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The Effect of Oil Prices and Regime Switches On Real Effective Exchange Rate in Pakistan: A Markov Regime Switching Approach

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Abstract. This study takes into the account relationship between oil prices and real effective exchange rate by using different exchange rate regimes in Pakistan. In this study following (Meese & Rogoff, 1988) and (Throop, 1993) Interest Rate Parity has been used to construct a model by using real effective exchange rate, Dubai crude oil price and interest rate differential from period of 1970m01 to 2014m03. Through examining the results all variables are found to be integrated of order one. The long run relationship has been examined between real effective exchange rate and Dubai crude oil price in case of all exchange rate regimes with the use of regime dummies and interaction terms except for no regime, two-tier exchange rate regime and unified exchange rate regime. Similarly between real effective exchange rate and interest rate differential long run relationship has been examined in all the exchange rate regimes. Long run and dynamic result has also been detected except for interest rate differential with the use of exogenous exchange rate regime dummies. Oil price impacting exchange rate positively in both long and short run, while interest rate differential negatively effects exchange rate in long run. Through examining the results for impact of exchange rate regime switching on exchange rate, during 1970-2000 structural shifts were causing the change in exchange rate regimes with depreciation being high during this period.

Keywords. Interest rate parity, Exchange rate regime, Regime switching, Structural shift and Dubai crude oil price.

JEL. E42, E43, F31.

1. Introduction

There are two important components of economy playing vital role in international market namely oil prices and exchange rate. Number of studies are conducted on empirical and theoretical studies in the past were conducted to study the relationship. The relationship shows depreciation in exchange rate of Pakistan due to increase in oil prices, with the appreciation of dollar. Basing this relationship on theoretical background role of oil price in elucidating exchange rate movements was studied earlier by (Golub, 1983) and (Krugman, 1983). An oil importing country may experience both the situations with the variation in oil prices .i.e. there can be appreciation (depreciation) when oil prices rise and depreciation (appreciation) when oil prices fall. Since oil is

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termed to be homogenous and internationally traded commodity priced in US dollar, depreciation in this case reduces the oil price to foreigners relative to the price of their commodities in foreign currencies, thereby increasing their purchasing power and oil demand and, in turn, pushing up the crude oil price in US dollar. Being major currency in invoicing and settlement, depreciation of dollar is linked to increase in nominal oil prices, whereas on the contrary increase in real oil prices is found to result in real appreciation. The nominal impact of oil price change is not very clear. The empirical literature shows no clear indications of the study highlighting the impact of effective exchange rate with particular measures when later is adopted. Cointegration is found between real effective exchange rates and real oil prices because of relationship between both variables in nominal terms or stem from price dynamics. Such differences are also important because of non-stationarity of real exchange rates to real oil price shocks (Chaudhuri & Daniel, 1998). This impact can be better explained by the most viable syndrome named as “Dutch Disease”, which is a phenomenon exploiting the relationship between natural resources and decline in the sector.

Pakistan is said to have adopted the floating exchange rate regime in 2000 which is also evident from the study of (Khan & 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 & 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 & 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 & 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 & 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 real effective exchange rate in Pakistan, with secondary objective of testing for interest rate differential’s impact on REER. 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 data and methodology. After introducing theoretical framework along with data and methodology, we proceed with the empirical findings. The final section will conclude the study with certain recommendations.

2. A Brief Theoretical Review

Different theoretical relationships have been established between exchange rate and oil price during different time periods. The relationship can be judged by taking into the account trade balance framework. (Krugman, 1983) formulated model by sacrificing trade balance determination information and interplayed between “real” and “financial” asymmetries, and assumed that it may push exchange rate in different directions. (Corden, 1984) discussed the Dutch Disease Economics by taking into the account spending and resource movement effect in his core model. He took prices in three sectors namely booming, lagging sector and non-tradable respectively to be immobile. Following (Meese & Rogoff, 1988) whose work was on uncovered interest rate parity took exchange rate as measure of international and domestic interest rate .i.e. his function was based on interest rate parity hypothesis. This model include nominal exchange rate, international price and domestic prices. The role of oil price is incorporated within the model used by (Aziz, 2009). 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 depend upon the effects on the goods markets of those countries. Following oil price increases, the less developed countries from exporting side typically have 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 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. It is due to these consequences and similar to the 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. These effects may change over time to some degree, as the oil exporting countries gradually increased their expenditures on the exports of oil-importing countries. However, the most important factor is the degree of dependence of the importing countries on imported oil. Based on the above discussion, using (Aziz, 2009)'s framework where he stated real exchange rate as a function of oil prices and interest rate differential. We can write function as:

$$e = f(oil, ird) \tag{1}$$

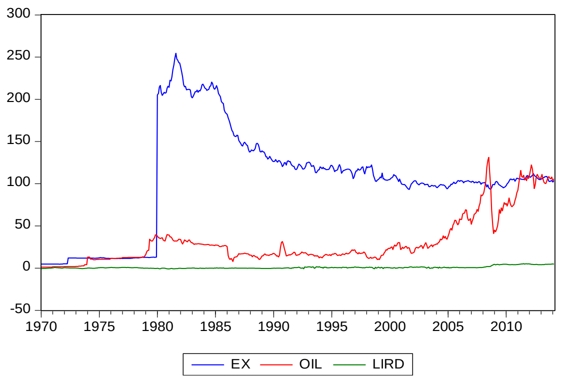
Where e = real effective exchange rate, oil = Dubai Crude Oil Prices andird = interest rate differential.

3. Methodology

Real effective exchange rate (REER) is provided by International Financial Statistics. The variable of Interest Rate Differential (IRD) is constructed by taking call money rates from International Financial Statistics whereas Dubai Crude Oil Price is taken from Quandl database referring to World Bank. Data period is taken from the period of 1970m01-2014m03. Calculation of interest rate differential is given as

$$IRD_t = CMR_{PAK} - CMR_{USA} \tag{2}$$

Reason to take REER as a measure of exchange rate is because of the reason that it takes into the account basket of exchange rates. This REER is constructed as an index from basket of exchange rates with CPI adjustments. Dubai Crude Oil is taken into the account because of the reason that Pakistan being the major importer of oil prices and dependent on oil and oil related products from Arab countries and Middle East. Graph 1 below shows the series plotted during the time period for which data is taken. It can be seen from the plot that in the period of 1970s' there were major shocks which included major energy crisis in 1973 and 1979. Beside this currency devaluation and Soviet Invasion were also seen as major shocks to exchange rate in Pakistan. In the meantime beside major shocks of 1970s' to oil prices there were shocks before that and they moved up to 2000s'. These shocks in major included conflicts between Iraq, Iran and Kuwait. Alongside this instability in Venezuela also led to the shocks in oil prices during this period.



Graph 1. *Graphical Representation of Real Effective Exchange Rate (EX), Dubai Crude Oil Price (OIL) and Interest Rate Differential (LIRD) for Study*

In order to analyze the underlying long run relationship between REER, IRD and Oil Prices, it is important to note that time series observations under the study are integrated of the same order. The results of (Bealieu & Miron, 1992) Seasonal Unit Root Test (SURT).

Following variables to be integrated of same order, we apply (Engle & Granger, 1987) and (Gregory & Hansen, 1996) which is followed by Markov Regime Switching VECM approach. Both EG and GH are two step residual based cointegration procedures with later having modified form of the first. (Gregory and Hansen, 1996) modified (Engle & Granger, 1987) approach by taking into the account level with trend and slope shift. The level shift with trend and slope shift gets the following form

$$Y_{1t} = \mu_1 + \mu_2\varphi_{t\tau} + \beta_t + \alpha^T Y_{2t} + \varepsilon_t \quad (3)$$

$$Y_{1t} = \mu_1 + \mu_2\varphi_{t\tau} + \beta_t + \alpha_{1T} Y_{2t} + \alpha_{2T} Y_{2t} + \varepsilon_t \quad (4)$$

In both the cases μ_1 and μ_2 are termed as in the level shift model, α_1 denotes the cointegrating slope coefficient before regime shift and α_2 denotes the change in slope coefficient. This is followed by Johansen Cointegration Approach to test for the long run relationship between the set of variables. In order to test for the random walk model .i.e. we apply Markov Switching Vector Error Correction Mechanism (MS VECM). Significant amount of work in this regard was taken in by Lam (1990), Philips (1991), Goodwin (1993), Kim (1994), Kahler & Marnet (1994a), Krolzig & Lutkepohl (1995) and Sensier (1996). All of these studies took into the account (Hamilton, 1989) model of the U.S. business cycle with at best slight modifications done. In line with these studies, we investigate the Real Effective Exchange Rate for Pakistan by using 2-state regime switching approach. The model estimated in this case is

$$\Delta Y_t = v(s_t) + \Gamma(L)(s_t)\Delta Y_{t-1} + \Pi(s_t)Y_{t-1} + \varepsilon_t \quad (5)$$

Where Δ is the difference operator and Y_t represents a K-dimensional vector of the observed time series consisting of a subset of the lagged REER 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 a finite number of regimes and constant transition probabilities.

$$P_{ij} = \Pr(s_{t+1} = j \mid s_t = i), P_{ij} > 0, \sum_{j=1}^{M} P_{ij} = 1 \forall i, j \in (1,......, M) \quad (6)$$

First expression in this above equation 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 not usually symmetric. So, the non-stationary behavior of the series in this regard is said to be accounted for by a 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 $\beta' Y_{t-1}$. 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 $\Pi(s_t)$ .i.e. the number of cointegrating relations r, and to estimate the coefficients of the r cointegrating vector in β' , we will employ the framework as developed by (Johansen, 1988; 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 $\Sigma(s_t)$ 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 the data to test for stationarity. To test for stationarity Bealieu & Miron (1992) seasonal unit root test is used because of the reason that data used is of monthly nature. To confirm the results of unit root obtained Augmented Dickey Fuller is also used. The results obtained for Bealieu & Miron (1992) SURT shows that all variables in general and exchange rate during different regimes in particular is found to be integrated of order 1 with only significant regime be fixed exchange rate regime. This order of integration is also confirmed by the use of Augmented Dickey Fuller test. Results show that models are random walk as calculated value in each of the case is found to be smaller in comparison to the critical values. (See-table 1).

Table 1. *Unit Root Test Using Bealieu and Miron (1992) Seasonal Unit Root and ADF*

Hypotheses	LRER	ΔLRER	LRER1	ΔLRER1	LRER2	ΔLRER2	LRER3	ΔLRER3	LRER4	ΔLRER4	LRER5	ΔLRER5
$\boldsymbol{t: \pi_1 = 0}$	-0.62	-7.09	-2.13	-6.67	-2.51	-6.51	-2.51	-6.51	-2.43	-6.55	-0.59	-7.05
$\boldsymbol{t: \pi_2 = 0}$	-6.68	-6.66	-6.71	-6.63	-6.71	-6.61	-6.71	-6.61	-6.71	-6.62	-6.70	-6.54
$\boldsymbol{F: \pi_3 = \pi_4 = 0}$	51.45	46.24	52.02	45.76	52.07	45.57	52.07	45.57	52.05	45.61	51.28	44.22
$\boldsymbol{F: \pi_5 = \pi_6 = 0}$	49.46	44.71	50.04	44.25	50.06	44.08	50.07	44.09	50.05	44.12	50.91	43.95
$\boldsymbol{F: \pi_7 = \pi_8 = 0}$	47.37	43.15	47.86	42.65	47.87	42.47	47.88	42.50	47.86	42.53	48.20	42.00
$\boldsymbol{F: \pi_9 = \pi_{10} = 0}$	47.88	43.52	48.41	43.05	48.43	42.88	48.44	42.89	48.42	42.93	49.06	42.61
$\boldsymbol{F: \pi_{11} = \pi_{12} = 0}$	48.48	44.00	49.11	43.55	49.12	43.4	49.15	43.44	49.13	43.48	48.74	42.37
Random Walk Model (ADF)	0.34*		1.39*		1.91*		1.92*		1.84*		0.65*	
D_F	0.75	2.70									1.62	2.84
D_{MF}			-0.08	-1.40							0.51	-0.46
D_T					-0.16	-0.29					0.38	-0.14
D_u							-0.05	-0.21			0.45	-0.07
D_{FF}									-0.21	-0.75	0.57	-0.01
Specification for Bealieu and Miron	C,d,nt	C,d,nt	C,d,nt	C,d,nt	C,d,nt	C,d,nt	C,d,nt	C,d,nt	C,d,nt	C,d,nt	nC,nd,nt	nC,nd,nt

Note: LRER is real effective exchange rate in fixed exchange rate regime, LRER1 is real effective exchange rate in managed floating exchange rate regime, LRER2 is real effective exchange rate in two-tier exchange rate regime, LRER3 is real effective exchange rate in two-tier exchange rate regime, LRER4 is real effective exchange rate in unified exchange rate regime, LRER5 is real effective exchange rate in floating exchange rate regime, D_F is Dummy for Fixed exchange rate regime, D_{MF} is dummy for Managed floating exchange rate regime, D_T is Dummy for Two-tier exchange rate regime, D_u is Dummy for Unified Exchange rate regime and D_{FF} is Dummy for Floating exchange rate regime. Critical values for C,d,nt are : $\pi_1 = -2.81, \pi_2 = -2.81$, $\pi_3 = \pi_4 = 6.36, \pi_5 = \pi_6 = 6.48$, $\pi_7 = \pi_8 = 6.33$, $\pi_9 = \pi_{10} = 6.41$, $\pi_{11} = \pi_{12} = 6.47$. For nC, nd, nt critical values are $\pi_1 = -1.93, \pi_2 = -1.94$, $\pi_3 = \pi_4 = 3.07, \pi_5 = \pi_6 = 3.06, \pi_7 = \pi_8 = 3.10, \pi_9 = \pi_{10} = 3.11$, $\pi_{11} = \pi_{12} = 3.11$ and * indicates acceptance of Random Walk at 5 percent using $\varphi_2 = 4.68$

Proceeding forward, we now analyze the data to test for different working hypotheses for long run relationship between REER, IRD and Oil Prices. Initially proceeding with the (Gregory & Hansen, 1996) procedure we include dummy and interaction term for each of the exchange rate regime. The results below in table-2 shows that except the cases of where only dummy for two-tier and unified exchange rate regime and dummy with interaction term for two-tier and unified exchange rate regime, there exist a long run relationship between real effective exchange rate and oil prices. In the said regimes order of integration for residual is the same to that of variables .i.e. residual is stationary at first difference. From the table-2 as it can be seen that there is present a long run relationship, we found that oil price has positive relationship with real effective exchange rate in long run. This long run is evident from the fact that with increase in oil prices in real terms exchange rate depreciates (appreciates), Aziz (2009), Hasanov & Samadova (2010) and Coudert *et.al* (2013). The reason behind this depreciation is that appreciation leads to the reduction of non-oil exports, thus causing burden on exchange rate and causing depletion. The results for long run are also confirmed when we use ADF test for residual. The results for error correction mechanism, in each of the case confirms the long run relationship as the results for level lag of the dependent variable is in accordance with the theory of (Engle & Granger, 1987), (See Table-2)

Table 2. *Long Run Relationship Results for REER vs. Oil Prices*

Variables/Regime	Regime 1		Regime 2			Regime 3			Regime 4			Regime 5		
	Dum	All	Dum	Dum+ Inter.	All	Dum	Dum + Inter.	All	Dum	Dum + Inter.	All	Dum	Dum + Inter.	All
Intercept	1.75	1.22	2.92	2.31	0.58	2.81	3.99	0.79	2.47	4.05	1.01	-0.16	3.64	0.37
Trend	0.001	-0.004	-0.002	0.001	0.002	-0.001	0.001	-0.001	0.001	0.001	-0.001	0.005	0.005	-0.001
Oil Prices	0.64	0.18	0.54	0.51	0.10	0.567	0.12	0.54	0.54	0.54	0.13	0.59	0.76	0.11
Oil Prices (DF)		0.83			0.79			0.79			0.79			0.79
Oil Prices(DMF)				0.74	0.39			0.39			0.39			0.39
Oil Prices (DTF)							0.096	0.11			0.11			
Oil Prices(DUF)										0.038	0.10			0.09
Oil Prices (DFF)													-0.38	0.13
R-Square	0.78	0.83	0.75	0.75	0.83	0.44	0.44	0.83	0.44	0.44	0.83	0.62	0.72	0.83
Adjusted R-Square	0.78	0.83	0.75	0.75	0.83	0.44	0.44	0.83	0.43	0.43	0.83	0.62	0.71	0.83
Error Term (Bealieu and Miron)	I(0)	I(0)	I(0)	I(0)	I(0)	I(1)	I(1)	I(0)	I(1)	I(1)	I(0)	I(0)	I(0)	I(0)
Serial Correlation LM Test	White Noise	White Noise	White Noise	White Noise	White Noise	White Noise	White Noise	White Noise	White Noise	White Noise	White Noise	White Noise	White Noise	White Noise
Error Term (ADF)	I(0)	I(0)	I(0)	I(0)	I(0)	I(1)	I(1)	I(0)	I(1)	I(1)	I(0)	I(0)	I(0)	I(0)
Serial Correlation LM Test	White Noise	White Noise	White Noise	White Noise	White Noise	White Noise	White Noise	White Noise	White Noise	White Noise	White Noise	White Noise	White Noise	White Noise

Note: Regime 1 = Fixed Exchange Rate Regime, Regime 2= Managed Floating Exchange Rate Regime, Regime 3= Two-Tier Exchange Rate Regime, Regime 4= Unified Exchange Rate Regime, Regime 5= Floating Exchange Rate Regime. Dum = Dummy for particular exchange rate regime, Dum+inter = Dummy with interaction term for particular regime and All = All dummies with interaction terms for regimes).

We can see from the results that in error correction mechanism (See-Table-3) oil prices transfer the impact to exchange rate in eighth month. From Table-3 above, we also get confirmation that short run impact of oil price on exchange rate stays for eighth month. This relationship concludes that relationship between oil price and exchange rate is regime dependent. This dependence is also linked to chain of events which occurred during the period of regime and length of regime. This mean that the relationship between exchange rate and oil prices in short run stays up to the 3rd quarter .i.e. impact becomes visible resulting in depreciation as pressure moves from oil products to non-oil products. This pressure results in inflation causing depreciation. If we look at the diagnostics in this case for each of the error correction mechanism, we found that there is only found problem of heteroskedasticity because of high values of chi-square as calculated. Residuals are also observed to be non-normal as values of Jarque-Berra in each of the case is found to be very high. Further results for diagnostics shows that there is no problem of autocorrelation and there is present no ARCH effect as calculated values of chi-square are found to be smaller in comparison to the critical values as found.

Similarly results for long run are obtained for relationship between REER and IRD by using same procedure of residual based cointegration. As have been discussed above to test for order of integration of residuals obtained in each of the regression, we used Bealieu & Miron (1992) seasonal unit root test and Augmented Dickey Fuller test. With the use of Bealieu & Miron (1992) seasonal unit root test, we found that except for dummy and interaction term for unified exchange rate regime case, in each of the case we found long run relationship. It is evident from the results of OLS estimation in each of the case that there is present a negative relationship between REER and IRD. This negative relationship is in accordance with (Hakkio, 1986) who stated that the negative relationship between REER and IRD is because of changes occurring in the inflation and expected inflation. Thus it lead to the negative relationship between REER and IRD, (See-Table-4). The relationship found was found to be negative in each of the case except for regime (1) .i.e. fixed exchange rate regime. Positive sign for regime (1) was in case of where only dummy along with interaction term for fixed exchange rate regime is used. This positive relationship is in accordance with the Fisher effect. Thus leading to the conclusion that there is present a positive relationship

While looking at the error correction mechanism to test for the evidence of long run relationship, we found that in each of the case in accordance with the theory of Engle & Granger (1987). Results obtained shows that in short run fluctuations in exchange rate occurs are only depending on the seasonal effect. Diagnostics for the association of REER and IRD shows that there is neither problem of autocorrelation present nor there is any ARCH (Autoregressive Conditional Heteroskedasticity) effect present. The absence of these two problems is found to be because of smaller values of chi-square calculated at first and twelfth lag at 5% level of significance. On the other side chi-square value calculated is found to be higher for heteroskedasticity in comparison to the critical value. This led to the conclusion that there is present a problem of heteroskedasticity. Similarly residuals are not found to be normal because of the reason that calculated value of Jarque-Berra is found to be very high in each of the mentioned case in Table-5. The detailed results are shown below in the Table-5.

Table 3(a). *Error Correction Mechanism for Residual Based Cointegration using REER and Oil Prices*

Variables/Regime	Regime-1		Regime-2			Regime-3	Regime-4	Regime-5		
	Dum	Dum+Inter	Dum	Dum+Inter	All	All	All	Dum	Dum+Inter	All
Intercept	0.036		0.036	0.043	0.018	0.018	0.019	0.036	0.04	0.019
t-statistic	1.57		1.57	1.82	0.68	0.69	0.7	1.57	1.88	0.7
Doil(t-8)	0.246	0.245	0.246	0.245	0.242	0.243	0.241	0.246	0.254	0.241
t-statistic	4.44	4.45	4.44	4.43	4.38	4.39	4.35	4.44	4.59	4.35
Seas(1)	0.056	0.057	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056
t-statistic	1.9	2.95	2.9	2.91	2.92	2.92	2.92	2.9	2.88	2.92
LEX(-1)	-0.016	-0.007	-0.016	-0.023	-0.018	-0.02	-0.02	-0.016	-0.009	-0.021
t-statistic	-2.5	-1.54	-2.5	-2.6	-1.98	-2.1	-2.1	-2.5	-1.9	-2.12
Loil(-1)	0.01	0.0085	0.01	0.016	0.015	0.017	0.017	0.01		0.043
t-statistic	1.48	1.193	1.48	1.89	1.75	1.88	1.91	1.48		1.43
Foil(-1)		0.0105			0.01	0.01	0.01			-0.002
t-statistic		2.22			1.79	1.84	1.86			-0.12
Moil(-1)					0.007	0.008	0.009			-0.003
t-statistic					1.39	1.55	1.58			-0.21
Toil(-1)				0.006		0.01	0.01			-0.008
t-statistic				1.17		0.73	0.76			-0.46
Uoil(-1)							0.003		-0.001	-0.01
t-statistic							0.33		-0.36	-0.76
Floil(-1)										
t-statistic										

Note: Regime 1=Fixed Exchange Rate Regime, Regime 2= Managed Floating Exchange Rate Regime, Regime 3 = Two Tier Exchange Rate Regime, Regime 4= Unified Exchange Rate Regime and Regime 5 = Floating Exchange Rate Regime. Dummy is dummy for each exchange rate regime, Dummy inter show results for Dummy and interaction term in the model while All include all the dummies and interaction terms in the model for each case, Doil (t-8) is eighth lag of oil price, seas (1) is first seasonal dummies, .Critical values for chi-square at (0.05, 1) is 3.841 and (0.05, 12) is 21.026 and Critical value for t-statistic at (0.05) is $\pm$1.96**.**

Table 3(b). *R-square , Adjusted R-square and Diagnostics for the Error Correction Mechanism for REER and Oil Prices*

	Regime-1		Regime-2			Regime-3	Regime-4	Regime-5		
	Dum	Dum+inter	Dum	Dum+inter	All	All	All	Dum	Dum+inter	All
R-square	0.071	0.076	0.071	0.074	0.08			0.071		
Adjusted R-square	0.064	0.069	0.064	0.065	0.069			0.064		
Autocorrelation(1)	0.15	0.23	0.15	0.26	0.05			0.15		
Autocorrelation(12)	0.5	1	0.5	0.45	0.57			0.5		
Heteroskedasticity	37.55	40.47	37.55	39.74	43.51			37.55		
ARCH(1)	0.003	0	0.003	0	0			0.003		
ARCH(12)	0.03	0.02	0.03	0.02	0.02			0.03		
Jarque-Berra Normality Test	2869292	2773460	2869292	2815483				2869292		

Table 4. *Long Run Relationship Results for REER vs IRD*

Variables/Regime	Regime 1			Regime 2			Regime 3			Regime 4			Regime 5	
Intercept	2.73	3.15	3.52	3.65	3.74	2.43	2.29	4.1	2.31	2.18	4.5	0.99	0.42	3.1
Trend	0.001	-0.009	0.006	0.006	0.004	0.006	0.006	0.005	0.006	0.006	0.005	0.009	0.01	0.005
IRD	-0.16	0.02	-0.23	-0.2	-0.11	-0.39	-0.4	-0.11	-0.4	-0.4	-0.1	-0.39	-0.99	-0.02
IRD(F)		-1.72			-1.3			-1.29			-1.28			-1.29
IRD(MF)				-0.72	-0.62			-0.64			-0.65			-0.66
IRD(TF)							2.26	-0.02			-0.02			
IRD(UF)										-0.01	-0.01			-0.01
IRD(FF)													-0.22	-0.01
R-Square	0.66	0.76	0.69	0.72	0.77	0.48	0.48	0.77	0.48	0.48	0.77	0.59	0.66	0.77
Adjusted R-Square	0.66	0.76	0.69	0.71	0.77	0.47	0.47	0.77	0.48	0.48	0.77	0.59	0.66	0.77
Error Term (Bealieu and Miron)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(1)	I(0)	I(0)	I(0)	I(0)	I(0)
Serial Correlation LM Test	White Noised	White Noised	White Noised	White Noised	White Noised	White Noised	White Noised	White Noised	White Noised	White Noised	White Noised	White Noised	White Noised	White Noised
Error Term (ADF)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
Serial Correlation LM Test	White Noised	White Noised	White Noised	White Noised	White Noised	White Noised	White Noised	White Noised	White Noised	White Noised	White Noised	White Noised	White Noised	White Noised

Note: Regime 1 = Fixed Exchange Rate Regime, Regime 2= Managed Floating Exchange Rate Regime, Regime 3= Two-Tier Exchange Rate Regime, Regime 4= Unified Exchange Rate Regime, Regime 5= Floating Exchange Rate Regime. Dum = Dummy for particular exchange rate regime, Dum+inter = Dummy with interaction term for particular regime and All = All dummies with interaction terms for regimes.

Table 5. *Error Correction Mechanism for Residual Based Cointegration using REER and IRD*

Variables/Regime	No Regime	Regime 1		Regime 2			Regime 3			Regime 4			Regime 5		
		Dummy	Dummy inter	Dummy	Dummy inter	All	Dummy	Dummy Inter	All	Dummy	Dummy inter	All	Dummy	Dummy inter	All
Intercept	0.051	0.051	0.07	0.051	0.051	0.07	0.051	0.051	0.07	0.051	0.05	0.07	0.051	0.056	0.07
t-statistic	2.38	2.38	3.32	2.38	2.37	3.32	2.38	2.37	3.32	2.38	2.37	3.31	2.38	2.59	3.31
Seas(1)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.061	0.061	0.06	0.06	0.06	0.06
t-statistic	3.14	3.14	3.16	3.14	3.13	3.15	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.2	3.14
LEX(-1)[1]	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
t-statistic	-2.34	-2.34	-3.31	-2.34	-2.33	-3.3	-2.34	-2.34	-3.3	-2.34	-2.33	-3.29	-2.34	-2.51	-3.29
Lird(-1)	-0.001	-0.001	-0.0085	-0.001	-0.008	-0.0015	-0.001	-0.001	-0.001	-0.001	-0.001	-0.0017	-0.001	-0.018	0.012
t-statistic	-0.47	-0.47	0.036	-0.47	-0.47	0.032	-0.47	-0.47	0.027	-0.47	-0.47	0.026	-0.47	-1.41	0.213
Fird(-1)			-0.07			-0.07			-0.07			-0.07			-0.082
t-statistic			-2.78			-2.77			-2.77			-2.77			-1.32
Mird(-1)					0	0			0			0			-0.011
t-statistic					0.039	0.045			0.05			0.047			-0.193
Tird(-1)								0.01	0.01			0.01			
t-statistic								0.2	0.21			0.21			
Uird(-1)											-0.009	-0.007			-0.019
t-statistic											-0.131	-0.097			-0.207
Flird(-1)														0.017	-0.012
t-statistic														1.33	-0.212
R-square	0.029	0.029	0.043	0.029	0.029	0.043	0.029	0.029	0.043	0.029	0.029	0.043	0.029	0.032	0.043
Adjusted R-square	0.023	0.023	0.036	0.023	0.021	0.034	0.023	0.022	0.032	0.023	0.022	0.03	0.023	0.025	0.03
Autocorrelation (1st Lag)	0.02	0.02	0.02	0.022	0.022	0.023	0.02	0.022	0.02	0.022	0.022	0.02	0.02	0.014	0.023
Autocorrelation (12th Lag)	0.5	0.5	3.1	0.59	0.59	3.1	0.59	0.59	3.1	0.59	0.60	3.1	0.5	0.95	3.14
Heteroskedasticity	14.91	14.91	21.72	14.91	14.95	21.76	14.91	14.91	21.76	14.91	14.93	21.78	14.91	17.15	21.78
ARCH (1)	0.003	0	0	0.003	0.003	0.002	0	0	0	0.0031	0.0031	0	0	0.003	0.002
ARCH (12)	0.03	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.02	0.031	0.31	0.02	0.03	0.03	0.025
Jarque-Bera Value	3651151	3651151	3452236	3651151	3651658	3455784	3651151	3653075	3457723	3651151	3650460	3457255	3651151	3584644	3457255

Note: Regime 1=Fixed Exchange Rate Regime, Regime 2= Managed Floating Exchange Rate Regime, Regime 3 = Two Tier Exchange Rate Regime, Regime 4= Unified Exchange Rate Regime and Regime 5 = Floating Exchange Rate Regime. Dummy is dummy for each exchange rate regime, Dummy+inter show results for Dummy and interaction term in the model while All include all the dummies and interaction terms in the model for each case, Chi-square value (0.05,1) is 3.841, Chi-square value (0.05,12) is 21.026 and t-statistic at 0.05 is ± 1.96)

[1] Level lags and to be more precise level lag of dependent plays a role of Error Correction term in accordance with the process of Engle and Granger (1987).

Moving ahead with the testing of long run relationship in terms of Johansen Cointegration procedure by following VAR estimation. We incorporate regime dummies as exogenous variables to test for the long run relationship. Using AIC criteria for lag selection in each case, we obtain 3 as optimal lag length. From each of the result following condition of no deterministic trend as per (Johansen 1991and 1995) we obtain 1 cointegrating equation as a result. The result of one cointegrating equation stay valid for all except that of fixed exchange rate regime where there is no cointegration present. This lead us to the conclusion that there is present a long run relationship between REER, IRD and Oil Prices.

The result in each case shows that there is present a significant relationship between REER and IRD and REER and Oil Prices. While looking at the results, as discussed, with IRD, REER has negative relationship because of the reason that variation occurring in inflation and expected inflation. Similarly positive relationship of REER with oil price is in accordance with the fact that depreciation occurring in this case is because of the reason that impact is transferred to non-oil exports, (See Table-6).

Table 6. *Long Run Equations from Johansen Cointegration*

Specification	Long Run Equation
No Dummy	$LEX_t = -0.7638LIRD_t + 2.0621LOIL_t + \varepsilon_t$ (8.204) (31.178)
Fixed Exchange Rate Regime	No Cointegration
Managed Floating Exchange Regime	$LEX_t = -0.5075LIRD_t + 1.634LOIL_t + \varepsilon_t$ (7.163) (43.418)
Two-Tier Exchange Rate Regime	$LEX_t = -0.776LIRD_t + 2.140LOIL_t + \varepsilon_t$ (8.553) (32.381)
Unified Exchange Rate Regime	$LEX_t = -0.791399LIRD_t + 2.015801LOIL_t + \varepsilon_t$ (8.692) (29.699)
Floating Exchange Rate Regime	$LEX_t = -0.580LIRD_t + 1.699LOIL_t + \varepsilon_t$ (8.294) (39.416)

Note: *Values in ( ) represents Chi-square (calculated using Likelihood ratio test) against respective co-efficient for each equation

In short run (Table-7) when we look at the results we see that in each case as shown in table-6, where cointegration exist, oil prices are have its impact on REER in eighth month with the presence of seasonal effect present in each case. Diagnostics as shown in table-7, in each case show that there is no problem of autocorrelation and heteroskedasticity with residual not found to be normal.

Table 7. *Short Run Dynamics, Goodness of Fit and Diagnostics*

Variables	No-Regime	Managed Floating Exchange Rate Regime	Two-Tier Exchange Rate Regime	Unified Exchange Rate Regime	Floating Exchange Rate Regime
Intercept*	-0.0147	-0.005	-0.016	-0.0137	-0.0068
*	0.2518	0.2465	0.2526	0.2510	0.247
Seas (1)*	0.0578	0.0578	0.0589	0.0579	0.0579
−1 *	-0.009	-0.0142	-0.0093	-0.0104	-0.0137
R-square	0.069	0.072	0.069	0.07	0.072
Adjusted R- square	0.064	0.067	0.064	0.064	0.067
Breusch Godfrey Serial Correlation LM Test	0.109 0.535	0.123 0.511	0.113 0.566	0.107 0.551	0.118 0.532
Autoregressive Conditional Heteroskedasticity Test	0.003 0.034	0.003 0.032	0.004 0.034	0.003 0.033	0.003 0.032
Normality	2776754	2757294	2715395	2768912	2753155

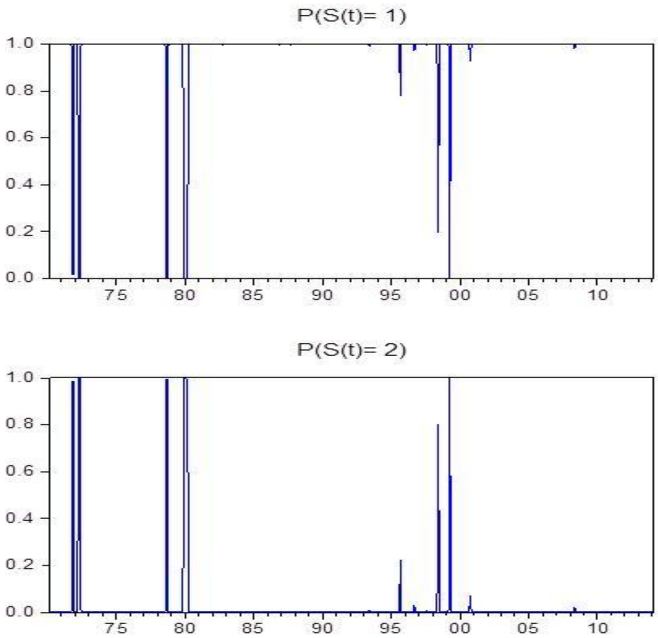
Note: * variables significant at 5 percent level of significance, Breusch Godfrey Serial Correlation LM Test values and Autoregressive Conditional Heteroskedasticity Test values are at 1st and 12th lag with critical values of 3.841 and 21.026.

4.1. Markov Regime Switching Approach

Turning to the result of estimating the random walk model for regime switches using MS VECM, we found that depreciation is significantly taking place in regime 2 in comparison to that of regime 1. This depreciation is because of the reason that in both the cases sigma is showing to have a negative value but having positive intercepts. The common elements present here with AR (1) being significant at 5 percent but the lagged value of exchange rate is found to be significant at 10 percent level. These common terms are also found to be enlisted as non-switching elements. Similarly when we look at the probabilities to stay in one regime and consistency in this regard we can conclude on the basis of result that probability to remain in regime 1 is more as transition probability in this case is found to be high in comparison to the second regime.

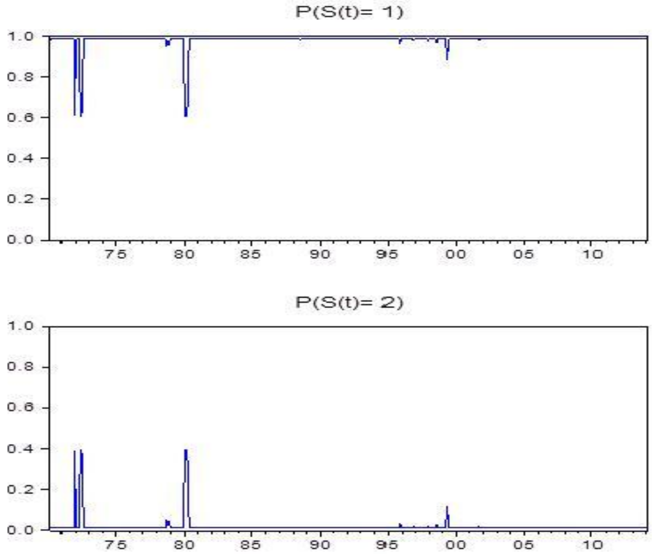
$$P = \begin{bmatrix} 0.988 & 0.011 \\ 0.606 & 0.393 \end{bmatrix}$$

Transition probabilities in this model are p11=0.988 and p22=0.393 suggests that the first regime is persistent since the transition probability of the exchange rate regime is higher in comparison to the second regime where real depreciation is said to be significant in comparison to regime 1. Furthermore, the computed transition probability $(s_t = 1| = 2) = 0.011$ and $(s_t = 2| = 1) = 0.606$ reported that an increasing transition probability occurs in real depreciation regime 2 in comparison to regime 1 because of transition probability in regime 1 is low. 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. Constant expected duration to stay in regime 1 is more in comparison to regime 2. When we look at the smooth regime probabilities, from the figure (2) we can see that during different periods there is movement observed in exchange rate.



Graph 2. *Smooth Regime Probabilities*

This movement is either because of shock or due to change of regime. The prominent movements were that of during the period of 1979-81 and 1998-2000. Mean probability of state-2 in this case is also found to be less in comparison to state-1. Thus this also confirms the impact of regime switching. The one-step ahead probability which can be used for probability of being in state at (t+1) time period. Having higher probability in state-1, results also confirm that REER for Pakistan stays in state-1 for maximum period in comparison to the state-2. The events (shocks) were also found more to occur during the first state as can be seen in figure (3).



Graph 3. *One-Step Ahead Forecasting Probabilities*

5. Conclusions and Recommendations

Since past number of years, Pakistan is found to be the major dependent on oil on which it has to spend huge amount while importing it. So keeping this point of view, this study focuses on the relationship between REER and Oil Prices as major relationship while with IRD as secondary objective to test along with the role of exchange rate regimes in determining this relationship. Beside this time varying impacts of REER .i.e. impact of change in regimes on REER itself has been tested. To carry out this study time series approach has been used to test the long and short run relationships and regime impact through Engle & Granger (1987), Gregory & Hansen (1996), Johansen and Markov Regime Switching approach and initially through Bealieu & Miron (1992) Seasonal Unit Root Test has been followed. Monthly data has been used since period of 1970m01-2014m03 for analysis. Regime dummies are also included in the models as previous studies had not considered the relationship based on exchange rate regimes. In Pakistan there was no work found in this context. To deal with the mechanism and oil being one of the exogenous factor in case of Pakistan Dubai Crude Oil Prices are taken as Pakistan is dependent on oil products via Dubai and Middle East as major supplier. While interest rate differential has been measured by taking into the account Call Money Rate of Pakistan and United States. From the analytical point, it can be concluded that Fixed Exchange Rate Regime was one of the significant regime played its role in Pakistan. While being an importing country with every rise in oil price there occurs depreciation in real terms because of being exogenous. Whereas with interest rate differential, negative impact was found with conclusion that there are also some other factors which are missing and it helps in determining the REER while looking into the models of REER versus IRD. However, regime dummies are also found to influence the long and short run relationship and change in slope and intercept occurs due to this inclusion along with interaction terms. So we can say

REER, Oil Prices and IRD relationship is dependent on the regimes of exchange rate and there occurs a major change in system in long run but less beneficial results are found in short run as only oil prices in 8th month while seasonal effect in terms of IRD are found significant.

Based on the above discussion of results and testing for relationship between REER, IRD and Oil Prices and dealing with exchange rate regimes there are some important points which should be taken into consideration from the policy perspective. Being an oil importing country, Pakistan's exchange rate is more liable to exogenous shocks and it should more look into the formulation of exchange stabilization fund to coup with such shocks without transferring impacts to domestic money supply. This fund can be created after formulation and amendments of laws in the form of an act, which United States is also having in function. The formulation of this fund can be used for the purchase of foreign currencies, to hold foreign exchange and special drawing rights (SDR) assets, and to provide financing to foreign governments. All operations of the exchange stabilization fund formed will require the explicit authorization of the central ministry and central bank in this regard. Further for monetary authority i.e. State Bank of Pakistan there is no need for intervention in the presence of fund i.e. State Bank of Pakistan should not react to the fluctuation of oil prices and designing policies accordingly.

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