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Real Exchange Rate Misalignment in Pakistan: An Application of Regime Switching Model

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Abstract

This study investigates the key determinants of exchange rate (RER) misalignment for the period 1991 to 2020. The BEER technique has been used to estimate the degree of the equilibrium exchange rate. To explore the actual exchange rate misalignment and to assess the behavior of variables that are different in different regimes of undervaluation and overvaluation, the nonlinear technique of Markov regime-switching (MSM) was applied. The mean and variance of each regime are highly significant and show that undervaluation episodes have a low mean (116.139) and more volatility (1.229) while overvaluation episodes have a high mean (126.732) with less volatility (0.871). The findings show that MSM accurately identifies exchange rate misalignment in both regimes as separate incidents of overvaluation and undervaluation. Results further depict that misalignment of the RER is affected by terms of trade, net foreign assets, interest differential, government investment, and consumption decision. Results recommend that if policymakers want to use the exchange rate as a policy tool, they must first consider the drivers of the equilibrium exchange rate. As a result, any deliberate actions to address exchange rate misalignment must focus on the underlying fundamentals that drive the exchange rate.

Keywords: Exchange Rate, Misalignment, Markov Regime-Switching, Non-Linearity, Pakistan

JEL Classification Code: F31, F33, L60, O14

1. Introduction

It is widely considered that the exchange rate misalignment is the culprit of numerous domestic and global economic ills. The misalignment of the exchange rate refers to a significant gap between the real exchange rate and its equilibrium level. Misalignment is often viewed as a key indicator of external competitiveness which may generate instability and are likely to affect economic performance. Maintaining an exchange rate at a wrong level may affect the level of development, employment, total factor productivity, competitiveness level, technical and technological advancement, size of foreign debt, the budget deficit, purchasing power, and capital flows in the economy. Misalignment of the exchange rate leads to overvaluation and undervaluation of the domestic currency.

Misalignment in terms of both overvaluation and undervaluation influences different sectors of the economy differently. Undervaluation or overvaluation of the exchange rate may cause severe economic and financial problems, e.g. on importers and exporters, which may result in unsustainable economic developments, such as in the balance of payments (Nguyen et al., 2021). Overvaluation affects the tradable sector which if persists for a long time it causes a trade deficit and hence the burden of external debt. The effect of misalignment of exchange rate either positive or negative, on the economy remains subjective.

The determination of the equilibrium real exchange rate is very crucial for computing a degree of misalignment in

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open economy macroeconomics. It also creates distortions in the relative prices of traded to non-traded goods that can generate incorrect signals to economic agents resulting in greater economic instability which affects the resource distribution among sectors. Exchange rate policy acts as a lever for economic growth, even in countries with weak institutions.

Exchange rate regime selection is one of the most important decisions of under-developed economies. Literature showed that the floating exchange rate is more flexible that leads towards more efficient resource allocation (Ghosh et al., 2003) in most of the developed countries while it can be problematic for developing countries. The fixed exchange rate is in favor of macroeconomic stability while a flexible exchange rate leads to misalignment of the exchange rate which results in a financial crisis due to an increase in the current account deficit (Ghosh et al., 2003). East Asian crisis 1997 and Mexico crisis 1994 are famous examples of financial crisis due to high deficit in the current account. Past studies also found that currency crises are often linked to real exchange rate misalignment.

In the era of globalization, studying the fluctuation in the Exchange rate and the accurate value of currency or optimal value of a currency is a concern for policymakers. Because exchange rate movement and variation can affect the value of a worldwide investment portfolio, exchange rate behavior has become one of the most important concerns in economic analysis (Raksong & Sombatthirs, 2021). Proper understanding of the exchange rate may lead to proper planning of the exchange rate. As stability in the exchange rate market is closely linked with stability in the overall economy (Omerbegovic, 2005).

Countries try to make policy-relevant when they get accurate knowledge about the misalignment of the exchange rate. For that, there is a lot of studies that estimate misalignment and its effect on macro-economic variables. In the case of Pakistan, various economists estimated the Misalignment. However, all these researches focused on the linear relationship between determinants of exchange rate while ignoring the non-linear relationship between variables. This urges the researcher to investigate the hypothesis that there exists a non-linear relationship between the exchange rate and its determinants.

This paper aims to evaluate Pakistan's exchange rate and, as a result, to find out the determinants of its equilibrium exchange rate, i.e. the exchange rate path which is consistent with the country's long-term goals. In the literature, this equilibrium exchange rate, ineffective terms, is referred to as the Equilibrium Real Effective Exchange Rate (EREER). We used the behavioral equilibrium exchange rate approach to find the equilibrium exchange rate by using the nonlinear econometric technique. The Markov regime-switching technique examines how these indicators had behaved in different regimes.

1.1. The Real Effective Exchange Rate: Definitions and Concepts

Effective Exchange rate (EER) indices are weighted averages of bilateral exchange rate indices that provide a more comprehensive picture of a country's position in the foreign exchange markets. They are crucial indicators of a country's international price competitiveness and its vulnerability to global inflationary trends.

Two main broad categories of EER can be distinguished:

- The Nominal Effective Exchange Rate Index (NEER) is a weighted average of a country's nominal bilateral exchange rates, indexed on a base year of choice.
- REER indices (Real Effective Exchange Rates) correct the NEER for changes in relative price or considerable expense.

Many national and international organizations usually calculated different kinds of EER according to different methodologies on monthly basis. For Pakistan, different NEER and REER indices are available. One of them is calculated by the State Bank of Pakistan (SBP) and published on their website, while the other is estimated by the International Monetary Fund (IMF) and published in International Financial Statistics (IFS). The NEER indices for Pakistan are a weighted geometric average of bilateral exchange rate indices of the Pakistan Rupee with the currencies of its 27 main international trade partners. The weights reflect the share of each of these 27 trade partners in either Pakistan's exports or its imports.

Pakistan's exchange rate policy has been characterized by a movement towards greater market flexibility, going along with increasing trade liberalization. A free-floating exchange rate has the advantage to provide an equilibrating mechanism that can contribute to restoring imbalances in the balance of payments automatically. On the other hand, to avoid potential excess exchange rate volatility, or even currency crises, caused by speculation, Pakistan's financial account has not yet been fully liberalized. Figure 1 below displays the historical USD to PKR rates from 1991 to 2020.

The graph shows the Rupee dollar value from 1990, from that the Pakistani rupee began fluctuating against the dollar under the managed exchange regime. During the 1990s, the exchange rate was Rs. 20 per dollar while its value decreased to Rs. 55 per dollar in 2000 on the back of declining economic growth. After 2000, however, Pakistan saw an

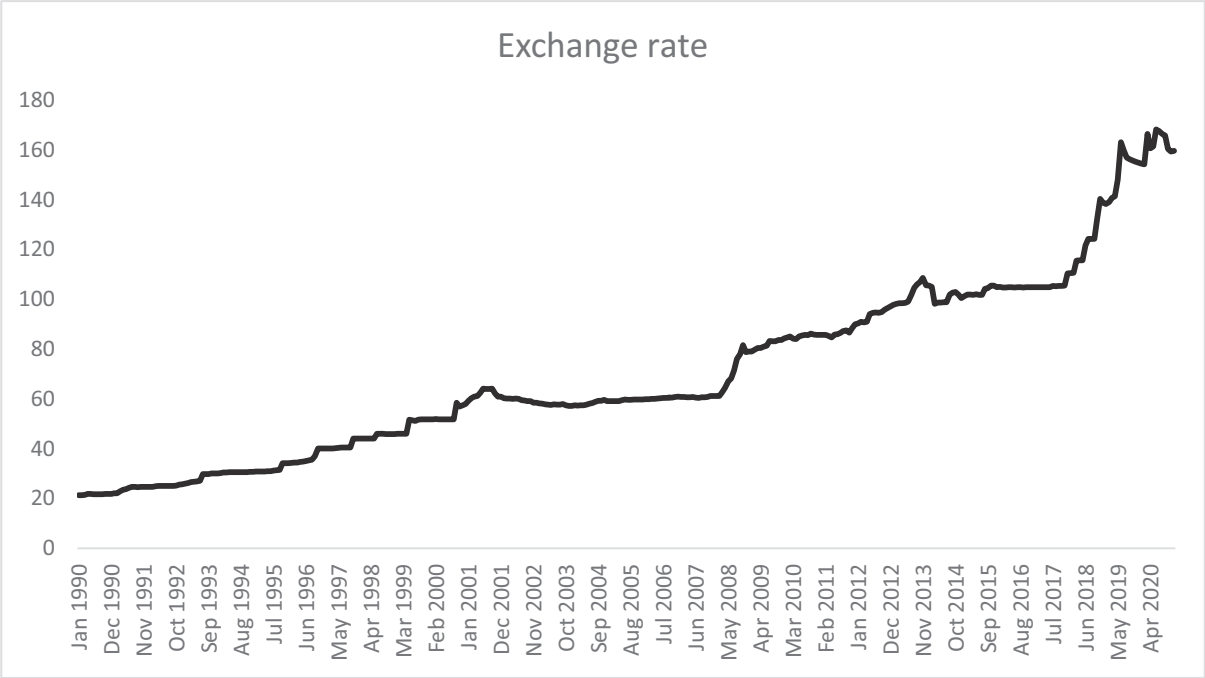

Figure 1: Exchange Rate from 1990 to 2020

era of privatization, improved governance, and increased exports under the Musharraf rule, which contributed to the current account surplus on the books of the State Bank, and thus the Pakistani rupee remained stable from Rs. 62 in 2001 to Rs. 60 in 2007. From 2007 to 2013, the country's immense current account deficits and terrorism contributed to deteriorating economic conditions, thereby depreciating Pakistan's rupee from Rs. 60 in 2007 to Rs. 101 in 2013. Variables like Subsidizing imports weak export base, current scenario lead to the unpredictable value of the Pakistani rupee against the dollar value.

Specifically, during PMLN tenure from 2013–2018, the Pakistani currency remained around 101 to 105. The PMLN government continued to intervene with import subsidies to keep the dollar cheaper in a high-supply country. Despite lower exports and high current account deficits, the rate was further artificially held down by the PMLN government. The government has introduced a free-float regime under the IMF program over the past year thus reducing import subsidies. This contributed to the current increase in Pakistan's dollar rupee from Rs. 121.48 in 2018 to around Rs. 158 in March 2020 and 175 in October 2021.

For economies with large industries and substantial export bases, currency devaluations are helpful. However, when the government recently implemented a free-float policy to let go of the unfairly held value of the rupee, it did much less to promote Pakistan's exports, as the industry has been facing a sluggish period for many years. Consequently, increasing the USD value against the Pakistani rupee has only increased our economy's pressure in terms of rising policy rates and discounts, rising inflation, and slowing GDP growth.

As the value of the US dollar increases against the rupee, borrowing costs have also risen dramatically, and with about $105 billion of external debt on our heads, the new USD to PKR rate is giving our economy a big setback. At present, a steady level around Rs. 155 against the US dollar was found by the Pakistani Rupee, which could be called the real value of the Pakistani rupee against the dollar. The latest Coronavirus epidemic, however, has shaken global economies around the world and we have to wait for a new level of valuation for our local currency with the Pakistani rupee rising again to Rs.166 against USD.

2. Literature Review

There is a lot of empirical research on exchange rate modeling and REER misalignment across countries. Razin and Collin (1997) studied exchange rate misalignment and argued that the policy of holding the actual depreciated exchange rate was generally related to competitive devaluation policies to stimulate the export sector of a nation. Sazanami and Yoshimura (1999) studied restructuring

East Asian exchange rate regimes. Their findings stressed that the yen-dollar stability to avoid large volatility in the region. Bouoiyour and Rey (2005) explored exchange rate regimes in the case of Morocco. They found that an increase in volatility leads to a decrease in the trade balance of the economy but there is no impact on foreign direct investment of the economy while Qamruzzaman et al. (2019) discovered that positive changes, such as the appreciation of the currency rate against the USD, reduce FDI inflows whereas negative shocks result in greater FDI inflows.

Coudert and Couharde (2009) investigated that currency misalignment and regime analysis in emerging and developing countries. They used panel data of 108 countries from 1974 to 2004 and found that pegged currencies are more overvalued than floating ones. Béreau et al. (2012) described the relationship between misalignment of the exchange rate and economic growth by using panel data from 1980-2008 for 32 countries. They concluded that misalignment had an asymmetric impact on growth. Overvaluations hamper the growth and undervaluation promotes the economic growth of the economy.

Dubas (2009) study the importance of exchange rate regimes in limiting misalignment. He used the annual data from 1973 to 2002 for 102 countries and found results by applying the DOLS method. Results showed that the regime matters to limit misalignment for developing countries but not for developed ones. In the case of America, Caputo and Magendzo (2011) looked at inflation and exchange rate regimes. They used annual data for nine countries from 1970 to 2010. They discovered that a degree of flexibility aids countries in achieving a more aligned exchange rate. At a level where misalignment is less common, countries may reduce inflation persistence.

Caputo (2015) studied the persistence misalignment and exchange rate regime. He used a panel of 54 countries and annual data from 1980 to 2011and found that exchange rate dynamics are inelastic to the exchange rate regime in the case of developing countries. Speed of adjustment and rate of appreciation differs across countries. A fixed exchange rate regime reduces the speed of convergence. Owoundi (2017) studied the underlying misalignment and exchange rate regime in the case of 17 Sub-Saharan African countries. It was found that misalignment is not dependent on the exchange rate regime.

Chen et al. (2018) investigated the nonlinear exchange rate adjustment with purchasing power parity. He used monthly data from 1990 to 2012 of developed high-growth countries. It was found that nonlinear and asymmetric adjustment towards PPP in five out of six countries. Tipoy et al. (2018) explained the misalignment of the exchange rate and economic growth of emerging countries. They used panel data from 1970 to 2014 and applied the PSTAR model. They found that increase in misalignment increase the output in the short run. But when there is a large misalignment, the output is reduced. They concluded that undervaluation promotes growth but when huge undervaluation is prevailing in the economy that will be harmful to economic growth.

It is well established that exchange rate misalignment has serious implications for the economy and that Pakistani PKR has historically remained misaligned from its equilibrium value. But the literature on that issue is scant in Pakistan. The applicability of PPP in the case of Pakistan was discovered by Chishti et al. (1993). On quarterly data from 1957 to1992, they used Engle and Granger's co-integration test. The findings verified that in the case of Pakistan, the simple PPP model is ineffective. Using annual data from 1960 to1990, Afridi (1995) investigated the factors that influence the real exchange rate. Excess demand for domestic credit and capital flows was found to be inversely related to the real effective exchange rate. Terms of trade do not affect REER.

Siddiqui et al. (1996) investigated the determinants of the real exchange rate. They used a simultaneous equation model for estimation of the behavioral relationship between monetary and real variables and REER. Results directed that both monetary and real variables influenced the equilibrium of REER.

The available literature is limited to economic fundamentals-based identification of the drivers of misalignment. Few researchers have researched exchange rate misalignment by using linear modeling but the literature showed that exchange rate is vulnerable to unexpected changes in behavior. These abrupt changes in the exchange rate cannot be easily captured through linear modeling. Nonlinear models, on the other hand, are ideally suited to capturing such sudden shifts in the exchange rate. As a result, the present study adds the following to the literature: First, a recent data set is used to estimate the REER equilibrium and exchange rate misalignment; second, a nonlinear regime-switching model is used to measure the misalignment behavior in such a way that the dynamics of the Pak Currency misalignment arise from one of two separate regimes, i.e. episodes of over-or undervaluation.

3. Methodology

3.1. Theoretical Framework and Empirical Model

In the literature, there are a large number of models which were used for exchange rate determination. For example, PPP, UIP, BOP monetary model, portfolio balance model, and macroeconomic models. The PPP approach served as the foundation for the interest parity model, which was subsequently combined with the monetary and portfolio balance models. With significant research and an

understanding of what's going on in financial markets, the elements that affect the exchange rate of economies begin to be incorporated into the model.

There are two ways to calculate equilibrium exchange rate: First one PPP criterion where equilibrium is calculated through equalized purchasing power in different countries. It is useful for the comparison of living standards. The FEER technique, which addresses the PPP inconsistency problem and incorporates the macro balance of the economy by including trade elasticities and capital flows, is the second method for determining the equilibrium exchange rate. PPP is helpful for comparison but not for measuring exchange rate misalignment, hence the theory of FEER is proposed. This approach was developed by IMF in 1970 by defining the equilibrium real exchange rate. It is described as the FEER approach to assessing exchange rate misalignments in the context of achieving medium-term macroeconomic equilibrium in the economy, including both domestic and foreign balance. Domestic balance refers to the economy's full employment situation, whereas foreign or external balance refers to the economy's medium-term balance of payments. This method allowed for changes in equilibrium when the economy's fundamentals are altered. The FEER model's key problem is that it's difficult to separate the factors of the model.

To avoid the problem of PPP and FEER, BEER was introduced to measure the equilibrium exchange rate. The BEER uses the economic factors which affect the equilibrium exchange rate. This method estimates current values of economic factors including terms of trade net foreign assets, fiscal balance, and interest differential. Fiscal balance includes government current expenditure and government development expenditure.

This study employs the BEER (Behavioral equilibrium exchange rate) approach developed by Clark and MacDonald (1998) for estimating the equilibrium exchange rate. This approach works as follows: (i) Real exchange rate is estimated against the fundamental determinants of RER. (ii) The estimated coefficients from the regression in the first step and the permanent components of the determinants of RER are used to compute equilibrium RER. (iii) RER misalignment is computed as the difference of the observed real exchange rate from the computed equilibrium RER. In pursuance of Step 1 above, the following model adapted from Naseem et al. (2013) has been estimated including both domestic as well as external factors determining equilibrium exchange rate as follows,

$$RER = f(nfa, tot, govcon, govinves, idiff)$$

Where RER represents the real effective exchange rate, NFA is for net foreign assets, tot represents terms of trade, govcons represents government consumption, govinves represents government investment, and idiff represents the interest rate differential. The study uses monthly data of time series from 1991 to 2020.

The theoretical relationship between macroeconomic factors is ambiguous. Though an increase in capital flows results in an increase in total assets, which causes the exchange rate to appreciate. When terms of trade deteriorate, the exchange rate depreciates, and vice versa. If government demand shifts to non-traded goods, non-traded goods prices rise, causing the exchange rate to appreciate. However, an increase in development spending leads to an increase in investment, which raises demand for imported machinery, resulting in exchange rate appreciation. However, there could be a supply-side which also affects the prices in affected sectors. If those supply-side changes were included in the nontraded goods sector, it will result in a real exchange rate depreciation.

Net Foreign Assets (±)

Net foreign assets (NFAs) are the value of a nation's owned overseas assets, minus the value of its foreign-owned domestic assets, adjusted for adjustments in valuation and exchange rates. A net foreign assets position is positive or negative and may impact the foreign exchange value of its currency over time.

Terms of Trade (±)

Terms of Trade (TT) are used for the terms of the trade index. The effect of terms of trade on the exchange rate would depend on substitution and income effect.

Government Investment (±)

The investment consists of the developmental expenditure of the government. Increased government development spending leads to increased investment in various projects, which leads to increased demand for machinery and imported products to finish the projects, causing the economy's exchange rate to fluctuate.

Government Consumption (±)

Govcon is used for Government consumption. As the government's current expenditure increases in the economy, demand will be put under more pressure. Changes in government consumption have an impact on demand, which in turn has an impact on demand for tradeable and non-tradeable items, affecting the exchange rate.

Interest Differential (±)

Interest differential is calculated using Interest Differentia (Idiff). It is calculated as the differential in interest rates between the United States and Pakistan. Increased interest rates encourage foreigners to invest, causing the exchange rate to rise, whereas lower interest rates cause the exchange rate to fall.

3.2. Preliminary Investigation

3.2.1. Test of Linearity

Nonlinearities exist due to change in mean and variance. In both cases, the linear model had not given appropriate results. It is best to define the linear model first before moving on to the nonlinear model to ensure that the linear model is adequate for the data. To find the null hypothesis of linearity, the linearity test calculates the Lagrange Multiplier (LM) statistics value and the p-values of the delay parameter. Nonlinearity qualities were found in the one with the highest statistics, which are greater than the Chi-Squared distributions, and the lowest *p*-values.

The empirical features of econometric tests for nonlinearity in mean in time-series data have been thoroughly documented in the literature. As a result, it's general knowledge that time-series data with non-constant variation might pose problems for these tests. It is common to over-reject the null hypothesis of linearity in the mean when the time series being analyzed is heteroskedastic. It's necessary to differentiate between the null hypothesis being rejected due to neglected nonlinearity in the mean and the existence of heteroskedasticity in some cases. In these cases, even if heteroskedasticity is present, a test for nonlinearity in the mean with the correct size is required.

3.2.2. Structural Stability Test

Parameters' stability is checked through CUSUM and CUSUM square tests. The results showed that the model is not stable. Figure 2 revealed that the blue line is not within the boundary of a 5 percent level of significance, so it is concluded that the model is not linear.

So, to tackle this problem either the model is linear or not we further perform the BDS test that the model is linear or not.

3.2.3. BDS Test

A nonparametric test of correlation integral was proposed by Brock-Dechert-Scheinkman. The basic idea is that the evolution of two values of the block which are close to some metric should also be close to the block metric. An observed series at the correlation integral $C(l, t)$ is given below as

$$c_n(l,t) = \frac{2}{(t_n \times (t_n - 1))} \sum_{t<s} I_t(x_t^n, x_s^n)$$

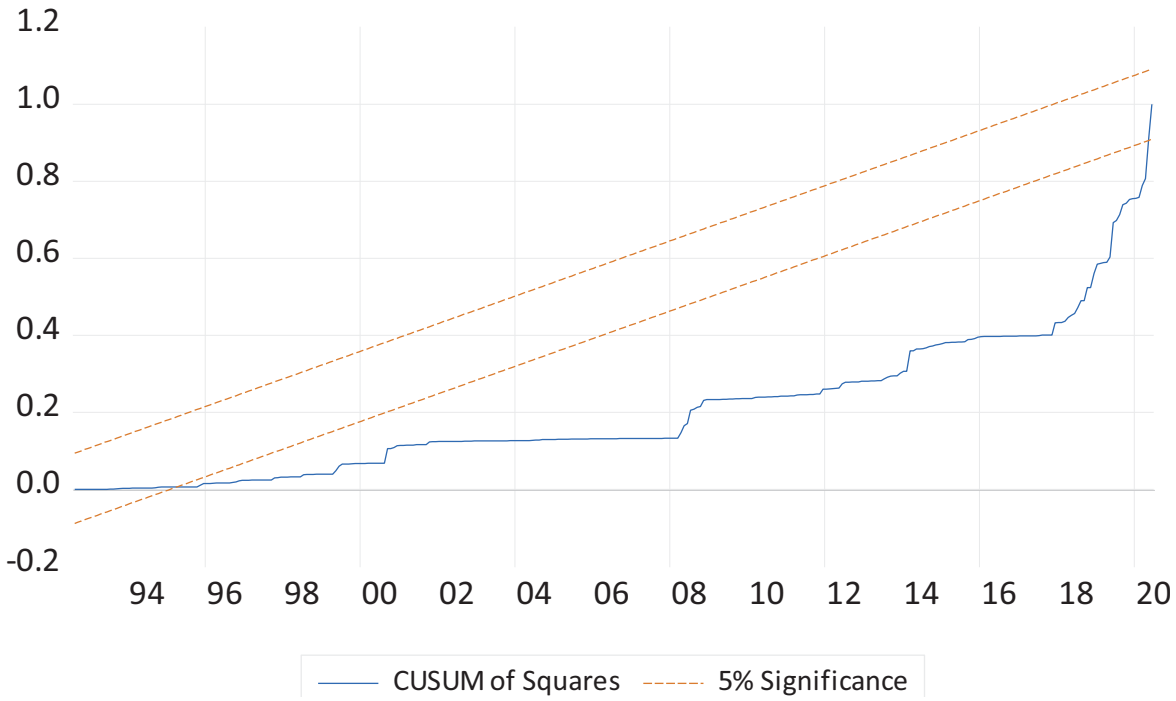

Figure 2: CUSUM and CUSUM Square Tests for Structural Stability

Where,

$$x_t^n = (x_t, x_{t+1}, \ldots\ldots\ldots\ldots x_{t+n-1})$$
$$x_s^n = (x_s, x_{s+1}, \ldots\ldots\ldots\ldots x_{s+n-1})$$

Are called *n*-histories. The probability that any two *n* histories are within l of each other is estimated using the correlation integral. If it's white noise, it's a no-no.

$$c_n(l,t) \to c_1(l,t)^n,\ ast \to \infty$$

And

$$w_n(l,t) = \frac{\sqrt{t}\left(c_n(l,t) - c_1(l,t)^n\right)}{\sigma_n(l,t)}$$

The BDS test the null hypothesis that series are white noise. This is a diagnostic test, so rejection of the null hypothesis means the dependence of data. BDS measures non-linearity since the first natural logarithmic distinction removed any linear dependence on the results. The null hypothesis in the BDS test is that the series is distributed independently and identically, but if we reject it, it implies that the series has some chaotic behavior, implying that it is dependent and not identically distributed. Table 1 shows the results of the BDS test. To complete the test, a dimension of 2–6 and a distance of 0.7 was chosen. All the BDS test statistics' *p*-values are less than the 5% significant level, according to the test. Since all of the stated dimensions are significant at a 1% level of significance, the BDS test results indicate that the relationship between exchange rate and its determinants is non-linear.

As supported by the test, the use of a nonlinear model is more appropriate. So, apply Markov switching model and the result of the Markov switching regression model indicated that both mean and variance are different in both regimes. The two-regime model is accurate for modeling. Due to events such as abrupt policy changes, economic crises, and oil price shocks, several macroeconomic time series exhibit regimes shifts in their behaviour. Understanding how macroeconomic time series behave as the economy moves through the business cycle has long been a challenge in empirical macroeconomics.

Table 1: Results of BDS iTest

Dimension	BDS Statistic	Prob.
2	0.059	0.00
3	0.103	0.00
4	0.133	0.00
5	0.146	0.00
6	0.147	0.00

Several researchers proposed different models with constant coefficients that ignore regime changes in the underline sequence. Such models are criticized for underperforming and producing incorrect results. The use of Markov regime-switching models is one solution to this problem. Such a model is commonly used to research macroeconomic series of non-linearities, asymmetries, and regime shifts. The distinct behavior of time series in various regimes can be captured using Markov regime-switching models.

3.3. Markov Regime-Switching Technique

For estimating the misalignment of the exchange rate, we used the Markov regime-switching technique. A Markov switching first-order autoregressive model for the real exchange rate where Ω_t (where i = 1, 2) parameter takes on one of two values depending on the realization of discrete-valued. The equation is written as

$$\Delta x_t = \varphi_i + \beta_i v_t + \varepsilon_t \quad (1)$$

In equation (1), x_t is the dependent variable and v_t is a vector of independent variables plus an error term. For this analysis, we used real effective exchange rate as a dependent variable while independent variables are net foreign assets, terms of trade, government consumption expenditure, government investment, and interest differential, and the error term. So, the equation of the determinants of the equilibrium real exchange rate which we used in this analysis are given as,

$$\begin{aligned} \text{rer}_t = \alpha + \beta_1 \text{nfa} + \beta_2 \text{tot} + \beta_3 \text{congov} \\ + \beta_4 \text{govinves} + \beta_5 \text{idiff} + \varepsilon_t \end{aligned} \quad (2)$$

Where rer is the real exchange rate, nfa for net foreign assets, tot is terms of trade, congov is government consumption, govinves is government investment and idiff is used as Interest differential and $\varepsilon_t \text{iid} \sim N(0, \sigma_s^2)$. The net foreign assets metric is closely related to the current account and balance of payments. A net foreign assets position is positive or negative and may impact the foreign exchange value of its currency over time.

The probability to remain in that state is 0 and 1 and to switch from one to another regime probability is captured in the p_r column.

$$\text{state} = \begin{Bmatrix} 1 = p_{11} \\ 2 = p_{22} \end{Bmatrix}$$

and

$$\text{pr} = \begin{pmatrix} p_{11} & p_{12} \\ p_{21} & p_{22} \end{pmatrix}$$

Where state one is low growth with high volatility and state 2 is high growth and low volatility. The important element of this technique is that the switching probabilities of one to another regime is endogenously modeled.

To find misalignment we estimate the equation and then find the fitted values of the real effective exchange rate and subtract these values from the permanent part of the real effective exchange rate which is found by the BEER method so the equation becomes.

$$\text{mis}_t = \text{RER}_t - \text{ER}_t \quad (3)$$

Here ER is the equilibrium exchange rate and RER is the real exchange rate. We measure misalignment of the exchange rate as mis > O Overvalued and mis < O Undervalued.

4. Results and Discussion

4.1. Unit Root Test

Before model estimation, unit root tests were conducted on the variables to understand the nature, behavior, and order of integration of all the series. The non-stationarity of the variables was determined using the Augmented Dickey-Fuller (ADF) and Phillips–Perron (PP) tests as the benchmark procedure. Table 2 summarizes the findings of unit root tests. The results of the PP tests indicate that net foreign asset and tot are first difference stationary, and all other variables are level stationery. but according to ADF, the lcon is the first difference with lnfa, and tot rest of all variables are level stationery at the level.

Since the main goal of current research is to determine the misalignment of the Pak Rupee. So, the first step is to calculate the equilibrium exchange rate (equ ER) by behavior equilibrium exchange rate given in equation 2. For estimating the model, the Markov regime-switching method was applied and the fitted value was found by using the permanent values of the fundamental variables and the fitted values obtained from the model, and then the misalignment of the real effective exchange rate is calculated.

Figure 3 depicts the fitted exchange rate versus equilibrium exchange rate (equ ER) from 1991 to 2020, as well as the degree of misalignment of the exchange rate (Mis RER).

4.2. Markov Switching Model and BEER Misalignment with Real Exchange Rate

The MS model uses the RER series as a dependent variable for the calculation of the probability of being in a particular regime at any given time. The MSM includes a test to see whether the data was produced by combining

Table 2: Unit Root Test Table (PP)

	At Level		At First Difference		
	***t*-statistic**	**Prob.**	***t*-statistic**	**Prob.**	
REER	−2.13	0.23	−14.77	0.00	*I*(0)
DIFF	−6.16	0.00***	−52.98	0.00	*I*(0)
GOVCON	−4.13	0.00***	−10.62	0.00	*I*(0)
LNFA	−1.07	0.73	−18.78	0.00	*I*(1)
TOT	−1.05	0.74	−7.78	0.00	*I*(1)
GOVINVES	−5.43	0.00***	−14.16	0.00	*I*(0)
Unit Root Test Table (ADF)					
REER	−2.39	0.15	−14.33	0.00	*I*(0)
DIFF	−2.92	0.04**	−13.43	0.00	*I*(0)
LCON	−0.14	0.94	−7.38	0.00	*I*(1)
LNFA	−1.06	0.73	−18.76	0.00	*I*(1)
LTOT2	−1.28	0.64	−4.75	0.00	*I*(1)
QINVES	−2.95	0.04**	−5.79	0.00	*I*(0)

two normal distributions with significantly different mean in different regimes. In the current research, the MS model was used to account for misalignment in two regimes i.e. overvaluation and undervaluation. The MS model results which were presented in Table 3 show that the mean values of the misalignment series vary significantly between the two regimes. Undervaluation episodes have a low mean (116.139) while overvaluation episodes have a high mean (126.732). The findings also indicate that the undervaluation period is significantly more volatile (1.229) than the overvaluation period (0.871). In regime 1, govt investment, TOT, NFA have a positive impact on the exchange rate while govt. consumption and interest differential negatively affect the overvaluation regime. In regime 2, the TOT, interest differential, and government consumption had a negative effect while government investment has a positive effect and NFA has no effect on the undervaluation regime.

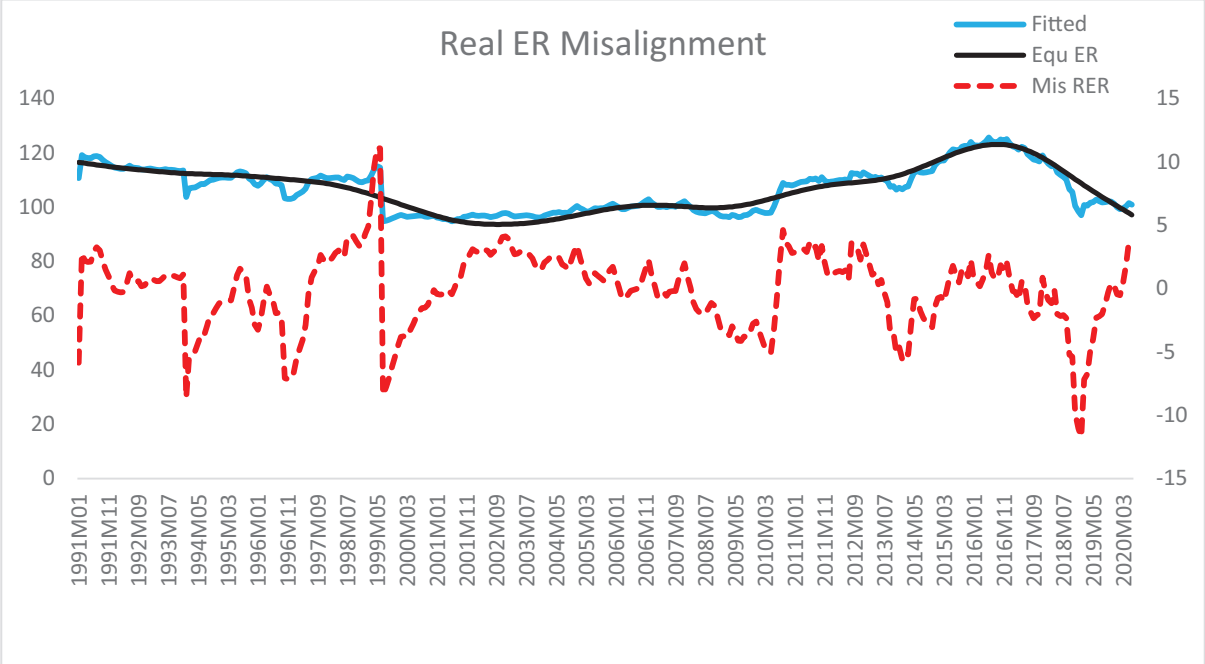

Figure 3: Actual Versus Equilibrium ER and Misalignment

Table 3: REER Misalignment with Regime Switching Model

Regime 1			Regime 2	
Variables	**Coefficient**	**Prob.**	**Coefficient**	**Prob.**
C	116.139	0.000	126.732	0.000
GOVCON	−0.262	0.046	0.004	0.972
GOVINVESTMENT	0.354	0.043	0.201	0.227
IDIFF	−1.465	0.000	−0.407	0.000
LNFA	2.020	0.000	−2.234	0.000
TOT	0.155	0.000	−0.318	0.000
LOG(SIGMA)	1.229	0.000	0.871	0.000
Transition Matrix Parameters				
P11-*C*	4.843	0.000		
P21-*C*	−4.060	0.000		

The values of P11 denote the probability of staying in-state one where state one is under-valuation regime given that the exchange rate was undervalued in the previous quarter. P22 is the probability of state two which shows that the exchange rate was in regime 2 (over-valuation). Table 4 presents the length of the regime classification relating to the MS model. The findings indicate that the conditional probability of staying in regime one is 0.992 and the probability of regime two is 0.983 to stay in state two. The parameters (P11 and P22) have greater values which indicate some stabilization. This shows that if the exchange rate is either in regime 1 or 2, it has a high probability to remain in that regime in the future (Pinno & Serletis, 2007). MS model revealed very notable results that undervaluation regimes seem to have a higher probability of average longer duration (about 127.77 versus 58.96) over a sample period.

The smoothed probabilities of being in regimes 1 and 2 are plotted in Figure 4. These probabilities compare estimated misalignment series (solid lines) from the long-run cointegrating relationship. The MSM system correctly detects both under-and overvaluation episodes.

Table 4: Duration of Regime Classification

Constant Transition Probabilities		
	1	2
1	0.992	0.008
2	0.017	0.983
Constantly Expected Durations		
	1	2
	127.774	58.968

5. Conclusion and Policy Recommendations

The primary objective of this research is to obtain reliable estimates of real exchange rate misalignment in Pakistan. Misalignment will be estimated by calculating the gap between the actual RER and its equilibrium value. Estimation of the degree of the equilibrium exchange rate has been carried out using the BEER approach by using the regime-switching model. The regime-switching models allow us to investigate and determine the significant impact of explanatory variables on response variables in different regimes. The MS model accurately captures the exchange rate misalignment over the study period in different regimes of over-and undervaluation. The results showed that terms of trade, interest rate differential, government consumption, net foreign assets, and investment have a long-term connection with the exchange rate of Pakistani currency. Results further confirmed that in regime 1, government investment, terms of trade, net foreign assets positively affect the exchange rate while government consumption and interest differential negatively affect the exchange rate in the overvaluation regime. In regime 2, the terms of trade, interest differential, and government consumption had a negative effect while government investment has a positive effect and net foreign assets did not affect the undervaluation regime. If policymakers want to use the exchange rate as a policy tool, they must first consider the drivers of the equilibrium exchange rate. As a result, any deliberate actions to address exchange rate misalignment must focus on the underlying fundamentals that drive the exchange rate.

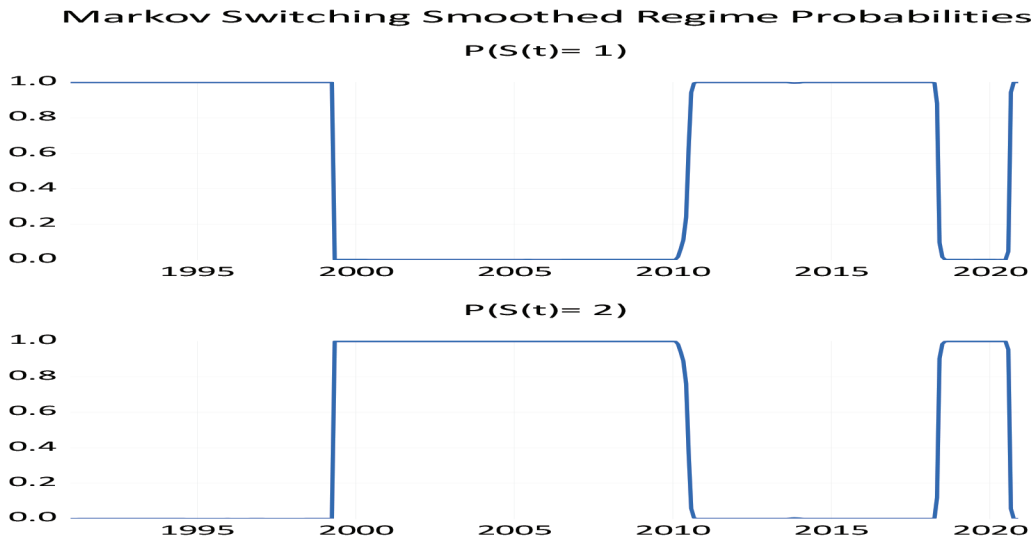

Figure 4: Smooth Probabilities of Markov Regime-Switching Model

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