REAL EXCHANGE RATE MISALIGNMENT IN ALGERIA

Mourad MADOUNI*

ABSTRACT

The purpose of this paper is to estimate the Equilibrium real exchange rate (ERER) of the Algerian Dinar from 1971 to 2012 by applying the Edward's model (1988) and Elbadawi (1994) and assess the degree of misalignment. We will use a cointegration method in order to see whether there is a long run relationship between the REER and its fundamentals such as: the oil prices as a proxy variable for the terms of trade, the openness, the government expenditure, relative productivity and for the adjustment in the short run the Error Correction Model (ECM) is used. Our findings are an increase in the oil prices or an improvement in terms of trade of one percent is associated with an appreciation of the real effective exchange rate (REER) of about 3,28%, and an appreciation of 1% of openness and government spending appreciate the REER of about 0,28 % and 1,11% respectively. However, increase in relative productivity depreciates the REER by 1, 38 %.

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I. INTRODUCTION

The real exchange rate misalignment remains one of the most important problems in the exchange rate policy. Consistent misalignment causes many serious macroeconomic discrepancies: undermine the international competitiveness, low agriculture output, higher import growth, drop in the international reserves, destabilization of the capital account and potential for debt crisis (Kaminsky et al. 1997), inflationary pressures and promotion for rent-seeking activities and hinder economic growth (Williamson 1985, Pfeffeman 1985, and Montiel 2003). It is why the policy makers want to keep the real exchange rate close to its equilibrium in order to avoid negative consequences of real exchange rate misalignment.

Edwards (1989), Elbadawi (1994), Montiel (1999), Razin (1999) and Baffes (1997) define the misalignment as a sustained departure of the actual real exchange rate from its equilibrium value. Even if the misalignment is negative or positive, it generates incorrect signals to the economic agents and economic instability.

When the Real exchange rate (*in incertain form*) [1] is under its equilibrium value, it means an overvaluation of the REER. A decline in the current account will be caused and drain of the international reserves (South east Asia countries 1997). In the other side, if the REER is above its equilibrium value

* University Aboubekr BELKAID of Tlemcen.

means an undervaluation. In this situation, there will be a profitable position of exportable goods and decrease of importable goods thus implied an inflationary pressures and unemployment (Brazil in 1980s).

In addition, we can distinguish between two kinds of misalignment (Edward 1987):

The first one is called **macroeconomic induced** misalignment appears when the actual real exchange rate deviates from its equilibrium due to inconsistence between macroeconomic policies (monetary and fiscal policy) and the official exchange rate regime.

The second is **the structural misalignment** occurs when there are changes in the real determinants of the Equilibrium Real Exchange Rate (ERER) that are not transformed in the short run into actual changes of REER.

In the light of the importance of misalignment and in the spirit of the seminal work of Edwards (1988) and Elbadawi (1994), we will assess the degree of misalignment of the Algerian real exchange rate by using the **cointegration of Johanson** and **the Error Correction Model** for the adjustment between the short and long run.

The rest of this paper is organized as follows: the literature review of equilibrium real exchange rate is presented in section two. Section three exposes the empirical evidence. Section four explains the Edward's model. Section five introduces the empirical framework, data of the fundamentals and results. Finally, section six concludes.

II. LITERATURE REVIEW

The well known theory of Purchasing Power Parity (PPP) developed by Cassel (1914, 1923) is the simplest and the widely used approach of the exchange rate determination. It relies on the Law of one price (LPU) and built upon a perfect market arbitrage. This basic model had obtained inconsistence results in developing countries (Balassa 1964, Rogoff 1996, Montiel 2003) because the PPP approach assumes that Real exchange rate remains stable in the long run (relative approach of the PPP).

In addition, there are some traditional theories of exchange rate determination: elasticity approach, monetary approach Frankel (1976) and Mussa (1976), interest rate parity (Keynes), and Portfolio balance. Dornbush's model (1976) explains the volatility in the short run of the real exchange rate.

And other theories: Coudert's model (1999) which based on the Samuelson effect and the debt to determine the equilibrium exchange rate. Cashin et al. (2003) developed a long-run equilibrium exchange rate for commodity exporting countries and found that the real commodity prices and the real exchange rate move together in the long run. Also, Montiel and Ostry (1993) proposed a model based on the parallel market premium (PMP), but they considered that this former as unreliable indicator of the sign and magnitude of real exchange rate misalignment. However, it can indicate the periods of disequilibrium or misalignment.

However, there are some modern theories of exchange rate determination such as: FEER, NATREX, BEER and Edward's model.

First, the Fundamental Equilibrium Exchange Rate (FEER), developed by Williamson (1994), is the rate that is expected to generate a current account balance equal to the underlying capital flows over the cycle without trade restrictions, the internal equilibrium being realized.

Second, The natural real exchange rate (NATREX), developed by Stein (1994), Stein and Lim (1995), is the rate that generates a current account balance which corresponds to equilibrium between optimal investment and saving while the rate of unemployment is at its natural level.

Third, the Behavioral Equilibrium exchange rate (BEER) is developed by Clark and MacDonald (1998), (2000). The BEER calculates the rate that is determined during the long run relationship between the

exchange rate and its determinants: interest rate differential, terms of trade, differential productivity, net foreign assets and government debt.

Finally, Sebastian Edawrds (1987), (1989), (1992), and (1994) presented a seminal work to determine the equilibrium exchange rate in developing countries. He defined the equilibrium real exchange rate as the relative price of tradable with respect to non-tradable goods that results in simultaneous attainment of equilibrium in the external and domestic sector in the economy. Edwards's model allows for both real and nominal factors to play a role in the short run, but only real factors (fundamentals) have an effect on the ERER in the long run.

Elbadawi (1994) adopts the concept of ERER and uses the cointegration technique to estimate it for Chile, Ghana and India. Between the period 1965 to 1990.

In addition, there are some other theories to define the ERER and assess misalignment such as: Permanent Equilibrium exchange rate developed by Gonzalo and Granger (1995), the Desired Equilibrium exchange rate proposed by Bayoumi et al. (1994) and the International Monetary Fund (2008, 2013) by the Consultative Group on Exchange Rate Issues (CGER) developed another new scientific method "the Macroeconomic Balance Approach and completed by The External Sustainability Approach.

III. EMPIRICAL EVIDENCE

Many studies have been conducted on the Algerian exchange rate problems (the real exchange rate misalignment), on MENA countries and some developing countries.

Koranchelian T. (2005), by applying the Cashin et al. model (2003), defines the Algerian's REER as a function of **relative productivities** between tradable to non-tradable goods as well as the **terms of trade** (composed mainly by the hydrocarbon sector revenue) and assesses the degree of misalignment during the period (1970-2003). His finding is that REER was substantially overvalued between1983 to 1992 and returns close to its equilibrium in the 2002-2003.

Boileau et al. (2007) applied the Cashin and others' (2003) model in the Algerian case (1970-2007). They assumed that the REER was explained by three important factors: the real price of the primary commodity (the world price of oil), differential productivity and government expenditure. They found that all these factors appreciate the Algerian REER, however the increase in government spending was associated with relatively small appreciation of the real effective exchange rate because the important properties of capital spending is directed toward imported goods.

The IMF (2012) [2] uses the methodology of CGER [3] in order to assess the degree of misalignment. The IMF staff estimated the equilibrium real exchange rate of Algeria and found that the REER was determined by terms of trade, the differential of output per worker in Algeria vis-à-vis trade partners (productivity) and government spending [4]. The analysis suggests that the REER was overvalued between (1984-2002) and in line the equilibrium level after 2010.

Achy Lahcen (2001) estimated an ERER for five MENA countries namely: Algeria, Morocco, Tunisia, Egypt and Turkey from the period of 1985 to 1997. By applying the Edwards's model (1989, 1994) and Elbadawi (1994), he uses a cointegration method to see whether there is a long run relationship between the REER and the fundamentals. According to the results of his research, the five MENA countries exhibited an overvaluation of their REER. Especially for Algeria, after 1987 there was a substantial overvaluation due to worsening in the terms of trade (sharp drop of the oil sector's income in 1986) also the fiscal deficit which was financed by money creation resulted in an overvaluation of REER of about 66% in 1989 and 56% in 1990. An improvement in the oil sector remains the REER at 6% in 1997.

Charfi Marrakchi F. (2008) estimates an ERER for Tunisia (1983-2000) and assesses the degree of misalignment by using the Edward's model and utilizes the cointegration method to see if there is a long run relationship between the REER and its fundamentals. She found that the REER was overvalued between 1989 and 1997.

Mongardini J. (1998) estimates an equilibrium real exchange rate for Egypt by using the Edwards's model from 1989-1996. His findings consists an overvaluation all along the line. The real exchange rate of the Egyptian Pound has reached a peak of 35% in 1989 and RER decline to be closer to its equilibrium in 1995.

HASANOV F. (2009) estimated the ERER by using several methods: Purchasing Power Parity (PPP) Macroeconomic Balance, BEER and Permanent real exchange rate. He found that relative productivity, trade openness, Net foreign asset, government expenditures, and oil prices are the main determinants of misalignment.

Some studies about other developing countries are exposed in follows:

Baffes et al. (1997) for Côte d'Ivoire and Burkina Faso; Aron, Elbadawi and Khan (1997) for South Africa; MacDonald and Ricci (2003) for South Africa; Elbadawi and Soto (1997) Chile; Mathisen (2003) for Malawi; Nikola Spatafora and Emil Stavrev (2003); Alper and Saglam (2000) and Sengül et al (2012) for Turkey.

All of them use the work of Edwards (1988) to estimate the ERER path and derive the degree of misalignment. All the countries were characterized by significant overvaluation of their currency and that this overvaluation had a cost in terms of exports competitiveness.

IV. THE EDWARDS'S MODEL

In the case of Algeria, the most appropriate framework is the Dependant economy or Salter-Swan model Salter (1959), Swan (1960), Aukrust (1977). Based on this model and many studies, Montiel, (1999, 2003), Edwards (1987), (1988) and Elbadawi (1994), the real exchange rate is defined as the relative price of tradable to non tradable goods, also called the internal real exchange rate (IREER).

$$RER = \frac{Pt}{Pn} \tag{1}$$

Pt: represents the price of tradable goods. Pn: represents the price of non-tradable goods.

This theoretical definition has not been used in empirical studies because the data on prices are not normally disaggregated into tradable and non-tradable goods. Hence the external real exchange rate has been used as proxy for the internal real exchange rate definition in empirical studies. Candau et al. (2010, 2014).

External REER is: $$EREER_t = N_t \times \left(\frac{P_t^*}{P_t}\right) \tag{2}$$

Where, N is the nominal exchange rate, defined as domestic currency per foreign currency, P_t^* is the foreign price level and $P_t$the domestic price level. Then, the prices can be expressed as tradable and non-tradable goods.

$$P = P_e^{\theta} \,.\, P_{ne}^{(1-\theta)} \text{ and } P^* = P_e^{*\lambda} \,.\, P_{ne}^{*(1-\lambda)} \tag{3}$$

Where, θ and λ are the shares of tradable goods in respectively domestic and foreign country. We replace both P and P^*in equation 2.

$$EREER_t = \frac{P_e^{*\lambda} \,.\, P_{ne}^{*(1-\lambda)}}{P_e^{\theta} \,.\, P_{ne}^{(1-\theta)}} \tag{4}$$

$$EREER_t = \left(N_t \times \frac{P_{e,t}^*}{P_{e,t}}\right).\left(\frac{(P_e/P_{ne})^{(1-\theta)}}{(P_e^*/P_{ne}^*)^{(1-\lambda)}}\right) = \left(N_t \times \frac{P_{e,t}^*}{P_{e,t}}\right) .\frac{IREER_t^{(1-\theta)}}{IREER_t^{*(1-\lambda)}} \tag{5}$$

The EREER and IREER have the same dynamic, under two conditions:

First, wages between domestic and partner countries have same evolution, we consider that $\theta = \lambda$, and law of One Price holds: $N.P_e^* = P_e$.

$$\text{So, } EREER_t = \frac{IREER_t^{(1-\theta)}}{IREER_t^{*(1-\lambda)}} \quad (6)$$

Second condition, the Internal REER of the foreign country doesn't change. So, the variations of the IREER are proportional to the EREER.

The equilibrium real exchange rate is defined as the relative price of tradable with respect to non-tradable goods which provides a simultaneous internal and external balance (equilibrium) Montiel (1993), (2003), Edwards (1987) and Elbadawi (1994).

The internal equilibrium is defined as meaning that the non tradable goods market clears in the current period and is expected to be in equilibrium in the future period.

On the other side, external equilibrium means that the current balance (present and future) are compatible with the long run sustainable capital flows.

There are three goods: exportable (X), importable (M) and non tradable goods (N). This economy is supposed to be small and open. It produces exportable (Qx), non-tradable goods (Qn) at the same time consumes importable (Cm) and non-tradable goods (Cn). The government consumes both importable (Gt) and non-tradable goods (Gn). There is tariff on imports (μ). It is assumed that the price of exportable in terms of foreign currency is fixed and equal to unity. $P_x^* = 1$. The price of domestic exportable is $P_x = P_x^*.E$ so, $P_x = E$ and E is the nominal exchange rate. $P_m$and $P_n$are the domestic price of importable and non-tradable goods respectively. P_m^* is the foreign price of importable goods.

The system of price is:

$$P_m = E\ P_m^* + \mu \qquad em = P_m/P_n \qquad em = (E\ P_m^*\ +\ \mu\ )/P_n \quad (7)$$

$$e^*m = EP_m^*/P_n \quad (8)$$

$$ex = P_x/P_n \qquad ex = E/Pn \quad (9)$$

$$e = \frac{P_t}{P_n}, \quad e = \frac{\alpha\ E\ P_m^* + (1-\alpha)P_x}{Pn} = \frac{E\ [\alpha P_m^* + (1-\alpha)\ ]}{Pn} \text{ or } e = \alpha e^*m + (1-\alpha)ex \quad \text{with } \alpha \in (0,1) \quad (10)$$

Demand side:

$$C = Cm(em, Y) + Cn(em, Y) \qquad \frac{\partial Cm}{\partial em} < 0, \frac{\partial Cm}{\partial Y} > 0, \frac{\partial Cn}{\partial em} > 0\ et\ \frac{\partial Cn}{\partial Y} > 0 \quad (11)$$

Supply side:

$$Q = Qx(ex, \rho) + Qn(ex, \rho) \qquad \frac{\partial Qx}{\partial ex} > 0\ , \frac{\partial Qx}{\partial \rho} > 0, \frac{\partial Qn}{\partial ex} < 0\ et\ \frac{\partial Qn}{\partial \rho} < 0 \quad (12)$$

Government sector

$$G = PnGn\ + EP_m^*Gt \quad (13)$$

Equations (11) through (13) summarize both demand and supply. When (**em)** and (**ex)** are respectively the domestic relative price of importable and exportable goods.

Naturally, (em) is the relevant price for consumption and production decisions. The function of demand depends on the relative prix of importable to non-tradable goods and on the level of real assets (Y). On the other side, supply function depends on the relative price of exportable to non-tradable goods and on the relative productivity (ρ).

In the external sector:

$$R = CA + NFA = 0 \quad (14)$$

The external sector is realized if the international reserves (R) are sustainable in long run.

$$CA = Qx(ex) - P^*m\ Cm(em, Y) - Gt + (i * NFA) \quad (15)$$

Equation (15) defines the current account (CA) as the difference between output of Qx and total (private and public) consumption of importable goods and the payment of the interest debt. NFA is the net foreign assets and (i) is the interest rate.

Finally, the system will be in equilibrium if the non-tradable sector clears and the external sector is in equilibrium.

$$Cn(em, Y) + Gn = Qn(ex, \rho) \quad (16)$$

$$R = CA + NFA = 0 \quad (17)$$

So, the equilibrium real exchange rate is defined as follow:

$$e = f(P^*m, \mu, NFA, i, Gn, Gt, \rho, Y) \quad (18)$$

The terms of trade is calculated as $TOT = P^*x/P^*m = 1/P^*m$.

1. Import tariff, terms of trade and equilibrium real exchange rate[6]:

A decrease of import tariffs or an improvement in the terms of trade has a same impact on the equilibrium real exchange rate. (Edwards 1988).

The income effect: a positive shock on the terms of trade improves the trade balance and results in a higher demand for importable and non tradable goods. Thus, the price of Pn will increase and an appreciation of the real exchange rate will take place.

The substitution effect: a positive shock of terms of trade or a decrease on import tariffs lets the price of importable goods lower than non-tradable goods. The prices of Pn decrease and the real exchange rate depreciates.

However, deterioration on terms of trade or increases in tariffs appreciates the REER whether the substitution effect prevails.

2. Net capital flows:

Empirical evidence tends to support that when the capital flows moves into the country it generates an appreciation of the real exchange rate. (Edwards 1988, Elbadawi 1994).

3. **Government consumption:**

An increase in the government consumption of non tradable goods will result in an equilibrium real exchange rate appreciation.

4. **The relative productivity (technological progress):**

The technological progress can be presented in two forms (Balassa 1964, Samuelson 1964):

A) Product augmenting or income augmenting: results in an increase in real incomes and prices of non-tradable goods, then an appreciation of the real exchange rate.

B) Factor augmenting: an increase in production with the same capacity in the economy results in a reduction in the price of non tradable goods and the depreciation takes place.

V. THE EMPIRICAL FRAMEWORK

1. Data

$$LnREER = \beta_0 + \beta_1 LnTOT + \beta_2 Ln\ Open + \beta_4 GOV + \beta_3 LnPROD + \epsilon \quad (19)$$

REER [7]: real effective exchange rate Real effective exchange rate is the nominal effective exchange rate (a measure of the value of a currency against a weighted average of several foreign currencies) divided by a price deflator or index of costs, in logarithmic terms. (See appendix and figure 3)

TOT: terms of trade [8] is the world crude oil price divided by the CPI. US. Data are extracted from the CNUCED, UNCTADstat (2013) as used in Cashin's model (2003).

Open: is the sum of exports and imports in current US divided by GDP (current US), in logarithmic terms, World development indicator (WDI) 2013.

Gov: general government final consumption expenditure in current US divided by GDP in logarithmic terms from WDI 2013.

Prod: GDP per capita (current US), in logarithmic terms, is used as proxy variable to the relative productivity.WDI 2013

The dataset consists of annual data from 1971 to 2012 (42 observations) [9]. The ADF and Phillips-Perron tests indicate that the non-stationarity hypothesis cannot be rejected in level for all variables. However, for the first difference, the hypothesis of nonstationarity is rejected at the level of 1 percent for all variables. So, it suggests that the variables (REER, TOT, OPEN, GOV, PROD) are integrated of order one I(I) (Table 2). The capital flow is not significant for the Algeria case.

The econometric analysis Engel-Granger (1987) and Johansen (1995) confirm the existence of a cointegration relationship between the REER, TOT, OPEN, GOV and PROD (See appendix Table 5 and 6).

So, the estimated long run real exchange rate equilibrium equation takes the following form:

$$REER = -3{,}28 \times TOT - 0{,}28 \times OPEN - 1{,}11 \times GOV + 1{,}38 \times PROD - 7{,}43 \qquad (20)$$

The results are consistent with theoretical background. An increase on the oil prices, in other words an improvements on terms of trade and in openness of 1% is associated with an appreciation of the REER (Income effect) of about 3, 28 % [10] and 0,28 % respectively.

An increase of government consumption of 1 percent is associated with an appreciation of the REER about 1, 11%, relatively small appreciation due to an important government expenditure is mainly directed towards imported goods (Loko et al. 2007) (See Figure 4). And an increase of 1% of productivity is associated with a depreciation of the REER of about 1, 38%.

Whenever the REER deviates from its equilibrium value, it reverts to its equilibrium level in the absence of shocks. The parameter of the cointegration vector is 0,24 implies that the half-life speed (HLS) of dissipation of a unit impulse is 2,5 years[11].

Finally [12], we find that the REER was overvalued between 1972 to 1979, 1982 to 1991 and (2009-2010). Since 1992 to 2012, the REER was undervalued. (see figure 1 and figure 2).

VI. CONCLUSION AND RECOMMENDATIONS

According to the main results of this paper, the REER movement is explained by fundamentals variables such as: the oil prices as proxy for terms of trade, openness, the government consumptions and the relative productivity. An improvement in terms of trade (the rising in the oil prices), the increase in both the government consumptions and openness lead to an appreciation of REER, but relative productivity lead to a depreciation of the REER. The deviations of the REER from its equilibrium value are adjusted in about 2, 5 years.

Our findings are that the REER was overvalued between 1972 to 1979, 1982 to 1991 and (2009-2010). Since 1992 to 2012, the REER was undervalued.

Given the large share of hydrocarbon exports and representing mainly the whole part of the government revenue, the Algerian economy remains very vulnerable to a decline in the world oil prices IMF (2011), (2012). In addition, the large part of import of foods and with its increasing world prices is another source of vulnerability.

So, the Algerian authority must implement a new program in order to encourage private investment for boosting non hydrocarbon growth, intensify trade relations with neighbor countries, coordinate with monetary and fiscal policies and take aware from the negative effects of misalignment of the REER which undermine the export diversification efforts.

NOTES

[1] We will use the Real Exchange Rate (RER) and the Real Effective Exchange Rate (REER) expressions interchangeably.

[2] IMF country report N 13/47 of Algeria. P.37

[3] According to the CGER, the misalignment is defined as the real exchange rate adjustment that would close the gap between the estimated "current account norm" and the underlying current account.

[4] The government implemented the Economic recovery Program (ERP) between 2001 and 2004 and the growth consolidation program ($140 billion) between 2005 and 2009 (Loko. Et al. 2007).

[5] Elbadawi (1994) replaces tariff rates with variable of openness which can take into account "implicit" trade restrictions (such as quotas and exchange rate controls).

[7] A decrease in the REER is equivalent to real appreciation.

[8] See Cashin et al. (2003) and Sorsa, P., (1999). "Algeria-The real exchange rate, export diversification and trade protection" IMF Working paper WP/99/49.

[9] These procedures will provide better results for larger number of observations.

[10] T. Koranchelian (2005) found that the oil prices affect the Algerian REER of about 0, 24%. 0, 26% in the study of Loko and al. (2007)

[11] The time T require to dissipate x percent (in this case 50%) of a shock is determined according to $(1-\theta)^t = (1-X)$, where θ is the coefficient of the error correction term and T is the required numbered periods (years).

[12] The result of this analysis should be treated with some caution, given the existence of parallel market premium (about 32% at end-2012) IMF (2012).

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VIII. APPENDIX

Table 1: Data and series construction

Variables	Data construction	Data source
Real effective exchange rate (REER)	Ln(REER)	Author's estimation
Terms of trade (tot)	(TOT)=Oil/CPI US	UNCTADstat 2013
Openness (open)	OPEN=Ln (X+M/GDP)	WDI 2013
Gov	Gov=Ln(GOV/GDP)	WDI 2013
Prod	Prod=Ln(GDP capita)	WDI 2013

Table 2: Statistics for ADF and PP unit root tests

	ADF		Phillips-Perron		
Variables	**Intercept**	**Trend & intercept**	**Intercept**	**Trend & intercept**	Observations
REER	-1,4054	-1,1094	-1,3757	-1,4560	Accept U.R at 1%
▲REER	-5,7050***	-5,6315***	-5,7140***	-5,6463***	REER is I(I) at 1%
TOT	-1,4171	1,5380	-1,3630	-1,4970	Accept U.R at 1%
▲TOT	-6,8350***	-4,7713***	-6,8375***	-6,7713***	TOT is I(I) at 1%
OPEN	-2,5744	-2,5417	-2,0478	-2,0323	Accept U.R at 1%
▲OPEN	-5,2317***	-5,1628***	-4,3493***	-4,3045***	OPEN is I(I) at 1%
GOV	-2,7314*	-2,5790	-2,1970	-2,0472	Accept U.R at 1%
▲GOV	-5,4676***	-5,4950***	-5,4107***	-5,4344***	GOV is I(I) at 1%
PROD	-2,8552*	-2,5715	-2,4978	-2,5228	Accept U.R at 1%
▲PROD	-4,6603***	-4,6683***	-4,7566***	-4,8089***	PROD is I(I) at 1%

Notes: *, ** and *** denote rejection at 10 %, 5 % and 1% critical values. The Lag length is determined based on Schwarz information Criterion (SIC).

Calculate methodology

According to Dohni. L and Hainaut C. (2004), Zamello and Desruelle (1997), the Algerian CPI-Based Real effective (multilateral) exchange rate (REER) is calculated as follows:

$$NEER^{Alg}_{t/t_{2005}} = 100 \times \prod_j \left(S^{alg}_{j,t/t_{2005}}\right)^{\alpha_j} \qquad \text{Where, } S^{j}_{j,t/2005} = \frac{S^{alg}_{j,t}}{S^{alg}_{j,t_{2005}}}$$

With, $NEER^{Alg}_{t/t_0}$: Nominal effective exchange rate index of Algeria at time t, with t_{2005} is the base year, is the geometric average of the bilateral exchange rates of Algeria with its trading partners ($S^{alg}_{j,t/t_{2005}}$) (domestic currency per foreign currency).

α_j: Shares of Algeria's trading partners.

$$\alpha_j = \frac{M_j + X_j}{\sum_{j=1}^{n} M_j + \sum_{j=1}^{N} X_j}$$

Where,

α_j: Weight of country j in the overall trade volume of the country. With $\sum_{j=1}^{n} \alpha_j = 1$.

M_j : Import of the Algerian economy from the country j.

X_j: Export of the Algerian economy to country j.

$\sum_{j=1}^{n} M_j$: Exports of the Algerian economy to its main trading partners. (n=7)

$\sum_{j=1}^{N} X_j$: Imports of the Algerian economy from its main trading partners. (n=4)

Table 3: Shares of Algeria's trading partners (base year= 2005)

Country	USA	Italy	Spain	France	Netherlands	Portugal	Belgium
Shares	0,28257131	0,21394761	0,14209251	0,21328464	0,07159229	0,03954997	0,03696167

Source: Author's calculations

$$REER_{t/2005}^{Alg} = 100 \times \prod_j \left(RBER_{j,t/t_{2005}}^{Alg}\right)^{\alpha_j}$$

With, $REER_{t/t_{2005}}^{Alg}$: Real effective exchange rate index of Algeria at time t, with t_{2005} is the base year.

$$REER_{t/t_{2005}}^{Alg} = \prod_j \left(100 \times \left(\frac{S_{j,t}^{alg}}{S_{j,t_{2005}}^{alg}}\right) \frac{CPI_{t/t_{2005}}^{j}}{CPI_{t/t_{2005}}^{alg}}\right)^{\alpha_j}$$

$CPI_{t/t_{2005}}^{j}$: The Consumer price index of the foreign country at time t with t_{2005} is the base year.

$CPI_{t/t_{2005}}^{alg}$: The Consumer price index of Algeria at time t with t_{2005} is the base year.

The REER can be expressed as follows:

$$REER_{t/t_{2005}}^{Alg} = 100 \times \prod_j \left(S_{j,t/t_{2005}}^{alg}\right)^{\alpha_j} \frac{1}{\prod_j \left(\frac{CPI_{t/t_{2005}}^{alg}}{CPI_{t/t_{2005}}^{j}}\right)^{\alpha_j}}$$

$$REER_{t/t_{2005}}^{Alg} = NEER \times \frac{1}{\prod_j \left(\frac{CPI_{t/t_{2005}}^{alg}}{CPI_{t/t_{2005}}^{j}}\right)^{\alpha_j}}$$

$$REER_{t/t_{2005}}^{Alg} = NEER \times \frac{1}{\frac{CPI_{t/t_{2005}}^{alg}}{\prod_j \left(CPI_{t/t_{2005}}^{j}\right)^{\alpha_j}}}$$

$$REER_{t/t_{2005}}^{Alg} = NEER \times \frac{\prod_j \left(CPI_{t/t_{2005}}^{j}\right)^{\alpha_j}}{CPI_{t/t_{2005}}^{alg}}$$

Data Sources:

Table 4: Data sources

Variables	Data source
Consumer Price index of Algeria, USA, France, Italy, Spain, Belgium, Netherlands	World development Indicator. World Bank 2013
Official exchange rate $/DZD	WDI. WB. 2013
Official exchange rate Ecu/USD and EUR/USD	Eurostat 2014, European Central Bank.
The 10 main suppliers of the Algerian economy	National Statistics Office Algeria.
The 10 main customers of the Algerian economy	National Statistics Office Algeria.

Figure 1: Relation between the Equilibrium real exchange rate (ERER) and REER of Algeria (1971-2012)

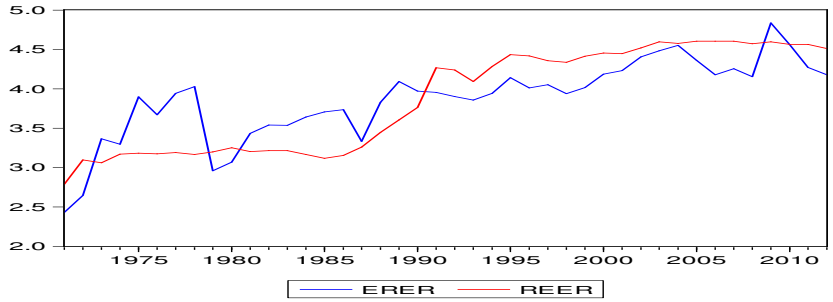
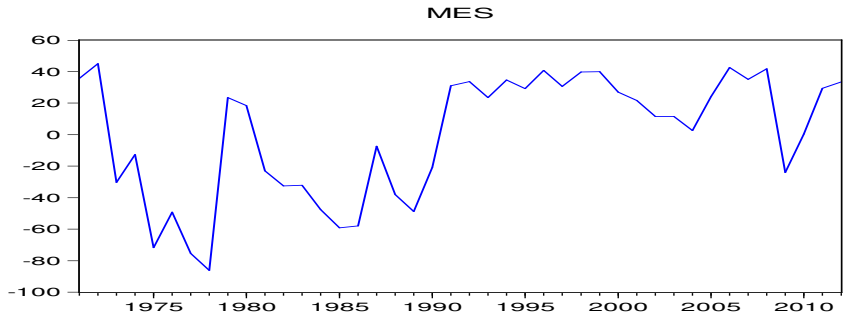


Figure 2: Degree of misalignment of REER of Algeria (1971-2012)



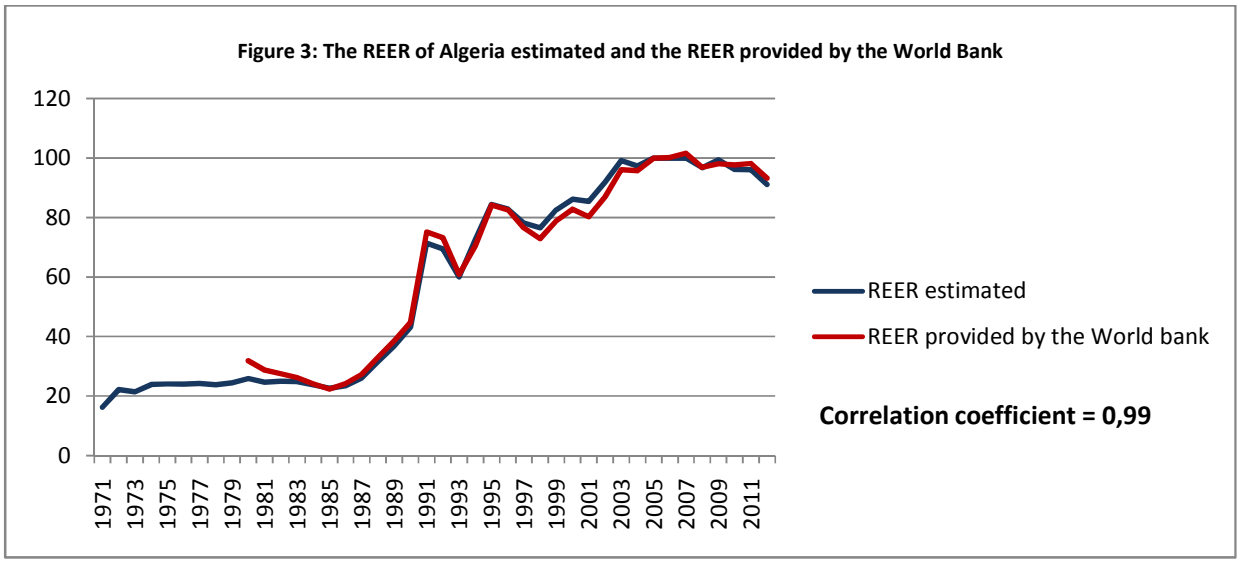


Table 5: Trace statistics for cointegration rank.

	Eigenvalue	Trace Statistics	Critical value	Prob. **
$R = 0$	0.739701	111.9759	69.81889	0.0000
$R \leq 1$	0.607417	60.83089	47.85613	0.0019
$R \leq 2$	0.303710	25.30060	29.79707	0.1510
$R \leq 3$	0.225714	11.54503	15.49471	0.1801

Table 6: Max-Eigen Statistics for cointegrating rank

	Eigenvalue	Maw-Eigen Statistics	Critical value	Prob. **
$R = 0$	0.739701	51.14505	33.87687	0.0002
$R \leq 1$	0.607417	35.53029	27.58434	0.0039
$R \leq 2$	0.303710	13.75557	21.13162	0.3854
$R \leq 3$	0.225714	9.720924	14.26460	0.2309