Equilibrium Exchange Rate and Competitiveness in Morocco: Estimation by the ARDL Cointegration Model

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This study estimated the real equilibrium exchange rate and its misalignment by adopting the Natural Real Exchange Rate (NATREX) approach and ARDL cointegration model. The aim is to interpret the impact of the determinants used to estimate the equilibrium exchange rate and assess the importance of the exchange rate in the Moroccan economy through the evolution and the reaction of the trade balance vis-à-vis the misalignment. The results showed that the rise in terms of trade can have an impact on the appreciation of the exchange rate and constrain Moroccan exports. This evidence confirms indeed the importance of the exchange rate as an instrument of price competitiveness. The study also identified a competitiveness problem linked to the structure of the Moroccan economy showing an absence of the Blassa-Samuelson effect. The impact of public spending on the exchange rate shows a problem of the nature of this spending which is more oriented towards tradable goods contributing to higher imports and hence to the deterioration of the trade balance.

Keywords: exchange rate equilibrium, NATREX, ARDL model, cointegration, competitiveness, misalignment, trade balance, Morocco

INTRODUCTION

The real exchange rate is an important macroeconomic concept that reflects relative price movements and is a key indicator of the price competitiveness of economies in international trade. Thus, it is essential that the real exchange rate does not deviate significantly and persistently from its equilibrium level determined by economic fundamentals, so that relative prices remain close to equilibrium over time and a country's external position is sustainable. However, the equilibrium of the real exchange rate is not directly observable and must be estimated using appropriate models in order to be able to judge price competitiveness from the analysis of the misalignment of the exchange rate from its equilibrium to the evolution of the trade balance. According to Edwards (1989), the misalignment of the exchange rate presented by deviations of the observed real exchange rate from its long-run equilibrium value is likely to generate macroeconomic imbalances, which gives it a central role in economic policy.

However, although the problem of the usefulness and the possibility of calculating the equilibrium exchange rate is still debated, it is still useful to estimate it in order to be able to draw evidence on the behaviour of the exchange rate by identifying periods of overvaluation (when the real exchange rate is above the ideal level) and undervaluation (the opposite situation).

There is also debate about the determinants of the equilibrium exchange rate, and more about the appropriate approach to determining its level. The most widely used approaches to determining the

equilibrium exchange rate are the FEER (Fundamental Equilibrium Exchange Rate) developed by Williamson (1983), the BEER (Behavioural Equilibrium Exchange Rate) of Clark and Macdonald (1998) and Stein's NATREX (Natural Real Exchange Rate) (1994). It is in this context that our study, aims at estimating the equilibrium real exchange rate using the NATREX approach for the Moroccan economy, which is already in the process of reforming its exchange rate policy. The aim is first to participate in the debate on exchange rate policy in Morocco, to answer the question on the determinants used to estimate the equilibrium exchange rate, and then to assess the importance of the exchange rate in the competitiveness of the Moroccan economy by analyzing the evolution and the reaction of the trade balance to misalignment.

Natural Real Exchange Rate Approach (NATREX)

Introduced by Jerome L. Stein (1994), NATREX adopts a positive approach like the BEER[1] but is based on a real exchange rate base that ensures balance of payments equilibrium just like the FEER[2]. NATREX is therefore the real exchange rate that allows the simultaneous achievement of internal and external equilibrium of the economy. It is an optimal rate without economic policies being socially optimal or maximizing welfare. It should be remembered that internal equilibrium is achieved when the economy pursues its non-inflationary growth path, while external equilibrium is synonymous with long-term sustainability of the current account.

The internal and external macroeconomic equilibrium is written as in the FEER model:

$$CA+KA= 0$$

NATREX will make savings *(S)* and investment *(I)* play a key role in the dynamics of the real exchange rate, via current account adjustments.

Thus the capital balance *(KA),* which represents the external equilibrium, is a function of investment (*I)* and savings *(S)*.

$$KA= I-S$$

This external equilibrium variable (*KA) is* in fact determined by the level of the capital stock per worker (*K),* the level of real foreign debt per worker (*F),* the real exchange rate (*R),* the real interest rate (*i),* and exogenous fundamental variables (*Z).*

The current account balance *(CA),* which represents the internal balance, is a function of the trade balance *(B)* minus the interest paid to foreigners (*iF).*

$$CA= B-iF$$

The trade balance is also determined by *(K, R, Z)*.

The equation for the balance of payments equilibrium can therefore be presented as follows:

$$CA\ (K, F, R, I, Z) + KA\ (K, F, R, i, Z) = 0$$

NATREX then explicitly distinguishes between medium-term and long-term equilibrium. By respecting the equilibrium condition, the real exchange rate is decomposed into 3 terms.

$$R_t = \{R_t^{ST}\text{-}R_t^{MT}\ [K_t,F_t, Z_t]\} + \{R_t^{MT}\ [K_t, F_t, Z_t]\text{-}\ R_t^{LT}[Z_t]\ \} + R_t^{LT}\ [Z_t]$$

The first term represents the deviations of the real exchange rate from the short term, affected by speculative and cyclical factors, of NATREX. The second term traces the deviations between medium-term NATREX and long-term NATREX, while the last term is the long-term NATREX which depends only on exogenous fundamental variables, namely: the productivity of domestic and foreign economies, preference for the present (inverse variable of savings), the terms of trade and the world interest rate, these last two

variables are also long-term fundamental variables but vary according to the size of the countries' economies[3]. The NATREX model generally assumes that the real exchange rate is a non-stationary variable, the long-term fundamentals (Z) are also non-stationary, while the short-term fundamentals are stationary.

Determination of the Equilibrium Exchange Rate in Morocco: NATREX of Small Economy (Lim and Stein 1995)

This axis will determine the equilibrium exchange rate for Morocco, based on the NATREX model of Lim and Stein (1995). The study covers the period from 1987 to 2016, i.e., the period preceding the last reform in 2018 concerning the widening of the fluctuation bands[4]. It should be pointed out that the NATREX model is based on the theory of cointegration[5], so a study of the stationarity of the variables is necessary before moving on to determine the number of cointegrating relationships to finally determine the validity and interpretation of the results obtained.

Definitions and Sources of Variables

The macroeconomic variables used in the study are taken from the World Bank database and spread over the period (1987-2016), making a sample of 31 observations.

Real Effective Exchange Rate. The effective real exchange rate is the prevailing nominal exchange rate (a measure of the value of a currency against a weighted average of several foreign currencies) divided by a price deflator or cost index. Changes in this variable represent an appreciation or depreciation of the Moroccan Dirham (MAD).

Public Spending. Government final consumption expenditure includes all current government spending on purchases of goods and services (including employee compensation). It also includes most defense and national security spending, but does not include government military spending that is part of the government's capital formation. A few studies consider that the bulk of government spending is for the purchase of non-tradable goods, which will increase their prices and consequently an appreciation of the exchange rate. However, the real effect of government spending on the real exchange rate is not so clear, and there are few empirical studies on the subject that show that government spending can be associated with either an appreciation or a depreciation of the real exchange rate[6].

Productivity. Productivity is one of the major determinants of the NTAREX model, and in accordance with the Blassa-Samuelson effect, a faster increase in domestic productivity, i.e. the productivity of tradable goods to that of non-tradable goods, leads to an appreciation of the exchange rate.

The relative productivity of a given country is calculated through GDP per capita. Its construction poses some practical problems due, among other things, to the unavailability of data on sectoral productivities for most developing countries. It is therefore common in the literature to approximate this variable. The famous practice is to consider GDP per capita in the United States as an approximate measure of productivity in the rest of the world (Macdonald and Vieira, 2010). However, this method seems limited to us because it does not really take into account the importance of different partners in a country's trade relations. This has led us to construct a variable based on Morocco's GDP per capita on that of OECD countries, which can be a proxy measure of Morocco's productivity.

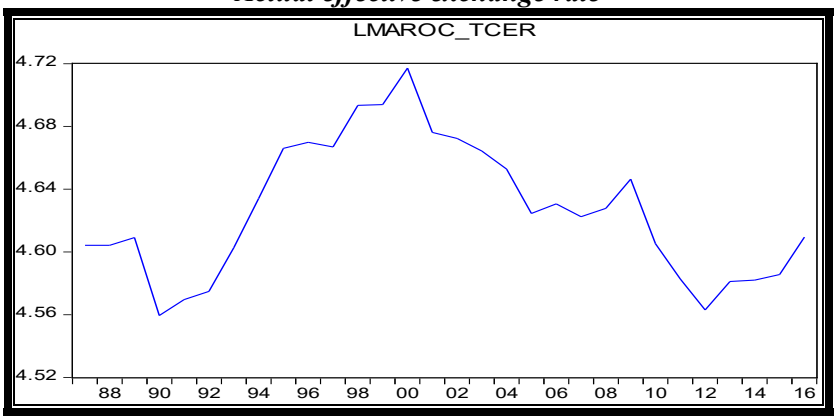
Savings. Gross savings as a % of GDP, it represents a temporal preference inverse to domestic consumption. Gross savings is calculated as gross national income minus total consumption plus net transfers. The expected sign depends on the nature of the savings (domestic or foreign).

Terms of Exchange. Are the ratio of export prices of goods and services to import prices, the variable used is the net merchandise terms of trade index, which is calculated as the ratio of the unit value of exports index to the unit value of imports index[7]. An increase in the real terms of trade will produce a real appreciation of the domestic currency.

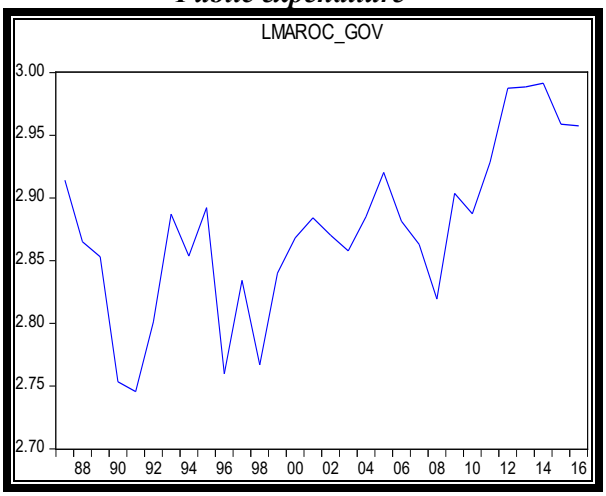
Given Morocco's low mobility of short-term capital due to restrictions, the **interest rate** variable is excluded as long as the country has no influence on the global economy through its interest rate.

FIGURE 1
GRAPHICAL EVOLUTION OF THE VARIABLES

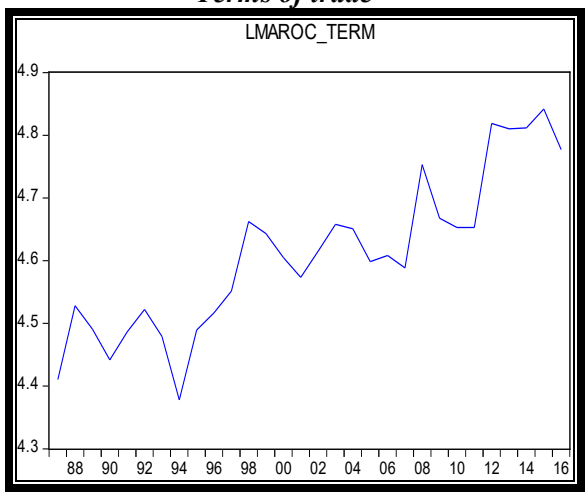
Actual effective exchange rate



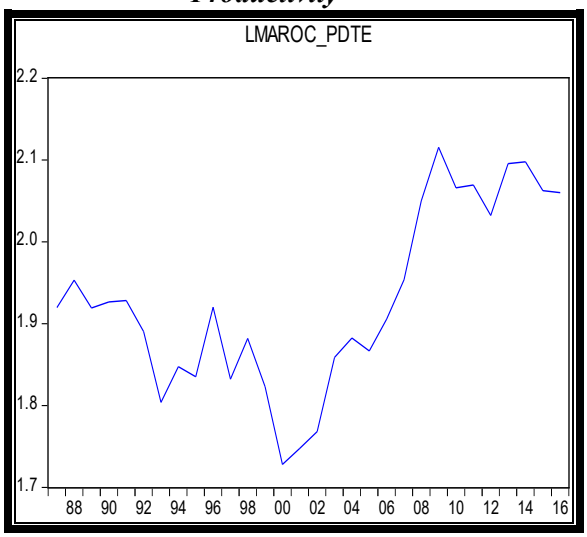
Public expenditure



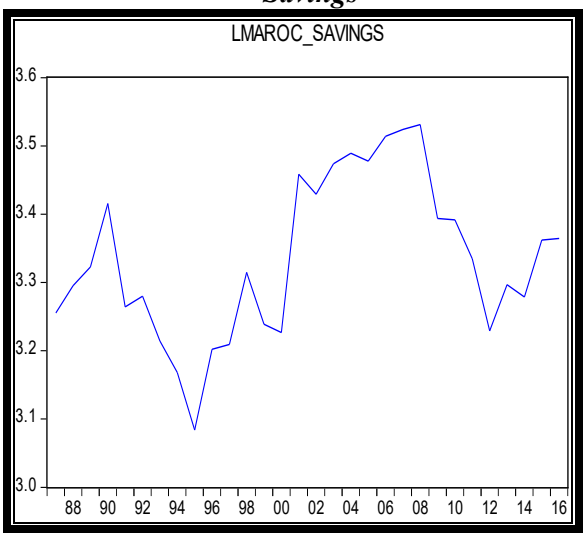
Terms of trade



Productivity



Savings



Specification of the ARDL Cointegration Model

To study NATREX and thus deduce the equilibrium exchange rate in Morocco, we will estimate the ARDL (Auto Regressive Distributed Lag model). This model, which is part of the class of dynamic models, allows to capture temporal effects and is presented as follows:

We consider (*Yt*) which can be explained by :

- Its own past values(Y_{t-i}), this is called an autoregressive (AR) model and can be written:

$$Y_t = a_0 + a_1 Y_{t-1} + \cdots + a_P Y_{t-p} + \varepsilon_t$$

or

$$Y_t = a_0 + \sum_{i=1}^{p} a_i Y_{t-i} + \varepsilon_t \ldots \quad (1)$$

with

ε_t ~idd (0, σ) error term.

- As well as by the exogenous variables (*Xt)* and their past values(X_{t-i}), we are talking here about distributed lags (DL) models which take the following form :

$$Y_t = \beta + b_0 X_t + \cdots + b_q X_{t-q} + z_t$$

or

$$Y_t = \beta + \sum_{i=0}^{q} b_i X_{t-i} + z_t \ldots \quad (2)$$

Indeed, the combination of the two models gives what is called the ARDL model (autoregressive models with distributed lags), so its form is written:

$$Y_t = \varphi + a_1 Y_{t-1} + \cdots + a_P Y_{t-p} + b_0 X_t + \cdots + b_q X_{t-q} + e_t$$

or

$$Y_t = \varphi + \sum_{i=1}^{p} a_i Y_{t-i} + \sum_{i=0}^{q} b_i X_{t-i} + e_t \ldots \quad (3)$$

We note that (b_0) explains the short-term effect of (Xt) on (Yt), and to explain the long-term effect of (*Xt)* on (*Yt)* one must calculate (λ) from the long-term relationship:

$$Y_t = k + \lambda + X_t + u$$

with

$$\lambda = \sum b_i / (1 - \sum a_i)$$

In the framework of our study, which seeks to study the determinants of the exchange rate in Morocco and its equilibrium using the NATREX model, the representation of our econometric model ARDL is presented as follows:

$$LnTCER_t = a_0 \sum_{i=0}^{p} a_1 \Delta LnTCER_{t-i} + \sum_{i=0}^{q} a_2 \Delta LnSAVINGS_{t-i} + \sum_{i=0}^{q} a_3 \Delta LnTERM_{t-i} + \Delta \sum_{i=0}^{q} a_5 LnGOV_{t-i} + b_1 LnTCER_{t-i} + b_2 LnSAVINGS_{t-i} + b_3 LnTERM_{t-i} + b_4 LnPDTE_{t-i} + b_5 LnGOV_{t-i} + e_t \ldots \quad (4)$$

with:

- Δ: Operator of the first difference; *Ln* is the natural logarithm a_0 Constant ; $a_1 \ldots a_5$ Coefficients**,** Short-term effects ; $b_1 \ldots b_5$ Long-term dynamic coefficients of the model ; e_t ~idd $(0, \sigma)$ error term (white noise).
- *TCER*: Real effective exchange rate, SAVINGS: Savings, *TERM:* Terms of trade, *PDTE:* Productivity, *GOV:* Public expenditure

Study of the Stationarity of the Variables

Time series analysis commonly begins with a study of the stationarity of the variables involved. To do this, the two categories of the most widely used tests that are still in use today, namely: the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test, whose null hypothesis is non-stationarity, are used. Thus, the results for the endogenous variable (real effective exchange rate) and its fundamentals (productivity, terms of trade, public spending, savings) are presented as follows:

TABLE 1
AUGMENTED DICKEY-FULLER TEST (ADF) AFTER THE FIRST DIFFERENCE

Method			Statistic	Prob.**
ADF - Fisher Chi-square			42.5407	0.0000
ADF - Choi Z-stat			-4.72812	0.0000
** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.				
Intermediate ADF test results D(UNTITLED)				
Series	Prob.	Lag	Max Lag	Obs
D(MOROCCO_TCER)	0.0867***	1	1	27
D(MAROC_SAVINGS)	0.0180**	1	1	27
D(MOROCCO_GOV)	0.0285**	1	1	27
D(MOROCCO_TERM)	0.0004*	1	1	27
D(MOROCCO_PDTE)	0.0300**	1	1	27

*, **, ***: Rejection of the null hypothesis of non-stationarity at 1%, 5% and 10%.

TABLE 2
PHILLIPS-PERRON (PP) TEST AFTER THE FIRST DIFFERENCE

Method	Statistic	Prob.**
PP - Fisher Chi-square	124.268	0.0000
PP - Choi Z-stat	-9.77223	0.0000
** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.		

Intermediate Phillips-Perron test results D(UNTITLED)			
Series	Prob.	Bandwidth	Obs
D(MOROCCO_TCER)	0.0011*	0.0	28
D(MAROC_SAVINGS)	0.0000*	2.0	28
D(MOROCCO_GOV)	0.0000*	27.0	28
D(MOROCCO_TERM)	0.0000*	27.0	28
D(MOROCCO_PDTE)	0.0001*	4.0	28

*, **, ***: Rejection of the null hypothesis of non-stationarity at 1%, 5% and 10%.

All the series studied are non-stationary in level for both tests (ADF and PP), this non-stationarity is stochastic in nature and is consistent with the logic of NATREX which assumes the non-stationarity of the exchange rate and its fundamentals. However, the two tables show that the variables are stationary after the first difference and are integrated of order 1, I(1). The results obtained then reveal the possibility of the existence of a cointegrating relationship between the different variables studied.

Cointegration Study: Optimal ARDL and Bounds Test

The study of cointegration is now being carried out by the method of Pesaran et al. (2001) and that of Naranyan (2005) for a small sample, knowing that the adoption of the Johansen test is admitted in cases where the series are integrated of the same order, whereas the "bounds test to cointegration" is adopted in cases where the series are integrated of two different orders I(0) and I(1), but it should be specified that this does not exclude the adoption of the "bounds test" in cases where the series are integrated of the same order. In this respect, we have taken the liberty to adopt this approach given the interest we had in the ARDL (AutoregressAutoRegressive Distributed Lag) models (AutoRegressive models with distributed lags) and to go beyond the requirement of the Johansen test about the same order of integration; the desire to add a reference that studies NATREX for the Moroccan case by this method is also a reason. Indeed, it must be said that this model, which serves as a basis for the test of cointegration (test of Pesaran et al. (2001)), generally takes the form of an error-correction model (VECM).

Determination of the Optimal ARDL Model

We will use (Akaike's) information criterion to select the optimal ARDL model, the one that offers statistically significant results with the least parameters.

Below are the estimation results of the optimal ARDL model selected from Eviews which in the 9th version displays the optimal model chosen from 20 other models considered the best in the whole evaluation. The model selected is that of : ARDL (3, 1, 1, 1.3)

Dependent Variable: LMAROC_TCER Method: ARDL Maximum dependent lags: 3 (Automatic selection) Model selection method: Akaike info criterion (AIC) Dynamic regressors (3 lags, automatic): LMAROC_PDTE LMAROC_TERM LMOROCCO_GOV LMAROC_SAVINGS Fixed regressors: C Number of models evaluated: 768 Selected Model: ARDL(3, 1, 1, 1, 1, 2)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LMAROC_TCER(-1)	0.852228	0.163891	5.199957	0.0001
LMAROC_TCER(-2)	0.242137	0.225382	1.074343	0.3008
LMAROC_TCER(-3)	-0.631372	0.194989	-3.237986	0.0060
LMAROC_PDTE	0.087352	0.078034	1.119403	0.2818

LMAROC_PDTE(-1)	-0.364388	0.078860	-4.620676	0.0004
LMAROC_TERM	0.142451	0.054611	2.608478	0.0206
LMAROC_TERM(-1)	0.120580	0.056465	2.135485	0.0509
LMOROCCO_GOV	-0.049403	0.094084	-0.525096	0.6077
LMOROCCO_GOV(-1)	-0.132044	0.093361	-1.414333	0.1791
LMAROC_SAVINGS	-0.182300	0.055694	-3.273271	0.0055
LMAROC_SAVINGS(-1)	0.067731	0.058296	1.161835	0.2647
LMAROC_SAVINGS(-2)	0.076468	0.045248	1.689987	0.1132
C	2.452091	0.561434	4.367548	0.0006
R-squared	0.946796	Mean dependent var		4.628691
Adjusted R-squared	0.901193	S.D. dependent var		0.045039
S.E. of regression	0.014157	Akaike info criterion		-5.370979
Sum squared resid	0.002806	Schwarz criterion		-4.747058
Log likelihood	85.50822	Hannan-Quinn criter.		-5.185455
F-statistic	20.76167	Durbin-Watson stat		1.840575
Prob(F-statistic)	0.000001			

Validation of the Model

The specification obtained in the ARDL model (3, 1, 1, 1, 2) is globally satisfactory. The model can explain almost 94.6% of the observed variability of the real exchange rate. In terms of robustness tests, the null hypothesis is accepted by all the tests and therefore the residuals fulfil the conditions of validity of the model, namely the absence of Autocorrelation, the existence of Normality and Homoscedasticity.

TABLE 3
DIAGNOSTIC TESTS ON THE ARDL MODEL

Test hypothesis	Test	F-statistics	Probability
Autocorrelation	Breusch-Godfrey Serial Correlation LM Test	0.31	0.73
Heteroskedasticity	Breusch-Pagan-Godfrey	0.52	0.86
Normality	Jarque-Berra	3. 73	0. 15

ARDL Model Bounds Test

TABLE 4
BOUNDS TEST

Pesarana et al (2001)		
Null Hypothesis: No long-run relationships exist		
Statistical Test	Value	K
F-statistic	7.240067	4
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.45	3.52
5%	2.86	4.01
2.5%	3.25	4.49
1%	3.74	5.06

Naranyan (2005)[8]		
10%	1.501	3.828
5%	1.855	4.560
2.5%	2.228	5.31
1%	2.734	6.320

Table *(4)* provides values for the *Bounds test,* which uses the Fisher test to test cointegration hypotheses. Thus, we test the null hypothesis of the absence of cointegration against the alternative hypothesis of the existence of a cointegrating relationship in the traditional approach of Pesaran et al (2001) and in the approach of Naranyan (2005) for small samples. The procedure of the test is such that one will have to compare the values of the bounds with that of Fisher. If the Fisher's value is above the upper bound the null hypothesis is rejected, while in the opposite case where the Fisher's value is below the lower bound the null hypothesis is accepted.

The *Bounds test* table shows that the Fisher statistic, which takes the value of (7.24), is higher than the first upper bound of (5.06) and the second (6.32), which leads us to reject the null hypothesis of the absence of a cointegrating relationship and consequently to accept the alternative hypothesis of the existence of a cointegrating relationship between the variables selected. This evidence of the existence of a cointegrating relationship therefore gives us permission to proceed with the estimation of the long and short term relationships of our ARDL model of cointegration.

Short and Long-Term Relationships: ARDL Cointegration

TABLE 5
ESTIMATES OF SHORT- AND LONG-TERM RELATIONSHIPS

ARDL Cointegrating And Long Run Form Dependent Variable: LMAROC_TCER Selected Model: ARDL(3, 1, 1, 1, 1, 2) Sample: 1987 2016				
Cointegrating Form				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LMAROC_TCER(-1))	0.389235	0.185630	2.096836	0.0547
D(LMAROC_TCER(-2))	0.631372	0.194989	3.237986	0.0060
D(LMAROC_PDTE)	0.087352	0.078034	1.119403	0.2818
D(LMAROC_TERM)	0.142451	0.054611	2.608478	0.0206
D(LMOROCCO_GOV)	-0.049403	0.094084	-0.525096	0.6077
D(LMAROC_SAVINGS)	-0.182300	0.055694	-3.273271	0.0055
D(LMAROC_SAVINGS(-1))	-0.076468	0.045248	-1.689987	0.1132
CointEq(-1)	-0.537007	0.126379	-4.249187	0.0008
CointEq = LMAROC_TCER - (-0.5159*LMAROC_PDTE + 0.4898 *LMAROC_TERM - 0.3379*LMOROCCO_GOV -0.0710 *LMAROC_SAVINGS + 4.5662)				
Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LMAROC_PDTE	-0.515889	0.088724	-5.814516	0.0000
LMAROC_TERM	0.489810	0.111606	4.388757	0.0006
LMOROCCO_GOV	-0.337886	0.136500	-2.475355	0.0267
LMAROC_SAVINGS	-0.070952	0.082877	-0.856107	0.4064
C	4.566216	0.344998	13.235475	0.0000

The estimates obtained in table *(5)* above, show that the adjustment coefficient is negative and statistically significant, which shows the existence of an error correction mechanism and therefore a long term relationship between the variables, the value of this coefficient is 0.53, indicating a misalignment of 53% of the exchange rate of its equilibrium.

In the first part of the table, **the terms-of-trade** variable has a positive effect on the exchange rate in the short term; a 1% increase in the terms of trade can appreciate the exchange rate by 0.14% and does not seem to change its effect over time. The other significant variable is **savings,** which negatively affects the exchange rate in the short term and seems to stop there. Indeed, the expected sign of savings is according to its nature according to Lim and Stein (1995) (in the long term the negative sign is in the case of domestic savings and the positive sign in the case of foreign savings). But, the variable used in our study is a variable combining the two, and which was negative, which in a way reflects the dominance of domestic savings in the country even if the effect on the exchange rate is only short-term. As for the other variables, no effect is shown.

In the same table, the lower part provides us with the long-term coefficients, the results show that in the long run, **productivity** is significant and depreciates the real exchange rate, which goes against the Blassa-Samuelson effect, in fact these results are similar to those of Lim and Stein (1995) on the case of a small open economy and are opposite to those obtained for large economies, thus a 1% increase in productivity leads to a 0.5% depreciation of the exchange rate.

The other significant variable is that of the **terms of trade,** which has a positive impact on the real exchange rate; a 1% increase in the terms of trade can lead to an appreciation of the exchange rate by 0.48%, which is in line with the results found by Lim and Stein (1995) and by other studies that have focused on developing countries[9].

With regard to **public spending,** there is a significant but negative effect on the exchange rate, i.e. a depreciation of the exchange rate. The elasticity shows that a 1% increase in public spending can lead to a 0.3% depreciation of the exchange rate. The relationship between public expenditure and the exchange rate is not so clear in the literature but can be explained according to the orientation of expenditure, if it is made on non-tradable goods, this can be associated with an appreciation of the real exchange rate, but if it concerns mainly tradable goods, it can cause a deterioration of the trade balance due to the increase in imports, This leads to a depreciation of the real exchange rate, and based on the operation of expansionary fiscal policy in fixed exchange rate regimes as set out in the Mundell-Fleming model, Morocco can be seen to stick to this mechanism of a negative relationship between public spending and the real exchange rate in the context of a fixed exchange rate regime with low capital mobility.

Moreover, unlike short-term results, the long-term **savings** variable is not significant. This result is consistent with research by Montiel and Servén (2009), who conclude that there is no clear association between real exchange rates and domestic savings.

Calculation of the Adjustment Speed

The 53% adjustment coefficient that explains the misalignment of the real exchange rate from its equilibrium level can be used to calculate the speed at which the exchange rate returns to its equilibrium after an exogenous shock. The formula for the speed is written as follows:

$$(1-\beta_0) = (1 - |\alpha_1|)^t$$
$$\text{Log } (1-\beta_0) = t * \log(1 - |\alpha_1|)$$

with t: number of years, α_1 the error correction coefficient and β_0 the percentage of shock to be removed (95%).

According to our model, eliminating 95% of a shock to the economy requires:

$$t = \frac{\text{Log } (1-\beta_0)}{\log(1-|\alpha_1|)} = \frac{\text{Log } (1-0,95)}{\log(1-0,53)} = \frac{-1,301}{-0,327} = 4\ years$$

The elimination of 95% of a real exchange rate shock may take 4 years for the exchange rate to return to equilibrium. This is in line with the results of Husted and Macdonald (1998) found for a large sample of countries with floating exchange rate regimes.

Determination of Real Exchange Rate Misalignment

As was well mentioned in the introduction, one of the reasons for finding the determinants of the real effective exchange rate is to be able to estimate the equilibrium exchange rate from which to infer the degree of misalignment. To do so, we will estimate the values of the equilibrium real exchange rate by replacing the economic fundamentals retained in the long-run cointegration equation and with the help of a Hodrick-Prescott filter.

FIGURE 2
OBSERVED REAL EFFECTIVE EXCHANGE RATE (MOROCCO TCER) AND EQUILIBRIUM REAL EXCHANGE RATE(MOROCCO_TCEREQUI)

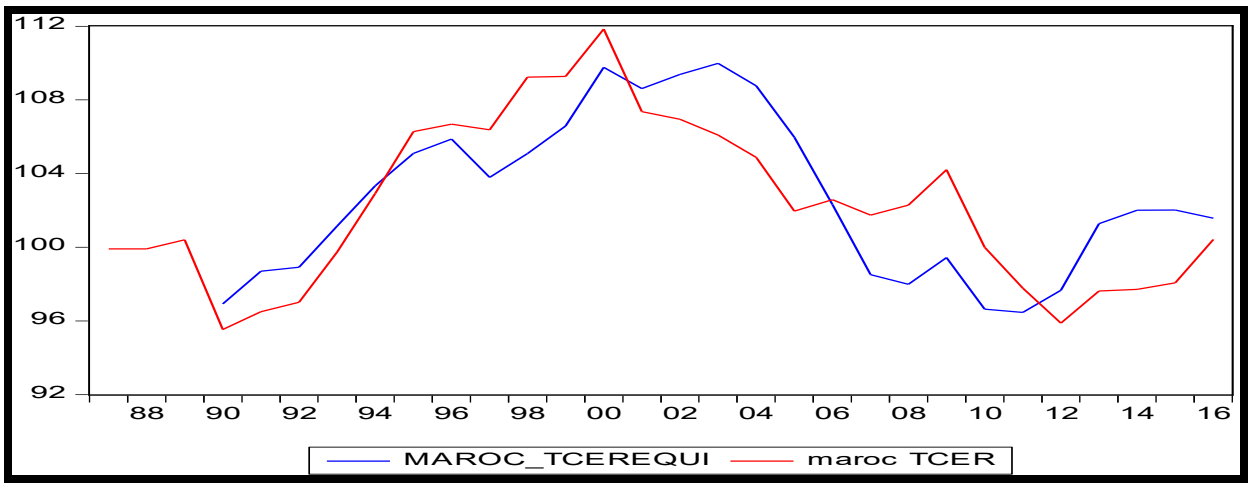
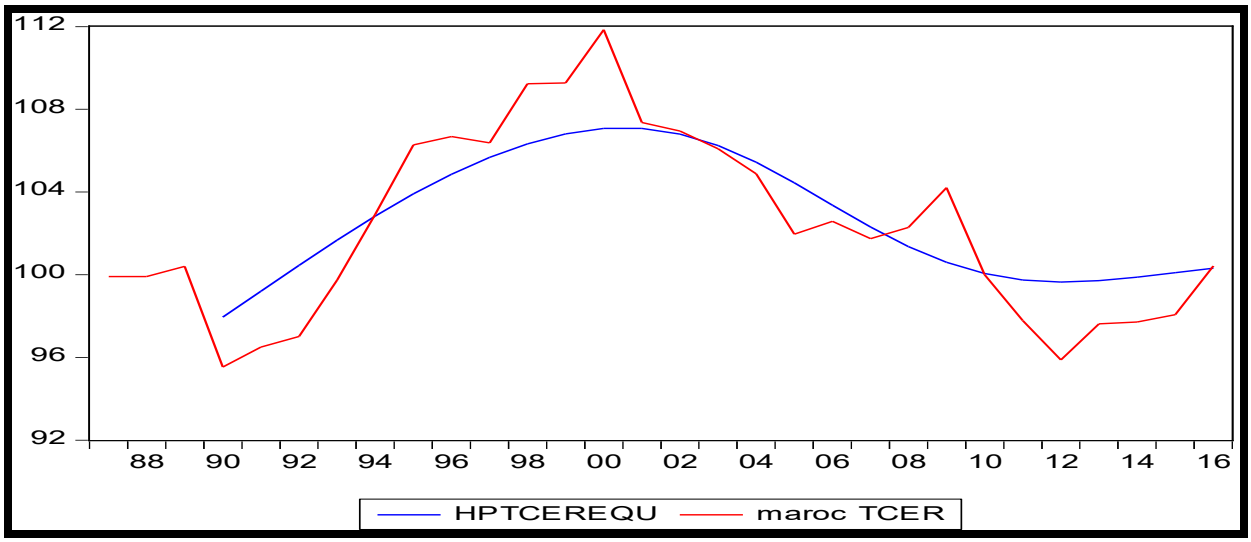


FIGURE 3
OBSERVED REAL EFFECTIVE EXCHANGE RATE (MOROCCO REER) AND FILTERED EQUILIBRIUM REAL EXCHANGE RATE (HPTCEREQUI)

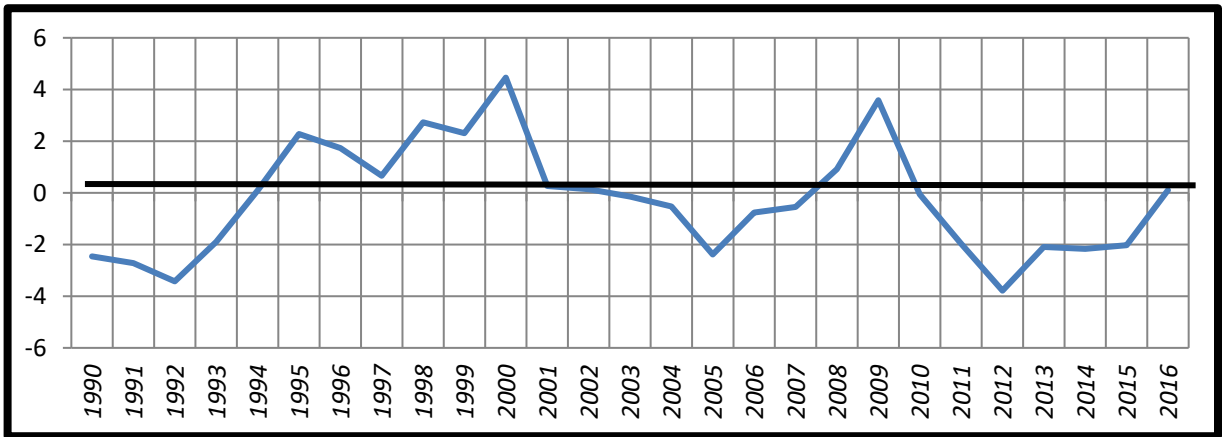


The difference between the observed and estimated values represents the deviations of the exchange rate from its equilibrium (misalignment). The calculation of this misalignment is obtained from the following formula:

$$misalignment = \frac{(Reel\ effective\ \ exchange\ rate - Real\ equilibrium\ exchnage\ rate\ (HP\ Filter))}{Real\ equilibrium\ exchnage\ rate\ (HP\ Filter)} * 100$$

The figure below shows the misalignment phases calculated from the formula.

FIGURE 4
MISALIGNMENT OF THE MOROCCAN DIRHAM (MAD)



Sources: Author's calculations

The 1990-1994 period was characterized by a real undervaluation of[10] the dirham, which is the result of a devaluation of the dirham carried out with a redesign of the basket in 1989. This devaluation occurred after the launching of the structural adjustment program in 1983.

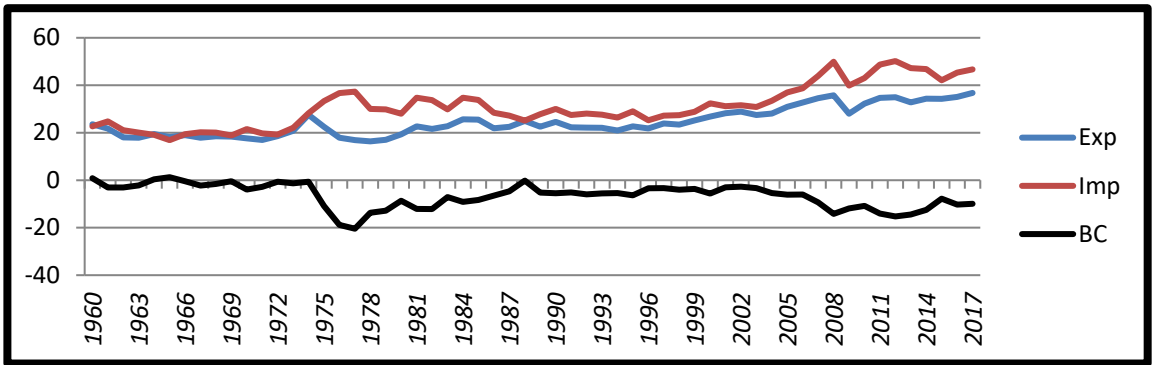
From 1994 to 2000 the dirham was overvalued compared to its equilibrium, but with the advent of the euro, a new revision of the basket was necessary with a devaluation undertaken in 2001 to restore the exchange rate to its equilibrium, this lasted for some time then we see an alternation between undervaluation and overvaluation which reached its peak in 2009 and then fell due to the financial crisis. Since 2010 the dirham has been undervalued but in 2016 (period which coincides with the final preparations for the adoption of the new fluctuation band) it reaches its equilibrium with the beginning of a slight overvaluation.

Periods of misalignment of the Dirham	
Period	Status
1990-1994	Under-evaluation
1994-2000	Overvaluation
2001-2002	Equilibre Equilibrium
2002-2007	Under-evaluation
2008-2010	Overvaluation
2011-2016	Under-evaluation

Exchange Rate Misalignment and Price Competitiveness of the Moroccan Economy

Morocco's economy has a persistent trade balance deficit, which despite the upward trend in exports supported by the liberal export stimulus package adopted since the mid-1990s, has not been able to reabsorbed, since imports are also growing at a very rapid pace and remain dominated by energy and food products.

FIGURE 5
EVOLUTION OF EXPORTS, IMPORTS, AND BALANCE OF TRADE (% OF GDP)

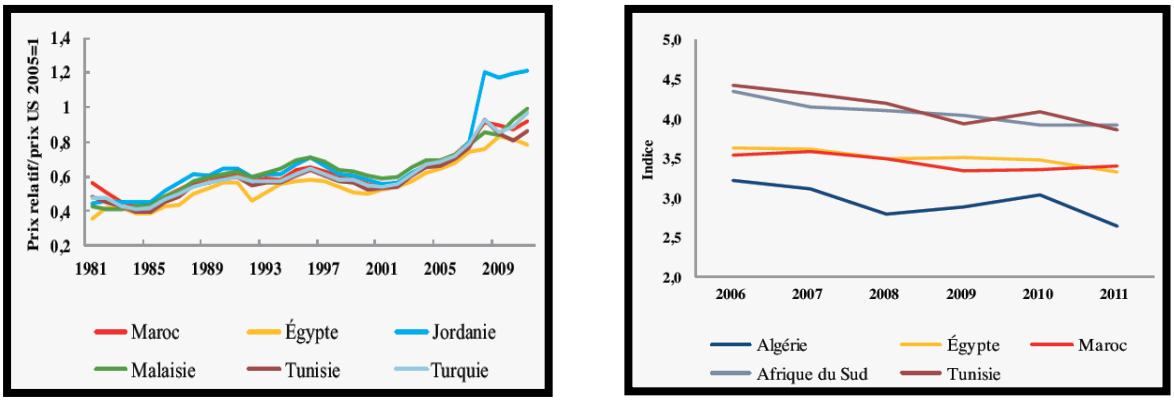


Source: World Bank

Assessing the competitiveness of Moroccan exports on the basis of export prices, which are considered an indicator of competitiveness,[11] raises at first glance a problem of the content of products that are of low quality; moreover, the degree of sophistication of Moroccan exports has not changed significantly[12] since the late 1990s, which indeed corroborates the hypothesis that there is a major problem arising from structural competitiveness.

Evolution of export prices of Morocco and comparator countries

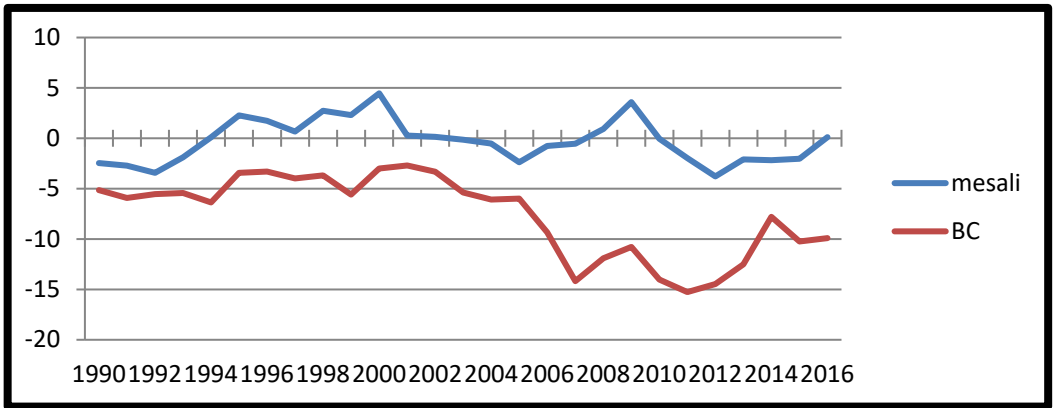
Export Innovation and Sophistication Index



Source: African Development Bank Report. 2015: Diagnosis of economic growth in Morocco

Thus, the question of price competitiveness can be assessed by studying the reaction of the trade balance to the phases of misalignment (undervaluation and overvaluation) of the exchange rate of its equilibrium. Indeed, the analysis of this relationship will allow, on the one hand, to assess the role of the exchange rate in the competitiveness of the Moroccan economy in order to know whether it is dependent on prices or on other rather structural factors, and on the other hand, to assess the exchange rate instrument in the country's economic policy.

FIGURE 6
EVOLUTION OF THE TRADE BALANCE AND MISALIGNMENT OF THE EXCHANGE RATE



Sources: Author's calculations and World Bank

From figure (6) it can be seen that periods of exchange rate undervaluation (1990-1994) and (2002-2007) do not immediately correspond to an improvement in the trade balance deficit except for the period (2011-2016), and periods of overvaluation (1994-2000) and (2008-2010) coincide with improvements in the trade balance deficit. In fact, this misalignment can be explained by a lagged effect of exchange rate misalignment on the trade balance, so the decomposition of this effect is manifested through the upward trends of undervaluation in the periods (1990-1992) and (2002-2005), which could be behind the downward trends in the trade balance deficit observed in the periods (1994-1995) and (2007-2009) respectively. In terms of the most representative periods of overvaluation, the upward trend of overvaluation during the period (1997-1998) is followed by a deterioration of the trade balance in the period (1998-1999), just as the upward trend of overvaluation during the period (2007-2009) is followed by a deterioration of the trade balance deficit in the period (2009-2011), but it should be noted that this period coincides with the 2008 financial crisis that limited the volume of Moroccan exports. However, the beginning of the decline in exchange rate overvaluation from 2009 shows an improvement in the trade balance deficit from 2011, but still not disappearing.

This analysis suggests that exchange rate misalignment can have a lagged effect on the trade balance and consequently on competitiveness in the short term (an undervaluation that improves the trade balance deficit and an overvaluation that worsens it). The exchange rate in Morocco is therefore a valid short-term instrument for influencing Moroccan exports through prices, reflecting the impact of the terms of trade on the exchange rate (previous empirical study), but the correction of the imbalance of the trade balance, which is still in deficit, requires rather the implementation of a long-term structural competitiveness based on a higher productivity, and moreover the absence of the Blassa-Samuelson effect detected in the model above may, in our opinion, allude to the weakness of the productive fabric of the Moroccan economy. However, the enrichment of the study on the relationship between misalignment and the evolution of the trade balance by a causality test (Granger) is desirable to bring more support to the previous analysis, but in our case the implementation of causality is constrained by the insufficiency of observations that could lead to doubtful results.

CONCLUSION

All the results obtained in our study are generally similar to those obtained by Lim and Stein (1995) in their original article on the NATREX model. Thus, the results have made it possible to estimate the equilibrium exchange rate and the phases of misalignment, as well as they show that the rise in the terms of trade index, which is an indicator of economic competitiveness, can have repercussions on the

appreciation of the exchange rate and consequently constrain Moroccan exports. This evidence confirms the importance of the exchange rate as an instrument of price competitiveness and can also be used as an adjustment tool. Moreover, the various competitive devaluations undertaken by the monetary authorities over the last three decades may have had a short-term effect on exports, and this can be seen from the delayed effect of the misalignment of the exchange rate on the evolution of the Moroccan trade balance, but it should be noted on the other hand that the prices of Moroccan exports, which have not changed significantly over the last three decades (thanks to low inflation) with a persistent trade balance deficit, are contributing to another competitiveness problem linked to the structure. Indeed, this idea can be corroborated by the result of the econometric study, which states that the Moroccan economy is devoid of a Blassa-Samuelson effect[13], since Morocco's low productivity fails to influence the exchange rate toward appreciation as intended by the Blassa-Samuelson effect in emerging economies. However, the impact of government spending on the exchange rate toward depreciation also raises a problem of the nature of this spending, which is more oriented toward tradable goods contributing to the increase in imports and thus to the deterioration of the trade balance.

The study also gives us an estimated 4-year duration of return of the real effective exchange rate to its equilibrium (return to equilibrium after a shock), a result that is perfectly in line with the work of Husted and Macdonald (1998) and others[14] that have focused on a set of countries with flexible exchange rate regimes, so it may mean that whatever the type of exchange rate regime (fixed or flexible), the duration of adjustment of the real effective exchange rate (return to equilibrium) may be the same.

Finally, although competitiveness in Morocco can be improved through the exchange rate, which can serve as an instrument of price competitiveness and adjustment in the short term, the long term requires structural competitiveness that can only be achieved through a competitive economic model based on improving productivity and the quality of exportable supply.

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ENDNOTES

1. Positive-base model because it does not compute the equilibrium exchange rate based on the potential of economic fundamentals like the FEER model but rather relies on observed values of the fundamentals. The basic FEER relationship is the financial equilibrium condition given by the unhedged interest rate parity.
2. Guarantees an internal and external macroeconomic equilibrium of the economy, the internal equilibrium requires a level of production that corresponds to full employment and a control of inflation, this equilibrium is achieved when economic activity is at its potential. External equilibrium is defined as the attainment of a position of equilibrium that guarantees equality between the current balance and capital flows or transactions on long-term assets.
3. In the presence of a large economy, both variables are endogenous, because the country has an influence on world interest rates and can affect the general level of prices, on the other hand, if we are in the presence of an average economy, the world interest rate is exogenous and the term of trade is endogenous. Finally, if we have a small economy, both variables are exogenous because the country has no influence on world interest rates and cannot influence the general price level.
4. The bands went from (+0.3%, -0.3%) to (+2.5%, -2.5%).
5. Engle, R. F. and C. W. J. Granger. 1987. 'Cointegration and error correction: representation, estimation and testing'. Econometrica, 55(2), pp. 251-276.
6. Cakrani, E., Resulaj, P. and Kabello, L. K. (2013) 'Government Spending and Real Exchange Rate Case of Albania', European Journal of Sustainable Development, pp. 303-310.
7. The unit value index is based on the data reported by countries that regularly pass UNCTAD's quality controls, supplemented by UNCTAD estimates using the previous year's market values in accordance with the three-digit Standard International Trade Classification as weights. To improve data coverage, particularly for the most recent periods, UNCTAD produces a set of average price indices in the three-digit Standard International Trade Classification version 3 product nomenclature, using UNCTAD merchandise price

statistics from international and national sources. The UNCTAD secretariat then estimates and calculates the unit value indices at the country level, using the current year's recovery values as weights.

8. Narayan, P. K. 2005. Reformulating critical values for the bounds F-statistics approach to cointegration: an application to the tourism demand model for Fiji, Discussion Papers 02/04-Department of Economics Monash University; p 21.
9. Drine, I. and Rault, C. 2005. Long-Term Determinants of Real Exchange Rates for Developing Countries: An International Comparison, Journal of Development Economics, 19(1), pp. 123-150.
10. Result consistent with that found by Lahcen achy for the period 1990-2000 in: Le DH Marocain: Distorsion de change, Dévaluation et Réforme du régime de change.]
11. The African Development Bank. 2015. Diagnosis of economic growth in Morocco. p: 58
12. The African Development Bank. 2015. *Op.cit*. p: 59.
13. Effect that often characterizes emerging countries in a catch-up phase and which stipulates that the increase in productivity in these countries contributes to the appreciation of the exchange rate.
14. MacDonald (1988, 1996); Frankel and Rose (1996); Jorion and Sweeney (1996); Wu (1996)

REFERENCES

Achy, L. (2000). *Le DH Marocain: Distorsion de change, Dévaluation et Réforme du régime de change*. Retrieved from https://www.researchgate.net/profile/Lahcen_Achy/publication/266067652_Le_DH_Marocain_Distorsion_de_change_Devaluation_et_Reforme_du_regime_de_change/links/553d29ca0cf2c415bb0f5952/Le-DH-Marocain-Distorsion-de-change-Devaluation-et-Reforme-du-regime-de-change.pdf

Bouoiyour, J., Marimoutou, V., & Rey, S. (2004). Equilibrium real exchange rate and exchange rate policy at Maroc: A non-parametric approach. *International Economics*, (97), 81–104.

Cakrani, E., Resulaj, P., & Kabello, L.K. (2013). Government Spending and Real Exchange Rate Case of Albania. *European Journal of Sustainable Development*, pp. 303–310.

Dickey, D.A., & Fuller, W.A. (1981). Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root. *Econometrica*, *49*(4), 1057–1079.

Drine, I., & Rault, C. (2005). Long-term determinants of real exchange rates for developing countries: An international comparison. *Journal of Development Economics*, *19*(1), 123–150.

Edwards, S. (1989). *Real Exchange Rates: Devaluation and Adjustment, Exchange Rate Policy in Developing Countries*. MIT Press. Massachusetts, U.S.A.

Engle, R.F., & Granger, C.W.J. (1987). Co-Integration and Error Correction: Representation, Estimation, and Testing. *Econometrica*, *55*(2), 251–276.

Frankel, J.A., & Rose, A.K. (1996). A panel project on purchasing power parity: Mean reversion within and between countries. *Journal of International Economics*. doi: 10.1016/0022-1996(95)01396-2

Haoudi, A., & Rabhi, A. (2020). Taux de change et croissance economique au maroc: Evidence empirique. *Finance et Finance Internatioanle*, *18*(1), 1–29. Retrieved from https://revues.imist.ma/index.php?journal=FFI&page=article&op=view&path%5B%5D=19178

Husted, S., & MacDonald, R. (1998). Monetary-based models of the exchange rate: A panel perspective. *Journal of International Financial Markets, Institutions and Money*, *8*(1), 1–19. doi: 10.1016/S1042-4431(98)00021-3

Jorion, P., & Sweeney, R. (1996). Mean reversion in real exchange rates: Evidence and implications for forecasting. *Journal of International Money and Finance*, *15*, 535–550.

Lim, G.C., & Stein, J.L. (1994). The Dynamics of the Real Exchange Rate and Current Account in a Small Open Economy: Australia, Chapter 3. In *Fundamental Determinants of Exchange Rates* (pp. 85–125). Oxford University Press.

Lim, G.C., & Stein, J.L. (1994). The Natural Real Exchange Rate of the United States Dollar, and Determinants of Capital Flows, Chapter 2. In *Fundamental Determinants of Exchange Rates* (pp 38–84). Oxford University Press.

Luqman, A., & Bashir, F. (2014). Long run Determinants of Real Exchange Rate: An Econometric

Analysis from Pakistan. *Pakistan Journal of Commerce and Social Sciences*, *8*(2), 471–484.
Macdonald, R. (1995). Long-Run Exchange Rate Modeling: A Survey of the Recent Evidence. *International Monetary Fund*, *42*(3), 437–489.
MacDonald, R. (1996). Panel unit root tests and real exchange rates. *Economics Letters*, *50*, 711.
MacDonald, R. (1997). *What determines real exchange rates?: The long and the short of it.* IMf Working paper 97/21.
Macdonald, R. (2002). Modelling the long-run real effective exchange rate of the new zealand dollar. *Australian Economic Papers*, *Special*(July 2000), 519–537.
MacDonlad, R. (1998). *Exchange rates and economic fundamentals: A methodological comparison of BEERs and FEERs*. IMF Working paper n 98/67.
Montiel, P.J., & Serven, L. (2009). *Real Exchange Rates, Saving And Growth: Is There A Link?* World Bank Policy Research Working Paper.
Narayan, P.K. (2005). *Reformulating critical values for the bounds F-statistics approach to cointegration: An application to the tourism demand model for Fiji*. Discussion Papers 02/04- Department of Economics Monash University.
Pesaran, M.H., Shin, Y., & Smith, R.J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, *16*(3), 289–326.
Phillips, P.C.B., & Perron, P. (1988). Testing for a unit root in time series regression. *Biometrika*, *75*, 335–346.
Ragbi, A., & Tounsi, S. (2015). Evaluation du niveau d'equilibre du dirham marocain. *Economic Critique*, *33*, 71–88.
Rey, S. (2009). L'apport du NATREX à la modélisation des taux de change d'équilibre: Théorie et application au dollar canadien. *L'Actualité Economique*, *85*(2), 131–181.
The African Development Bank. (2015). *Diagnosis of economic growth in Morocco.*
Vieira, F.V., & MacDonald, R. (2010). *A panel data investigation of real exchange rate misalignment and growth*. CESIFO Working Paper, no 3061.
Williamson, J. (1983). The Exchange Rate System. *Policy Analysis in International Economics*, *5*. Institute for International Economics, Washington D.C.
Wu, Y. (1996). Are real exchange rates nonstationary? Evidence from a panel-data test. *Journal of Money Credit and Banking*, *28*, 54–63.