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THE MISALIGNMENT OF THE ALGERIAN DINAR'S REAL EFFECTIVE EXCHANGE RATE

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ABSTRACT

This paper analyzes exchange rate misalignments in Algeria from 1980 to 2020 using the behavioral BEER method. We investigate the real effective exchange rate (REER) and its cointegration with key economic indicators in Algeria. By considering Algeria's level of commercial openness, we identify periods of misalignment and examine their causes and effects. Our findings reveal significant fluctuations in the exchange rate, deviating from its long-term equilibrium.

Keywords: Exchange rate, REER, BEER, Misalignment

JEL Classification: F31, C32, C22

RÉSUMÉ

Cet article analyse les mésalignements du taux de change en Algérie de 1980 à 2020 en utilisant la méthode comportementale BEER. Nous examinons le taux de change effectif réel (TCER) et sa coïntégration avec des indicateurs économiques clés en Algérie. En

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tenant compte du niveau d'ouverture commerciale de l'Algérie, nous identifions les périodes de mésalignement et examinons leurs causes et leurs effets. Nos résultats révèlent d'importantes fluctuations du taux de change, s'éloignant fréquemment de son équilibre à long terme.

Mots clés: Taux de Change, Taux de Change Effectif Réel, BEER, Mésalignement

ملخص

موضوع هذا البحث يتمحور حول تحليل عدم توازن أسعار الصرف في الجزائر من عام 1980 إلى 2020. يتم تطبيق أسلوب BEER لإنشاء نموذج تصحيح الأخطاء، بناءً على تكامل سعر الصرف الفعال الحقيقي (REER) ومؤشرات اقتصادية مهمة أخرى في الجزائر.

بالنظر إلى مستوى انفتاح الجزائر التجاري، قمنا بتحديد التوازن لسعر الصرف الفعال الحقيقي وتحديد فترات العدم المواءمة، مع دراسة أسبابها وتأثيراتها. تكشف النتائج عن تقلبات كبيرة في سعر الصرف، متخلفة بشكل متكرر عن التوازن على المدى الطويل.

كلمات المفتاحية: سعر الصرف، سعر صرف فعال حقيقي، تباين.

INTRODUCTION

The field of economics that examines the transactions between nations is known as the analysis of international economic relations (Simon & Morel, 2015). Governments make economic decisions, known as economic policy, to attain economic and social objectives using monetary policy, budget policy, and exchange rate policy. Economic policy can either be short-term or long-term. Misaligned exchange rates can result in global economic issues such as economic imbalances and the 2008-2009 financial crisis, leading to increased attention on the long-term factors that affect exchange rates. According to (Kaminsky, Lizondo, & Reinhart, 1998), real exchange rate misalignment significantly impacts the current account's sustainability. (Jongwanich, 2009)also, real exchange rate misalignment can significantly affect an economy's balance.

The impact of the exchange rate on macroeconomic balance is a current issue (Williamson, 1994), whereas previously, appropriate alignment of the exchange rate was considered crucial for economic development. The exchange rate is considered a key indicator of the balance of the external sector and is currently a major economic concern. Several studies have therefore focused on the econometric determination of an exchange rate standard, especially for developing hydrocarbon-exporting countries such as Algeria (Ghoufrane & Bousselhami, 2014). The Algerian exchange rate policy aims to achieve a fundamentally effective exchange rate. Research on REER misalignment for similar economies has shown that exchange rate flexibility can reduce inflation, especially when combined with a target inflation policy(Cashin, Céspedes, & Sahay, 2003).

The 2013 IMF report on the Algerian economy showed that exchange rate policy was influenced by central bank intervention to maintain a low exchange rate, which resulted in significant macroeconomic costs such as high inflation and a deterioration in the terms of trade. The reports recommended reforms to improve exchange rate management and correct misalignments. (Loko, 2007)using an empirical approach showed that the REER estimated was overvalued relative to the equilibrium REER, causing a loss of competitiveness for exports. The studies recommend reforms to correct misalignments and improve Algeria's competitiveness. The current study aims to understand how macroeconomic fundamentals can affect the misalignment of the exchange rate of the national currency: What is the extent of the misalignment of the Algerian dinar's REER?

Our study focuses on the empirical estimation of the equilibrium real effective exchange rate (REER) of the dinar and assessing its degree of misalignment during the period 1980-2021.

To carry out our work effectively, we will start by examining the situation in Algeria and its exchange rate regime. We will then focus on the methodology of our study, which is divided into two parts: the theoretical framework and the econometric methodology. This study aims to estimate the real effective exchange rate equilibrium rate and potential misalignments. Finally, we will present a detailed analysis of the results.

1- BACKGROUND

Over the years, Algeria has adopted different exchange rate regimes to deal with economic fluctuations. However, these choices significantly impact the country's economic stability(Lekkam, 2021). To maintain the price competitiveness of national products, it is crucial to maintain the credibility of monetary authorities and the stability of the exchange rate.

At first, Algeria was tied to the franc zone, but due to persistent imbalances in the balance of payments, the country had to adopt managed exchange rate policy and the creation of the Algerian Dinar. Since 1995, Algeria has adopted a directed flexible exchange rate system to preserve the stability of its real effective exchange rate. The rate of the Algerian dinar is established on an interbank market and the Central Bank of Algeria ensures that fluctuations remain reasonable.

In 1998, the way of classifying exchange rate regimes was revised to better reflect the reality of the monetary policies of countries. Previous classifications were based solely on official declarations of countries to the IMF, without taking into account their actual implementation. The IMF classifies countries' exchange rate regimes based on information provided by members. In 2016, Algeria continued to adjust its exchange rate in response to fluctuations in the currency market (Bank of Algeria, 2017).

2- METHODOLOGY

The BEER theoretical framework and the use of cointegration and the vector error correction model (VECM) are utilized to determine the equilibrium real exchange rate and the extent of misalignment for Algeria(Clark & McDonald, 1999). This topic will be further discussed in the subsequent sub-sections.

2.1- Theoretical framework

The Behavioural Equilibrium Exchange Rate (BEER) model was proposed by(Clark & McDonald, 1999). It is a positive approach to the real exchange rate based on uncovered interest rate parity. The model depends on two components: expectations of the future real exchange rate and the differential of real interest rates. The fundamentals of the real exchange rate include the net foreign position, the domestic-foreign productivity ratio, and the terms of trade. However, this model is imperfect as uncovered interest rate parity is not always verified and the determinants of the real exchange rate can include additional factors such as risk premium(Achy, 2001).

The macroeconomic factors influencing the exchange rate in Algeria include terms of trade, foreign direct investment (FDI), productivity, government spending, and oil price fluctuations. Changes in relative prices, FDI, productivity, and government spending impact the exchange rate. Additionally, oil price fluctuations can lead to imbalances in the current account. Understanding these factors is crucial for understanding exchange rate dynamics in Algeria.

2.2- Econometric methodology

To calculate the REER, we will determine the equation that explains the behavior of the effective realexchange rate using the BEER model(Clark & McDonald, 1999). As a result, our model will be based on the following formula:

$$lnreer^{1}=b_0+b_1 lnX_t+\varepsilon_t \text{ such as } \varepsilon_t \Rightarrow N(0,\sigma^2)^{*}$$

It is important to note that the relationship between the variables in our model is linear.

The real effective exchange rate (REER) in the short-term will eventually stabilize in its long-term relationship. This thought is described by a general error correction model which can be expressed as follows:

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[1] **X_t** : A vector of fundamentals for year t, **εt :**A random stationary variable with a zero mean.

$\Delta\ lntcere_t$[2]$=\alpha(lntceret\text{-}1\text{-}b0\text{-}b1lnXt\text{-}1)+\sum_{j=1}^{p} u_i\ \Delta\ lntcere_{t-j}+\sum_{j=0}^{p} v\ \Delta b_1 X_{t-j}+\varepsilon_t$

The estimation of the equilibrium real exchange rate can be achieved through the use of cointegration and Vector Error Correction Model (VECM) methodology. To begin with, we will assess the nonstationarity of the real exchange rate and its related fundamental variables by performing the Augmented Dickey-Fuller (ADF) test(Dicky & Fuller, 1979). If the series in question is found to be nonstationary in levels but stationary in first differences, then the Johansen cointegration test will be employed. Upon detection of cointegration, the VECM will be estimated(Dreger & Wolters, 2010).

The next part of the analysis will cover the data and the equilibrium real exchange rate estimation results.

Following this, the misalignment ofthe REER will be calculated by comparing the observed REER to its estimated equilibrium value, typically by calculating the difference between the two and its deviations will be analyzed.

3- EQUILIBRIUM REAL EXCHANGE RATE ESTIMATION

The table below summarizes the fundamentals used in our study, along with their main features and associated calculation formulas. The variables are annually and transformed into logarithm (letters "ln"), variables are often transformed into logarithms in econometric studies to linearize relationships, handle exponential growth, address heteroscedasticity, and facilitate the interpretation of

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[2] **α(lntceret-1-b0-b1lnXt-1):** The normalized cointegration relationship on the REER that allows us to determine the long-term dynamics of the equilibrium REER.

percentage changes. Logarithmic transformations help improve model performance and enhance the understanding of the relationships between variables by making them more easily interpretable and comparable(Greene, 2012).

Table 1. Presentation of the Estimation Data for Our Model

Variable	Title	Formula	Unit	Transformation
lnreer	REER	$REER = \prod_{i=1}^{n}(ei\ \frac{P_A}{P_i})^{w_{i}}$[3]	2010 is the base year	ln
lntot	Terms of trade	Equation 1: Tot= (Export unit price index / Import unit price index) * 100	USD	ln

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[3] $\boldsymbol{e_i}$: The bilateral exchange rate between Algeria and its trade partner, noted as i, for a base year;

$\boldsymbol{\frac{P_A}{P_i}}$ **:** Ratio of consumer price indices between Algeria and its trade partner, noted as i;

$\boldsymbol{W_i}$ **:** Is the share of trade partner i in Algeria's share of trade.

To determine the exchange rate equilibrium, the following steps can be followed:

Collect the necessary data: Gather the bilateral exchange rates, price levels in Algeria, and price levels of trade partners for the base year.

Calculate the relative prices: Compute the ratio of the price level in Algeria (P_A) to the price level of each trade partner (P_i).

Apply the weights: Multiply each relative price by its corresponding weight (w_i).

Consider the bilateral exchange rates: Multiply each weighted relative price by the bilateral exchange rate between Algeria and the trade partner (e_i).

Take the product: Take the product of all the resulting values from the previous step.

The resulting value represents the Real Effective Exchange Rate (REER) and provides an estimate of the exchange rate equilibrium.

lnprdct	Productivity	$Productivity = \frac{GDP}{Working\ population}$	USD	ln
Lnide	FDI	IDE as a % of GDP	Bn USD	ln
lntdpp	Public expenditure	Algerian Official Journal	Bn USD	ln
lnoil	Oil price	Prix international	USD	ln

Source: Table constructed from the data.

3.1- Descriptive statistics

Table 2. The descriptive statistics of the estimation data

	lnreer	lndpp	lnoil	lnide	lnprdct	lntot
Mean	4.99	10.30	3.52	8.94	9.15	3.97
Median	4.77	10.46	3.51	11.03	9.13	3.97
Maximum	6.10	11.17	4.63	12.52	9.82	4.66
Minimum	4.46	8.40	2.49	-2.30	8.53	3.24
Std. Dev.	0.53	0.68	0.62	4.26	0.39	0.34
Skewness	1.02	-0.75	0.23	-1.44	0.05	-0.09
Kurtosis	2.41	2.85	1.86	4.20	1.82	2.67

Source: Eviews 10 results.

The analysis shows that the means of all data series are not close to zero and the standard deviations are relatively high, meaning these series are volatile and not centered around the mean. The variables with the highest standard deviations are oil price, public spending, and foreign direct investments. Given the small size of our economy, this may justify the use of a model like BEER, which is designed for small economies. The flattening coefficient is greater than 2 for all variables except for oil price and productivity. This means that these series are leptokurtic (the distribution has fatter statistical tails), implying that any shock will result in large fluctuations and significant volatility due to the fat-tailed characteristic of these series. The remaining variables are platykurtic (have thinner tails than a normal distribution, resulting in fewer extreme positive or negative events). Thus, the results in terms of skewness and flattening reinforce the rejection of normality.

3.2- Correlation Matrix

The table below displays the correlation matrix of economic fundamentals and is presented in the following manner:

Table 3. Estimation data correlation matrix

	lnreer	lndpp	lnide	lnoil	lnprdct	lntot
lnreer	1.00	-0.48	-0.55	-0.47	-0.22	-0.08
lndpp		1.00	0.19	0.34	0.56	-0.34
lnide			1.00	0.59	0.47	0.26
lnoil				1.00	0.86	0.18
lnprdct					1.00	-0.11
lntot						1.00

Source: Eviews 10 results.

The correlation matrix, as displayed in Table 3, offers valuable insights into the interrelationships among various economic fundamentals. The analysis reveals negative correlations between the natural logarithm of the real effective exchange rate (lnreer) and the natural logarithms of domestic price level (lndpp), foreign direct investment (lnide), oil price (lnoil), productivity (lnprdct), and total (lntot). Notably, the strongest negative correlation is observed between lnreer and lnide. Conversely, positive correlations emerge between lndpp and lnide, lndpp and lnoil, lnide and lnoil, and lnide and lnprdct. These findings indicate potential linkages between the aforementioned economic variables, warranting further investigation and econometric modeling to ascertain the strength and significance of these associations.

3.3- Stationarity of variables

We applied the ADF test to test the stationarity of the variables. The results obtained are summarized in the following table:

Table 4. Study of Level Stationarity

Variable	Model	Lag	Stat-ADF	Critical Value at 5%	Conclusion
REER	(3)	1	-1.2946	-3.5297	I(1)
TOT	(3)	1	-2.6717	-3.5236	I(1)
Prdct	(3)	1	-1.4149	-3.5236	I(1)
DPP	(3)	1	-3.2416	-3.5403	I(1)
FDI	(3)	1	-3.2515	-3.5366	I(1)
OIL	(3)	1	-2.2415	-3.5236	I(1)

Source: Eviews 10 results.

After examining the table, it was determined that the variables are non-stationary in level. As a result, the focus of the study shifted towards investigating their stationarity after first differencing. The table below presents the results of the ADF test conducted on the first difference of the variables:

Table 5. Study of Stationarity After Differentiation

Variable	Stat-ADF	Critical Value at 5%	Conclusion
BEER	-4.6830	-1.95	I(0)
TOT	-6.3580	-1.95	I(0)
PRDCT	-5.9648	-1.95	I(0)
DPP	-5.6371	-1.95	I(0)
IDE	-2.0617	-1.95	I(0)
OIL	-6.5003	-1.95	I(0)

Source: Eviews 10 results.

This table shows that all variables are stationary after one-time differentiation. therefore, these variables are integrated into order 1. This result prompts us to study whether there is a cointegration relationship between these variables.

3.4- Determining the number of lags

Table 6. Lag Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-111.8563	NA	4.13e-05	6.932726	7.202084	7.024585
1	38.47575	238.7627*	5.14e-08*	0.207309*	2.092813*	0.850319*
2	60.36270	27.03681	1.45e-07	1.037488	4.539139	2.231651

Source: Eviews 10 results.

The above table, designed through Eviews 10, shows that the lag of the following criteria (FPE, AIC, and HQ) is 2, which indicates that the model is of type VAR(2). Given the small number of observations in our study (42), we have decided to only take into account one lag (P=1) for the cointegration test. If we discover the existence of cointegration relationships, we will estimate a VECM (1) model. If not, we will settle for estimating a VAR (2) model.

3.5- Johansen cointegration test

To determine how many cointegration relationships exist in our VAR system, we will resort to the Johansen test and its trace test(Baharumshah, Lau, & Fountas, 2003). This step will allow us to determine how many cointegration relationships exist in our system.

Table 7. Johansen Cointegration Test

Number of cointegration vectors	Eigenvalue	Trace	Critical Value at 5%	Prob.**
		Statistic		
None *	0.890577	147.8673	69.81889	0.0000
At most 1 *	0.640256	77.06625	47.85613	0.0000
At most 2 *	0.574895	44.35067	29.79707	0.0006
At most 3 *	0.354379	16.97728	15.49471	0.0297
At most 4	0.088804	2.975907	3.841466	0.0845

Source: Eviews 10 results.

As shown in the table above, the Trace test results indicate that 4 cointegration relationships are statistically significant at a 5% confidence level.

This suggests that there may be a cointegration relationship among these variables, specifically the normalized cointegration relationship of the REER. Once this relationship is established, the subsequent step will be to estimate the short-term and long-term dynamics of the equilibrium REER.

3.6- VECM results

We will now move on to estimating the VECM model and the dynamics of the REER :

3.6.1. The VECM model and the estimation of REER’s dynamics

After creating the REER series and estimating it with a VECM model including both short and long-term dynamics, we obtained the following model:

$$\begin{gathered}D(LNREER) = -0.074052*(LNREER(-1) + 1.47024300463*LNDPP(-1) + \\ 0.0437397537675*LNFDI(-1) + 0.862702187869*LNOIL(-1) - \\ 2.69975518107*LNPRDCT(-1) - 0.218865809889*LNTOT(-1) + \\ 1.92223797929) + 0.286664*D(LNREER(-1)) - 0.022139*D(LNDPP(-1)) + \\ 0.019595*D(LNFDI(-1)) + 0.173636*D(LNOIL(-1)) - \\ 0.235104*D(LNPRDCT(-1)) - 0.160603*D(LNTOT(-1)) - 0.037678\end{gathered}$$

Our VECM model is justified by the equation that shows that the coefficient of the error term is negative and statistically significant. This indicates that there is a long-term relationship between TCER and its base elements. Thus, this error coefficient (-0.074052) represents the force that brings the relationship between TCER and its base elements back to its long-term equilibrium level.

3.6.2. The long-term dynamics of the relationship between TCER and its fundamentals

Once our model has been estimated, we will examine the stable relationship to understand the long-term relationship between REER and its fundamentals. To do this, we will first focus on the long-term dynamics of REER using a normalized equation on the REER endogenous variable. The equation is then:

$$Cointeq1 = \ln reer + 1.74 \ln dpp + 0.044 \ln fdi + 0.8627 \ln oil - 2.6997 \ln prdct - 0.2188 \ln tot + 1.9222$$

This correlation illustrates the long-term dynamics towards which REER tends and adjusts to reach its long-term equilibrium level. As a result, in the long term, close to the stable equilibrium of the system, this cointegration relationship must be canceled and is presented as follows:

Table 4. Coefficients and Significance of the Fundamentals

Variable	Coefficient	t-statistic
dpp	-1.4702	[8.41287]
fdi	-0.44	[3.04586]
oil	-0.8627	[4.66578]
prdct	+2.6997	[-8.72138]
tot	0.2188	[-0.97823]
constant	-1.9222	

Source: Eviews 10 results.

The REER is quoted at a certain level, a decrease in its value indicates a decrease in the real value of the currency, while an increase indicates an increase.

It is important to note that to evaluate the relevance of the coefficients in our VECM model, we have 41 observations available. Based on this, the threshold of the t statistic is approximately equal to 1.684 (1.96 for an infinite number of observations). We observe that most of the variables have an absolute value of the t statistic greater than 1.684, which means that the coefficients in our VECM model are relevant.

3.7- Model Validation Tests

To validate the model, it is crucial to analyze the residuals, through the residual autocorrelation plot and the Jarque-Bera normality test:

3.7.1. Autocorrelation Plot of Residuals

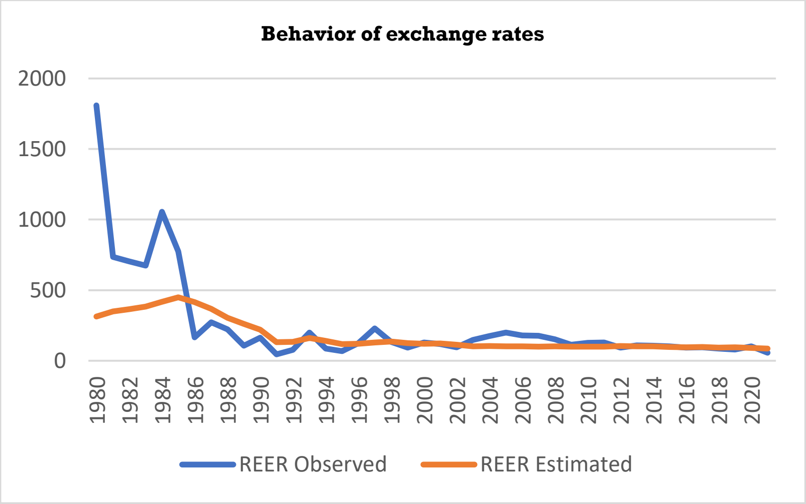
the test was performed with h=30. The probability is higher than 0.05 (it is 0.189), which means that the residuals are not autocorrelated and we can accept the “white noise” hypothesis. This means that the errors are independent of each other and are not influenced by previous or subsequent values.

3.7.2. Test of normality of residuals

the Jarque-Bera probability is greater than 0.05 (it is 0.381871). This means that the residuals follow a normal distribution and, since the tests are valid, we can conclude that the errors represent Gaussian "white noise". This means that the errors are independent of each other and follow a normal distribution around the mean.

We generated a graph after estimating the equilibrium real exchange rate, showcasing the relationship between the observed real exchange rate and the calculated equilibrium real exchange rate:

Figure 1. Behaviors of the estimated and observed REER



Source: Eviews 10 results.

This graph represents observed and estimated values of the Real Effective Exchange Rate (REER) from 1980 to 2021. Comparing the observed and estimated values helps assess the accuracy of the estimation model and its ability to capture the underlying dynamics of the REER. Analysis of the plotted data provides insights into the behavior of the exchange rate and its potential drivers. From an economic perspective, the REER serves as a crucial indicator for evaluating a country's international competitiveness, with higher values indicating currency appreciation and lower values suggesting depreciation. Consequently, governments and policymakers closely monitor the REER to ensure it aligns with economic fundamentals.

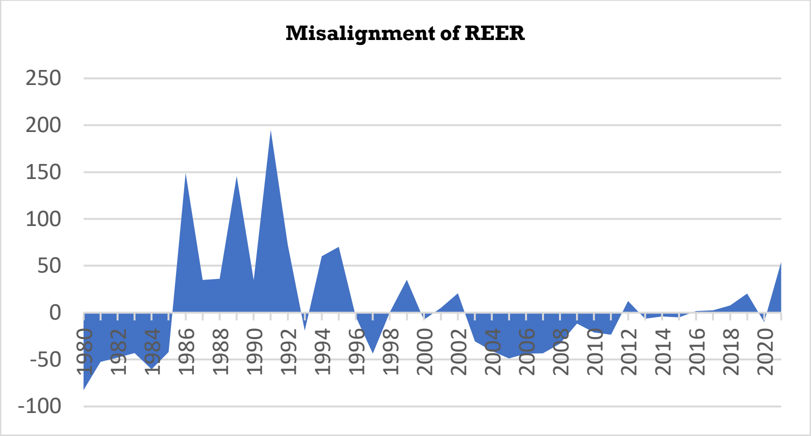
4- REAL EXCHANGE RATE MISALIGNMENT

To determine the moments when the real exchange rate is overvalued or undervalued, we can use a method that assesses the gap between the actual real exchange rate and its theoretical equilibrium level. This formula provides us with information on the degree of deviation between the real exchange rate and its ideal equilibrium(Bai & Perron, 2003):

$$MISALIGNMENT = \left(\frac{REERObserved - REEREstimated}{REEREstimated}\right) * 100$$

The degree of misalignment is presented in the following figure:

Figure 2. The extent of the misalignment of the REER



Source: Eviews 10 results.

The difference between the real exchange rate and its equilibrium value can have significant impacts on the competitiveness of companies in international markets and the allocation of economic resources between sectors that are exposed to international competition and those that are not. This mismatch is defined as the "misalignment" of the exchange rate. Data related to this misalignment will be presented in the following table:

Table 5. Periods of misalignment

Periods of misalignment	
Undervaluation	Overvaluation
1980-1984	1985-1992
1993	1994-1995
1996-1997	1998-1999
2000	2001-2002
2003-2011	2012
2013-2015	2016-2019
2020	2021

Source: Eviews 10 results.

The above table describes the different periods of under/overvaluation of the Algerian dinar that took place between 1980 and 2020. The undervaluation of the dinar is linked to several factors, such as the end of the Bretton Woods system, devaluations, the collapse of hydrocarbon prices, and the Covid-19 crisis. Undervaluation of the currency can have positive consequences, such as improved export competitiveness and stimulation of domestic production, but it can also have negative consequences, such as inflation and a current account surplus. It is important to consider the advantages and disadvantages of currency undervaluation before making economic decisions.

The periods of overvaluation were caused by various factors such as inflation, monetary and budget policies, interest rates, the country's economic conditions, international exchange rates, and fluctuations in raw material prices. The central bank has regularly made slight adjustments to the exchange rate to maintain the stability of the currency. When the Algerian dinar's foreign currency reserves reached a high level, the Algerian authorities overvalued the currency to encourage household consumption. In 2016-2019, strong purchases of imported products prompted the government to implement restrictive measures to regulate imports.

During these misalignment periods, the authorities implemented a strategy to increase Algeria's competitiveness by focusing on stabilizing macroeconomic performance, enhancing the flexibility of the monetary system, and improving the export products' price competitiveness. This strategy was accomplished by adopting effective macroeconomic management that led to a favorable improvement in the real effective exchange rate fundamentals, as well as by modifying the composition of exported products. To achieve these goals, the Algerian authorities have sometimes deliberately depreciated the value of the dinar.

CONCLUSION

We used a methodology to model the Algerian dinar's Real Effective Exchange Rate (REER) and understand the factors that determine it. To do this, we used an approach called Behavioural Equilibrium Exchange Rate (BEER) to create a cointegration-based error correction model between the REER index and a set of economic fundamentals in Algeria.

Our empirical data analysis revealed that the REER in Algeria is partially misaligned from its equilibrium. The results showed significant fluctuations and a trend to be away from its medium-term equilibrium. Using the BEER approach, we established an error correction model based on the cointegration of the REER index and a set of economic fundamentals in Algeria. The results of this study indicate that the REER is determined in the medium term by factors such as current public spending, productivity, terms of trade, average annual oil price, and Foreign Direct Investment (FDI), The REER deviates from its equilibrium level, which poses a threat to the Algerian economy in the case of an undervalued or overvalued dinar.

Consequently, we provide recommendations for improving the balance of the Real Effective Exchange Rate in Algeria. To reduce the vulnerability of the Algerian economy to hydrocarbon price fluctuations, we recommend diversifying income sources by investing in other sectors such as the knowledge economy, which is currently gaining promotion and can contribute to the diversification of the Algerian economy, agriculture, tourism, and services. It is also essential to maintain monetary stability to avoid Real Effective Exchange Rate fluctuations in Algeria by adopting appropriate monetary and fiscal policies and efficiently managing foreign exchange reserves. Additionally, it is important to ensure good public financial governance and a business environment favorable to Foreign Direct Investments.

Finally, it is important to enhance international cooperation in terms of trade and investment. This can be done by encouraging international partnerships, strengthening ties with partner countries, and creating cooperation programs to promote trade and investment.

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Appendix.

Cointégration

Date: 12/20/22 Time: 01:59

Sample (adjusted): 1986 2021

Included observations: 32 after adjustments

Trend assumption: Linear deterministic trend

Series: LNDPP LNIDE LNOIL LNPRDCT LNTCER LNTOT

Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.968496	218.1120	95.75366	0.0000
At most 1 *	0.794099	107.4672	69.81889	0.0000
At most 2 *	0.504989	56.89575	47.85613	0.0056
At most 3 *	0.444768	34.39412	29.79707	0.0138
At most 4 *	0.282894	15.56632	15.49471	0.0488
At most 5 *	0.142656	4.925312	3.841466	0.0265

Trace test indicates 6 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.968496	110.6447	40.07757	0.0000
At most 1 *	0.794099	50.57150	33.87687	0.0002
At most 2	0.504989	22.50163	27.58434	0.1958
At most 3	0.444768	18.82780	21.13162	0.1019
At most 4	0.282894	10.64101	14.26460	0.1731
At most 5 *	0.142656	4.925312	3.841466	0.0265

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

LNDPP	LNIDE	LNOIL	LNPRDCT	LNTCER	LNTOT
4.716007	0.134285	-3.291167	-1.231418	-0.820484	1.629426
0.825087	-0.131952	5.064528	-8.496039	1.334819	-5.223218
2.781521	0.228388	5.076596	-10.04556	7.185277	-4.380660
-7.100425	0.008438	-7.412314	15.07021	-5.435123	-3.519603
-4.664332	-0.506091	-10.20139	19.49977	-6.818754	3.371754
2.694372	0.021312	1.444186	-1.318704	-0.163602	0.532311

```
 Unrestricted Adjustment Coefficients (alpha):

==========================================================================
  D(LNDPP)    -0.197212   -0.104111    0.059191   0.044810 -0.004503  0.006247
  D(LNIDE)    -0.789159    1.132259   -0.410343  -0.292092  0.737970 -0.322428
  D(LNOIL)     0.078561   -0.035576   -0.086452   0.084515 -0.004270 -0.047354
 D(LNPRDCT)   -0.049263   -0.009731   -0.047228   0.023825 -0.027436 -0.018794
  D(LNTCER)   -0.022696    0.023918   -0.043707   0.011670 -0.015213  0.014786
  D(LNTOT)     0.058392    0.045746   -0.029006   0.123849 -0.005060 -0.049722
==========================================================================

1 Cointegrating
Equation(s):               Log-likelihood    81.92201
==========================================================================
Normalized cointegrating coefficients (standard error in
parentheses)
    LNDPP       LNIDE       LNOIL     LNPRDCT    LNTCER     LNTOT
   1.000000    0.028474   -0.697872   -0.261114  -0.173978   0.345510
               (0.00434)   (0.09857)   (0.14268)  (0.07047)  (0.07709)

Adjustment coefficients (standard error in parentheses)
  D(LNDPP)    -0.930053
               (0.18167)
  D(LNIDE)    -3.721680
               (2.43883)
  D(LNOIL)     0.370495
               (0.24464)
 D(LNPRDCT)   -0.232326
               (0.11673)
  D(LNTCER)   -0.107034
```

```
              (0.09417)
 D(LNTOT)      0.275379
              (0.26380)
================================================================

2 Cointegrating
Equation(s):            Log-likelihood    107.2078
================================================================
Normalized cointegrating coefficients (standard error in
parentheses)
  LNDPP       LNIDE       LNOIL       LNPRDCT   LNTCER  LNTOT
  1.000000    0.000000    0.335318    -1.777945   0.096827 -0.663493
                          (0.23983)   (0.33057)   (0.15506) (0.17718)
  0.000000    1.000000    -36.28491   53.27003   -9.510500 35.43549
                          (7.97001)   (10.9855)   (5.15272) (5.88791)

Adjustment coefficients (standard error in parentheses)
 D(LNDPP)     -1.015954    -0.012745
              (0.14217)    (0.00559)
 D(LNIDE)     -2.787468    -0.255376
              (2.12071)    (0.08339)
 D(LNOIL)      0.341142     0.015244
              (0.24509)    (0.00964)
D(LNPRDCT)    -0.240355    -0.005331
              (0.11799)    (0.00464)
 D(LNTCER)    -0.087299    -0.006204
              (0.09171)    (0.00361)
 D(LNTOT)      0.313124     0.001805
              (0.26278)    (0.01033)
```

3 Cointegrating Equation(s): Log-likelihood 118.4586

Normalized cointegrating coefficients (standard error in parentheses)

LNDPP	LNIDE	LNOIL	LNPRDCT	LNTCER	LNTOT
1.000000	0.000000	0.000000	-1.312193	-0.148318	-0.376804
			(0.07680)	(0.08360)	(0.12841)
0.000000	1.000000	0.000000	2.870791	17.01676	4.412693
			(2.87370)	(3.12820)	(4.80480)
0.000000	0.000000	1.000000	-1.388986	0.731082	-0.854978
			(0.07484)	(0.08147)	(0.12513)

Adjustment coefficients (standard error in parentheses)

D(LNDPP)	-0.851313	0.000774	0.422274
	(0.14515)	(0.00776)	(0.20683)
D(LNIDE)	-3.928845	-0.349093	6.248469
	(2.39347)	(0.12794)	(3.41062)
D(LNOIL)	0.100673	-0.004501	-0.877619
	(0.26003)	(0.01390)	(0.37053)
D(LNPRDCT)	-0.371722	-0.016118	-0.126911
	(0.12175)	(0.00651)	(0.17349)
D(LNTCER)	-0.208870	-0.016186	-0.026051
	(0.08942)	(0.00478)	(0.12742)
D(LNTOT)	0.232442	-0.004820	-0.107752
	(0.30155)	(0.01612)	(0.42969)

4 Cointegrating Equation(s): Log-likelihood 127.8725

Normalized cointegrating coefficients (standard error in parentheses)

LNDPP	LNIDE	LNOIL	LNPRDCT	LNTCER	LNTOT
1.000000	0.000000	0.000000	0.000000	0.200167	3.234922
				(0.34946)	(0.48202)
0.000000	1.000000	0.000000	0.000000	16.25435	-3.488976
				(3.11160)	(4.29192)
0.000000	0.000000	1.000000	0.000000	1.099962	2.968118
				(0.37358)	(0.51530)
0.000000	0.000000	0.000000	1.000000	0.265575	2.752436
				(0.29141)	(0.40195)

Adjustment coefficients (standard error in parentheses)

D(LNDPP)	-1.169480	0.001152	0.090130	1.208065
	(0.21603)	(0.00710)	(0.25974)	(0.48089)
D(LNIDE)	-1.854866	-0.351558	8.413548	-8.927701
	(3.84251)	(0.12636)	(4.61986)	(8.55337)
D(LNOIL)	-0.499418	-0.003788	-1.504069	2.347633
	(0.38293)	(0.01259)	(0.46039)	(0.85239)
D(LNPRDCT)	-0.540887	-0.015917	-0.303506	0.976819
	(0.19142)	(0.00629)	(0.23015)	(0.42610)
D(LNTCER)	-0.291734	-0.016087	-0.112555	0.439670
	(0.14329)	(0.00471)	(0.17227)	(0.31895)
D(LNTOT)	-0.646941	-0.003775	-1.025763	1.697257
	(0.41397)	(0.01361)	(0.49772)	(0.92149)

5 Cointegrating Equation(s): Log-likelihood 133.1930

Normalized cointegrating coefficients (standard error in parentheses)

LNDPP	LNIDE	LNOIL	LNPRDCT	LNTCER	LNTOT
1.000000	0.000000	0.000000	0.000000	0.000000	3.394849
					(0.51189)
0.000000	1.000000	0.000000	0.000000	0.000000	9.497667
					(4.37365)
0.000000	0.000000	1.000000	0.000000	0.000000	3.846948
					(0.71277)
0.000000	0.000000	0.000000	1.000000	0.000000	2.964621
					(0.43864)
0.000000	0.000000	0.000000	0.000000	1.000000	-0.798964
					(0.40175)

Adjustment coefficients (standard error in parentheses)

D(LNDPP)	-1.148479	0.003430	0.136063	1.120266	0.235301
	(0.24306)	(0.01405)	(0.35654)	(0.67027)	(0.27342)
D(LNIDE)	-5.297003	-0.725038	0.885230	5.462543	-4.234053
	(3.95169)	(0.22850)	(5.79665)	(10.8972)	(4.44521)
D(LNOIL)	-0.479499	-0.001626	-1.460505	2.264361	-1.163360
	(0.43113)	(0.02493)	(0.63242)	(1.18890)	(0.48498)
D(LNPRDCT)	-0.412917	-0.002032	-0.023623	0.441828	-0.254331
	(0.20536)	(0.01187)	(0.30125)	(0.56632)	(0.23101)
D(LNTCER)	-0.220774	-0.008388	0.042642	0.143014	-0.223189

	(0.15722)	(0.00909)	(0.23062)	(0.43355)	(0.17685)
D(LNTOT)	-0.623342	-0.001214	-0.974149	1.598598	-0.833903
	(0.46606)	(0.02695)	(0.68365)	(1.28521)	(0.52427)

VECM

Vector Error Correction Estimates

Date: 12/20/22 Time: 01:58

Sample (adjusted): 1985 2021

Included observations: 34 after adjustments

Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LNTCER(-1)	1.000000
LNDPP(-1)	1.470243
	(0.17476)
	[8.41287]
LNIDE(-1)	0.043740
	(0.01436)

	[3.04586]
LNOIL(-1)	0.862702
	(0.18490)
	[4.66578]
LNPRDCT(-1)	-2.699755
	(0.30956)
	[-8.72138]
LNTOT(-1)	-0.218866
	(0.22374)
	[-0.97823]
C	1.922238

Error Correction:	D(LNTCER)	D(LNDPP)	D(LNIDE)	D(LNOIL)	D(LNPRDCT)	D(LNTOT)
CointEq1	-0.074052	-0.605037	-2.874883	-0.014626	-0.154896	0.088274
	(0.04759)	(0.15339)	(1.57918)	(0.16209)	(0.07235)	(0.17691)
	[-1.28586]	[-3.94446]	[-1.82049]	[-0.09023]	[-2.14094]	[0.49897]
D(LNTCER(-1))	0.286664	-0.029262	-9.497181	-0.725203	-0.124534	-0.008478

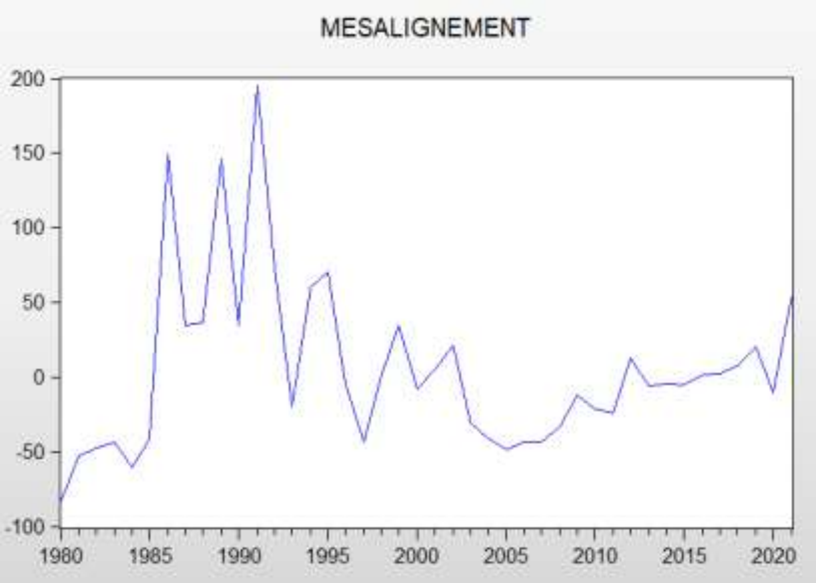
	(0.24513)	(0.65290)	(6.72172)	(0.68992)	(0.30795)	(0.75302)
	[1.16946]	[-0.04482]	[-1.41291]	[-1.05114]	[-0.40439]	[-0.01126]
D(LNDPP(-1))	-0.022139	0.215144	2.764868	-0.003873	0.095783	0.057850
	(0.07525)	(0.20043)	(2.06351)	(0.21180)	(0.09454)	(0.23117)
	[-0.29419]	[1.07339]	[1.33988]	[-0.01828]	[1.01316]	[0.25025]
D(LNIDE(-1))	0.019595	-0.022685	-0.163511	-0.001568	0.014343	0.007473
	(0.00628)	(0.01673)	(0.17219)	(0.01767)	(0.00789)	(0.01929)
	[3.12057]	[-1.35630]	[-0.94959]	[-0.08874]	[1.81810]	[0.38741]
D(LNOIL(-1))	0.173636	-0.210881	-3.265602	0.074812	0.229328	-0.133216
	(0.12562)	(0.33459)	(3.44467)	(0.35356)	(0.15782)	(0.38590)
	[1.38224]	[-0.63027]	[-0.94802]	[0.21159]	[1.45314]	[-0.34521]
D(LNPRDCT(-1))	-0.235104	-0.880032	-7.044875	0.370572	-0.313275	-0.199279
	(0.27203)	(0.72455)	(7.45943)	(0.76564)	(0.34175)	(0.83566)
	[-0.86426]	[-1.21459]	[-0.94443]	[0.48400]	[-0.91668]	[-0.23847]
D(LNTOT(-1))	-0.160603	0.337794	8.471374	-0.489531	-0.204297	-0.066919
	(0.12649)	(0.33690)	(3.46843)	(0.35600)	(0.15890)	(0.38856)
	[-1.26973]	[1.00266]	[2.44242]	[-1.37508]	[-1.28566]	[-0.17222]

C	-0.037678	0.077145	-0.002450	0.003747	0.005001	0.017352
	(0.02063)	(0.05495)	(0.56569)	(0.05806)	(0.02592)	(0.06337)
	[-1.82643]	[1.40401]	[-0.00433]	[0.06454]	[0.19297]	[0.27381]
R-squared	0.382469	0.505699	0.312296	0.146974	0.271797	0.120810
Adj. R-squared	0.216210	0.372617	0.127145	-0.082686	0.075742	-0.115895
Sum sq. resids	0.275201	1.952360	206.9343	2.180061	0.434348	2.597064
S.E. equation	0.102882	0.274027	2.821172	0.289566	0.129250	0.316049
F-statistic	2.300446	3.799926	1.686708	0.639964	1.386331	0.510382
Log-likelihood	33.63854	0.330555	-78.94660	-1.544777	25.88068	-4.520270
Akaike AIC	-1.508150	0.451144	5.114506	0.561457	-1.051805	0.736486
Schwarz SC	-1.149006	0.810287	5.473650	0.920601	-0.692661	1.095630
Mean dependent	-0.044741	0.061184	0.237815	0.042015	0.018698	0.015332
S.D. dependent	0.116209	0.345961	3.019663	0.278289	0.134442	0.299187

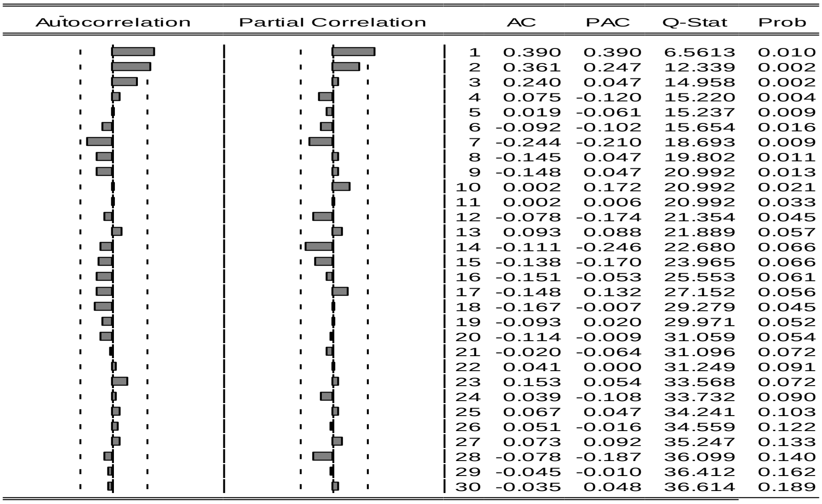
Determinant resid covariance (dof adj.)	4.57E-08
Determinant resid covariance	9.14E-09
Log-likelihood	25.21076

Akaike information criterion	1.693485
Schwarz criterion	4.117704
Number of coefficients	54

MISALIGNMENT

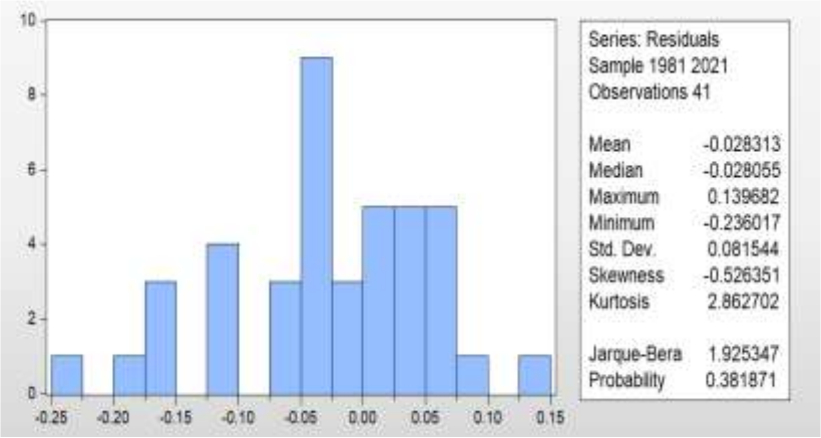


Residualscorrelogram



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.390	0.390	6.5613	0.010
		2	0.361	0.247	12.339	0.002
		3	0.240	0.047	14.958	0.002
		4	0.075	-0.120	15.220	0.004
		5	0.019	-0.061	15.237	0.009
		6	-0.092	-0.102	15.654	0.016
		7	-0.244	-0.210	18.693	0.009
		8	-0.145	0.047	19.802	0.011
		9	-0.148	0.047	20.992	0.013
		10	0.002	0.172	20.992	0.021
		11	0.002	0.006	20.992	0.033
		12	-0.078	-0.174	21.354	0.045
		13	0.093	0.088	21.889	0.057
		14	-0.111	-0.246	22.680	0.066
		15	-0.138	-0.170	23.965	0.066
		16	-0.151	-0.053	25.553	0.061
		17	-0.148	0.132	27.152	0.056
		18	-0.167	-0.007	29.279	0.045
		19	-0.093	0.020	29.971	0.052
		20	-0.114	-0.009	31.059	0.054
		21	-0.020	-0.064	31.096	0.072
		22	0.041	0.000	31.249	0.091
		23	0.153	0.054	33.568	0.072
		24	0.039	-0.108	33.732	0.090
		25	0.067	0.047	34.241	0.103
		26	0.051	-0.016	34.559	0.122
		27	0.073	0.092	35.247	0.133
		28	-0.078	-0.187	36.099	0.140
		29	-0.045	-0.010	36.412	0.162
		30	-0.035	0.048	36.614	0.189

Jarque-Bera test of normality of residuals



Series: Residuals
Sample 1981 2021
Observations 41

Mean	-0.028313
Median	-0.028055
Maximum	0.139682
Minimum	-0.236017
Std. Dev.	0.081544
Skewness	-0.526351
Kurtosis	2.862702
Jarque-Bera	1.925347
Probability	0.381871