Oil Prices and Exchange Rate with Impact of Pre-Dollar and Post-Dollar Regime Dummies

Syed Shujaat Ahmed

Sustainable Development Policy Institute

21 February 2019

Oil Prices and Exchange Rate with Impact of Pre-Dollar and Post-Dollar Regime Dummies

Syed Shujaat Ahmed[1]

Abstract

This study explains the relationship between oil prices and exchange rate of Pakistan in the time when Pakistan didn't adopt for dollar and when Pakistan adopted for dollar as standard currency. By following the approach used by (Meese and Rogoff, 1988) and (Throop,1993) Interest Rate Parity has been used to construct a model by using exchange rate of Pakistan, Dubai crude oil price and interest rate differential from period of 1970m-1 to 2017m05. Results of the analysis shows that all variable are found to be integrated at level after application of Bealieu and Miron Seasonal Unit Root test. Results of the relationship between oil prices and exchange rate show that oil price is impacting exchange rate positively, while interest rate differential is negatively influencing the exchange rate. While examining the results for impact of change in regime on exchange rate, structural shifts were prominent during managed floating regime and floating regime which were causing Changes in the exchange rate policies.

Keywords: Interest rate parity, exchange rate regime, regime switching, structural shift ,Dubai crude oil price.

1. Introduction

Exchange rate and oil prices are considered to be two important components of economy in the developing part of the world. Different countries do come up with policies to control and manage exchange rate in order to manage minimal level of reserves to run affairs of the state. To explore the empirical and theoretical relationship between exchange rate and oil price with the change in policy regime for exchange rate; appreciation of dollar during these policy regimes; and control of monetary authorities over the exchange rate was debated in number of studies. This debate came into the limelight with the global financial crisis of 2007 where countries had to bail them out with borrowings and printing of new currency. During this whole process exchange rate depreciation and pressure is visible on the countries with major dependence on oil. This case was also of Pakistan where due to increase in oil prices and value of dollar going up there is pressure on exchange rate. Basing this relationship and theoretical background discussed in elucidating exchange rate movements was primarily studied by (Golub 1983; and Krugman 1983). When one looks at an oil importing country, it may experience both the situations i.e. there can be appreciation (depreciation) when oil prices rise and depreciation (appreciation) when oil prices fall depending on the regime and components of that regime from policy perspective. Since oil is

[1] Author is associated with Sustainable Development Policy Institute as Research Associate and can be reached at: syedshujaatshah@hotmail.com

termed to be homogenous and internationally traded in US dollar, depreciation in this case reduces oil price to foreigners relative to price of their commodities in foreign currencies, thereby increasing their purchasing power and oil demand, and in turn, pushing up the oil prices in US dollar. Being major currency in invoicing and settlement, depreciation of dollar is thus linked to increase in nominal oil prices, whereas increase in real oil prices is found to result in real appreciation. The nominal impact of oil price change in this regard is not very clear.

Pakistan is said to have adopted the floating exchange rate regime in 2000 which is also evident from the study of (Khan and Qayyum, 2008). In the beginning of this regime, exchange rate was found to be devalued by 1.5 percent. Soon after 9/11 exchange rate which appreciated against the dollar but depreciation took place against other currencies, (Kemal and Haider, 2005). This appreciation is said to be attributed to massive inflow of foreign exchange. This is also said to be accompanied with the improvement in current account balance i.e. 5.3 percent of the GDP. Apart from this improvement, Pakistan continuously faced current account problems during the period of 1981-2010, that is an average of 3.9 percent, 4.5 percent and 3.9 percent of GDP in 1980's, 90's and 2000's respectively, (Tufail and Qurat-ul-ain , 2013). It has been reported that real effective exchange rate appreciates as a result of variation in oil price soon in second quarter. It (REER) revert its tendency and starts depreciation over the period of next 24-months. This finding here implies that the exchange rate appreciation will be transitory and will revert to above its pre-shock levels after all prices and wages have adjusted (Khan and Ahmed, 2011). This finding implies that mean-reverting behavior is found to be consistent with the long run implications of the overshooting exchange rate models (Kim and Roubini, 2000). The impact of oil price shocks on real effective exchange rate stays for three quarters and it gets back to its pre-shock position in fourth and fifth quarter most probably, and oil prices dominate exchange rate by 10 percent during the fifth period (Jamali et.al, 2011).

The objectives of this study are to investigate the impact of oil prices on exchange rate of Pakistan, with secondary objective of testing for interest rate differential's impact on exchange rate of Pakistan. Further the objectives inclined towards impact of regime switches on real effective exchange rate of Pakistan.

The remaining paper is organized as follows: the following section provides brief theoretical background followed by methodology. After introducing theoretical framework along with data and methodology, we proceed with the empirical findings in the results and discussion section. The final section will conclude the study with certain recommendations.

2. Brief Theoretical Review

Number of studies established theoretical relationships between exchange rate and oil price during different time periods. Oil price shock may be transmitted to the exchange rate through two main channels (Bodenstein et al 2011): 1) A negative shock (fall in oil prices for an oil exporter) drives down the price of non-traded goods in the domestic economy and thereby the real exchange rate. This shock is defined as the relative price of a basket of traded and non-traded goods between the domestic and the foreign economy. In a particular situation, where it can be noted that as prices of non-traded goods may be sticky, adjustment of the real exchange rate could require nominal exchange rate depreciation too **(The terms of trade);** and 2) a negative oil price shock results in transfer of wealth from oil exporters to oil importers, leading to large shifts in current account balances and portfolio reallocation (Kilian, 2007). Thus in order to restore the external net financial sustainability of oil importers (exporters), exchange rate has to depreciate (appreciate) following a negative shock to the oil price, in order to improve the non-oil trade balance **(Wealth Effect)**.

Alongside these channels, this relationship was studied by (Krugman, 1983) where model was formulated by sacrificing trade balance determination information and interplayed between "real" and "financial" asymmetries, and assumed that it may push exchange rate in different directions. Similarly, (Corden, 1984) also discussed the Dutch Disease Economics by taking into the account spending and resource movement effect in one of his core models related to exchange rate and oil price. He took price in three sectors such as booming, lagging sector and non-tradable respectively to be immobile.

Meese and Rogoff (1988) worked on uncovered interest rate parity where they took exchange rate as measure of international and domestic interest rate i.e. function which they constructed was based on interest rate parity hypothesis. This model includes nominal exchange rate, international and domestic prices. Further the role of oil price is incorporated by (Aziz, 2009; Ahmed & Qayyum, 2016) in order to capture the impact on currency and how the impact transfers to oil and non-oil trade.

Throop (1993) used the generalized model for uncovered interest rate parity models of exchange rate. To incorporate the role of oil prices, the important aspects to be looked in include the budget deficits, the effects of oil price changes on the flexible price equilibrium value of real exchange rates between currencies of the oil importing countries depending upon the effects on the goods market of those countries. Following oil price increases, the less developed countries from exporting side temporarily invested the proceeds of higher oil export revenues in the capital markets of the developed importing countries, which in turn have lent much of these funds to other national capital mobility that has been fairly high, so that it can be assumed real interest rates in different countries would continue to be roughly balanced in flexible-price equilibrium.

Thus due to these and similar effects of budget deficits, the effect of an oil price change on equilibrium exchange rates of the oil-importing countries depends upon the relative effects on aggregate demand in those countries. Such effects may change over time to some degree, as the oil exporting countries gradually increased their expenditures on the exports. These effects may change over time to some degree, as the oil exporting countries gradually increased their

expenditures on the exports of countries with oil imports with the degree of dependence. Based on the discussion and taking into the account (Aziz, 2009; Ahmed and Qayyum, 2016), we can write function as:

$$e = f(oil, ird) \quad (1)$$

Where e = Exchange Rate, oil = Dubai Crude Oil Prices and ird = interest rate differential.

3. Methodology

Exchange rate is provided by fxtop database. In this scenario it is defined by taking into the account PKR against dollar.

In order to calculate interest rate differential (IRD) call money rates are taken from International Financial Statistics (IFS) and Dubai Crude Oil Prices are taken from Quandl database with other source from World Bank. Data period is taken from 1970m01-2017m05.

Interest rate differential is calculated by using the following formula:

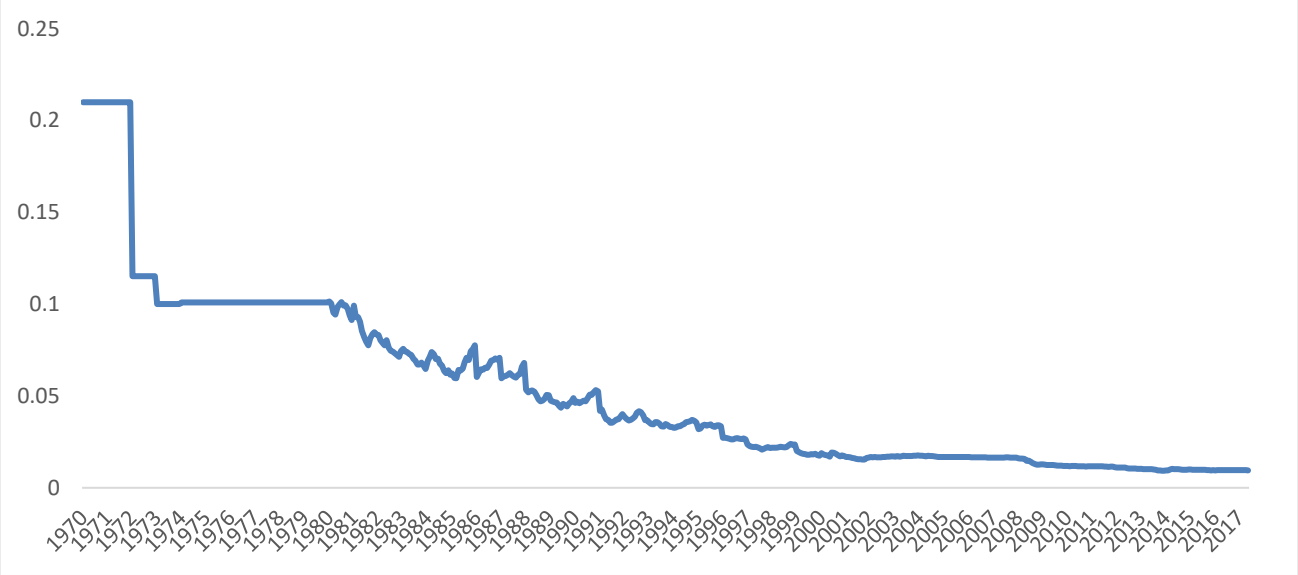
$$IRD = CMR_{PAK} - CMR_{USA} \quad (2)$$

Reason to take exchange rate i.e. dollars against PKR is because of usage of dollar as currency of international trade and dealing. Dubai Crude Oil price is taken into the account because of the reason that Pakistan being major importer of oil prices and dependent on oil and oil related products from Arab countries and Middle East.

Figure-1 below shows data plotted for the study, exchange rate as can be observed post-independence was linked to pound. This delinking from pound took place in 1971 and Pakistan started dealing with all the international partners using dollar as mode of exchange in terms of currency.

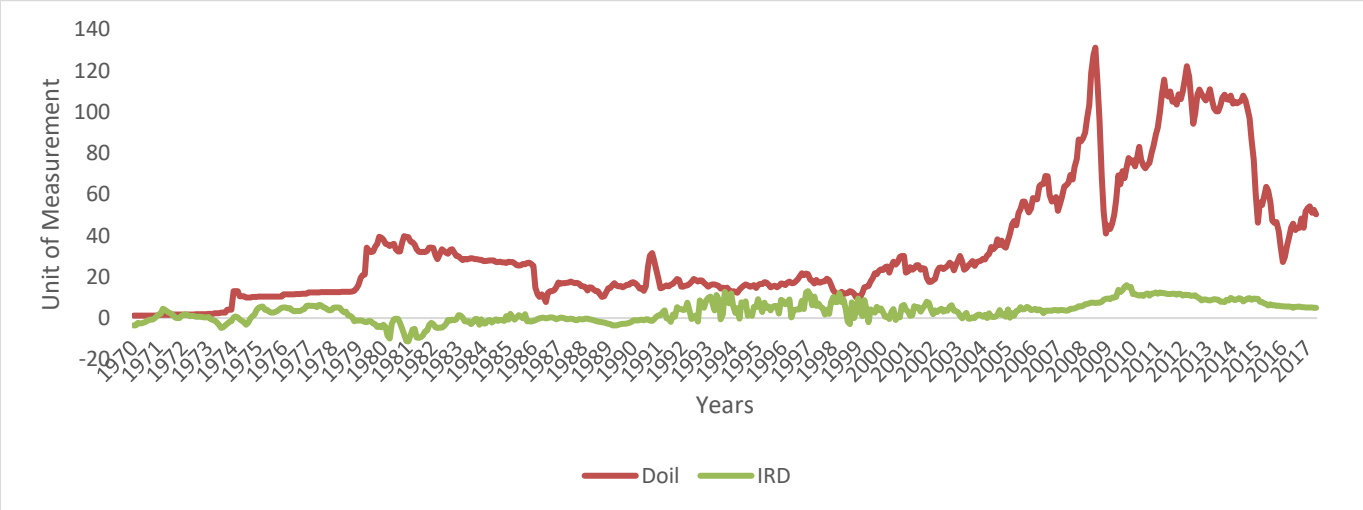
Fluctuations can be observed from the plot during 1972-73 due to currency devaluation, Soviet invasion and energy crisis. These shocks in later period led to the change in exchange rate regime and Pakistan moved to managed floating regime in early periods of 1980s'. During 1998 when Pakistan conducted nuclear tests, there were sanctions in place which resulted in two short period regimes (two tier and unified exchange rate regime). During early 2000s' Pakistan decided to go with floating exchange rate regime.

Figure 1: Exchange Rate PKR versus Dollar



For the same time period, besides major shocks of 1970s' related to oil prices there were shocks before that they moved up to 2000s'. these shocks were related to conflicts between Iraq, Iran and Kuwait. Alongside this shock, there was instability in Venezuela also led to the shocks in oil prices during this period. Whereas interest rate differential is concerned, it fluctuated to both inflationary and non-inflationary shocks which occurred in Pakistan and United States of America.

Figure 2: Graphical Representation of Exchange Rate, Dubai Crude Oil Price and Interest Rate Differential



In order to analyze the underlying relationship between exchange rate (ER), IRD and Oil Price, it is important to take into the consideration time series observations under the study and check for order of integration. Order of integration will be checked by Bealieu and Miron (1992) Seasonal Unit Root Test (SURT). Following the order of integration, Ordinary Least Square (OLS) is applied followed by Markov Regime Switching Approach. OLS will be used to estimate the magnitude of relationship depending upon the effect of change in slope and change in interaction term. Generalized form of the model will be:

$$Y_{it} = \alpha_1 + \beta_1 X_{1t} + \varepsilon_t$$
$$Y_{it} = (\alpha_1 + D_t) + \beta_1 X_{1t} + \beta_2 (X_{1t} + X_{zt}) + \varepsilon_t$$

It is to note that terms such as D_t is termed as change in the slope coefficient. This change in the slope coefficient depends on the use of regime dummies in the model. Further $(X_{1t} + X_{zt})$ is the change due to interaction term i.e. use of variable within the particular regime. In order to test for the random walk model, Markov Switching Vector Error Correction Mechnism (MS VECM) will be applied. Significant amount of work is done by (Krolzig, 1997). All of these referred studies took into the account (Hamilton, 1989) model of the U.S. business cycle with at best slight modifications done. In line with the above mentioned studies, exchange rate will be investigated using 2-state regime switching approach. The model to estimate in this case will be:

$$\Delta Y_t = v(s_t) + \Gamma(L)(s_t)\Delta Y_{t-1} + \Pi(s_t) Y_{t-1} + \varepsilon_t$$

Where Δ is the difference operator and Y_t represents a K-dimensional vector of the observed time series consisting of a subset f the lagged ER in accordance with the observation, $v(s_t)$ is a K-dimensional vector of regime-dependent intercept terms and ε_t defines a K-dimensional vector of error terms with regime-dependent variance-covariance matrix $\sum(s_t), \varepsilon_t \sim NIID(0, \sum(s_t))$. The KxK matrix lag polynomial $\Gamma(L)(s_t)$ of order p denotes the state-dependent short run dynamics of the model. The stochastic regime-generating process in this case is assumed to be an ergodic, homogenous and irreducible first-order Markov Chain with finite number of regimes and constant transition probabilities.

$$P_{ij} = P_r(s_{t+1} = j | s_t = i), P_{ij} > 0, \sum_{j=1}^{M} P_{ij} = 1 \; \forall \; i, j \epsilon \; (1, \dots \dots \dots, M)$$

First expression in the above equation mentioned gives the probability of switching regime I to regime j at time t+1, which is said to be independent of the history of the process, P_{ij} is the element in the ith row and the jth column of the MxM matrix of the transition probabilities P, which is usually symmetric. So, the non-stationary behavior of the series in this regard is said to be accounted for the reduced rank (r<K) restriction of the state-dependent KxK long-run level matrix $\Pi(s_t)$, which here can be fragmented into two Kxr matrices $\alpha(s_t)$ and β such that $\Pi(s_t) = \alpha(s_t)\beta'$. β' here gives the coefficients of the variables for the r long-run relations, which in this case are assumed to be constant over the whole sample period, while $\alpha(s_t)$ contains the regime-dependent adjustment coefficients describing the reaction of each variable to disequilibria from the r long run relations given by the r-dimensional vector $\beta' \gamma_{t-1}$. Hence, here in the model, there will be distinction

between regimes is the speed at which deviations from long-run equilibria are corrected, given by $\alpha(s_t)$. Here in order to identify the rank of $\prod(s_t)$ .i.e. the number of cointegrating relations r, and estimate the coefficients of the r-cointegrating vector in β'. We will employ the framework as developed by (Johansen 1988 and 1991). Then conditional on these cointegrating vectors, the regime dependent adjustment parameters $\alpha(s_t)$, intercept terms $v(s_t)$, autoregressive coefficients $\Gamma(L)(s_t)$, and variance-covariance matrix $\sum(s_t)$ as well as the transition probabilities, will be estimated using a Markov Chain Monte Carlo (MCMC) method, namely the multi-move iterative Gibbs sampling procedure as proposed by (Krolzig, 1997).

4. Results and Discussion

We now proceed with analyzing data to test for stationarity. To test for stationarity (Bealieu and Miron, 1992) seasonal unit root test (SURT) is used because of monthly nature of the data. The results obtained from the test reveals that all variables are stationary at level using different specifications as given by (Franses and Hobijn, 1997) for critical values. This thus leads to the conclusion that all variables are stationary at level.

Table-1: Unit Root Results

Hypotheses	Variables	Lex	Loil	ird
$t: \pi_1 = 0$	T-Calculated	-3.91	-3.11	-8.55
	T-Critical	-3.35	-1.93	-2.81
$t: \pi_2 = 0$	T-Calculated	-4.9	-6.81	-4.78
	T-Critical	-2.81	-1.94	-2.81
$F: \pi_3 = \pi_4 = 0$	F-calculated	30.5	54.89	72.33
	F-Critical	6.35	3.07	6.35
$F: \pi_5 = \pi_6 = 0$	F-calculated	36.23	62.63	50.60
	F-Critical	6.48	3.06	6.48
$F: \pi_7 = \pi_8 = 0$	F-calculated	31.29	59.16	67.57
	F-Critical	6.3	3.10	6.33
$F: \pi_9 = \pi_{10} = 0$	F-calculated	26.41	47.23	75.7
	F-Critical	6.4	3.11	6.41
$F: \pi_{11} = \pi_{12} = 0$	F-calculated	48.15	92.25	102.19
	F-Critical	6.46	3.11	6.47
Specifications		C,d,t	nC,nd,nt	C, d, nt

Note:(C,d,t= Constant, dummy and trend; nC, nd,nt= No constant, no dummy and no trend; C,d,nt= Constant, dummy and no trend)

Similarly, for case of exchange rate, different regimes are used (Bealieu and Miron, 1992) SURT is used to check significance of regimes as primary objective followed by stationarity of the variable. Results reveal that none of the regime is significant as used in each of the model and it didn't influence the order of integration of exchange rate. Results reveal that exchange rate is still stationary at level. (**See-table: 2)**

Table-2: Unit Root Results with Regimes

Hyp	Variables	Lex	Lex1	Lex2	Lex3	Lex4	Lex5	Lex6	Lex7	Lex8	Lex9	Lex10
$t: \pi_1 = 0$	T-Calculated	-4.04	-3.91	-4.03	-3.92	-4.19	-4.00	-4.24	-3.92	-4.24	-3.91	-3.04
	T-Critical	-3.35	-3.35	-3.35	-3.35	-3.35	-3.35	-3.35	-3.35	-3.35	-3.35	-1.93
$t: \pi_2 = 0$	T-Calculated	-4.90	-4.90	-4.90	-4.90	-4.89	-4.91	-4.90	-4.9	-4.89	-4.90	-4.58
	T-Critical	-2.81	-2.81	-2.81	-2.81	-2.81	-2.81	-2.81	-2.81	-2.81	-2.81	-1.94
$F: \pi_3 = \pi_4 = 0$	F-calculated	30.53	30.44	30.47	30.43	30.29	30.29	30.13	30.44	30.08	30.45	25.49
	F-Critical	6.35	6.35	6.35	6.35	6.35	6.35	6.35	6.35	6.35	6.35	3.07
$F: \pi_5 = \pi_6 = 0$	F-calculated	36.2	36.15	36.12	36.16	36.04	36.29	36.1	36.19	36.05	36.16	31.32
	F-Critical	6.48	6.48	6.48	6.48	6.48	6.48	6.48	6.48	6.48	6.48	3.06
$F: \pi_7 = \pi_8 = 0$	F-calculated	31.38	31.22	31.32	31.23	31.22	30.95	30.94	31.28	30.91	31.24	24.66
	F-Critical	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.30	3.10
$F: \pi_9 = \pi_{10} = 0$	F-calculated	26.32	26.35	26.27	26.35	26.04	26.06	25.77	26.37	25.73	26.36	22.58
	F-Critical	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	3.11
$F: \pi_{11} = \pi_{12} = 0$	F-calculated	48.15	48.11	48.08	48.01	48.12	48.72	48.57	47.98	48.72	48.07	41.65
	F-Critical	6.46	6.46	6.46	6.46	6.46	6.46	6.46	6.46	6.46	6.46	3.11
Pre-Dollar (period) _D1	T-cal	1.59		1.56		1.91		1.91		1.91		1.17
Fixed Exchange Rate Regime_D2			0.35	0.19		1.56		1.17		1.06		-2.78
Managed Floating Exchange Rate Regime_D3					0.28	1.66		1.27		1.17		-2.63
Two Tier Exchange Rate Regime_D4							-1.68	-1.39		-1.41		-2.72
Unified Exchange Rate Regime_D5									-0.28	-0.22		-1.97
Floating Exchange Rate Regime_D6											0.11	-2.40
Specifications		C,d,t	C,d,t	C,d,t	C,d,t	C,d,t	C,d,t	C,d,t	C,d,t	C,d,t	C,d,t	nC,nd,nt

Proceeding forward, we now analyze the data to test for different working hypotheses to test for the relationship between exchange rate, interest rate differential and Dubai crude oil price. As results from (Bealieu and Miron,1992) revealed that all variables are stationary at level, thus using Ordinary Least Square (OLS) we include dummies and interaction terms for each regime of exchange rate. Results from the analysis shows that except the cases of where no dummy or single dummy is used magnitude of the relationship between exchange rate and oil price is positive but weaker. Positive relationship between oil prices and exchange rate can be described as depreciation (appreciation)[2] of exchange rate. Studies such as Aziz (2009), Hasanov and Samadova (2010), Coudert et.al (2013) and Ahmed and Qayyum (2016). The reason which explains this appreciation is the reduction of non-oil exports, causing burden on exchange rate and causing depletion. Positive sign with highest value can be observed for two-tier exchange rate regime. This highest value in this case shows that within this short period there was higher depreciation (appreciation) which occurred.

Contrary to results shown below in tables (3a and b) with all regimes overall results show that this relationship between oil price and exchange rate is negative. This means that with the increase in oil prices exchange rate depreciates for Pakistan being oil importing country[3]. This negative oil price relationship can be further taken into the fact that with the increase in oil prices there will be increase in import bills thus pressure will be on the reserves. Therefore, there will be decline in forex reserves. Pakistan observed this decline during the period of global financial crisis where with the higher oil prices it has to bail itself out with the involvement of State Bank of Pakistan (SBP).

[2] With positive sign of exchange rate as can be seen in the results, there was pressure exerted on non-oil commodities.
[3] Aziz, M.I.A. and Bakar, A.N., 2009, August. Oil price and exchange rate: A comparative study between net oil exporting and net oil importing countries. In *ESDS International Annual Conference, London*.

Table 3a: Relationship between Exchange Rate and Oil Price

Variables	No-Regime	Pre-Dollar		Fixed Exchange Rate Regime			Managed Floating Exchange Rate Regime			Two Tier Exchange Rate Regime		
		Dummy	Dummy and Interaction Term	Dummy	Dummy and Interaction Term	All Regimes	Dummy	Dummy and Interaction Term	All Regimes	Dummy	Dummy and Interaction Term	All Regimes
Oil Price	0.039	0.1	0.1	0.039	0.097	0.096	0.039	0.039	0.129	0.034	0.034	0.139
Oil Price_Pre-Dollar			0.18			0.172			0.205			0.07
Oil Price_Fixed Regime					0.012	0.113			0.096			-0.42
Oil Price_Managed Regime								0.036	0.076			-0.06
Oil Price_Two Tier Regime											-0.219	-0.36
Trend	-0.05	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005
Intercept	-1.19	-0.678	3.48	-0.96	-1.089	-0.87	-1.06	-0.956	-0.59	-1.33	-0.69	0.41
R-square	0.9748	0.9829	0.9829	0.9749	0.9761	0.983	0.9749	0.9749	0.9854	0.9753	0.9753	0.9856
Adj-R-square	0.9748	0.9828	0.928	0.9748	0.976	0.982	0.9748	0.9748	0.9852	0.9752	0.9751	0.9853
Heteroskedasticity	45.02	0.53	0.56	50.63	47.27	1.53	43.29	43.30	0.01	48.18	48.49	0
Autocorrelation (Lag-1)	521.87	484.97	482.8	524.83	521.53	480.35	524.77	524.83	462.46	518.84	518.24	464.46
Autocorrelation (Lag-12)	522.09	491.97	194.1	257.77	243.57	186.31	253.04	255.21	125.38	519.2	518.68	473.74

Pressure during this period on currency was due to more dollars being taken which for market dealing was to be converted to local currency, thus with the higher oil prices and excessive printing of currency there occurred inflation during that period.

Table 3b: Relationship between Exchange Rate and Oil Price

Variables	Unified Exchange Rate Regime			Floating Exchange Rate Regime		
	Dummy	Dummy+ Interaction Term	All Regimes and Dummies	Dummy	Dummy+ Interaction Term	All Regimes and Dummies
Oil Price	0.034	0.034	0.121	0.039	0.015	-0.22
Oil Price_Pre-Dollar			0.076			-0.14
Oil Price_Fixed Regime			-0.225			0.09
Oil Price_Managed Regime			-0.053			0.067
Oil Price_Two Tier Regime[4]			-0.343			
Oil Price Unified Regime		0.133	0.007			0.12
Oil Price Floating Regime					0.131	0.12
Trend	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005
Intercept	-1.44	-1.755	0.089	-0.866	-1.5	0.78
R-square	0.9767	0.9767	0.9861	0.9749	0.9768	0.9861
Adj-R-square	0.9766	0.9765	0.9858	0.9748	0.9766	0.9858
Heteroskedasticity	64.01	64.07	0.28	45.25	49.13	0.29
Autocorrelation (Lag-1)	512.52	513.19	459.69	521.95	518.64	459.69
Autocorrelation (Lag-12)	512.86	513.54	468.74	522.25	519.07	468.74

Similarly, relationship between exchange rate and interest rate differential can be seen as a temporal relationship because of the argument like domestic interest rate would attract capital inflow with the results of a currency appreciation and it may apply only to a single country. It is because, the rise in interest rate of a single country could easily influence to other countries, resulting in the inter-temporal rise in the interest

[4] To avoid problem of collinearity dummy for two-tier exchange rate regime along with interaction term is omitted here.

rate of other countries. When other countries have caught up with the rise in interest rate in the next time period, there is possibility that capital flow may be large enough to influence the price of the currency (Li and Wong, 2011)[5].

Based on this argument it can be seen below (See-Table: 4a and b) that there is present negative relationship between exchange rate and interest rate differential. This negative relationship is in accordance with (Hakkio, 1986; Ahmed and Qayyum 2016). Both of the studies stated that the negative relationship is because of changes occurring in the inflation and expected inflation. Thus it can be the case that during this period while the shocks occurring in interest rate of United States of America (USA) to which Pakistani interest adjusts itself or shocks to Pakistani interest rate where adjustments may occur, there is possibility of large influence of the prices with respect to currency.

Table 4a: Relationship between Exchange Rate and Interest Rate Differential

Variables	No-Regime	Pre-Dollar		Fixed Exchange Rate Regime			Managed Floating Exchange Rate Regime			Two Tier Exchange Rate Regime		
		Dummy	Dummy and Interaction Term	Dummy	Dummy and Interaction Term	All Regimes	Dummy	Dummy and Interaction Term	All Regimes	Dummy	Dummy and Interaction Term	All Regimes
IRD	-0.006	-0.008	-0.008	-0.007	-0.006	-0.008	-0.006	-0.001	-0.003	-0.006	-0.006	-0.003
IRD_Pre-Dollar			0.01			0.01			0.13			0.01
IRD_Fixed Regime					-0.008	-0.009		-0.11	-0.005			-0.005
IRD_Managed Regime									-0.026			-0.02
IRD_Two Tier Regime											-0.007	-0.007
Trend	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.004	-0.005	-0.005	-0.004
Intercept	-1.17	-0.89	-0.89	-1.17	-1.17	-0.89	-1.03	-1.13	-0.68	-1.36	-1.35	-0.69
R-square	0.9747	0.9796	0.9797	0.9749	0.9749	0.9798	0.9748	09754	0.9854	0.9754	0.9754	0.9854
Adj-R-square	0.9746	0.9795	0.9796	0.9748	0.9748	0.9796	0.9746	0.9752	0.9852	0.9753	0.9753	0.9852
Heteroskedasticity	36.14	2.98	2.4	46.07	45.77	3.48	34.89	40.7	17.65	42.19	42.19	17.66
Autocorrelation (Lag-1)	519.6	499.87	499.12	518.44	519.03	498.54	519.85	511.56	408.66	514.34	514.42	409.45
Autocorrelation (Lag-12)	520.16	503.66	503.27	518.86	519.43	502.78	520.24	512.45	421.49	514.74	514.84	423.17

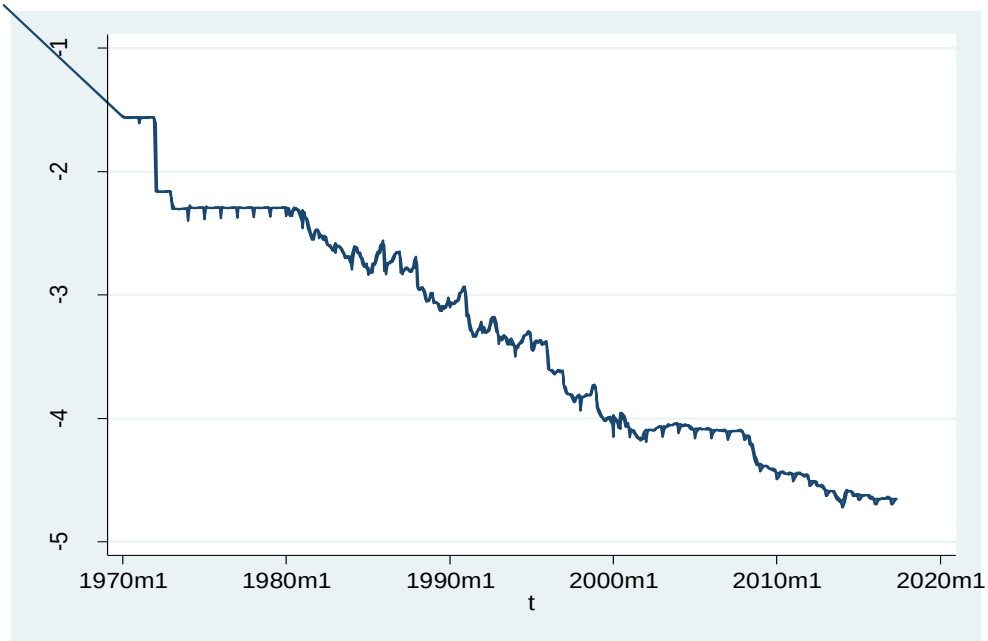
[5] https://mpra.ub.uni-muenchen.de/35297/1/MPRA_paper_35297.pdf

Table 4b: Relationship between Exchange Rate and Interest Rate Differential

Variables	Unified Exchange Rate Regime			Floating Exchange Rate Regime		
	Dummy	Dummy and Interaction Term	All Regimes	Dummy	Dummy and Interaction Term	All Regimes
IRD	-0.007	-0.007	-0.004	-0.006	-0.01	-0.007
IRD_Pre-Dollar			0.009			0.007
IRD_Fixed Regime			-0.005			-0.005
IRD_Managed Regime			-0.025			-0.025
IRD_Two Tier Regime			-0.007			
IRD_Unified Regime		0.003	0.003			0.003
IRD_Floating Regime					0.005	-0.004
Trend	-0.005	-0.005	-0.004	-0.005	-0.005	-0.004
Intercept	-1.46	-1.49	0.55	-1.11	-1.65	-8.31
R-square	0.9770	0.9770	0.9860	0.9748	0.9761	0.999
Adj-R-square	0.9768	0.9768	0.9857	0.9747	0.9760	0.999
Heteroskedasticity	57.55	57.73	23.91	37.29	45.63	169.3
Autocorrelation (Lag-1)	506.58	506.79	408.28	519.67	507.93	408.28
Autocorrelation (Lag-12)	507.24	507.69	420.84	520.08	508.95	420.84

Before following the approach of regime switching first thing which we do is to seasonally adjust the data of exchange rate. The objective behind this adjustment is to remove seasonal pattern from the data which will affect the results. This comparison can be seen in the figure (3).
As figure below shows that there are very minor differences within both variables, thus for markov approach exchange rate without seasonal adjustment can be used.

Figure 3: Seasonal Adjustment for Exchange Rate



(Source: Author's own calculation)

Table-5 below shows intercept for two regimes along with transition probabilities and sigma for both the regimes. From the results in table below it can be observed that intercept in both cases is negative meaning that change in exchange rate is causing depreciation post fixed exchange rate regime. It is to note that state-1 is highly significant in this case in comparison to state-2. Thus this also signifies the fact that exchange rate change or depreciation is mostly occurring in state-1.

Table 5: Results of Markov Regime Switching Approach

	Co-efficient	Std. Error	z	P>|z|
State-1_Cons	-4.12	0.026	-158.08	0.000
State-2_Cons	-2.51	0.026	-93.42	0.000
Sigma	0.41	0.012		

Similarly looking at the smooth probabilities i.e. how much probability is there for exchange rate to stay in one regime and how much that probability is consistent. Numbers of probability below depicts that probability of exchange rate to remain in regime-1 is more as transition probability in this case is found to be high. Probabilities of remaining within the same regime during the following period having following values.

$$P = \begin{bmatrix} 0.99 & 0.01 \\ 0.999 & 0.001 \end{bmatrix}$$

Transition probabilities in this model are p11= 0.99 and p22=0.001 suggests that first regime is persistent because of the reason that transition probability of the exchange rate regime is higher in comparison to the second regime with depreciation to be significant in comparison in comparison to regime-1. Further the computed transition probabilities probability$Prob$ (st = 1|st = 2) = 0.011 and $Prob$ (st = 2|st = 1) = 0.999 also reported that an increasing transition probability occurs in depreciation regime-2 in comparison to regime-1 because of low transition probability in regime-1. The constant transition probabilities for two regimes i.e. for all periods show that regime-2 is more dominant in comparison to the regime-1. In this scenario, constant expected duration to stay in regime-1 is more in comparison to regime-2. This is because of greater value of intercept.

The overall results and probabilities show that there were jumps with very weak impact during the period of 1970-92. These jumps were either because of political events or change in policy discourse. This was followed by the period of 1992-95 where probability being high and approaching to 1 also conclude that during this particular period political events and frequent change in political set-up resulted in variation of exchange rate. During period post 1995 there are fluctuations which later on movement towards floating exchange rate. Variations occurring during change in floating exchange rate regime are over the time due to various factors such as political uncertainty, war on terror and internal factors.

Conclusion and Policy Recommendations

It is to note that Pakistan is major dependent of oil and its products where it spends huge amount while importing. So keeping in view this key indicator of economy, this study tries to highlight relationship between exchange rate and oil prices as major relationship while interest rate differential being the secondary objective with the role of exchange rate regimes in determining this relationship. Exchange rate regimes which are taken are known and they are from pre-dollar period to current floating exchange rate regime. Beside these objectives impact of change in regime on exchange rate itself has been tested. To carry out analysis for this study time series approach has been used to test the relationship. Initially Bealieu and Miron Seasonal Unit root has been followed on the data ranging from 1970m01-2017m05, followed by ordinary least square approach. Within this analysis regime dummies (slope and interaction term) are also included in the models with no significant work in the past conducted.

Thus to deal with the mechanism and oil being one of the exogenous factor, Dubai Crude Oil Prices are taken on monthly basis in dollars as major dependence of Pakistan is on oil imports from Dubai and Middle East. While unit of measurement being dollar in major part of the analysis Call Money Rate of Pakistan and United States is taken to calculate interest rate differential.

From the analytical point of view, it can be concluded that for all regimes relationship between exchange rate and oil price is positive whereas when all regimes are used this relation comes out to be negative showing significant variation with the inclusion of all policies. Results also conclude

that Pakistan being an importing country with every rise in oil price there occurs depreciation in real terms because of being exogenous. With this exogenous nature of the oil price pressure do comes on non-oil commodities thus also result in inflation.

Whereas in case of interest rate differential, there is found negative impact with the conclusion that there are also some other missing factors helping in managing the determinants of exchange rate while looking into the models of exchange rate versus interest rate differential. However, regime dummies are also found to influence the magnitude of relationship in each regime. Thus, it can be said that exchange rate, oil price and interest rate differential relationship do depend on exchange rate regimes.

Thus based on the above discussion of results and testing for relationship between exchange rate, oil price and interest rate differential there are some important points which should be consideration for the authorities from policy perspective include: 1) Being an oil importing country, Pakistan's exchange rate is more liable to exogenous shocks and it should come up with stabilization mechanism with central policy framework. This stabilization framework should work under State Bank of Pakistan and should pool in a found to coup with all type of exogenous shocks in the long run without transferring the impact on money supply and other non-oil commodities. This will bring in control on other determinants of exchange rate including inflation as one of the key determinant. 2) Government should come up with energy mix to manage the demand and supply mechanism between oil and other energy commodities.

References

Ahmed, S.S. and Qayyum, A., 2016. The Effect of Oil Prices and Regime Switches On Real Effective Exchange Rate in Pakistan: A Markov Regime Switching Approach. *Journal of Economics Library*, *3*(4), pp.643-661.

Aziz, M.I.A. and Bakar, A.N., 2009, August. Oil price and exchange rate: A comparative study between net oil exporting and net oil importing countries. In *ESDS International Annual Conference, London*.

Beaulieu, J.J. and Miron, J.A., 1993. Seasonal unit roots in aggregate US data. *Journal of econometrics*, *55*(1-2), pp.305-328.

Bodenstein, M., Erceg, C.J. and Guerrieri, L., 2011. Oil shocks and external adjustment. *Journal of International Economics*, *83*(2), pp.168-184.

Corden, W.M., 1984. Booming sector and Dutch disease economics: survey and consolidation. *oxford economic Papers*, *36*(3), pp.359-380.

Coudert, V., Couharde, C. and Mignon, V., 2015. On the impact of volatility on the real exchange rate–terms of trade nexus: Revisiting commodity currencies. *Journal of International Money and Finance*, *58*, pp.110-127.

Franses, P.H. and Hobijn, B., 1997. Critical values for unit root tests in seasonal time series. *Journal of Applied Statistics*, *24*(1), pp.25-48.

Hakkio, C.S., 1986. Interest Rates and Exchange Rates–What is the Relationship?. *Economic Review*, (Nov), pp.33-43.

Hamilton, J.D., 1989. A new approach to the economic analysis of nonstationary time series and the business cycle. *Econometrica: Journal of the Econometric Society*, pp.357-384.

Hasanov, F. 2010, The Impact of Real Oil Price on Real Effective Exchange Rate: The Case of Azerbaijan (No. 1041), Discussion papers, German Institute for Economic Research.

Kilian, L., 2008. The economic effects of energy price shocks. *Journal of Economic Literature*, *46*(4), pp.871-909.

Krolzig, H-M., 1997. Markov-Switching Vector Autoregression: Modeling, Statistical Inference and Application to Business Cycle Analysis, Lectures Notes in Economics and Mathematical Systems. Springer

Krugman, P., 1983. Oil shocks and exchange rate dynamics. In *Exchange rates and international macroeconomics* (pp. 259-284). University of Chicago Press.

Li, K.W. and Wong, D.K., 2011. The Exchange Rate and Interest Rate Differential Relationship: Evidence from Two Financial Crises.

Meese, R. and Rogof, K., 1988. Was it real? The exchange rate-interest differential relation over the modern floating-rate period. *the Journal of Finance*, *43*(4), pp.933-948.

Throop, A.W., 1993. A generalized uncovered interest parity model of exchange rates. *Economic Review-Federal Reserve Bank of San Francisco*, (2), p.3.