Oil Price Pass Through To Inflation in Pakistan; Evidence from Transfer Functions Approach

By

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A Thesis submitted to the Pakistan Institute of Development Economics, Islamabad for partial fulfillment of the requirement for the degree of Master of Philosophy in Econometrics

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AUTHORSHIP STATEMENT

I UM -I-SAFIA solemnly declare that I myself have written this MPhil thesis with my own work and means, and I have not used any further means except those I have mentioned in references. All stufftaken from internet or other sources have been mentioned in references.

UM-I-SAFIA D/O MUZAFFAR ALI

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UM-I-SAFIA

DEDICATED TO MY FATHER, MOTHER, FATHER IN-LAW, MOTHER IN-LAW AND MY HUSBAND

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ABSTRACT

The study aims to find the pass-through of world oil price and domestic oil price to the inflation through transfer function model. Monthly data has been used for the period of 1974 M7 to 2014 M6. Transformation of the series has been checked with Box-Cox transformation (1964) and it suggests log transformation for all the series. Unit root of the series was checked with Beaulieu and Miron(1993) monthly unit root test. At level there was unit root at zero frequency in all three series. So, after first differencing all the series were stationary. Logged and first differenced series were used to identify and estimate the transfer function models. The results of bivariate transfer function models concluded that 8% and 11% of shock of tenth and fifteenth lag of world oil price passed to inflation respectively. 34% and 40% of the shock of first and thirteenth lag of domestic oil price passed to inflation. And 8%, 8% and 5% 0f the shock in current, third and seventh lag of world oil price passed to domestic oil prices respectively. The results of bivariate model concluded that 6%, 11% and 5% of the shock in tenth fifteenth and sixteenth lag of world oil price passes to inflation and 35% and 41% of the shock in first and thirteenth lag of domestic oil price passes to inflation.World oil prices takes almost a year to pass on its affect to inflation. As world oil prices transmits through different channels to domestic economy, so it takes almost a year to affect inflation. Domestic oil price transmits its change to inflation after a month and its effect remains in inflation for almost a year. Khan & Ahmed, (2011) obtained almost similar results.

Chapter 1

INTRODUCTION

Inflation in an economy will result in decrease in the purchasing power of the individuals of the market. (Either they are consumer or firms) inflation will affect the poor individuals of the economy either they are small firms or poor consumers resulting in decrease in their wellbeing. Inflation in an economy further worsens the income distribution of the economy. By making poor more poor and rich richer.

Inflation in an economy decreases the aggregate demand. Which further worsens the economic situation in the country. The overall supply of money in market increases as now individuals requires more money to do his transactions. And to control this if central bank tightens the monetary policy this will result in decrease in investment and the overall production will decrease. There is a multiplier effect of inflation on an economy. Due to the increase in the price levels the balance of trade of an economy also deteriorate as now the domestic goods become more expensive and exports decreases which will result in less demand for domestic currency and result in depreciation of the domestic currency.

Oil price and the inflation have a positive relationship as they move up and down together. The reason behind this is as the oil is an important input in production, transportation and other activities like heating and etc. The increase in price of oil will result in overall increase in inflation. The increase in oil prices in international market has a direct and an indirect effect on domestic inflation. This relationship got fame after the sudden and big increase in oil prices in international market in 1970's. Which resulted in the increase of inflation with same rate as oil prices increased. This relationship deteriorate after 1980 for developed countries but the relationship still exist in small, open, developing and oil importing country like Pakistan. (Barsky & Kilian, 2002)

Due to the integration of the economies the external shocks affect the domestic economy, especially for a small and open economy like Pakistan. External shocks in international market passes to the country and affect the economic variables.

As Pakistan is a small and open economy and it imports and exports different goods. External shocks pass through to the country through these links. Pakistan majorly fulfils its demand of oil by importing from international market. And the shocks in the prices of oil in international market passes to the domestic market effecting different variables in economy. The fluctuations in the oil price also effect the inflation rate in Pakistan especially the shock in oil prices in international market in 2008 has a big effect on Pakistan's economy. It effected the cost of production which effected the industrial productivity and results in decreased output growth. There is bulk of literature which empirically states a strong relation between international oil prices and domestic economic variables. Especially for a small, open, oil importing and emerging country like Pakistan.

Theoretical and empirical literature has proven that shock in oil price adversely affect the economic variables especially for oil importing countries like Pakistan, creating inflation and budget deficit. In a country where 32% of the energy demand is fulfilled by oil and 82% of the oil demand is fulfilled by importing from international market. (Malik, 2007)

After 1970's oil prices shock many researchers and policy makers started analyzing the relationship between oil price shocks and economic variables. Inflation was one of the main variable which many researcher studied and some even started associating these shocks with the rescissions. Bruno and Sachs (1982) Hamilton (1983) and then in (1996, 2000) Burbidge and Harrison (1984) Federer (1996)Lee & Ratti, (1995)Gisser & Goodwin, (1986)Mork, (1989)Hoover and Perez (1994) Barsky and Kilian carried a research in (2002) and he concluded that oil price shocks are undoubtedly inflationary, especially when CPI is used as measure of inflation.

1.1 Significance of the study

Different researchers employed different methodologies to empirically investigate the relationship between oil prices and inflation. But transfer function has not been employed yet to see the relationship between oil prices and inflation.Especially on the data of Pakistan. As according to Bartlett, (1935) if there is auto correlation present in the variables,the coefficients become spurious. So, simple OLS estimatesbecomes spurious. And transfer function addresses this problem. Transfer function results are also applicable for policy recommendations. The results will tell us the number of lag periods oil prices takes to effect the inflation in Pakistan and for how long this effect remains in inflation.

1.2 Objectives of the Study

1.2.1 Main objective

The main objective of the study is to investigate the impact of international and domestic oil price on inflation and find after how many lag periods change in oil price starts toaffect the time path inflation in Pakistan and for how long the effect of oil prices remains in inflation.

1.2.2 Sub objectives

1. To investigate the impact of world oil price on domestic oil price and after how many lag periodschange in world oil price start to affect the time path domestic oil prices and for how long the effect of world oil prices remains in domestic oil prices.

2. To investigate the impact of domestic oil price on inflation and after how many lag periodschange in domestic oil price start toaffect the time pathof inflation and for how long the effect of domestic oil price remains in inflation.

3. To investigate the impact of world oil price on inflation and after how many lag periods change in world oil price start to affect the time path inflation and for how long the effectof world oil prices remains in inflation.

1.3 Hypothesis:

Main hypothesis

H_1: The oil prices has no lag effect on the inflation.

H_0: The oil prices has lag effect on the inflation.

Hypothesis for domestic oil prices

H_3: The world oil price has no lag effect on the domestic oil prices.

H_0: The world oil price has lag effect on the domestic oil prices.

H_4: The world oil prices has no direct effect on the domestic oil prices.

H_0: The world oil prices has direct effect on the domestic oil prices.

1.4 Methodology

According to the Keynesians inflation is caused by the disruptions in the supply of inputs,which results in increase in prices of inputs and hence results the overall inflation in economy.Lescarousx & Mignon, (2008)The world oil prices affect the domestic inflation through different channels. One is world oil prices passes to domestic prices and effects the inflation. As due to increase in domestic oil prices the production and transportation cost increases.Gordon, (1988). Second is world oil prices directly affect the domestic inflation as due to increase in world oil prices the overall prices in the world increases including food and transportation which transmits to domestic inflation,especially in a small and open country like Pakistan.(Hooker, 2002)

1.5 Econometric methodology

We have used transfer function to see the pass through of oil prices to inflation. As transfer functions can be used to study dynamic relationship of the variables.

1.6 Data source

We useddata of four series, world oil prices, domestic oil prices in Pakistan and CPI percentage change of Pakistan and exchange rate of Pakistan. Data is collected for the period of 1974M7 to 2014M6. Domestic oil prices were collected from Pakistan bureau of statistics and rest of the data was collected from IMF.

1.7 Plain of The Study

In the second chapter we will give some salient features of inflation in Pakistan and oil prices in the world. Third chapterwill be literature review. In fourth chapter we will briefly write the methodology of the research. Fifth chapter will be of results and discussion. Sixth chapter will be conclusions and recommendations.

CHAPTER 2

SALIENT FEATURES OF INFLATION AND OIL IN PAKISTAN AND OIL PRICES IN THE WORLD

2.1 Introduction

In this chapter we will briefly give the back ground of inflation in Pakistan. And a brief history of world oil prices.

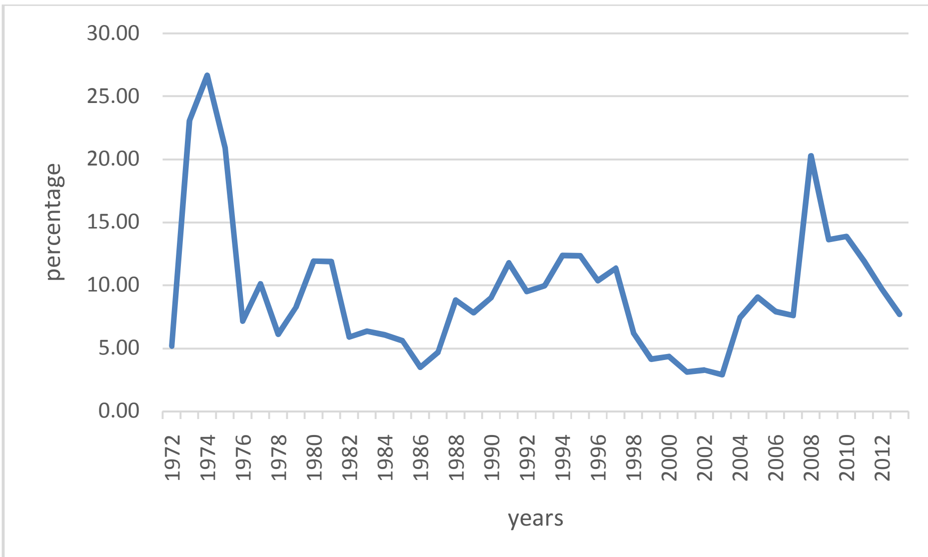
After the creation of Pakistan the inflation rate has been quite stable on average but during some periods it has been quite high. Especially during the times when the international oil prices were high. Only 5 times it was less than 5 percent. During the decade of 1970's the inflation was on average 11.9 and in 1980's it decreased to 7.5. But during 1990's it was again 9.7 and in 2000 it was 8.5 and from 2001 to 2014 it is 9.7.

2.2 Trend of inflation in Pakistan

After 1972 to 1975 inflation was at its peaks with 26-20% inflation. But after that until 1980 inflation remained normal. And then during 1980-81 inflation was in double digits. Inflation remained normal throughout the decade after 1981. But in next decade of 1990's inflation rate was in double digit for the whole decade. The reason behind this was military rule, afghan war, sanctions, deregulation of markets and the central bank got its autonomy and Pakistan switched from fixed to float exchange rates. Then from 1999 to 2003 inflation remained below 5%. Inflation remained below 5% for five consecutive years. Inflation was below 5% once in 1986 - 87. After 2003 inflation remained at the average of 7.5% till 2008. But it suddenly increased to

20% in 2008 and after 2008 till 2012 inflation remained in double digits. And then after 2012 till now it remained on average of 8%.

Figure No.2.1: Inflation in Pakistan (1972-2014)



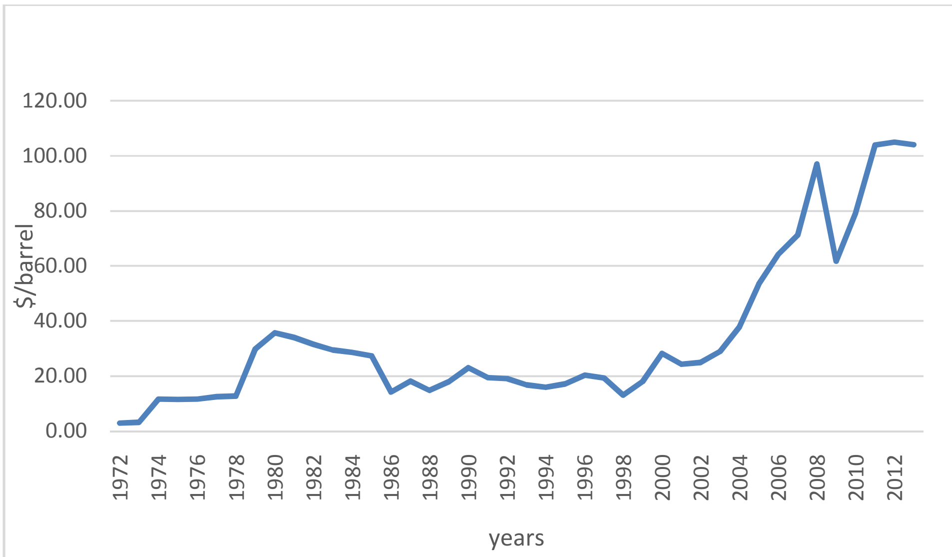
2.3 Trend in International Oil Price

The reason behind the spikes in the oil price are the geopolitical, OPEC supply disruptions and non OPEC supply disruptions. Before 1971 oil prices were controlled by the US (Taxes, Oklahoma, and Louisiana). But after a decade of formation of OPEC in 1971 it realized its control over oil prices. Initially in 1960 there were five members of OPEC and then in 1971 six more members joined OPEC.

In 1972 the world oil price was 3.5$/ barrel. But 1973 Egypt and Syria attacked Israel and United States and other western countries took side of Israel. So, many Arab oil exporting countries including Iran embargo on western countries and United States and curtailed its production.

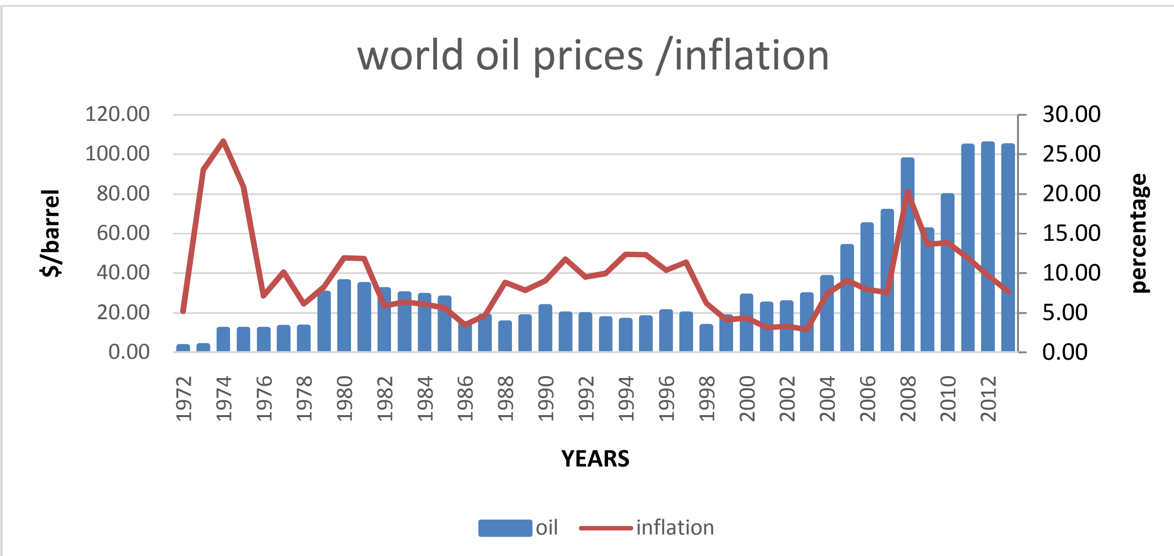
That's why the price of oil in international market tripled in 1974. After 1974 to 1978 oil prices remained

Figure No. 2.2: World Oil Prices $/barrel (1972-2014)



even. But in 1979 due to the Iranian revolution the supply disrupted and again prices increased but soon they controlled there production. And then in 1980 Iraq invaded Iran and due to the disruption in the production of both countries the prices increased. But after 1980's the prices got stabled because of non OPEC production and geopolitical stability. But in 1990 when Iraq invaded Kuwait prices slightly increased and after 1990 almost throughout the decade the prices remained stabled. So, in 1999 OPEC started to cut down its production. And due to the increasing demand for oil by emerging and developed countries prices increased. But in next three years the prices remain stable due to the increase in production of non OPEC countries especially Russia. In 2003 US invaded Iraq and due to the growing demand for oil in developed and emerging countries and disruption of production in Iraq and Venezuela the price of oil started increasing. These hikes in the prices were demand driven. As most of the countries were building their inventories of oil including US. 1n 2008 price of oil reached 97US $. In 2009 OPEC again decreased its supply and due to increase in demand of oil in Asian countries and disruption of 400,000 barrel/ day due to civil war in Libya the prices increased. After 2010 the price of oil continued to increase due to growing demand in emerging and developed countries.

Figure No.2.3: Inflation in Pakistan and World oil Prices(1972-2014)



The graph of inflation rate and world oil prices show that the shock in world oil price have effect on the domestic inflation, as the spikes in oil prices coincide with the hikes in inflation. Same results were found when the graph of world oil prices and US inflation was graphed together. It showed that after great depression three recession coincide with high spikes in oil price concluding that there is a relationship between oil price and inflation.

2.4 Conclusion

As Pakistan fulfills about 80% of its overall oil consumption by importing it from international market. So it is vulnerable to shocks in oil prices as there is no other substitute or one cannot shift to other energy in short run. The domestic oil prices of Pakistan are controlled by the government of Pakistan. And it changes with the changes in international market. Due to this the productioncost, transportation cost and other cost increase, which results in inflation in market. The oil prices increase in international market also transmits to domestic inflation as international food and overall inflation increases with oil prices.

Chapter 3

LITERATURE REVIEW

3.1 Introduction

In this chapter we will do literature review of previous studies related to the oil prices and inflation relationship. We have divided this chapter into two parts. First part of the chapter contains literature on international economies and the second part contains literature on Pakistan economy.

3.2 International literature

Pakistan was experiencing high inflation during past decades. Both internal and external shocks effect the inflation. Domestic factors effecting inflation are fiscal, monetary shocks and demand supply gap. On the other hand the external shocks include shocks in exchange rate food and energy price shocks in international market and global events.

In small country like Pakistan, such global events and other external shocks do effect the economy of the country and specially the inflation rate with varying pass-through rates from country to country. This pass through is large in small countries like Pakistan. Gelos & Ustyugova,(2012) in a study proved that the pass-through is higher in developing countries and small economies as compare to the developed ones.

Due to the integration of the economies the external shocks affect the domestic economic variables. One of the best examples is the pass through of international oil prices shock to the domestic inflation. Oil prices pass-through to inflation got attention after the 1973-1974 oil price shock.

Oil price shocks are considered as supply side shock and neoclassical believe that a shock in supply results in increase in general prices (Abel & Bernanke, 2005)

Many researchers used different techniques to see the effect of world oil prices on domestic inflation for different regions. Here we want to see either shocks in oil prices affect the domestic inflation in Pakistan and will see how much of the shock pass through to domestic oil prices and inflation in Pakistan. We are also interested to find how long shocks in world oil prices takes to affect the time path of domestic oil price and domestic inflation.

In a research by Gao *et al.,*(2013)onthe economyUS tried to find the effect of oil shock on consumer. They used a bivariate VAR model to see the pass through of oil price shock to aggregate CPI and dis aggregated CPI's of energy, housing, transportation, food, medical care and apparel. The impulse response function of oil shock to aggregate CPI showed strong pass through effect. Some of the disaggregated CPI (food, medical care and apparel) showed small pass through. While results showed strong pass through for energy and transportation. The pass through of oil shock to housing CPI was positive and significant but the pass through remained short period.

A research was carried for the economy of Japan to study the pass-through of world oil prices to domestic inflation. VAR (TVP-VAR) was employed to see either the pass through has decreased or increased over time. The results concluded that the pass-through has decreased and the reasons are that now oil price is a small portion of input cost and due to substitution effect of inputs. As firms have shifted now to other energy sources and using less oil intensive production systems.(Shioji & Uchino, 2010)

The research by Niyimbanira, (2013) was aimed atstudying the effect of oil prices on inflation. The researcher used cointegration method to see either their exist relation between oil prices and inflation. For this he first checked the stationarity of the series by ADF test. The result exhibits relationship between oil prices and inflation. The direction of relationship between oil prices and inflation was checked by Granger Causality test. The results showed a unidirectional relationship between oil prices and inflation running from oil prices to inflation.

Using a 4 equation VAR model Bhattacharya & Bhattacharyya, (2001) aimedat studying the pass through of shock of oil price to the inflation of the commodities other than oil in India. It also aimedat finding out that how long shocks in oil prices takes to pass through to inflation. The results exhibits bidirectional relationship between oil prices and inflation of other commodities than oil. The impulse response function showed pass through of shocks of oil prices to inflation and concluded that oil prices takes five to seven months to pass its shock to inflation.

Al-Shawarby & Selim, (2012) carried a research for the economy of Egypt for the period of 2001 -2011. Researchers wants to study the pass through of shocks of international food prices to the inflation by usingsimple OLS and VAR. The results confirm the pass through of international food prices to the inflation. The pass through was more in short run then in long run and it takes about 6 months to a year to pass through. The results concluded that a small portion of international food prices passes to inflation and the pass through is asymmetric.

Adenuga *et al*, (2012)wants to find out the effect of oil prices on the Nigerian inflation rate. The researchers used ARDL approach. They used quarterly data for the period of 1990-2010. The results concluded that oil price has a pass through effect on inflation rate in Nigeria in both short and long run. It is more in long run. But the pass through is not complete.

A research was carried for the economy of Turkey to study the existence of the pass through in low and height inflation regimes by using Markov Switching Autoregressive (MS-VAR) model. The results did not showed strong pass through of crude oil to inflation in low and height regimes. But the results showed a pass through of refined oil prices to inflation in both regimes. The pass through of refined oil prices to inflation declines as the economy moves from height to low inflation regimes as suggested by Taylor (2000).(Çatik & Karaçuka, 2012)

A study was carried out for the economy of Sri Lanka in March 2008 to study the effects of external shocks to the domestic inflation. They used Exchange Rate, Food and Oil Prices and Import Prices shocks as proxy to External Shocks. They used the VAR model to analyze the effect. The result showed that there is incomplete pass through effect of the Exchange Rate, Food and Oil Prices and The Import Prices Shocks to the Domestic Inflation. The result showed that there is room for other factors to effect the domestic inflation, like administration of prices and other factors like monetary policy and other. External shocks only explain 25% of the variations in domestic inflation. While rest of the 75% of domestic inflation can be controlled through monetary and fiscal policy.(Duma, 2008)

A research was carried out for economy of Spain and Euro area to find out the impact of oil price and domestic inflation. The result showed that oil price change has a less pass through effect to the domestic inflation andcrude oil price is one of main drivers in the inflation fluctuation. The results also showed the pass through is higher in Spain than in euro area and the direct effect transmission channel is getting more important over the time than indirect. (Álvarez *et al.,* 2009)

Atukeren, (2003) Tried to find out the effect of oil price shock on Switzerland, which is open, small and without oil resources. He used granger causality test to see if oil shock granger cause macroeconomic variables. The results found that oil shock has adversely effected the GDP, exports and imports. But there is no effect of oil shock on inflation.

Sukati, (2013) Used VAR and co-integration to see the effect of oil price shocks on inflation in South Africa. He used a bivariate model. The results found no relation between oil prices and inflation. So he suggests to find other determinants of inflation.

A research carried out in Chile in November 2001 to study the international price and exchange rate effect on the inflation they used quarterly data from 1986 quarter 1 to 2001 quarter 1. The checked the stationary of the variables and then used differenced variables. (García & Restrepo, 2001)

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

Using the Global VAR method the researcher aimed at studying how much of the shock of oil and food prices transmits to the domestic inflation. Firstly they studied the short run effect of the shocks of both food and oil price to inflation. And the results showed that the direct effect/short run effect of oil prices is high in developed countries, while pass through is less in emerging countries. And the direct or short run effect of food prices to domestic inflation is high for emerging countries and is less for developing countries. And through Generalized impulse response function the results showed that there is second round effect of food and oil prices on domestic inflation. And major part of inflation in CPI is due to foreign source. (Galesi & Lombardi, 2009)

To study the global patterns of inflation the researcher studied 24 OECD countries for the period of 1980-2007. He used Factor traditional Phillips Curve frame work. The results showed that the shocks in import prices effect the inflation the researcher also included the output gap and monetary policy. (Eickmeier & Moll, 2009)

Aiming to find out the difference between 1970's oil shocks and 21st century a research was carried out byWong, (2013). The results of the study showed that the demand driven oil price shocks are not inflationary. Secondly the shocks of the oil prices due to supply and speculative demand has been also decreased. And thirdly the market expect high oil prices so, it builds inventories. And results into incomplete or less pass through of shock of oil prices to inflation.

A research was carried out by the Central Bank of Chile. It aimed at studying the declining trend of oil prices pass through to domestic inflation. They used correlation, augmented Phillips curve and they also tested for breaks for 34 countries. They found a declining trend of pass through for industrial countries but for emerging countries this declining trend is less. They also estimated rolling vector autoregressive for 12 countries. And impulse response functions and defined their integrals as pass through coefficients. The result showed that the pass through of oil prices shock to domestic inflation has fallen for all 12 countries. The reason behind the decrease in pass through effect of oil prices to inflation is decreasing trend of dependency of countries on only oil. Rather they shifted to the other types of energy and the decrease in pass through of exchange rate. And one main reason is that the current shocks in oil prices are demand driven. Above mentioned factors are the reason behind the decrease in the pass through of oil prices to inflation. (Gregorio *et al*., 2007)

A research aimed at studying the dynamics of the inflation in Ethiopia and Kenya was carried out by using Error correction model. To study the dynamics of inflation they included the CPI, Exchange rate, money supply, domestic agricultural supply shock, food and noon food world prices and energy prices. The results presented that both the countries inflation dynamic are same. There is a long run effect of world food prices and exchange rates on inflation. Where there is a short run effect of money supply growth and agricultural supply shock on the inflation. The results also clearly showed inflation inertia. The results clearly concluded there is lack of monetary or exchange rate policy for both countries. (Durevall & Sjö, 2012)

The high world oil prices in the period of 2002-2008 also affected the Kenya's economy by highly effecting its inflation. This study aims to find the pass through of world oil prices shock to domestic inflation. For this they used Phillips curve approach. The results showed that the oil prices shocks in the world do effect the domestic inflation with .5% in short run and 1% in long run pass through due to 10% shock in oil price. The exchange rate pass through to inflation is .32 in short run and .64 in long run. The results show that both oil price shock and exchange rate shock pass through to inflation is not complete. The study also concludes that inflation is also effected by domestic demand. (Kiptui, 2009)

A study carried out by Jalil & Zea, (2011)tried to find out how the world food pricesaffect the domestic inflation in Latin American countries (Chile, Peru, Brazil, Colombia and Mexico). Researcher used the impulse response analysis of co integrated vector autoregressive method. The results empirically stated that world food prices take three months to one and half year to pass on the shock into inflation. And the elasticity calculated by domestic prices to international food prices stated that the pass through is not complete. They also calculated separate elasticity for both local food prices and headline prices to international price to check for the second round effect. Concluded that second round effect does exist. So they suggest a monetary policy to control the domestic inflation when the world food prices inflate.

A research was carried out for the economy of Australia to study the effects of external shocks and monetary policy to domestic inflation. As we know that Australia is a small country so it is vulnerable to the external shocks. X Chen used SVAR frame work to study. External shocks include oil prices, exchange rate and import prices shock. The results conclude that the oil prices have the most effect on domestic inflation exchange rate and import prices. All three jointly describe 20% of the variations in domestic inflation. He further concludes that the monetary policy has a negative effect on domestic inflation. To see the effect of monetary policy he divided the whole period into two parts, before and after RBA's inflation policy. And the results concluded that after the RBA's inflation policy the import prices pass through to inflation has diminished. So this study suggests monetary policy to control pass through of external shocks to domestic inflation. (Chen, 2010)

Using monthly data a research was carried out for the economy of Taiwan for the period of 1982 M1-2010m12 by Chou & Tseng, (2011). The used different price determinants like CPI, core index and basic sub-indices. The results empirically stated that the pass through of shocks of the oil prices to the domestic inflation determinants is present in long run but absent in short run. They used ARDL model with augmented Phillips curve, rolling regression and recursive regression.

3.3 Literature in context of Pakistan

A study was carried out byKhan & Ahmed, (2011) in Pakistan aimedat finding out how the external shocks, (oil price and food price) shocks effect the domestic inflation and some other macroeconomic variables using the monthly data from 1990 M1 to 2011M7. They used the SVAR frame work to analyze the pattern of pass through. They used generalized impulse response and generalized forecast variance decomposition functions to figure out the impact of both oil and food pricesand they came to know that the oil price shocks positively affect the inflation and it also affects the other macroeconomic variables including the real effective exchange rate. And the study also clarifies the positive affect of food price shocks on inflation showing that the external shock are the main determinants of inflation in Pakistan.

Jafri *et al*., (2012) carried a research to estimate the pass through of international food and oil inflation to domestic inflation. Using monthly data from 1993 M2 to 2012 M2 they first check the stationarity of the variables through ADF and then used the simple ordinary least square method to estimate the pass through. They used the differenced variables which were I(1) and level variables which were I(0). The estimates says that the food and oil prices and industrial inputs prices positively affect the inflation.

A research carried out by Ansar & Asghar, (2013)aimed at finding out the impact of oil price change on the stock market and inflation. They used monthly data from 2007 to 2012 and then used multiple regression model for this they first used checked the stationarity of the variables (price, KSE 100 index) and oil prices using ADF result showed that the variables are stationary at 1st difference. And then he used Johansson co-integration. The results showed that there is a positive relationship between oil and stock market KSE 100 index and oil and inflation.

A research was carried out to study the external and domestic determents of inflation in Pakistan. They used the ARDL approach to check for long run and short run behavior of variables. They used annual data for the period of 1972-2010. The results of ARDL approach stated that the growth of money supply, lag of inflation, foreign inflation and financial crisis inflate the domestic prices in long run. While in short run only growth in money supply is in significant. Further they used ECM (error correction model) to check for convergence. And the results show that in long run inflation converges to equilibrium point. They recommend that proper policies must be made to control the pass through of external shocks to domestic inflation. (Asghar *et al.,* 2013)

A research was carried out in Pakistan to check for the effect of world food and oil prices shock to the local food prices. He used Granger non causality test. For this he first check the integration order of variables by the ADF test. The results of granger non causality stated that domestic food inflation Pakistan is effected by world food inflation. They checked the persistence of inflation and its volatility using AR (1) models. And they also used graphs to check the diffusion of inflation. The graphs showed that the changes in domestic food prices change follow the world food prices change. And nonfood inflation is more affected by international shocks (Hanif, 2012)

3.4 Conclusion

The above studies have employed different methodologies to fulfill their different objectives. Some used panel data and some used time series data. Some researchers have used VAR model to estimate the pass through of oil price to inflation. And some have used co-integration to see the relationship both in long run and in short run. Some of them wants to see the causal relationship so they used Granger Casualty test. And some want to know simple relationship so they used OLS and ARDL, bivariate and simple dynamic models to fulfill their objectives.

The relationship between oil price and inflation got importance after 1970's when Hamilton and some other researchers argued that almost every oil price shock is followed by a recession. So to investigate this relationship different researchers in different part of the world employed different methodologies and got different results. Some researchers were interested to find causal relationship between oil prices and inflation. Some of them were interested to find out the pass through of oil price shock to inflation.

The results were different for different methodologies and different areas. Some of them concluded that there exist a causal relationship between oil prices and inflation. And found different pass through rates in different areas in long and short run. Some concluded that the pass through rate has decreased over the time. It is not as high as it was in 1970's and especially for developed countries like US. But still in small, emerging, open and oil importing countries there still exist the effect of oil price on inflation. Even some oil exporting countries like Iran have also positive effect of oil prices on inflation. Due to increase in revenues and fiscal expansion there exist inflationary trend.

CHAPTER 4

METHODOLOGY

4.1 Introduction

In this chapter we will briefly describe the methodology we adopted to carry this research. Each and every single step has been briefly discussed. First step is the economic model specification. Second part is econometric model and then the econometric methodology. Econometric methodology portion briefly discuses whole econometric estimation. And at last the source of thedata is given.

4.2 Economic Model:

Barsky & Kilian, (2002)in a research argued that the shocks in oil price are inflationary and estimated a bivariate VAR model to estimate it. Inflation is function of world oil price and domestic oil price.

$\pi_t = f\ (WOP_t, DOP_t)$ (4.1)

Domestic oil price is function of world oil price

$DOP_t = f\ (WOP_t)$ (4.2)

WOP = world oil price in Rs/litters

DOP = domestic oil prices in Rs/litters

π = inflation (percentage change in CPI)

4.3 Econometric Model

4.3.1. Bivariate transfer function model of inflation and world oil price

Considering a bivariate transfer function model initially and deriving function for inflation**.**

One Output Variable = π and One Input Variable = WOP

Input variable is related to the output variable. We can split inflation into two components, that is;

$\pi = U_T + N_t$(4.3)

Where U_T is Explained part of π, N_t is error term, that part which is not explained by the input series, i.e. WOP

Assume Dynamic linear relationship between U_t and WOP_t

$$U_t + \delta U_{t-1} + \ . \ . \ . \ + \delta_r U_{t-r} = \omega_0 WOP_{t-b} + \omega_1 WOP_{t-b-1} + \ . \ . \ . \ + \omega_s WOP_{t-b-s}$$

$$U_t = \frac{\omega_0 + \omega_1(B) + \ . \ . \ . \ . \ + \omega_s(B^s)}{1 + \delta(B) + \ . \ . \ . \ . \ + \delta_r(B^r)} \ WOP_{t-b}$$

Where $U_t = \frac{\omega\,(B)}{\delta\,(B)}$ WOP_{t-b} $U_t = \upsilon(B)\ WOP_{t-b}$

Where $\upsilon\,(B) = \frac{\omega\,(B)}{\delta\,(B)}$

- $\omega(B)$ is moving average operator
- $\delta(B)$ is autoregressive operator, and
- b is purely delay parameter, which represents number of complete time intervals before a change in WOP begins to have effect on π.

$$\pi = \frac{\omega(B)}{\delta(B)} WOP_{t-b} + N_t$$

If N_t is non-stationary it can be represented by ARIMA(p, d, q) model

$$\Delta^d N_t = c + \frac{\theta(B)}{\phi(B)} a_t$$

Where π and WOP are seasonal series of order s

$$\Delta^d \Delta^D \pi = \frac{\omega(B)}{\delta(B)} \Delta^d \Delta^D WOP_{t-b} + N_t$$

Where N_t is the seasonal operator of the noise variable

$$\text{SARIMA}(p,d,q)*(P,D,Q) = \Delta^d \Delta^D N_t = \frac{\theta(B)\Theta(B^s)}{\phi(B)\Phi(B^s)} a_t$$

$$\boldsymbol{\Delta^d \Delta^D \pi = \frac{\omega(B)}{\delta(B)} \Delta^d \Delta^D WOP_{t-b} + \frac{\theta(B)\Theta(B^s)}{\phi(B)\Phi(B^s)} a_t} \qquad \textbf{(4.4)}$$

Inflation is a function of world oil price. Through this equation we will see after how many lag periods thechange in world oil price starts to affect the inflation and for how long the effect remains in inflation.

From the procedure mentioned above similarly function can be derived for other model of inflation and DOP.

4.3.2 Bivariate transfer function model of inflation and domestic oil price

Inflation is a function of domestic oil price. Through this equation we will see after how many lag periods the change indomestic oil price start to affect the inflation and for how long the effect remains in inflation.

$$\Delta^{\mathbf{d}}\Delta^{\mathbf{D}}\,\boldsymbol{\pi} = \frac{\boldsymbol{\omega}(\mathbf{B})}{\boldsymbol{\delta}(\mathbf{B})}\Delta^{\mathrm{d}}\Delta^{\mathrm{D}}\boldsymbol{DOP}_{\mathbf{t-b}} + \frac{\boldsymbol{\theta}(\mathbf{B})\boldsymbol{\Theta}(\mathbf{B^s})}{\boldsymbol{\phi}(\mathbf{B})\boldsymbol{\Phi}(\mathbf{B^s})}\,\mathbf{a_t} \qquad \textbf{(4.5)}$$

4.3.3 Bivariate transfer function model of domestic oil price and world oil price

Domestic oil price is a function of world oil prices. Through this equation we will see after how many lag periods thechange in world oil price starts to affect the domestic oil price and for how long the effect remains in domestic oil price.

$$\Delta^{\mathbf{d}}\Delta^{\mathbf{D}}\,\boldsymbol{DOP} = \frac{\boldsymbol{\omega}(\mathbf{B})}{\boldsymbol{\delta}(\mathbf{B})}\,\Delta^{\mathrm{d}}\Delta^{\mathrm{D}}\boldsymbol{WOP}_{\mathbf{t-b}} + \frac{\boldsymbol{\theta}(\mathbf{B})\boldsymbol{\Theta}(\mathbf{B^s})}{\boldsymbol{\phi}(\mathbf{B})\boldsymbol{\Phi}(\mathbf{B^s})}\,\mathbf{a_t} \qquad \textbf{(4.6)}$$

4.3.4 Multivariate transfer function Model of inflation, domestic oil price and world oil price

To see the effect of both world oil prices and domestic oil price on the inflation we made a multivariate model as.Inflation is a function of both domestic oil price and world oil price. Through this equation we will see after how many lags periods the change in domestic oil price and change inworld oil pricestarts to affect the inflation and for how longthis effect remains in inflation.

$$\Delta^{\mathbf{d}}\Delta^{\mathbf{D}}\,\boldsymbol{\pi} = \frac{\boldsymbol{\omega}(\mathbf{B})}{\boldsymbol{\delta}(\mathbf{B})}\,\Delta^{\mathrm{d}}\Delta^{\mathrm{D}}\boldsymbol{DOP}_{\mathbf{t-b}} + \frac{\boldsymbol{\omega}(\mathbf{B})}{\boldsymbol{\delta}(\mathbf{B})}\Delta^{\mathrm{d}}\Delta^{\mathrm{D}}\boldsymbol{WOP}_{\mathbf{t-b}} + \frac{\boldsymbol{\theta}(\mathbf{B})\boldsymbol{\Theta}(\mathbf{B^s})}{\boldsymbol{\phi}(\mathbf{B})\boldsymbol{\Phi}(\mathbf{B^s})}\,\mathbf{a_t} \qquad \textbf{(4.7)}$$

4.4 Econometric Methodology

4.4.1 Transformation

In quantitative analysis we usually don’t have normal data. Due to the presence of extreme values and overlap of more than on one data collection processes. In this case we have to take some remedial measures which includes transformation of the data/series. It make the non-normal data normal one.

Objectives of transformation are

- To stabilize the variance of the data.
- To make the seasonal data additive.
- To induce symmetry or possible normality.
- To produce the residuals of constant and minimum variance.

Box-Cox Transformation

We have used improved form of power transformation by Box-Cox in 1964. Box- Cox defines the function as a continuous varying function with its power parameter λ .

$$\mathrm{Y}_t(\lambda) = \frac{Y_t^{\lambda} - 1}{\lambda} \tilde{Y}^{1-\lambda} \text{ if } \lambda \neq 0 \qquad (4.8)$$

$$\mathrm{Y}_t(\lambda) = \tilde{Y} \log Y_t \text{ if } \lambda = 0 \qquad (4.9)$$

Box-Cox transformation uses geometric mean of the series as weight to overcome the biased issues.

Following are the steps

- Chose 11 values of λ from -1 to 1 with equal intervals.
- Generate $Y_t\lambda$ according to the Box Cox specification. It will yield 11 series of each λ value.

- Calculate variance ($\hat{\sigma}^2(\lambda)$) for each λ.
- Evaluate maximum likelihood for each value of λ .

$$L_{\max}(\lambda) = \frac{-1}{2} n \ln \hat{\sigma}^2(\lambda) \quad (4.10)$$

  - n is the total no of observations.
  - $\ln\hat{\sigma}^2(\lambda)$ is constant variance in the case of univariate time series or 1/n times RSS from the model which choose value of λ.

The maximum $L_{\max}(\lambda)$ value ofλand minimum variance will suggest the type of transformation of the series.

Before estimation of transfer function we have to check the stationary of the series. We have used Beaulieu and Miron (1993) to test the unit roots.

4.4.2 Monthly Unit root test

Beaulieu and Miron(1993) extendedHEGY (1990) is a procedure to test unit roots as the frequency of the data is monthly.It is simply the extension of Frances (1991).

Let the data generating process is

$$\varphi(\mathrm{B})\mathrm{Y}_t = \mu_t + \varepsilon_t \qquad (4.11)$$

With $\varepsilon_t \sim iid\left(0,\sigma^2\right)$

$\varphi(\mathrm{B})$ is a polynomial in the back shift operator, μ_t contains constant term, seasonal dummies and the time trend. ε_t is white noise term. While γ_k are the root of the polynomial $\varphi(\mathrm{B})$.

Beaulieu and Miron proposed the test of unit root in monthly data. The null hypothesis are

$H_0 : \pi_1 = \pi_2 .... \pi_{12} = 0$

$H_1 :$ At least one of them is not zero

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

$\varphi(B)\, y_t = \mu_t + \pi_1 Y_{1,\, t-1} + \pi_2 Y_{2,\, t-1} + \pi_3 Y_{3,\, t-1} + \pi_4 Y_{4,\, t-1} + \pi_5 Y_{5,\, t-1} + \pi_6 Y_{6,\, t-1} + \pi_7 Y_{7,\, t-1} + \pi_8 Y_{8,\, t-1} + \pi_9 Y_{9,\, t-1} + \pi_{10} Y_{10,\, t-1} + \pi_{11} Y_{11,\, t-1} + \pi_{12} Y_{12,\, t-1} + \varepsilon_t$ (4.12)

The variables can be generated by following equations.

$Y_{1t} = (1+B+B^2+B^3+B^4+B^5+B^6+B^7+B^8+B^9+B^{10}+B^{11})y_t$ (4.13)

$Y_{2t} = -(1-B+B^2 - B^3+B^4-B^5+B^6-B^7+B^8-B^9+B^{10}-B^{11})y_t$(4.14)

$Y_{3t} = -(B-B^3+B^5-B^7+B^9-B^{11})y_t$(4.15)

$Y_{4t} = (1-B^2+B^4-B^6+B^8-B^{10})y_t$(4.16)

$Y_{5t} = ½ (1+B+B^2+B^3+B^4+B^5+B^6+B^7+B^8+B^9+B^{10}+B^{11})y_t$(4.17)

$Y_{6t} = 3^{1/2}/2 (1-B+B^3-B^4+B^6-B^7+B^9-B^{10})y_t$(4.18)

$Y_{7t} = ½ (1-B-2B^2-B^3+B^4+2B^5+B^6-B^7-2B^8-B^9+B^{10}+2B^{11})y_t$(4.19)

$Y_{8t} = -3^{1/2}/2 (1+B-B^3-B^4+B^6+B^7-B^9-B^{10})y_t$(4.20)

$Y_{9t} = -½ (3^{1/2}-B+B^3-3^{1/2}B^4+2B^5-3^{1/2}B^6+B^7-B^9+3^{1/2}B^{10}-2B^{11})y_t$(4.21)

$Y_{10t} = ½(1-3^{1/2}B+2B^2-3^{1/2}B^3+B^4-B^6+3^{1/2}B^7-2B^8+3^{1/2}B^9-B^{10})y_t$(4.22)

$Y_{11t} = ½(3^{1/2}+B-B^3-3^{1/2}B^4-2B^5-3^{1/2}B^6-B^7+B^9+3^{1/2}B^{10}+2B^{11})y_t$(4.23)

$Y_{12t} = -½(1+3^{1/2}B+2B^2+3^{1/2}B^3+B^4-B^6-3^{1/2}B^7-2B^8-3^{1/2}B^9-B^{10})y_t$(4.24)

$Y_{13t} = (1-B^{12})y_t$(4.25)

Where $\mu_t = DT + DS = \delta + \beta t + \sum\alpha_s D_{s,t}$

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

Roots in the monthly data are tested as follows.

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

4.5 Estimation

We have used the transfer function (introduced by Box and Jenkins) method to see how the world oil prices effect the time path of both domestic inflation and domestic oil prices. This methodology is applicable to our study as we are using a dynamic econometric model. We have used the bivariate and multivariate transfer function model.

Identificationof Transfer Function:

After checking for the stationarty of the series and if series are not stationary we will make series stationary by differencing them. The next step is the identification of transfer function model.

Following are the steps of identification and estimation transfer function model.

Step 1

Fit an SARIMA model of X_t series. A well fitted SARIMA model will estimate the data generating process of X_t series. We will calculate the residuals of SARIMA model and will save as ε_{xt}. ε_{xt} are the filtered values of X_t series and they are the innovations in the X_t series.

Box – Jenkins approach to estimate SARIMA model.

1. First of all calculate the ACF and PACF of the series. And check if there exist non stationarity and 12 period seasonality. If series is non-stationary then make it stationary by differencing it.
2. Check ACF, PACF and graph of differenced series for problem of variance and non stationarity. Take 12 difference of the seriesif there exist non ststionarity.
3. Calculating the ACF and PACF of seasonally adjusted series and examine the graphs carefully either series is free from variance non-stationary problem.
4. After calculating the ACF and PACF examine the graphs carefully to select the model.
5. Next step is to estimate the observed model.
6. Check if the included lags are significant or not. Decrease and remove if they are not significant.

Step 2

Next step is to filter the Y_t series with the same filterwith which we filtered the X_t series.

$$\frac{(\theta(B)\Theta(B^s))}{(\phi(B)\Phi(B^s))}Y_t = Y_{ft}\,(4.26)$$

After filtering the Y_t series form a cross correllogram between Y_{ft} and ε_{xt-i}. Obtain the sample variance of the cross correlation coefficient.

$$\text{var}\left[\gamma_{yx}(\text{i})\right] = \left(T-i\right)^{-1}(4.27)$$

$\gamma_{yx}(i)$ is the sample cross correlation coefficient between Y_{ft} and ε_{xt-i}. Where T is the no of useable observations. To test the significance of the cross correlation we use Ljung-Box (1978) Q statistic

$$Q = T\left(T+2\right)\sum_{i=0}^{k}\gamma_{yx}^{2}(\text{i})/(\text{T}-\text{k})(4.28)$$

Step 3

Thoroughly examine the cross correlation between $Y_{ft}$and ε_{xt-i}. It can be used to identify the form of A(L) and C(L). Spikes show the values of c_i. And decay patterns indicates the estimates of A(L). Examination of cross correlation will suggest different transfer models but we will select the best fitted model of the form

$$\left[1-A(\text{L})\text{Y}_t\right] = C(\text{L})\text{X}_t + e_t\,(4.29)$$

Step 4

The e_t in step 3 is the value of $B(L)\varepsilon_t$. We will check either it is white noise or not if it is white noise then our task is complete. However correlogram of e_t will suggest different forms of B(L). But we will use e_t to estimate various B(L) and select the best fitted one.

Step 5

Next step is to combine the results of step 3 and step 4 to estimate the equation (1). We will be estimating the A(L), C(L) and B(L) simultaneously. The coefficients be of high quality, the model should be parsimonious, error term must be white noise and forecast errors must be small. This can be done by estimating different models suggested in step 3 and step 4

We have estimate the transfer functions through Maximum Likelihood Method. It corresponds to many well-known estimation techniques. As it is not possible to measure /study the whole population. So, MLE can be used to estimate unknown mean and variance assuming data has normal distribution.

4.6 Data Source

We have collected monthly data for the all the variables for the period of 1974 M7 to 2014 M6. The variables are exchange rates,World oil prices,domestic oil prices anddomestic inflation. The data of three variables is collected from IMF only the data for domestic oil prices is taken from the publication of Government of Pakistan. As the world oil prices were given in $/barrel so we have convert them to rupee/ litter by dividing the series by 159, as there are 159 litters in one barrel and then multiplied the resulted series with the exchange rate series. Some of the observations of the domestic oil prices were given in rupee/ gallon so we converted it to rupee/litter by dividing it by 4.5, as there are 4.5 litters in one gallon.

4.7 Conclusion

In this chapter we have discussed the whole methodology we have under gone during research process. It briefly carries the model we selected for research and the econometric methodology we have gone through. First is the transformation checking of the series using Box-Cox methodology. Then the next step was checking of the stationarity of the series using Beaulieu and Miron method. After that we have used the transfer function to see the relationship between oil price and inflation.

Chapter 5

RESULTS AND INTERPRETATION

5.1 Introduction

In this chapter we are going to present the resultsand their interpretation the. It includes the results of the transformation checking using Box-Cox transformation. The results of unit root test and then the results of four transfer function models to see the dynamic relationship between oil prices and inflation. And we will discuss the results of the models and compare them with previous literature.

5.2 Transformation

We checked for the type of transformation required for all three variables using Box-Cox transformation with minimum variance and maximum likelihood method. First of all we calculated the geometric mean of the series which is 5.130564 for world oil price, 8.03699 for Inflation and 14.6449 for domestic oil price, as geometric mean is required to calculate series by Box Cox formula. Then we selected 21 values of λ. And generated the new series for each λ, according to Box Cox formula..

5.2.1 Minimum variance

Minimum variance value of λ will suggest the type of transformation of the series.

Table No.5.1: Minimum variance

λ	Domestic oil price	World oil price	Inflation
-1	703.7534	114.7202	36.11786
-0.9	593.2946	94.06955	32.66919
-0.8	507.6537	78.56221	29.80549
-0.7	441.4288	67.00217	27.4321
-0.6	390.5656	58.5024	25.47354
-0.5	352.0367	52.43061	23.86979
-0.4	323.6061	48.34621	22.57341
-0.3	303.6592	45.96136	21.54734
-0.2	291.0809	**45.1168**	20.7632
-0.1	**285.1736**	45.77034	20.19997
0	285.6061	47.99712	19.84312
0.1	292.3907	52.0027	**19.68389**
0.2	305.885	58.1511	19.7189
0.3	326.8204	67.01251	19.94996
0.4	356.359	79.43808	20.38412
0.5	396.1849	96.67342	21.03384
0.6	448.638	120.5289	21.91743
0.7	516.9031	153.6336	23.05973
0.8	605.2729	199.8158	24.49298
0.9	719.5104	264.6707	26.25805
1	867.3454	356.4152	28.40591
Min var	**285.1736**	**45.1168**	**19.68389**

Minimum Variance value of Domestic Oil Price (DOP) given in Table No 5.1 suggests the log transformation of the series. As at λ= -.0.1 value of variance is minimum.And it is close to 0.

Minimum Variance value of world Oil Price (WOP) given in Table No 5.1suggests the log transformation of the series. As at λ= -.0.2 value of variance is minimum. And it is close to 0.

Minimum Variance value of Inflation given in Table No 5.1suggests the log transformation of the series. As at λ= -0.1 value of variance is minimum. And it is close to 0.

5.2.2 Maximum likelihood

The maximum $L_{max}(\lambda)$ value of λ will suggest the type of transformation of the series.

Table No.5.2: Maximum Likelihood

λ	Domestic oil price	World oil price	Inflation
-1	-1596.49	-1154.8	-873.383
-0.9	-1554.92	-1106.47	-848.946
-0.8	-1516.96	-1062.61	-826.608
-0.7	-1482.92	-1023.85	-806.402
-0.6	-1453.11	-990.818	-788.365
-0.5	-1427.82	-964.136	-772.531
-0.4	-1407.31	-944.387	-758.934
-0.3	-1391.82	-932.07	-747.606
-0.2	-1381.52	**-927.554**	-738.58
-0.1	**-1376.53**	-931.055	-731.883
0	-1376.9	-942.623	-727.543
0.1	-1382.62	-962.14	**-725.581**
0.2	-1393.6	-989.351	-726.014
0.3	-1409.72	-1023.89	-728.851
0.4	-1430.79	-1065.31	-734.093
0.5	-1456.59	-1113.12	-741.733
0.6	-1486.86	-1166.83	-751.753
0.7	-1521.35	-1225.92	-764.124
0.8	-1559.78	-1289.92	-778.807
0.9	-1601.88	-1358.36	-795.751
1	-1647.38	-1430.83	-814.896
lmax	**-1376.53**	**-927.554**	**-725.581**

Maximum Likelihood value of Domestic Oil Price (DOP) given in Table No 5.2suggests the log transformation of the series. As at λ= -.0.1 value of Maximum Likelihood is maximum. And it is close to 0.

Maximum Likelihood value of world Oil Price (WOP) given in Table No 5.2suggests the log transformation of the series. As at λ= -.0.2 value of Maximum Likelihood is maximum. And it is close to 0.

Maximum Likelihood value of Inflation given in Table No 5.2suggests the log transformation ofthe series. As at λ=.0.1 value of Maximum likelihood value is maximum. And it is close to 0.

5.3 Monthly Unit Root Test

As the Box-Cox transformation suggested log transformation of all the three series. Now the next step is unit root test of the series. We used Beaulieu and Mironmonthly unit root test to check stationarity of the series because we have monthly data.

The results showed that all the three variables are stationary at 1^{st} difference. In table No.5.3 the results show that all three variables have unit root at zero frequency at level. Andall three variables are stationary at 1^{st} difference. The critical valuesfor unit root tests in seasonal time series, byFranses & Hobijn, (1997). We included constant, trend and seasonal dummies in auxiliary regression. After converting monthly no of observations to years the no of observations become 40 and α=0.05 and S=12 as data is monthly. And we added lags to white noise the error terms.

Table No.5.3: Results of Testing Unit Root of Series Using Beaulieu and Miron

variables	Auxiliary regression	lags	t,π_1 Zero Frequency	t,π_2 Biannual Frequency	$F,\pi_3\cap\pi_4$	$F,\pi_5\cap\pi_6$	$F,\pi_7\cap\pi_8$	$F,\pi_9\cap\pi_{10}$	$F,\pi_{11}\cap\pi_{12}$
LNDOP	**C,T,SD**	0	-2.94	-5.95**	54.89**	57.10**	41.96**	41.04**	45.47**
			π_1=-3.35	π_1=-2.81	(6.35)	(6.48)	(6.30)	(6.40)	(6.46)
LNWOP	**C,T,SD**	0	-2.32	-6.45**	45.37**	55.65**	53.37**	47.05**	28.99**
			π_1=-3.35	π_1=-2.81	(6.35)	(6.48)	(6.30)	(6.40)	(6.46)
LNCPI	**C,T,SD**	7	-3.07	-5.62**	41.54**	41.71**	34.57**	56.46**	43.12**
			π_1=-3.35	π_1=-2.81	(6.35)	(6.48)	(6.30)	(6.40)	(6.46)
DLNDOP	**C,T,SD**	0	-7.23**	-5.78**	45.23**	46.34**	36.00**	37.82**	38.07**
			π_1=-3.35	π_1=-2.81	(6.35)	(6.48)	(6.30)	(6.40)	(6.46)
DLNWOP	**C,T,SD**	0	-6.95**	-6.72**	46.28**	56.12**	53.25**	48.40**	31.04**
			π_1=-3.35	π_1=-2.81	(6.35)	(6.48)	(6.30)	(6.40)	(6.46)
DLNCPI	**C,T,SD**	7	-5.73**	-5.74**	41.48**	42.23**	31.08**	44.92**	42.13**
			π_1=-3.35	π_1=-2.81	(6.35)	(6.48)	(6.30)	(6.40)	(6.46)

Note: ** shows the rejection of the null hypothesis at 5% significance level. Null hypotheses: $\pi_1 = 0$, $\pi_2 = 0$, $\pi_3 \cap \pi_4 = 0$, $\pi_5 \cap \pi_6 = 0$, $\pi_7 \cap \pi_8 = 0$, $\pi_9 \cap \pi_{10} = 0$ and $\pi_{11} \cap \pi_{12} = 0$

5.4 Pass through from world oil prices to inflation

We need pre whitened input and output series for the estimation of transfer function. So before identification of the transfer function we will filter the series through univariate SARIMA model. We will estimate Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) of the series to identify the univariate models. Autocorrelation Function (ACF) of the series will tell us about the Moving Average (MA) part of univariate model and Partial Autocorrelation Function will tell us about the Autoregressive (AR) part of univariate model.

The Autocorrelation Function (ACF) and Partial Autocorrelation Function of the first difference of input series (world oil prices)(dlnwop) is in table 5.4 .

Figure No. 5.1: Autocorrelation Function (ACF) of Dlnwop

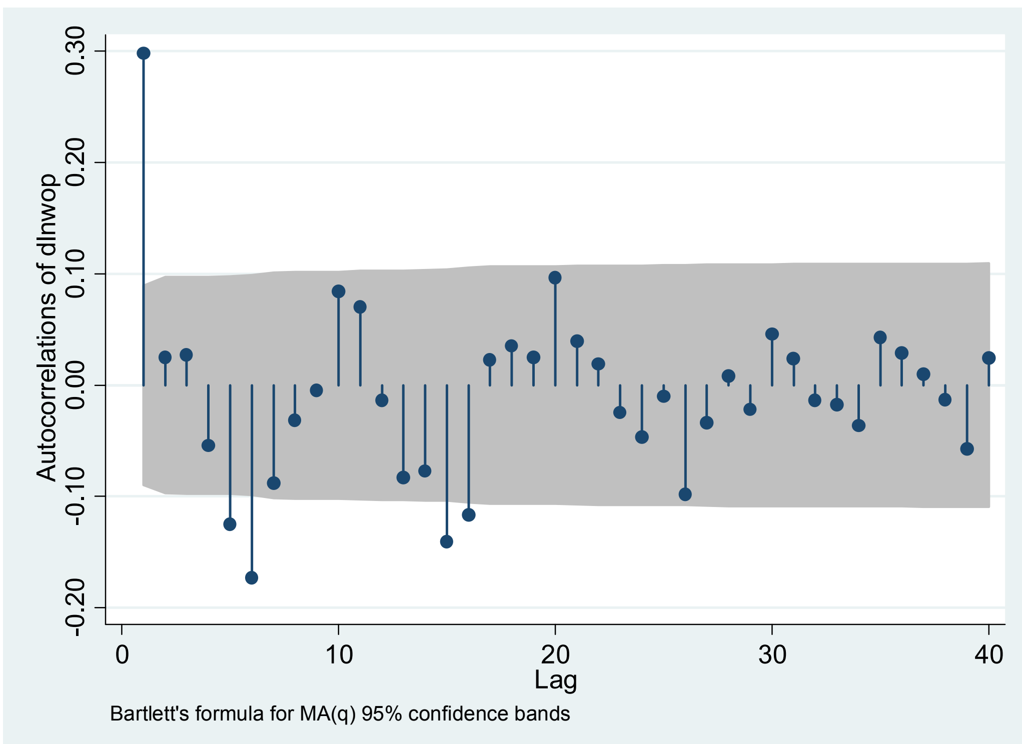


Figure No. 5.2: Partial Autocorrelation Function (PACF) of Dlnwop

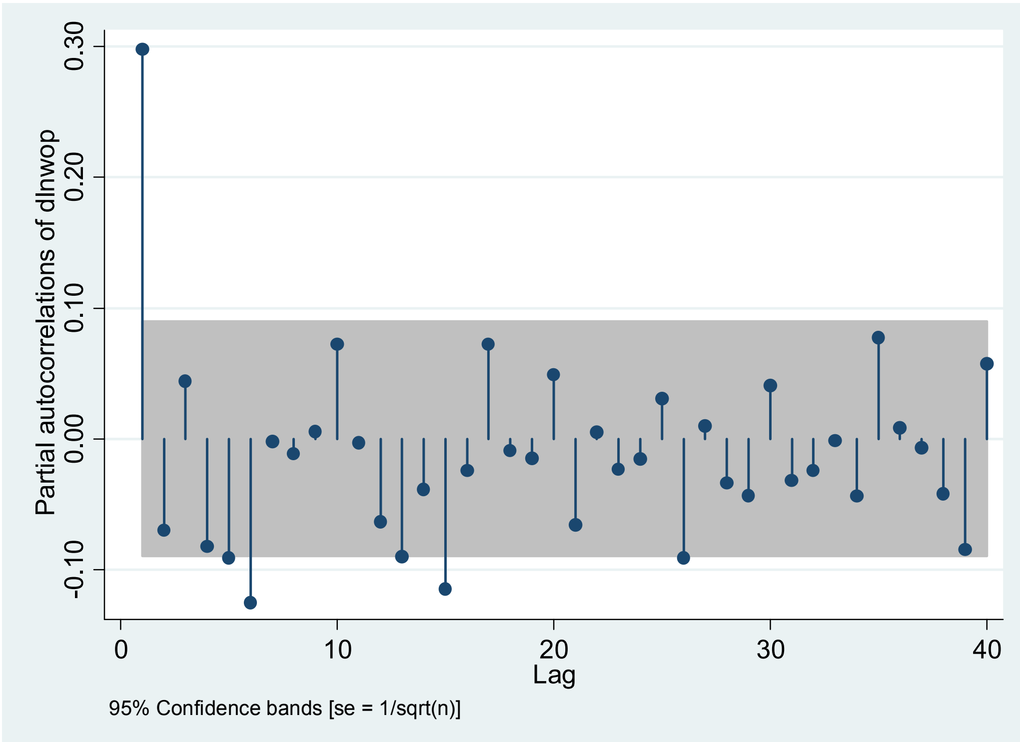


Table No. 5.4: Correllogram of DLNWOP

LAG	AC	PAC	Q	Prob>Q
1	0.2980	0.2980	42.797	0.0000
2	0.0247	-0.0703	43.092	0.0000
3	0.0271	0.0443	43.448	0.0000
4	-0.0547	-0.0825	44.898	0.0000
5	-0.1248	-0.0910	52.468	0.0000
6	-0.1732	-0.1255	67.076	0.0000
7	-0.0878	-0.0021	70.838	0.0000
8	-0.0314	-0.0117	71.321	0.0000
9	-0.0046	0.0056	71.331	0.0000
10	0.0841	0.0722	74.802	0.0000
11	0.0702	-0.0032	77.23	0.0000
12	-0.0138	-0.0634	77.324	0.0000
13	-0.0830	-0.0899	80.73	0.0000
14	-0.0776	-0.0388	83.715	0.0000
15	-0.1406	-0.1149	93.534	0.0000
16	-0.1166	-0.0244	100.3	0.0000
17	0.0228	0.0724	100.56	0.0000
18	0.0350	-0.0093	101.17	0.0000
19	0.0252	-0.0149	101.49	0.0000
20	0.0968	0.0487	106.19	0.0000
21	0.0398	-0.0658	106.99	0.0000
22	0.0189	0.0052	107.17	0.0000
23	-0.0246	-0.0236	107.47	0.0000
24	-0.0463	-0.0153	108.56	0.0000
25	-0.0103	0.0308	108.61	0.0000
26	-0.0982	-0.0911	113.51	0.0000
27	-0.0335	0.0099	114.08	0.0000
28	0.0085	-0.0341	114.12	0.0000
29	-0.0220	-0.0437	114.37	0.0000

The Autocorrelation Function (ACF) shows first, fifth and fifteenth lag is significant and the Partial Autocorrelation Function (PACF) shows that first, fifth, sixth, fifteenth and sixteenth lags are significant. As they fall out of the band, +.046 and -.046 it is calculated by $\frac{1}{\sqrt{n}}$ (Box and Jenkins). Because the current world oil price is related to its first, fifth and fifteenth lag.

We estimate different SARIMA models by MLE and selected the best one. We have dropped the insignificant lags, seasonal dummies and constant term in the model by using T-test to get a parsimonious model. The critical value of T-test is 1.98 at 5% significance and with n 480.

$$d\,\text{lnwop} = 0.028563S_1 + 0.025195S_5 + 0.024954S_8 - 0.102608d\,\text{lnwop}_{(t-6)} - 0.402991d\,\text{lnwop}_{(t-15)}$$

(2.52) (2.25) (2.20) (-2.39) (-3.80)

$$+0.320485MA(1) + 0.296712MA(15) \quad (5.1)$$

(7.37) (2.87)

R^2 =0.149477

The serial correlation LM test is applied on the first lag and compared χ^2 calculated value with the $\chi^2_{(0.95,1)} = 3.841459$. The χ^2 calculatedvalue came out to be 0.000000which is less than 3.841459. So according to the decision rule of BG-LM test do not reject the null hypothesis and concluded that there is no problem of autocorrelation on first lag.

The serial correlation LM test is applied on the 12th lag and compared χ^2 calculated value with the $\chi^2_{(0.95,12)} = 21.02$. The χ^2 calculatedvalue came out to be 9.415416which is less than 21.02. So according to the decision rule of BG-LM test do not reject the null hypothesis and concluded that there is no problem of autocorrelation on the twelfth lag.

The value of the R^2 is 0.149477. It means 14.9% of the variation in the world oil price is defined by the first, fifth and eighth season, its sixth and fifteenth lag and first and fifteenth lag of error term.

Now after this we can filter the series of world oil price (dlnwop) by the best fitted model to pre whiten the series.

$$\alpha_{1t} = d\,\text{lnwop} - 0.028563S_1 - 0.025195S_5 - 0.024954S_8 + 0.102608d\,\text{lnwop}_{(t-6)}$$

$$+0.402991d\,\text{lnwop}_{(t-15)} - 0.320485MA(1) - 0.296712MA(15) \qquad (5.2)$$

We will filter the output series which is inflation with same filter to pre whiten it.

$$\beta_{1t} = d\,\text{lncpi} - 0.028563S_1 - 0.025195S_5 - 0.024954S_8 + 0.102608d\,\text{lncpi}_{(t-6)}$$

$$+0.402991d\,\text{lncpi}_{(t-15)} - 0.320485MA(1) - 0.296712MA(15) \; (5.3)$$

Figure No. 5.3: Cross Correlogram of pre-whiten series α_{1t} and β_{1t}

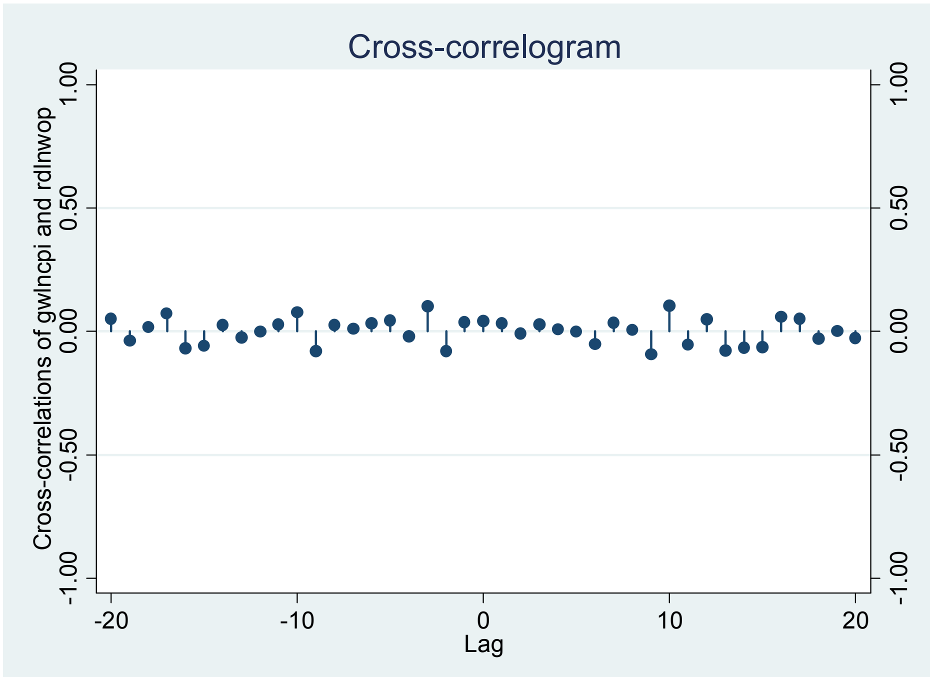


Table No. 5.5: Cross-correlationofpre-whiten series α_{1t} and β_{1t}

LAG	CORR
0	0.0434
1	0.0328
2	-0.0078
3	0.0299
4	0.0070
5	-0.0020
6	-0.0516
7	0.0363
8	0.0059
9	-0.0932
10	0.1043
11	-0.0548
12	0.0485
13	-0.0777
14	-0.0648
15	-0.0634
16	0.0586
17	0.0525
18	-0.0282
19	0.0017
20	-0.0266

The cross correlation between pre whiten input and output series shows that sixth, tenth, eleventh, twelfth, thirteenth, fourteenth, fifteenth, sixteenth and seventeenth lag are significant lags. As they fall out of the band, +.046 and -.046 it is calculated by $\frac{1}{\sqrt{n}}$ (Box and Jenkins)

In the final step we combine the results and add the lag and current values of world oil price (dlnwop) series whose cross correlation coefficients are significant and will add the lags of inflation (dlncpi) series and the residuals.

Table No. 5.6:Transfer Function Model for World Oil Price Pass-through to Inflation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001845	0.000728	2.534001	0.0116
DLNWOP(-10)	0.081228	0.026390	3.077947	0.0022
DLNWOP(-15)	0.110543	0.028062	3.939204	0.0001
DLNCPI(-12)	0.342154	0.046251	7.397747	0.0000
DLNCPI(-24)	0.278570	0.043884	6.347885	0.0000
MA(12)	-0.953044	0.013743	-69.34985	0.0000

R^2 =0.291868

The serial correlation LM test is applied on the first lag and compared χ^2calculated value with the$\chi^2_{(0.95,1)} = 3.841459$. The χ^2calculatedvalue came out to be 1.599843which is less than 3.841459. So according to the decision rule of BG-LM test do not reject the null hypothesis and concluded that there is no problem of autocorrelation on first lag.

The serial correlation LM test is applied on the 12th lag and compared χ^2calculated value with the$\chi^2_{(0.95,12)} = 21.02$. The χ^2calculatedvalue came out to be 10.89520which is less than 21.02. So according to the decision rule of BG-LM test do not reject the null hypothesis and concluded that there is no problem of autocorrelation on the twelfth lag**.**

We dropped the insignificant terms using T-test. The critical value of T-test at 5% significance and n=480 is 1.98.The value of the R^2 is 0.291868. It means 29% of the variation in the inflation is defined by the tenth and fifteenth lag of world oil price, twelfth and twenty forth lag of inflation and twelfth lag of error term.

The results presented in table 5.6 shows that change in the inflation depends on the tenth and fifteenth lag of the world oil price. So the change in world oil price is transmitted to inflation after ten to fifteenth months. 8% of the change in tenth lag of world oil prices is transmitted to inflation and 11 % of the change in fifteenth lag of world oil price is transmitted to inflation. The world oil prices positively affect the inflation. Inflation is 34% negatively affected by its 12th lagand 27% negatively affected by its 24th lag. And 95% of the change in the twelfth lag transfers to inflation. Error term negatively affects the inflation. World oil prices takes almost a year to pass on its affect to inflation. As world oil prices transmits through different channels to domestic economy, so it takes almost a year to affect inflation.Khan & Ahmed, (2011) obtained almost similar results.

5.5 Pass through from domestic oil price to inflation

To identify the transfer function of pass through of domestic oil price to inflation we need the pre whitened series of domestic oil price oil. We will whiten the series with univariate SARIMA model. So we will calculate ACF and PACF of domestic oil price.

Figure No. 5.4: Autocorrelation Function (ACF) of dlndop

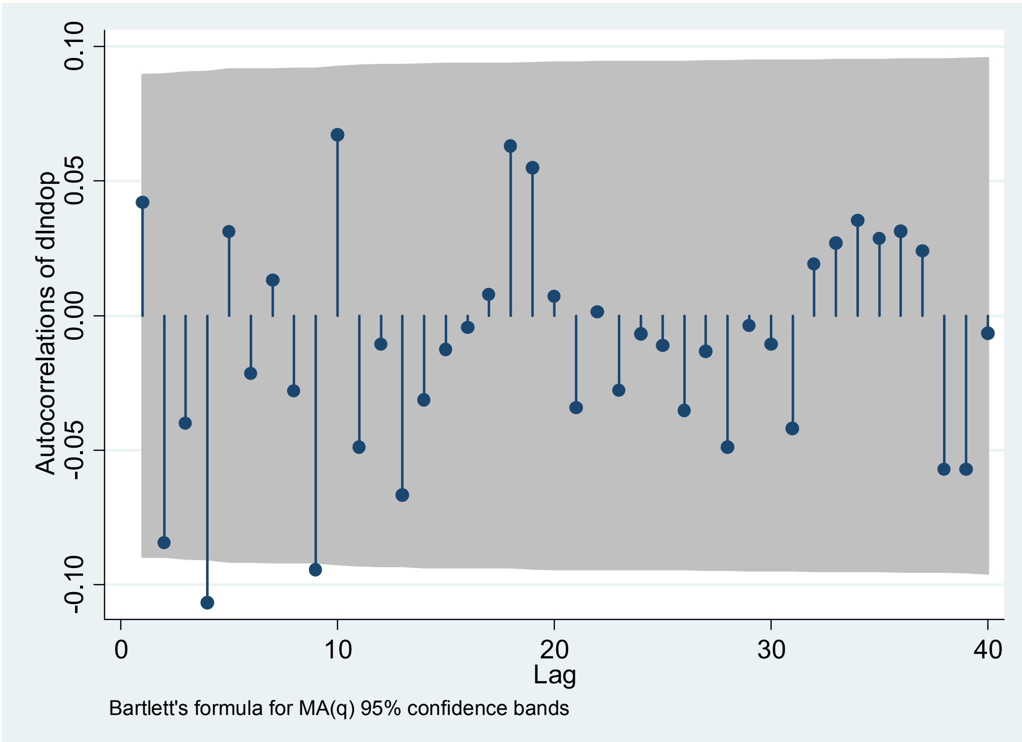


Figure No. 5.5: Partial Autocorrelation Function (PACF) of dlndop

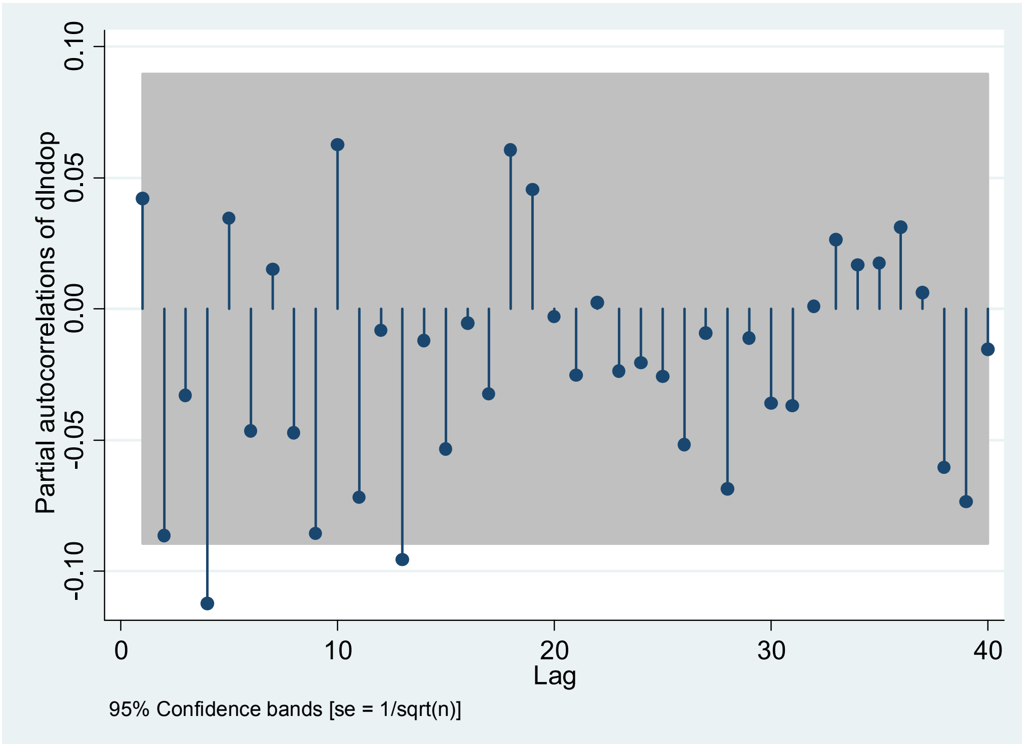


Table No. 5.7: Correllogram of dlndop

LAG	AC	PAC	Q	Prob>Q
1	0.0421	0.0421	.85576	0.3549
2	-0.0846	-0.0866	4.3145	0.1156
3	-0.0401	-0.0330	5.0936	0.1651
4	-0.1068	-0.1124	10.626	0.0311
5	0.0312	0.0345	11.101	0.0494
6	-0.0217	-0.0466	11.33	0.0787
7	0.0130	0.0151	11.413	0.1216
8	-0.0280	-0.0472	11.796	0.1605
9	-0.0945	-0.0856	16.176	0.0633
10	0.0671	0.0624	18.39	0.0487
11	-0.0488	-0.0719	19.565	0.0517
12	-0.0107	-0.0082	19.621	0.0746
13	-0.0667	-0.0958	21.824	0.0582
14	-0.0313	-0.0121	22.309	0.0725
15	-0.0127	-0.0534	22.388	0.0980
16	-0.0046	-0.0054	22.399	0.1308
17	0.0078	-0.0325	22.429	0.1688
18	0.0630	0.0607	24.415	0.1419
19	0.0549	0.0453	25.926	0.1323
20	0.0071	-0.0030	25.951	0.1674
21	-0.0343	-0.0253	26.541	0.1866
22	0.0014	0.0025	26.542	0.2291
23	-0.0279	-0.0237	26.937	0.2587
24	-0.0067	-0.0207	26.96	0.3063
25	-0.0111	-0.0259	27.022	0.3548
26	-0.0353	-0.0516	27.656	0.3756
27	-0.0132	-0.0093	27.745	0.4242
28	-0.0488	-0.0687	28.964	0.4144
29	-0.0037	-0.0112	28.971	0.4666

The Autocorrelation Function (ACF) shows forth and ninth lag is significant and the Partial Autocorrelation Function (PACF) shows that forth an thirteenth lags are significant. As they fall out of the band, +.046 and -.046 it is calculated by $\frac{1}{\sqrt{n}}$ (Box and Jenkins)

We estimate different SARIMA models with seasonal dummies by MLE and selected the best one. We dropped the insignificant terms using T-test. The critical value of T-test at 5% significance and n=480 is 1.98.

$$d\,\text{lndop} = 0.008203 + 0.576445d\,\text{lndop}_{(t-4)} - 0.684423MA(4) - 0.104983MA(9) \quad (5.4)$$

(8.63) (4.46) (-6.02) (-2.94)

R^2 =0.041541

The serial correlation LM test is applied on the first lag and compared χ^2 calculated value with the $\chi^2_{(0.95,1)} = 3.841459$. The χ^2 calculatedvalue came out to be 0.830260 which is less than 3.841459. So according to the decision rule of BG-LM test do not reject the null hypothesis and concluded that there is no problem of autocorrelation on first lag.

The serial correlation LM test is applied on the 12^{th} lag and compared χ^2 calculated value with the $\chi^2_{(0.95,12)} = 21.02$. The χ^2 calculatedvalue came out to be 14.09129 which is less than 21.02. So according to the decision rule of BG-LM test do not reject the null hypothesis and concluded that there is no problem of autocorrelation on the twelfth lag**.**

The value of the R^2 is 0.041541. It means 4% of the variation in the domestic oil price is defined by its forth lag and forth and ninth lag of error term.

Now after this we can filter the series of domestic oil price (dlndop) by the best fitted model to pre whiten the series.

$$\alpha_{2t} = d\,\text{lndop} - 0.008203 - 0.576445 d\,\text{lndop}_{(t-4)} + 0.684423 MA(4) + 0.104983 MA(9) \quad (5.5)$$

We will filter the output series which is inflation with same filter to pre whiten it.

$$\beta_{2t} = d\,\text{lncpi} - 0.008203 - 0.576445 d\,\text{lncpi}_{(t-4)} + 0.684423 MA(4) + 0.104983 MA(9) \quad (5.6)$$

Figure No. 5.6: Cross Correlogram of pre-whiten series α_{2t} and β_{2t}

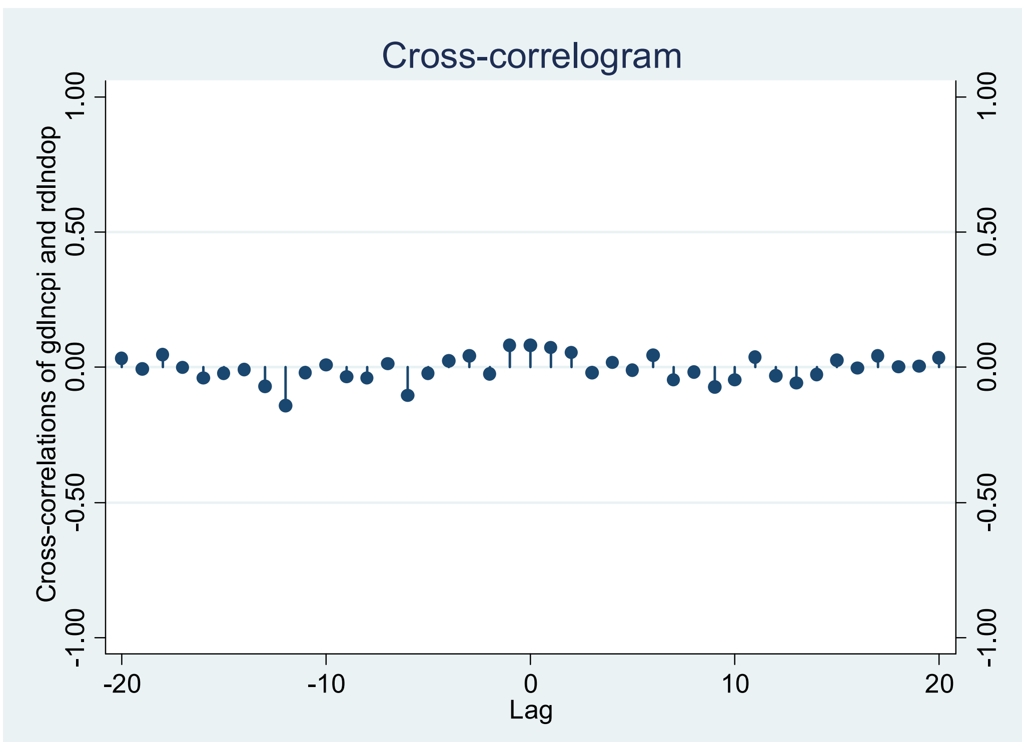


Table No. 5.8: Cross-correlationof pre-whiten series α_{2t} and β_{2t}

LAG	CORR
0	0.0816
1	0.0715
2	0.0534
3	-0.0204
4	0.0179
5	-0.0101
6	0.0438
7	-0.0473
8	-0.0166
9	-0.0734
10	-0.0466
11	0.0382
12	-0.0301
13	-0.0578
14	-0.0259
15	0.0272
16	-0.0043
17	0.0426
18	0.0011
19	0.0045
20	0.0359

The cross correlation between pre whiten input and output series shows that current ,first second, seventh, ninth, tenth and thirteenth lag of world oil price are significant lags. As they fall out of the band, +.046 and -.046 it is calculated by $\frac{1}{\sqrt{n}}$ (Box and Jenkins)

In the final step we combine the results and add the lag and current values of domestic oil price (dlndop) series whose cross correlation coefficients are significant and will add the lags of inflation (dlncpi) series and the residuals.

Table No. 5.9:Transfer Function Model for Domestic Oil Price Pass-through to Inflation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLNDOP(-1)	0.345170	0.141057	2.447016	0.0148
DLNDOP(-13)	-0.403201	0.141306	-2.853387	0.0045
DLNCPI(-12)	0.147234	0.075901	1.939827	0.0530
DLNCPI(-24)	0.159722	0.056174	2.843338	0.0047
MA(12)	-0.741840	0.062079	-11.95000	0.0000

R^2 =0.277409

The serial correlation LM test is applied on the first lag and compared χ^2 calculated value with the $\chi^2_{(0.95,1)} = 3.841459$. The χ^2 calculatedvalue came out to be 1.999057which is less than 3.841459. So according to the decision rule of BG-LM test do not reject the null hypothesis and concluded that there is no problem of autocorrelation on first lag.

The serial correlation LM test is applied on the 12th lag and compared χ^2 calculated value with the $\chi^2_{(0.95,12)} = 21.02$. The χ^2 calculatedvalue came out to be 13.03641which is less than 21.02. So according to the decision rule of BG-LM test do not reject the null hypothesis and concluded that there is no problem of autocorrelation on the twelfth lag**.**

We dropped the insignificant terms using T-test. The critical value of T-test at 5% significance and n=480 is 1.98.

The value of the R^2 is 0.277409. It means 27% of the variation in the inflation is defined by the first and thirteenth lag of domestic oil price, twelfth and twenty forth lag of inflation and twelfth lag of error term.

The results presented in table 5.9 shows that change in the inflation depends on first and thirteenth lag of the domestic oil price. So the change in world oil price is transmitted to inflation after one and thirteen months.34% of the change in first lag of domestic oil prices is transmitted to inflation and 40% of the change in thirteenth lag of domestic oil prices is transmitted to inflation. The first lag of domestic oil prices positively affect the inflation while thirteenth lag negatively affect the inflation. Inflation is 14% and 15% positively affected by its 12th and 24th lag respectively. And 74% of the change in twelfth lag of error term passes to inflation. Error term negatively affects the inflation. Domestic oil price transmits its change to inflation after a month and its effect remains in inflation for almost a year. Khan & Ahmed, (2011) obtained almost similar results.

5.6 Pass through from world oil price to domestic oil price

To identify the transfer function of pass through world oil price to domestic oil price we need the pre whitened series of world oil price. Which we have estimated in equation (5.2). We will filter the domestic oil price series with the same filter to pre whitened it.

$$\alpha_{1t} = d\,\text{lnwop} - 0.028563S_1 - 0.025195S_5 - 0.024954S_8 + 0.102608d\,\text{lnwop}_{(t-6)}$$

$$+0.402991d\,\text{lnwop}_{(t-15)} - 0.320485MA(1) - 0.296712MA(15) \quad (5.2)$$

We will filter the output series which is domestic oil prices with same filter to pre whiten it

$$\beta_{3t} = d\,\text{lndop} - 0.028563S_1 - 0.025195S_5 - 0.024954S_8 + 0.102608d\,\text{lndop}_{(t-6)}$$

$$+0.402991d\,\text{lndop}_{(t-15)} - 0.320485MA(1) - 0.296712MA(15) \quad (5.7)$$

To identify the lag of world oil prices that effect the change in domestic oil price we will calculate the cross correlation between α_{1t} and β_{2t}.

Figure No. 5.7: Cross Correlogram of pre-whiten series α_{1t} and β_{3t}

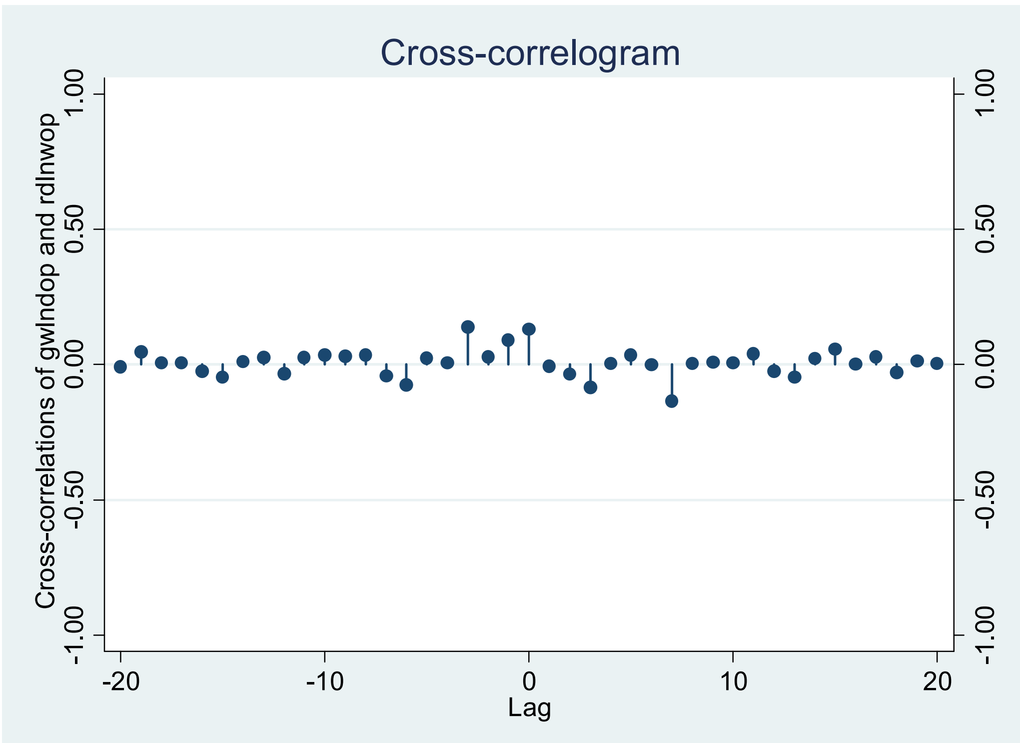


Table No. 5.10: Cross Correlation ofpre-whiten series α_{1t} and β_{3t}

LAG	CORR
0	0.1296
1	-0.0068
2	-0.0362
3	-0.0832
4	0.0041
5	0.0345
6	-0.0020
7	-0.1356
8	0.0033
9	0.0082
10	0.0053
11	0.0411
12	-0.0231
13	-0.0475
14	0.0225
15	0.0558
16	0.0008
17	0.0293
18	-0.0278
19	0.0128
20	0.0037

The cross correlation between pre whiten world oil price and domestic oil price series shows that current, third, seventh, thirteenth and fifteenth lag of world oil price are significant lags. As they fall out of the band, +.046 and -.046 it is calculated by $\frac{1}{\sqrt{n}}$ (Box and Jenkins)

In the final step we combine the results and add the lag and current values of world oil price (dlnwop) series whose cross correlation coefficients are significant and will add the lags of domestic oil price (dlndop) series and the residuals.

Table No. 5.11: Transfer Function Model for World Oil Price Pass-through to Domestic Oil Price

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003524	0.000934	3.771661	0.0002
DLNWOP	0.086852	0.020516	4.233344	0.0000
DLNWOP(-3)	0.081511	0.022201	3.671496	0.0003
DLNWOP(-7)	-0.052269	0.023716	-2.203943	0.0280
DLNDOP(-4)	0.429182	0.108635	3.950690	0.0001
MA(4)	-0.573554	0.100078	-5.731089	0.0000
MA(9)	-0.143302	0.038575	-3.714920	0.0002

R^2 =0.109773

The serial correlation LM test is applied on the first lag and compared χ^2 calculated value with the $\chi^2_{(0.95,1)} = 3.841459$. The χ^2 calculatedvalue came out to be 0.077478 which is less than 3.841459. So according to the decision rule of BG-LM test do not reject the null hypothesis and concluded that there is no problem of autocorrelation on first lag.

The serial correlation LM test is applied on the 12th lag and compared χ^2 calculated value with the $\chi^2_{(0.95,12)} = 21.02$. The χ^2 calculatedvalue came out to be 19.64652 which is less than 21.02. So according to the decision rule of BG-LM test do not reject the null hypothesis and concluded that there is no problem of autocorrelation on the twelfth lag.

We dropped the insignificant terms using T-test. The critical value of T-test at 5% significance and n=480 is 1.98.

The value of the R^2 is 0.109773. It means 10% of the variation in the domestic oil price is defined by the current, third and seventh lag of world oil price, forth lag of domestic oil price and twelfth and twenty forth lag of error term.

The results presented in table 5.11 shows that change in the domestic oil price depends on the current, third, seventh lag of the world oil price. So the change in world oil price is transmitted to domestic inflation after one and seven months. 8% of the change in current of world oil prices is transmitted to inflation.8% of the change in third lag of world oil prices is transmitted to inflation. The current and third lag of world oil prices positively affect the domestic oil price wile seventh lag negatively affect the domestic oil prices. Domestic oil price is 42% positively affected by its 4^{th} lag. And 57% and14% of the shock in the fourth and ninth lag of error term transfers to domestic oil price respectively. Error term negatively affects the domestic oil price. World oil prices pass its affect to domestic oil prices in three to seven month. The government passes the prices of oil to consumers in three to seven months.

5.7 Pass through from oil prices to inflation

To identify the transfer function of pass through of world and domestic oil price to inflation we need the pre whitened series of both world and inflation which we have estimated in equation (5.2) and equation (5.3) and pre whiten series of domestic oil price and inflation which are calculated in equation (5.5) and equation (5.6). We will add the lags of world oil price in the transfer function which are significant in cross correlation between α_{1t} and β_{1t}. And add the lags of domestic oil price which are significant in the cross correlation between α_{2t} and β_{2t}.

$$\alpha_{1t} = d\,\text{lnwop} - 0.028563S_1 - 0.025195S_5 - 0.024954S_8 + 0.102608d\,\text{lnwop}_{(t-6)}$$

$+0.402991d\ \text{lnwop}_{(t-15)} - 0.320485MA(1) - 0.296712MA(15)$ (5.2)

We will filter the output series which is inflation with same filter to pre whiten it.

$\beta_{1t} = d\ \text{lncpi} - 0.028563S_1 - 0.025195S_5 - 0.024954S_8 + 0.102608d\ \text{lncpi}_{(t-6)}$

$+0.402991d\ \text{lncpi}_{(t-15)} - 0.320485MA(1) - 0.296712MA(15)$ (5.3)

$\alpha_{2t} = d\ \text{lndop} - 0.008203 - 0.576445d\ \text{lndop}_{(t-4)} + 0.684423MA(4) + 0.104983MA(9)$ (5.5)

We will filter the output series which is inflation with same filter to pre whiten it.

$\beta_{2t} = d\ \text{lncpi} - 0.008203 - 0.576445d\ \text{lncpi}_{(t-4)} + 0.684423MA(4) + 0.104983MA(9)$ (5.6)

Dependent Variable Identification

We will identify the univariate model of residuals by the univariate model of the output variable. As residuals follow same model as output variable. So we will calculate the ACF and PACF of output series which is inflation.

Figure No. 5.8: Autocorrelation Function (ACF) of dlncpi

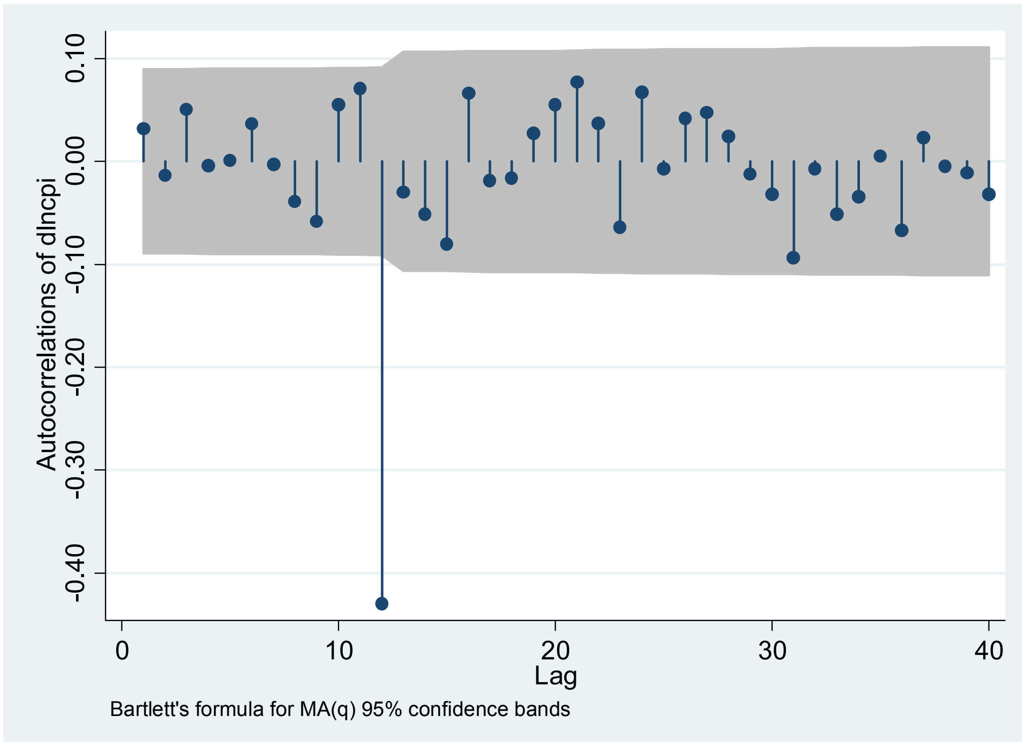


Figure No. 5.9: Partial Autocorrelation Function (PACF) of dlncpi

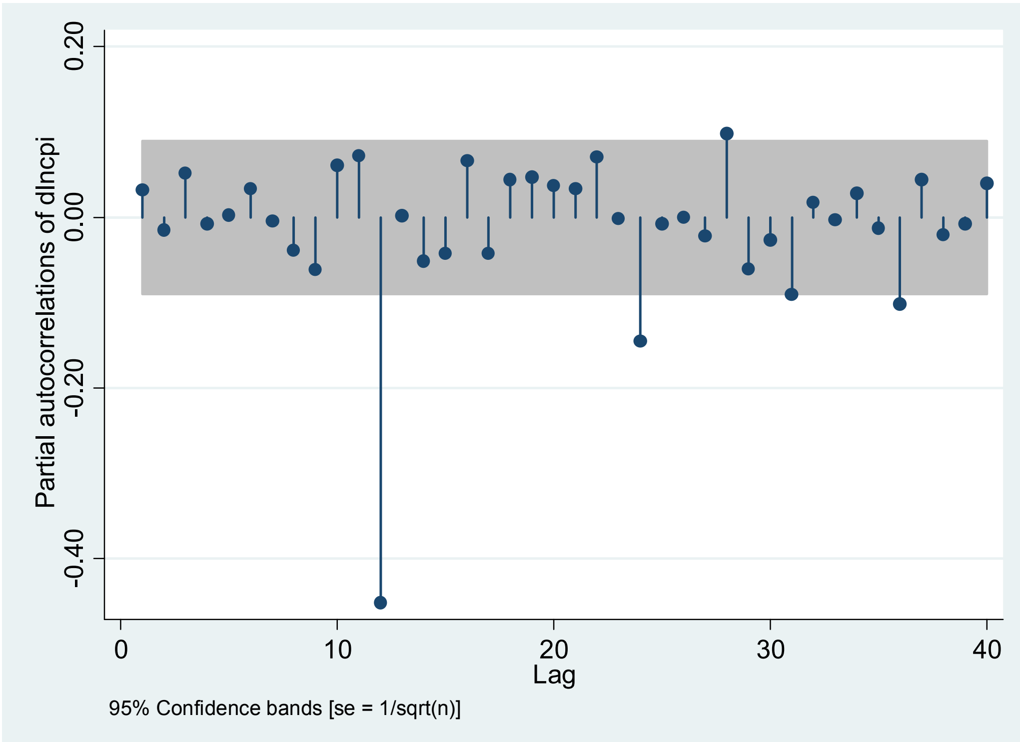


Table No. 5.12: Correllogramof dlncpi

LAG	AC	PAC	Q	Prob>Q
1	0.0316	0.0316	.48234	0.4874
2	-0.0138	-0.0148	.57383	0.7506
3	0.0504	0.0516	1.8052	0.6138
4	-0.0039	-0.0075	1.8125	0.7702
5	0.0009	0.0029	1.8129	0.8744
6	0.0365	0.0335	2.4635	0.8725
7	-0.0031	-0.0046	2.4681	0.9295
8	-0.0389	-0.0385	3.2083	0.9206
9	-0.0585	-0.0611	4.8841	0.8443
10	0.0552	0.0609	6.3827	0.7822
11	0.0707	0.0716	8.8418	0.6365
12	-0.4298	-0.4517	99.991	0.0000
13	-0.0300	0.0021	100.44	0.0000
14	-0.0513	-0.0513	101.74	0.0000
15	-0.0800	-0.0428	104.91	0.0000
16	0.0660	0.0658	107.08	0.0000
17	-0.0187	-0.0425	107.26	0.0000
18	-0.0160	0.0444	107.38	0.0000
19	0.0274	0.0472	107.76	0.0000
20	0.0553	0.0369	109.3	0.0000
21	0.0766	0.0334	112.25	0.0000
22	0.0370	0.0705	112.93	0.0000
23	-0.0639	-0.0014	115	0.0000
24	0.0674	-0.1450	117.3	0.0000
25	-0.0073	-0.0075	117.32	0.0000
26	0.0419	0.0000	118.22	0.0000
27	0.0473	-0.0224	119.36	0.0000
28	0.0245	0.0983	119.66	0.0000
29	-0.0124	-0.0604	119.74	0.0000

The Autocorrelation Function (ACF) shows twelfth lag is significant and the Partial Autocorrelation Function (PACF) shows that twelfth and twenty forth lags are significant. As they fall out of the band, +.046 and -.046 it is calculated by $\frac{1}{\sqrt{n}}$ (Box and Jenkins)

In the final step we combine the results and add the lag and current values of world oil price (dlnwop) and domestic oil price series (dlndop) series whose cross correlation coefficients are significant and will add the lags of inflation (dlncpi) series and the residuals.

Table No. 5.13:Transfer Function Model for Oil Price Pass-through to Inflation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001850	0.000861	2.149849	0.0321
DLNWOP(-10)	0.069773	0.026632	2.619846	0.0091
DLNWOP(-15)	0.118345	0.028989	4.082450	0.0001
DLNWOP(-16)	0.052302	0.027483	1.903099	0.0577
DLNDOP(-1)	0.354786	0.142395	2.491556	0.0131
DLNDOP(-13)	-0.419896	0.144319	-2.909510	0.0038
DLNCPI(-12)	0.333422	0.045473	7.332316	0.0000
DLNCPI(-24)	0.276593	0.043600	6.343866	0.0000
MA(12)	-0.955131	0.011834	-80.70763	0.0000

R^2 =0.308604

The serial correlation LM test is applied on the first lag and compared χ^2 calculated value with the $\chi^2_{(0.95,1)} = 3.841459$. The χ^2 calculatedvalue came out to be 0.532342 which is less than 3.841459. So according to the decision rule of BG-LM test do not reject the null hypothesis and concluded that there is no problem of autocorrelation on first lag.

The serial correlation LM test is applied on the 12th lag and compared χ^2 calculated value with the $\chi^2_{(0.95,12)} = 21.02$. The χ^2 calculatedvalue came out to be 10.90210 which is less than 21.02. So according to the decision rule of BG-LM test do not reject the null hypothesis and concluded that there is no problem of autocorrelation on the twelfth lag**.**

We dropped the insignificant terms using T-test. The critical value of T-test at 5% significance and n=480 is 1.98.

The value of the R^2 is 0.308604. It means 30% of the variation in the inflation is defined by the tenth, fifteenth and sixteenth lag of world oil price, first and thirteenth lag of domestic oil price twelfth and twenty forth lag of inflation and twelfth lag of error term.

The results presented in table 5.13 shows that change in the inflation depends on the tenth, fifteenth and sixteenth lag of the world oil price and on first and thirteenth lag of domestic oil price so the change in world oil price is transmitted to domestic inflation after ten and sixteen months.The change in domestic oil price is transmitted to domestic inflation after one month and thirteen months. 6% of the change in tenth lag of world oil prices is transmitted to inflation.11% of the change in fifteenth lag of world oil prices is transmitted to inflation and 5% of the change in sixteenth lag of world oil prices is transmitted to inflation. While 35% of the change in first lag of domestic oil prices is transmitted to inflationand 27% of the change in thirteenth lag of domestic oil prices is transmitted to inflation.Thetenth, fifteenthand sixteenth lag of world oil prices and domestic oil price positively affect the inflation and thirteenth lag negatively affect inflation. Inflation is 33% positively affected by itstwelfth lag. And 95% of the change in twelfth lag of error term transfer to inflation. Error term negatively affects the inflation. World oil price takes longer time to pass on its affect to inflation than domestic oil price. World oil price take almost a year while domestic oil price takes one month.

5.5 Conclusion

First of all we checked for the transformation of the series with Box and Cox transformation. Box and Cox transformation suggested log transformation of the all the series. Then to check the Unit root of the series we usedBeaulieu and Miron monthly unit root test. The results showed that there is unit root at zero frequency in all three series. So we differenced all the series and checked the unit root. And all the series were stationary at first difference.

The next step was the identification and estimation of the transfer function. For this we estimated the ACF and PACF of the log of differenced series. And estimated the SARIMA models of the input series to pre whitened the input series and filtered the output series to pre whiten the series. After the pre whitening of the input and output series we estimated the cross correlation between them. And estimated the transfer functions including the lag of input and output series.

Chapter 6

Conclusion

6.1 Introduction

The objective of this research was to find how the oil prices effected the inflation. Oil prices includes world and domestic oil prices. For this we used transfer function model. We used monthly data for the period of 1974 M7 to 2014 M6. First step of data analysis was checking for the suitable transformation of the series. So we used Box and Cox method of minimum variance and maximum likelihood. Box and Cox method suggested log transformation for all series. After transformation we checked for unit root in the series using Beaulieu and Miron unit root test. All the series were unit root at level so we differenced the series and checked for unit root and the series were stationary. After checking for unit root we headed for identification of transfer function.

6.2 Results

The results showed that the change in inflation depends on variations in oil prices. Inflation effected by shocks in world oil price.8% of the shock in tenth lag of world oil price passes to inflation11% of fifteenth lag shock passes to inflation.While 34% of shock in first lag of domestic oil passes to inflation and same percent of shock of thirteenth lag of domestic prices passes to inflation. 8% of the shock in the third lag of world oil price passes to domestic oil prices and 5% of shock of seventh lag of world oil price passes to domestic oil prices. While the bivariate model results show that 6% of the shock in tenth lag of world oil price passes to inflation and 11% of the shock in fifteenth lag of world oil price passes to inflation and 5 % of shock in sixteenth lag of world oil price passes to inflation. And 35% of shock in first lag of domestic oil price passes to inflation and 41% of shock of thirteenth lag of domestic oil price passes to inflation.

6.3 Policy implications

The aim of the research was to find the pass through of oil prices to inflation. And as the results showed that there is positive effect of oil prices on inflationbut there is much room for the government to control the prices as 100% the variation in inflation is not due to oil priceswhile its percentage is small. So the external shocks do effect the inflation in Pakistan but there is more room for policy maker to control the inflation.

6.4 Further study

This research can be elaborated by incorporating other variables in the multivariate model like exchange rate and the interest rate. As we have not incorporated these variables in the model.

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