Oil Price Uncertainty, Exchange Rate Volatility and Inflation: Evidence from Pakistan

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CERTIFICATE

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In the Name of Almighty Allah who is the most Merciful, the most Beneficent

DEDICATED
TO
MY BELOVED PARENTS

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IBRAR ASIF

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Abstract

This study examines the relationship between oil prices uncertainty, exchange rate volatility and inflation by taking the monthly data from 1972-M6 to 2015-M12. At the first stage different GARCH-specifications have been applied on the return series of the oil prices and exchange rate. The results show positive and statistically significant impact of oil prices uncertainty on the exchange rate volatility by capturing the asymmetries in terms of negative and positive shocks. This positive impact suggests that the rising oil prices leads to the increase in exchange rate i.e., depreciation of the exchange rate and vice versa. In the next stage in order to test the time series properties the Beaulieu and Miron (1992) seasonal unit root has been applied. Oil prices and exchange rate are stationary at the first difference and inflation is stationary at level. Then, for the long-run and short-run co-integration relationship among the variables the ARDL technique has been applied. The results of the co-integration technique show the positive and statistically significant impact of oil prices on the consumer prices i.e., rising oil prices leads to increase in consumer prices and vice versa. On the other hand the exchange rate has positive and statistically insignificant impact on the consumer prices in long-run and short-run except at its second lag where the exchange rate has significant impact on the consumer prices. The positive impact of exchange rate on consumer prices implies that the rise in exchange rate i.e., depreciation of the exchange rate leads to rise in the consumer prices of the country and vice-versa. In the last stage the total effect of oil prices on consumer prices is decomposed into direct and indirect effects. Exchange rate is used as a mediator and for testing its mediating role the Sobel test is applied. The total effect of oil prices on consumer prices in the presence and absence of exchange rate is positive i.e., higher oil prices will cause higher consumer prices and vice-versa.

CHAPTER 1

INTRODUCTION

1.1. Introduction

Energy is considered to be one of the most important resources throughout the world history. The economic development of the countries accelerated their speed with industrialization since 1750 and at that time the locomotive power of industries was energy. Industrialization is considered as an important basis for overall material development and it took out many countries from poverty traps and brought high living standards in these countries by improving the human creativity. Industrialization is not possible without sufficient access to raw material, trained human capital and energy resources (most importantly oil). Therefore, the way of development or underdevelopment relies on energy resources where oil has a dominant position.

The impact of oil prices transfers to an economy through different transmission channels. First, the rising oil prices lead to increase in the energy costs and decrease in the usage of oil. As a result, lower productivity of labor and capital obstructs the output growth (Brown & Yücel, 1999; Abel and Bernanke, 2001). This is a classical supply side effect. Second, the rising oil prices lead to an income transfer from oil-importing economies to oil-exporting economies and consequently reduce the disposable income of oil-importing economies (Dohner, 1981). This is known as an income effect. Third, the oil price induced inflation decreases real balances and increases demand for money. In order to meet this growing demand if monetary authority does not increase the supply of money, interest rate rises and produces recession in the economy which is known as a real balance effect (Mork, 1994). Fourth, the oil prices uncertainty reduces the investment expenditures (Bernanke

1983, Hamilton 1988). It has been said that the rising oil prices uncertainty causes recessions during the periods of oil crisis (Pindyck and Rotemberg, 1983) because the firms usually delay their investment expenditures when the future oil prices are uncertain. This is known as an investment channel effect.

Fifth, oil prices shocks can also influence the unemployment by changing the production structure of the economy. Under rising oil prices firms usually try to adopt less oil intensive methods of production which lead to labor reallocations among different sectors. This unemployment channel affects the economy in the long-run (Loungani, 1986). Sixth, the oil prices shocks have a pass though impact on consumer prices (Fuhrer, 1995; Hooker, 2002) which can also severely affect the economy by a price wage loop (a vicious circle process in which wage increase causes price increase which in turn causes wage increase, possibly with no answer to which comes first). Seventh, oil-exporting economies may experience a negative relationship between prices of oil and exchange rate which implies that rising oil prices cause exchange rate appreciation and falling oil prices cause exchange rate depreciation (Golub 1983; Corden 1984). Whereas oil-importing economies may experience a positive relationship between prices of oil and exchange rate which implies that rising oil prices cause exchange rate depreciation (increase in exchange rate) and falling oil prices cause exchange rate appreciation i.e. fall in exchange rate (Chen and Chen, 2007). So oil prices can also transfer to an economy through an exchange rate channel.

Theoretically, the impact of hike in oil prices transmits to the economy of oil-importing country through decline in disposable income and rise in production cost which compresses aggregate supply and increases the prices of intermediate goods that eventually destroys profit level and overall competitiveness of domestic producers. The rise in prices of oil increases general prices level that destroys purchasing power of consumers and as a result the aggregate demand decreases in the economy which further reduces the aggregate output. In addition, the impact of change in oil prices on any economy also depends upon domestic oil production, size and status of an economy, internal situation and level of energy use mix of the economy. Likewise, the impact of oil prices in short-run and long-run is different because in the short-run prices of oil affect the production cost whereas in the long-run it influence every aspect of an economy i.e. cost and price, distribution and consumption, investment and trade etc.

As Pakistan is an oil-importing economy it always faces the burden when the oil prices increase because the total energy mix of the country consists of 29% of oil which is being used directly or indirectly in almost every walk of life (Pakistan Economic Survey 2012-13). Pakistan spends above 80% of her foreign exchange reserves and almost two times of her remittances on oil imports every year. It has been predicted that the Pakistan's dependence on oil for energy consumption will increase in future because there are neither short-run alternatives nor long-run planning to deal with the severe issues of energy crisis within the economy. This will probably not only affect the growth and development scenario but also influence the social and political issues of the country (Hasanat et al. 2013).

An important term the "oil price uncertainty" refers to the possibility that the prices of oil will remain unstable. The word uncertainty means the chance or speculation that the price will change. For example, a shortage of oil might produce uncertainty in the prices of oil. The major reasons of worldwide oil prices uncertainty are shocks in the aggregate demand and supply of oil. The changes in the precautionary demand for oil as a result of concerns about future oil supply also influence the prices. The prices of oil may also become more unpredictable particularly due to rise in oil demand from emerging economies and prevailing political problems in Middle East. A number of studies projected that the world oil demand will rise much more in future at the face of depleting oil resources (Kilian, 2009).

The oil prices have different transmission channels and also have widespread impact on the economy but the focus of the study is to find out the transmission channels of oil prices uncertainty on exchange rate volatility and consumer prices in Pakistan. As oil contracts are settled in US-dollar in the international market, so a rise or fall in the prices of oil can significantly affect the demand and supply of foreign exchange reserves. Crude oil price is among various important factors that affect the exchange rate movements of a currency as it is a non-renewable and naturally available energy resource that is being widely used in every field of economic activity and in making of almost everything like fabrics, rubber, plastic, aluminum and steel etc. That’s why a country having abundant oil resources is considered to have comparative advantage due to availability of this strategic resource of energy. The fluctuations in the crude oil prices determine the global economic performance and it can influence the world economy significantly. A hike in crude oil price increases the cost of production which leads to increase in the commodity prices and in this way put downward pressure on the demand side of the economy and vice versa. A rise in prices of crude oil not only affects demand side but also shifts income from oil-importing countries to oil-exporting countries which in turn influence the exchange rate. Whenever there is rise in oil prices, the oil-importing countries may experience exchange rate depreciation and vice versa (Krugman, 1983).

With the mounting level of international trade and capital movements, the exchange rate of a currency becomes one of the most important factors that determine the country's strength and relative economic health in the world market. Pakistan's exchange rate system has evolved gradually with the passage of time from fixed (pegged) exchange rate regime to presently managed floating exchange rate regime which is also called a dirty float. In the past, the Pakistani Rupee fluctuated persistently against the US-dollar in international market which has made the study of exchange rate volatility most essential (Goel and Rohit, 2015).

Pakistan is the sixth most populous country of the world and with this immense size of population country requires huge amount of oil to satisfy the needs of its people. This ever mounting demand increases the oil imports of Pakistan which lead to higher inflation rates in the country and it consequently decrease the competitive strength of Pakistani rupee against the US-dollar. In fact, only few countries are able to maintain the fixed price for crude oil and Pakistan's inability to maintain the fixed pricing policy affects the users of petroleum products severely. Among petroleum products the petrol and diesel are being used as the major fuels for transportation, Industrial and other purposes within the country. That is why the fluctuations in the prices of petrol and diesel have a downward impact on the economy of Pakistan. According to Economic Survey of Pakistan, 2013-14, the consumption of petroleum products in transportation and power sector was 47% and 43% respectively of total oil consumption and about 62.4% of the electricity produced in Pakistan was thermal. Thus, the Pakistan's economy is highly dependent on the petroleum products and also very vulnerable to the fluctuations in the crude oil prices. The domestic oil refineries also have low capacity which constraints the oil supply of the country and further contributes to the fluctuations of the petroleum product prices and brings inflation in the country (Saleem and Khalil, 2015).

Since 1974, dollar was linked officially with the oil and majority of the world oil trades were started to invoice, settle and deliver in US-dollar and even today the most of the oil trades are in US dollar (dollar per barrel). The fluctuation of the US-dollar exchange rate influences the stability of world by affecting the oil prices in the petroleum industry of the countries. It also influences the oil policies in different oil-exporting and oil-importing economies as well as the development and exploration of the world's oil. The depreciation of US-dollar increases inevitably the international oil prices and appreciation of US-dollar brings a drop in international oil prices (Yan, 2012). A paper presented by (Bal & Rath, 2015) found a significant two ways nonlinear Granger causality between the crude oil prices and exchange rate in China and India by using the Hiemstra and Jones (1994) non-linear Granger causality test to VAR residuals. In order to check the robustness, GARCH (1, 1) model was used by considering the persistence of variance equation. The same results consistently hold in India but in China there was only a unidirectional causality from exchange rate to oil prices. Nguyen and Seiichi (2007) stated that there was dual causality between real exchange rate and inflation in Vietnam before 1999 and also there was strong relationship between the same variables in other ASEAN economies (Singapore, China, Malaysia and Thailand). Noer et al. (2010) found that the depreciation of nominal exchange rate affected inflation and the inflation further promoted the depreciation of nominal exchange rate in Malaysia. Further, they also concluded the same results as Nguyen and Seiichi (2007). So as far as past studies are concerned there is evidence of dual causality between oil prices and exchange rate, and also there is an indication of dual causality between exchange rate and inflation in some countries.

There is a possibility that the prices of oil might influence consumer prices through exchange rate where exchange rate may be considered as a mediator. The three variables relate in a way that as major proportion of Pakistan's imports consists of oil so in order to pay huge amount of imported oil bills country needs dollars because the oil prices are denominated in US-dollar. It is the reason that the rising oil prices increases the demand for dollars and decreases demand for rupee in the foreign exchange market. A rise in the demand for US-dollars causes an appreciation of the dollar against the rupee and similarly a fall in the demand for Pakistani rupee causes a depreciation of rupee against the US-dollars. When the demand of a currency increases it appreciates that currency and vice versa (Krugman et. al, 2012). Due to depreciation of Pakistani rupee its exports become cheaper for foreigners and as a result the demand of local goods rises in the foreign market which also inflates the prices of local goods in domestic markets.

The rising import bills of Pakistan as a result of rise in oil prices also affect the economy by making imports greater than exports and consequently creating budget deficit in the economy. In order to cover the budget deficit and to meet the other expenditures of the country government imposes different types of direct and indirect taxes which lead to increase in the consumer prices and as a result exchange rate of rupee further loses its value and depreciates against the US-dollar.

The major sectors of an economy i.e. industrial, transport and power sector are heavily dependent on energy resources foremost to oil. So the impact of oil prices also transfers to the economy through these sectors. The rising oil prices increases different types of costs in these major sectors which in turn transfer the costs effect to the whole economy, consequently, it inflates the prices of almost everything. For example in the industrial sector the hike in the prices of oil increases the cost of production and the firms cut production and raise the prices of their products. This rise in the product prices decreases the demand of the economy and the firms have to further cut their production. This low production also affects the exports of the country and widens the exports imports gap and in order to cover this gap sometimes government prints new money which also brings higher consumer prices in the economy.

1.2. Objectives of the Study

The first objective of the study is to estimate the impact of oil prices uncertainty on the exchange rate volatility by applying different GARCH-specifications through the consideration of symmetrical, threshold and asymmetrical effects of price shocks. Also the persistence of volatility shocks is measured by using these GARCH models.

The second objective of the study is to analyze the long-run and short-run dynamics among the three variables of the study i.e. oil prices, exchange rate and consumer prices. To meet this objective ARDL co-integration technique is applied as our variables are of different order of integration.

The third objective of the study is to capture direct and indirect effects among oil prices, exchange rate and consumer prices. We have decomposed the total effect of oil prices into direct and indirect effects. The direct effect is between oil prices and consumer prices without considering the role of exchange rate and the indirect effect of oil prices on consumer prices is through exchange rate where exchange rate is performing the role of a mediator. For testing the role of mediator we have applied Sobel test.

1.3. Significance of the Study

This study explores the impact of oil prices uncertainty on the exchange rate volatility for Pakistan by capturing the ARCH effect and using the more sophisticated GARCH-specifications. We also measure the duration of persistence with the help of these specifications. The study also uses the Beaulieu and Miron seasonal unit root test for monthly time series data instead of ADF test to check the stationarity of the series. Further the direct and indirect effects of oil prices on consumer prices are also measured through which we come to know that how much oil prices contribute to consumer prices directly and how much indirectly under the influence of exchange rate. The results of the GARCH-specification and the direct and indirect effects will help policy makers to respond to an innovation in oil prices regarding exchange rate and consumer prices.

1.4. Plan of the Study

Chapter 1 is the introductory chapter while the remaining study consists of five chapters. Chapter 2 gives the literature review concerning the oil prices uncertainty, exchange rate volatility and CPI inflation. Chapter 3 provides information regarding status of petroleum sector in Pakistan and historical prospective of oil shocks. Chapter 4 describes the data and econometric methodology that has been used to achieve the objectives of the study. In chapter 5 the estimations and empirical results have been discussed. Finally, chapter 6 concludes the whole discussion in the light of findings of the study and offers some policy recommendations.

CHAPTER 2

LITERATURE REVIEW

The role of oil prices is very important as it is linked with many important economic variables of an economy. The focus of this study is on the nexus between oil prices, exchange rate and CPI inflation. A broad review of literature is available as in the past many researchers conducted different studies to analyze this relationship.

2.1. Literature related to Oil Prices and Exchange Rate

Shalmani et al. (2015) conducted a study to analyze the influence of crude oil prices on the exchange rate of Pakistani-rupee against the US-dollar by utilizing the simple linear regression method on the time series data from 1986-2010. The results of the study showed that the rise in crude oil prices increased the imports of crude oil which in turn raised the demand for dollars in the foreign exchange market of Pakistan, as a result, the Pakistani rupee depreciated against the US dollar. Ali et al. (2015) estimated the relationship between crude oil prices and exchange rate in South Africa by utilizing monthly data from 1960-2014. The results based on Engle-Granger showed the long-run co-integration relationship between the variables but based on TAR and MTAR models the findings were opposite that showed insignificant relationship between the variables with no co-integration and also speed of adjustment was symmetric.

Goel and Rohit (2015) studied the relationship between international oil prices and real exchange rate by taking monthly data of oil prices and nominal exchange rate of India from January 2001 to September 2013. The data had been analyzed by using regression technique, F-statistics and statistical formulae. The results showed that with the increase in prices of oil the Indian currency depreciated against the US-dollars in real terms which in turn increased nominal exchange rate of the country.

Fowowe (2014) explained the relationship between oil prices and exchange rate in South Africa by using GARCH autoregressive conditional jump intensity model of Chan and Maheu (2002). The study used the daily data from 2nd January, 2003 to 27th January, 2012. The results showed that the rising trend of oil prices depreciated the South African rand against the US-dollar.

Kaushik et al. (2014) studied the link between oil prices and real exchange rate of Indian rupee against the US-dollar by applying Johansen (1988) co-integration approach on the quarterly time series data from 1996-2012. A monetary based model of the exchange rate was developed that incorporated home and foreign country interest rates, real money balances, real GDP and the real prices of crude oil. The findings showed that the rising oil prices had depreciating impact on the Indian currency against the US-dollar in the long-run but problem was that the estimated results of error correction model showed no relationship between the variables as indicated by its statistically insignificant coefficient. Hidhayathulla and Rafee (2014) estimated the impact of oil prices on Indian-US exchange rates by utilizing multiple linear regression models on the time series data from 1972-73 to 2012-13. The results suggested that the import of crude oil had increased due to increase in future crude oil prices and as a result the demand for dollars increased in the foreign exchange market of India which depreciated the Indian rupee against the US-dollar.

Chen et al. (2013) analyzed the link between crude oil prices and exchange rates of Philippine by applying threshold auto regressive (TAR) and momentum autoregressive (MTAR) models on quarterly data form 1970-2011. The results of TAR model revealed that in the long-run both the variables are non stationary. However, the results of momentum autoregressive (MTAR) showed asymmetrical co-integration between the variables in the long-run. Dogan et al. (2012) examined the nexus between real oil prices and real exchange rate by employing co-integration technique with structural breaks tests by Kejriwal-Perron (2009) on the monthly data of Turkey from 2001-2011. The results showed that the oil prices movements influenced the real exchange rate of the country negatively.

Tuhran et al. (2012) selected the exchange rates of 13 emerging economies to examine the nexus between oil prices and exchange rates before and after the periods of financial crisis. The study utilized the VAR systems and Granger causality tests on the daily time series data from 03-01-2003 to 02-06-2010. The results showed that after the financial crisis the hike in oil prices depreciated the local currencies against the US-dollar. Basher et al. (2012) analyzed the link among crude oil prices, stock prices and dollar exchange rate by using structural VAR model on the data from 1988-2008. The results showed limited association among the variables in question. Ghosh (2011) analyzed the relationship between crude oil prices and Indian exchange rate by utilizing the GARCH and EGARCH models over a period of one year by using daily data from July 2007 to November 2008. The findings showed that Indian exchange rate depreciated against the US-dollar as a result of rise in oil prices and also the oil prices shocks had a permanent impact on the exchange rate volatility. Further, as the study was confined to one year data, so it only provided the short run relationship between the oil prices and Indian exchange rate.

Nazlioglu and Soytas (2011) estimated the link among crude oil prices, exchange rate and agricultural prices in Turkey by applying Toda Yamamoto causality and impulse response function on monthly data from 1994-2010. The results of the study showed that prices of agricultural products were not affected by the shocks in crude oil prices and exchange rates. Coleman et al. (2011) studied the relationship between real oil prices and real exchange rates for a group of African economies. The study employed Johansen and Juselius (1988, 1990) co-integration approach on the quarterly data from 1970:Q1 to 2004:Q4. The results of the study suggested that the real oil price shocks were among the major determinants of the real exchange rate movements.

Lizardo and Mollick (2010) used the US-dollar against the major international currencies and found the link between fluctuations in crude oil prices and the US-dollar exchange rates by taking data from 1970 to 2008. The study added crude oil prices to the monetary model of exchange rates and then utilized Johansen (1988, 1991) Trace and Maximum Eigen statistics for the long-run analysis. Their findings showed that hike in the oil prices depreciated the US-dollar in relation to the oil-exporting countries (Canada, Russia, and Mexico) in the long-run but in contrast the currency of the oil-importing countries e.g. Japan depreciated against the US-dollar in the same situation. Cifarelli and Paladino (2010) analyzed the link among crude oil prices, stock prices and US-dollar exchange rate by applying a trivariate GARCH-M model on the weekly data spans from 6 October 1992 to 24 June 2008. The results found negative association between crude oil prices and dollar exchange rate changes i.e., the rise in prices of oil brought appreciation of US dollar.

Mukhriz (2009) analyzed the impact of real oil prices and real interest rate differentials on the real exchange rates of five oil-importing economies (Pakistan, Côte d'Ivoire, Japan, South Africa, and Switzerland) and three oil-exporting economies (Denmark, Malaysia and Canada). The monthly panel data was utilized from 1980-2008. The results of the panel co-integration tests confirmed the existence of long-run relationship among all the variables only for oil-importing economies and also there was causality running from real oil prices to real exchange rate. Further by using pooled mean group estimator, the findings of the study showed that the real oil prices influenced the real exchange rates for the net oil-importing economies positively and significantly, implying that the rising oil prices brought the depreciation of real exchange rates**.**

Zhang and Reed (2008) documented the impact of crude oil prices on feed grain and pork prices by employing VARMA model, Granger causality and Johansen-Juselius technique. The monthly data of China had been used from January 2000 to October 2007. The results showed no influential impact of crude oil prices on Chinese feed grain and pork prices. Narayan et al. (2008) utilized the GARCH and Exponential GARCH models to analyze the relationship between oil prices and US-Fijian dollar nominal exchange rates for daily data from 2000-2006. The results found the appreciation of Fijian dollar as a result of rise in prices of oil. Huang and Guo (2007) utilized four dimensional structural VAR model to find out the impact of oil prices and three other macroeconomic shocks on the real exchange rate of China. The study used the monthly data from January 1990 to October 2005. The results showed that the real oil price shocks caused a little appreciation of the real exchange rate of oil-importing country China in the long-run and also the real shocks were dominant in determining the variations in the real exchange than the nominal shocks.

Chen and Chen (2007) examined the long-run relationship between real oil prices and exchange rates across G-7 economies by using monthly data from 1972-2005. The study used Johansen technique for co-integration and investigated the results from Trace and Max-Eigen values. The findings showed that the real oil prices not only influenced the exchange rates in the long-run but also forecasted the future value of exchange rates. Benassy-Quere et al. (2007) analyzed the impact of oil prices on the real effective exchange rate of US-dollar for the time frame of 1974-2004. The study carried out the Trace test proposed by Johansen and Juselius (1988, 1990) and found that 10% hike in oil prices appreciated the US-dollar approximately 4.3% in the long-run. Rautava (2004) analyzed the relationship between crude oil prices and real exchange rate for Russian economy by utilizing vector auto regression (VAR) methodology and co-integration technique. The study used the quarterly data set covering the period from from 1995:Q1 to 2001:Q3. The results of the study indicated that increase in crude oil prices depreciated Russian ruble in the long-run.

Akram (2004) documented a negative link between the prices of oil and Norway's exchange rate but being an oil-exporting country the study results seemed to be implausible. Amano and Norden (1998) analyzed the link between crude oil prices and real effective exchange rate of US-dollar (focusing on post Bretton Woods period) by applying co-integration technique and ECM model on the monthly data from 1972-1995. Their results showed that the crude oil prices were the most important source of the persistent shocks in the US-dollar exchange rate. Blomberg and Harris (1995) explained the link between oil prices and exchange rate by implying one price law for all tradable goods. Their study suggested, "As oil is homogenous, world tradable commodity and also oil prices are expressed in terms of US dollars so the depreciation of the dollar enhances the purchasing power of foreigners, as a result, the demand for crude oil increases which in turn raises the oil prices".

Throop (1993) analyzed the factors affecting the exchange rate movements among US-dollar and the other major currencies in post 1973 flexible exchange rate system. The results of the Johansen co-integration technique concluded that the change in real oil prices, government budget deficit and productivity growth were the most important factors affecting the stability of exchange rate. Krugman (1980) analyzed the impact of crude oil prices on the US-dollars and found that the increase in oil prices affected US-dollars differently in the short-run and long-run i.e., hike in oil prices appreciated the dollars in short-run and depreciated in long-run.

2.2. Literature related to Oil Prices and Inflation

Saleem and Khalil (2015) examined the impact of crude oil prices on inflation and also investigated the other determinants of inflation besides oil prices. They utilized the Johansen co-integration procedure for the long-run and short-run analysis of the time series data of Pakistan from 1979 to 2012. The results concluded that the hike in real GDP reduced inflation and the hike in crude oil price, interest rate, money supply, exchange rate and indirect taxes accelerated inflation in the economy. Rafee and Hidhayathulla (2015) analyzed the nexus between international crude oil prices and inflation in India by using monthly time series data from 2011 to 2014. The correlation matrix and regression did not find the perfect association between the two variables and also the results of Granger Causality test confirmed no influence of rise in prices of crude oil on the CPI inflation.

Mansor and Kanokwan (2014) analyzed the link between crude oil prices and other price indexes in Thailand by adopting both the symmetric and asymmetric approaches of co-integration. The findings showed that the crude oil prices had more severe impact on energy, transportation, communication and non-raw food prices inflation. This suggested that the oil price inflation affected the price indexes of some commodities more than the others depending upon the type of the commodity. Hasanat et al. (2013) analyzed the long run co-integration relationship of oil prices and oil prices fluctuations with inflation, export and GDP of Pakistan by employing ARDL bound test and taking data from 1990 to 2010. The results showed that when GDP was considered as a dependent variable there existed co-integration relationship among the variables and when inflation was considered as a dependent variable then the long run co-integrating relationship existed only when independent variable was oil price fluctuation instead of oil price. The estimated results of the VECM and augmented granger causality technique confirmed the causality from oil prices and oil prices fluctuations to inflation and GDP along with other variables and also individually in Pakistan. On the other hand there was causality from oil prices and oil prices fluctuations to export and vice versa. Finally study concluded that oil price fluctuations rapidly and asymmetrically affected the macro economy of Pakistan.

Atif et.al (2012) used the multiple linear regressions to examine the impact of high speed diesel oil prices on the food sector prices (i.e. wheat, rice, chicken, maize and cooking oil) in Pakistan by utilizing the time series data from 2001-2010. The results concluded that the high speed diesel oil prices affected the food inflation positively and significantly in Pakistan. Benjamin Wong (2012) studied the different oil prices shocks and their impact on the inflation and inflation expectations in the US since 1970's. The findings of the study showed that the demand side oil shocks were more important than those of supply side oil shocks in explaining the inflation dynamics and movements and inflation expectations. Further the exogenous political proceedings also induced more inflationary oil shocks.

Shaari et al. (2012) analyzed the impact of crude oil prices shocks on inflation by utilizing VAR-VECM and Granger causality model on the monthly data of Malaysia from 2005-2011. The empirical findings of the study showed the existence of co-integration between the variables in long-run but in short-run only the crude oil prices influenced the inflation of Malaysia. The results of the Granger causality showed the indication of two ways causality from inflation to oil prices and form oil prices to inflation. On the other hand results showed no causality form inflation and oil prices to exchange rate and also the exchange rate did not granger cause to both of the variables. Sanchez (2011) studied six developing oil-importing economies (Kenya, Tanzania, Bangladesh, Nicaragua, El Salvador, and Thailand) by using computable general equilibrium (CGE) model and found the welfare impact of increase in oil prices during 1990-2008. The findings of the study showed that the oil prices had significant negative impact on GDP and positive impact on the inflation of these developing economies.

Arinze (2011) used the consumer price index (CPI) to see the impact of petrol prices on inflation in Nigeria by utilizing the simple regression analysis and covering the data from 1978-2007. The findings showed the positive relationship between the petrol prices and the inflation i.e., higher the petrol prices the higher will be the consumer price index (inflation) and vice-versa. Chou and Tseng (2011) estimated oil prices pass through impact on inflation by employing ARDL technique with the augmented Philips curve on the monthly data of Taiwan from 1982M1-2010M12. The results showed the significant impact of global oil prices on inflation in long-run but in short-run the impact was not significant. Greenidge and DaCosta (2009) conducted their study on the factors influencing the inflation of Caribbean countries (Jamaica, Tobago, Barbados, Guyana and Trinidad) by utilizing an unrestricted ECM and Pesaran et al.'s (2001) bounds test for a co-integration relationship over the period from 1970 to 2006. The results concluded that the oil prices influenced the inflation level of these countries significantly both in the short-run and long-run.

Cavallo (2008) investigated the impact of rise in oil prices on core inflation for four countries; U.S., U.K., euro area and Canada over the last decade. The results of the two simple variants of the Phillips curve model found that the rising oil prices affected core inflation of the euro area positively and significantly but there was no significant impact of rise in oil prices on core inflation of other three countries. Ito (2008) analyzed the impact of oil prices and monetary shocks on Russian economy by utilizing the VEC model and covering the time period from 1997:Q1-2007:Q4. The results found that 1% hike in oil prices increased the real GDP and inflation by 0.25% and 0.36% respectively. In addition the real GDP growth and inflation were also influenced by the interest rate. Baffes (2007) studied the impact of crude oil price changes on the prices of 35 internationally traded primary commodities by covering the annual data from 1960 to 2005. The results of the simple econometric model (OLS regression) showed that the crude oil prices pass through into the total non-energy commodity index was 0.16. The prices of food group and precious metals also had a strong relationship with the changes in crude oil prices.

Olivier and Jordi (2007) analyzed that the shocks in the oil prices had increased the CPI inflation during financial crisis and the changes in the oil prices pass through into the energy component of CPI was about 60% of the total fluctuations in CPI inflation (Mun, 2008). Philip and Akintoye (2006) analyzed the impact of oil prices shocks on the macroeconomic activity in Nigeria by employing VAR methodology and taking the data from 1970-2003. The findings showed that the oil prices shocks had insignificant impact on inflation and output and significant impact on the exchange rate. Cologni and Manera (2005) analyzed the impact of oil prices on inflation and output growth in G-7 economies by employing structural co-integrated VAR model on the quarterly data from 1980:Q1 to 2003:Q4. The findings of the study showed that the higher oil prices caused higher inflation and lower output growth in the majority of these economies. As a result the countries increased their interest rates to overcome the problem of inflation.

LeBlanc and Chin (2004) examined the impact of changes in oil prices on the inflation of oil-importing countries (U.S., U.K., Japan, France, and Germany) by utilizing the estimates of Augmented Philips Curve and associated statistics. The study used the quarterly time series data from 1980:Q1 to 2001:Q4. The results showed that the current increase in oil prices had only a minor impact on inflation of these countries. When oil prices increased by 10% it would lead to increase in inflation about 0.1% to 0.8% in the U.S and E.U. but the impact of oil prices on inflation was larger in Europe as compared to United States. Bhattacharya and Bhattacharya (2001) investigated the transmission mechanism of rising petroleum prices on the prices of other commodities and output in India by utilizing a four equation VAR model. The study used monthly data from April 1994 to December 2000. The empirical result of the paper showed two ways causality between the oil inflation and prices of commodities inflation in the country.

IMF (2000) studied the impact of oil prices on the GDP and inflation of different countries. The study showed that a rise in oil prices lowered the GDP of India and Pakistan by 0.1% and 0.4% in first and second rounds respectively. Similarly, the inflation caused by rise in oil prices in Pakistan and India were 0.4% and 1.3% respectively. Brown and Yucel (1999) analyzed the impact of oil prices on U.S aggregate economic activity by using the VAR model on the monthly data from January 1965 to December 1997. Their results showed that the rising oil prices shocks reduced the real GDP and raised the inflation and policy rate both in long-run and short-run.

As mentioned above, oil prices have extensive impact, so this research focuses on the impact of crude oil prices on exchange rate and inflation in Pakistan.

2.3. Contribution of the Study/Literature Gap

The impact of changes in crude oil prices on exchange rate volatility depends on the country's nature whether the country is an exporter or importer of oil. We have contributed to the literature by taking an oil-importing country Pakistan and adopting different GARCH-specifications through the consideration of symmetrical, threshold and asymmetrical effects. We have evaluated the empirical relationship between oil prices uncertainty and exchange rate volatility by utilizing these GARCH-specifications and also contributed to the literature by measuring the persistence of volatility of these variables for Pakistan. The results of this research will assist policy makers to react against different changes in oil prices. Further we have contributed to the literature in terms of direct and indirect effects of oil prices on consumer prices. The direct and indirect effects between oil prices and consumer prices are measured jointly under the mediating role of exchange rate. We checked the possible role of exchange rate as a mediator between oil prices and consumer prices by applying sobel test.

CHAPTER 3

STATUS OF PETROLEUM SECTOR AND HISTORICAL PERSPECTIVE

3.1. Introduction

This chapter discusses the status of petroleum sector in Pakistan which includes the detail about its oil reserves, national and international oil companies and its oil refineries. Also the chapter discusses the historical perspective of oil shocks by giving the details about different oil shocks.

3.2. Status of Petroleum Sector in Pakistan

Pakistan's economy is growing continuously which demands higher energy consumption and as a result putting high pressure on the limited energy resources of the country. The three primary energy resources of the country are oil, Natural gas and hydro that are being used to fulfill the energy demands of the country. The economy of Pakistan largely relies on oil and gas resources for its energy requirements. However, the country's energy reserves are insufficient to meet the energy demands of growing economy. Also due to political nature of the hydro energy Pakistan has to import oil and oil based products from the Middle East particularly from Saudi Arabia. The local and international companies are involved in oil sector and Pakistan's government is trying to make such policies that can attract foreign investors in this sector. But the unsteady political situation and the high degree of uncertainty create risk for the foreign investors.

According to Oil and Gas Journal (OGJ), the major oil reserves of the Pakistan are located in the southern half of country. The three major oil producing fields are located in Southern Indus Basin and additional producing fields of oil are located in the Middle and Upper Indus Basins [EIA, 2006]. In 1866, first oil well was discovered in the upper region of Indus valley at Kundal and in the subsequent years shallow wells were drilled. In 1886, a small scale oil production was initiated in Khattan (Balochistan). In 1915, the first sequence of commercial oil was discovered in Potwar basin (Punjab). In 1960's, Pakistan's government established Oil and Gas Development Company Limited (OGDCL) that discovered major reserves of oil and gas within the country. After 1973 oil crisis, the private sector and OGDCL made impressive discoveries of oil in Pakistan.

In June 2006, initial recoverable gas reserves were anticipated at 52 trillion cubic feet out of which 33 trillion cubic feet remained to be produced. On the other hand, initial recoverable oil reserves were only 844 million bbl with a remaining balance of 309 million bbl [EIA, 2006]. Since the late 1980s, the oil production was quite flat at about 60,000 barrels per/day with an average of 58,000 barrels per/day throughout the first eleven months of 2006. Due to very low oil production, the Pakistan's economy is heavily dependent on the oil imports to meet its domestic oil demand. In November 2006, the economy consumed about 350 thousand oil barrels and different petroleum products, among that, above 80% were imported oil [EIA-2006, World Bank Report]. Transport sector was the largest consumer that consumed about 48% of the petroleum products and after that the energy, industrial and residential sectors consumed about 36%, 12% and 4% respectively (Pakistan energy year book, 2006-07).

In 1977, ministry of petroleum and natural resources was formed to organize and regulate the oil sector of the country. The most important role of the ministry is to offer oil discounts by open tendering system and private negotiations. As well as ministry offers different royalties payment and tax incentives to oil companies functioning in the economy in order to boost and encourage the oil sector. The most important national oil companies currently working in the country are Oil and Gas Development Company Limited (OGDCL), Pakistan Petroleum Limited (PPL), Pakistan Oilfields Limited (POL), Mari Petroleum Company Limited (MPCL) and Pakistan State Oil (PSO).

The national companies have joint ventures and partnerships with some domestic firms and various international companies. The major international oil companies currently working in Pakistan are BP [“British Petroleum” (UK)], ENI ["Ente Nazionale Idrocarburi"(Italy)], OMV [“Österreichische Mineralölverwaltung” (Austria)] and Orient petroleum (Canada). In addition, there is shortage of domestic oil refineries in Pakistan due to which the demand for refined petroleum products becomes greater than the oil refining capacity of the country. It is the reason that the major proportions of country’s oil imports are refined products. The major oil refineries working in Pakistan are Pak Arab Refinery Limited (PARCO), National Refinery Limited (NRL), Attock Refinery Limited (ARL), Byco Petroleum Pakistan Limited previously known as Bosicor Pakistan Limited (BPL) and Pakistan Refinery Limited (PRL).

The impact of oil prices is more severe for developing countries because there is inefficient use of energy in these countries and also the alternative energy resources are limited. The use of oil in net oil-importing developing economies is much more than those of developed economies. The developing economies are less able to manage the financial crisis created by higher oil import prices [International Energy Agency (IEA, 2004)]. Pakistan’s government mostly shifts the burden of rising oil prices on the consumers because government has to manage other severe losses running within the country. In Pakistan, Oil and Gas Regulatory Authority (OGRA) usually gives the justification of rise in oil prices on various grounds (Adiqa, 2011).

3.3. Historical Perspective of Oil Shocks

In the past, oil prices were steady at around $3/barrel from 1948 to 1970. The main development in the history of oil was the OPEC formation in 1960 by Iran, Iraq, Kuwait, Saudi Arabia and Venezuela. The five most important oil price shocks were occurred in the world history. The first three oil shocks were supply driven because they influenced market supply mechanisms and to some extent the psychological factors were also the reasons of these oil price shocks. On the other hand the "new oil crisis" since 2003-2008 would be different from the previous oil crisis because they were mainly demand driven particularly from India and China. The demand of these two countries had increased significantly and thus contributed much to the oil crises.

3.3.1. 1973-1996: The Age of OPEC

The 1st oil price shock was occurred due to Yom Kippur War that became the reason of OPEC Oil Embargo in 1973. The oil prices had risen four times from $3 in 1972 to $12 in 1974. During the Yom Kippur War the Egypt and Syria attacked on Israel on October 6, 1973 and at that time the US some of the Western countries supported Israel. On October 17, out of anger the Arab nations imposed an oil-embargo on these countries by decreasing oil production by 5 million barrels/day. In this way the US control on the prices of oil shifted to OPEC nations during "Arab Oil Embargo". OPEC countries decided to decrease the oil supply until the territory occupied by Israel was "free" and the rights of Palestinian people were "re-established". The "Gulf Six" (Iraq, Iran, Qatar, Abu-Dhabi, Saudi Arabia and Kuwait) increased the prices of Saudi Light Blend by 17 % from $3.12 to $3.65 per barrel and also cut their oil production. As the industrialized Western world heavily dependent on oil so the OPEC ministers decided to use oil supply as a "weapon" and to exert pressure against “unfriendly states” by increasing oil prices, decreasing exports and imposing embargoes.

Saudi Arabia, Libya and some other Arab countries firstly embargoed United States on October 19, due to its political and military support for Israel. After that Netherlands was embargoed because this country provided the air force facilities to the US for the supply flights to Israel. On November 5, Arab Oil Ministers announced a cut in oil production which was 25% below than the September level. The oil-embargo was further extended to Rhodesia, Portugal and South Africa. In December 1973, after the meeting of OPEC Gulf six the next significant increase in oil prices was decided from $5.12 per barrel to $11.65 per barrel. The overall cut in oil production was about 7% during the first oil price shock of 1973 and there was significant increase in oil prices from $2.59 per barrel in 1973 to $13.06 per barrel in June 1974 indicating more than 500% increase in oil prices within just seven months. This price level remained steady at a level ranging from 13 to15 US-dollars per barrel until 1979.

2nd oil price shock was occurred due to the Iranian revolution and the war with neighboring Iraq. The Iranian Islamic Revolution in January 1979 decreased the Iran’s oil production rapidly to 2.5 million barrels per day. The oil price increased up to 30$ which was below 15$ in December 1978. This 100% increase in oil price was caused by the major disruption in oil supply. The labor strikes and overall political situation nearly stopped the oil supply from Iran at the end of 1978. There was 15% fall in overall oil production of Arab oil exporting countries from September 1978 to January 1979 and in this way the world suffered a 5% cut in oil production. In September 1980, the neighboring country Iraq attacked on Iran which further worsened the situation. The joint oil production of both countries (Iran and Iraq) reached to just one million barrels/day as compared to 6.5 million barrels/day in 1978. This reduced the world oil production by 10% and the prices of oil reached to $35/barrel in 1980.

The main reason for this attack was struggle for dominance in the region between two oil rich countries. The Iran-Iraq war influenced the oil supply of both the countries and the overall oil supply of Arab oil exporting countries dropped in September 1980 by 35% as compared to last year and the world suffered a 12% cut in oil production over the same period. The oil price rose to the highest level of $39/barrel in February 1981which was 160% more than the prices before the Iranian revolution. The oil crises of 1970s had decreased the economic activities across industrial nations. This resulted in oil conservation and overproduction and as a result there was rapid decrease in consumption and prices of crude oil. The US decreased oil imports from 46.5 percent in 1977 to just 28% in 1983. The prices of oil that had risen to $35 in 1980 dropped to just $10 within six years.

3rd oil price shock was started due to the occupation of Kuwait and the First Persian Gulf War. On August 2, 1990, the Iraq attacked on Kuwait, the markets responded with fear that the oil supply from Kuwait or Iraq could be vulnerable and as a result the oil shortage would be occurred. The USA announced that it would not endure this war in Gulf-region impacted upon oil prices. Due to war between Iraq and Kuwait more than 60% of global oil reserves started to concentrate in the region. The war further influenced the Iraq’s neighboring country Saudi Arabia holding more than 20% of the world oil reserves. The war caused 100% increase in oil prices from $16.54/barrel in July 1990 to $32.88/barrel in October 1990 just within two months. In August 1990, the oil supply from the Arab countries dropped by 25% mainly due to the failure of Kuwait as an oil supplier and also due to trade embargo against the Iraq.

During this period the monthly oil consumption in the US seemed to be unaffected and also the oil consumption in European OECD countries decreased only to a little extent until September.

In the meantime, a UN-coalition, leading by United-States organized a key military operation against Iraq to free Kuwait and to restore the state. The military operation named "Desert Storm" started in January 1991 and with the devastating firepower and technological dominance, the US led alliance forces restored the situation by defeating the Iraqi military forces. The war finished on February 28, 1991 and the prices of oil had decreased rapidly to pre war level. The price of oil became $18.32 per barrel in April 1991 which was only slightly above than the pre-war level of $16.54 per barrel.

3.3.2. 1997-2010: A New Industrial Age

The 4th oil shock of 1999-2000 and the final oil price shock of 2003-2008 were radically different from the previous three oil shocks. Crude oil prices that had decreased during the transitory Asian financial crisis of 1997 started to increase again in 1999 due to the OPEC target reductions and tightening stocks. The Asian financial crises were short lived as the world returned to growth and new industrialization process that had increased the petroleum demand worldwide. At the end of the 1999, the oil prices rose to the same level as before the financial crisis of 1997. The price of West Texas Intermediate (WTI) continued to increase up to a level of additional 38% within one year from November 1999 to November 2000, later on, it dropped again due to global economic downturn in 2001 and 2002 (Hamilton, 2011).

The Venezuela strikes eliminated oil production up to 2.1 million barrels/day from Venezuela in December, 2002 and January, 2003. Soon after this the U.S. attacked on Iraq (second Persian Gulf War) which also eliminated further 2.2 million barrels/day from April to July. These both the crisis would be characterized as exogenous geopolitical events and Kilian (2008) argued that both the supply driven oil shocks should be incorporated in list of post-war oil shocks. However, these supply shocks influenced only a smaller proportion of the worldwide oil supply and also the obstruction in oil supply had only a little apparent impact on global oil supplies. In 2004 to 2005, the world economic growth was remarkable and also according to an estimate of IMF the overall real world product grew by an average annual rate of 4.7%. The world oil demand grew 5 million barrels/day over this period, or 3% per year. These strong demand pressures were the main reasons for the rise in oil prices during this period.

Although, there was originally sufficient excess capacity to retrain production growing along with this demand but that capacity was not utilized thoroughly and even that the oil production didn’t continue to grow after 2005. In contrast to several others past oil shocks, there were no dramatic geopolitical events linked with this shock. The continuing unsteadiness in Iraq and Nigeria was a contributing factor and also many oil fields that had sustained previous oil production got maturity with comparatively rapid declining rates. The production of the North-Sea that contained 8% of world production in 2001 had decreased to an additional 2 million barrels/day at the end of 2007. The world’s second largest producing field, Mexico’s Cantarell, oil production declined by 1 million barrels/day from 2005 to 2008. The Indonesia, original member of OPEC, oil production was at peak level in 1998 but it later on became an oil importer rather than an oil exporter (Hamilton, 2011).

On the other hand, the demand for oil had a continual growth with world real GDP growing by an additional 5% per year from 2006 to 2007, at a faster rate of economic growth together with 5 million barrels/day improved oil consumption from

2003 to 2005. The China alone had increased its oil consumption by 840,000 barrels/day from 2005 to 2007 at the face of no more oil being produced. As a result the other countries had to reduce their oil consumption in spite of powerfully growing incomes. A huge shift in the oil demand at the face of an inadequate enhancement in oil supply had increased the oil prices from 55$/barrel in 2005 to 142$/barrel in 2008 (Hamilton, 2009).

CHAPTER 4

DATA AND METHODOLOGY

4.1. Introduction

In this chapter, the section 4.2 discusses the data sources and its time span. The monthly data has been used in this study for the period from 1972-M6 to 2015-M12. Section 4.3 gives the detail about some key descriptive statistics and also the correlation among variables of the study. The next section 4.4 deals with the different methodological frameworks i.e., GARCH models, ARDL and Sobel test. So this study has used both the techniques of financial and economic time series econometrics. GARCH models have applied to measure the impact of oil price uncertainty on the exchange rates volatility. As the data used in this study is monthly, so to check the stationarity of the data we have applied Beaulieu and Miron (1992) seasonal unit root test. Further to check the existence of long-run and short-run co-integration relationship among the variables we have applied ARDL technique. Finally in the last step direct and indirect effects have been analyzed and with the help of sobel test the study explores the role of exchange rate as a mediator between oil prices and consumer prices.

4.2. Data Sources

The three variables that have been utilized in this study are oil prices, exchange rate and CPI inflation. Time series data for the period from June 1972 to December 2015 has been used for the analysis. The Oil prices data has been collected from World Bank Commodity Prices Data (The pink sheet) which represents the prices of oil in dollars per barrel. The monthly Average Exchange Rates data has been taken from Monthly Statistical Bulletin, Annual Report of SBP and International Financial Statistics (IFS) where the Monthly Nominal Exchange Rates are in Pak rupee per US $. Finally for inflation the consumer prices index (CPI) data has also been taken from the International Financial Statistics (IFS).

4.3. Descriptive Statistics

We have used the three measures of descriptive statistics, central tendency or averages of the variables (mean), measures of variability (standard deviation) and stability ratio (standard deviation divided by mean) to explain the dataset. Moreover, by dividing data series into different subsamples, the quantitative measures have been used for each subsample separately. In our study for descriptive statistics we have also divided data series into different decades. The division of data into decades and calculating mean, standard deviation and coefficient of variation for each decade will tell how differently variables behave during these decades.

As in the first stage the concern of our study is the measurement of uncertainty/volatility for which we can use the standard deviation and also the stability ratio as a measure of volatility in descriptive statistics. When we use standard deviation as a volatility measure then the problem with this volatility measure is that the different subsamples with highest standard deviations also have the highest means which makes the standard deviation as a poor measure of volatility. On the other hand, the advantage of using stability ratio as a volatility measure is that it not only identifies the magnitudes of the volatility difference of variables by decades but also takes into account the difference in means of subsamples and then decides the volatility. So it’s better to use stability ratio as a measure of volatility for different sub samples than the simple standard deviation.

In brief, the standard deviation alone cannot be the best volatility measure, particularly when comparing different eras or different subsamples and when the means of the series are also different. The stability ratio not only includes both the mean and standard deviation but also tells us about which subsample has the higher standard deviation relative to mean for different variables. So, the stability ratio better identifies which time series is more volatile. In conclusion, it can be said that these simple and easily applied descriptive statistics provide valuable information and enable an analyst to understand the basic behavior of a time series over different periods. These descriptive statistics have provided only the univariate analysis of the variables and for the bivariate analysis we have applied the bivariate correlation coefficients.

4.4. Methodological Framework

The first objective of the study is to measure the impact of oil prices uncertainty on the exchange rate volatility for which we have applied different GARCH models. The second objective of the study is to find out long-run and short-run impact of oil prices and exchange rate on consumer prices for which we have applied ARDL technique. Finally in the last objective we have analyzed the direct and indirect effects of oil prices on consumer prices and in order to check the possible role of exchange rate as mediator we have applied Sobel test in our methodology.

4.4.1. Using GARCH Extensions as a Measure of Uncertainty/Volatility

In earlier studies, several methods had been used to measure the uncertainty and volatility in variables. For example simple moving averages method, the moving standard deviation method and the ARCH and GARCH models. The simple moving average method that had used to measure the uncertainty was popular for calculating the averages of data at different points. In some other studies moving average standard deviation method had also been used as a measure of uncertainty which was among one of the measures being used in descriptive statistics as well. However, in order to measure the uncertainty in oil prices and exchange rate GARCH models had been used in some of the recent studies. Moving average is the simplest and common method of computing volatility which yields only observed volatility however GARCH extensions provide volatility based on the estimated conditional variance. Moreover, moving average standard deviation method is commonly used for computing volatility in annual data however GARCH extensions are used for computing volatility in high frequency data such as monthly or quarterly data (Baillie and McMahon, 1989). So as far as our study is concerned we are using monthly data and interested in volatility given by conditional variance so this study has employed GARCH methodology.

4.4.1.1. GARCH Methodology

The variance of an error term usually remains constant with the passage of time (homoskedastic assumption), but mostly financial and also some of the economic time series analysis show volatility clustering. In this case the periods of large changes are followed by further periods of large changes in opposite direction and periods of small changes are followed by further periods of small changes in opposite direction. For example, the stock market follows large changes (high volatility) and more relaxed periods of small changes (low volatility). This usually happens for the high frequency data. So, when there is volatility clustering the variance of 'μ_t' depends upon its history. In this case it is preferred to examine the conditional variance (time dependent) rather than the unconditional variance (Asteriou and Hall, 2006).

So now a days in order to estimate the uncertainty of a particular variable the time dependent variance (conditional variance) is used as a proxy for uncertainty of the variable (Friedman, 1977; Bernanke, 1983). In the earlier studies the simple moving averages, the moving standard deviation or the variance of variable (time independent) were used as a proxy for uncertainty. But later on it was revealed that such practices could not differentiate between anticipated and un-anticipated components and also their calculated uncertainty was based only on the un-anticipated change/component (Bredin and Fountas, 2009). GARCH models solve the problems of the earlier uncertainty methods (simple moving averages method and moving standard deviation method) by using the time dependent conditional variance. GARCH models use the conditional variance of variable as a measure of uncertainty rather than simply considering the variable's variability as a tool for uncertainty. GARCH models also have some more advantages over the earlier practices. GARCH models tell us about whether the uncertainty of the variable is statistically significant or not. Also these models provide the estimation of mean and variance equations at the same time. So on the basis of above discussion it is better now to use GARCH models to measure the impact of oil prices uncertainty on the exchange rate volatility.

4.4.1.2. Models of Volatility

The family of Autoregressive Conditional Heteroskedasticity Models has been applied for modeling the relationship between oil prices and the exchange rate. Every GARCH family model requires two distinct specifications: the mean and variance equations. The mean equation estimates a linear link between two variables by taking exchange rate as a dependent variable and oil prices as an independent variable. The linear link based on the Mansor (2011) models can be written as follows:

$$r_{ER_t} = \alpha + \beta\, r_{OP_t} + \mu_t \quad \text{.........} \ (4.1)$$

Where the returns of the oil prices are denoted by (r_{OP_t}) and the returns of the exchange rate are denoted by (r_{ER_t}).

$$r_{OP_t} = \log(OP_t / OP_{t-1}) \quad \text{..........} \ (4.2)$$

$$r_{ER_t} = \log(ER_t / ER_{t-1}) \text{ .... (4.3)}$$

Through variance equations of the GARCH models we have analyzed the impact of oil prices uncertainty on the volatility of the exchange rate for an oil-importing country Pakistan. The GARCH models have confirmed whether these effects are statistically significant or not as well as the persistence of volatility. We have applied different GARCH models that are GARCH, GARCH-M, TGARCH and EGARCH respectively.

- **The Generalized ARCH (GARCH) Model**

Bollerslev (1986) and Taylor (1986) proposed independently the GARCH model as substitute for ARCH model. The general form of conditional variance equation for GARCH (p, q) model is given as

$$h_t = \gamma_0 + \sum_{i=1}^{q} \alpha_i \mu_{t-i}^2 + \sum_{j=1}^{p} \beta_j h_{t-j} \text{ .... (4.4)}$$

Where p is the order of GARCH term and q is the order of ARCH term. The conditional variance equation of GARCH model is function of a constant term, lagged squared residuals and the last period's variance. Alexander and Lazar (2006) assumed that $\gamma_0 > 0; \alpha_i \geq 0; i = 1,...,q; \beta_j \geq 0, j = 1,...,p; \Sigma_{i=1}^{q}\alpha_i + \Sigma_{j=1}^{p}\beta_j < 1$ for ensuring 'h_t' as a weak stationary. Also the Enocksson and Skoog (2012) identified some restrictions on the GARCH model. One of the most important restrictions is that the GARCH model cannot capture the asymmetries. In fact GARCH models are symmetric and can only capture the symmetrical performance where the positive shocks have the same impact on the volatility as negative shocks of the same magnitude.

- **The GARCH in Mean or GARCH-M Model**

One of the main problems in financial econometrics is to measure the effects of volatility of a variable on its returns. In this regard the Engle et al. (1987) proposed

GARCH-M model in which conditional variance or standard deviation appears in mean equation which capture the effects of volatility on returns. In this model, the conditional mean equation is specified as

$$r_{ER_t} = \alpha + \beta r_{OP_t} + \lambda \sigma_t^2 + \mu_t \text{ .... (4.5)}$$

$$r_{ER_t} = \alpha + \beta r_{OP_t} + \lambda \sqrt{\sigma_t^2} + \mu_t \text{ .... (4.6)}$$

The general form of conditional variance equation for GARCH-M (p, q) model is same as that of GARCH model which is given as:

$$h_t = \gamma_0 + \sum_{i=1}^{q} \alpha_i \mu_{t-i}^2 + \sum_{j=1}^{p} \beta_j h_{t-j} \text{ .... (4.7)}$$

The conditional variance equation of the GARCH-M model given above is again function of a constant term, lagged squared residual term captured by ARCH and the last period variance captured by the lagged h_t term/GARCH. Again the problem with this GARCH model is that it can only capture the symmetric performance of the volatility series where the positive shocks have exactly the same impact on the volatility as those of negative shocks of the same magnitude. So in order to overcome these drawbacks of the symmetrical models (GARCH and GARCH-M) the threshold GARCH model was introduced.

- **The Threshold GARCH (TGARCH) Model**

Glosten et al. (1993) proposed T-GARCH or Threshold GARCH model. It is also sometimes termed as GJR-GARCH model. The general form of conditional variance equation for T-GARCH (p, q) model is written as:

$$h_t = \gamma_0 + \sum_{i=1}^{q} \alpha_i \mu_{t-i}^2 + \sum_{i=1}^{q} \gamma_i I_{t-i} \mu_{t-i}^2 + \sum_{j=1}^{p} \beta_j h_{t-j} \text{ .... (4.8)}$$

Where, $I_t = 1$ for $\mu_t < 0$ and $I_t = 0$ for $\mu_t > 0$

At above 'I_t' is an indicator term and its sign identifies the asymmetries (Patrick et al., 2006). In above model, positive shocks imply that $\mu_t > 0$ and negative shocks imply that $\mu_t < 0$ and in this way these two shocks of equal size have different impact on conditional variances. Positive shocks have an impact of α_i and negative shocks have an impact of $\alpha_i + \gamma_i$. Negative shocks increase the volatility when $\gamma_i > 0$ which implies the presence of asymmetries i.e., the shocks impact is asymmetric, while if $\gamma_i = 0$ the shocks impact is symmetric. So the advantage of using the T-GARCH model is that it can capture the asymmetries in terms of positive and negative shocks whereas the GARCH models can only capture the symmetrical performances.

- **The Exponential GARCH (EGARCH) Model**

Nelson (1991) proposed the E-GARCH model and the advantage of using this model is that it not only captures asymmetries but also tests TGARCH. The general form of conditional variance equation for E-GARCH (p, q) model is specified as:

$$\log h_t = \gamma_0 + \sum_{i=1}^{q} \alpha_i \left| \frac{\mu_{t-i}}{\sqrt{h_{t-i}}} \right| + \sum_{i=1}^{q} \gamma_i \frac{\mu_{t-i}}{\sqrt{h_{t-i}}} + \sum_{j=1}^{p} \beta_j \log(h_{t-j}) \text{ .... (4.9)}$$

$\mu_{t-i} > 0$ and $\mu_{t-i} < 0$ implies good news and bad news respectively. When $\gamma_i = 0$ then the model is symmetric, while when $\gamma_i < 0$ the expectation is that the volatility generated by negative shocks is greater than the positive shocks. So 'γ' term examines whether the shocks have symmetric or asymmetric impact on the volatility. The non negativity restrictions are required on coefficients of GARCH models, and also the coefficient of threshold term for GJR-GARCH must also be positive for the existence of leverage affect (Brooks, 2014). The advantage of using E-GARCH model as compared to simple GARCH and GJR-GARCH model is that non-negativity constraints are not required on coefficients. In case of E-GARCH model there is negative relationship between volatility and returns, so coefficient of its threshold term will be negative and therefore the non-negativity constraints are not needed.

4.4.2. ARDL Model for Co-integration

4.4.2.1. Unit Root Test

The empirical analysis of the time series data usually starts with the examination of time series properties of variables like unit root test. Generally, most of the variables which are used for research in "macro economics", "monetary economics" and "financial economics" are not stationary (Hill et al., 2001). Non-stationary data is usually unpredictable and cannot be modeled or forecasted. The results obtained by using non-stationary time series may be spurious. In order to get consistent and reliable results it is important that the data used must be appropriate and that's why we have to check stationarity of the variables. We have list of the tests which can be applied to check the presence of unit root for example ADF test (Dickey and Fuller, 1981), PP Test (Phillips and Perron, 1988) and KPSS test (Kwiatkowski, Phillips, Schmidt and Shinn, 1992) etc. But as far as our study is concerned we are using monthly data so there is a possibility of seasonal unit root in the data. For this purpose the Beaulieu and Miron (1992) seasonal unit root test is more appropriate for monthly data which is actually the extension of the HEGY (1990) test.

4.4.2.2. Beaulieu and Miron (1992) Seasonal Unit Root Test

Beaulieu and Miron (1992) conducted the investigation of seasonal and non-seasonal unit roots (unit root at zero, biannual and annual frequency) in monthly time series data by extending the approach of HEGY (Hylleberg, Engle, Granger and Yoo, 1990). Frances (1990) also provided a similar analysis. The auxiliary regression model to perform the monthly unit root test is given by the following equation

$$\Delta_{12} y_t = \alpha_0 + \alpha_1 t + \sum_{k=2}^{12} \alpha_k D_{kt} + \sum_{k=1}^{12} \pi_k y_{k,t-i} + \varepsilon_t \quad \text{..........} \ (4.10)$$

The estimated equation includes a constant term, trend, eleven seasonal dummies and lags of the dependent variable. The series of the variables can be generated as follows.

$$y_{1t} = (1 + B + B^2 + B^3 + B^4 + B^5 + B^6 + B^7 + B^8 + B^9 + B^{10} + B^{11}) y_t$$

$$y_{2t} = -(1 - B + B^2 - B^3 + B^4 - B^5 + B^6 - B^7 + B^8 - B^9 + B^{10} - B^{11}) y_t$$

$$y_{3t} = -(B - B^3 + B^5 - B^7 + B^9 - B^{11}) y_t$$

$$y_{4t} = -(1 - B^2 + B^4 - B^6 + B^8 - B^{10}) y_t$$

$$y_{5t} = -\frac{1}{2}(1 + B - 2B^2 + B^3 + B^4 - 2B^5 + B^6 + B^7 - 2B^8 + B^9 + B^{10} - 2B^{11}) y_t$$

$$y_{6t} = \frac{\sqrt{3}}{2}(1 - B + B^3 - B^4 + B^6 - B^7 + B^9 - B^{10}) y_t$$

$$y_{7t} = \frac{1}{2}(1 - B - 2B^2 - B^3 + B^4 + 2B^5 + B^6 - B^7 - 2B^8 - B^9 + B^{10} + 2B^{11}) y_t$$

$$y_{8t} = -\frac{\sqrt{3}}{2}(1 + B - B^3 - B^4 + B^6 + B^7 - B^9 - B^{10}) y_t$$

$$y_{9t} = -\frac{1}{2}(\sqrt{3} - B + B^3 - \sqrt{3}B^4 + 2B^5 - \sqrt{3}B^6 + B^7 - B^9 + \sqrt{3}B^{10} - 2B^{11}) y_t$$

$$y_{10t} = \frac{1}{2}(1 - \sqrt{3}B + 2B^2 - \sqrt{3}B^3 + B^4 - B^6 + \sqrt{3}B^7 - 2B^8 + \sqrt{3}B^9 - B^{10}) y_t$$

$$y_{11t} = \frac{1}{2}(\sqrt{3} + B - B^3 - \sqrt{3}B^4 - 2B^5 - \sqrt{3}B^6 - B^7 + B^9 + \sqrt{3}B^{10} + 2B^{11}) y_t$$

$$y_{12t} = -\frac{1}{2}(1 + \sqrt{3}B + 2B^2 + \sqrt{3}B^3 + B^4 - B^6 - \sqrt{3}B^7 - 2B^8 - \sqrt{3}B^9 - B^{10}) y_t$$

$$y_{13t} = (1 - B^{12}) y_t$$

After the generation of the series the next step is the estimation of the model which is done by OLS (Ordinary Least Square). The model can be written as follows

$$\varphi(B) y_{13t} = \mu_t + \pi_1 y_{1,t-1} + \pi_2 y_{2,t-1} + ...+ \pi_{12} y_{12,t-1} + \varepsilon_t \quad .... \text{ (4.11)}$$

Where $\varphi(B)$ represents the remainder with roots outside the unit circle, and μ_t represents the trend and seasonality which is further equal to

$$\mu_t = D_t + D_s = \delta + \beta_t + \Sigma \alpha_s D_{s,t} \quad .... \text{ (4.12)}$$

After estimation the next step is to check the white noising of the residuals at 1st and 12th lag. For this purpose we have applied serial correlation LM test under the null hypothesis of no autocorrelation against the alternative of autocorrelation. If there is autocorrelation problem i.e. the residuals are not white noised then we have to add the lags of the dependent variable until the residuals are white noised. After this process we have tested different hypotheses which vary between even and odd. First two hypotheses are usually tested individually while the rest of the hypotheses are tested jointly by applying Wald test. The null hypotheses can be written as follows

$$H_{a0} : \pi_1 = 0$$

$$H_{b0} : \pi_2 = 0$$

$$H_{c0} : \pi_3 = \pi_4 = 0$$

$$H_{d0} : \pi_5 = \pi_6 = 0$$

$$H_{e0} : \pi_7 = \pi_8 = 0$$

$$H_{f0} : \pi_9 = \pi_{10} = 0$$

$$H_{g0} : \pi_{11} = \pi_{12} = 0$$

The zero frequency unit root ($\pi_1 = 0$) and bi-annual frequency unit root ($\pi_2 = 0$) are tested by using one sided t-statistics. While the other complex unit roots are tested by using joint F-statistics. If the calculated value of t-statistics is less than the critical values then we reject the null hypothesis and conclude that there is no unit root but in the opposite case when there is unit root problem we have to apply the stationary filters in order to make the data stationary. On the other hand for F-statistics we reject the null hypothesis if the calculated value of F-statistics is greater than the critical values.

4.4.2.3. Econometric Specifications of ARDL Model

- **Testing of Long-run and Short-run Relationships**

The study further adopts the ARDL technique developed by (Pesaran et al., 2001) to find out the long-run and short-run impact of oil prices and exchange rate on consumer prices. The problem with the conventional Johansen and Juselius (1990) co-integration technique is that it estimates the long-run and short-run relationships among the variables within a context of a system of equations. Whereas ARDL technique utilizes only a single reduced form equation for the long-run and short-run analysis (Pesaran & Shin, 1995). Moreover, this technique is applicable for the existing relationship among the variables irrespective of their order of integration. The variables can be I (0), I (1) or a mixture of both but we have to be careful about the variables which are I (2). Moreover, in ARDL approach there is also no need to make different specifications as compared to standard co-integration technique. These specifications are decisions regarding exogenous and endogenous variables, deterministic elements and the optimal lags to be specified. These different alternative choices and methods available for estimation generally make the empirical results very sensitive (Pesaran & Smith, 1998). Another advantage of using ARDL technique is that we can select different number of optimal lags for different variables that is not possible with standard co-integration technique.

- **ARDL Model Specification**

Basically, in our study the ARDL approach to co-integration estimates the error correction model for CPI and its different determinants:

$$\Delta CPI_t = \alpha_0 + \sum_{i=1}^{p} \phi_i \Delta CPI_{t-i} + \sum_{i=0}^{q} \theta_i \Delta OP_{t-i} + \sum_{i=0}^{q} \lambda_i \Delta ER_{t-i} + \delta_1 CPI_{t-1} + \delta_2 OP_{t-1}$$
$$+ \delta_3 ER_{t-1} + \nu_t \text{ ....}(4.13)$$

Where CPI, OP, and ER are consumer prices, oil prices and exchange rate respectively, Δ is the first difference operator and p and q are the optimal lag lengths of dependent and independent variables.

- **Bounds Testing**

F-statistics is used to check the existence of long-run relationship among the variables. The null hypothesis in this regard is that the coefficients of the lagged variables are simultaneously equal to zero which means there is no long-run relationship. The alternative hypothesis is that at least one is different from zero which implies there is long-run relationship among variables.

$$H_0 = \delta_1 = \delta_2 = \delta_3 = 0 \qquad \text{[No Co integration]}$$

$$H_1 : \delta_1 \neq \delta_2 \neq \delta_3 \neq 0 \qquad \text{[Co integration]}$$

The estimated F-test statistic is compared with the critical values proposed by Pesaran et al. (2001). If the estimated F-test statistic is greater than the upper bound critical value at 5% significance level, then there is long run co-integration relationship among the variables. When the long run relationship exists, then there should be the normalization of dependent variable. If the estimated F-test statistic is less than the lower bound critical value at 5% significance level, then there is no long-run co-integration relationship among variables. Also, if the estimated F-test statistic lies between upper and lower bound critical values, then it is inconclusive to decide about the co-integration relationship among variables.

When there is evidence of a long-run co-integration relationship among variables, then the long-run parameters can be estimated by using the following model:

$$CPI_t = \alpha_1 + \sum_{i=1}^{p} \phi_{1i} CPI_{t-i} + \sum_{i=0}^{q} \theta_{2i} OP_{t-i} + \sum_{i=0}^{q} \lambda_{1i} ER_{t-i} + \mu_t \quad .... (4.14)$$

The order of optimal lags is selected on the basis of Akaike Information Criterion (AIC) and before this the selected model is estimated by Ordinary Least Squares. In addition, because of the possibility of trend existence in the series, equation (4.13) is estimated also by taking into consideration the unrestricted intercept and unrestricted trend and if the trend is insignificant we will exclude it and take into account the unrestricted intercept and no trend as by Pesaran et al. (1999).

The ARDL specification for short-run dynamics is estimated by using the following equation:

$$\Delta CPI_t = \alpha_2 + \sum_{i=1}^{p} \phi_{2i} \Delta CPI_{t-i} + \sum_{i=0}^{q} \theta_{2i} \Delta OP_{t-i} + \sum_{i=0}^{q} \lambda_{2i} \Delta ER_{t-i} + \psi ECM_{t-1} \quad .... (4.15)$$

At above ECM_{t-1} is the error correction term and it can be written as

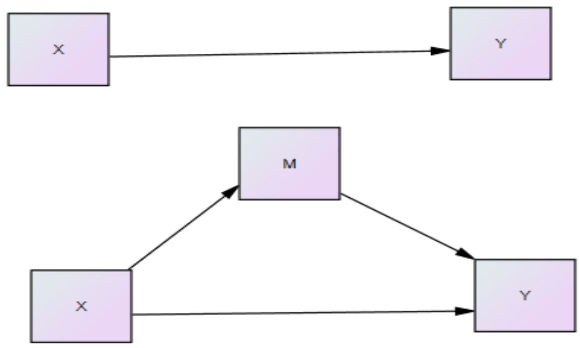
$$ECM_t = CPI_t - \alpha_1 - \sum_{i=1}^{p} \phi_{1i} CPI_{t-i} - \sum_{i=0}^{q} \theta_{2i} OP_{t-i} - \sum_{i=0}^{q} \lambda_{1i} ER_{t-i} + \mu_t \quad .... (4.16)$$

In the equation (4.15), the parameters associated with summation signs are the short-run parameters and the coefficient of ECM (Ψ) represents the speed of adjustment of the model's convergence towards the long-run equilibrium and for convergence this coefficient/speed of adjustment must be negative and statistically significant.

4.4.3. Direct and Indirect Effects

4.4.3.1. Mediation Model

Most studies focus on the relationships that exist between dependent and independent variables, Y and X, concerning the conditions under which Y is affected or caused by X. But the relationship between the dependent and independent variables can also be contained under these conditions.



The relationship between Y and X is via the direct and mediated effect indirectly causing X to affect Y through M. The mediation model explains the existing relationship between a dependent and an independent variable under the influence of mediating variable. The meditational model hypothesis assumes that the independent variable first affects the mediating variable which in turn affects the dependent variable. So, in this way the total effect of X on Y (c) is divided into a direct effect (c') and an indirect effect ($\alpha\beta$). Thus, the total effect is ($c = c' + \alpha\beta$). A measure of mediation effect is also the difference between (c) and (c') which is equal to the product of the paths to and from the mediator. Therefore, $(c - c') = \alpha\beta$

4.4.3.2. The Classical Mediation Test

There are more than a dozen distinct methods to test for mediation effect. MacKinnon et al. (2002) divided these mediation methods into three important groups: the causal steps approach; difference in coefficients approach; and the product of coefficients approach.

- **Mediation Regression Equations**

The most popular example of causal step approach is given by Baron and Kenny (1986).Using their approach; in order to evaluate mediation effect three different regression models are examined:

$$Y = \gamma_1 + cX + \varepsilon_1 \text{ .... } (4.17)$$

$$M = \gamma_2 + \alpha X + \varepsilon_2 \text{ .... } (4.18)$$

$$Y = \gamma_3 + c'X + \beta M + \varepsilon_3 \text{ .... } (4.19)$$

Where Y is dependent variable; M indicates the mediator and X represents the independent variable. γ_1, γ_2 and γ_3 are intercepts; α, β, c and c' are the regression coefficients capturing the relationship among the variables. The term 'c' indicates the coefficient connecting the dependent and independent variables; 'α' represents the coefficient related to independent variable and mediator; 'c'' shows the coefficient linking the dependent and independent variables by adjusting them for mediating variable; 'β' shows the coefficient connecting the mediating variable to the dependent one after adjusting them for independent variable; and, finally, the epsilons ε_1, ε_2, and ε_3 are model fit errors.

For establishment of the mediation model, the Baron and Kenny approach suggests four steps/conditions according to which the evidence from mediation is said to be likely if in the first step, the term 'c' in equation (4.17) is significant, i.e., there must be linear relationship between independent and dependent variable. In second step, the term 'α' in equation (4.18) is significant, i.e., there must be linear relationship between the independent and mediating variable. Next the term 'β' in equation (4.19) is significant, indicating that the mediating variable must be linearly related to dependent variable and finally, in fourth step, the term 'c'' linking the dependent and independent variables in the regression analysis in which both the mediating and independent variables, in the unique equation, are predictors of the dependent variable must become significantly smaller in size than the coefficient 'c' connecting the dependent variable to the independent variable in equation (4.17). Moreover, if either (α) or (β) is not significant, there is said to be no mediation. If the first three conditions hold, then there will be "partial mediation" and if the first three conditions hold and also (c') is not significantly different from zero, then there will be perfect or complete mediation.

MacKinnon et al. (2002) stated that, "the overall purpose of the causal steps methods is to establish the conditions for mediation rather than a statistical test of the indirect effect". Baron and Kenny go on to recommend the Sobel (1982) z-test in order to check the statistical significance of indirect path $\alpha \times \beta$ (product of the coefficients) and difference in the coefficients ($c - c'$). The product of the coefficients approach calculate the product of paths from independent variable to mediator and then from mediator to dependent variable. After that the product is divided by its pooled standard error and compared with the normal distribution. On the other hand the difference in coefficients approach compares the relationship between dependent and independent variables before and after accounting the role of mediating variable (Clogg et al., 1992). Also in this approach the difference in the coefficients is divided by pooled standard error and then compared with normal distribution. There are several formulas for calculating pooled standard error for mediation effect in both the approaches and these standard error formulas have only a minor difference in their estimation (Goodman, 1960; Baron and Kenny, 1986; Sobel, 1982). Goodman (1960) proposed the sample based estimate where pooled standard error of the coefficients ($\alpha\beta$) is equal to $S_{\alpha\beta} = (\alpha^2 S_\beta^2 + \beta^2 S_\alpha^2 - S_\alpha^2 S_\beta^2)^{1/2}$, Baron and Kenny (1986) offered a population based estimate, where $S_{\alpha\beta} = (\alpha^2 S_\beta^2 + \beta^2 S_\alpha^2 + S_\alpha^2 S_\beta^2)^{1/2}$, and Sobel (1982) developed an approximation without the final term which is equal to $S_{\alpha\beta} = (\alpha^2 S_\beta^2 + \beta^2 S_\alpha^2)^{1/2}$. Among these different estimates of standard errors we have adopted Soble's standard error approximation in our study and finally to test the mediation effect, the terms ($\alpha\beta / S_{\alpha\beta}$) or ($c - c' / S_{\alpha\beta}$) have been tested against a z-distribution under the null hypothesis of $\alpha\beta$ or ($c - c'$) are equal to zero.

The product of the coefficients and difference in coefficients approaches provide a more formal statistical mediation test as compared to the conditions of causal steps approach. The Z-statistics for the product of the coefficients and difference in coefficients can be written as

$$z = \frac{\alpha \times \beta}{\sqrt{\alpha^2 S_\beta^2 + \beta^2 S_\alpha^2}} \quad \text{OR} \quad z = \frac{c - c'}{\sqrt{\alpha^2 S_\beta^2 + \beta^2 S_\alpha^2}}$$

Where (α) and (S_α^2) can be obtained from equation (4.18), and (β) and (S_β^2) from equation (4.19) respectively.

CHAPTER 5

EMPIRICAL RESULTS AND DISCUSSIONS

5.1. Introduction

The estimated results and their discussions are presented in this chapter. The results have been presented from the estimation techniques employed in the study namely the GARCH models, co- integration technique and sobel test. First of all the results of descriptive statistics are presented in section 5.2. The results of GARCH modeling to estimate the impact of oil prices uncertainty on the exchange rate volatility are presented in section 5.3. The results of Beaulieu and Miron monthly seasonal unit root test are reported in section 5.4 and the results of the autoregressive distributed lag methodology of the long-run and short-run parameters are presented in section 5.5. Finally the results of direct and indirect effects are reported in section 5.6.

5.2. Descriptive Statistics

5.2.1. Univariate Analysis

For descriptive analysis, the complete sample period for all the variables has been divided into different sub samples (decades) in the table 5.1. The average oil price for the complete sample period from 1972-M6 to 2015-M12 is 34.77 and the standard deviation is 30.07, while the stability ratio (coefficient of variation) is 86.48%. The standard deviations and stability ratios are the measures of volatility. The values of both the standard deviation and stability ratio for the complete sample period of oil prices show the higher volatility as compared to other subsamples that have lower values of these two measures. Similarly, for exchange rate and consumer price index the averages for whole sample periods are 40.21 and 41.15 with the standard deviations of 29.89 and 39.79 respectively. The stability ratios (coefficients of variations) are 74.33% and 97.70% for exchange rate and consumer price index.

Again the standard deviations and stability ratios of the complete sample period show the higher volatility as compared to the other subsamples of the exchange rate and consumer price index. Therefore, it can be said that the complete sample period is the most volatile for all the three variables according to the volatility measures of the standard deviation and stability ratio.

Further there are different decades or subsamples for which the standard deviation or stability ratio (coefficient of variation) shows the volatility of variables in each decade. There are different values of the standard deviations and stability ratios and higher value is an indication of higher volatility. If we use standard deviation as a measure of volatility, then the two subsamples of the 2000s and 2010s (six years) for the oil prices have higher standard deviations i.e., these subsamples are more volatile as compared to others and the subsample of the 90s has lowest standard deviation i.e., this subsample is less volatile. But as we discussed in methodology the standard deviation alone cannot be called the best volatility measure. So we use stability ratio as a measure of volatility instead of standard deviation. Therefore, among different sub samples of oil prices the 70s (eight years) has the highest stability ratio i.e., it is more volatile and subsample of 90s has lowest stability ratio i.e., this subsample is least volatile.

Similarly for exchange rate and consumer price index if we take standard deviation as a measure of volatility then among different subsamples the three subsamples of the 90s, 2000s and 2010s have highest standard deviations but the problem with this measure of volatility is that these subsamples also have the highest means. So it’s better to use stability ratio as a measure of volatility. When we use the stability ratio as the measure of volatility then among different sub samples of exchange rate the 90s has the highest stability ratio i.e., it is more volatile and subsample 70s has lowest stability ratio i.e., this subsample is least volatile. Similarly, among different sub samples of the consumer price index the sample period of 90s has the highest while the sample period of 2010s has the lowest stability ratio.

Table-5.1: Descriptive Statistics

Variables	Period	Mean	S.D	Coefficient of Variation
OP	1972:M6-2015:M12	34.77	30.07	86.48%
	1972:M6-1979:M12	12.16	8.41	69.16%
	1980:M1-1989:M12	24.36	8.59	35.26%
	1990:M1-1999:M12	16.59	3.54	21.34%
	2000:M1-2009:M12	46.73	25.27	54.08%
	2010:M1-2015:M12	91.04	22.22	24.41%
ER	1972:M6-2015:M12	40.21	29.89	74.33%
	1972:M6-1979:M12	10.01	0.31	3.10%
	1980:M1-1989:M12	14.75	3.45	23.39%
	1990:M1-1999:M12	33.51	9.35	27.90%
	2000:M1-2009:M12	62.43	7.97	12.77%
	2010:M1-2015:M12	94.97	7.62	8.02%
CPI	1972:M6-2015:M12	41.15	39.79	97.70%
	1972:M6-1979:M12	6.06	1.58	26.07%
	1980:M1-1989:M12	12.55	2.18	17.37%
	1990:M1-1999:M12	29.26	8.07	27.58%
	2000:M1-2009:M12	57.56	14.49	25.17%
	2010:M1-2015:M12	125.65	16.49	13.12%

5.2.2. Bivariate Analysis (Correlation matrix)

At above we have used the univariate analysis and now we are moving towards the bivariate analysis among the variables for which we have used the bivariate correlation coefficients. The results of correlation coefficients among different variables are as expected. The oil prices have positive correlation with the exchange rate. This positive correlation indicates that higher the oil prices higher will be the exchange rate i.e., depreciation of exchange rate and vice versa. The oil prices and exchange rate also have positive correlation with the consumer price index. The positive correlation between prices of oil and consumer price index indicates that the rising oil prices will lead to increase in consumer prices of the country and vice versa.

Further the positive correlation between exchange rate and consumer price index indicates that the increase in exchange rate i.e., depreciation of exchange rate will lead to increase in consumer prices and vice versa.

$$\begin{array}{c} \\ OP \\ ER \\ CPI \end{array}\begin{array}{c} \begin{array}{ccc} OP & ER & CPI \end{array} \\ \begin{bmatrix} 1 & 0.78 & 0.84 \\ & 1 & 0.97 \\ & & 1 \end{bmatrix} \end{array}$$

Significant at 5% significance level

5.3. Modeling Oil Prices Uncertainty and Exchange Rate volatility

The first objective of the study is to measure the impact of oil prices uncertainty on the exchange rate volatility. In order to meet this objective and for modeling the uncertainty and volatility we have used the GARCH specifications. For the said purpose, first of all the heteroskedastic ARCH-LM test has been applied on mean equation and observed that whether ARCH effect is present in oil prices and exchange rate or not. In this regard null hypothesis of no ARCH effect is tested against the alternative of ARCH effect as suggested by Engle (1982). We can run ARCH family model if and only if ARCH effect is present in the financial return series of oil prices and exchange rate. The ARCH-LM test is presented in table 5.2.

Table-5.2: Heteroskedasticity Test

Variables	Lags (p)	Chi^2	Probability
Oil Prices	1	21.541	0.000
Exchange Rate	1	14.991	0.000

$H_0 =$ No ARCH effect. $H_1 =$ ARCH effect.

The probability values of T*R-squared are less than 5% which leads to the rejection of null hypothesis and thus indicate the presence of ARCH effect. So now we can apply the GARCH family models. We have to apply different specification of these models in order to capture symmetrical, threshold and asymmetrical effects.

5.3.1. Models of Volatility

- **Parameter Estimates of GARCH Family Models**

Here we have applied simple to general modeling approach. Table 5.3 gives the detail about the estimated results of GARCH family models where every model requires two distinct specifications: the mean and variance equations. In this study GARCH models; namely, GARCH (1, 2), GARCH-M (1, 2), TGARCH (2, 2) and EGARCH (1, 3) are based on AIC and SBC criterion. GARCH (1, 2) and GARCH-M (1, 2) are symmetric models and indicating the symmetrical impact of the oil prices uncertainty on the exchange rate volatility. TGARCH (2, 2) and EGARCH (1, 3) models show the threshold and asymmetrical effects respectively and the results of these two models indicate the statistically significant impact of oil prices uncertainty on the exchange rate volatility. On the other hand the symmetrical models show that prices of oil have insignificant impact on exchange rate and the reason for this insignificant impact is the nature of the symmetrical models i.e. positive and negative shocks of the same magnitude have equal impact on the volatility series. As in the oil price series there are lots of negative and positive shocks so the symmetrical models are unable to capture the impact of all these shocks on exchange rate properly because these models deals both the positive and negative shocks as equal. Therefore, the proposed models that can capture the impact of oil prices uncertainty on exchange rate volatility are threshold and asymmetrical models in terms of negative and positive shocks. The results of mean equations of all the GARCH models show that the oil prices have positive relationship with the exchange rate i.e., higher the oil prices higher will be the exchange rate and vice versa. So, rising oil prices will lead to exchange rate depreciation and falling oil prices will lead to exchange rate appreciation. Thus, for the GARCH (1, 2) and GARCH-M (1, 2), a 10% rise in oil prices will depreciate the exchange rate by 0.06% and 0.04% respectively. Likewise for T-GARCH (2, 2) and for E-GARCH (3, 1), a 10% rise in oil prices will depreciate the exchange rate by 0.04% and 0.02% respectively.

Table-5.3: Parameter Estimates of Extended GARCH Models

	GARCH (1,2)	**GARCH-m (1,2)**	**T-GARCH (2,2)**	**E-GARCH (1,3)**
Mean Equations				
C	0.002 (0.238)	0.002 (0.004)	0.002 (0.034)	0.004 (0.000)
OP	0.006 (0.338)	0.004 (0.298)	0.004 (0.062)	0.002 (0.000)
AR (1)	0.478 (0.000)	0.473 (0.000)	0.414 (0.000)	0.617 (0.000)
λ	-	8.381 (0.068)	-	-
Variance Equations				
γ_0	3.97E-05 (0.128)	2.10E-06 (0.000)	2.08E-06 (0.000)	-0.808 (0.000)
α_0	0.447 (0.000)	0.469 (0.000)	0.142 (0.000)	0.759 (0.000)
α_1	(-0.312) (0.012)	-0.433 (0.000)	-0.044 (0.000)	-0.218 (0.004)
α_2	-	-	-	-0.581 (0.000)
β_0	0.670 (0.001)	0.939 (0.000)	1.091 (0.000)	0.914 (0.000)
β_1	-	-	-0.167 (0.024)	-
γ	-	-	-0.122 (0.000)	0.286 (0.000)

Probability values are given in parentheses.

The variance equations report the estimated parameters of different conditional volatility models used in study. The significant coefficients of all the conditional GARCH specifications show the strong validity of the models. In the variance equations, the estimated results of the threshold GARCH model proposed by Glosten et al. (1993); exponential GARCH model introduced by Nelson (1991), capture the asymmetries in terms of negative and positive shocks because the coefficient of threshold term (γ) is significant for both the models. So the positive and negative shocks have different impact on volatility series which implies that when oil price uncertainty is an independent variable then rise or fall in oil prices has different impact on exchange rate volatility.

In brief, oil prices uncertainty has positive and significant impact on the exchange rate volatility i.e., rising oil prices will lead to exchange rate depreciation (increase in exchange rate) and vice versa. These results have consistency with the findings of the Shalmani et al. (2015) for Pakistan. The economic reason for this relationship is that the rising oil prices increases oil imports which in turn increase the demand for dollars in the Pakistani foreign exchange market because oil is traded in US-dollars in the international market. As a result imports of the crude oil depreciate the Pakistani rupee against the US-dollar. The rising oil prices and imports cause a huge cost to the economy because Pakistan is a net oil importer and lot of foreign exchange reserves are spent on the oil imports every year. Thus, the rising oil prices not only decreases the purchasing power of Pakistani rupee in international market, but also reduces the people faith on rupee domestically.

- **Persistence of Volatility**

In the next stage we find out the persistence of volatility which tells for how much time the volatility persist (continued or prolonged) for our GARCH models. We find it by taking into account persistence of shocks, intensity of shocks, leverage effect, asymmetry and ARCH and GARCH effects respectively. The results of the persistence of volatility are given in table 5.4.

Table-5.4: Persistence of Volatility

	Persistence of Shocks	Intensity of Shocks	Leverage Effect	Asymmetry	ARCH and GARCH Effects
Symmetric Models:	$\sum_{i=1}^{q}\alpha_i + \sum_{j=1}^{q}\beta_j$	$\sum_{i=1}^{q}\alpha_i$	-	-	$\sum_{i=1}^{q}\alpha_i + \sum_{j=1}^{q}\beta_j$
GARCH	0.81	0.14	-	-	0.81
GARCH-M	0.98	0.04	-	-	0.98
Asymmetric Models:	$\sum_{i=1}^{q}\alpha_i + \sum_{j=1}^{q}\beta_j + \gamma/2$ & $\sum_{j=1}^{q}\beta_j$	$-\sum_{i=1}^{q}\alpha_i + \gamma$ & $\sum_{i=1}^{q}\alpha_i + \gamma$	γ	$\frac{\lvert\alpha - \gamma\rvert}{\alpha + \gamma}$	$\sum_{i=1}^{q}\alpha_i + \sum_{j=1}^{q}\beta_j$
T-GARCH	0.96	-0.22 ; -0.02	-0.12	-9.17	1.02
E-GARCH	0.91	0.33 ; -0.25	0.29	1.33	0.87

The two different values in column 3 show the intensity of negative and positive shocks respectively for asymmetric models.

The parameter estimates of GARCH (2, 1) and GARCH-M (2, 1) analyze the symmetrical impact of oil prices uncertainty on the volatility of exchange rate. The volatility follows a stationary process under the restriction ($\Sigma_{i=1}^{q}\alpha_i + \Sigma_{j=1}^{p}\beta_j < 1$) which is equal to 0.81 for GARCH and 0.98 for GARCH-M model. On the other hand, the parameter estimates of T-GARCH (2, 2) and E-GARCH-M (1, 3) show the threshold and asymmetrical effects of oil prices uncertainty on the volatility of exchange rate because the coefficient of leverage term (γ) is significant for both these GARCH models. The coefficient of the leverage effect (γ) is equal to -0.12 for threshold model which is negative and also statistically significant, indicating asymmetries in the news which implies that the positive shocks have larger impact on volatility series than the negative shocks. This coefficient is equal to 0.29 for the asymmetrical model which is positive and statistically significant, indicating that the negative shocks have lower impact on the volatility series than the positive shocks. The volatility/duration of the leverage effect is more persistent for the asymmetrical model as compared to threshold model. Moreover, the relative degree of asymmetry is negative and statistically significant for T-GARCH (-9.17) while it is positive and statistically significant for E-GARCH (1.33) indicating that positive oil price shocks have powerful impact on the conditional variance/volatility of exchange rate. The intensity of shocks is positive for both the symmetrical models and as the other two models deals with both the positive and negative shocks so the intensity of these shocks might be different. For T-GARCH (2, 2), the intensity associated with positive shocks is more than that of negative shocks and opposite is the case for E-GARCH (1, 3), the intensity associated with negative shocks is more than that of positive shocks.

All the above GARCH family models are presented after some diagnostic checkings. The different residuals diagnostics like correlogram Q-statistics and squared residuals and ARCH-LM test are performed for all the GARCH models. The results of the correlogram show that the residuals are not auto correlated. This is shown by insignificant Q-statistics at all lags which implies the absence of serial correlation in residuals. The results of ARCH-LM test also show that all the GARCH models manage to eliminate the problems of heteroscedasticity. This is also shown by the insignificant p-values which imply that the residuals are homoscedastic.

The second objective of the study is to find out the long-run and short-run relationship among oil prices, exchange rate and consumer prices for which first of all we have checked the time series properties of the variables like unit root test. This test tells us about the order of integration of the variables.

5.4. Beaulieu and Miron (1992) Monthly Seasonal Unit Root Test

Beaulieu and Miron seasonal unit root test has been used to check stationarity in monthly data. Under this test we check the stationarity using t-statistics for seasonal unit root detection, while Wald test for non-seasonal unit root detection. After the auxiliary regression we test the serial correlation at 1st and 12th lag by using Breshch serial correlation LM test. The results of the tests are as under:

Table-5.5: Results of Seasonal Unit Root Test Using Beaulieu and Miron approach

Hypothesis	*OP*	ΔOP	*ER*	ΔER	*INF*
$t:\pi_1=0$	-0.93 (-1.93)	-6.75** (-1.93)	-1.79 (-3.35)	-5.57** (-3.35)	-2.97** (-2.82)
$t:\pi_2=0$	-6.52** (-1.94)	-6.60** (-1.94)	-7.28** (-2.81)	-6.79** (-2.81)	-4.03** (-1.94)
$F:\pi_3=\pi_4=0$	47.02** (3.07)	45.89** (3.07)	55.39** (6.35)	51.05** (6.35)	22.26** (3.07)
$F:\pi_5=\pi_6=0$	77.12** (3.06)	67.43** (3.06)	39.17** (6.48)	33.56** (6.48)	24.67** (3.05)
$F:\pi_7=\pi_8=0$	34.94** (3.10)	35.65** (3.10)	58.38** (6.30)	49.4** (6.30)	28.08** (3.09)
$F:\pi_9=\pi_{10}=0$	46.88** (3.11)	43.00** (3.11)	55.31** (6.40)	46.00** (6.40)	27.72** (3.09)
$F:\pi_{11}=\pi_{12}=0$	25.77** (3.11)	26.45** (3.11)	30.06** (6.46)	27.03** (6.46)	29.66** (3.10)
Auxiliary Regression	NC, NT, ND	NC, NT, ND	C, T, D	C, T, D	C, NT, ND

Critical values given by Franses and Hobijn (1997) are in parentheses and ** shows 5% level of significance

Table-5.5 shows the results of the Beaulieu and Miron seasonal unit root test both at level and at first difference. The critical values for unit root test in seasonal time series consider only yearly observations; therefore, we have converted monthly observations into yearly observations. The numbers of monthly observations after adjustment are 40 years. We consider 5 percent significance level using Frances and Hobijin (1997) critical values for seasonal unit root detection of 40 years. The results show that at level the calculated values of the t-statistics for π_1 are -0.93 and -1.79 for oil prices and exchange rate. These calculated values at zero frequency unit root are greater than critical values, so null hypothesis cannot be rejected which implies the presence of unit root at zero frequency i.e. series of oil prices and exchange rates are non-stationary at level. Therefore we have transformed the variables by using first difference filter at zero frequency that is $(1-B)y_t = y_t - y_{t-1}$. After transforming, the calculated values of t-statistics for both π_1 and π_2 are less than the critical values for oil prices and exchange rate. On the other hand the calculated values of F-test statistics are greater than critical values which lead to the rejection of null hypothesis. Therefore, oil Prices and exchange rate become stationary at first difference. Whereas for CPI inflation the calculated value of the t-statistics for π_1 is -2.97 at level. This calculated value is less than the critical value at 5% significance level which implies that inflation contains no unit root at zero frequency. Also the calculated value for π_2 is less than critical value and the F-statistics values are greater than the critical values which leads to the conclusion that the inflation contains no unit root at any frequency and stationary at level.

The Breusch Godfrey serial correlation LM-test has been applied at 1st and 12th lags both for level and at 1st difference. First of all at level, the chi-square calculated values at 1st lag are 2.225, 0.008 and 1.032 for oil prices, exchange rate and consumer prices respectively. These values are smaller than the chi-square tabulated value of 3.841. So null hypothesis is not rejected which leads to the conclusion that there is no problem of autocorrelation at 1st lag of the variables. Similarly, the chi-square calculated values at 12th lag are 10.217, 3.817 and 20.289 for oil prices, exchange rate and consumer prices respectively. These calculated values are also smaller than the critical value of the chi-square at 12th lag which is equal to 21.026. It also concludes that there is no problem of autocorrelation even at 12th lag for all the three variables. The Breusch-Godfrey serial correlation LM test for 1st difference show that at 1st lag the chi-square calculated values are 2.993 and 0.022 for oil prices and exchange rate which are again smaller than the chi-square tabulated value of 3.841. Similarly, the chi-square calculated values are 8.232 and 5.080 for oil prices and exchange rate at 12th lag. Also these calculated values are smaller than the critical value of the chi-square at 12th lag which is equal to 21.026. Again it leads to the conclusion that there is no problem of auto correlation for oil prices and exchange rate at 12th lag of the variables for 1st difference.

So finally we conclude that at level there is no problem of autocorrelation at 1st and 12th lag for oil prices and exchange rates but both variables are non-stationary at level. At first difference there is neither the problem of autocorrelation nor the problem of unit root for oil prices and exchange rates so we can say that both the variables are integrated of order 1. On the other hand for consumer prices there is no problem of autocorrelation at 1st and 12th lag and it is stationary at level. So in the next section we apply ARDL technique as our order of integration is different for different variables and also none of them is I (2).

5.5. ARDL Bounds Testing for Co-integration

In the ARDL model, first of all we have estimated the existence of long-run relationship among variables by computing F-statistics. The orders of the optimal lags are selected on the basis of Akaike Information Criterion and estimation has been conducted for the time period from 1972-M6 to 2015-M12. In fact, we have used AIC to determine the orders of optimal lags to be included in conditional Error Correction Model, while ensuring there's no problem of serial correlation, as emphasized by Pesaran et al. (2001). We have used the Hendry ''General to Specific Approach'' for parsimonious specification. We have selected initially 5 lags (based on AIC) and then drop the insignificant variables, except current (level) variables and intercept. The results of estimated F-test statistic for co-integration have been presented in Table-5.6 along with the critical values suggested by Pesaran et al. (1999). The estimated F-test statistic (22.727) of the Wald test is greater than the upper bound critical values at 1%, 5% and 10% significance level which implies that the null hypothesis of no co-integration is rejected. Therefore, it is concluded that there is a long-run co-integration relationship among variables.

Table-5.6: F-test Statistics for Co-integration Relationship (parsimonious specification)

			Bound critical values (unrestricted intercept and no trend)	
Test statistics	Value	Significance Level	I (0)	I (1)
F-statistics	22.727			
		1%	5.15	5.36
		5%	3.79	4.85
		10%	3.17	4.14

Critical values suggested by Pesaran et al. (1999)

The empirical results of long-run model after the normalization of consumer price index have been reported in Table-5.7. The oil prices have significant and exchange rate have insignificant impact on the consumer price index of Pakistan in the long-run.

Table-5.7.Long-run model

	Independent Variables	
	OP	ER
Dependent Variable:	3.831	2.060
CPI	(0.000)	(0.162)

Probability values are given in parenthesis.

The estimated results of short-run dynamics have been displayed in Table-5.8. In short-run the exchange rate has insignificant impact on the CPI except at its second lag whereas current oil prices and its two lags have significant impact on the CPI. Moreover, in short-run the CPI is also affected by its own four lags values.

Table-5.8. Error Correction Model for CPI

Dependent Variable: $d(CPI)_t$	
Independent variables:	**Coefficients**
Constant	-8.73E-06 (0.999)
$d(CPI)_{t-1}$	0.086 (0.049)
$d(CPI)_{t-2}$	-0.099 (0.023)
$d(CPI)_{t-3}$	0.225 (0.000)
$d(CPI)_{t-4}$	-0.126 (0.005)
$d(er)_t$	0.018 (0.584)
$d(er)_{t-1}$	0.021 (0.554)
$d(er)_{t-2}$	0.090 (0.007)
$d(op)_t$	0.016 (0.006)
$d(op)_{t-1}$	0.016 (0.012)
$d(op)_{t-2}$	0.014 (0.017)
ECT_{t-1}	-0.002 (0.000)

Probability values are given in parenthesis.

The results show that both the oil prices and exchange rate associated positively with the consumer price index. The increase in crude oil prices and exchange rate accelerates consumer prices both in the short-run and long-run. This positive impact of oil prices and exchange rate on consumer prices is also consistent with the findings of Saleem and Khalil (2015). Oil prices have positive relationship with the consumer prices because the coefficient linking the two variables have a positive sign which indicates that one unit rise in oil prices will lead to 3.83 unit rise in consumer prices in the long-run. Pakistan's economy is very vulnerable to the fluctuations in crude oil prices because it is largely dependent on oil imports and also the demand for petroleum products is inelastic due to shortage of alternative energy resources. That's why consumer prices are not negatively related with the oil price fluctuations. Exchange rates also have positive relationship with the consumer prices because again the coefficient linking the two variables has a positive sign which indicates that one unit rise in exchange rate will lead to 2.06 unit rise in consumer prices in the long-run. Pakistan usually has a negative trade balance because its imports are always more than exports. The imports of the country are consisted on oil, heavy machinery and different production inputs. The increase in exchange rate makes these imports expensive and also inflates the domestic prices. The use of imported goods in the economy and also in different production methods brings imported inflation in the country. The coefficients of oil prices are statistically significant both in the long-run and short-run. On the other hand the coefficients of exchange rate are statistically insignificant in long-run and short-run except at its second lag which shows the significant impact on consumer prices in the short-run. It is probably because the real impact of the central bank's policy adjustment for exchange rate change shows into the local economy after some time.

These results have consistency with findings of the Choudhri and Khan (2002) as according to empirical analysis of their paper, the depreciation of rupee has no significant impact on consumer prices in short-run. Also the recent theoretical analysis shows a weak short-run relationship between exchange rate changes and the consumer prices. During last many years, rupee has depreciated significantly in nominal as well as in real terms and this long period loss of rupee's real value implies that even in long-run; the consumer prices of Pakistan cannot fully reflect the depreciation of rupee. Therefore, the inflationary consequences of exchange rate depreciation are unsupported by the facts. Moreover, the results also have consistency with the study of Atif (2010) according to which the short-run and long-run impact of exchange rate changes on consumer price inflation by considering the existing real exchange rate misalignment (RERM) as an independent variable is close to zero in Pakistan. Although the literature provides mixed results about the impact of exchange rate on consumer prices but the dominant view is that exchange rate depreciation has no significant impact on domestic consumer prices (Siddiqui and Akhtar, 1999). Also the findings of Zulfiqar & Shah (2004) have showed that the exchange rate changes have only a little impact on consumer prices and the pass through impact of exchange rate is stronger in whole sale price index relative to consumer price index.

In our model the coefficient of the ECM term provides evidence on the existence of long-run co-integration relationship among the variables. The coefficient is equal to (-0.002) which means that about -0.2% speed of adjustment or convergence will take place towards equilibrium. This negative and statistically significant coefficient of ECM implies that there will be no problem of long-run adjustment due to the shocks in short-run. Further at above the final model is selected when the estimated equations fulfill different diagnostic tests. We have performed two major diagnostic tests the residual diagnostics (serial correlation LM-test) and stability diagnostic (CUSUM test). The results of residual diagnostic have shown that model has no serial correlation problem and the results of the stability diagnostic have shown that our model is stable.

The third objective of the study is to find out direct and indirect effects among the oil prices, exchange rate and consumer prices i.e., the direct effect of oil prices on consumer prices without considering mediating role of exchange rate and the indirect effect of oil prices on consumer prices under mediating role of exchange rate. We have applied the Sobel test to check the role of exchange rate as a mediator.

5.6. Direct and Indirect Effects

First of all we find out the total effect of oil prices on consumer prices separately before inclusion of exchange rate as a mediator in the regression analysis. After that we find out the total effect (combination of direct and indirect effects) of oil prices on consumer prices under mediating role of exchange rate. Table 5.9 summaries the estimated results of the total effects before and after the exchange rate (mediator) enter into the regression model. In our analysis the total effect of oil prices on consumer prices is (1.11) before the role of exchange rate as a mediator. On the other hand by using mediation effect when exchange rate is used as a mediator, the total effect of oil prices on consumer prices is decomposed into two parts, the direct and indirect effects. The direct effect of oil prices on consumer prices is (0.28) and the indirect effect through exchange rate as a mediator is equal to (0.78*1.07 = 0.8346). So the effect of oil prices on consumer prices before the role of exchange rate is (1.11) and under the role of exchange rate as a mediator is (0.28). Therefore, it can be said that when there is exchange rate as a mediator in a regression analysis/model, the effect of oil prices on consumer prices is reduced which is equal to (1.11 - 0.28 = 0.83). Sobel test determines whether the reduction in this effect, after including the exchange rate in regression analysis, is a significant reduction or not and whether the mediation effect of exchange rate (indirect effect) is statistically significant or not.

Table -5.9: Summary of Estimates of Total Effects

Before mediator (ER) enter the model

	Coefficients	S.E.	P-value	Result
OP→CPI	1.11	0.031	0.000	Significant

After mediator (ER) enter the model

	Coefficients	S.E.	P-value	Result
OP→CPI	0.28	0.020	0.000	Significant
OP→ER	0.78	0.027	0.000	Significant
ER→CPI	1.07	0.020	0.000	Significant

Under Sobel test in a single mediator model, the mediation effect is computed in two ways, namely, the product of coefficients approach ($\alpha\beta$) and the difference in coefficients approach ($c - c'$) respectively. The computed Z-statistics for the product of coefficients approach is equal to (Z =25.42) and for the difference in coefficients approach it is equal to (Z = 25.28). These computed Z-statistics values for both the approaches are greater than the critical values of normal distribution. So the null hypothesis that ($\alpha\beta$) or ($c - c'$) is not different than zero is rejected, therefore, it is concluded that when exchange rate is included in regression analysis there is significant indirect effect of oil prices on consumer prices and also there is significant reduction in the effect of oil prices on consumer prices.

The total effect of oil prices on consumer prices before the inclusion of exchange rate in the model is positive which means that rising oil prices will increase the consumer prices i.e., one unit rise in oil prices will lead to 1.11 unit rise in consumer prices. On the other hand after the inclusion of exchange rate in model, the total effect of oil prices on consumer prices can be divided into two parts, one is direct and the other is indirect effect. The direct effect is positive which shows that whenever there is one unit rise in oil prices it will bring about 0.28 unit rise in consumer prices. The indirect effect through exchange rate is also positive which shows that the rising oil prices will lead to rise in domestic currency exchange rate (depreciation of exchange rate) i.e., one unit rise in oil prices will bring about 0.78 unit rise in exchange rate. Further the exchange rate as a mediator also affect consumer prices positively i.e., one unit increase in exchange rate will lead to 1.07 unit increase in consumer prices. Thus, the indirect effect is equal to (0.78*1.07 = 0.8346) and in this way the total effect of oil prices on consumer prices under the influence of exchange rate which is combination of direct and indirect effect is (0.28

+ 0.8346 = 1.11). Therefore, the total effect of oil prices on consumer prices before and after including exchange rate in the regression analysis is positive i.e., (1.11) and with the help of sobel test we come to know that how much oil prices contribute to consumer prices directly and how much indirectly. At last in brief, it can be said that higher the oil prices higher will be the consumer prices even under the influence of exchange rate (mediator). The reason for this positive relationship is that the high oil imports of Pakistan lead to depreciation of rupee against the US dollar. As a result the exports of the domestic country become cheaper and the demand for its products rises in the foreign market. This rising demand leads to increase in prices of the products not only in foreign market but also in domestic market. In this way the exchange rate as a mediating variable brings higher consumer prices in the economy.

CHAPTER 6

CONCLUSION AND POLICY RECOMMENDATIONS

Conclusion

At first stage the study examines the nexus between the oil prices uncertainty and exchange rate volatility by utilizing monthly time series data of Pakistan covering the period from 1972-M6 to 2015-M12. The study employs GARCH-specifications as a measure of the oil prices uncertainty and exchange rate volatility. These different specifications show that the oil prices have positive relationship with the exchange rate i.e., higher the oil prices higher will be the exchange rate and vice versa which implies that rising oil prices will lead to exchange rate depreciation and falling oil prices lead to exchange rate appreciation. The oil prices have asymmetric impact on the exchange rate i.e., asymmetric in the sense that the rise and fall of oil prices have different impacts in magnitude. The positive oil shocks have larger impact on exchange rate volatility as compared to negative shocks. Also the uncertainty shocks of the oil prices have persistent impact on conditional exchange rate volatility.

Oil prices and exchange rate contain unit root at zero frequency and become stationary at first difference. The consumer prices contain no unit root at any frequency and stationary at level. The results of the co-integration technique show that both the oil prices and exchange rate associated positively with the consumer prices but the oil prices have statistically significant and exchange rates have insignificant impact on consumer prices in the long-run and short-run. Oil prices have positive relationship with the consumer prices because being an oil importer the economy of Pakistan is largely dependent on oil and also the demand for petroleum products is inelastic due to shortage of alternative energy resources. That’s why consumer prices are not negatively related with the fluctuations in the oil prices. On the other hand exchange rate also has positive relationship with the consumer prices because the economy of Pakistan usually has a negative trade balance due to expensive imported products. The increase in exchange rate makes these imports further expensive and inflates the domestic prices. The use of imported goods in the economy and also in different production methods brings imported inflation in the country.

Finally in the last stage, we find out the total effects of oil prices on consumer prices before and after mediating role of exchange rate. The sobel test is used to test the possible role of exchange rate as a mediator. The total effect of oil prices on consumer prices before inclusion of exchange rate as a mediator in the regression model is positive i.e., higher the oil prices higher will be the consumer prices and vice versa. On the other hand the total effect (direct and indirect effects) of oil prices on consumer prices under mediating role of exchange rate is also positive. Under direct effect oil prices have positive relationship with the consumer prices i.e., higher oil prices cause higher consumer prices and under indirect effect firstly oil prices are positively related to exchange rate i.e., higher the oil prices higher will be the exchange rate and secondly exchange rate related positively to the consumer prices i.e., higher the exchange rate higher will be the consumer prices. The results of the Sobel test conclude that when the exchange rate is included in the model there is significant indirect effect of oil prices on consumer prices. Also there is a significant reduction in the effect of oil prices on the consumer prices after the inclusion of exchange rate as a mediator. The mediating impact of exchange rate transfers to consumer prices through depreciation of exchange rate which lowers the worth of rupee and brings higher consumer prices in the economy.

Policy Recommendations

As the oil prices are positively related to both the consumer prices and exchange rate which implies that the rising oil prices lead to rise in consumer prices and exchange rate. So in order to reduce the dependency on oil and to avoid from the rising CPI inflation and depreciation of the exchange rate some policy implications are suggested. There is a dire need that the attention should be given on policies related to oil prices. Optimal mix of energy resources is needed to reduce the pressure on oil consumption. The diversification of country's energy mix is required in this regard. This implies that the government should not only depend on oil but also look for alternative energy resources easily available in Pakistan like hydro, coal, wind, nuclear and solar energy resources. As the industrial and other major sectors of the economy are heavily dependent on electricity which is produced by oil so there is a desperate need of effective water resource management to enhance the hydrel electricity production capacity. The government should also give such incentives to domestic and foreign investors that attract them to come and invest in projects related to oil exploration. In this regard there is a need of such policies which are not affected by change of government. Law and order situation should also be improved with in the country for the safe and secure environment to the investors. Government should also provide subsidies on the oil prices for the domestic users. In order to decrease the unbalance pattern of petroleum products consumption there is need of tax rationalization in this sector. The above all policy implications will help the country to overcome the severe problems of rising oil prices within the country. The impact of oil prices on consumer prices and on the depreciation of exchange rate can be decreased by the implementation of these policy recommendations.

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