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The asymmetric effect of exchange rate fluctuations on economic growth in Morocco: Application of non-linear ARDL approach

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Abstract

Exchange rate changes have a great impact on different macroeconomic variables and in particular on economic growth. This study claims to give a suitable measure of exchange rate fluctuations impact on growth in Morocco. In this study, we employ two techniques; namely Autoregressive distributed lags and non-linear Autoregressive distributed lags to test for possible asymmetric effect of exchange rate on gross domestic product along with the proxies of fiscal and monetary policies (money supply and public expenditures). The results showed the existence of a correlation relationship between variables, whereas, the nonlinear autoregressive distributed lags approach confirmed that there is no asymmetric effect of exchange rate fluctuations on economic growth in Morocco in the short and long run. In addition, we found that week currency hurts growth, while strong currency adds to growth. Besides these, we confirm symmetric impact of exchange rate on economic growth in Morocco and don't find evidence of short and long run asymmetry in the ER variations.

Keywords: asymmetric effect; exchange rate; GDP; NARDL approach; Morocco.

JEL Classification : G15 ; G17 ; C2 ; C51 ; C52.

L'effet asymétrique des fluctuations du taux de change sur la croissance économique au Maroc : Application de l'approche ARDL non linéaire

Résumé

Les variations du taux de change ont un grand impact sur différentes variables macroéconomiques et en particulier sur la croissance économique. Cette étude essaye de donner une mesure appropriée de l'impact des fluctuations du taux de change sur la croissance au Maroc. Dans cette étude, nous utilisons deux techniques, à savoir les autorégressifs à retards distribués et les autorégressifs à retards distribués non linéaires pour tester l'éventuel effet asymétrique du taux de change sur le produit intérieur brut en utilisant les proxies des politiques fiscales et monétaires (la masse monétaire et les dépenses publiques). Les résultats ont montré l'existence d'une relation de corrélation entre les variables, alors que l'approche autorégressive à retards distribués non linéaire a confirmé qu'il n'y a pas d'effet asymétrique des fluctuations du taux de change sur la croissance économique au Maroc à court et à moyen terme. En outre, nous avons constaté que la monnaie faible nuit à la croissance, alors que la monnaie forte y contribue. Par ailleurs, nous confirmons l'impact symétrique du taux de change sur la croissance économique et l'inexistence d'asymétrie dans les variations du taux de change.

Mots clés : effet asymétrique ; taux de change ; PIB ; approche ARDL non linéaire ; Maroc.

Classification JEL : G15 ; G17 ; C2 ; C51 ; C52.

Introduction

The exchange rate is a manifestation to economic agents of the price of the country currency expressed in relation to another country currency, it is the price that allows to evaluate the evolution of the economic situation (Chérif, 2002). This definition suggests that the exchange rate is an important tool for ensuring international transactions between countries. The main characteristic of the exchange rates is that they are in permanent change according to their determinants situation. As a result, a large public in general and policy makers in particular carefully follow the variations of the exchange rates. The challenge for countries is to choose an adequate exchange rate system which will not negatively affect key economic variables as inflation, trade balance and economic growth.

The impact the of exchange rate on economic growth has remained an interesting puzzle in the economic literature especially in developing country like Morocco. The country adopted a new flexible exchange rate regime. This decision has been made by the Moroccan Ministry of Economy and Finance after consulting central bank (BAM). This decision is based on the widening of the fluctuation bands to ±2.5% in relation to a central rate compared with ±0.3% previously. After that in March 2020, the country widened the fluctuation bands of the dirham from ± 2.5% to ± 5% to react to the external shock that was emerging due to the Covid 19 crisis.

Economic growth in Morocco shows some stability, but the economy remains dependent on the agricultural sector and the climate risks. Although it was impacted by the health crisis in 2020, the economy has proven resilient thanks to its diversification and the structural reforms that have been made. In this context, a deterioration in the balance of payments was also expected, but it was not the case, thanks in particular to the decrease in imports associated with the drop in energy prices, and the resilience of foreign remittances.

Several studies and works have focused on the analysis of the relationship between the exchange rate and economic growth in different international context. The objective was to verify the existence of a cointegrating relationship between the two variables and to ensure that this relationship is maintained in time. but few of them have been interested in studying a plausible asymmetric impact of the exchange rate on growth, as the principal objective of our paper.

The impact of exchange on economic growth rate has caught the attention of researchers and professionals of international finance. Although the effect of the exchange rate on economic

growth has been debated by many researchers, the existing empirical literature has not reached consensus on the direction and magnitude of the potential impact. Our contribution will be to try to determine the direction of the impact in the short and long term by using a recent econometric method.

The present study tries to test for possible asymmetric effect of exchange rate on economic growth in a developing country. The study assumes the impact of appreciation of moroccan dirham on growth to be different from depreciation. The study uses a nonlinear autoregressive distributed lags (NARDL) methodology developed by (Shin & al. 2014) to test for the existence of an asymmetric impact of exchange rate variation on GDP in Morocco. This current study provides analysis on asymmetric effect of ER on GDP, and will contribute to the empirical literature with an important analysis, and consequently participate in enlightening the public decision makers concerning the studied phenomenon.

The article is segregated into six sections, not including the introduction and conclusion. Section n ° 2 in general presents the conceptual aspect of the study, the third section tries to give a review of relevant research on the relation between exchange rate and economic growth. The fourth section gives details about the works related to the influence of the exchange rate on economic growth in Morocco. The fifth one presents the materials, methods and results of the study. Finally; section n° 6 presents the results discussion.

1. Conceptual aspect of study

In this study, we used aggregate macroeconomic variables to construct our econometric model. Two principal concepts were used, economic growth which is the endogenous variable is represented by the gross domestic product (GDP) to determine the macroeconomic performance of the country. The Gross Domestic Product (GDP) is an economic indicator that measures the wealth created in a country during a given period. It is the sum of value added (public and private sector). It is used in the literature to express the economic growth of countries.

The second concept is an explanatory variable which is the exchange rate that is defining the manifestation to economic agents of the price of the currency of a country expressed in relation to the currency of another country.

The real effective exchange rate has been used as a proxy for the exchange rate, which synthesizes the price situation of goods and services in one country in relation to another

country. "It makes it possible to identify the evolution of the price competitiveness of one country in relation to another, taking into account both the evolution of the nominal exchange rate and price movements in the two considered countries. (Chérif**,** 2003)**.**

2. Exchange rate and economic growth in the literature

A large literature has been devoted to analyze the impact of the exchange rate on economic growth, several studies have assessed the relationship between exchange rate movements and economic growth, they found controversial results. Tharakan (1999) found that widely fluctuated exchange rate impact negatively economic growth and less volatile exchange rates have a positive impact on exchange rate.

A study in the developing country context carried out by (Toulaboe, 2011**)**, it focuses on the impact of exchange rate misalignments on economic growth, the results show that the exchange rate misalignments are associated with a weak economic growth, the author confirms that the maintaining of exchange rate in the relevant level is important of economic growth, the inappropriate exchange rate may explain the decline in growth observed in developing country.

A study in Chinese context done by (Tang, 2014)**,** investigates the link between exchange rate and economic growth in China using a cointegrated VAR model (CVAR). The results of study show that there are no direct linkages between the RER and economic growth in the long run, the economy has not benefited from the RMB undervaluation. Empirical evidence confirms that the Chinese economic growth is stimulated by exports expansion and inflow of foreign capital.

Razzaque, Bidisha, & Khondker (2017) in their paper which addressed the exchange rate and economic growth in Bangladesh, they used an analytical framework to derive an empirical specification by using cointegration techniques to determine the real response of Bangladesh economic growth to the exchange rate variations. The results suggest that in the long run, a 10% depreciation in the RER is associated with 3,2 % increase in aggregate output. In the short run, contractionary effect is observed, the same magnitude of depreciation generates a 0,05% decrease in GDP.

3. The impact of exchange rate on economic growth in Morocco

Morocco has introduced a wider fluctuations band of its currency (±5%) within a fixed price. Through this, its economy indicates a transition to a flexible exchange rate regime. We

present a brief literature review concerning the different works that have studied the relationship between the exchange rate and economic growth. A study done by (Rabhi & haoudi, 2020) aims to construct a model of economic growth that includes the exchange rate. The empirical analysis is based on the ARDL to cointegration method (AutoRegressive Distributed Lags). The study concludes that an overvaluation of the exchange rate in Morocco has a negative impact on economic growth, whereas, the long run effect didn't show the expected results, which allows us to predict that a plausible depreciation will not stimulate the economic growth in the flexible regime. Moreover, the depreciation in a flexible exchange system will not participate in stimulating competitiveness and reducing the trade balance deficit. Another study carried out by (EL Yamani, Jerry, Qafas, Charef & Saadaoui, 2019**),** in this study the econometric estimation done shows that the effect of the real effective exchange rate on GDP growth is not significant over the period 1988-2017. The authors proposed other alternatives in order to achieve the desired levels of growth through the channel of the industrial sector and investment, which are under the desired levels.

A study done by (Yamani, Qafas, & Jerry, 2021) using another econometric tool concerning links between the exchange rate and economic growth in Morocco using an econometric model with simultaneous equations to reach the purpose. The estimation of the model by the triple ordinary least squares technique shows that the exchange rate affects significantly the economic growth, the exports, imports and FDI (foreign direct investment), are the transmission channels of exchange rate variations on growth.

As we have observed, most of the empirical studies carried out in Morocco have confirmed the existence of a correlation between the exchange rate and economic growth. however, few of papers and works were interested in verifying the existence of an asymmetric effect of the variation of the exchange rate on GDP, this issue will be the core of our work.

following this review of theoretical and empirical literature, we have been informed by the application of a more flexible econometric technique in the form of NARDL (Nonlinear Autoregressive Distributed Lags) for many macroeconomic relationships. This method is more convenient for estimating the dynamic and asymmetric impact of the variables. In this paper we used both ARDL and Nonlinear ARDL to test for the existence of asymmetry in the short and long term of the impact of exchange rate variations on economic growth in Moroccan context.

4. Materials and methods

To trace if the real exchange rate has an impact on Moroccan GDP (gross domestic product) and to test for possible asymmetric effect of exchange rate on economic growth, we estimate an autoregressive distributed lags model. This model belongs to the category of dynamic models that allow to capture the variables effects over time (adjustment delay, anticipations, etc.).

The ARDL model is used to test the existence of long-term relationships in small sample sizes. The ARDL model makes it possible to test the relationships between variables with different orders of integration, the general model (linear functional form) can be written as follow:

$$GDP = f\ (\ ER, GEX, BM) \qquad (1)$$

$$\ln GDP_t = a + b \ln ER_t + c \ln GEX_t + d \ln BM_t + \varepsilon_t \qquad (2)$$

With GDP is the gross domestic product in Morocco, ER is the real effective exchange rate which represents the real effective value of the national currency, BM (broad money) is the money supply (the monetary aggregate M_3) used to represent monetary policy, GEX are the government's public expenditures as a measure of fiscal policy (see Appendix 1) for variables definitions and data sources.

To study both the short- and long-term effects of the explanatory variables (ER, GEX, BM) on economic growth, using the ARDL model, we can write equation (1) as follow:

$$\begin{aligned}\Delta\ ln\ GDP_t\ =\ \alpha\ +\ \sum_{i=1}^{p1} \beta_{1i}\ \Delta\ ln\ GDP_{t-i} + \sum_{i=0}^{p2} \beta_{2i}\ \Delta \ln ER_{t-i} + \sum_{i=0}^{P3} \beta_{3i}\ \ \Delta \ln GEX_{t-i} \\ + \sum_{i=0}^{P4} \beta_{4i}\ \Delta \ln BM_{t-i}\ + \lambda_1\ ln\ GDP_{t-i} +\ \lambda_2\ ln\ ER_{t-i} +\ \lambda_3\ ln\ GEX_{t-i} \\ +\ \lambda_4\ ln\ BM_{t-i}\ +\ \varepsilon_t \qquad (3)\end{aligned}$$

With Δ express the operator of the first difference; α is a constant; $\boldsymbol{\beta_{ji}}$ represents the vectors of coefficients of short-term dynamic, while $\boldsymbol{\lambda_j}$ are long-term coefficients of explanatory variables, and ε_t represents the error term (white noise); **p** and **q** represents lags order of ARDL [1]. All the variables were transformed into logarithmic form. This specification allows to avoid heteroskedasticity problems.

Although; equation (3) allows to study short- and long-run effects between the different variables; it becomes irrelevant when these relationships are non-linear and/or asymmetric. To estimate and test if the exchange rate (real exchange effective rate) has a symmetric or

[1] it is suggested to include a maximum of 4 delays (quarterly data).

asymmetric effect on GDP, the NARDL model (of Shin & al, 2014) is used. the $\Delta \ln ER_i^+$ constituted to represent positive changes, the negative variations of the exchange rate are denoted $\Delta \ln ER_i^-$. Two time series are developed, the first represents the positive variations, denoted POS_t and the second includes negative variations, denoted NEG_t.. Nonlinear autoregressive distributed lags to cointegration model uses positive and negative partial summative decompositions to allow the detection of asymmetric in the short- and long-term effects. The equation of positive and negative partial sums, i.e ER_t^+ and ER_t^- (increases and decreases variations respectively) can be written as follow:

$$POS_t = \sum_{i=t}^{t} \Delta \ln ER_i^+ = \sum_{i=0}^{t} \text{Max}\ (\Delta\, ER_i\ , 0) \qquad (4)$$

$$NEG_t = \sum_{i=t}^{t} \Delta \ln ER_i^- = \sum_{i=0}^{t} \text{Min}\ (\Delta\, ER_i\ , 0) \qquad (5)$$

Equation (3) is extended to the general NARDL model expressed as follow:

$$\begin{aligned}\Delta \ln PIB_t = \alpha + \sum_{i=1}^{p1} \beta_{1i} \Delta \ln PIB_{t-i} + \sum_{i=0}^{p2} \beta_{2i} \Delta \ln POS_{t-i} + \sum_{i=0}^{p3} \beta_{3i} \Delta \ln NEG_{t-i} \\ + \sum_{i=0}^{p4} \beta_{4i} \Delta \ln DP_{t-i} + \sum_{i=0}^{p=} \beta_{5i} \Delta \ln M_{t-i} + \lambda_1 \ln PIB_{t-1} + \lambda_2 \ln POS_{t-1} \\ + \lambda_3 \ln NEG_{t-1} + \lambda_4 \ln DP_{t-1} + \lambda_5 \ln M_{t-1} + \varepsilon_t \qquad (6)\end{aligned}$$

The specification of equation (6) allows the three possibilities to be tested: asymmetries can occur in the short term and the long term, or only in the long term, or only in the short term[2]. These assumptions are grouped in the table below:

Table 1: The null and alternate hypotheses for short-run and long-run asymmetry.

Hypothesis	*Short-term Asymmetry*	*Long-term Asymmetry*
Nulle	$\boldsymbol{\beta_{2i} = \beta_{3i}}$	$\boldsymbol{\lambda_{2i} = \lambda_{3i}}$
Alternative	$\boldsymbol{\beta_{2i} \neq \beta_{3i}}$	$\boldsymbol{\lambda_{2i} \neq \lambda_{3i}}$

Source: author

The asymmetry in the short term can be established if only the numbers of lags related to the ΔPOS_{t-i} is not equal to that of ΔNEG_{t-i} and can be only determined by observation. In addition, if the null hypothesis is rejected by the Wald test, long-run asymmetry can be proven in the case where the Wald test rejects the null hypothesis associated with the standardized coefficients. (Table 1 presents the formulation of the hypotheses). Since the NARDL model incorporates an additional explanatory variable compared to the ARDL model; therefore Shin & al. (2014) recommend to consider the POSt and NEGt variables as one variable.

4.1. Statistical characteristics of data

The table (2) below presents the descriptive statistics for variables. It can be seen that the mean of all variables is positive and very close in value, except for exchange rate. This

[2] For more details, see Shin, yu, and Grennwood-Nimmo (2011).

implies that their distributions are symmetric and indicates a lower variability of the data. It is also noted that the sub-study variables are normally distributed (Pob. of Jarque-Berra > 5%), except for government expenditures and GDP.

Table 2: Statistical characteristic of data

Variables	GDP	ER	BM	GEX
Observations	*67*	*67*	*67*	*67*
Minimum	*-3.329*	*-2.467*	*-1.148*	*-73.137*
Maximum	*3.714*	*2.038*	*5.559*	*69.928*
Mean	*1.041*	*-0.079*	*1.987*	*1.658*
Q3	*2.090*	*0.738*	*2.865*	*17.912*
Q1	*0.408*	*-0.937*	*1.127*	*-11.006*
Standard Deviation	*1.596*	*1.371*	*1.371*	*22.113*
Skewness	*-0.927*	*-0.010*	*0.331*	*0.075*
Kurtosis	*0.380*	*-1.039*	*-0.033*	*1.446*
Test (p-value)	*0.004*	*0.261*	*0.524*	*0.029*

Source: EViews output

Q1 and Q3 represent the first and third quartile respectively. B_{ij} is the normality test based on skewness and kurtosis following a Chi-squared distribution with two degrees of freedom. Skewness assesses the extent to which a variable distribution is asymmetric. The exchange rate is approximately symmetric while Skewness coefficient is between -0.5 and 0.5. The GDP is moderately skewed because the coefficient is between -0.5 and -1.

The Kurtosis gives an idea about the height or the sharpness of the central peak, relative to that of a standard bell curve. The GDP and ER kurtosis coefficients indicate a relatively flattened distribution since they are close to 0.

4.2. Stationarity tests

A time series whose mean and/or variance varies over time is non-stationary, this non-stationarity (deterministic or stochastic), if it is not treated, it can produce spurious regression. The concept of stationarity is important in the modeling of time series, the spurious regression problem shows that a linear regression with non-stationary variables is not valid.

To verify the stationarity or non-stationarityy (existence of a unit root) of variables time series, we use the Dickey-Fuller augmented ADF test which is efficient in the case of error autocorrelation, and the Phillippe-Perron/PP test which allows us to take into account the presence of the autocorrelation and heteroskedasticity. The results of these tests are grouped in (table 3) below:

Table 3: unit root test

	ADF		PP T		KPSS	
Variables	Level	First diff	Level	First diff	Level	First diff
GDP	-2.504	-3.635*	-6.66*	-21.905**	0.093	0.099
ER	-1.807	-8.644**	-1.785	-8.643**	0.791***	0.210
GEX	-1.164	-13.947**	-3.160*	-25.865**	1.011***	0.088
BM	-3.255*	-1.697*	0.084	-6.130**	0.154**	0.159

**

significant at 1% * significant at 5% for ADF & PP test
** significant at 5%; *** significant at 1% for KPSS test

Source: Eviews

-For ADF and PP Tests:

H_0: time series has a unit root (non-stationary).

H_1: time series doesn't have a unit root (stationary).

Since the plus value of the statistic < 5%. We reject H0. the series are stationary.

-For KPSS:

H_0: time series doesn't have a unit root.

H_1: time series has a unit root.

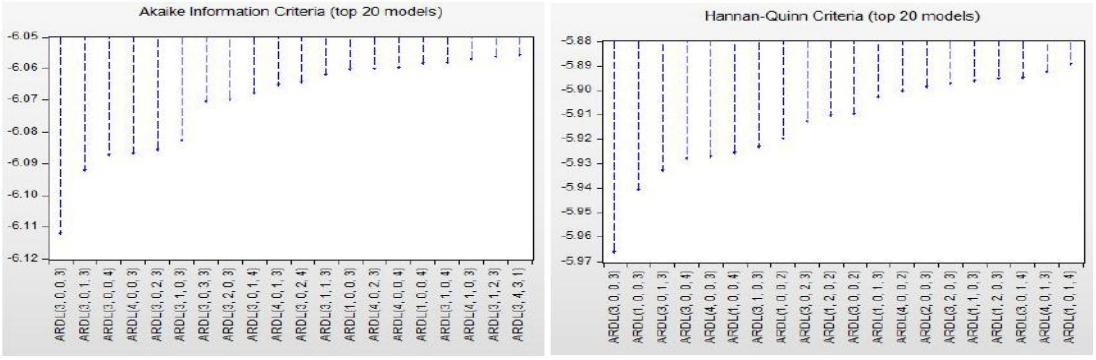
Since the plus value of the statistic is > 5%, we reject H_1. The series are stationary.

Regarding The ADF test, the GDP, ER and GEX series are integrated of order 1 (stationary after the first difference), while the broad money (BM) remains stationary in level (without differentiation). In reference to the KPSS Test, GDP and ER are stationary both at level and first difference, while GEX and BM are only stationary at the first difference. The series are integrated at different orders according to the Phillippe-Perron and KPSS tests.

4.3. Optimal lag and estimation of ARDL and NARDL models

To determine the lags optimal number to be considered in the ARDL model, we used the information criteria of (AIC) and (Hannan-Quinn), i.e., the criterion which provides statistically significant results with the smallest number of parameters. The optimal number of lags to be retained is shown in *Figure (1*) below.

Figure 1 – Optimal model with information criteria graphs



Source: *EViews*

As for any dynamic model, we will use the information criteria (AIC and HQ) to determine the optimal lag (p* or q*); an optimal lag is the one for which the model offers the minimum value of one of the criteria listed. These selected criteria are Akaike (AIC) and Hannan and Quinn (HQ). The ARDL model (3,0,0,3) is the most optimal among the 19 others presented, because it offers the smallest values of (AIC) and (Hannan-Quinn**).**

4.4. Co-integration test

According to the ARDL model, a long-term relationship between the variables of the model exists when the null hypothesis of absence of co-integration is rejected[3]. This hypothesis is tested by a Fisher test where the calculated value of the statistic is compared to the values of simulated critic values by (Pesaran & al, 2001)**.** These authors provide two values representing upper and lower limits, respectively. The hypothesis of no co-integration is rejected when the calculated value of the Fisher F-statistic is higher than the upper limit.

Table 4: Cointegration results test of Pearson and al. (2001).

Test Statistic	Value	Significance	I(0)	I(1)
ARDL Model				
F-statistic	7.871041	10%	3.47	4.45
k	3	5%	4.01	5.07
		1%	5.17	6.36
NARDL Model				
F-statistic	14.07263	10%	3.03	4.06
k	4	5%	3.47	4.57
		1%	4.4	5.72

Source: EViwes

The results of the bounds test to cointegration presented in (Table 4) confirm the existence of a co-integrating relationship between the series studied (the value of F-stat is superior to the

[3] See Pearson et al. (2001)

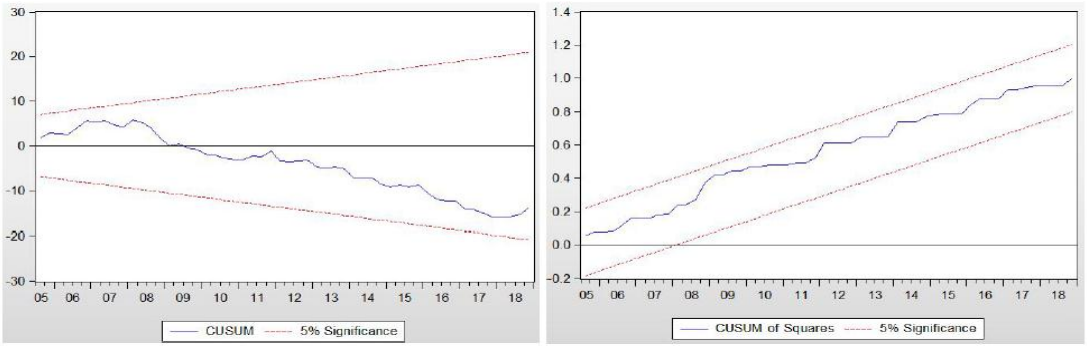
upper bound for both models). So, the null hypothesis of no cointegration can be rejected. Even if there is a cointegrating relationship between the variables, the result will be without importance if the parameters are not stable along the study period. Instability in a parameter appears due to structural breaks, so it is important to check if the parameters are stable to make the inference very reliable. As the next step in our analysis, we evaluate the stability of the model.

4.5. Model stabilization study

To confirm or infirm the instability of the model, we use the CUSUM and CUSUM Square tests. These two tests are complementary and are based on the recursive residue approach. This makes it possible to detect the breakpoints of the model.

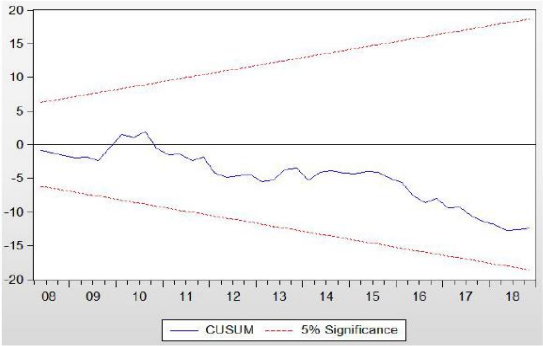
According to these two tests, the stability of the model depends on the stability of the graph of the reduced cumulative sums of the recursive residues for the case of the CUSUM test, and of the graph of the sums of squares of the recursive residuals for the case of the CUSUM Square. The stability of these graphs is judged from their position relative to the corridor because if the plot crosses the confidence region, at a given date, the assumption of stability of the model parameters is not retained and we consider this date as a break date.

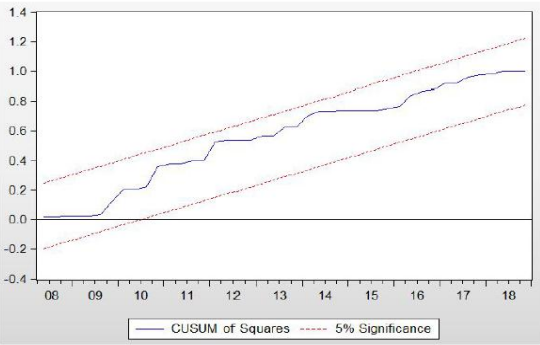
Figure 2– CUSUM and CUSUM square test (ARDL model).



Source: EViews

Figure 3– CUSUM and CUSUM square test (NARDL model).





Source: EViews

The results of figure (2) and (3) show that the stability condition is satisfied for both the ARDL and NARDL models, since the graphs of the CUSUM and CUSUMSQ statistics are all strictly within the critical limits or the confidence range.

4.6. ARDL versus NARDL model estimation

4.6.1 Long-term coefficients and short-term dynamics of the ARD model

Table 5: Short-term estimations of the ARDL model

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
LGDP(-1)	0.288772	0.122506	2.357204	0.0221
LGDP(-2)	0.167865	0.127051	1.321243	0.1920
LGDP(-3)	-0.302362	0.119074	-2.539289	0.0140
LER	-0.176971	0.085953	-2.058918	0.0443
LBM	0.104594	0.025239	4.144155	0.0001
LGEX	-0.012636	0.010245	-1.233314	0.2228
LGEX(-1)	-0.023842	0.010613	-2.246404	0.0288
LGEX(-2)	0.037992	0.009988	3.803923	0.0004
LGEX(-3)	0.024334	0.010253	2.373417	0.0212

Source: EViews

Table 6: Short-term estimation of the ARDL model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LER	-0.209253	0.101188	-2.067962	0.0434
LBM	0.123674	0.022003	5.620882	0.0000
LGEX	0.030563	0.025179	1.213869	0.2301

Source: EViews

The short-term and long-term estimates results table (5) and (6) show the complex dynamics that may exist between changes in GDP and changes in the explanatory variables (see appendix 3) (A.R.D.L estimation model). Most of the coefficients estimated for the long term are statistically significant. In the short term:

The lagged values (past values) of GDP have positive effects on growth, these effects are rather being reversed in the third quarter, the real exchange rate did not show the expected effect (positive) constituting an obstacle to economic growth. an ER increase of 1% decelerates the growth by 0.0176% in the short term. The increase in the money supply (M3) translates into an increase in growth, Government expenditures have a negative effect on economic growth in the short run. This effect is is not proportional; a 1% increase in GEX decelerates growth by 0.023% in the short run. These effects are rather reversed over time, in one year and two quarters approximatively, the effect of public expenditures on growth becomes positive.

Table (6) provides the estimated long-term coefficients or elasticities. As in the short run, the effects of the exchange rate and money supply on economic growth remain unchanged in the long run. The impact of the exchange rate on economic growth remains negative in both the long term and short term. On the other hand, public expenditures show the expected (positive) effects in long term with a decrease in significance.

4.6.2 Long-term coefficients and short-term dynamics of the NARDL model

Table 7: short term estimation of NARDL Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LGDP(-1)	0.228467	0.106135	2.152609	0.0370
LGDP(-2)	0.001555	0.117453	0.013242	0.9895
LGDP(-3)	-0.479117	0.125907	-3.805326	0.0004
LER_POS	-0.352639	0.302005	-1.167661	0.2494
LER_POS(-1)	0.772121	0.349065	2.211966	0.0323
LER_POS(-2)	-0.026843	0.360157	-0.074533	0.9409
LER_POS(-3)	-0.984051	0.320011	-3.075059	0.0037
LER_NEG	-0.067418	0.275280	-0.244906	0.8077
LER_NEG(-1)	-0.587624	0.372843	-1.576064	0.1223
LER_NEG(-2)	-0.270856	0.403845	-0.670693	0.5060
LER_NEG(-3)	1.012170	0.363469	2.784745	0.0079
LER_NEG(-4)	-0.842561	0.208721	-4.036772	0.0002
LBM	0.215227	0.131329	1.638840	0.1085
LBM(-1)	-0.150952	0.203398	-0.742149	0.4620
LBM(-2)	-0.218383	0.203145	-1.075010	0.2884
LBM(-3)	0.353337	0.125414	2.817361	0.0073
LGEX	-0.025258	0.011700	-2.158899	0.0365
LGEX(-1)	-0.040376	0.011518	-3.505541	0.0011

Table 8: Long term estimation of NARDL model

Variable	Coefficient	Std. Error	t-Statistic	Prob.

LER_POS	-0.473474	0.216263	-2.189344	0.0340
LER_NEG	-0.605470	0.105715	-5.727400	0.0000
LBM	0.159499	0.016783	9.503465	0.0000
LGEX	-0.052546	0.016271	-3.229428	0.0024

As can be seen in table (7) and according to the results shown in appendix 3 (for N.A.R.D.L model estimations), the lagged GDP coefficients remain unchanged in terms of significance and signs than those of the ARDL model estimation. We observed that only the lagged ER+ coefficients are significant, the effect of ER+ on growth is positive after the first quarter, these effects become negative after the third quarter. ER- variable lagged by three quarters has a significant and positive coefficient, which means that a 1% depreciation of the real exchange rate translates into a 1.012% decrease in GDP after 3 quarters.

The variable (BM) or (M3) has lagged effects, but only significant effects in the third quarter, a 1% increase in (BM) leads to an acceleration of GDP by 0.353% after the third quarter. as in the ARDL estimation, public expenditures are associated with a negative and significant coefficient. In the long-term, the variables coefficients are significant at 5%, the reactions of the variables (M3) and (GEX) remain the same as those of the short run; the estimated coefficients of ER+ and ER- show a negative sign, i.e., positive changes in ER decelerate growth, while negative changes increase GDP in the long run.

From this modeling, we can conclude that these results are not fully consistent with economic reality. probably due to the fact that economic growth economic growth can be explained by other factors that we didn't take into account in this work; (investment and interest rate inflation rate…); which makes this model, even if it is presented with satisfactory statistical qualities, unable to reflect the real behavior of variables in the economic reality.

4.7. Exchange rate asymmetry test

Concerning the exchange rate asymmetry, we analyze the null hypothesis of symmetry versus the alternative of asymmetry based on the Wald statistic.

The results of Wald test are grouped in the table 9 below:

Table 9: Asymmetric test of exchange rate in short and long term

Wald Test for Short Run Asymmetry			
Test Statistic	Value	df	Probability
t-statistic	0.493808	43	0.6240
F-statistic	0.243847	(1, 43)	0.6240
Chi-square	0.243847	1	0.6214
Wald Test for Long Run Asymmetry			
Test Statistic	Value	df	Probability
t-statistic	-0.559722	43	0.5786
F-statistic	0.313288	(1, 43)	0.5786
Chi-square	0.313288	1	0.5757

Wald tests for the short and long run indicate the absence of asymmetry for the real exchange rate variable (since the p-values > 5%), then we reject the hypothesis of the presence of the asymmetry i.e. positive changes in the real exchange rate have the same effects as negative changes.

This may be explained by the fact that, despite the relationship between the two variables, the low volatility of the real exchange rate generates an asymmetric effect that is not significant (not captured).

5. Results discussion

The economic reality shows that the exchange rate fluctuations affect macroeconomic variables, including economic growth through, exports and investment flows. The results we found will be compared with those found in the Asian context by Hussin & al (2019). In their article entitled "An analysis of the asymmetric impact of exchange rate changes on GDP in Pakistan: application of non-linear ARDL". The authors used the NARDL model and found an asymmetric effect of the exchange rate on GDP, the study used government expenditures and money supply as approximate of variables representing fiscal and monetary policies in Pakistan. According to the study, the results of the linear ARDL estimation were poor, while those of the non-linear ARDL were significant and provide richer information on the question discussed. This may support our choice to use non-linear model in this current study. The authors confirm the asymmetric impact of the exchange rate on GDP growth in Pakistan and find evidence of short-run, long-run and adjustment asymmetries, from the results, it is evident that devaluation has a negative impact on GDP and revaluation has a positive impact on GDP in Pakistan. Negative impact can be associated with persistent trade deficit and contractionary effect is supported by (Bahmani & Mohammadian, 2017**)** in their study. In

contrast to these results, we did not find any asymmetry, i.e., the up variations have the same effect as the down variations despite the existence of correlation between the variables.

In Ghana, a study carried out by (Mwinlaaru & Kwesi Ofori, 2017) using the ARDL cointegration estimation technique, the study found that real exchange rate and economic growth are cointegrated. The results suggest that real exchange rate exerts a positive and statistically significant effect on economic growth in both the long-run and short run. It is recommended by the authors to ensure exchange rate stability in the Ghanaian economy to boost economic growth.

Haoudi & Rabhi, (2020) found in Moroccan context by an empirical study using the ARDL cointegration method that the short-term impact of the exchange rate on economic growth is significant after one period, but it does not have an effect in the long run. This allow to annihilate the expected effect of price competitiveness in the long term. This observation has been confirmed by many studies in Morocco which confirm that the absorption of the trade balance deficit by a devaluation policy is not practical and achievable.

Conclusion

The results of the study showed that the correlation between GDP and the exchange rate exists, a cointegration relationship between GDP and exchange rate was confirmed bay tests. The objective of the study is tow pranged, firstly to test for the existence of a correlation relationship between the exchange rate and economic growth. Secondly to apply more flexible NARDL model of (Shin & al, 2014) to test for the existence of an asymmetric effect of appreciation and depreciation of the exchange rate in the short and long term along with the proxies of fiscal and monetary policies. Both ARDL and NARDL models were applied to the quarterly date from 20020 to 2018. The results of NARDL model were rich and bring more information to the studied issue. Besides these, we infirm the asymmetric effect of ER on GDP in Morocco and we confirm the same impact of positives variations of exchange rate and negative variations on GDP.

Finally, to create in order to achieve economic growth in Morocco and achieve the sustainable development goals, the monetary authorities are called upon to move towards a stronger currency and to manage the exchange rate in a way that neutralizes its deleterious effects on growth.

Future research is urged to work on larger samples, to introduce more explanatory variables in the model to represent the economic reality of the variables under study.

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Appendices

APPENDIX 1: Variables definitions, and data sou

Variables	Definition	Source
(RGDP)	*Real Gross Domestic Product* (measured at constant prices)	**the high commissioner of the plan directorate of statistics**
REER (reel effective exchange rate	a weighted sum of exchange rates with various trading partners and competitors.	**statistics of the central bank of morocco**
BM (the money supply)	The quantity of money in circulation in Morocco	**statistics of the central bank of morocco**
GEX(gouvernement expenditures)	general government spending.	**BKAM's quarterly reports, including those of the international research directorate;**

APPENDIX 2: Estimation for ARDL (the short term)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LGDP(-1)	0.288772	0.122506	2.357204	0.0221
LGDP(-2)	0.167865	0.127051	1.321243	0.1920
LGDP(-3)	-0.302362	0.119074	-2.539289	0.0140
LER	-0.176971	0.085953	-2.058918	0.0443
LBM	0.104594	0.025239	4.144155	0.0001
LGEX	-0.012636	0.010245	-1.233314	0.2228
LGEX(-1)	-0.023842	0.010613	-2.246404	0.0288
LGEX(-2)	0.037992	0.009988	3.803923	0.0004
LGEX(-3)	0.024334	0.010253	2.373417	0.0212
C	9.172627	1.665130	5.508656	0.0000
@TREND	0.005763	0.001117	5.157602	0.0000

R-squared	0.997447	Mean dependent var	12.13168
Adjusted R-squared	0.996974	S.D. dependent var	0.190786
S.E. of regression	0.010495	Akaike info criterion	-6.122853
Sum squared resid	0.005947	Schwarz criterion	-5.754880
Log likelihood	209.9927	Hannan-Quinn criter.	-5.977664
F-statistic	2109.755	Durbin-Watson stat	1.954491
Prob(F-statistic)	0.000000		

APPENDIX 3: Results of estimation of long-term coefficients (ARDL model).

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LER	-0.209253	0.101188	-2.067962	0.0434
LBM	0.123674	0.022003	5.620882	0.0000
LGEX	0.030563	0.025179	1.213869	0.2301

EC = LGDP - (-0.2093*LER + 0.1237*LBM + 0.0306*LGEX)

APPENDIX 4: Estimation of NARDL model in the long term

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LGDP(-1)	0.228467	0.106135	2.152609	0.0370
LGDP(-2)	0.001555	0.117453	0.013242	0.9895
LGDP(-3)	-0.479117	0.125907	-3.805326	0.0004
LER_POS	-0.352639	0.302005	-1.167661	0.2494
LER_POS(-1)	0.772121	0.349065	2.211966	0.0323
LER_POS(-2)	-0.026843	0.360157	-0.074533	0.9409
LER_POS(-3)	-0.984051	0.320011	-3.075059	0.0037
LER_NEG	-0.067418	0.275280	-0.244906	0.8077
LER_NEG(-1)	-0.587624	0.372843	-1.576064	0.1223
LER_NEG(-2)	-0.270856	0.403845	-0.670693	0.5060
LER_NEG(-3)	1.012170	0.363469	2.784745	0.0079
LER_NEG(-4)	-0.842561	0.208721	-4.036772	0.0002
LBM	0.215227	0.131329	1.638840	0.1085
LBM(-1)	-0.150952	0.203398	-0.742149	0.4620
LBM(-2)	-0.218383	0.203145	-1.075010	0.2884
LBM(-3)	0.353337	0.125414	2.817361	0.0073
LGEX	-0.025258	0.011700	-2.158899	0.0365
LGEX(-1)	-0.040376	0.011518	-3.505541	0.0011
C	12.81929	1.782559	7.191507	0.0000
@TREND	0.007639	0.001960	3.896913	0.0003

R-squared	0.998199	Mean dependent var	12.14275
Adjusted R-squared	0.997403	S.D. dependent var	0.183103
S.E. of regression	0.009332	Akaike info criterion	-6.257796
Sum squared resid	0.003745	Schwarz criterion	-5.577436
Log likelihood	217.1206	Hannan-Quinn criter.	-5.990207
F-statistic	1254.050	Durbin-Watson stat	2.155311
Prob(F-statistic)	0.000000		