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Real Exchange Rate Misalignments of Libyan Dinar: Fundamentals and Markov Switching Regimes

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Key words

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Abstract: This study found evidence for a time -varying misalignments of equilibrium RER of the Libyan dinar. Markov switching model explains the overvaluation episodes during (1974, 1978), (1986, 1999) and (2011, 2015) and undervaluation episodes during (1962, 1973), (1979, 1985) and (2000, 2010). Policy makers should urgently align the actual exchange rate very close to the movements in fundamentals such as real oil price, real relative productivity and degree of openness in order to avoid the inverse impacts of real exchange rate misalignments, up to by a factor of six now, on the Libyan economy.

JEL code: F31, F13, F14

1. INTRODUCTION

In recent months, the official exchange rate of one US dollar is 1.41 Libyan dinars but it is sold for 8.30 Dinars in parallel markets. What causes such misalignments in Dinar rates? Dinar has experienced considerable cycles of real exchange rate (RER) appreciation and depreciation in the past five decades despite various policies adopted for stability in foreign exchange market to remove such misalignments by the Central Bank of Libya (CBL). Objective of this paper is to analyze the degree of such misalignment and suggest remedial measure to correct this problem. Section 2 provides a historical context, with empirical regularities in section 3, Markov Switching Model in section 4 followed by conclusions in section 5.

2. DEVELOPMENTS IN THE LIBYAN EXCHANGE RATE REGIME:

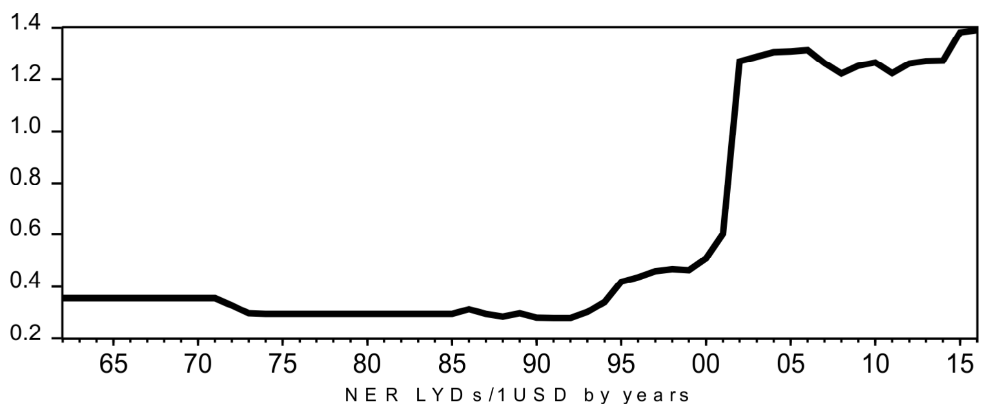
The Libyan Dinar was pegged to the US dollar from 1962-1970, at 1$ = 0.35714 LYD with slightly nominal appreciation during 1971-1973. At the beginning of

1981, the payments imbalance occurred following a fall in oil prices. The Libyan authorities responded by import restrictions and foreign exchange controls, but high inflation led to the premium in black markets of the exchange rate by approximately factor of ten by the end of nineties. In 1986, for more flexibility, the (CBL) pegged the Libyan dinar to special drawing rights (SDR) rather than the US dollar, at 1LY D = 2.8 SDR.

In 1999-2001 the Libyan monetary authorities applied a new programme, which allowed the sale of foreign currencies through commercial banks with prices were determined by CBL. These prices went up increasingly to eliminate the black market of foreign exchange gradually, as well as to realign the prices level.

By fixing dinar to 1 LYD = 0.608 SDR on 24 December 2001 or to 1LYD = 0.5175 SDR on 14 June 2003, as a considerable devaluation, the black market was eliminated with a low levels of inflation. Recently, the black market has come back again sharply after the Libyan revolution. Political strife and blockaded oil infrastructures that led to lower oil production and appreciation.

Figure 1: Trend of nominal exchange rate of the Libyan Dinar for 1 US Dollar, 1962-2016



3. METHODOLOGY AND DATA

Edwards (1989) mentioned that RER movements, either in the form of an appreciation or depreciation at high levels, may lead to RER misalignments resulting in over or undervaluation of national currency and ultimately affecting the competitiveness of the home economy against its major trading partners. The undervaluation is expected to increase the investment profitability in tradable goods while overvaluation may lower the growth rate in the economy (Caputo 2015).

In theory given foreign price ?(p^*) and home price (p), the purchasing power parity (PPP) assumption implies the RER to be $e^{ppp} = \frac{p}{p^*}$ (Gustav Cassel 1918). Then, define $\lambda = \frac{e^n}{p / p^*}$ or $\lambda = \frac{e^n . p^*}{p}$, , where, λ is RER, e^n being the nominal exchange rate, units of national currency per one unit of foreign currency. Therefore, if λ = 1 in equilibrium, λ > 1 implies undervaluation and λ < 1 implies overvaluation. For empirical analysis the RER could be calculated as, RER = $\frac{e^n . p_T^*}{P_N}$, where, P^*_T is the international prices level for traded goods, P_N is the domestic price levels of non- traded goods. It usually employs the wholesale price index (WPI) to express foreign prices of tradable goods, whereas CPI represents the local prices of non-tradable goods as (Edwards 1989) : RER = $\frac{E.WPI^*}{CPI}$.

The PPP hypothesis is proved as a weak method to estimate the long run real exchange rate (Dornbusch 1982). Many studies employed consumer price index (CPI) as a price index because available for many economies, but it contains great amounts of non-tradable goods. Additionally, the PPP method assumes that the equilibrium RER results from fundamentals and stays unchanged. In reality there are some changes caused by fundamentals.

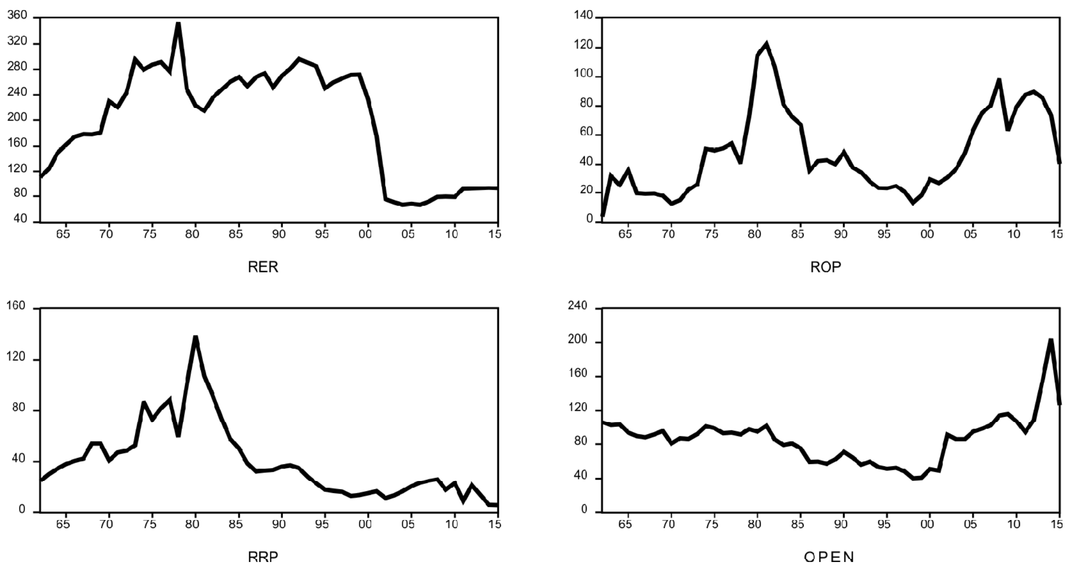
This paper uses reduced-form fundamental equilibrium exchange rate (FEER) framework where the RER depends on the real oil price (ROP), real relative productivity per capita (RRP) as applied by Cashin (2004). We added the trade openness (OPEN) to this model as:

$$RER = \beta_0 + \beta_1 ROP + \beta_2 RRP + \beta_2 OPEN + \mu_t$$

where, μ_t is the error term. Annual Data in US Dollars were obtained from the Central Bank of Libya (CBL, 2017), IFS, International Financial Statistics (IFS, IMF, 2017), Organisation for Economic Co-operation and Development (OECD, 2017), Arab Monetary Fund (AMF, 2017) and WBDI, World Bank (WB, 2017). ROP is used to capture impacts of external shocks. This variable is calculated as average prices of petroleum export by the Libyan companies and divided by CPI as, ROP = $\frac{OP_{L,t}}{CPI_{L,t}}$. RRP is measured as a percentage of real domestic GDP per capita to real foreign (US) GDP per capita as [$RRP_t = \left[\frac{RGDP_{L,t}}{N_{L,t}} / \frac{RGDP_{US,t}}{N_{US,t}}\right]$ to capture the economic performance. OPEN is employed as a proxy of trade restrictions which is defined as,

OPEN = (IMPORTS + EXPORT) / GDP.

Figure 2: Real exchange rate (index2010) and the key fundamentals determinants (1962-2015)



Each model variable, as shown in Figure 2, is not stationary at its level but is stationary at the first difference according to the ADF and PP tests, but they are co-integrated. Therefore, we applied the Fully Modified Ordinary Least Squares (FM-OLS) to estimate the long-run co-integration equation with results given in Table 1.

Table 1: Determinants of RER: FM-OLS results (1962-2015)

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
ROP	-0.781398	0.466737	-1.674172	0.1005
RRP	2.040547	0.402287	5.072362	0.0000
OPEN	-1.642242	0.430638	-3.813511	0.0004
C	300.6021	36.29139	8.283014	0.0000
R-squared	0.601825			
Adjusted R-squared	0.577446			

From table (1), an increase in RRP is associated with RER appreciation, but ROP and OPEN are linked with RER depreciation.

Misalignments more likely to happen when the actual exchange rate do not respond sufficiently to fundamentals (Holtemöller and Mallick 2013). RER overvaluation (undervaluation) occurs when actual RER is more (less) appreciated (depreciated) than the equilibrium path (Edwards 1989). The predicted values are computed by employing filtering technique, Hodrick - Presscott (HP) filter[1]. Misalignments are calculated by subtracting RER from the equilibrium level (ERER) and vary by regimes as shown in section 4.

Figure (3) and (4) illustrate equilibrium RER and misalignments of the Libyan dinar.

Figure 3: The actual and equilibrium RER (1962-2015)

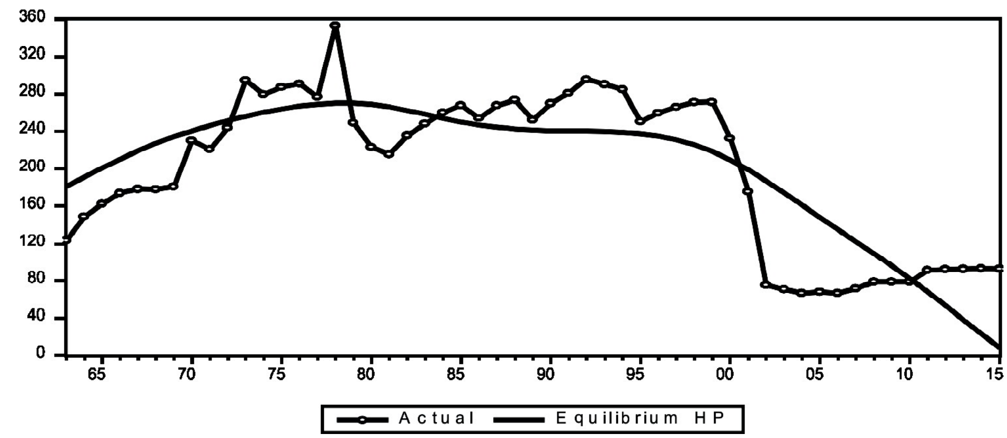
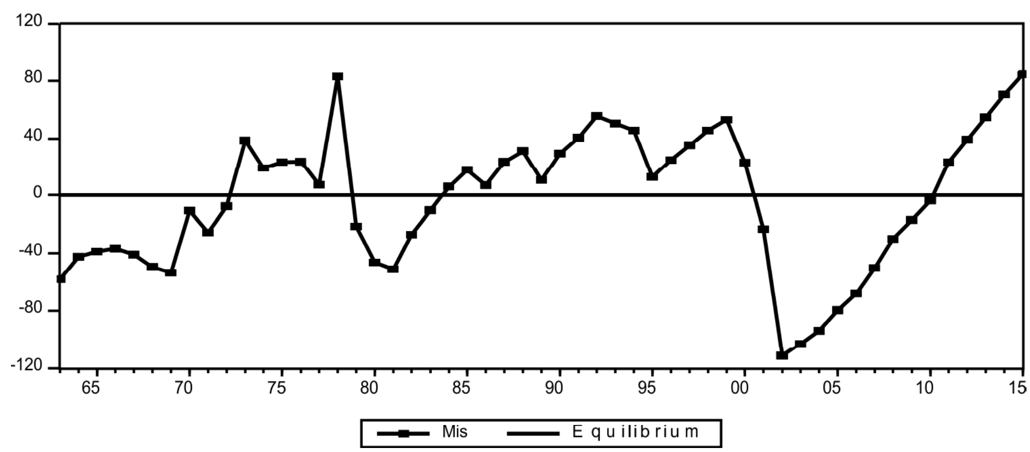


Figure 4: The equilibrium and misalignments of RER (1962-2015)



4. MARKOV - SWITCHING REGIME, REAL EXCHANGE RATE MISALIGNMENTS AND MOVEMENTS

Hamilton (1989) suggested Markov Switching Model (MSM) which particularly accounts for unobservable indicators that probably shift from one regime to another and return back again. The model supposes k number of regimes working in this process, normally distributed with different means (μ_1, μ_2) and variances (σ^2_1, σ^2_2) in case of regimes (1) and (2). This model takes the following formula:

$$MIS_t = \beta_1 S_t + \beta_2 (1 - S_t) + [\sigma_1 S_t + \sigma_2 (1 - S_t)]\epsilon_t \text{ for } \epsilon_t \sim N(0, 1)$$

Where, MIS is RER misalignment, S_t is a double variables indicating the unobserved regime as the following probabilities:

$$\text{Prob } [S_t = 1 \mid S_{t-1} = 1] = P_{11}$$
$$\text{Prob } [S_t = 2 \mid S_{t-1} = 1] = 1 - P_{11}$$
$$\text{Prob } [S_t = 2 \mid S_{t-1} = 2] = P_{22}$$
$$\text{Prob } [S_t = 1 \mid S_{t-1} = 2] = 1 - P_{22}$$

According to Terra and Valladares (2010) on MSM, the misalignment has over (o) or under (u) valuation first order Markov process shown in the next matrix for transition probability

$$p = \begin{bmatrix} p_{oo} & p_{ou} \\ p_{uo} & p_{uu} \end{bmatrix} = \begin{bmatrix} p_{oo} & 1 - p_{oo} \\ 1 - p_{uu} & p_{uu} \end{bmatrix}$$

Table 2: Over and undervaluation switching

Process	t_{-1}	t
p_{oo}	Overvaluation	Overvaluation
p_{ou}	Overvaluation	Undervaluation
p_{uo}	Undervaluation	Overvaluation
p_{uu}	Undervaluation	Undervaluation

Table 3: MSM results for misalignments of Dinar

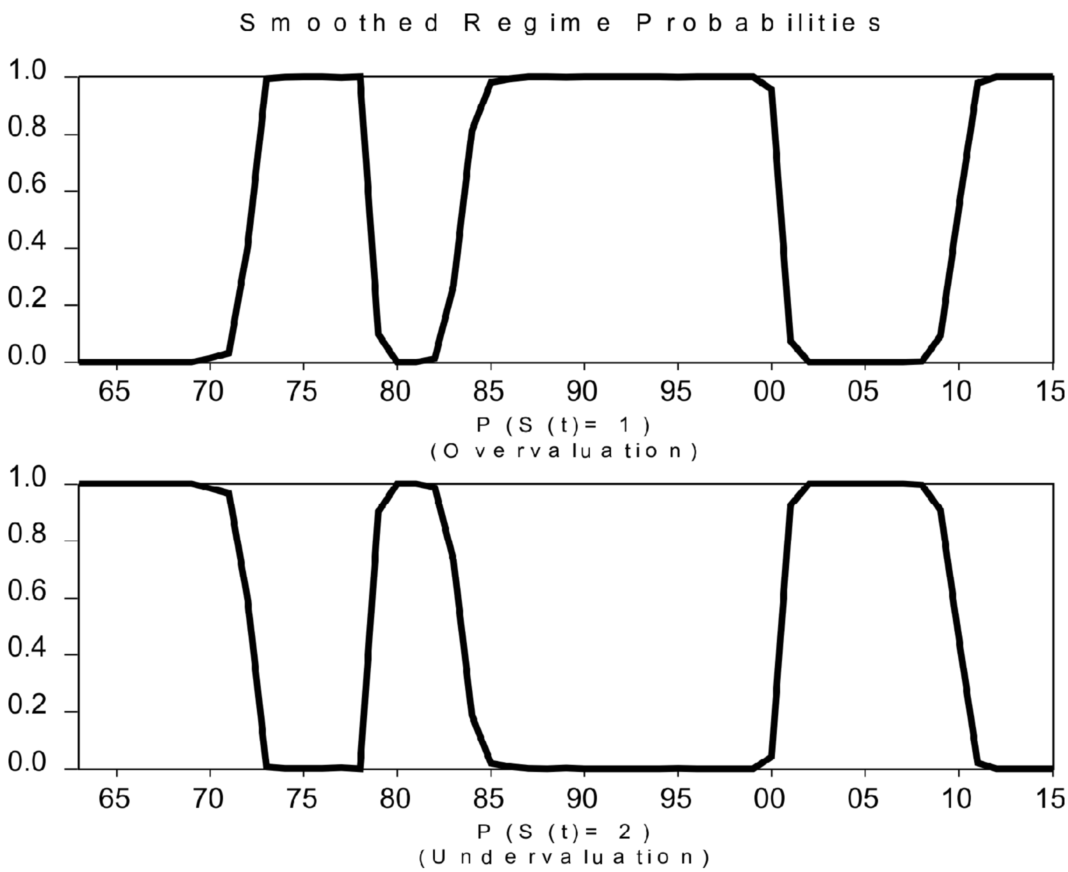
Parameter	*Estimation*	*Z-Statistic*	*Prob*
μ_1	32.95	6.35	0.0000
μ_2	-45.48	-6.47	0.0000
σ^2_1	3.13	19.35	0.0000
σ^2_2	3.36	20.45	0.0000

Overvaluation has a positive mean ($\mu_1 = 32.95$) whereas undervaluation has a negative mean ($\mu_2 = -45.48$). The findings also explain that overvaluation and undervaluation episodes have nearly the same volatility 3.13 and 3.36 respectively. Probabilities between over and undervaluation are:

$$p = \begin{bmatrix} 0.91 & 0.09 \\ 0.11 & 0.89 \end{bmatrix}$$

p_{oo}, p_{uu} indicate the probability of remaining in overvaluation (1) and undervaluation (2) regimes and switching to the same state in the next period, while p_{ou}, p_{uo} are explaining changing from one regime to different regime. Significantly, the corresponding expected durations for the two regimes are about 11.20 and 9.35 for over and undervaluation respectively.

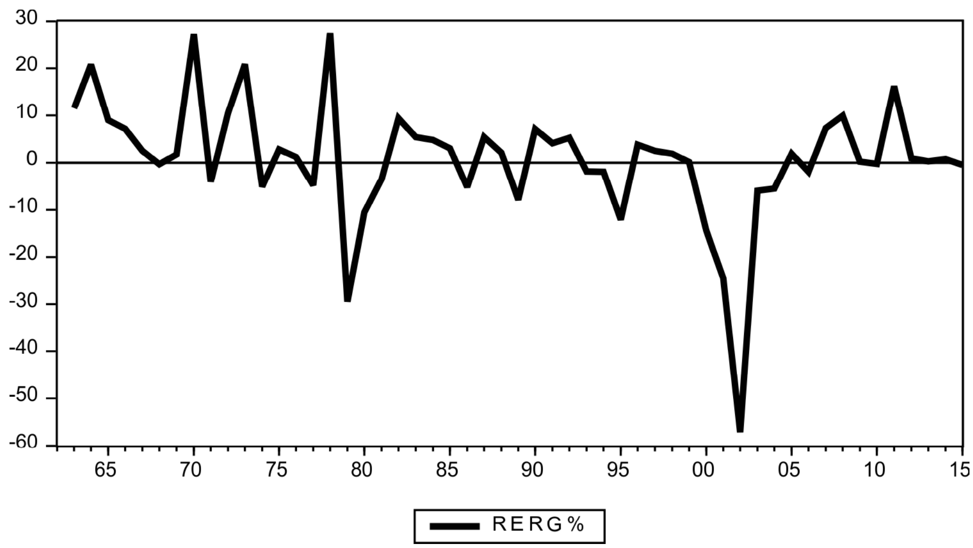
Graph 5: Smoothed regime probabilities (overvaluation and undervaluation)



The RER volatility provide signals about RER movements as an appreciation or depreciation. Empirically, MSM also explains the dynamics of RER movements and likelihood of the Libyan dinar to be appreciated or depreciated, as:

$$\text{Depreciation } (-) \text{ or Appreciation } (+) = [\ln(RER_{i,t}) - \ln(RER_{i,t-1}))]^{*}\ 100 \quad (11)$$

Graph 6: Real exchange rate volatility



According to MSM, RER appreciation (a) or depreciation (d) as a first order Markov process has transition probability matrix as:

$$p = \begin{bmatrix} p_{aa} & p_{ad} \\ p_{da} & p_{dd} \end{bmatrix} = \begin{bmatrix} p_{aa} & 1 - p_{aa} \\ 1 - p_{dd} & p_{dd} \end{bmatrix}$$

Table 4: Appreciation and depreciation switching.

Process	t_{-1}	t
p_{aa}	Appreciation	Appreciation
p_{ad}	Appreciation	Depreciation
p_{da}	Depreciation	Appreciation
p_{dd}	Depreciation	Depreciation

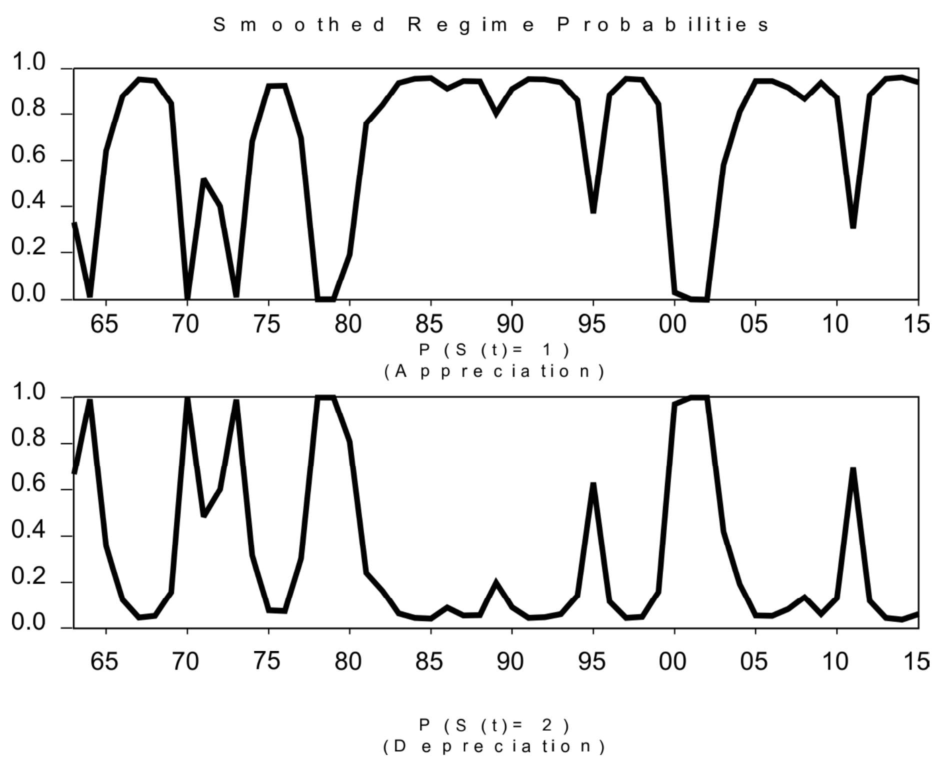
Table 5: MSM results (Appreciation and depreciation)

Parameter	*Estimation*	*Z-Statistic*	*Prob*
μ_1	1.61	1.53	0.13
μ_2	-1.25	-0.21	0.83
σ^2_1	1.58	6.90	0.00
σ^2_2	3.09	13.49	0.00

Appreciation regime has a positive mean (μ_1 = 1.61) whereas the depreciation regime has a negative mean (μ_2 = –1.25). The findings shows the volatility of 1.58 and 3.09 for appreciation and depreciation respectively. The transition probability matrix between these two regimes is estimated as:

$$p = \begin{bmatrix} 0.81 & 0.19 \\ 0.42 & 0.58 \end{bmatrix}$$

Graph 7: Smoothed regime probabilities (appreciation and depreciation of dinar)



5. CONCLUSION

The RER volatility in Libya can be explained by fundamental determinants, such as real oil price, relative rate of productivity and openness. Markov switching model explains highly periodic misalignments, over and undervaluation, as well as, real appreciation and depreciation of exchange rate, up to a factor of six in 2017. Policy makers should urgently align the official exchange rate to these fundamentals to minimise level of misalignments, to avoid adverse impacts on the Libyan economy.

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APPENDIX

Table 1: MSM transition probabilities (over and undervaluation)

	Overvaluation	*Undervaluation*
Overvaluation	0.910746	0.089254
Undervaluation	0.106902	0.893098
Constant expected durations		
	1	2
	11.20394	9.354385

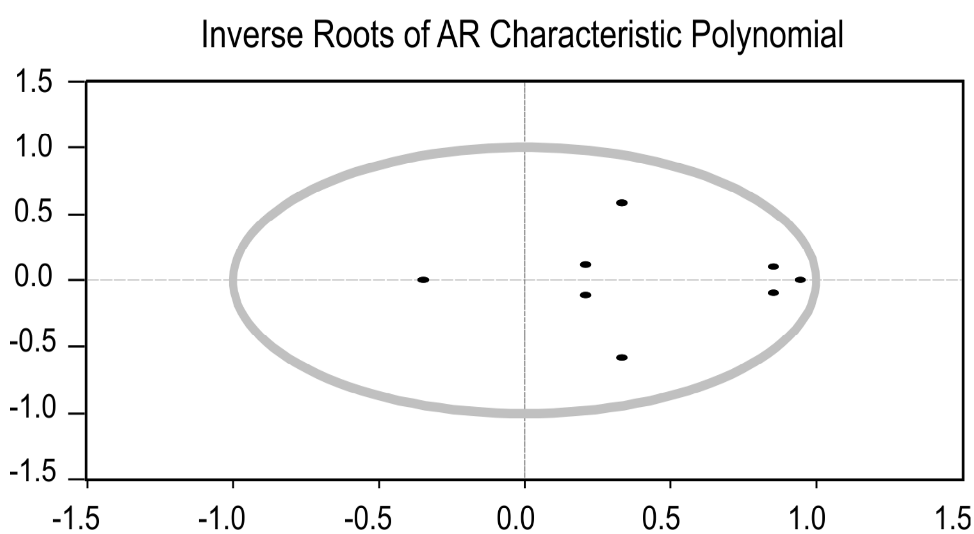
Constant expected durations = (1/0.089254) = 11.20394 and (1/0.106902) =9.354385

Table 2: MSM transition probabilities (Appreciation and Depreciation)

	Appreciation	*Depreciation*
Appreciation	0.808973	0.191027
Depreciation	0.421074	0.578926
Constant expected durations:		
	1	2
	5.234856	2.374878

Constant expected durations = (1/0.191027) = 5.234856 and (1/0.421074) = 2.374878

Graph 1: AR characteristic polynomial for MF-OLS method



Graph 2: Normality test for MF-OLS method