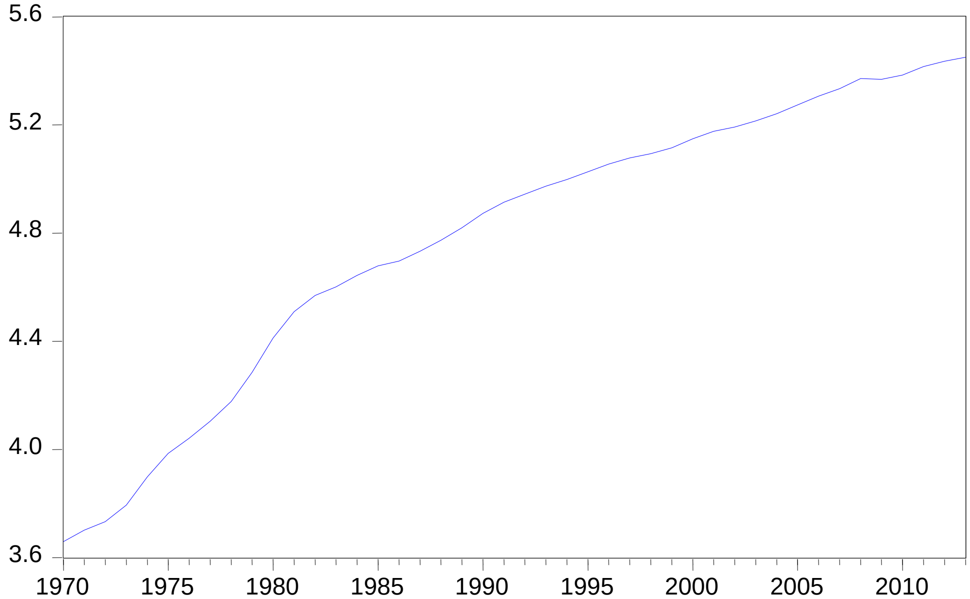



**Figure 5.8 Nominal Effective Exchange Rate of Pakistan**

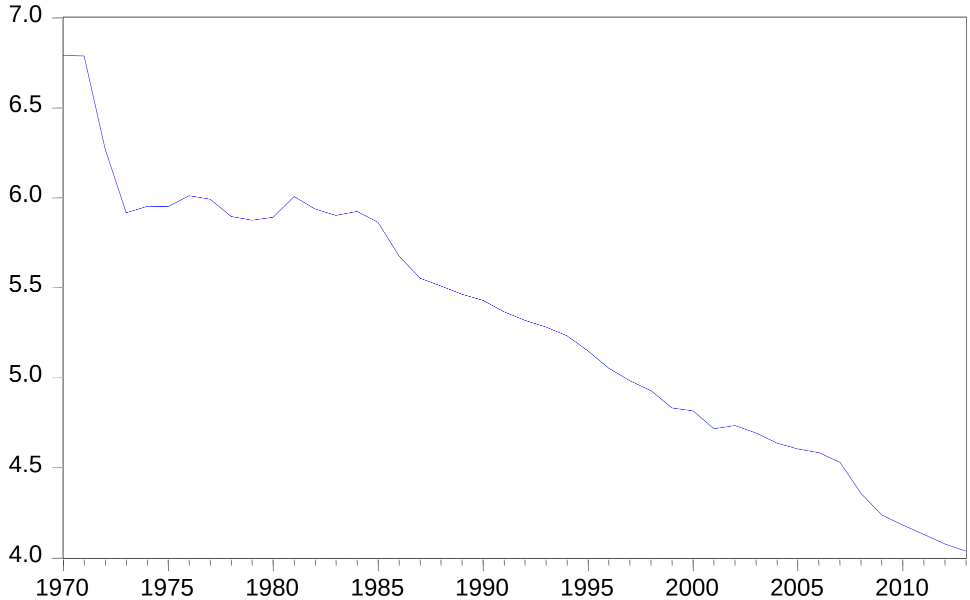


**Figure 5.9 Electricity Prices of Pakistan**

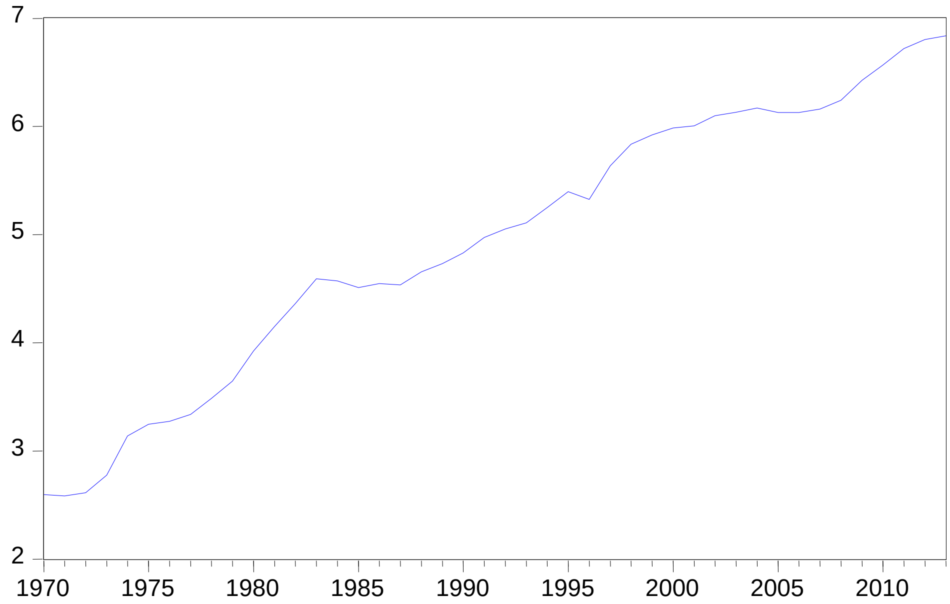



**Figure 5.10 Agricultural Electricity Prices of Pakistan**

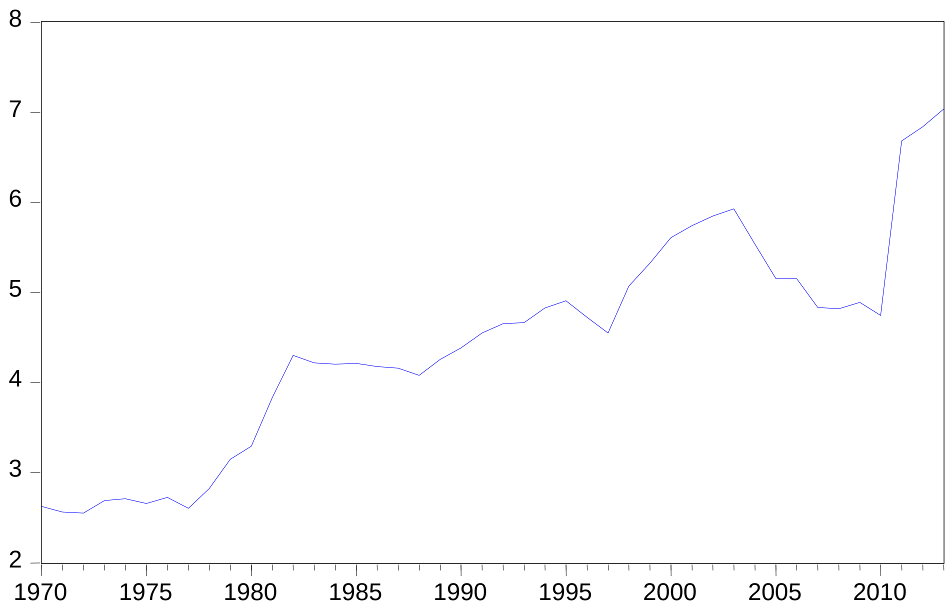


**Figure 5.11 Commercial Electricity Prices of Pakistan**

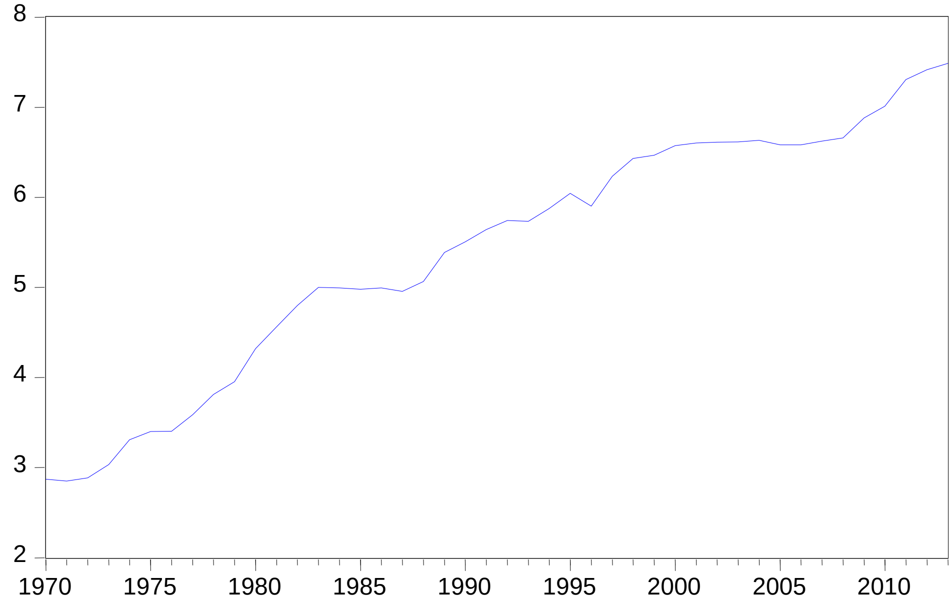



**Figure 5.12 Domestic Electricity Prices of Pakistan**

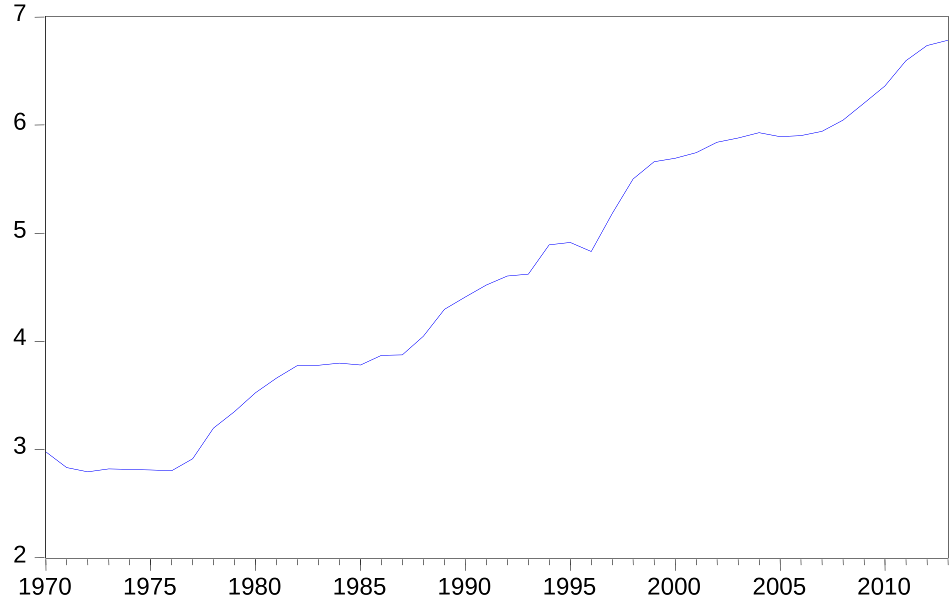
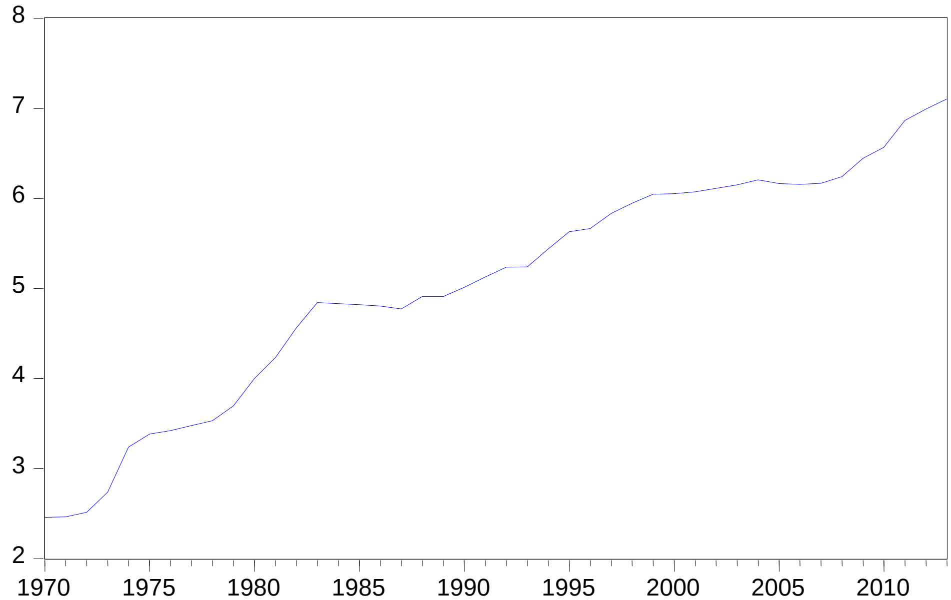


**Figure 5.13 Industrial Electricity Prices of Pakistan**




First of all, the DF test with drift and time trend in the model has estimated for all the variables. In the beginning, the unit root is tested at level or without differencing the data set. As for the inflation, food inflation, non-food inflation, core inflation, GDP, money supply, commercial and agricultural electricity prices, we do not need to incorporate the lags of dependent variables as independent variables to remove the problem of serial correlation, so Dickey Fuller test has been applied on these variables in order to check their stationarity. For the foreign prices, nominal effective exchange rate, total electricity prices, industrial and domestic electricity prices, lags are taken to remove the problem of serial correlation, so Dickey Fuller test becomes Augmented Dickey Fuller test for these variables. The results are given in the following Table 5.1 and Table 5.2 It can be seen from the Table 5.1 that at level all the variables instead of food and non-food inflation are non-stationary. Therefore all the variables instead of food and non-food inflation are integrated of order one I(1).

**Table 5.1: Results of Augmented Dickey Fuller Test (Annual Data (T =44))**

| ***Level*** | | | | |
|---|---|---|---|---|
| **Variable** | **Deterministic** | **Lags** | **ADF tau-stat** | **Outcome** |
| **P** | Intercept and trend | 0 | -3.285 | I(1) |
| **$P^{Food}$** | Intercept and trend | 0 | -3.759 | I(0) |
| **$P^{Non\text{-}Food}$** | Intercept and trend | 0 | -3.802 | I(0) |
| **$P^{Core}$** | Intercept and trend | 0 | -1.790 | I(1) |
| **$LP^{ele}$** | Intercept and trend | 1 | -2.542 | I(1) |
| **$LP^{dom}$** | Intercept and trend | 1 | -3.436 | I(1) |
| **$LP^{com}$** | Intercept and trend | 0 | -1.397 | I(1) |
| **$LP^{agr}$** | Intercept and trend | 0 | -2.163 | I(1) |
| **$LP^{ind}$** | Intercept and trend | 1 | -2.930 | I(1) |
| **$LP^{for}$** | Intercept and trend | 2 | -2.695 | I(1) |
| **Le** | none | 3 | -0.955 | I(1) |
| **Ly** | Intercept and trend | 0 | -2.22 | I(1) |
| **Lm2** | Intercept and trend | 0 | -2.21 | I(1) |

**Table 5.2: Results of Augmented Dickey Fuller Test (Annual Data (T =44))**

| ***First Difference*** | | | | |
|---|---|---|---|---|
| **Variable** | **Deterministic** | **Lags** | **ADF tau-stat** | **Outcome** |
| **$\Delta P$** | none | 0 | -6.425 | I(0) |
| **$\Delta P^{Core}$** | none | 0 | -6.290 | I(0) |
| **$\Delta LP^{ele}$** | Intercept | 0 | -4.600 | I(0) |
| **$\Delta LP^{dom}$** | none | 0 | -3.114114 | I(0) |
| **$\Delta LP^{Com}$** | Intercept | 0 | -5.074104 | I(0) |
| **$\Delta LP^{agr}$** | none | 0 | -5.531707 | I(0) |
| **$\Delta LP^{ind}$** | Intercept | 0 | -4.102909 | I(0) |
| **$\Delta Le$** | none | 2 | -4.147025 | I(0) |
| **$\Delta LP^{for}$** | Intercept | 1 | -2.521 | I(0) |
| **$\Delta Ly$** | Intercept | 0 | -5.758 | I(0) |
| **$\Delta Lm2$** | Intercept | 0 | -5.308 | I(0) |

As the ADF test of unit root just test the unit root in the data set without considering the structural breaks. But there is an important aspect of unit root in the presence of structural break, is the trend property of the variables. If there is no upward trend in the data, the test power to reject the no-break null hypothesis is reduced as the critical values increase with the inclusion of trend variable (Ben David and Papell, 1997). On the contrarily, if the series shows some sort of trend, then estimating model without trend may fail to capture some important characteristics of the data set. Since all the series under study depict some upward or downward trend, so we estimate model C of Zivot and Andrews test of unit root with structural break with the inclusion of $\beta t$ term. The results for Zivot and Andrew unit root test are presented in Table 5.3 and Table 5.4.

**Table 5.3: Results of Zivot and Andrews Structural Break Unit Root Test at Level**

| Variable | Deterministic | Lags | Zivot and Andrews t-stat | Break Date | Outcome |
|---|---|---|---|---|---|
| **P** | Intercept and trend | 1 | -4.570** | 1988 | I(1) |
| **$P^{Food}$** | Intercept and trend | 0 | -4.258** | 2006 | I(1) |
| **$P^{Non\text{-}Food}$** | Intercept and trend | 0 | -4.301** | 2006 | I(1) |
| **$P^{Core}$** | Intercept and trend | 0 | -4.081** | 1999 | I(1) |
| **$LP^{ele}$** | Intercept and trend | 1 | -4.130** | 1980 | I(1) |
| **$LP^{dom}$** | Intercept and trend | 0 | -4.099096** | 1977 | I(1) |
| **$LP^{com}$** | Intercept and trend | 0 | -4.613562** | 1997 | I(1) |
| **$LP^{agr}$** | Intercept and trend | 0 | -4.335607** | 1998 | I(1) |
| **$LP^{ind}$** | Intercept and trend | 0 | -4.001657** | 1997 | I(1) |
| **$LP^{for}$** | Intercept | 2 | -5.297* | 1979 | I(1) |
| **Le** | Intercept and trend | 1 | -4.692215*** | 1981 | I(1) |
| **Ly** | Intercept | 0 | -2.84** | 2002 | I(1) |
| **Lm2** | Intercept and trend | 0 | -4.005793** | 1992 | I(1) |

**Note:** * denotes statistical significance at 1% level. ** denotes statistical significance at 5% level and ***denotes the statistical significance at 10% level.

**Table 5.4: Results of Zivot and Andrews Structural Break Unit Root Test at First Difference**

| *First Difference* | | | |
|---|---|---|---|
| **Variable** | **Lags** | **Zivot & Andrews** | **Outcome** |
| **$\Delta P$** | 2 | -6.090 | I(0) |
| **$\Delta P^{Food}$** | 2 | -6.842 | I(0) |
| **$\Delta P^{Non\text{-}Food}$** | 2 | -6.842 | I(0) |
| **$\Delta P^{Core}$** | 0 | -7.498 | I(0) |
| **$\Delta LP^{ele}$** | 0 | -5.532 | I(0) |
| **$\Delta LP^{dom}$** | 0 | -5.775 | I(0) |
| **$\Delta LP^{com}$** | 0 | -5.942 | I(0) |
| **$\Delta LP^{agr}$** | 0 | -5.334 | I(0) |
| **$\Delta LP^{ind}$** | 0 | -5.217 | I(0) |
| **$\Delta LP^{for}$** | 1 | -6.88 | I(0) |
| **$\Delta Le$** | 0 | -5.735 | I(0) |
| **$\Delta Ly$** | 0 | -5.184 | I(0) |
| **$\Delta Lm2$** | 1 | -5.491 | I(0) |

The results of Zivot and Andrews test suggest that all the variables are non-stationary at level with structural break. Then after applying the first difference the variables are stationary with structural break. Thus the order of integration of all variables are I(1) along with significant structural break. These results are similar with the results which are obtained by the ADF test instead for the food and non-food variable series. For food and non-food inflation series the

Zivot and Andrews test suggests that these series are non-stationary with the significance structural break at 2006.

As all the variables are integrated of the same order I(1), then we can apply the cointegration analysis. Thus in order to check the long run relationship between the variables, we will use the Johansen Maximum Likelihood Method.

## 5.3 Dynamic Analysis of Total Electricity Prices and Overall Inflation

**Long Run Analysis**

After performing the unit root tests and determining the order of unit root, the first step for the Johansen (1988) likelihood ratio test is to decide the optimal lag length of the vector autoregressive (VAR) system which ensures that the residuals are not serially correlated. So the VAR model is estimated with six variables ($P^{inf}, Lm, Ly, Le, LP^{for}, LP^{ele}$) and one exogenous dummy variable (dummy = 2008). In 2008, the whole world was suffering from the severe financial crisis so the prices were high all over the world (Hamilton, 2011). The increase in the inflation in 2007-08 was because of the increase in the food prices, a weaker rupee/dollar exchange rate, the gradual withdrawal of the subsidies to the gas, electricity and petroleum, imposition of custom duty on various imported items and an increase in the prices of wheat and sugarcane crops. Now the numbers of lags which are included in the analysis are as following:

**Table 5.3.A: VAR Lag Order Selection for Total Electricity Prices and Inflation**

| VAR | LM-Stats | |
|---|---|---|
| | **Lag 1** | **Lag 2** |
| 1 | 61.64500 (0.0049) | 54.29115 (0.0258) |
| 2 | 38.97415 (0.3374)* | 65.08389 (0.0021) |
| 3 | 48.82469 (0.0751)* | 39.79541 (0.3049)* |

Note: * indicates the level of significance at 5%

So the VAR (3) model is selected. The lag length of VAR model is selected on the bases of Johansen (1995) multivariate LM test.

After selecting the optimal lag length of VAR model, we have to decide about the suitable treatment of deterministic components such as drift and trend term. As most of the series in this study are showing a linear trend in the level of the series, therefore intercept term is included unrestrictedly while performing cointegration analysis (Johansen, 1995 and Harris and Sollis, 2003).

As Johansen (1988) proposed two test statistics to check the order of cointegrating vectors i.e Trace test and Maximum Eigenvalue test. The results of these tests are given in the following Table 5.3.B. The trace test shows that the null hypothesis of no cointegration ($r = 0$), one cointegration ($r \leq 1$), two cointegration ($r \leq 2$), three cointegration ($r \leq 3$), four cointegration ($r \leq 4$) and five cointegrating vectors ($r \leq 5$) can be rejected, but it is failed to reject the null of six cointegrating vectors at five percent level of significance. While, the maximum eigenvalue statistic with the null hypothesis $r = 1$ is rejected, $r = 2$ is rejected and so on $r = 5$ is rejected but the null hypothesis r = 6 is not rejected and refers to six long run relationships exist among the variables.

As trace test is more powerful as compare to maximum eigenvalue test because it considers all (k-r) values of the smallest eigenvalues [Kasa(1992) and Serletris and King(1997)]. So we continue our analysis on the bases of trace test.

**Table 5.3.B: Trace and Maximum Eigenvalues Test of Cointegration for Inflation and Electricity Prices**

| **Trace Statistics** | | | | **Maximum Eigen Values Statistics** | | | |
|---|---|---|---|---|---|---|---|
| $H_0$ | $H_A$ | Test Statistics | Critical Value | $H_0$ | $H_A$ | Test Statistics | Critical Value |
| $r = 0$ | $r \geq 1$ | 340.6925* | 103.8473 | $r = 0$ | $r = 1$ | 125.3855* | 40.95680 |
| $r \leq 1$ | $r \geq 2$ | 215.3070* | 76.97277 | $r = 1$ | $r = 2$ | 80.02102* | 34.80587 |
| $r \leq 2$ | $r \geq 3$ | 135.2859* | 54.07904 | $r = 2$ | $r = 3$ | 48.04999* | 28.58808 |
| $r \leq 3$ | $r \geq 4$ | 87.23595* | 35.19275 | $r = 3$ | $r = 4$ | 36.98446* | 22.29962 |
| $r \leq 4$ | $r \geq 5$ | 50.25149* | 20.26184 | $r = 4$ | $r = 5$ | 32.67212* | 15.89210 |
| $r \leq 5$ | $r \geq 6$ | 17.57937 | 19.164546 | $r = 5$ | $r = 6$ | 17.57937 | 19.164546 |

After finding the no. of cointegrating vectors, we will estimate the long run relationship by using Maximum likelihood method. As we have found that there exist six cointegrating vectors, but we are interested only in one cointegrating relationship in the following study. So the normalized long run coefficients are given in equation (5.3.1). The chi-square values are given in parentheses.

$$P_t = 59.665 + 80.010Lm2_t - 88.135Ly_t + 64.129LP_t^{for} - 39.379Le_t +$$

(15.348) (95.693) (129.958) (48.468) (12.532)

$$1.702LP_t^{ele} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (\mathbf{5.3.1})$$

(0.044)

This equation shows that the money supply positively affect the inflation in the long run as expected and has significant impact on inflation. These results are in line with the results of [Qayyum (2006), Kema l (2006), Haider et al (2013), Khan and Qasim (1996) and Bashir et al (2011)]. The impact of GDP on inflation is also significant and negative. This result is similar with the result of [Kemal (2006) and Khan and Qasim (1996)]. Foreign prices effect the inflation positively and significantly. Similarly nominal effective exchange rate effects the inflation negatively. All these control variables i.e foreign prices, money supply and nominal effective exchange rate influence the inflation significantly. Whereas the impact of electricity prices on inflation is positive. But electricity prices have insignificant impact on inflation in the long run. This result is in line with the finding of (Heerden et al, 2008), as the South African Reserve bank warned against the inflationary effect due to the higher increase in the prices of electricity but such significant results are not found in that study. The reason of electricity prices effect on inflation is that electricity is a component of CPI so when electricity prices increases, it leads a direct increase in the CPI or inflationary shock [Gordon (1997) and Hooker (2002)]. The extent of higher electricity prices effect on inflation also depends on the share of electricity prices in the overall CPI. But the insignificant impact of electricity prices on inflation is may be because of aggregate electricity prices consistent of different sectoral prices. And different sectors have to pay electricity tariffs differently. Also government provides subsidy on electricity tariffs in the past many years. In fact, tariffs were frozen between 2003 to 2007 at very low rates. These are below the cost recovery level. In the last two years more than 90% increase in tariffs were taken place. But this increase is not monitored in the calculation of CPI. As in August 2013, government had significantly increased the prices of electricity for industrial, commercial and bulk consumers. But Pakistan Bureau of Statistics (PBS) did not include the impact of higher electricity tariffs for industrial, commercial and bulk consumers in CPI calculation [Asif Bajwa, Chief Statistician of Pakistan (Express Tribune, September 3rd 2013)]. As results the impact of increase in prices of electricity on inflation is not significant.

**Short Run Dynamic Error Correction Model**

Once the variables are cointegrated, we move forward to estimate the short run dynamic relationship between the variables. In this section the results of error correction model are present. The residuals of the long run cointegration equation are the important determinants of the ECM. Theses residuals are known as error correction term. This measures the disequilibrium from long run in period t-1 and provides information about the speed of adjustment. The ECM is estimated by ordinary least square (OLS) method. By considering general to specific approach (David Hendry, 2004) the general model is estimated by incorporating the drift term, dummy variable (dummy = 2008), lag of error correction term and lag length three for each first difference variables. We have the following model after dropping the insignificant variables. The short run ECM model with t-values in parentheses is given as follows;

$$\Delta P_t = -5.803 + 0.315\Delta P_{t-2} - 36.858\Delta Lm2_t + 30.485\ \Delta Lm2_{t-1} + 34.657\Delta Ly_t$$

(-2.446) (2.917) (-4.419) (3.334) (3.604)

$$-28.688\Delta Le_t - 0.731ECM_{t-1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \textbf{(5.3.2)}$$

(-4.678) (-5.721)

**Diagnostic Tests**

$R^2 = 0.727$ $\overline{R}^2 = 0.679$ DW = 1.737

Jarque Bera test of Normality $\chi^2_{(2)} = 1.066$ (0.586),

Breusch Godfrey LM test of Autocorrelation [$\chi2$ (1) = 0.3173 and $\chi2$ (2) = 0.6048]

Engl's 1982 ARCH LM Test for Hetroscadasticity [$\chi2$ (1) = 0.1350 and $\chi2$ (2) = 0.2813]

The dynamic model (5.3.2) is diagnosed through the residuals of the model. Firstly, the normality is tested, the chi-square value of Jarque Bera test is 1.06 which tells us that the residual are normally distributed as the null hypothesis is not rejected. Then the serial correlation of the residuals is tested by LM test as [$\chi2$ (1) = 0.3173 and $\chi2$ (2) = 0.6048] which shows that null hypothesis is not rejected so no problem of serial correlation. The residuals also have equal spread of variance as Engl's 1982 ARCH LM Test for Hetroscadasticity [$\chi2$ (1) = 0.1350 and $\chi2$ (2) = 0.2813]. The values of $R^2$ and adjusted $R^2$ are 72% and 67% which shows the goodness of fit of the model respectively.

In equation (5.3.2), the ECM term is significant and negative which is according to the theory. As the negative sign of ECM term confirms adjustment towards equilibrium. So the value of ECM term indicates that error is correcting with the speed of 73% in one year. The significance of this term also ensures the long run relationship between the variables.

The effect of second lagged coefficient of inflation has positive impact on it. The coefficient of current money supply has negative impact on inflation whereas the lagged coefficient of money supply has positive impact on inflation in the short run. But in the short run GDP has positive impact on inflation. This is because may be in the short run by increasing the output will directly affect the inflation. But the impact of nominal effective exchange rate is also significant and negative as it was in the long run.

So it is concluded that the impact of overall electricity prices on inflation in the long run is positive but in the short run it has no impact on inflation. Negative association in the inflation and real GDP implies that any increase in the output in the short run resulting from demand stimulus results in decline in the output and causes higher prices in the long run. But the effect of all control variables is according to the theory in the long run as well as in the short run.

Finally, the stability of the dynamic model is tested by utilizing the CUSUM and CUSUMSQ test (Brown et al, 1975). These plots are used to plot the cumulative sum along the 5% critical lines to test the mean and variance stability of the parameters. The CUSUM and CUSUMSQ plots are given in figure 5.3.1 and 5.3.2, which show that there is no significant structural instability and residual variance is stable during the analysis period because CUSUM and CUSUMSQ remain within the 5 percent critical bound.

**Figure 5.3.1: CUSUM of Mean Stability for Inflation and Electricity Prices**

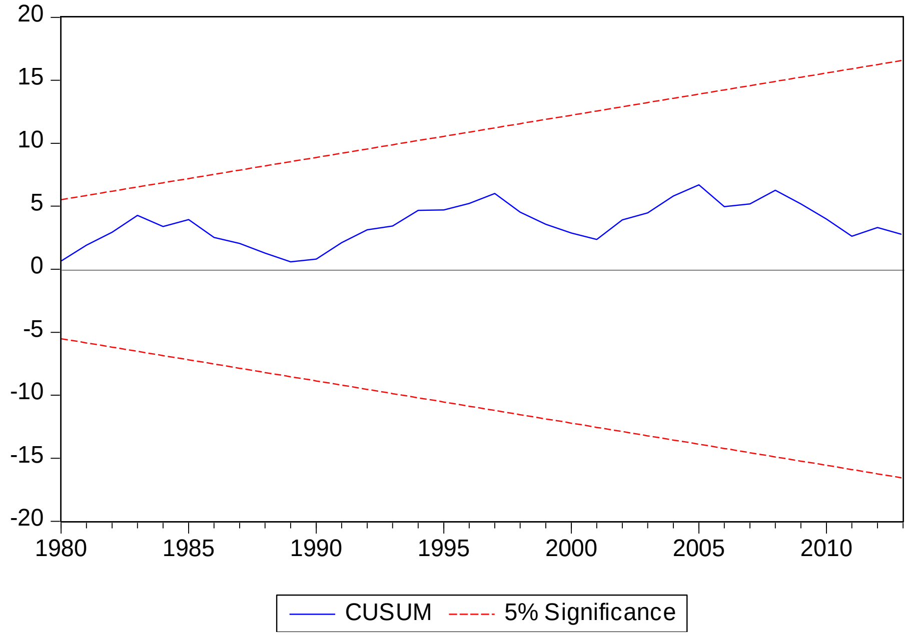
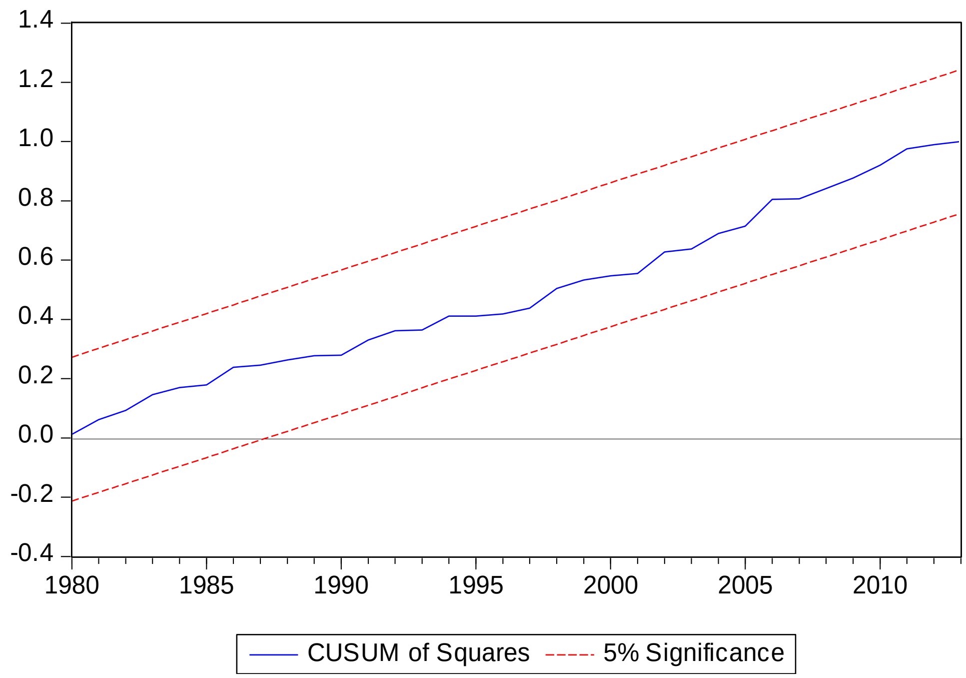



**Figure 5.3.2: CUSUMSQ of Variance Stability for Inflation and Electricity Prices**



## 5.4 Dynamic Analysis of Total Electricity Prices and Food Inflation

### Long Run Analysis

Now for applying the Johansen cointegration test for the estimation of the second model in which we want to analyze the impact of aggregate electricity prices on food inflation, the optimal lag length of the vector autoregressive (VAR) system which ensures that the residuals are not serially correlated is selected. So the VAR model is estimated with six variables ($P^{food}, Lm, Ly, Le, LP^{for}, LP^{ele}$) and one exogenous dummy variable (dummy = 2008). In 2008, the whole world was suffering from the severe financial crisis so the prices were high all over the world (Hamilton, 2011). Pakistan was hit by global food and oil prices in 2008.In September 2008 the Government has raised the prices of wheat by 50% from Rs 625/40 Kg to 950/40 Kg which in turn pushed up the prices of both wheat and wheat flour across the country. The increase in the inflation in 2007-08 was because of the mainly increase in the food prices, an increase in the prices of wheat and sugarcane crops. Now the numbers of lags which are included in the analysis are as following:

**Table 5.4.A: VAR Lag Order Selection for Total Electricity Prices and Food Inflation**

| VAR | LM-Stats | |
|---|---|---|
| | Lag 1 | Lag 2 |
| 1 | 67.12172 (0.0013) | 45.41515 (0.1351) |
| 2 | 58.45219(0.0104) | 40.67809 (0.2719)* |
| 3 | 35.73285 (0.4812)* | 43.78694 (0.1746)* |

Note: * indicates the level of significance at 5%

So the VAR (3) model is selected. The lag length of VAR model is selected on the bases of Johansen (1995) multivariate LM test.

After selecting the optimal lag length of VAR model, we have to decide about the deterministic components, as most of the series show the increasing trend at the level therefore intercept term is included unrestrictedly in the cointegration analysis (Johansen, 1995 and Harris and Sollis, 2003).

As Johansen (1988) proposed two test statistics to check the order of cointegrating vectors i.e Trace test and Maximum Eigenvalue test. The results of these tests are given in the following Table 5.4.B. The trace test shows that the null hypothesis of no cointegration ($r = 0$), one cointegration ($r \leq 1$), two cointegration ($r \leq 2$), three cointegration ($r \leq 3$), four cointegration ($r \leq 4$) and five cointegrating vectors ($r \leq 5$) can be rejected, but it is failed to reject the null of six cointegrating vectors at five percent level of significance. While, the maximum eigenvalue statistic with the null hypothesis $r = 1$ is rejected, $r = 2$ is rejected and so on $r = 5$ is rejected but the null hypothesis $r = 6$ is not rejected and refers to six long run relationships exist among the variables.

On the bases of trace test we have selected six cointegrating vectors and continue our analysis.

**Table 5.4.B: Trace and Maximum Eigenvalues Test of Cointegration for Food Inflation and Electricity Prices**

| Trace Statistics | | | | Maximum Eigen Values Statistics | | | |
|---|---|---|---|---|---|---|---|
| $H_0$ | $H_A$ | Test Statistics | Critical Value | $H_0$ | $H_A$ | Test Statistics | Critical Value |
| r = 0 | r ≥ 1 | 288.2632* | 95.75366 | r = 0 | r = 1 | 103.9615* | 40.07757 |
| r ≤ 1 | r ≥ 2 | 184.3017* | 69.81889 | r = 1 | r = 2 | 85.03496* | 33.87687 |
| r ≤ 2 | r ≥ 3 | 99.26678* | 47.85613 | r = 2 | r = 3 | 44.67369* | 27.58434 |
| r ≤ 3 | r ≥ 4 | 54.59309* | 29.79707 | r = 3 | r = 4 | 35.72486* | 21.13162 |
| r ≤ 4 | r ≥ 5 | 18.86823* | 15.49471 | r = 4 | r = 5 | 18.75973* | 14.26460 |
| r ≤ 5 | r ≥ 6 | 0.108495 | 3.841466 | r = 5 | r = 6 | 0.108495 | 3.841466 |

After finding the no. of cointegrating vectors, we will estimate the long run relationship by using Maximum likelihood method. As we have found that there exist six cointegrating vectors, but we are only interested in one cointegrating relationship in the following study. So the normalized long run coefficients are given in equation (5.4.1). The chi-square values are given in parentheses.

$$P_t^{food} = 71.427Lm2_t - 80.567Ly_t + 33.573LP_t^{for} - 30.547Le_t + 1.86LP_t^{ele} \ldots \quad (\mathbf{5.4.1})$$

(204.347) (99.180) (14.758) (12.358) (0.130)

This equation (5.4.1) shows that the money supply positively affect the food-inflation in the long run as expected and has significant impact on it. These results are in line with the results of [Khan and Qasim (1996) and Kemal et al (2011)]. The impact of GDP on food-inflation is also significant and negative. This result is similar with the result of [Kemal et al (2006) and Khan and Qasim (1996)]. As output is very important determinant of food-inflation. So increase in the output by improving the supply situation can help to reduce the food prices. Foreign prices affect the food-inflation positively and significantly. Similarly nominal effective exchange rate affects the food-inflation negatively. All these control variables i.e foreign prices, money supply and nominal effective exchange rate influence the food-inflation significantly. Whereas the impact of electricity prices on food-inflation is positive. But electricity prices have insignificant impact on food-inflation in the long run. Because in the long run there are many other factors which highly effect the food inflation as the 2008 world food crises, when the food inflation in Pakistan reached at its highest rate 34% which was mainly in the raise of prices of wheat and sugarcane crops.

**Short Run Dynamic Error Correction Model**

By considering general to specific approach (David Hendry, 2004) the general model is estimated by incorporating the drift term, dummy variable (dummy = 2008), lag of error correction term and lag length three for each first difference variables. We have the following model after dropping the insignificant variables. The short run ECM model with t-values in parentheses is shown as follows;

$$\Delta P_t^{food} = -1.477 - 25.720\Delta Le_t - 0.879ECM_{t-1} \quad \ldots\ldots\ldots\ldots\ldots \quad (\mathbf{5.4.2})$$

(-1.899)* (-3.953) (-7.041)

**Diagnostic Tests**

$R^2 = 0.639$ $\overline{R}^2 = 0.621$ DW = 1.689

Jarque Bera test of Normality $\chi^2_{(2)}$ = 1.805(0.405),

Breusch Godfrey LM test of Autocorrelation [$\chi2$ (1) = 0.2548 and $\chi2$ (2) = 0.5225]

Engl's 1982 ARCH LM Test for Hetroscadasticity [$\chi2$ (1) = 0.0747 and $\chi2$ (2) = 0.1087]

The dynamic model (5.4.2) is diagnosed through the residuals of the model. Firstly, the normality is tested, the chi-square value of Jarque Bera test is 1.805 which tells us that the residual are normally distributed as the null hypothesis is not rejected. Then the serial correlation of the residuals is tested by LM test as [$\chi2$ (1) = 0.2548 and $\chi2$ (2) = 0.5225] which shows that null hypothesis is not rejected so no problem of serial correlation. The residuals also have equal spread of variance as Engl's 1982 ARCH LM Test for Hetroscadasticity is [$\chi2$ (1) = 0.0747 and $\chi2$ (2) = 0.1087]. The values of $R^2$ and adjusted $R^2$ are 63% and 62% which shows the goodness of fit of the model respectively.

In equation (5.4.2), the ECM term is significant and negative which is according to the theory. As the negative sign of ECM term confirms adjustment towards equilibrium. So the value of ECM term indicates that error is correcting with the speed of 87% in one year. The significance of this term also ensures the long run relationship between the variables.

In the short run all the variables have insignificant impact on food-inflation but only exchange rate has the significant impact on food-inflation. This shows that there is 1% increase in nominal effective exchange rate causes 25.72% decreases in food-inflation.

So it is concluded that the impact of overall electricity prices on food-inflation in the long run is positive but in the short run it has no impact on food-inflation. Negative association in the food-inflation and real GDP implies that any increase in the output in the long run causes the food-inflation to reduce. But the effect of all control variables is according to the theory in the long run.

Finally, the stability of the dynamic model is tested by utilizing the CUSUM and CUSUMSQ test (Brown et al, 1975). The figure 5.4.1 and 5.4.2 show that there is no structural instability and residual variance is also stable during the analysis period as CUSUM and CUSUMSQ remain within the 5% critical bound.

**Figure 5.4.1: CUSUM of Mean Stability for Food-Inflation and Electricity Prices**

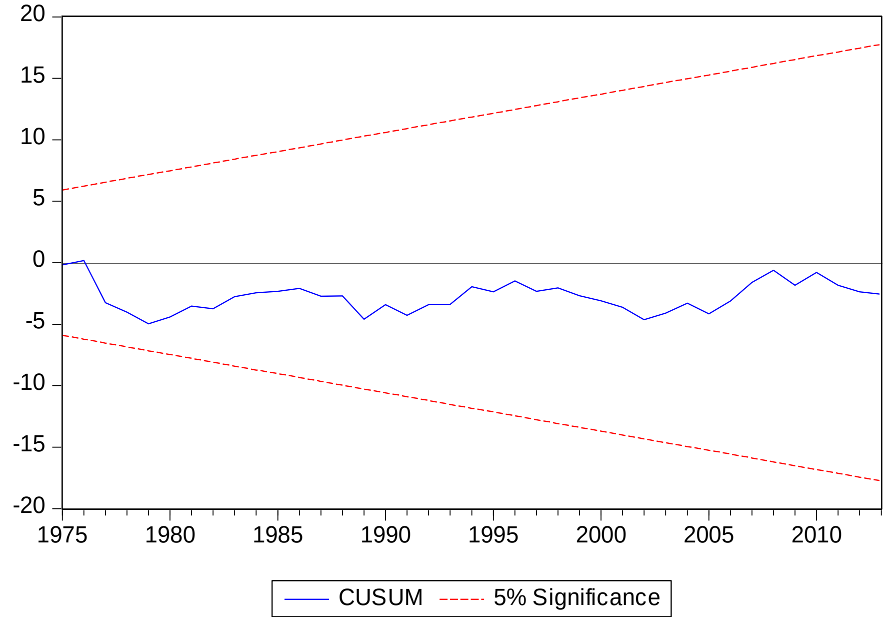
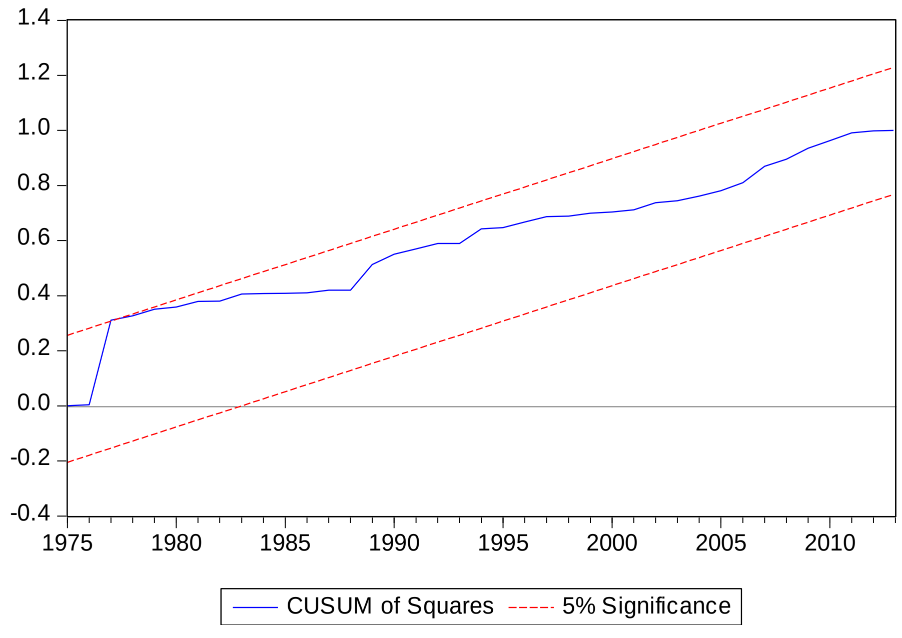



**Figure 5.4.2: CUSUMSQ of Variance Stability for Food-Inflation and Electricity Prices**



## 5.5 Dynamic Analysis of Total Electricity Prices and Non-Food Inflation

### Long Run Analysis

Applying the Johansen cointegration test for the estimation of the third model in which we want to analyze the impact of aggregate electricity prices on Non-food inflation, the optimal lag length of the vector autoregressive (VAR) system is selected which ensures that the residuals are not serially correlated. So the VAR model is estimated with six variables ($P^{Non-food}, Lm, Ly, Le, LP^{for}, LP^{ele}$) and one exogenous dummy variable (dummy = 2008). In 2008, the whole world was suffering from the severe financial crisis so the prices were high all over the world (Hamilton, 2011). Pakistan was hit by global food and oil prices in 2008. Now the numbers of lags which are included in the analysis are as following:

**Table 5.5.A: VAR Lag Order Selection for Total Electricity Prices and Non-Food Inflation**

| **VAR** | **LM-Stats** | |
|---|---|---|
| | **Lag 1** | **Lag 2** |
| 1 | 67.37052 (0.0012) | 45.72807 (0.1248) |
| 2 | 58.65382 (0.0099) | 40.56878 (0.2759)* |
| 3 | 35.65133 (0.4850)* | 43.64188 (0.1785)* |

Note: * indicates the level of significance at 5%

So the VAR (3) model is selected. The lag length of VAR model is selected on the bases of Johansen (1995) multivariate LM test.

After selecting the optimal lag length of VAR model, we have to decide about the suitable treatment of deterministic components such as drift and trend term. As most of the series in this study are showing a linear trend in the level of the series, therefore intercept term is included unrestrictedly while performing cointegration analysis (Johansen, 1995 and Harris and Sollis, 2003).

As Johansen (1988) proposed two test statistics to check the order of cointegrating vectors i.e Trace test and Maximum Eigenvalue test. The results of these tests are given in the following Table 5.5.B. The trace test shows that the null hypothesis of no cointegration ($r = 0$), one cointegration ($r \leq 1$), two cointegration ($r \leq 2$) can be rejected and so on five cointegration ($r \leq 5$) can be rejected but it is failed to reject the null of six cointegrating vectors at five percent level of significance. While, the maximum eigenvalue statistic with the null hypothesis $r = 1$ is rejected, $r = 2$ is rejected and so on $r = 5$ is rejected but the null hypothesis $r = 6$ is not rejected and refers to six long run relationships exist among the variables.

As trace test is more powerful as compare to maximum eigenvalue test because it considers all (k-r) values of the smallest eigenvalues [Kasa(1992) and Serletris and King(1997)]. So we continue our analysis on the bases of trace test.

**Table 5.5.B: Trace and Maximum Eigenvalues Test of Cointegration for Non-Food Inflation and Electricity Prices**

| Trace Statistics | | | | Maximum Eigen Values Statistics | | | |
|---|---|---|---|---|---|---|---|
| $H_0$ | $H_A$ | Test Statistics | Critical Value | $H_0$ | $H_A$ | Test Statistics | Critical Value |
| r = 0 | r ≥ 1 | 288.8461* | 95.75366 | r = 0 | r = 1 | 103.8081* | 40.07757 |
| r ≤ 1 | r ≥ 2 | 185.0379* | 69.81889 | r = 1 | r = 2 | 85.80591* | 33.87687 |
| r ≤ 2 | r ≥ 3 | 99.23203* | 47.85613 | r = 2 | r = 3 | 44.70775* | 27.58434 |
| r ≤ 3 | r ≥ 4 | 54.52428* | 29.79707 | r = 3 | r = 4 | 35.74352* | 21.13162 |
| r ≤ 4 | r ≥ 5 | 18.78077* | 15.49471 | r = 4 | r = 5 | 18.68502* | 14.26460 |
| r ≤ 5 | r ≥ 6 | 0.095749 | 3.841466 | r = 5 | r = 6 | 0.095749 | 3.841466 |

After finding the no. of cointegrating vectors, we will estimate the long run relationship by using Maximum likelihood method. As we have found that there exist six cointegrating vectors, but we are interested only in one cointegrating relationship in the following study. So the normalized long run coefficients are given in equation (5.5.1). The chi-square values are given in parentheses.

$$P_t^{Non-food} = 72.614Lm2_t - 82.188Ly_t + 35.132LP_t^{for} - 31.996Le_t +$$

(204.504) (101.639) (15.712) (13.156)

$$2.446LP_t^{ele} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad \mathbf{(5.5.1)}$$

(0.215)

This equation (5.5.1) shows that the money supply positively affect the Non-food inflation in the long run as expected and has significant impact on it. These results are in line with the results of (Khan and Qasim, 1996). The impact of GDP on Non-food inflation is also significant and negative. This result is similar with the result of (Khan and Qasim, 1996). Foreign prices affect the Non-food inflation positively and significantly. Similarly nominal effective exchange rate affects the Non-food inflation negatively. All these control variables i.e foreign prices, money supply and nominal effective exchange rate influence the Non-food inflation significantly. Whereas the impact of electricity prices on Non-food inflation is positive. But electricity prices have insignificant impact on Non-food inflation in the long run.

**Short Run Dynamic Error Correction Model**

By considering general to specific approach (David Hendry, 2004) the general model is estimated by incorporating the drift term, dummy variable (dummy = 2008), lag of error correction term and lag length three for each first difference variables. We have the following model after dropping the insignificant variables. The short run ECM model with t-values in parentheses is shown as follows;

$\Delta P_t^{Non-food} = 21.115\Delta Lm2_{t-1} - 14.872\Delta Lm2_{t-2} - 12.459\Delta Le_{t-3} -$

(1.980)* (-1.547)* (-1.940)*

$0.713ECM_{t-1}$ ……………. (**5.5.2**)

(-5.676)

**Diagnostic Tests**

$R^2 = 0.583$ $\bar{R}^2 = 0.548$ DW = 2.091

Jarque Bera test of Normality $\chi^2_{(2)} = 2.357(0.307)$,

Breusch Godfrey LM test of Autocorrelation [$\chi2$ (1) = 0.6239 and $\chi2$ (2) = 0.3785]

Engl's 1982 ARCH LM Test for Hetroscadasticity[$\chi2$ (1) = 0.6971 and $\chi2$ (2) = 0.2812]

The dynamic model (5.5.2) is diagnosed through the residuals of the model. Firstly, the normality is tested, the chi-square value of Jarque Bera test is 2.35 which tells us that the residuals are normally distributed as the null hypothesis is not rejected. Then the serial correlation of the residuals is tested by LM test as [$\chi2$ (1) = 0.6239 and $\chi2$ (2) = 0.3785] which shows that null hypothesis is not rejected so no problem of serial correlation. The residuals also have equal spread of variance as Engl's 1982 ARCH LM Test for Hetroscadasticity [$\chi2$ (1) = 0.6971 and $\chi2$ (2) = 0.2812]. The values of $R^2$ and adjusted $R^2$ are 58% and 54% which shows the goodness of fit of the model respectively.

In equation (5.5.2), the ECM term is significant and negative which is according to the theory. As the negative sign of ECM term confirms adjustment towards equilibrium. So the value of ECM term indicates that error is correcting with the speed of 71% in one year. The significance of this term also ensures the long run relationship between the variables.

In equation (5.5.2) the coefficient of second lag of money supply has negative impact on Non-food inflation whereas the first lagged coefficient of money supply has positive impact on Non-food inflation in the short run. But the impact of nominal effective exchange rate is also significant and negative as it was in the long run.

So it is concluded that the impact of overall electricity prices on Non-food inflation in the long run is positive but in the short run it has no impact on it. But the effect of all control variables is according to the theory in the long run and the impact of exchange rate is significant and negative both in the short run as well as in the long run.

Finally, the stability of the dynamic model is tested by utilizing the CUSUM and CUSUMSQ test (Brown, et al, 1975). The figure 5.5.1 and 5.5.2 show that there is no structural instability and residual variance is also stable during the analysis period as CUSUM and CUSUMSQ remain within the 5% critical bound.

**Figure 5.5.1: CUSUM of Mean Stability for Non-Food Inflation and Electricity Prices**

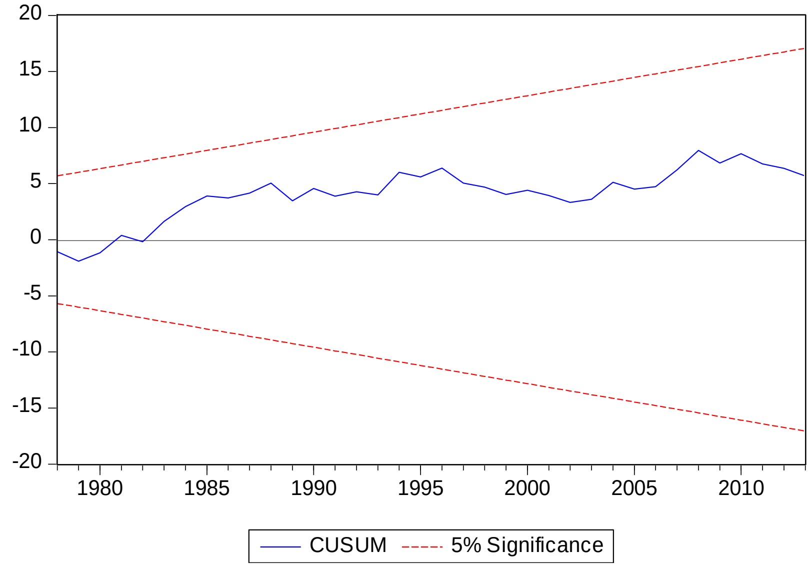
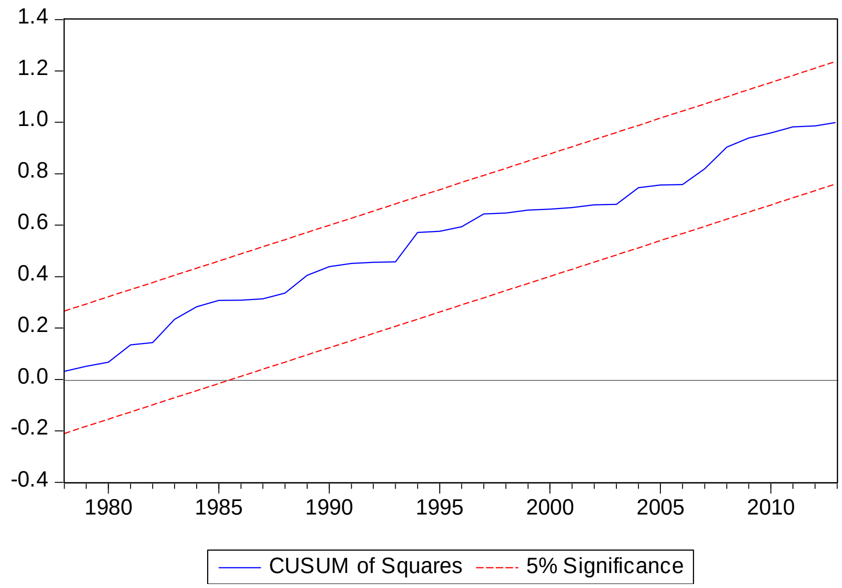



**Figure 5.5.2: CUSUMSQ of Variance Stability for Non-Food Inflation and Electricity Prices**



## 5.6 Dynamic Analysis of Total Electricity Prices and Core Inflation

**Long Run Analysis**

Applying the Johansen cointegration test for the estimation of the fourth model in which we want to analyze the impact of aggregate electricity prices on core inflation, the optimal lag length of the vector autoregressive (VAR) system is selected which ensures that the residuals are not serially correlated. So the VAR model is estimated with five variables ($P^{Core}, Lm, Ly, Le, LP^{ele}$) and one exogenous dummy variable (dummy = 2008). In 2008, the whole world was suffering from the severe financial crisis so the prices were high all over the world (Hamilton, 2011). Pakistan was hit by global food and oil prices in 2008. Now the numbers of lags which are included in the analysis are as following:

**Table 5.6.A: VAR Lag Order Selection for Total Electricity Prices and Core Inflation**

| **VAR** | **LM-Stats** | |
|---|---|---|
| | **Lag 1** | **Lag 2** |
| **1** | 36.64506 (0.0624)* | 27.90465 (0.3123)* |

Note: * indicates the level of significance at 5%

So the VAR (1) model is selected. The lag length of VAR model is selected on the bases of Johansen (1995) multivariate LM test.

After selecting the optimal lag length of VAR model, we have to decide about the deterministic components, as most of the series show the increasing trend at the level therefore intercept term is included unrestrictedly in the cointegration analysis (Johansen, 1995 and Harris and Sollis, 2003).

As Johansen (1988) proposed two test statistics to check the order of cointegrating vectors i.e Trace test and Maximum Eigenvalue test. The results of these tests are given in the following Table 5.6.B. The trace test shows that the null hypothesis of no cointegration ($r = 0$), one cointegration ($r \leq 1$) and two cointegration ($r \leq 2$) can be rejected, but it is failed to reject the null of three cointegrating vectors at five percent level of significance. While, the maximum eigenvalue statistic with the null hypothesis $r = 1$ is rejected and $r = 2$ is rejected but the null hypothesis $r = 3$ is not rejected and refers to three long run relationships exist among the variables.

On the bases of trace test we have selected three cointegrating vectors and continue our analysis.

**Table 5.6.B: Trace and Maximum Eigenvalues Test of Cointegration for Core Inflation and Electricity Prices**

| **Trace Statistics** | | | | **Maximum Eigen Values Statistics** | | | |
|---|---|---|---|---|---|---|---|
| $H_0$ | $H_A$ | Test Statistics | Critical Value | $H_0$ | $H_A$ | Test Statistics | Critical Value |
| $r = 0$ | $r \geq 1$ | 126.7369* | 69.81889* | $r = 0$ | $r = 1$ | 65.90399* | 33.87687* |
| $r \leq 1$ | $r \geq 2$ | 60.83291* | 47.85613* | $r = 1$ | $r = 2$ | 34.14748* | 27.58434* |
| $r \leq 2$ | $r \geq 3$ | 26.68542 | 29.79707 | $r = 2$ | $r = 3$ | 18.79737 | 21.13162 |
| $r \leq 3$ | $r \geq 4$ | 7.888057 | 15.49471 | $r = 3$ | $r = 4$ | 7.649855 | 14.26460 |
| $r \leq 4$ | $r \geq 5$ | 0.238202 | 3.841466 | $r = 4$ | $r = 5$ | 0.238202 | 3.841466 |

After finding the no. of cointegrating vectors, we will estimate the long run relationship by using Maximum likelihood method. As we have found that there exist three cointegrating vectors, but we are interested only in one cointegrating relationship in the following study. So the normalized long run coefficients are given in equation (5.6.1). The chi-square values are given in parentheses.

$$P_t^{Core} = 60.253Lm2_t - 81.659Ly_t + 16.299Le_t + 24.278LP_t^{ele} \ldots\ldots\ldots\ldots\ldots\ldots \quad (\mathbf{5.6.1})$$

(47.116) (136.037) (259.354) (40.957)

This equation (5.6.1) shows that the money supply positively affect the core inflation in the long run as expected and has significant impact on it. The impact of GDP on core inflation is also significant and negative. Similarly nominal effective exchange rate affects the core inflation positively. Whereas the impact of electricity prices on core inflation is positive. And electricity prices significantly affect the core inflation. These results are in line with the results of (Haider et al, 2013) in their study they have found the impact of energy prices on non-energy inflation which is positive and also (Munnaza, 2013) in her study she finds the impact of electricity prices on non-energy CPI positive and significant.

**Short Run Dynamic Error Correction Model**

By considering general to specific approach (David Hendry, 2004) the general model is estimated by incorporating the drift term, dummy variable (dummy = 2008), lag of error correction term and lag length one for each first difference variables. We have the following model after dropping the insignificant variables. The short run ECM model with t-values in parentheses is shown as follows;

$$\Delta P_t^{Core} = -7.036 - 0.345\Delta P_{t-1}^{Core} + 31.047\Delta Lm2_{t-1} + 14.907\Delta Ly_t - 14.662\Delta Le_t +$$

(-5.693) (-3.151) (5.268) (3.151) (-2.456)

$$5.437\Delta LP_t^{ele} - 0.436ECM_{t-1} + 1.283D \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad \textbf{(5.6.2)}$$

(1.990) (-3.976) (2.377)

**Diagnostic Tests**

$R^2 = 0.876$ $\overline{R}^2 = 0.803$ DW = 2.111

Jarque Bera test of Normality $\chi^2_{(2)} = 0.4204(0.810)$,

Breusch Godfrey LM test of Autocorrelation [χ2 (1) = 0.6481 and χ2 (2) = 0.1852]

Engl's 1982 ARCH LM Test for Hetroscadasticity[χ2 (1) = 0.4721 and χ2 (2) = 0.6783]

The dynamic model (5.6.2) is diagnosed through the residuals of the model. Firstly, the normality is tested; the chi-square value of Jarque Bera test is 0.4204 which tells us that the residual are normally distributed as the null hypothesis is not rejected. Then the serial correlation of the residuals is tested by LM test as [χ2 (1) = 0.6481 and χ2 (2) = 0.1852] which shows that null hypothesis is not rejected so no problem of serial correlation. The residuals also have equal spread of variance as Engl's 1982 ARCH LM Test for Hetroscadasticity [χ2 (1) = 0.4721 and χ2 (2) = 0.6783]. The values of $R^2$ and adjusted $R^2$ are 87% and 80% which shows the goodness of fit of the model respectively.

In equation (5.6.2), the ECM term is significant and negative which is according to the theory. As the negative sign of ECM term confirms adjustment towards equilibrium. So the value of

ECM term indicates that error is correcting with the speed of 43% in one year. The significance of this term also ensures the long run relationship between the variables.

In equation (5.6.2) the coefficient of first lag of core inflation has negative impact on it whereas the first lagged coefficient of money supply has positive impact on core inflation in the short run. The impact of real GDP on core inflation is significant and positive. But the impact of nominal effective exchange rate is also significant and negative as it was in the long run. The impact of electricity prices on core inflation is positive and significant in the short run and the dummy= 2008 has positive and significant impact on core inflation in the short run.

So it is concluded that the impact of overall electricity prices on core inflation in the long run as well as in the short run is significant and positive. But the effect of all control variables is according to the theory in the long run and the impact of exchange rate is significant and negative both in the short run as well as in the long run. The dummy variable also shows significant impact on core inflation.

Finally, the stability of the dynamic model is tested by utilizing the CUSUM and CUSUMSQ test (Brown et al, 1975). The figure 5.6.1 and 5.6.2 show that there is no structural instability and residual variance is also stable during the analysis period as CUSUM and CUSUMSQ remain within the 5% critical bound.

**Figure 5.6.1: CUSUM of Mean Stability for Core Inflation and Electricity Prices**

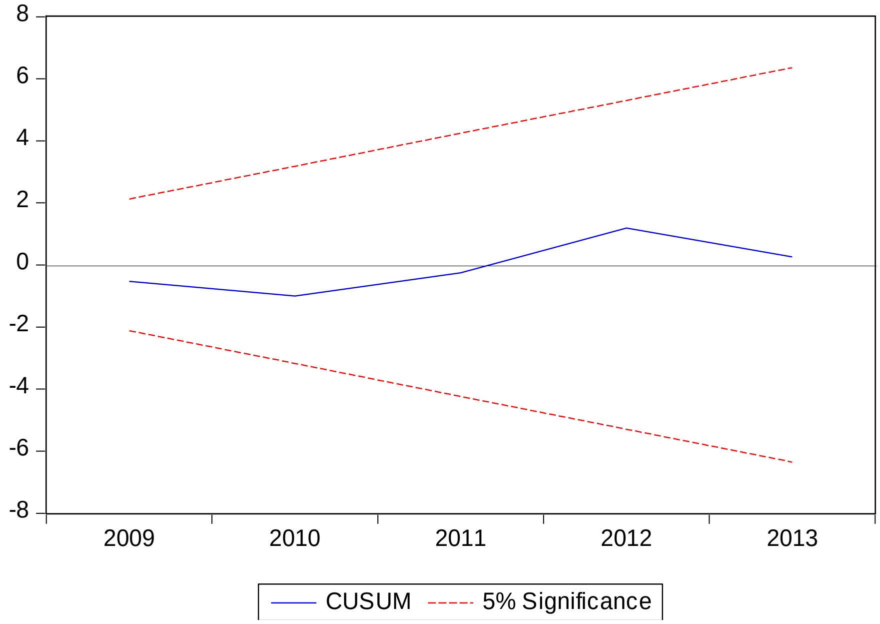
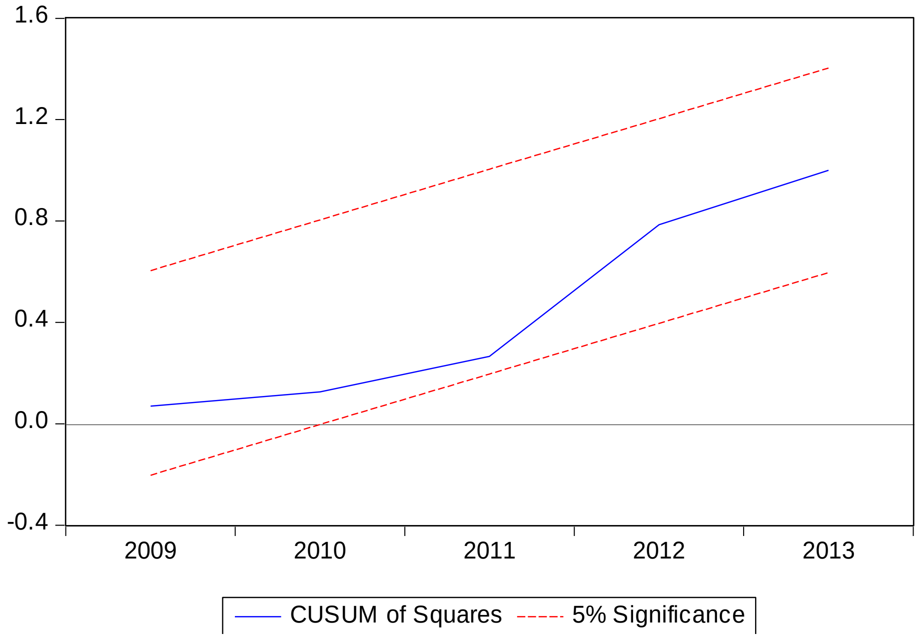



**Figure 5.6.2: CUSUMSQ of Variance Stability for Core Inflation and Electricity Prices**



## 5.7 Dynamic Analysis of Disaggregated Electricity Prices and Overall Inflation

Now we will analyze the impact of disaggregated electricity prices on inflation. In the previous section we have analyzed the impact of aggregated electricity prices on inflation, food, non-food and core inflation. But in the following section we will analyze the impact of sectoral electricity prices such as industrial, commercial, agricultural and domestic electricity prices on inflation.

**Long Run Analysis**

Applying the Johansen cointegration test for the estimation of the fifth model in which we want to analyze the impact of disaggregated electricity prices on overall inflation, the optimal lag length of the vector autoregressive (VAR) system is selected which ensures that the residuals are not serially correlated. So the VAR model is estimated with nine variables ($P^{inf}, Lm, Ly, Le, LP^{for}, LP^{ind}, LP^{agr}, LP^{com}, LP^{dom}$) and one exogenous dummy variable (dummy = 2008). In 2008, the whole world was suffering from the severe financial crisis so the prices were high all over the world (Hamilton, 2011). Pakistan was hit by global food and oil prices in 2008. Now the numbers of lags which are included in the analysis are as following:

**Table 5.7.A: VAR Lag Order Selection for Disaggregated Electricity Prices and Inflation**

| **VAR** | **LM-Stats** | |
|---|---|---|
| | **Lag 1** | **Lag 2** |
| **1** | 91.28213 (0.2039)* | 80.83223 ( 0.4844)* |

Note: * indicates the level of significance at 5%

So the VAR (1) model is selected. The lag length of VAR model is selected on the bases of Johansen (1995) multivariate LM test.

After selecting the optimal lag length of VAR model, we have to decide about the deterministic components, as most of the series show the increasing trend at the level therefore intercept term is included unrestrictedly in the cointegration analysis (Johansen, 1995 and Harris and Sollis, 2003).

As Johansen (1988) proposed two test statistics to check the order of cointegrating vectors i.e Trace test and Maximum Eigenvalue test. The results of these tests are given in the following Table 5.7.B. The trace test shows that the null hypothesis of no cointegration ($r = 0$), one cointegration ($r \leq 1$), two cointegration ($r \leq 2$) can be rejected and so on five cointegration ($r \leq 5$) can be rejected but it is failed to reject the null of six cointegrating vectors at five percent level of significance. While, the maximum eigenvalue statistic with the null hypothesis $r = 1$ is rejected, $r= 2$ is rejected and $r = 3$ is rejected but the null hypothesis $r = 4$ is not rejected and refers to four long run relationships exist among the variables.

As trace test is more powerful as compare to maximum eigenvalue test because it considers all (k-r) values of the smallest eigenvalues [Kasa(1992) and Serletris and King(1997)]. So we continue our analysis on the bases of trace test.

**Table 5.7.B: Trace and Maximum Eigenvalues Test of Cointegration for Inflation and Disaggregated Electricity Prices**

| Trace Statistics | | | | Maximum Eigen Values Statistics | | | |
|---|---|---|---|---|---|---|---|
| $H_0$ | $H_A$ | Test Statistics | Critical Value | $H_0$ | $H_A$ | Test Statistics | Critical Value |
| r = 0 | r ≥ 1 | 357.4430* | 197.3709 | r = 0 | r = 1 | 105.9011* | 58.43354 |
| r ≤ 1 | r ≥ 2 | 251.5420* | 159.5297 | r = 1 | r = 2 | 83.34603* | 52.36261 |
| r ≤ 2 | r ≥ 3 | 168.1959* | 125.6154 | r = 2 | r = 3 | 62.03235* | 46.23142 |
| r ≤ 3 | r ≥ 4 | 106.1636* | 95.75366 | r = 3 | r = 4 | 31.26445 | 40.07757 |
| r ≤ 4 | r ≥ 5 | 74.89914* | 69.81889 | r = 4 | r = 5 | 28.35473 | 33.87687 |
| r ≤ 5 | r ≥ 6 | 46.54441 | 47.85613 | r = 5 | r = 6 | 20.02294 | 27.58434 |
| r ≤ 6 | r ≤ 7 | 26.52147 | 29.79707 | r = 6 | r = 7 | 18.09508 | 21.13162 |
| r ≤ 7 | r ≤ 8 | 8.426393 | 15.49471 | r = 7 | r = 8 | 8.343152 | 14.26460 |
| r ≤ 8 | r ≤ 9 | 0.083241 | 3.841466 | r = 8 | r = 9 | 0.083241 | 3.841466 |

After finding the no. of cointegrating vectors, we will estimate the long run relationship by using Maximum likelihood method. As we have found that there exist six cointegrating vectors, but we are interested in only one cointegrating relationship in the following study. So the normalized long run coefficients are given in equation (5.7.1). The chi-square values are given in parentheses

$$P_t^{inf} = 36.401Lm2_t - 28.960Ly_t - 25.727LP_t^{for} - 15.516Le_t - 20.467LP_t^{ind} -$$

(224.998) (90.551) (33.079) (49.345) (87.853)

$$27.549LP_t^{dom} - 0.881LP_t^{agr} + 37.166LP_t^{com} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad \textbf{(5.7.1)}$$

(192.392) (2.823) (156.112)

This equation (5.7.1) shows that the money supply positively affect the inflation in the long run as expected and has significant impact on it. These results are in line with the results of [Khan and Qasim (1996)]. The impact of GDP on inflation is also significant and negative. This result is similar with the result of [Khan and Qasim (1996)]. Foreign prices affect the inflation negatively and significantly. Similarly nominal effective exchange rate affects the inflation negatively. Whereas the impact of sectoral electricity prices on inflation is positive and negative. As the industrial electricity prices affect the inflation negatively, similarly domestic and agricultural electricity prices also effect the inflation negatively and significantly. This is mainly because of the government provides the subsidy to the domestic consumers as there is an increase in the prices of electricity, so many government offices, educational institutions and worship places which should be in commercial sector are consider under the domestic sector or lifeline consumers and can take the advantages of such subsidies and misuse such advantages. Industrial sector electricity prices show the negative relationship with the inflation in the long run because in the long run when the prices increase the industrial sector will produce electricity independently for the production of goods and also switch towards the alternative sources of electricity like biogas, generator etc. But electricity prices of commercial sector have significant and positive impact on overall inflation in the long run. The coefficient of commercial sector electricity prices shows that it has the more effect on inflation than any other sector.

**Short Run Dynamic Error Correction Model**

By considering general to specific approach (David Hendry, 2004) the general model is estimated by incorporating the drift term, dummy variable (dummy = 2008), lag of error correction term and lag length one for each first difference variables. We have the following model after dropping the insignificant variables. The short run ECM model with t-values in parentheses is shown as follows;

$\Delta P_t^{inf} = 0.11t + 21.693\Delta Lm2_t - 20.458\Delta Ly_{t-1} + 54.619\Delta LP_t^{for} - 8.514Le_t -$

(2.682) (-2.666) (-2.016) (2.317) (-1.698)*

$11.500\Delta Le_{t-1} + 10.811LP_t^{ind} - 8.007\Delta LP_{t-1}^{dom} + 4.518\Delta LP_t^{agr} -$

(-2.167) (1.829)* (-1.606)* (-2.652)

$0.496ECM_{t-1}$ ……………. (**5.7.2**)

(-3.414)

**Diagnostic Tests**

$R^2 = 0.723$ $\overline{R}^2 = 0.645$ DW = 2.191

Jarque Bera test of Normality $\chi^2_{(2)} = 0.355(0.837)$,

Breusch Godfrey LM test of Autocorrelation [$\chi2$ (1) = 0.240 and $\chi2$ (2) = 0.062]

Engl’s 1982 ARCH LM Test for Hetroscadasticity[$\chi2$ (1) = 0.259 and $\chi2$ (2) = 0.579]

The dynamic model (5.7.2) is diagnosed through the residuals of the model. Firstly, the normality is tested, the chi-square value of Jarque Bera test is 0.355 which tells us that the residual are normally distributed as the null hypothesis is not rejected. Then the serial correlation of the residuals is tested by LM test as [$\chi2$ (1) = 0.240 and $\chi2$ (2) = 0.062] which shows that null hypothesis is not rejected so no problem of serial correlation. The residuals also have equal spread of variance as Engl's 1982 ARCH LM Test for Hetroscadasticity [$\chi2$ (1) = 0.259 and $\chi2$ (2) = 0.579]. The values of $R^2$ and adjusted $R^2$ are 72% and 64% which show the goodness of fit of the model respectively.

In equation (5.7.2), the ECM term is significant and negative which is according to the theory. As the negative sign of ECM term confirms adjustment towards equilibrium. So the value of ECM term indicates that error is correcting with the speed of 49% in one year. The significance of this term also ensures the long run relationship between the variables.

In equation (5.7.2) the coefficient of money supply has positive impact on inflation in the short run. The impact of real GDP on inflation is negative but foreign prices positively affect the inflation. The impact of nominal effective exchange rate and its first lag is also significant and negative as it was in the long run. Industrial sector electricity prices positively affect inflation because in the short run the industries cannot produce electricity independently and also cannot move quickly towards the alternative sources of electricity production. Whereas the first lag of domestic electricity prices negatively affect inflation in the short run. Agricultural sector electricity prices also effect positively inflation in the short run.

So it is concluded that the impact of all control variables is according to the theory in the long run as well as in the short run, and the impact of exchange rate is significant and negative both in the short run as well as in the long run. But the sectoral electricity prices differently influence the overall inflation in the short run as well as in the long run.

Finally, the stability of the dynamic model is tested by utilizing the CUSUM and CUSUMSQ test (Brown et al, 1975). The figure 5.7.1 and 5.7.2 show that there is no structural instability and residual variance is also stable during the analysis period as CUSUM and CUSUMSQ remain within the 5% critical bound.

**Figure 5.7.1: CUSUM of Mean Stability for Overall Inflation and Disaggregated Electricity Prices**

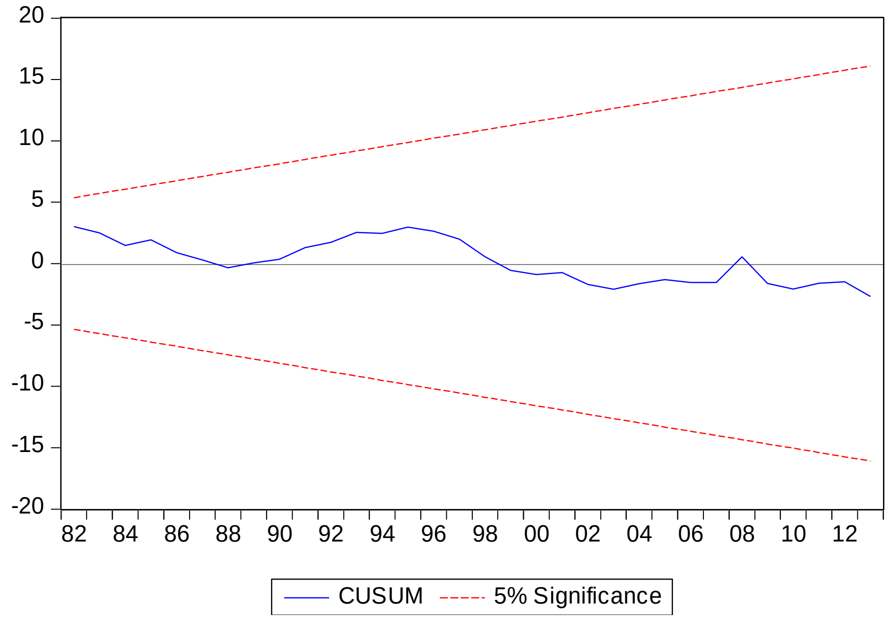
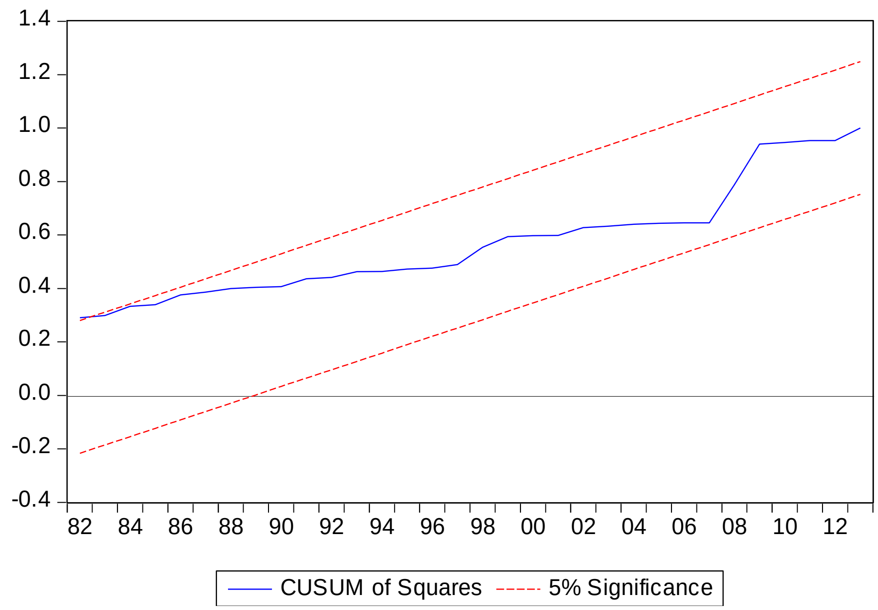



**Figure 5.7.2: CUSUMSQ of Variance Stability for Overall Inflation and Disaggregated Electricity Prices**



## 5.8 Dynamic Analysis of Disaggregated Electricity Prices and Food Inflation

**Long Run Analysis**

Applying the Johansen cointegration test for the estimation of the sixth model in which we want to analyze the impact of disaggregated electricity prices on food inflation, the optimal lag length of the vector autoregressive (VAR) system is selected which ensures that the residuals are not serially correlated. So the VAR model is estimated with nine variables ($P^{food}, Lm, Ly, Le, LP^{for}, LP^{ind}, LP^{agr}, LP^{com}, LP^{dom}$) and one exogenous dummy variable (dummy = 2008). In 2008, the whole world was suffering from the severe financial crisis so the prices were high all over the world (Hamilton, 2011). Pakistan was hit by global food and oil prices in 2008. Now the numbers of lags which are included in the analysis are as following:

**Table 5.8.A: VAR Lag Order Selection for Disaggregated Electricity Prices and Inflation**

| **VAR** | **LM-Stats** | |
|---|---|---|
| | **Lag 1** | **Lag 2** |
| **1** | 95.00257 (0.1369)* | 82.18617 (0.4423)* |

Note: * indicates the level of significance at 5%

So the VAR (1) model is selected. The lag length of VAR model is selected on the bases of Johansen (1995) multivariate LM test.

After selecting the optimal lag length of VAR model, we have to decide about the deterministic components, as most of the series show the increasing trend at the level therefore intercept term is included unrestrictedly in the cointegration analysis (Johansen, 1995 and Harris and Sollis, 2003).

As Johansen (1988) proposed two test statistics to check the order of cointegrating vectors i.e Trace test and Maximum Eigenvalue test. The results of these tests are given in the following Table 5.7.B. The trace test shows that the null hypothesis of no cointegration ($r = 0$), one cointegration ($r \leq 1$), two cointegration ($r \leq 2$) can be rejected and so on seven cointegration ($r \leq 7$) can be rejected but it is failed to reject the null of eight cointegrating vectors at five percent level of significance. While, the maximum eigenvalue statistic with the null hypothesis $r = 1$ is rejected, $r = 2$ is rejected and $r = 3$ is rejected but the null hypothesis $r = 4$ is not rejected and refers to four long run relationships exist among the variables.

As trace test is more powerful as compare to maximum eigenvalue test because it considers all (k-r) values of the smallest eigenvalues [Kasa(1992) and Serletris and King(1997)]. So we continue our analysis on the bases of trace test.

**Table 5.8.B: Trace and Maximum Eigenvalues Test of Cointegration for Food Inflation and Disaggregated Electricity Prices**

| Trace Statistics | | | | Maximum Eigen Values Statistics | | | |
|---|---|---|---|---|---|---|---|
| $H_0$ | $H_A$ | Test Statistics | Critical Value | $H_0$ | $H_A$ | Test Statistics | Critical Value |
| r = 0 | r ≥ 1 | 381.5809* | 208.4374 | r = 0 | r = 1 | 112.2323* | 59.24000 |
| r ≤ 1 | r ≥ 2 | 269.3487* | 169.5991 | r = 1 | r = 2 | 84.43729* | 53.18784 |
| r ≤ 2 | r ≥ 3 | 184.9114* | 134.6780 | r = 2 | r = 3 | 61.11610* | 47.07897 |
| r ≤ 3 | r ≥ 4 | 123.7953* | 103.8473 | r = 3 | r = 4 | 34.32835 | 40.95680 |
| r ≤ 4 | r ≥ 5 | 89.46695* | 76.97277 | r = 4 | r = 5 | 30.20674 | 34.80587 |
| r ≤ 5 | r ≥ 6 | 59.26021* | 54.07904 | r = 5 | r = 6 | 23.26255 | 28.58808 |
| r ≤ 6 | r ≤ 7 | 35.99766* | 35.19275 | r = 6 | r = 7 | 16.87240 | 22.29962 |
| r ≤ 7 | r ≤ 8 | 19.12526 | 20.26184 | r = 7 | r = 8 | 10.94292 | 15.89210 |
| r ≤ 8 | r ≤ 9 | 8.182340 | 9.164546 | r = 8 | r = 9 | 8.182340 | 9.164546 |

After finding the no. of cointegrating vectors, we will estimate the long run relationship by using Maximum likelihood method. As we have found that there exist eight cointegrating vectors, but we are interested in only one cointegrating relationship in the following study. So the normalized long run coefficients are given in equation (5.8.1). The chi-square values are given in parentheses

$$P_t^{food} = 9.082 + 53.859Lm2_t - 46.526Ly_t + 2.785LP_t^{for} - 12.772Le_t - 28.826LP_t^{ind} -$$

(0.033) (545.466) (250.518) (0.419) (36.442) (192.722)

$$19.890LP_t^{dom} + 2.057LP_t^{agr} + 23.907LP_t^{com} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (\mathbf{5.8.1})$$

(122.073) (17.701) (70.605)

This equation (5.8.1) shows that the money supply positively affect the food inflation in the long run as expected and has significant impact on it. These results are in line with the results of [Khan and Qasim (1996)]. The impact of GDP on food-inflation is also significant and negative. This result is similar with the result of [Khan and Qasim (1996)]. Foreign prices affect the food-inflation positively and insignificantly. Similarly nominal effective exchange rate affects the food-inflation negatively. Whereas the impact of sectoral electricity prices on food-inflation is positive and negative. As the industrial electricity prices affect the food-inflation negatively, similarly domestic electricity prices also affect the food-inflation negatively and significantly. But electricity prices of commercial and agricultural sectors have significant and positive impact on food-inflation in the long run. As with the increase in the prices of electricity of commercial and agricultural sectors, it is positively affect the food-inflation as most of the production of food items is taken place from agricultural sector.

**Short Run Dynamic Error Correction Model**

By considering general to specific approach (David Hendry, 2004) the general model is estimated by incorporating the drift term, dummy variable (dummy = 2008), lag of error correction term and lag length one for each first difference variables. We have the following model after dropping the insignificant variables. The short run ECM model with t-values in parentheses is shown as follows;

$$\Delta P_t^{food} = 0.108t + 16.800\Delta Lm2_{t-1} - 33.042\Delta Ly_{t-1} - 19.122\Delta Le_{t-1} + 10.994\Delta LP_t^{ind} -$$

(1.994)* (1.770)* (-2.875) (-2.918) (1.417)*

$$22.017\Delta LP_{t-1}^{ind} - 12.745\Delta LP_t^{dom} - 31.104\Delta LP_{t-1}^{dom} + 3.554\Delta LP_t^{agr} +$$

(-2.309) (-1.824)* (-3.092) (1.690)*

$$39.410\Delta LP_{t-1}^{com} - 0.766ECM_{t-1} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (\mathbf{5.8.2})$$

(3.309) (-4.810)

**Diagnostic Tests**

$R^2 = 0.771$ $\overline{R}^2 = 0.697$ DW = 1.855

Jarque Bera test of Normality $\chi^2_{(2)} = 0.139(0.932)$,

Breusch Godfrey LM test of Autocorrelation [χ2 (1) = 0.5195 and χ2 (2) = 0.1651]

Engl's 1982 ARCH LM Test for Hetroscadasticity [χ2 (1) = 0.2423 and χ2 (2) = 0.3991]

The dynamic model (5.8.2) is diagnosed through the residuals of the model. Firstly, the normality is tested, the chi-square value of Jarque Bera test is 0.139 which tells us that the residual are normally distributed as the null hypothesis is not rejected. Then the serial correlation of the residuals is tested by LM test as [χ2 (1) = 0.5195 and χ2 (2) = 0.1651] which shows that null hypothesis is not rejected so no problem of serial correlation. The residuals also have equal spread of variance as Engl's 1982 ARCH LM Test for Hetroscadasticity [χ2 (1) = 0.2423 and χ2

(2) = 0.3991]. The values of $R^2$ and adjusted $R^2$ are 77% and 69% which shows the goodness of fit of the model respectively.

In equation (5.8.2), the ECM term is significant and negative which is according to the theory. As the negative sign of ECM term confirms adjustment towards equilibrium. So the value of ECM term indicates that error is correcting with the speed of 76% in one year. The significance of this term also ensures the long run relationship between the variables.

In equation (5.8.2) the coefficient of money supply has positive impact on food-inflation in the short run. The impact of real GDP on food-inflation is negative. The impact of nominal effective exchange rate is also significant and negative as it was in the long run. The coefficient of industrial sector electricity prices positively affects food-inflation whereas the first lag of it has negative impact on food inflation. Similarly domestic electricity prices and first lag of it negatively affect the food inflation. Agricultural electricity prices and commercial electricity prices positively affect food-inflation in the short run.

So it is concluded that the impact of all control variables is according to the theory in the long run as well as in the short run, and the impact of exchange rate is significant and negative both in the short run as well as in the long run. But the sectoral electricity prices differently influence the food-inflation in the short run as well as in the long run. As the industrial electricity prices have positive impact on food-inflation in the short run because in the short run the food industries can not immediately switch towards the alternative sources of electricity production and are not independently produce electricity. And the agricultural, commercial and domestic sector electricity prices have the same long run as well as short run effect on the food-inflation rate.

Finally, the stability of the dynamic model is tested by utilizing the CUSUM and CUSUMSQ test (Brown et al, 1975). The figure 5.8.1 and 5.8.2 show that there is no structural instability and residual variance is also stable during the analysis period as CUSUM and CUSUMSQ remain within the 5% critical bound.

**Figure 5.8.1: CUSUM of Mean Stability for Food Inflation and Disaggregated Electricity Prices**

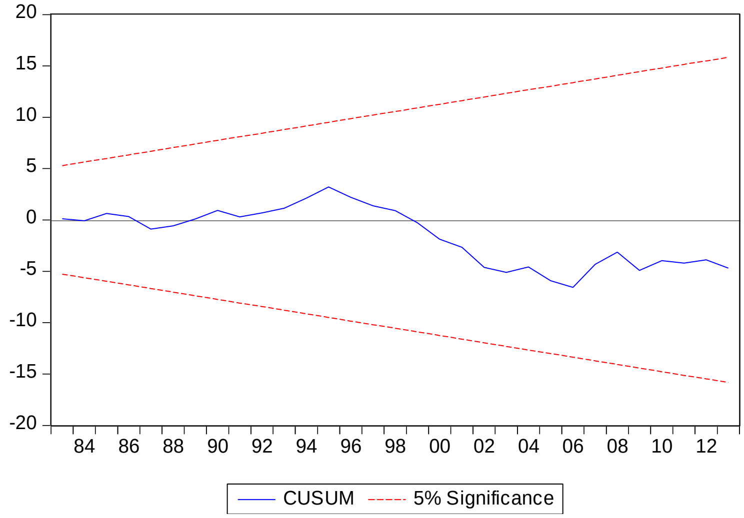
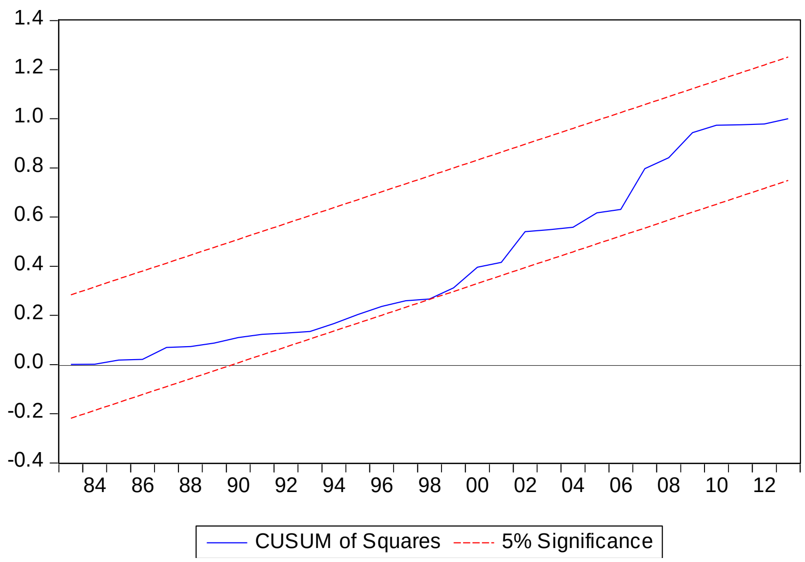



**Figure 5.8.2: CUSUMSQ of Variance Stability for Food Inflation and Disaggregated Electricity Prices**



## 5.9 Dynamic Analysis of Disaggregated Electricity Prices and Non-Food Inflation

**Long Run Analysis**

Applying the Johansen cointegration test for the estimation of the seventh model in which we want to analyze the impact of disaggregated electricity prices on non-food inflation, the optimal lag length of the vector autoregressive (VAR) system is selected which ensures that the residuals are not serially correlated. So the VAR model is estimated with nine variables ($P^{Non-food}, Lm, Ly, Le, LP^{for}, LP^{ind}, LP^{agr}, LP^{com}, LP^{dom}$) and one exogenous dummy variable (dummy = 2008). In 2008, the whole world was suffering from the severe financial crisis so the prices were high all over the world (Hamilton, 2011). Pakistan was hit by global food and oil prices in 2008. Now the numbers of lags which are included in the analysis are as following:

**Table 5.9.A: VAR Lag Order Selection for Disaggregated Electricity Prices and Non-Food Inflation**

| **VAR** | **LM-Stats** | |
|---|---|---|
| | **Lag 1** | **Lag 2** |
| **1** | 99.04474 (0.0844)* | 99.75182 (0.0772)* |

Note: * indicates the level of significance at 5%

So the VAR (1) model is selected. The lag length of VAR model is selected on the bases of Johansen (1995) multivariate LM test.

After selecting the optimal lag length of VAR model, we have to decide about the deterministic components, as most of the series show the increasing trend at the level therefore intercept term is included unrestrictedly in the cointegration analysis (Johansen, 1995 and Harris and Sollis, 2003).

As Johansen (1988) proposed two test statistics to check the order of cointegrating vectors i.e Trace test and Maximum Eigenvalue test. The results of these tests are given in the following Table 5.9.B. The trace test shows that the null hypothesis of no cointegration ($r = 0$), one cointegration ($r \leq 1$), two cointegration ($r \leq 2$) can be rejected and so on five cointegration ($r \leq 5$) can be rejected but it is failed to reject the null of six cointegrating vectors at five percent level of significance. While, the maximum eigenvalue statistic with the null hypothesis $r = 1$ is rejected, $r = 2$ is rejected and $r = 3$ is rejected but the null hypothesis $r = 4$ is not rejected and refers to four long run relationships exist among the variables.

As trace test is more powerful as compare to maximum eigenvalue test because it considers all (k-r) values of the smallest eigenvalues [Kasa(1992) and Serletris and King(1997)]. So we continue our analysis on the bases of trace test.

**Table 5.9.B: Trace and Maximum Eigenvalues Test of Cointegration for Non-Food Inflation and Disaggregated Electricity Prices**

| **Trace Statistics** | | | | **Maximum Eigen Values Statistics** | | | |
|---|---|---|---|---|---|---|---|
| $H_0$ | $H_A$ | Test Statistics | Critical Value | $H_0$ | $H_A$ | Test Statistics | Critical Value |
| r = 0 | r ≥ 1 | 376.5850* | 197.3709 | r = 0 | r = 1 | 112.5793* | 58.43354 |
| r ≤ 1 | r ≥ 2 | 264.0057* | 159.5297 | r = 1 | r = 2 | 94.61523* | 52.36261 |
| r ≤ 2 | r ≥ 3 | 169.3904* | 125.6154 | r = 2 | r = 3 | 52.99402* | 46.23142 |
| r ≤ 3 | r ≥ 4 | 116.3964* | 95.75366 | r = 3 | r = 4 | 38.35351 | 40.07757 |
| r ≤ 4 | r ≥ 5 | 78.04291* | 69.81889 | r = 4 | r = 5 | 30.95736 | 33.87687 |
| r ≤ 5 | r ≥ 6 | 47.08555 | 47.85613 | r = 5 | r = 6 | 22.10044 | 27.58434 |
| r ≤ 6 | r ≤ 7 | 24.98511 | 29.79707 | r = 6 | r = 7 | 17.43938 | 21.13162 |
| r ≤ 7 | r ≤ 8 | 7.545729 | 15.49471 | r = 7 | r = 8 | 7.533149 | 14.26460 |
| r ≤ 8 | r ≤ 9 | 0.012581 | 3.841466 | r = 8 | r = 9 | 0.012581 | 3.841466 |

After finding the no. of cointegrating vectors, we will estimate the long run relationship by using Maximum likelihood method. As we have found that there exist six cointegrating vectors, but we are interested only in one cointegrating relationship in the following study. So the normalized long run coefficients are given in equation (5.9.1). The chi-square values are given in parentheses

$$P_t^{Non-food} = 42.177Lm2_t - 34.312Ly_t + 18.508LP_t^{for} - 2.108Le_t - 24.804LP_t^{ind} -$$

(502.830) (202.289) (25.944) (1.463) (208.948)

$$15.058LP_t^{dom} + 2.355LP_t^{agr} + 16.140LP_t^{com} \quad \ldots\ldots\ldots\ldots\ldots \quad (\mathbf{5.9.1})$$

(93.496) (48.139) (34.790)

This equation (5.9.1) shows that the money supply positively affect the non-food inflation in the long run as expected and has significant impact on it. These results are in line with the results of [Khan and Qasim (1996)]. The impact of GDP on non-food inflation is also significant and negative. This result is similar with the result of [Khan and Qasim (1996)]. Foreign prices affect the non-food inflation positively and significantly. Similarly nominal effective exchange rate affects the non-food inflation negatively and it has insignificant impact. Whereas the impact of sectoral electricity prices on non-food inflation is positive and negative. As the industrial electricity prices affect the non-food inflation negatively, similarly domestic electricity prices also affect the non-food inflation negatively and significantly. But electricity prices of commercial and agricultural sectors have significant and positive impact on non-food inflation in the long run*.[1]

**Short Run Dynamic Error Correction Model**

By considering general to specific approach (David Hendry, 2004) the general model is estimated by incorporating the drift term, dummy variable (dummy = 2008), lag of error correction term and lag length one for each first difference variables. We have the following

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[1] *Note: Non-food inflation is the non-food inflation rate which is calculated as $P_{Nf} = \frac{P_g - \beta P_f}{1-\beta}$ where β is the weight of CPI food. So non- food inflation also contains the impact of overall inflation and food inflation.

model after dropping the insignificant variables. The short run ECM model with t-values in parentheses is shown as follows;

$$\Delta P_t^{Non-food} = 0.091t - 19.329\Delta Ly_{t-1} - 27.500\Delta Le_{t-1} - 12.446\Delta LP_t^{dom} -$$

(1.807)* (-2.002) (-4.946) (-2.007)

$$23.883\Delta LP_{t-1}^{dom} + 20.617\Delta LP_{t-1}^{com} - 0.979ECM_{t-1} \quad \ldots\ldots\ldots\ldots\ldots\ldots.. \quad (\mathbf{5.9.2})$$

(-2.477) (2.278) (-8.215)

**Diagnostic Tests**

$R^2 = 0.750$ $\overline{R}^2 = 0.707$ DW = 1.661

Jarque Bera test of Normality $\chi^2_{(2)} = 0.653(0.721)$,

Breusch Godfrey LM test of Autocorrelation [$\chi2\ (1) = 0.1520$ and $\chi2\ (2) = 0.2761$]

Engl's 1982 ARCH LM Test for Hetroscadasticity [$\chi2\ (1) = 0.3043$ and $\chi2\ (2) = 0.5532$]

The dynamic model (5.9.2) is diagnosed through the residuals of the model. Firstly, the normality is tested, the chi-square value of Jarque Bera test is 0.653 which tells us that the residual are normally distributed as the null hypothesis is not rejected. Then the serial correlation of the residuals is tested by LM test as [$\chi2\ (1) = 0.1520$ and $\chi2\ (2) = 0.2761$] which shows that null hypothesis is not rejected so no problem of serial correlation. The residuals also have equal spread of variance as Engl's 1982 ARCH LM Test for Hetroscadasticity [$\chi2\ (1) = 0.3043$ and $\chi2\ (2) = 0.5532$]. The values of $R^2$ and adjusted $R^2$ are 75% and 60% which show the goodness of fit of the model respectively.

In equation (5.9.2), the ECM term is significant and negative which is according to the theory. As the negative sign of ECM term confirms adjustment towards equilibrium. So the value of ECM term indicates that error is correcting with the speed of 97% in one year. The significance of this term also ensures the long run relationship between the variables.

In equation (5.9.2) the impact of real GDP on non-food inflation is negative. The impact of nominal effective exchange rate is also significant and negative as it was in the long run. The coefficient of domestic sector electricity prices and its first lag negatively affects non-food inflation. Commercial sector electricity prices positively affect non-food inflation in the short run.

Finally, the stability of the dynamic model is tested by utilizing the CUSUM and CUSUMSQ test (Brown et al, 1975). The figure 5.9.1 and 5.9.2 show that there is no structural instability and residual variance is also stable during the analysis period as CUSUM and CUSUMSQ remain within the 5% critical bound.

**Figure 5.9.1: CUSUM of Mean Stability for Non-Food Inflation and Disaggregated Electricity Prices**

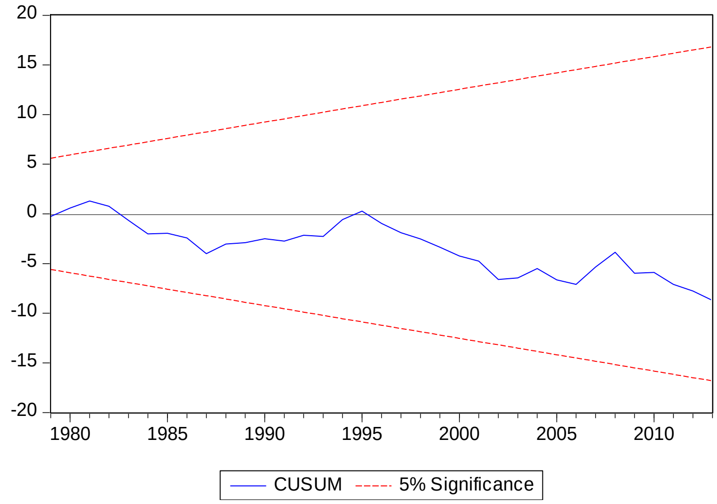
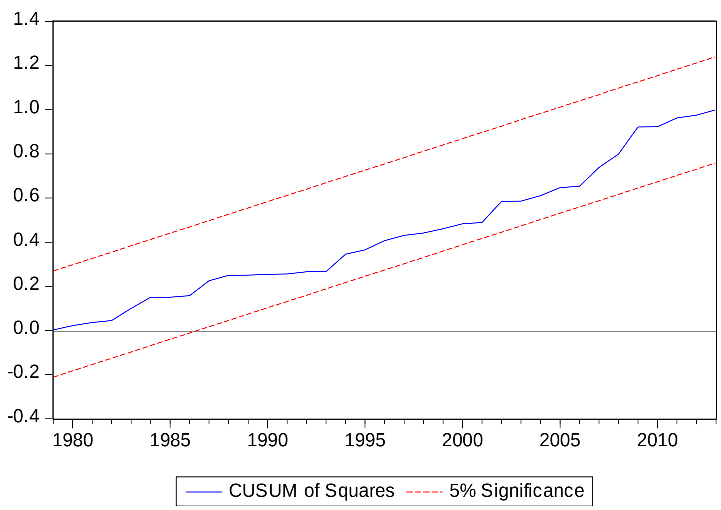



**Figure 5.9.2: CUSUMSQ of Variance Stability for Non-Food Inflation and Disaggregated Electricity Prices**



## 5.10 Dynamic Analysis of Disaggregated Electricity Prices and Core Inflation

### 5.10.1. Dynamic Analysis of Domestic Electricity Prices and Core Inflation

**Long Run Analysis**

Applying the Johansen cointegration test for the estimation of the following model in which we want to analyze the impact of domestic electricity prices on core inflation, the optimal lag length of the vector autoregressive (VAR) system is selected which ensures that the residuals are not serially correlated. So the VAR model is estimated with five variables ($P^{Core}, Lm, Ly, Le, LP^{dom}$) and one exogenous dummy variable (dummy = 2008). In 2008, the whole world was suffering from the severe financial crisis so the prices were high all over the world (Hamilton, 2011). Pakistan was hit by global food and oil prices in 2008. Now the numbers of lags which are included in the analysis are as following:

**Table 5.10.1.A: VAR Lag Order Selection for Domestic Electricity Prices and Core Inflation**

| VAR | LM-Stats | |
|---|---|---|
| | **Lag 1** | **Lag 2** |
| **1** | 31.25274 ( 0.1808)* | 22.72216 ( 0.5938)* |

Note: * indicates the level of significance at 5%

So the VAR (1) model is selected. The lag length of VAR model is selected on the bases of Johansen (1995) multivariate LM test.

After selecting the optimal lag length of VAR model, we have to decide about the deterministic components, as most of the series show the increasing trend at the level therefore intercept term is included unrestrictedly in the cointegration analysis (Johansen, 1995 and Harris and Sollis, 2003).

As Johansen (1988) proposed two test statistics to check the order of cointegrating vectors i.e Trace test and Maximum Eigenvalue test. The results of these tests are given in the following Table 5.10.1.B. The trace test shows that the null hypothesis of no cointegration ($r = 0$), one cointegration ($r \leq 1$), two cointegration ($r \leq 2$) can be rejected and so on three cointegration ($r \leq 3$) can be rejected but it is failed to reject the null of four cointegrating vectors at five percent level of significance. While, the maximum eigenvalue statistic with the null hypothesis $r = 1$ is rejected, $r = 2$ is rejected and $r = 3$ is rejected but the null hypothesis $r = 4$ is not rejected and refers to four long run relationships exist among the variables.

As trace test is more powerful as compare to maximum eigenvalue test because it considers all (k-r) values of the smallest eigenvalues [Kasa(1992) and Serletris and King(1997)]. So we continue our analysis on the bases of trace test.

**Table 5.10.1.B: Trace and Maximum Eigenvalues Test of Cointegration for Core Inflation and Domestic Electricity Prices**

| **Trace Statistics** | | | | **Maximum Eigen Values Statistics** | | | |
|---|---|---|---|---|---|---|---|
| $H_0$ | $H_A$ | Test Statistics | Critical Value | $H_0$ | $H_A$ | Test Statistics | Critical Value |
| r = 0 | r ≥ 1 | 162.5132* | 88.80380 | r = 0 | r = 1 | 77.95357* | 38.33101 |
| r ≤ 1 | r ≥ 2 | 84.55958* | 63.87610 | r = 1 | r = 2 | 36.62847* | 32.11832 |
| r ≤ 2 | r ≥ 3 | 47.93111* | 42.91525 | r = 2 | r = 3 | 29.77665* | 25.82321 |
| r ≤ 3 | r ≥ 4 | 18.15446 | 25.87211 | r = 3 | r = 4 | 10.13484 | 19.38704 |
| r ≤ 4 | r ≥ 5 | 8.019619 | 12.51798 | r = 4 | r = 5 | 8.019619 | 12.51798 |

After finding the no. of cointegrating vectors, we will estimate the long run relationship by using Maximum likelihood method. As we have found that there exist four cointegrating vectors, but we are interested only in one cointegrating relationship in the following study. So the normalized long run coefficients are given in equation (5.10.1.a). The chi-square values are given in parentheses

$$P_t^{Core} = 9.837t + 68.763Lm2_t - 15.595Ly_t - 29.891Le_t + 0.011LP_t^{dom} \quad \text{……} \ (\mathbf{5.10.1.a})$$

(0.325) (8.454) (12.460) (17.256) (0.00251)

This equation (5.10.1.a) shows that the money supply positively affect the core inflation in the long run as expected and has significant impact on it. The impact of GDP on core inflation is also significant and negative. Similarly nominal effective exchange rate affects the core inflation negatively and it has significant impact. Whereas the impact of domestic electricity prices on core inflation is positive but insignificant in the long run.

**Short Run Dynamic Error Correction Model**

By considering general to specific approach (David Hendry, 2004) the general model is estimated by incorporating the drift term, dummy variable (dummy = 2008), lag of error correction term and lag length one for each first difference variables. We have the following model after dropping the insignificant variables. The short run ECM model with t-values in parentheses is shown as follows;

$$\Delta P_t^{Core} = -9.659 + 0.751\Delta P_{t-1}^{Core} + 20.070\Delta Lm2_t + 26.830\Delta Lm2_{t-1} +$$

(-3.555) (4.830) (2.050) (3.576)

$$21.205\Delta Ly_t - 20.427\Delta Le_t + 2.420D_{2008} - 0.684ECM_{t-1}$$ …….. (**5.10.1.b)**

(2.946) (-2.628) (3.294) (-2.186)

**Diagnostic Tests**

$R^2$ = 0.907 $\overline{R}^2$ = 0.853 DW = 1.838

Jarque Bera test of Normality $\chi^2_{(2)}$ = 0.430(0.806),

Breusch Godfrey LM test of Autocorrelation [χ2 (1) = 0.7073 and χ2 (2) = 0.9247]

Engl's 1982 ARCH LM Test for Hetroscadasticity [χ2 (1) = 0.5140 and χ2 (2) = 0.6182]

The dynamic model (5.10.1.b) is diagnosed through the residuals of the model. Firstly, the normality is tested, the chi-square value of Jarque Bera test is 0.430 which tells us that the residual are normally distributed as the null hypothesis is not rejected. Then the serial correlation of the residuals is tested by LM test as [$\chi2$ (1) = 0.7073 and $\chi2$ (2) = 0.9247] which shows that null hypothesis is not rejected so no problem of serial correlation. The residuals also have equal spread of variance as Engl's 1982 ARCH LM Test for Hetroscadasticity [$\chi2$ (1) = 0.5140 and $\chi2$ (2) = 0.6182]. The values of $R^2$ and adjusted $R^2$ are 90% and 85% which show the goodness of fit of the model respectively.

In equation (5.10.1.b), the ECM term is significant and negative which is according to the theory. As the negative sign of ECM term confirms adjustment towards equilibrium. So the value of ECM term indicates that error is correcting with the speed of 68% in one year. The significance of this term also ensures the long run relationship between the variables.

In equation (5.10.1.b) the impact of the lag of core inflation, money supply and the first lag of money supply and real GDP on core inflation is positive. The Dummy variable of 2008 also has significant and positive impact of core inflation.

Finally, the stability of the dynamic model is tested by utilizing the CUSUM and CUSUMSQ test (Brown et al, 1975). The figure 5.10.1.a and 5.10.1.b show that there is no structural instability and residual variance is also stable during the analysis period as CUSUM and CUSUMSQ remain within the 5% critical bound

**Figure 5.10.1.a: CUSUM of Mean Stability for Core Inflation and Domestic Electricity Prices**

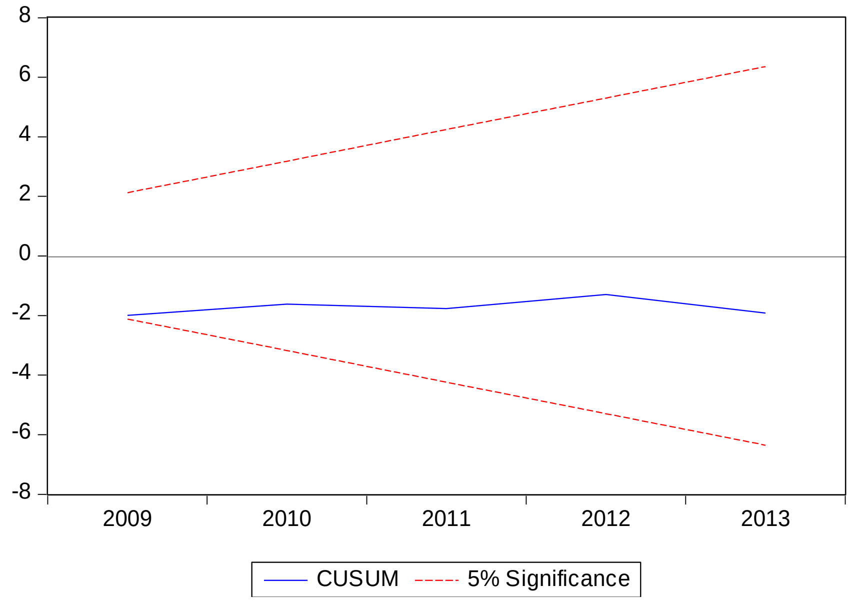
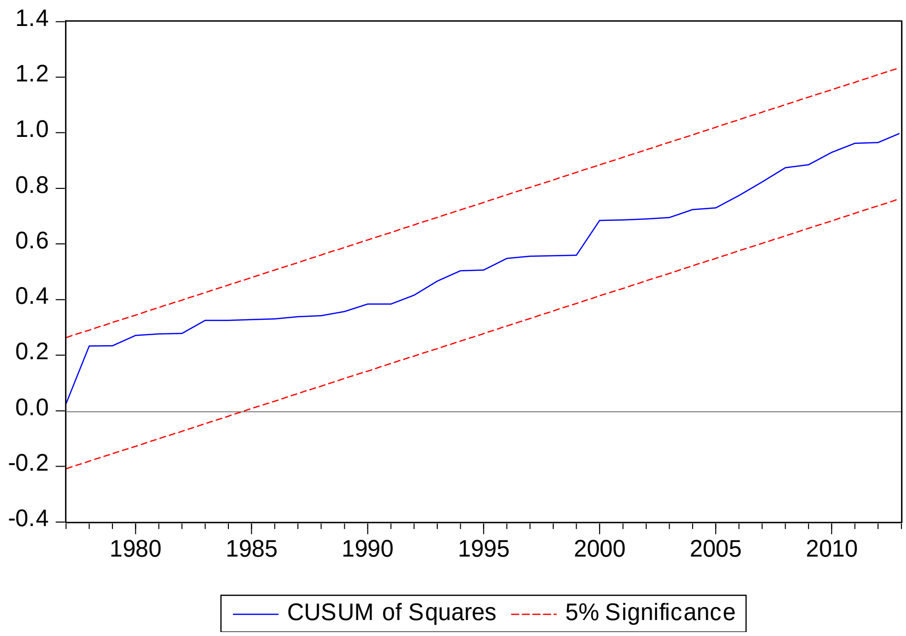



**Figure 5.10.1.b: CUSUMSQ of Variance Stability for Core Inflation and Domestic Electricity Prices**



### 5.10.2 Dynamic Analysis of Industrial Electricity Prices and Core Inflation

**Long Run Analysis**

Applying the Johansen cointegration test for the estimation of the following model in which we want to analyze the impact of Industrial electricity prices on core inflation, the optimal lag length of the vector autoregressive (VAR) system is selected which ensures that the residuals are not serially correlated. So the VAR model is estimated with five variables ($P^{Core}, Lm, Ly, Le, LP^{ind}$) and one exogenous dummy variable (dummy = 2008). In 2008, the whole world was suffering from the severe financial crisis so the prices were high all over the world (Hamilton, 2011). Pakistan was hit by global food and oil prices in 2008. Now the numbers of lags which are included in the analysis are as following:

**Table 5.10.2.A: VAR Lag Order Selection for Industrial Electricity Prices and Core Inflation**

| **VAR** | **LM-Stats** | |
|---|---|---|
| | **Lag 1** | **Lag 2** |
| **1** | 31.14465(0.1843)* | 24.45770(0.4931)* |

Note: * indicates the level of significance at 5%

So the VAR (1) model is selected. The lag length of VAR model is selected on the bases of Johansen (1995) multivariate LM test.

After selecting the optimal lag length of VAR model, we have to decide about the deterministic components, as most of the series show the increasing trend at the level therefore intercept term is included unrestrictedly in the cointegration analysis (Johansen, 1995 and Harris and Sollis, 2003).

As Johansen (1988) proposed two test statistics to check the order of cointegrating vectors i.e Trace test and Maximum Eigenvalue test. The results of these tests are given in the following Table 5.10.1.B. The trace test shows that the null hypothesis of no cointegration (r = 0), one cointegration (r ≤ 1), two cointegration (r ≤ 2) can be rejected and so on three cointegration (r ≤ 3) can be rejected but it is failed to reject the null of four cointegrating vectors at five percent level of significance. While, the maximum eigenvalue statistic with the null hypothesis r = 1 is rejected, r = 2 is rejected and r = 3 is rejected but the null hypothesis r = 4 is not rejected and refers to four long run relationships exist among the variables.

As trace test is more powerful as compare to maximum eigenvalue test because it considers all (k-r) values of the smallest eigenvalues [Kasa(1992) and Serletris and King(1997)]. So we continue our analysis on the bases of trace test.

**Table 5.10.2.B: Trace and Maximum Eigenvalues Test of Cointegration for Core Inflation and Industrial Electricity Prices**

| **Trace Statistics** | | | | **Maximum Eigen Values Statistics** | | | |
|---|---|---|---|---|---|---|---|
| $H_0$ | $H_A$ | Test Statistics | Critical Value | $H_0$ | $H_A$ | Test Statistics | Critical Value |
| r = 0 | r ≥ 1 | 135.3005* | 69.81889 | r = 0 | r = 1 | 63.36300* | 33.87687 |
| r ≤ 1 | r ≥ 2 | 71.93747* | 47.85613 | r = 1 | r = 2 | 41.29420* | 27.58434 |
| r ≤ 2 | r ≥ 3 | 30.64326* | 29.79707 | r = 2 | r = 3 | 21.77456* | 21.13162 |
| r ≤ 3 | r ≥ 4 | 8.868707 | 15.49471 | r = 3 | r = 4 | 6.547923 | 14.26460 |
| r ≤ 4 | r ≥ 5 | 2.320784 | 3.841466 | r = 4 | r = 5 | 2.320784 | 3.841466 |

After finding the no. of cointegrating vectors, we will estimate the long run relationship by using Maximum likelihood method. As we have found that there exist four cointegrating vectors, but we are interested only in one cointegrating relationship in the following study. So the normalized long run coefficients are given in equation (5.10.1.a). The chi-square values are given in parentheses

$P_t^{Core} = 40.294Lm2_t - 37.609Ly_t + 48.962Le_t + 22.449LP_t^{ind}$ ……. (**5.10.2.a**)

(18.323) (48.784) (87.621) (9.332)

This equation (5.10.2.a) shows that the money supply positively affect the core inflation in the long run as expected and has significant impact on it. The impact of GDP on core inflation is also significant and negative. Similarly nominal effective exchange rate affects the core inflation positively and it has significant impact. Whereas the impact of industrial electricity prices on core inflation is positive and significant in the long run. This shows that the core inflation which is non-food and non-energy inflation is positively affected by the increase in industrial sector electricity prices.

**Short Run Dynamic Error Correction Model**

By considering general to specific approach (David Hendry, 2004) the general model is estimated by incorporating the drift term, dummy variable (dummy = 2008), lag of error correction term and lag length one for each first difference variables. We have the following model after dropping the insignificant variables. The short run ECM model with t-values in parentheses is shown as follows;

$$\Delta P_t^{Core} = -11.077 + 1.436\Delta P_{t-1}^{Core} + 35.567\Delta Lm2_{t-1} + 14.239\Delta Ly_t -$$

(-3.656) (4.427) (4.293) (2.208)

$$20.398\Delta Le_t - 0.845ECM_{t-1} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad \textbf{(5.10.2.b)}$$

(-2.483) (-2.479)

**Diagnostic Tests**

$R^2 = 0.849$ $\overline{R}^2 = 0.795$ DW = 2.531

Jarque Bera test of Normality $\chi^2_{(2)} = 0.989(0.609)$,

Breusch Godfrey LM test of Autocorrelation [$\chi2$ (1) = 0.6183 and $\chi2$ (2) = 0.3955]

Engl's 1982 ARCH LM Test for Hetroscadasticity [$\chi2$ (1) = 0.4049 and $\chi2$ (2) = 0.7787]

The dynamic model (5.10.2.b) is diagnosed through the residuals of the model. Firstly, the normality is tested, the chi-square value of Jarque Bera test is 0.989 which tells us that the residual are normally distributed as the null hypothesis is not rejected. Then the serial correlation of the residuals is tested by LM test as [$\chi2$ (1) = 0.6183 and $\chi2$ (2) = 0.3955] which shows that null hypothesis is not rejected so no problem of serial correlation. The residuals also have equal spread of variance as Engl's 1982 ARCH LM Test for Hetroscadasticity [$\chi2$ (1) = 0.4049 and $\chi2$ (2) = 0.7787]. The values of $R^2$ and adjusted $R^2$ are 84% and 79% which show the goodness of fit of the model respectively.

In equation (5.10.2.b), the ECM term is significant and negative which is according to the theory. As the negative sign of ECM term confirms adjustment towards equilibrium. So the value of

ECM term indicates that error is correcting with the speed of 84% in one year. The significance of this term also ensures the long run relationship between the variables.

In equation (5.10.2.b) the impact of the first lag of core inflation, first lag of money supply and real GDP on core inflation is positive. The impact of nominal effective exchange rate is significant and negative.

Finally, the stability of the dynamic model is tested by utilizing the CUSUM and CUSUMSQ test (Brown et al, 1975). The figure 5.10.2.a and 5.10.2.b show that there is no structural instability and residual variance is also stable during the analysis period as CUSUM and CUSUMSQ remain within the 5% critical bound.

**Figure 5.10.2.a: CUSUM of Mean Stability for Core Inflation and Industrial Electricity Prices**

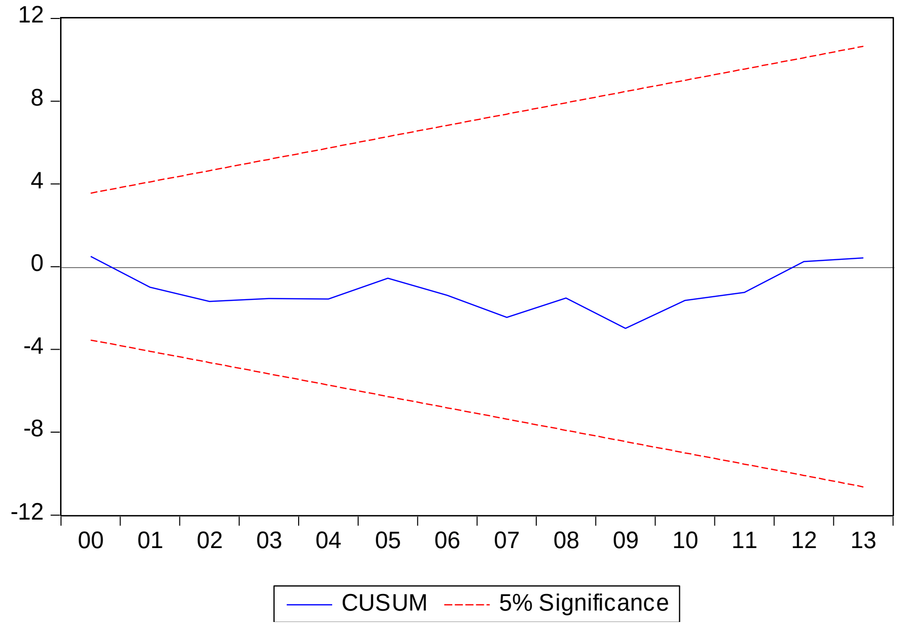
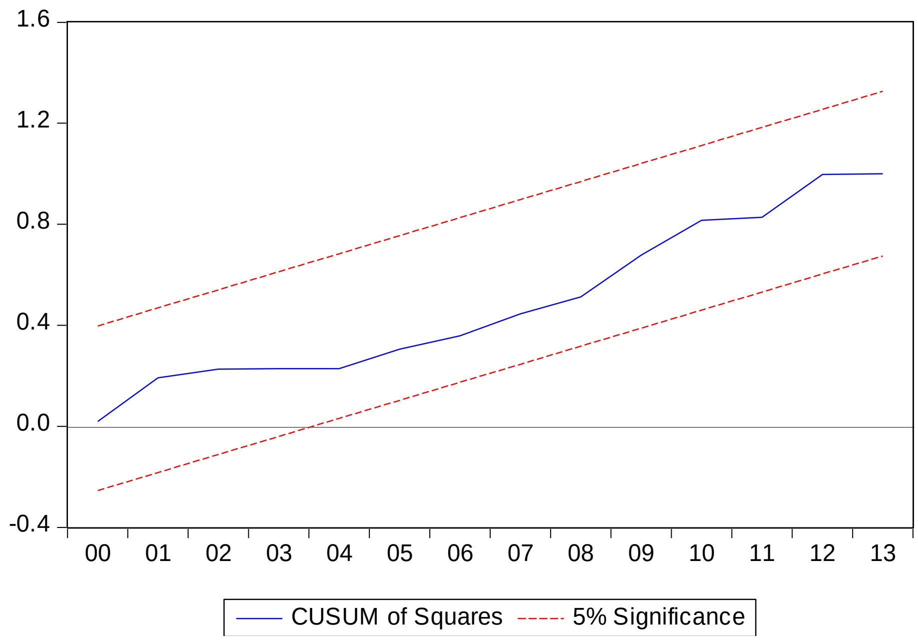



**Figure 5.10.2.b: CUSUMSQ of Variance Stability for Core Inflation and Industrial Electricity Prices**



### 5.10.3 Dynamic Analysis of Commercial Electricity Prices and Core Inflation

**Long Run Analysis**

Applying the Johansen cointegration test for the estimation of the following model in which we want to analyze the impact of Commercial electricity prices on core inflation, the optimal lag length of the vector autoregressive (VAR) system is selected which ensures that the residuals are not serially correlated. So the VAR model is estimated with five variables ($P^{Core}, Lm, Ly, Le, LP^{com}$) and one exogenous dummy variable (dummy = 2008). In 2008, the whole world was suffering from the severe financial crisis so the prices were high all over the world (Hamilton, 2011). Pakistan was hit by global food and oil prices in 2008. Now the numbers of lags which are included in the analysis are as following:

**Table 5.10.3.A: VAR Lag Order Selection for Commercial Electricity Prices and Core Inflation**

| VAR | LM-Stats | |
|---|---|---|
| | **Lag 1** | **Lag 2** |
| **1** | 28.09350 (0.3036)* | 29.72708 (0.2347)* |

Note: * indicates the level of significance at 5%

So the VAR (1) model is selected. The lag length of VAR model is selected on the bases of Johansen (1995) multivariate LM test.

After selecting the optimal lag length of VAR model, we have to decide about the deterministic components, as most of the series show the increasing trend at the level therefore intercept term is included unrestrictedly in the cointegration analysis (Johansen, 1995 and Harris and Sollis, 2003).

As Johansen (1988) proposed two test statistics to check the order of cointegrating vectors i.e Trace test and Maximum Eigenvalue test. The results of these tests are given in the following Table 5.10.3.B. The trace test shows that the null hypothesis of no cointegration (r = 0), one cointegration (r ≤ 1), two cointegration (r ≤ 2) can be rejected but it is failed to reject the null of three cointegrating vectors at five percent level of significance. While, the maximum eigenvalue statistic with the null hypothesis r = 1 is rejected and r = 2 is rejected but null hypothesis r = 3 is not rejected and refers to three long run relationships exist among the variables.

As trace test is more powerful as compare to maximum eigenvalue test because it considers all (k-r) values of the smallest eigenvalues [Kasa(1992) and Serletris and King(1997)]. So we continue our analysis on the bases of trace test.

**Table 5.10.3.B: Trace and Maximum Eigenvalues Test of Cointegration for Core Inflation and Commercial Electricity Prices**

| **Trace Statistics** | | | | **Maximum Eigen Values Statistics** | | | |
|---|---|---|---|---|---|---|---|
| $H_0$ | $H_A$ | Test Statistics | Critical Value | $H_0$ | $H_A$ | Test Statistics | Critical Value |
| r = 0 | r ≥ 1 | 115.9316* | 69.81889 | r = 0 | r = 1 | 58.86938* | 33.87687 |
| r ≤ 1 | r ≥ 2 | 57.06223* | 47.85613 | r = 1 | r = 2 | 32.17074* | 27.58434 |
| r ≤ 2 | r ≥ 3 | 24.89150 | 29.79707 | r = 2 | r = 3 | 17.32718 | 21.13162 |
| r ≤ 3 | r ≥ 4 | 7.564318 | 15.49471 | r = 3 | r = 4 | 7.376925 | 14.26460 |
| r ≤ 4 | r ≥ 5 | 0.187393 | 3.841466 | r = 4 | r = 5 | 0.187393 | 3.841466 |

After finding the no. of cointegrating vectors, we will estimate the long run relationship by using Maximum likelihood method. As we have found that there exist three cointegrating vectors, but we are interested only i one cointegrating relationship in the following study. So the normalized long run coefficients are given in equation (5.10.3.a). The chi-square values are given in parentheses

$P_t^{Core} = 67.696 Lm2_t - 82.969 Ly_t + 16.668 Le_t + 20.862 LP_t^{com}$ ……. (**5.10.3.a**)

(63.588) (161.058) (231.761) (33.082)

This equation (5.10.3.a) shows that the money supply positively affect the core inflation in the long run as expected and has significant impact on it. The impact of GDP on core inflation is also significant and negative. Similarly nominal effective exchange rate affects the core inflation positively and it has significant impact. Whereas the impact of commercial electricity prices on core inflation is positive and significant in the long run.

**Short Run Dynamic Error Correction Model**

By considering general to specific approach (David Hendry, 2004) the general model is estimated by incorporating the drift term, dummy variable (dummy = 2008), lag of error correction term and lag length one for each first difference variables. We have the following model after dropping the insignificant variables. The short run ECM model with t-values in parentheses is shown as follows;

$\Delta P_t^{Core} = -6.679 + 0.792 \Delta P_{t-1}^{Core} + 33.195 \Delta Lm2_{t-1} + 18.804 \Delta Ly_t -$

(-3.266) (4.122) (4.477) (2.604)

$12.438 \Delta Le_t + 5.275 \Delta LP_t^{Com} + 1.929 D_{2008} - 0.481 ECM_{t-1}$ ……. **(5.10.2.b)**

(-1.590)* (1.436)* (2.335) (-1.673)*

**Diagnostic Tests**

$R^2$ = 0.894 $\overline{R}^2$ = 0.832 DW = 1.593

Jarque Bera test of Normality $\chi^2_{(2)}$ = 0.819(0.663),

Breusch Godfrey LM test of Autocorrelation [$\chi 2$ (1) = 0.8670 and $\chi 2$ (2) = 0.9558]

Engl's 1982 ARCH LM Test for Hetroscadasticity [$\chi 2$ (1) = 0.5270 and $\chi 2$ (2) = 0.6999]

The dynamic model (5.10.3.b) is diagnosed through the residuals of the model. Firstly, the normality is tested, the chi-square value of Jarque Bera test is 0.819 which tells us that the residual are normally distributed as the null hypothesis is not rejected. Then the serial correlation of the residuals is tested by LM test as [$\chi 2$ (1) = 0.8670 and $\chi 2$ (2) = 0.9558] which shows that null hypothesis is not rejected so no problem of serial correlation. The residuals also have equal spread of variance as Engl's 1982 ARCH LM Test for Hetroscadasticity [$\chi 2$ (1) = 0.5270 and $\chi 2$ (2) = 0.6999]. The values of $R^2$ and adjusted $R^2$ are 89% and 83% which show the goodness of fit of the model respectively.

In equation (5.10.3.b), the ECM term is significant and negative which is according to the theory. As the negative sign of ECM term confirms adjustment towards equilibrium. So the value of ECM term indicates that error is correcting with the speed of 48% in one year. The significance of this term also ensures the long run relationship between the variables.

In equation (5.10.3.b) the impact of the lag of core inflation, first lag of money supply and real GDP on core inflation is positive. The effect of exchange rate on core inflation in the short run is negative as it was in the long run. The Dummy variable of 2008 also has significant and positive impact of core inflation. Similarly the impact of commercial sector electricity prices on core inflation in the short run is also positive.

Finally, the stability of the dynamic model is tested by utilizing the CUSUM and CUSUMSQ test (Brown et al, 1975). The figure 5.10.3.a and 5.10.3.b show that there is no structural instability and residual variance is also stable during the analysis period as CUSUM and CUSUMSQ remain within the 5% critical bound.

**Figure 5.10.3.a: CUSUM of Mean Stability for Core Inflation and Commercial Electricity Prices**

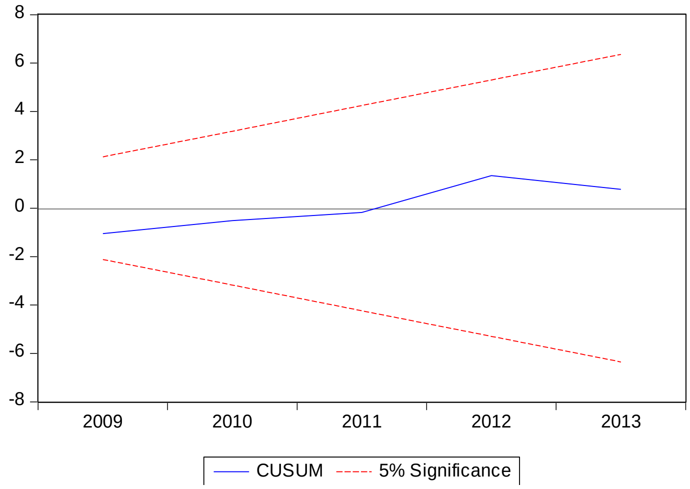
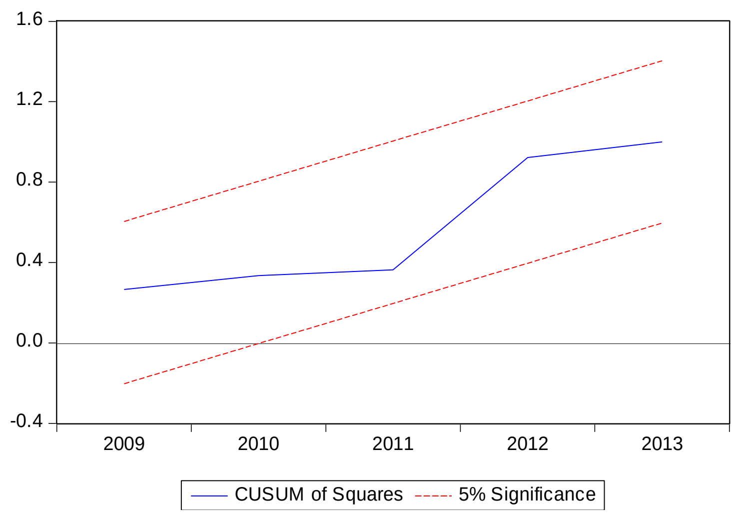



**Figure 5.10.3.b: CUSUMSQ of Variance Stability for Core Inflation and Commercial Electricity Prices**



### 5.10.4 Dynamic Analysis of Agricultural Electricity Prices and Core Inflation

**Long Run Analysis**

Applying the Johansen cointegration test for the estimation of the following model in which we want to analyze the impact of Agricultural electricity prices on core inflation, the optimal lag length of the vector autoregressive (VAR) system is selected which ensures that the residuals are not serially correlated. So the VAR model is estimated with five variables ($P^{Core}, Lm, Ly, Le, LP^{agr}$) and one exogenous dummy variable (dummy = 2008). In 2008, the whole world was suffering from the severe financial crisis so the prices were high all over the world (Hamilton, 2011). Pakistan was hit by global food and oil prices in 2008. Now the numbers of lags which are included in the analysis are as following:

**Table 5.10.4.A: VAR Lag Order Selection for Agricultural Electricity Prices and Core Inflation**

| VAR | LM-Stats | |
|---|---|---|
| | **Lag 1** | **Lag 2** |
| **1** | 39.75938(0.3036)* | 20.78689(0.7044)* |

Note: * indicates the level of significance at 5%

So the VAR (1) model is selected. The lag length of VAR model is selected on the bases of Johansen (1995) multivariate LM test.

After selecting the optimal lag length of VAR model, we have to decide about the deterministic components, as most of the series show the increasing trend at the level therefore intercept term is included unrestrictedly in the cointegration analysis (Johansen, 1995 and Harris and Sollis, 2003).

As Johansen (1988) proposed two test statistics to check the order of cointegrating vectors i.e Trace test and Maximum Eigenvalue test. The results of these tests are given in the following Table 5.10.4.B. The trace test shows that the null hypothesis of no cointegration (r = 0), one cointegration (r ≤ 1) and two cointegration (r ≤ 2) can be rejected but it is failed to reject the null of three cointegrating vectors at five percent level of significance. While, the maximum eigenvalue statistic with the null hypothesis r = 1 is rejected, r = 2 is rejected and r = 3 is also rejected but null hypothesis r = 4 is not rejected and refers to three long run relationships exist among the variables.

As trace test is more powerful as compare to maximum eigenvalue test because it considers all (k-r) values of the smallest eigenvalues [Kasa(1992) and Serletris and King(1997)]. So we continue our analysis on the bases of trace test.

**Table 5.10.4.B: Trace and Maximum Eigenvalues Test of Cointegration for Core Inflation and Agricultural Electricity Prices**

| **Trace Statistics** | | | | **Maximum Eigen Values Statistics** | | | |
|---|---|---|---|---|---|---|---|
| $H_0$ | $H_A$ | Test Statistics | Critical Value | $H_0$ | $H_A$ | Test Statistics | Critical Value |
| r = 0 | r ≥ 1 | 130.6801* | 69.81889 | r = 0 | r = 1 | 58.25157* | 33.87687 |
| r ≤ 1 | r ≥ 2 | 72.42853* | 47.85613 | r = 1 | r = 2 | 44.70010* | 27.58434 |
| r ≤ 2 | r ≥ 3 | 27.72843 | 29.79707 | r = 2 | r = 3 | 21.52419* | 21.13162 |
| r ≤ 3 | r ≥ 4 | 6.204239 | 15.49471 | r = 3 | r = 4 | 6.180375 | 14.26460 |
| r ≤ 4 | r ≥ 5 | 0.023864 | 3.841466 | r = 4 | r = 5 | 0.023864 | 3.841466 |

After finding the no. of cointegrating vectors, we will estimate the long run relationship by using Maximum likelihood method. As we have found that there exist three cointegrating vectors, but we are interested only in one cointegrating relationship in the following study. So the normalized long run coefficients are given in equation (5.10.4.a). The chi-square values are given in parentheses

$P_t^{Core} = 51.376Lm2_t - 39.122Ly_t + 45.356Le_t + 6.469LP_t^{agr}$ ……. (**5.10.4.a**)

(41.992) (92.666) (99.004) (0.941)

This equation (5.10.4.a) shows that the money supply positively affect the core inflation in the long run as expected and has significant impact on it. The impact of GDP on core inflation is also significant and negative. Similarly nominal effective exchange rate affects the core inflation positively and it has significant impact. Whereas the impact of agricultural electricity prices on core inflation is positive and insignificant in the long run.

**Short Run Dynamic Error Correction Model**

By considering general to specific approach (David Hendry, 2004) the general model is estimated by incorporating the drift term, dummy variable (dummy = 2008), lag of error correction term and lag length one for each first difference variables. We have the following model after dropping the insignificant variables. The short run ECM model with t-values in parentheses is shown as follows;

$$\Delta P_t^{Core} = -11.997 + 1.152\Delta P_{t-1}^{Core} + 47.152\Delta Lm2_{t-1} + 21.508\Delta Ly_t -$$

(-4.382) (4.861) (5.090) (3.095)

$$20.299\Delta Le_t + 1.897\Delta LP_{t-1}^{agr} - 0.680ECM_{t-1} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad \textbf{(5.10.4.b)}$$

(-2.611) (2.288) (-2.591)

**Diagnostic Tests**

$R^2 = 0.879$ $\overline{R}^2 = 0.824$ DW = 2.731

Jarque Bera test of Normality $\chi^2_{(2)}$ = 1.633(0.435),

Breusch Godfrey LM test of Autocorrelation [$\chi2$ (1) = 0.0583 and $\chi2$ (2) = 0.0653]

Engl's 1982 ARCH LM Test for Hetroscadasticity [$\chi2$ (1) = 0.2904 and $\chi2$ (2) = 0.5726]

The dynamic model (5.10.3.b) is diagnosed through the residuals of the model. Firstly, the normality is tested, the chi-square value of Jarque Bera test is 1.633 which tells us that the residuals are normally distributed as the null hypothesis is not rejected. Then the serial correlation of the residuals is tested by LM test as [$\chi2$ (1) = 0.0583 and $\chi2$ (2) = 0.0653] which shows that null hypothesis is not rejected so no problem of serial correlation. The residuals also have equal spread of variance as Engl's 1982 ARCH LM Test for Hetroscadasticity [$\chi2$ (1) = 0.2904 and $\chi2$ (2) = 0.5726]. The values of $R^2$ and adjusted $R^2$ are 87% and 82% which show the goodness of fit of the model respectively.

In equation (5.10.4.b), the ECM term is significant and negative which is according to the theory. As the negative sign of ECM term confirms adjustment towards equilibrium. So the value of ECM term indicates that error is correcting with the speed of 68% in one year. The significance of this term also ensures the long run relationship between the variables.

In equation (5.10.4.b) the impact of the lag of core inflation, first lag of money supply and real GDP on core inflation is positive. The effect of exchange rate on core inflation in the short run is negative as in it was in the long run. But the impact of agricultural sector electricity prices on core inflation in the short run is positive and significant.

Finally, the stability of the dynamic model is tested by utilizing the CUSUM and CUSUMSQ test (Brown et al, 1975). The figure 5.10.3.a and 5.10.4.b show that there is no structural instability and residual variance is also stable during the analysis period as CUSUM and CUSUMSQ remain within the 5% critical bound.

**Figure 5.10.4.a: CUSUM of Mean Stability for Core Inflation and Agricultural Electricity Prices**

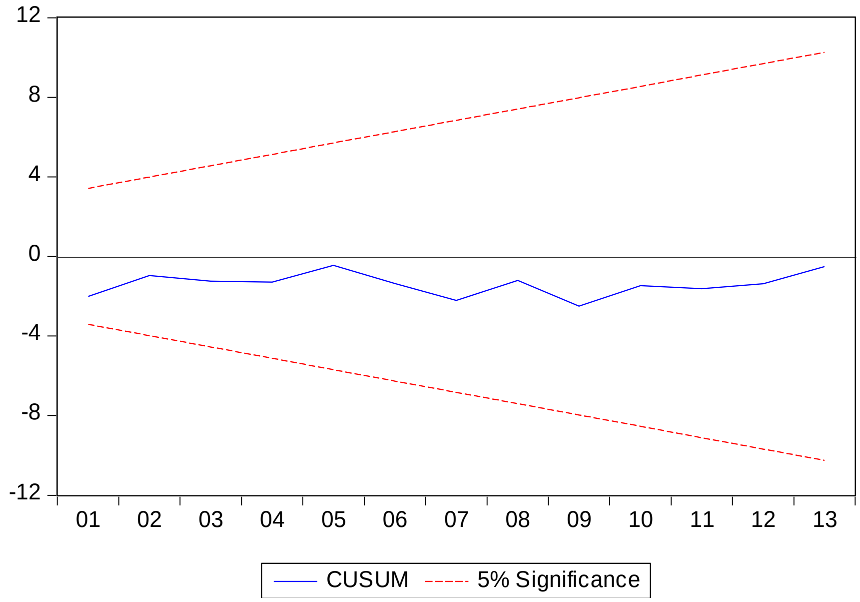
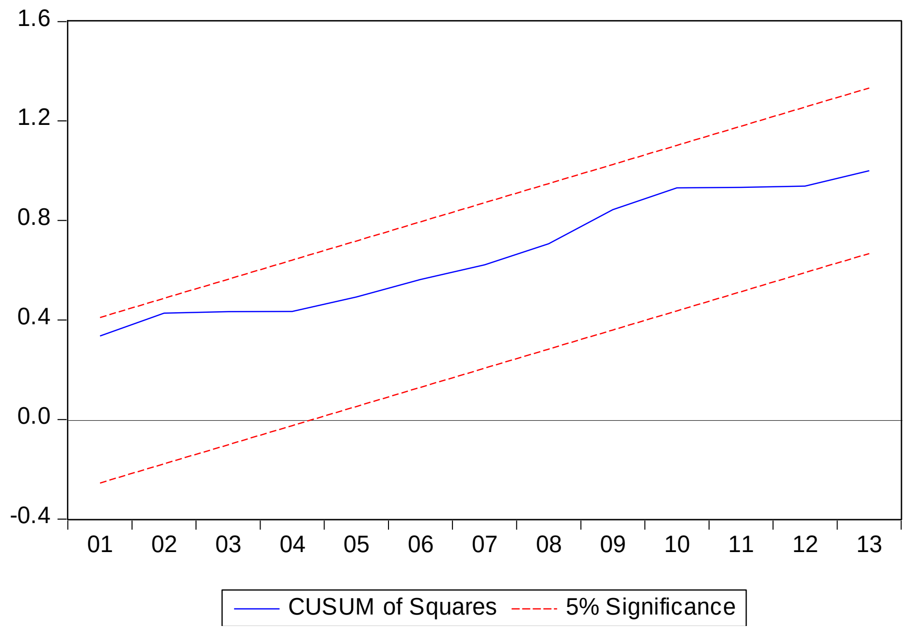



**Figure 5.10.4.b: CUSUMSQ of Variance Stability for Core Inflation and Agricultural Electricity Prices**



## 5.11 Concluding Remarks

In this chapter first of all unit root test results of ADF and Zivot and Andrews are presented which shows that all variables are integrated of I(1). Then moving ahead the long run relationship between the variables is found by utilizing the Johansen cointegration test of Maximum Likelihood Method, which shows that all the above given models are cointegrated. And then short run relationship between the variables is tested. Then we have concluded the following result:

- ✓ Aggregate Electricity prices effect the inflation, food, non-food inflation and core inflation positively but it is only significantly affect the core inflation in the long run.
- ✓ In the short run only core inflation is positively and significantly affected by the aggregate electricity prices.
- ✓ At disaggregate level it can be seen that the industrial and domestic sectors electricity prices affect the inflation, food inflation and non-food inflation negatively in the long run. But these two sector's electricity prices positively affect the core inflation in the long run but have insignificant impact in the case of domestic electricity prices.
- ✓ At disaggregate level the agricultural and commercial sector electricity prices affect the inflation, food inflation, non-food inflation and core inflation positively but in the case of overall inflation the agricultural electricity prices have insignificant impact.
- ✓ In the short run all the sectoral electricity prices instead of domestic sector electricity prices, affect the overall inflation, food, non-food and core inflation positively. But in the short run industrial electricity prices have no impact on core inflation.
- ✓ All the other variables affect the inflation, food, non-food and core inflation accordingly in the long run as well as in the short run.

- ✓ The dummy variable 2008 only have the significant impact on the core inflation at the disaggregate level when we find the impact of domestic and commercial sector electricity prices on core inflation.

# Chapter 6

## CONCLUSION AND POLICY RECOMMENDATIONS

Pakistan is facing the electricity related problems since past many years, specially the rapid increase in the electricity prices and its short fall which is affecting the economy and has a great influence on inflation. So we set the task of examining the impact of electricity prices on inflation in Pakistan at aggregate and disaggregate level. Though some studies have conducted to check the impact of energy prices specially oil prices (as a proxy of energy prices) on inflation and other macroeconomics variables, none of these studies have examined the impact of electricity prices both at aggregate and disaggregate level. In Pakistan, the impact of electricity prices has been discussed by the researchers but mainly in the context of the relationship with the economic growth, demand and consumption but do not account for the impact of electricity prices on inflation. As electricity has a major share of total energy consumed in the country, it is important to check its impact on inflation. It is also important to check its impact on inflation at aggregate and disaggregate level and also on food, non-food and core inflation as well because it may have different impact on different types of inflation. In this study we have estimated the impact of electricity prices on overall inflation, food, non-food and core inflation at aggregate and at disaggregate level by using annual data from 1970 to 2013. To test the long run and short run relationship between the variables Johansen approach of cointegration is used and initially ADF and Zivot and Andrews tests of unit root are used to detect the order of integration.

### 6.1 Conclusion

This study shows the mix effect of electricity prices on inflation. As at aggregate level the electricity prices effect the overall inflation, food and non-food inflation positively but insignificantly in the long run and have no impact in the short run. But in the case of core inflation, electricity prices have positive and significant impact both in the long and short run. But at the disaggregate level of electricity prices we have found interesting results. At disaggregate level the domestic electricity prices effect the overall inflation, food and non-food inflation negatively in the long run as well as in the short run. But it has positive impact on core inflation in the long run but it has insignificant impact. And in the short run it has no impact on core inflation. This is mainly because of different reasons. As the major portion of electricity is consumed in domestic sector which is 46.1% (Pakistan Energy Year Book 2010), so as long as electricity prices increase this sector are subsidies by the government and many educational institutes, government offices and worship places which should be charged according to the commercial sector wise are taking the advantage of lifeline consumers and consider under domestic consumer category. They also misuse of such opportunity. The industrial sector electricity prices effect the overall inflation, food and non-food inflation negatively in the long run but positively in the short run because in the long run many in genuine favors are given to the industries and in the long run many industries use the alternative sources of electricity like generator and also produce electricity independently for the industrial production. But in the short run the increase in the industrial electrical prices have also a great impact on inflation, food and non-food inflation. But industrial electricity prices effect the core inflation positively in the long run but has no impact on it in the short run. The commercial and agricultural electricity prices affect all types of inflation positively both in the long run as well as in the short run. So overall impact of electricity prices on all types of inflation is mixed as positive and negative but the dominant impact of electricity prices on inflation is positive both in the long as well as in the short run. And we found that the most dominant effect of increasing in the electricity prices at aggregate and disaggregate level is on the core inflation.

## 6.2 Policy Recommendation

The policy implications for this study could be, firstly; the rapid increase in the electricity prices which effect the inflation, food, non-food and core inflation, this is mainly because of the huge gap between supply and demand of electricity, rehabilitation and replacement of the outdated transmission and distribution system is necessary to bridge this gap of supply and demand so there should be more steps to take to reduce this gap. Secondly, alternative sources of electricity should be made like construction of new dams, solar, wind, nuclear and biomass power plants.

Thirdly, improving and increasing ties with future energy rich countries must not be neglected.

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