Impact of Oil Price and Its Volatility on CPI of Pakistan: Bivariate EGARCH Model

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ABSTRACT

Oil is becoming as an important determinant which affects the macroeconomic activities in unusual patterns among various parts of the world particularly since the first oil crisis in 1973. Also Petroleum products are recognized to be the essential source of energy and power throughout the world and gaining massive importance as a tool for survival and security of developed nations. The research study targets to explore the impact of oil price and its volatility on CPI in case of Pakistan from the period 1980:M1 to 2014:M12. In this study we used the financial time series econometrics techniques; first applied the Box-Cox transformation on the data which suggested log transformation is required for all series. As data used will be monthly, Beaulieu and Miron (1992) seasonal unit root test is used to test stationarity of the data. All variables hold unit root at zero frequency and become stationary at first difference. Further to confirm if co-integration relationship exists between the variables we have estimated Engle and Granger (1987) two-step method. And finally Bivariate EGARCH model is applied to scrutinize the impact of oil price volatility on CPI. This model is estimated by using Maximum Likelihood Method proposed by Bollerslev and Wooldridge (1992). The results of Bivariate EGARCH model concluded that positive relationship between oil prices and CPI. We have also found the asymmetric impact of news on the change in consumer price index. In case of Pakistan, it is positive and significant statistically; which suggests that positive news tends to intensify the CPI volatility more than the negative news.

Keywords: Oil prices, Volatility of oil prices, CPI, Monthly Unit Root, Co-integration, EGARCH, Pakistan.

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Note: This study is extracted from the MPhil Econometrics thesis of Abida Naurin.

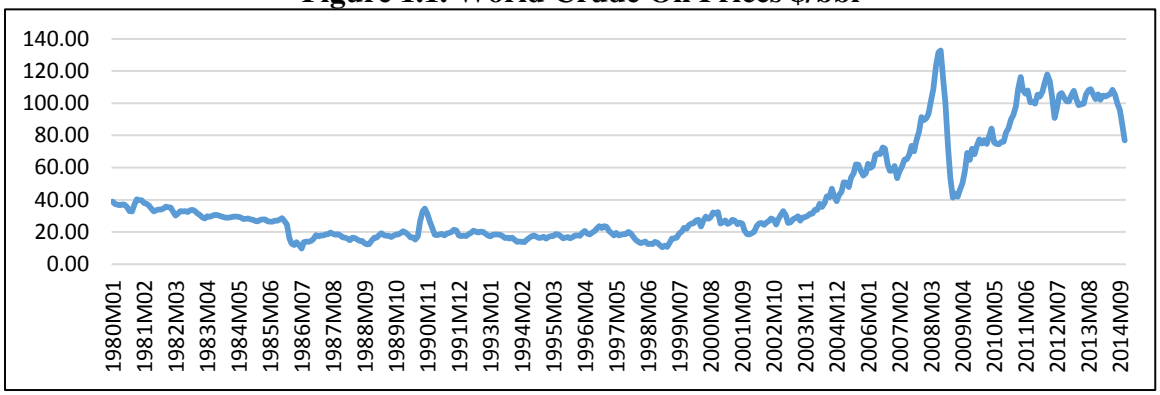
1. INTRODUCTION

Oil prices have captured the attention of new investigators as a significant factor which has an effect on macroeconomic actions in different ways over the globe particularly since 1973 when the first oil crisis occurred. Oil is measured as a most integral source of energy in the world and achieving substantial significance as a mean of urbanized countries' protection and continuous existence. According to Hamilton (1983), remarkable increase in the prices of crude oil resulted in the seven out of eight postwar downturns in the United States. Such conclusions and estimations have provided the base for the researchers to study oil as a significant determinant while assessing the economic activities in any country. Oil is the biggest need of every country that's why the alterations in oil prices affect the financial environment of industrial and developing states.

Production cost includes oil as a major element. For the oil importing and exporting countries instability of oil prices have asymmetric impact. Due to the increase in oil prices worth of currency decline in the countries which are importing oil as compared to the value of currency in oil exporting nations. Therefore, the dealing between oil exporting and the country with huge dependence on oil import would be the most gainful deal Siddiqui, (2014).

Now a day's oil price has been taken the importance as the gold price. The largest goods market over the world is oil marketplace and the fluctuations in crude oil prices have direct and indirect shock on economy. Oil price changes are not considered in predicting the international stability of the economic activity.

Figure 1.1. World Crude Oil Prices $/bbl



Source: World Bank Data Indicator

The trend of world crude oil prices observed in the era of 1990s was traded between $18 and $23. But in 2004 it crossed the limit of $40 and rose gradually and reaches on $60 in 2005.

While in the middle of 2007, it is priced $70 and crossed the highest limit of $178 in middle of 2008. These shocks have great importance for oil importing countries like Pakistan, China, and India etc. Literature discussed that these shocks have negative impact on the economy of oil importing countries, specifically where foreign exchange reserves are low, policy frameworks are weak and access to international capital markets is restricted (Fatima and Bashir, 2014).

Top market variations have been took place in 2008. Many folds increase in the inflation rate is the consequence of disaster after predicament that beat the chief countries. In 2008 the inflation rate in Pakistan was 25.3% and the key determinants that hit the price of each good include oil (GOP, 2009).

The prices of oil are going to be high day by day in Pakistan due to our increasing spending on oil being an oil importer country. In the whole world demand for oil is increasing. Oil demand increase from 89,203 tons to 597,954 tones in July2012 in Pakistan (Ansar and Asghar, 2013). To monitor the position of economy of any country the consumer price index is the significant meter; as the inflation rate has a great effect on the investment and its return therefore, the financiers must have the up to date knowledge of inflation rate who want to supply their money in the stock exchange and assess the risk and profit edge.

The developed as well as developing economies are facing the problem of oil prices unpredictability. Hamilton (1983) was first who studied this relationship, while Jones and Kaul (1996) studied this effect on stock market. But still there is very little research to analyses the relationship and forecast it. A lot of researches are made for data of UK or USA or EU or developed or industrial countries while the studied on BRIC and GCC countries are also found. Siddique (2014), Ansar and Asghar (2013) and Jawad (2013) have examined the relationship between Oil prices and Consumer price index in case of Pakistan. There are number of issue in the above mentioned studies, as there are used small data sets for the time series which can't fulfill the basic criteria of minimum data/observation selection of time series analysis Linear model is used by the majority of the offered studies on this field. By relaying on the market arrangement or asymmetric market information this model ignores the nonlinear factors. Econometric analyses like co-integration and Granger causality test are applied to examine this issue. These techniques are not appropriate for proper results. Our study is important because, most of the relationship in the financial markets is non-linear in its behavior. The data frequency

is low, thus using monthly data will give more consistent and efficient results. This study is being conducted with the key purpose to cover this space in literature by using better technique of estimation of non-linear model i-e ARCH family, with the help of large data set. Increase and decrease in the oil prices do not have similar affect. Park and Ratti (2007) demonstrate in their study that decline in oil price has less influence on the economy than increase in its price. The main objective of this study is to investigate the impact of oil price and its volatility on Consumer price index in Pakistan from the period 1980:M1 to 2014:M12. The other objective of the study is to examine the long run impact of oil price and its volatility on CPI. We also found the asymmetric effects of oil price in case of Pakistan.

This study is arranged as follows; section 2 demonstrates the salient features of inflation and oil prices in Pakistan. Section 3 describes literature review of previous studies at national and international level, followed by Econometric Methodology in section 4, results and discussion is discussed in section 5. Finally conclusion and policy recommendation is discussed in section 6.

2. SALIENT FEATURES OF OIL SECTOR AND INFLATION IN PAKISTAN

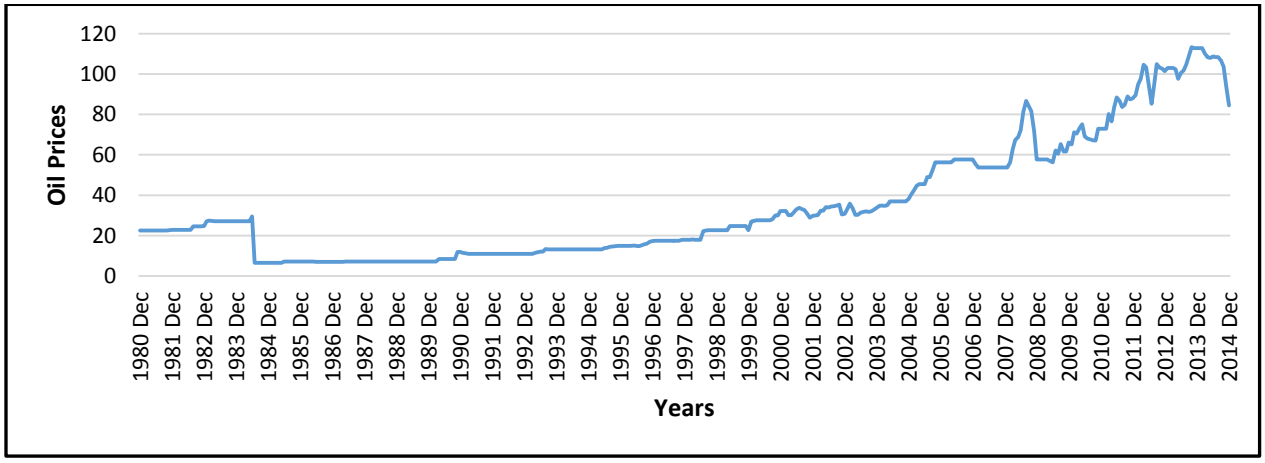
We try to overlook the brief history of oil prices with respect to Pakistan as well as world in this section along with shedding light on inflation scenario of Pakistan in past years. In early time period of independence the inflation rate was quite stable but later on it has been evaluated remarkably. Specifically in those periods when international oil price were at peak then it went up and it was observed that inflation was less than 5% just 5 times in the history. The inflation rate starting form 70's to present is substantially fluctuating. The inflation rate was 11.9 on average in 70's however it was drop to 7.5 in 1980's. In the decade of 1990 it was again flourishing to 9.7 on average. This digit was decline to 8.5 in 2000 and in the period from 2001 to 2011 it was quite stable to 9.7. Moreover inflation rates are 7.75, 8.2 and 4.81 for 2012-13, 2014 and July 2015 respectively (Economic Survey of Pakistan, 2014).

The economy of Pakistan has long history about its dependence upon oil either directly or indirectly. The production of industrial and energy products all depends on oil products. The two major elements of energy mix are oil and gas that contribute to 65 % approximately. Oil takes share of 15% while 50% contributes by gas out of this 65%. For long term growth it is essential

to shorten the demand for oil. If this does not hold then Pakistan oil demand was expected to rise 7 percent year on year basis to 21 million metric tons.

Since 1973 oil shocks the world economy affected severely. In history the five major oil shocks that affect world economy rigorously. It means oil prices leads to that peak where recession experience or simply decelerate economy individually and as a whole. These shocks about oil prices depict that it have great impact on CPI and Stock Price Index of oil importing country (Pakistan) either directly and indirectly. With collaboration these external shocks Pakistan oil prices are also affected by the internal shocks due to various natural disasters and political conflicts prevailing within country. The earth quake of 2005 in northern areas of Pakistan badly affect its economy and accelerate inflation in all the sectors of economy due to this natural disaster. Yet before that GDP was high and stable in 2004. Another natural disaster was 2011 flood that ruins agriculture and infrastructure badly and tumbled down the economy as a whole. Such miscue leads to high import prices and create shortage of recourses due to high oil prices that is the one of the major input in almost all sectors economy. The oil prices trend is shown in figure 2.1.

Figure 2.1: Current Oil Prices in Pakistan (1980-2014)

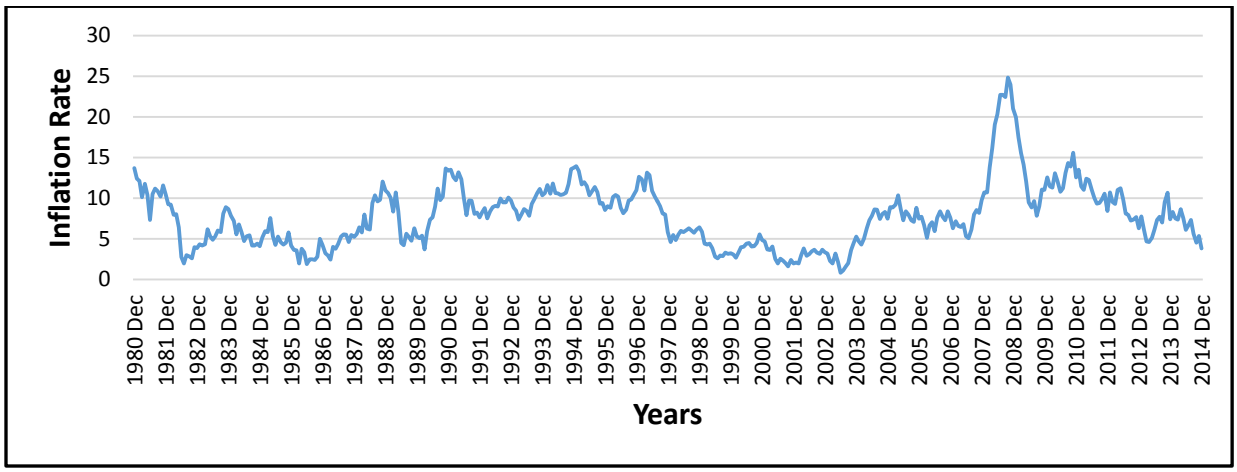


Source: Monthly statistical bulletins of Pakistan.

The inflation rate was 20 to 26% in between 1972-75 which is recorded as highest. After that it got normal till 1980 but during 1980-81 inflation was again in double digits. Later on it comes to causal path throughout the decade. However in subsequent decade of 1990's rate of inflation was again in twofold during the whole decade. As it was preceded by war in

Afghanistan, military rule, markets deregulation and additionally autonomy of central bank of Pakistan that switched exchange rate policy from fixed to float exchange rates. Inflation rate remained beyond 5% in between 1999 to 2003 and same was happened in 1986-87. Inflation remained at 7.5% till 2008 but after that all of sudden it goes up to 20% in 2008 and it remained double digits during 2008 to 2012. Afterward from 2012 till present inflation rate persisted on average of 8%. The figure 2.2 explains the inflation trends in Pakistan from 1980-2014.

Figure .2.2: Inflation in Pakistan (1980-2014)



Source: Data taken from International Financial Statistics (IFS).

Specifically the various Oil and Gas Corporations and other power generation institutions including PEPCO (Pakistan Electric Power Company limited), Independent power producers (IPPs) and WAPDA (Water and Power Development Authority) are facing power supply shortage due to non-payment of bills of circular debt and it is one of the major problem. Drastically Pakistan oil prices are comparable to world oil prices in 1990-95, however in 2003 world oil prices higher than Pakistan oil prices. But from 2004 to present world oil prices and Pakistan oil prices shows same trend.

Since 2005 Pakistan's GDP because of increase in petroleum prices about 7%. The upward trend in power consumption leads to higher GDP as it accelerates the GDP growth rate and it was up to 8.4% in 2004-2005. The current deficit which was 1.8% of GDP in fiscal year 2003-2004 went to 8.4% of GDP in 2007-2008 and the only reason was upward movement in the oil prices in the global market and it became the major reason of decline in exports. Even though with high oil prices the oil consumption accelerated GDP growth until 2007-2008. In 2001

Pakistan economy showed only 28% increase in oil price as compared to 47% increase in the world oil prices. The world oil price showed upward movement of 39% from year 2010 to 2011 where the price moved from 83 US $/bb to 115 US $/bbl. Due to acceleration in global Oil prices as a result the consumption of Oil in Pakistan also decreased as there was also 28% upward movement of oil prices prevailed in the country in 2011.

3. REVIEW OF LITERATURE

There are many studies on the subject of energy price, especially in case of oil prices and inflation at International and national level.

Yoshizaki and Haomori (2014) conducted a study on "The effects of oil price shocks on expenditure category CPI. The sample period has been used from December 1974 to December 2010. For this analysis, a two block structural vector autoregressive (VAR) is applied which was planned by Kilian and Park (2009). The results approve that similar structural shocks produce different responses for each expenditure category price index. Furthermore, results show that changes in oil price affect each expenditure category price differently between the United States and Japan and these detailed-level differences may lead to aggregate-level differences in the price response of both countries to changes in oil prices.

Rahman and Serletis (2011) studied the effects of oil price uncertainty and its asymmetry on existent economic activity in the United States by using secondary data from 1981-1 to 2007-1.The econometric method of this paper is general bivariate GARCH-in-Mean errors. The reason to use this model is that it allows for the possibilities of spillovers and asymmetries in the variance-covariance structure for genuine output growth and the change in actual price of oil. Oil price improbability has been measured by the conditional variance of the oil price change forecast error and isolates the effects of volatility in the change in the price of oil and its asymmetry on output growth. To calculate generalized impulse response functions (GIRFs) Simulation methods has been employed and volatility Response Functions (VIFRs) are used to trace the effects of independent shocks on the provisional means and conditional variances, respectively, of the variables.

Mordi and Adebiyi (2010) improves structural VAR model which is used to evaluate the asymmetric impact of oil price shocks on output and price in a unifying model. This model is applied to Nigeria by using monthly data from 1999-01 to 2008-12 and the experimental results

disclosed that the nature of impact of oil price shocks on output and prices is asymmetric and the decrease in oil price has significantly greater impact than oil price increase. Changes in oil price play a momentous role in determining the variance decompositions of output and prices. Any policy that is aimed at moving the economy forward must focus on price stability.

A research was carried out for the emerging Asian countries to check the oil prices pass through to inflation. Researchers used the standard Phillips curves. They found a strong long run pass through of oil prices but in short run it was not prominent. To study further they classified the oil price into dramatic and high oil price shock. And the results showed that during the high oil price shocks the short run pass through to inflation is high. The reason behind this is oil is a necessary goods and the consumer has to buy it (Chou & Tseng, 2011).

A research was carried for the economy of Japan to study the pass-through of world oil prices to domestic inflation. VAR (TVP-VAR) was employed to see either the pass through has decreased or increased over time. The results concluded that the pass-through has decreased and the reasons are that now oil price is a small portion of input cost and due to substitution effect of inputs. As firms have shifted now to other energy sources and using less oil intensive production systems. (Shioji & Uchino, 2010). Adenuga *et al*, (2012) wants to uncover the effect of oil prices on the Nigerian inflation rate, they used ARDL approach and quarterly data for the period of 1990-2010. The results concluded that oil price has a pass through effect on inflation rate in Nigeria in short and long run. It is more in long run. But the pass through is not complete.

A research was carried out for economy of Spain and Euro area to find out the impact of oil price and domestic inflation. The result showed that oil price change has a less pass through effect to the domestic inflation and crude oil price is one of main drivers in the inflation fluctuation. The results also showed the pass through is higher in Spain than in euro area and the direct effect transmission channel is getting more important over the time than indirect (Álvarez *et al.,* 2011).

Jawad (2013) study the oil price volatility and its impact on economic growth in Pakistan. The object of this study is to explore the impact of oil price volatility on the economic growth of Pakistan. For this the researcher estimated the linear regression by using the secondary data from 1973 to 2011.To check the stationary, unit root test i-e Augmented Dickey-Fuller Test has been employed. This study revealed that oil price volatility has immaterial impact on Gross Domestic Production. Khan and Ahmed (2011), shows the impact of oil price shocks and food prices on

economy of Pakistan. In this study Structural Vector Auto Regressive (SVAR), generalized impulse response function has used to test the impact by using monthly data. The study finds that IRF shows oil shocks cause inflation. Generalized Impulse Response Function (GIRF) shows exchange rate is one of most important factor to fluctuate the oil prices and food prices. Kiani (2011) during 1990 to 2008 discussed the impact of higher oil prices on the Pakistan's economy. Pakistan is oil importing country not oil producing. An increase in oil price leads to inflation, increase budget deficit and puts downward pressure on exchange rate which makes imports more expensive. This study analyzes the positive change in real GDP as an effect of change in the price of crude oil and many other factors differently.

The above literatures have employed different methodologies to fulfill their different objectives. Some used panel data and some used time series data. Majority of the studies reveal that oil prices has positive impact on consumer price index.

4. METHODOLOGY

Nelson (1991) has developed the Exponential Generalized Autoregressive Conditional Heteroskedasticity (EGARCH) model. Braun, *et al.* (1995), Kroner and Ng (1996, 1998), Henry and Sherma (1999) and Engle and Cho (1999) have extended Exponential Generalized Autoregressive Conditional Heteroskedasticity (EGARCH) model in bivariate version. Nelson (1991) argues that market information affects the conditional variances and this affection varies from information to information and to capture asymmetric adjustment margins effect he set up an EGARCH model. Engle and Ng (1993) recommends a standard measure to how news information can be incorporated in to the volatility estimates. In order to better estimation and scantest news information impact curves to the data, a number of new candidates for modeling time fluctuating volatility are introduced and compared. These models permit numerous types of asymmetry in the effect of news information on volatility. Yoo (1987) and lee (1994) say that the error-correction term is a critical component to describe the conditional mean of the co-integration variables. EC-GARCH model contain the error-correction term in the GARCH model which proposed by Lee (1994). Empirical results in Enders and Granger (1998) conclude that the asymmetric ECM could describe the long run equilibrium relation. In this paper, we use the model extended with error correction term in the mean equation to establish the Bivariate EGARCH model. Further Engle and Granger (1987) two step method is used for the presence of

cointegrating relationship between the variables. As a first step we estimated the long run equation and then apply unit root test on the residual from the cointegrating equation.

The Engle-Granger two step method for consumer price index is

$$LCPI_t = \alpha + \beta LOP_t + \varepsilon_t \quad \text{.....} \quad \textbf{(4.1a)}$$

$$\Delta\varepsilon_t = \rho\varepsilon_{t-1} + \beta_1\Delta\varepsilon_{t-1} + \beta_2\Delta\varepsilon_{t-2} + \ldots + \beta_p\Delta\varepsilon_{t-p} + \mu_t \quad \text{...} \quad \textbf{(4.1b)}$$

Where $LCPI_t$ is log of consumer price index, LOP_t is log of oil price, ε_t is residual from cointegrating equation and μ_t is residual from the equation of unit root test which is supposed to be white noise.

The Bivariate EGARCH (*p, q*) model for the CPI is given in the following two equations.

$$\Delta lcpi_t = \alpha_0 + \sum_{i=1}^{p} \beta_i \Delta lcpi_{t-i} + \sum_{j=0}^{q} \beta_j \Delta lop_{t-j} + \sigma lop_{t-i}^2 + \gamma ecm_{t-1} + \varepsilon_t \quad \text{.....} \quad \textbf{(4.2a)}$$

$$l(\sigma cpi_t^2) = \alpha_0 + \delta_c l\, \sigma cpi_{t-1}^2 + \theta_c zlcpi_{t-1} + \beta_c\big(|zlcpi_{t-1}| - E(|zlcpi_{t-1}|)\big) + \sigma lop_{t-i}^2 +$$

$$\theta_p zlop_{t-1} + \beta_P\big(|zlop_{t-1}| - E(|zlop_{t-1}|)\big) \quad \text{... .....} \quad \textbf{(4.2b)}$$

Where i = 1, 2…p and j = 0, 1…q

The variables used in the above equations are as follows:

$\Delta lcpi$ = Log difference of consumer price Index

$l(\sigma cpi_t^2)$= Variance of log of consumer price index

Δlop = Log difference of oil prices

σlop^2 = Variance of log of oil prices

γecm = Error correction term

ε_t = Random variable $\varepsilon\, t|\Omega t\text{-}1 \sim N\,[0, (\sigma cpit)^2]$

The equation (4.2a) is conditional mean equation of log difference of consumer price index. That is dynamic error correction model. The random variable (i.e., εt) is supposed to have zero mean and conditional variance. Later the second equation of the model i.e., (4.2b) indicates the conditional variance of the log CPI. This equation depends upon the lagged value of innovation of log CPI and the log of oil prices, lag of conditional variance of log CPI and the terms to detect asymmetric effect. The parameter θ_c shows last period forecast variance and β_c indicates CPI news effects. While the parameters $\theta_p$and β_p shows the last period forecast variance and the asymmetric impact of oil price respectively in the conditional variance of

consumer price index. Further, the θ's permit asymmetry news impact from CPI. The estimated parameter of GARCH term that is δ_c shows persistence of volatility.

Data for this study is taken from the period of 1980-01 to 2014-12. The variables in this regard used are current oil prices and consumer price index of Pakistan. Oil prices (OP)-oil (petroleum) prices monthly data of Pakistan is taken from the monthly statistical bulletins of Pakistan. International financial statistics (IFS) can be used as a source for consumer price index. Here is the description of econometric techniques that we will use in this study for our findings.

It is important to test the time series before building a model, if there is a need to transform the data. As transformation ensure proper functional form of the model. Before the estimation of univariate and multivariate models, it is necessary to transform the dependent and independent variables. Power family of transformation is modified by **"**Box and Cox**"** in 1964.Further modify the box-cox transformation by using the Geometric mean in the transformation. So we applied Box-Cox transformation in this study by using following formula:

$$Y_t(\lambda) = (Y_t^{\lambda} - 1)/\lambda Y^{*\lambda-1} \text{ If } \lambda \neq 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \textbf{(4.3)}$$

$$Y_t(\lambda) = Y^{*} \ln Y_t \quad \text{if } \lambda = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \textbf{(4.4)}$$

$$L(\lambda) = -T/2(1+LN2\pi + LN\,RSS/T) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \textbf{(4.5)}$$

The maximum L (λ) value of λ will suggest the type of transformation of the series. Before estimation of Bivariate EGARCH model we have to check the stationary of the series. The test was developed by Beaulieu and Miron (1993) to test the seasonal and non-seasonal unit root (i.e. unit root at zero, biannual and annual frequency) in monthly time series. It extended to the Frances (1991) U.R Test by generating 12 series to detect the complex U.R separately. Beaulieu and Miron proposed the test of unit root in monthly data. The null hypothesis are

H_0: $\pi_1 = \pi_2 \ldots\ldots \pi_{12} = 0$ and H_1: At least one of them is not zero

To test the unit root in monthly series Beaulieu and Miron suggest estimation of the following equation.

$$\Delta_{12} Y_t = \alpha + \beta T + \sum_{k=2}^{12} \beta_k D_{tk} + \sum_{k=1}^{12} \pi_k Y_{t-i,k} + \epsilon_t \quad \ldots \quad \textbf{(4.8)}$$

We have estimated the equation with OLS. And test for the serial autocorrelation of the residuals. For this we have used LM test at 1st and 12th lag. If the residuals are not white noise then we added lags of dependent variable until the error terms of the series is whiten. Hypothesis

which is tested for this test varies between even and odd. First two coefficients .i.e. $\pi_1$and π_2 are tested individually using t-test and remaining are tested using F-test by applying the Wald Test. Roots in the monthly data are tested as follows.

- The zero frequency unit root ($\boldsymbol{\pi_1}$ = 0) and bi-annual frequency unit root ($\boldsymbol{\pi_6}$= 0) are tested using left sided t-statistics.
- While the complex roots are tested by using joint test (F-test).
- If all $\boldsymbol{\pi_i}$= 0, then we apply $(1-B^{12})$ filter.
- If $\boldsymbol{\pi_i} \neq 0$ data are stationary and use seasonal dummies.

In this study Engle and Granger Two- Step Method is used for cointegration. Engle and Granger (1987) offered the two step co-integration test also called as residual based test. But this test is not appropriate for more than two variables. This method is following as:

Step 1

While moving with the step 1 of Engle and Granger (1987) approach with regression of the variables, it is necessary to include variables expected to be co-integrated and have sustained shocks on the equilibrium. The variables that have sustained the shocks are termed as exogenous shocks and basically are included in the form of dummy variable. As a first step we will be estimated the long run equation and then apply unit root test on the residual from the co-integrating equation.

The Engle-Granger two-step method for consumer price index can be performed as:

$$Yt = \alpha + \beta Xt + \varepsilon t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \textbf{(4.9)}$$

$$\Delta\varepsilon_t = \rho\varepsilon_{t-1} + \beta_1\Delta\varepsilon_{t-1} + \beta_2\Delta\varepsilon_{t-2} + \ldots + \beta_p\Delta\varepsilon_{t-p} + \mu_t \quad \ldots\ldots\ldots\ldots \quad \textbf{(4.10)}$$

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

Where Y_t = ($LCPI_t$) is log of consumer price index and X_t= (LOP_t) is log of oil price. ε_t is residual from co-integrating equation and μ_t is residual from the equation of unit root test which is assumed to be white noise. After obtaining the residual, order of integration is tested using a unit root test based on the nature of data and it is to check that if variables are integrated of order 1 .i.e. they are stationary at 1st difference, residual should be level stationary. The obtained residual is then tested for the hypothesis .i.e. null hypothesis of no cointegration against the alternative hypothesis of cointegration present.

Step 2

After testing for order of integration, short run dynamics are tested by taking into account both Yt and Xt in the difference form along with the error correction term .i.e. lagged form of the residual.

$$\Delta Yt = \alpha + \beta 1 \Delta Xt + \beta 2 \varepsilon t-1 \quad \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \quad (4.11)$$

Where $\varepsilon t-1$ is $Yt-1$.

It is important to note in this case that variables in the two steps mentioned above are stationary. The univariate ARIMA model is used to filter series before going into deeper estimation techniques. To determine the order of ARIMA we use correlogram for first difference of LCPI and LOP series. EGARCH Model is presented by Nelson (1991). According to Nelson this model addressed with the asymmetric effect and relaxed the restriction of non-negativity and also captures the effect of news on volatility better than GARCH model. Braun, *et al.* (1995), Kroner and Ng (1996, 1998), Henry and Sherma (1999) and Engle and Cho (1999) have extended Exponential Generalized Autoregressive Conditional Heteroskedasticity (EGARCH) model in bivariate version. This model is estimated by the Maximum Likelihood Method offered by Bollerslev and Wooldridge (1992). The desired model fulfills the number of diagnostic tests. For example, Godfrey Lagrange Multiplier (LM) (1978) test is applied to test the null hypothesis of serial correlation in the residual term of error correction model. Further Engle's (1982) LM test is used to detect the autocorrelation conditional heteroscedasticity (ARCH) in the residuals to confirm that there is constant variance in the residual series. Test of normality Jarque Bera (JB) test is applied to check the normality of the residual of the model.

5. RESULTS AND DISCUSSION

First Box-Cox transformation is applied on all variables to check for what type of transformation of the series is required. This suggested log transformation is required for all three variables. After that to detect unit root we applied Beaulieu and Miron monthly seasonal unit root test. According to this test we test stationarity both for seasonal and non- seasonal using t-test for seasonal unit root detection, while Wald test for the existence of non-seasonal unit root. We found all variables of integrated of order (1) and become stationary at first difference.

Table-5.1 shows the result for unit root test using Bealieu and Miron seasonal unit root test. The model is with constant, seasonal dummy and trend. The numbers of observation after adjustments are 406 for monthly data. In order to check the critical values these observations should be in years i.e. 406/12=34≈ 30 because the π table considers yearly observations, $\alpha = 0.05$ and S=12 for monthly data. The result of the table-5.1above shows that all the hypothesis are rejected showing that there is no unit root present, but the problem lies with the 1st value of the test statistic LCPI and LOP are -2.16 and -2.56 respectively. This result indicate that in the case of $t: \pi_1$ calculated values are exceeding the tabulated value which is -3.32, so null

Table-5.1: Bealieu and Miron Seasonal Unit Root Test

Hypotheses	**LCPI**	$\Delta_{12}LCPI$	**LOP**	$\Delta_1 LOP$
$t: \pi_1 = 0$	**-2.16**	-3.83	**-2.56**	-6.06
$t: \pi_2 = 0$	-7.15	-6.72	-5.62	-5.56
$F: \pi_3 = \pi_4 = 0$	44.40	37.68	40.18	35.17
$F: \pi_5 = \pi_6 = 0$	37.76	32.14	39.27	34.58
$F: \pi_7 = \pi_8 = 0$	53.39	42.21	38.23	33.73
$F: \pi_9 = \pi_{10} = 0$	39.38	34.29	34.86	31.33
$F: \pi_{11} = \pi_{12} = 0$	26.79	25.78	40.42	35.18
LM-Test				
	0.8070	0.6339	0.5434	0.8972
	5.5044	0.2556	2.3545	1.0000
Specifications for Bealieu and Miron	C,d,t	C,d,t	C,d,t	C,d,t
$^*\pi_1 = -3.32$	$*\pi_2 = -2.79$	$*\pi_3, \pi_4$ 6.35	$*\pi_5, \pi_6$ 6.34 $*\pi_9, \pi_{10}$ 6.37	$*\pi_7, \pi_8$ 6.30 $^*\pi_{11}, \pi_{12}$ 6.31

hypothesis of unit root is said to be accepted and concluding that series are non-stationary at level. The filter required to make series stationary at zero frequency is $(1 - B)Y_t = Y_t - Y_{t-1}$.

After transforming the variables using first difference filter, all the variables .i.e. CPI and Oil Price are found to be stationary at first difference in the presence of intercept, seasonal dummy/dummies and trend are found to be significant. From the above table-5.1 shows that estimated value of $t: \pi_1$ of log difference of CPI and OP are less then tabulated or critical values. So null hypothesis of unit root is not accepted. Similarly in the case of seasonal unit root

as F-statistic calculated value is greater than critical or tabulated value, so null hypothesis of unit root in this case also stays rejected. Hence it is concluded here that all series are stationary at non-seasonal and seasonal unit roots.

Within this procedure after the application of Breusch Godfrey Serial Correlation LM test, at both level and difference form which are presented in Table-5.2 and Table-5.3 respectively, above show that at 1st and 12th lag chi-square calculated value is smaller as compare to that of tabulated value. So according to the decision rule of Breusch Godfrey-LM test do not reject the null hypothesis and concluded that there is no problem of autocorrelation at the 1st and 12th lag on level and difference Regressions. Hence residuals are said to be white noised in this regard.

5.1. Dynamic Analysis for Consumer Price Index and Oil Prices

The possibility of a long run relationship between consumer price index and oil price is examined by using Engle-Granger (1987) two step method. This step leads to conclude whether an error correction term have to contain in the EGARCH model or not. As a first step consumer price index is regressed on Oil prices. The results are presented below (t-statistics in parentheses).

$$LCPIt = 2.0114 + 0.0063\,\mathrm{T} + 0.0536LOPt \quad \ldots \quad \textbf{(5.1)}$$

(119.52) (118.15) (7.06)

R-squared 0.99 *F*-statistic 22825.61 *ADF* –1.097 (–3.81)

In the second step, we tested the existence of cointegration between the two variables is tested by using the Dickey Fuller test of unit root on the residual obtained from long run equation (5.1). The DF unit root is tested at level or without differencing the data set. The Engle-Granger's critical value at five percent level of significance is (-3.81). Thus the results show that presence of unit root in the residual series. In other words these two series are not cointegrated for the period under analysis. Which concludes that Bivariate EGARCH model will be estimated without error correction term in the conditional mean equations.

The serial correlation LM test is applied on the 1st lag and 12th lag compared χ^2calculated value with the $\chi^2_{(0.95,1)} = 3.8113\ and\ \chi^2_{(0.95,12)} = 21.02$ respectively. The calculated values came out to be 3.89 and 66.12 which is greater than 3.8113 and 21.02 respectively. So according to the decision rule of BG-LM test reject the null hypothesis and concluded that there is problem of autocorrelation or the error term is not white noised. To eliminate the problem of serial

correlation so Dickey Fuller test become Augmented Dickey Fuller test, otherwise it is Dickey Fuller test. The serial correlation LM test is applied on the 1st lag and 12th lag χ^2 calculated values are smaller as compare to tabulate values which are 0.3231 and 16.2062 respectively. So according to the decision rule of BG-LM test do not reject the null hypothesis and concluded that there is no problem of autocorrelation. Hence residuals are said to be white noised in this regard.

5.2. ARCH Analysis

The study has been used techniques of financial time series econometrics. First the time series properties of data is examined. Particularly financial data is skewed and leptokurtic in their behavior, which violate the assumption of normality.

Figure 5.1: Consumer Price Index

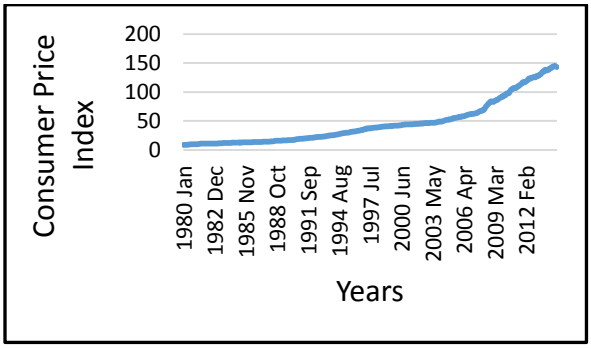


Figure 5.2: Current Oil Prices of Pakistan

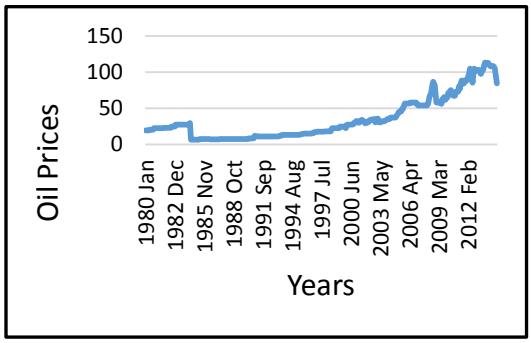


Figure 5.3: Volatility in Consumer Price Index

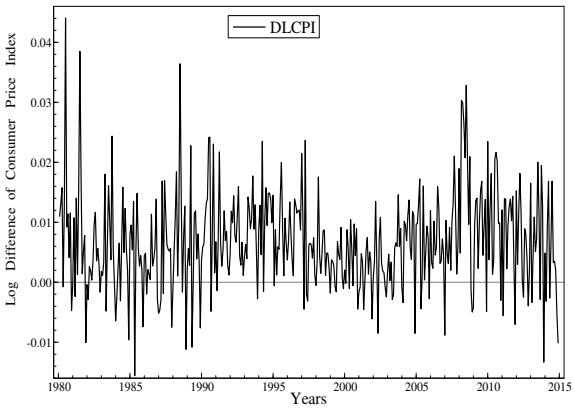
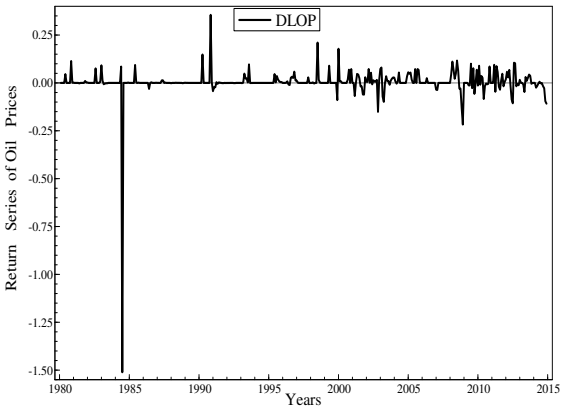


Figure 5.4: Volatility in Current Oil Price of Pakistan



n

Figure 5.5: Consumer Price Index Distribution

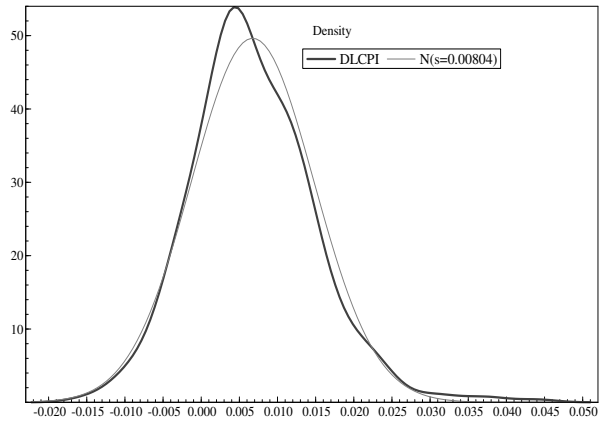
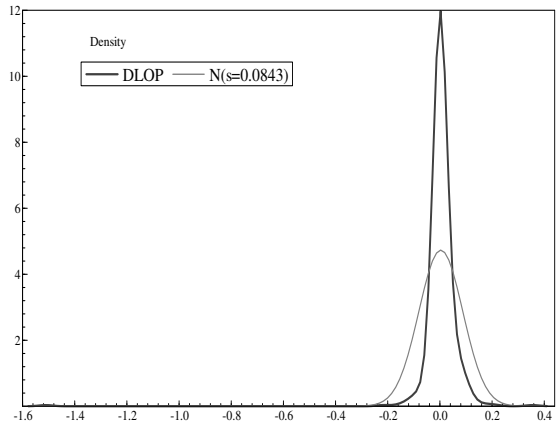


Figure 5.6: Ddistribution Return on Oil Price of Pakista



The above plots of actual series has drawn to observe the pattern of series and present in the Figures 5.1 and 5.2.These graphs show actual series of (CPI and OP), on monthly data. These graphs show that series are non-stationary because series are not fluctuate around the zero mean level. So graphs also show the problem of autocorrelation as well as of heteroscedasticity. All the graphs also show increasing trend of the data. So, our model become random walk model with drift and trend. Through figures 5.3 and 5.4 it can be noted that series are stationary because mean reversion behavior. But spread is not same. Volatility clustering is here which defines heteroscedasticity. There is prolonged period of low volatility and high volatility. In this regard we can say that periods of high volatility tend to be followed by periods of high volatility and periods of low volatility are followed by periods of low volatility. This suggest that, there is may be autocorrelation problem. So we call it ARCH effect. Because series conditionally depends on its lags.

Above figures 5.5 and 5.6 show that distribution is like leptokurtic. These show that probability of extreme values is higher than normal. So, these are left skewed except fig.5.5. It means that distinct players are active with different preferences in same market. The heavy tails show that the probability of extreme values are high. There is fluctuation in the data. Series are subject to leptokurtic.

5.2.4. Engle's ARCH Heteroscedasticity Test for CPI and OP

In order to examine the ARCH effect we estimated the regression by OLS and obtain residualsμ_t. Then we applied ARCH LM test on the estimated residuals. The estimated results are given as following;

$$\Delta lcpi_t = 0.0067 + 0.0047\ \Delta lop_t \qquad \ldots \textbf{(5.2)}$$
$$(17.09) \quad (1.03)$$

The absence of ARCH components is the null hypothesis, $\alpha_i = 0$ for all$i = 0,1, \ldots n$. The presence of ARCH components is alternative hypothesis, at least one of the estimated coefficients must be significant. The test statistic NR² follows χ^2 distribution with q degrees of freedom. Chi-square tabulated value is less than the estimated value of NR² then we reject the null hypothesis and conclude that there is an ARCH effect.

To determine the order of ARIMA we use correlogram for first difference of LCPI, LOP and LKSE series. These correlogram show the order of ARIMA for all of them. We used 20 lag lengths and 95 percent confidence interval for visual inspection. By visual inspection we have found that there is problem of autocorrelation in series. Because these correlogram are showing that many spikes lie outside its confidence interval except Dlop which are present in the following figures:

Figure 5.7: ACF of Dlcpi

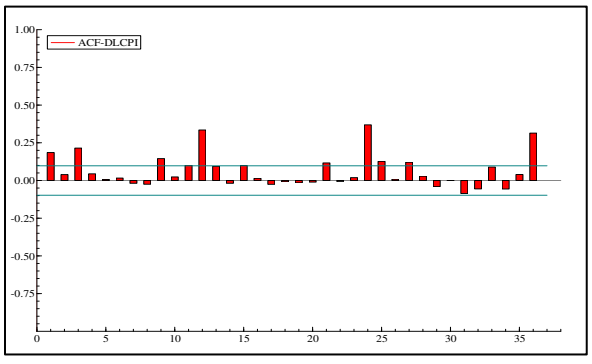


Figure 5.8: PACF of Dlcpi

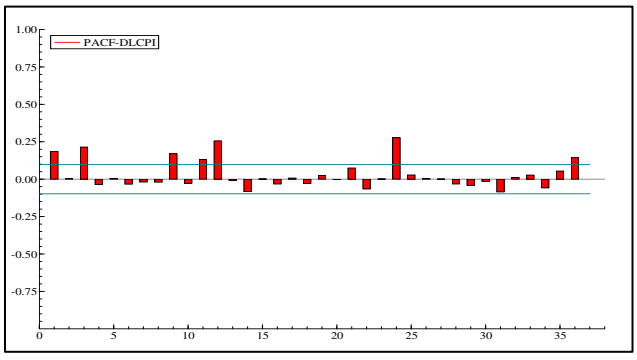


Figure 5.9: ACF of Dlop

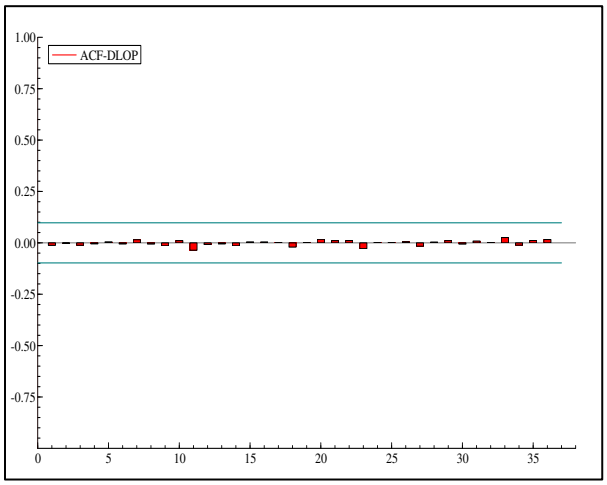
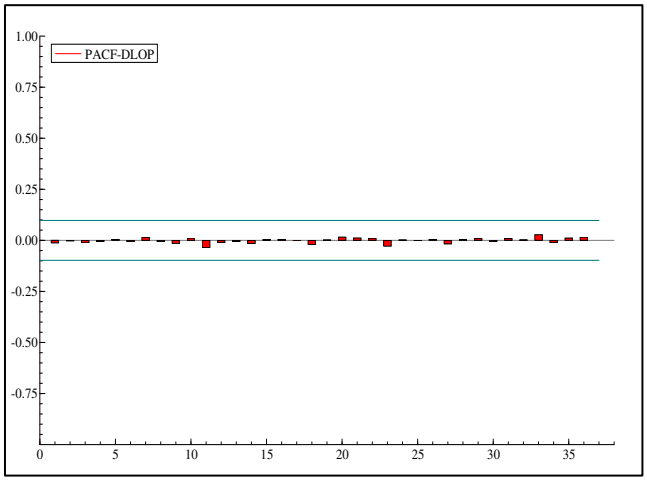


Figure 5.10: PACF of Dlop



5.3 The impact of oil price on CPI Bivariate E-GARCH model

This study applies ARIMA BIVARIATE EGARCH (1, 1) model to investigate the impact of oil price on CPI from the period 1980:M1 to 2014:M12. CPI and oil prices contain unit root at zero frequency and become stationary at first difference. This model is estimated by the Maximum Likelihood Method suggested by Bollerslev and Wooldridge (1992). The results are presented below (t-statistics in parentheses).

$$\Delta lcpi_t = 0.005579 - 0.157051\ \Delta lcpi_{t-3} - 0.188864\ \Delta lcpi_{t-9} + 0.117591\ \Delta lcpi_{t-21} + 0.805640\ \Delta lcpi_{t-24} +$$

(5.793327) (-4.902321) (-6.455485) (4.358341) (28.53231)

$$0.331864\ \varepsilon_{t-3} + 0.295653\ \varepsilon_{t-9} + 0.119514\ \varepsilon_{t-12} - 0.648628\ \varepsilon_{t-24} + 0.193792\ \varepsilon_{t-36} +$$

(9.383389) (9.094151) (3.298672) (-26.17582) (4.177933)

$$0.007995 \qquad \ldots \quad \textbf{(5.3a)}$$

(9.383389)

$$(\sigma cpi_t^2) = -3.035332 + 0.706777\ l\ \sigma cpi_t^2{}_{-1} + 0.265726\ zlcpi_{t-1} + 0.005656\ (|zlcpi_{t-1}| - E\ (|zlcpi_{t-1}|)) \quad \textbf{(5.3b)}$$

(-3.115820) (7.694081) (3.776709) (0.056121)

Diagnostic tests:

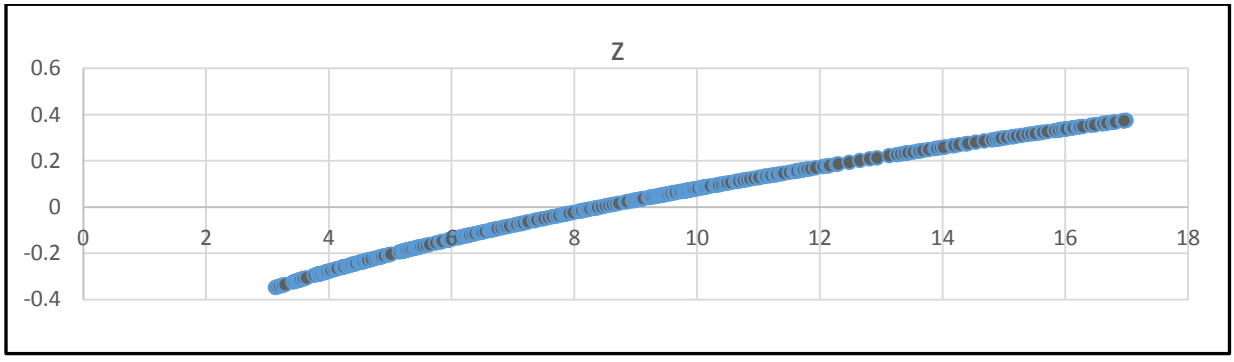
ARCH LM Test $\chi^2_{(1)} = 0.00016$ Autocorrelation Test Q-Statat $\chi^2_{(1)} = 0.0002$, $\chi^2_{(12)} = 6.7$

Test of Normality, Jarque-Bera $\chi^2_{(2)} = 4.3736$

All the diagnostic tests are satisfied the criterion at the 5% level of significance. Conclude that our ARIMA Bivariate EGARCH (1, 1) model has no serial correlation, no ARCH effect and with normal residual. All the estimators of the model are consistent and significant at the 5% level of significance. The equation (5.3a) is conditional mean equation of simple Bivariate EGARCH model. Which reveals that change in CPI is not only significantly influenced by its lag but change in oil prices also plays an important role in determining the consumer price index. We have found positive relationship between oil prices and CPI. It means CPI is positively affected by oil prices. Thus any increase in the change in oil prices, indicating increases the change in consumer price index.

The equation (5.3b) is conditional variance equation of simple Bivariate EGARCH model. The parameterθ_c, indicate asymmetric impact of news on the change in consumer price index. The size effect of news reinforce by negative innovation while it is partially effected by a positive innovation. In our case of Pakistan this have positive value and statistically significant. This entails that CPI volatility is more intensify with good news rather to bad one. The relative importance formula for positive and negative news was introduced by Yang and Doong (2004) i.e. $\left|-1+\theta_c\right| / (1+\theta_c)$. According to them it also measure the differential impact between current conditional variance and own innovation of market. This ratio for Pakistan is 0.58 in our analysis calculated by above formula. The positive shocks in CPI reveals onetime larger impact on its volatility as compare to negative shocks in it.

Figure 5.11: News impact curve of oil price on CPI



Above graph validates our estimated results of news impact of oil price on consumer price index. Generally for the persistent of volatility shocks is captured by sum of ARCH and GARCH

coefficients. It also validates in case of Pakistan that these shocks of CPI are very persistent in our case but they are vanished out overtime. It means that the current volatility is more dependent on past negative innovation than the positive innovation in past.

5.4. The impact of oil price volatility on CPI Bivariate E-GARCH model

ARIMA BIVARIATE EGARCH (1, 1) model is to investigate the impact of oil price volatility on CPI from the period 1980:M1 to 2014:M12. This model is estimated by the Maximum Likelihood Method offered by Bollerslev and Wooldridge (1992). The results are presented below (t-statistics in parentheses).

$\Delta lcpi_t = 0.0059 - 0.1616\Delta lcpi_{t-}3 - 0.2084\ \Delta lcpi_{t-}9 + 0.1101\ \Delta lcpi_{t-}21 + 0.7982\Delta lcpi_{t-}24$

(3.066573) (-5.243145) (-7.161018) (3.835241) (27.58169)

$+ 0.3486\ \varepsilon_{t-}3 + 0.3028\ \varepsilon_{t-}9 + 0.1222\ \varepsilon_{t-}12 - 0.6262\ \varepsilon_{t-}24 + 0.2189\ \varepsilon_{t-}36$

(10.36627) (8.507488) (3.096610) (-23.95942) (4.694830)

$- 0.0105\ \sigma lop_t^2 + 0.1937\ \sigma lop_{t-1}^2 + 0.0845\ \sigma lop_{t-2}^2 - 0.5184\sigma lop_{t-3}^2 - 0.0190\ \sigma lop_{t-4}^2$

(-0.769576) (20.08493) (9.628009) (-10.61527) (-7.860739)

$+ 0.1939\sigma lop_{t-5}^2 + 0.6716\sigma lop_{t-6}^2 - 0.7669\sigma lop_{t-7}^2 + 0.1718\sigma lop_{t-10}^2$ **....** **(5.4a)**

(13.99621) (130.0622) (-8.076880) (3.101305)

$(\sigma cpi_t^2) = -3.312940 + 0.686280l\ \sigma cpi_{t-1}^2 + 0.254676\ zlcpi_{t-1} + 0.075973\ (|zlcpi_{t-1}| - E\ (|zlcpi_{t-1}|))$ **(5.4b)**

(-2.772873) (6.114503) (3.370336) (0.634914)

Diagnostic tests:

ARCH LM Test $\chi^2_{(1)}$= (0.4694) Autocorrelation at Test $\chi^2_{(1)}$= (0.4739), $\chi^2_{(12)}$ = (8.030)

Test of Normality, Jarque Bera $\chi^2_{(2)}$ = (7.37)

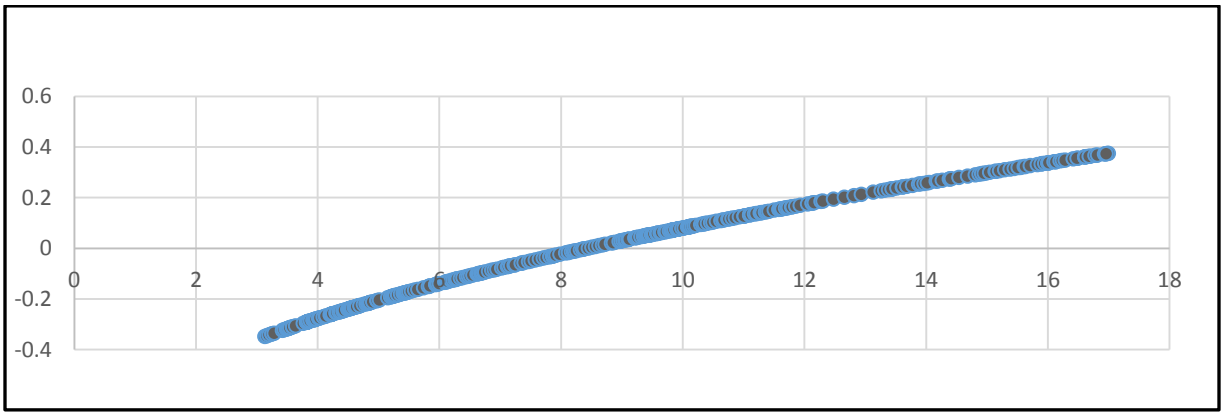
All the diagnostic tests are satisfied the criterion at the 5% level of significance except the Jarque Bera test. It conclude that our ARIMA Bivariate EGARCH (1, 1) model has no serial

correlation, no ARCH effect but with non-normal residual. But still all the estimators of the model are consistent and significant at the 5% level of significance

The equation (5.4a) is conditional mean equation of the impact of oil price volatility on change in CPI Bivariate EGARCH model. Which reveals that change in CPI is not only affected significantly by its lag but oil price volatility and its lags also play a significant role in determining the consumer price index. The nonnegative estimates of conditional variance validates exponential leverage effect rather quadratic.

The equation (5.4b) is conditional variance equation of oil price volatility Bivariate EGARCH model. News effect CPI asymmetrically that captures by parameter θ_c.The size effect of news reinforce by negative innovation while it is partially effected by a positive innovation. In our case of Pakistan this have positive value and statistically significant. This entails that CPI volatility is more intensify with good news rather to bad one. The relative importance formula for positive and negative news was introduced by Yang and Doong (2004) i.e $|-1+\theta_c|/(1+\theta_c)$. According to them it also measure the differential impact between current conditional variance and own innovation of market. This ratio for Pakistan is 0.6 in our analysis calculated by above formula. The positive shocks in CPI reveals onetime larger impact on its volatility as compare to negative shocks in it.

Figure 5.12: News impact curve of oil price volatility on CPI



Above graph validates our estimated results of news impact of oil price volatility on consumer price index. Generally for the persistent volatility of shocks is captured by sum of ARCH and GARCH coefficients. That is near to one which also validates in in case of Pakistan.

Although these shocks of CPI are persistent in our case but they are vanished out overtime. It means that the current volatility is more dependent on past negative innovation than the positive innovation in past.

6. CONCLUSION AND POLICY RECOMMENDATIONS

Since many years Pakistan is suffering from oil related problems. Because Pakistan is found to be the major dependent on oil and related products. That is why, it has to spend huge amount while importing it. According to this point of view, the impact of oil price and its volatility on CPI has been analyzed in this study. While some studies have conducted to examine the impact of energy prices specially oil prices on inflation and other macroeconomics variables but still there is no study has examined the impact of oil price volatility on CPI. In Pakistan, we can see that limited studies were done regarding to this topic. So there is a gap in literature that impact of oil price volatility on CPI in Pakistan has not studied and observed for said relationship. In this study we used the financial time series econometrics techniques. First applied the Box-Cox transformation on the data. Which suggested log transformation is required for all series. As data used will be monthly, Beaulieu and Miron (1992) seasonal unit root test is applied here to test stationarity of the data. All variables contain unit root at zero frequency and become stationary at first difference. Further to test for the presence of co-integration relationship between the variables we have estimated Engle and Granger (1987) two-step method. And finally Bivariate EGARCH model is used to investigate the impact of oil price volatility on CPI. EGARCH Model is presented by Nelson (1991). According to Nelson this model addressed with the asymmetric effect and relaxed the restriction of non-negativity and also captures the effect of news on volatility better than GARCH model. This model is estimated by using Maximum Likelihood Method proposed by Bollerslev and Woolridge (1992).

From the analysis finally it can be concluded that change in CPI is not only affected significantly by its lag but change in oil prices also plays a significant role in determining the consumer price index. And Oil price volatility and its lags also play a significant role. We have found positive relationship between oil prices and CPI. It means CPI is positively affected by oil prices. Thus any increase in the change in oil prices, indicating increases the change in consumer price index. We also found the asymmetric impact of news on the change in consumer price index. In our case of Pakistan it has positive value and statistically significant. This entails that CPI volatility is more intensify with good news rather to bad one. The positive shocks in CPI

reveals that onetime larger impact on its volatility as compare to negative shocks in it. Generally for the persistent volatility of shocks is captured by sum of ARCH and GARCH coefficients. That is near to one which also validates in case of Pakistan. Although these volatility shocks of CPI are very persistent in our case but they are vanished out overtime.

There are some main points which could be take into consideration from the policy perspective. These steps are based on the above discussion of results and testing for relationship between Oil Prices and CPI. According to this study, CPI is positively affected by oil prices. If oil prices are stable then CPI is also stable. Being an oil importing country, First government can get advantage by increasing their strategic oil reserves and protect themselves from the risk of supply shortage. Secondly, government would be made alternative fuels like Coal, natural gas and renewable energy. In order to minimize the oil price fluctuations which have an adverse impact on our national economy government would improve dialogue with oil exporting countries.

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