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THE IMPACT OF THE EXCHANGE RATE ON BALANCE OF PAYMENTS IN ALGERIA: AN ARDL MODEL APPROACH

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Abstract: This study aims at examining the extent to which the exchange rate impacts on balance of payments in Algeria (BoP) during the period 1980-2019, using the Auto-Regressive Distributed Lag (ARDL) model and the Error Correction Model (ECM). This approach tests the presence of a long-run relationship between the variables.A set of relevant variables, in addition to exchange rate, were used to include real interest rate, oil price, GDP per capita, Government expenditure, and inflation rate, based on previous studies of the subject. The results indicate the existance of a long-run equilibrium relationship between the dependent and independent variables. The exchange rate has a negative impact on the balance of payments in the short-run.

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1. Introduction

The current debates over currency impacts are comprehensive in their approach to the matter. The exchange rate particularly affects the balance of payments (BoP)

(Current Account (CA) and Capital and Financial Account (CFA)), inflation, interest rate, transfers, foreign direct investment(FDI), money supply, unemployment, tourism, and government operations (public debt and budget deficit) and some other macroeconomic variables. Nevertheless, the exchange rate has a significant impact on the balance of payments (BoP) and other macroeconomic variables.The exchange rate variable is one of the macroeconomic variables that affect not only the economic performance of a particular country, but also the economic performance of other countries around the

The currency basically refers to the price of country's exchange rate in terms of another foreign currency. Several countries typically operate under different exchange rate regimes. However, in Algeria, both floating and fixed exchange rate systems have been adopted. In theory, the balance of payments (BoP) should be zero, meaning that assets (credits) and liabilities (debits) should be equal In practice, this is barely the case, not only for Algeria but also world-wide. The exchange rate has therefore an impact on each BoP rate, namely, currency, capital, and financial accounts and their subdivisions.

Based on the above, the following main question can be asked:

To what extent does the exchange rate affect the balance of payments in Algeria?

Research importance:

The importance of this research lies in the fact that increasing interest in the exchange rate issue, particularly from the point of view of the discrepancy in the exchange rate policy adopted by the Algerian government, moving between floatation and centralization.

Research objectives:

The objectives of the research were to explore the extent to which the exchange rate policy impacts on the balance of payments (BoP) andthe manner in which the effect of some macroeconomic variables,including; interest rate, inflation rate, and GDP is reflected inthe country's BoP.

Data sources:

In order to perform econometric analysis, data were collected from a variety of sources, including:

- Annual Reports of the central bank of Algeria (CBA) compiled for several years;
- National Bureau of Statistics (NBS);
- World Bank's Open Data;
- OPEC; and
- Interest ratesstatistics obtained from Perspective Monde website.

2. Previous studies

Several studies have examined the relationship between exchange rates (ExR) and balance of payments (BoP), and can be summarized as:

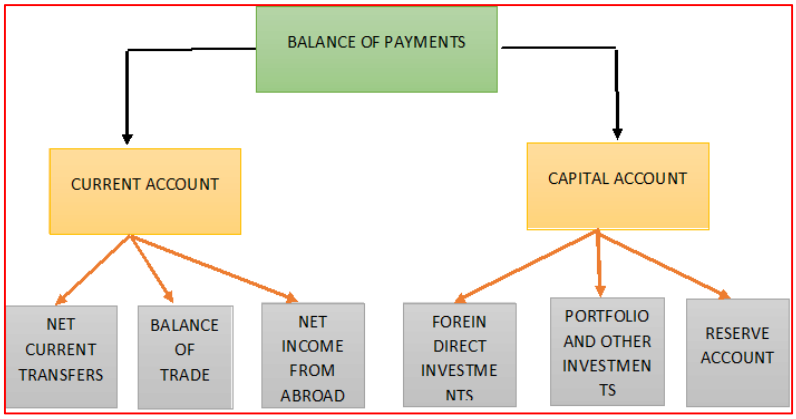
- Ahmad et al., (2014) (Nawaz, Rizwan, Khoso, & Palwishah, 2014)conducted a study on the impact of exchange rate on balance of payment in Pakistan. The study aimed to ascertain the volatility of exchange rates and its tendency on balance of payment. Monthly data was collected of Exchange rate and Balance of Payment from the official website of State Bank of Pakistan (SBP) and was comprised of seven-year-period, from January 2007 to October 2013. In order to achieve the purpose of the study, various test such as unit root, ARDL and Granger causality test were employed. The authors have deduced that there is a significant and positive relation between ExR and BoP, and thus opine that exchange ratestability may create a positive environment by encouraging the investment, and this can improves balance of payment.
- Lyoboyi et al., (2014) (Iyoboyi, Muftau, & McMillan, 2014) conducted an econometric study examining the impact of exchange rate depreciation on the balance of payments (BoP) in Nigeria over the period 1961–2012 by the use of an error correction model. The authors have found that there is a long-run equilibrium relationship between BoP, ExR and a set of relevantvariables (including, GE, GDP, M2, IR and TOP).The overall study results concluded that the policy implication is that exchange rate depreciation which has been preponderant in Nigeria since the mid-1980s has not been very useful in promoting the country's positive BoP.
- Priyatharsiny's (2017) (Priyatharsiny, 2017) study entitled "*The Impact Of Exchange Rate on Balance of Payment: An Econometric Investigation In Sri Lanka*" over the period of 1978-2016 used an approach to determine the number of cointegrating relationship between variables by means of Johansen cointegration and tried to examine short and long-run relationships, where a set of variables (CA, ExR, rGDP, rIR, CPI, and TOPI) were used.Both Trace and Maximum
- Eigenvalue tests were identified two co-integrating relations.The study results showed that there is a positive and significant a positive and significant adjustment towards the long-run equilibrium between ExR and BoP in the State of Sri Lanka.
- Odili (2014) (Odili, 2014) econometric investigation into the Exchange Rate and Balance of Payments in Nigeria over the period 1971–2012, using an AutoRegressive Distributed Lag/ARDL modeling technique to examine short and long-run relationships between the variables and the extent to which Marshall-Lerner (M-L) condition is fulfilled. The study results found that there is a positive and significant long-run equilibrium relationship between BoP and ExR, and that there isa positive and insignificant short run relationship between the variables. The study also found that devaluation leads to an improvement in the balance of payments and thus the Marshal-Lerner condition is satisfied in Nigeria.

3. Theoretical approach to exchange rate and balance of payments

3.1. Balance of payments (BoP) is defined as a record in which economic transactions between the residents and the non-residents of a particular country are recorded, during a fixed period, usually annually. It is defined also (Josette, 1990) as the record of all commercial and financial transactions that take place between the country and the outside world; meaning that it is a record of the State's rights and obligations towards the outside world.

3.2. Balance of payments (BoP) components: As today's world has witnessed extreme development and stock markets ease investment, the idea has changed and the balance of payment (BoP) consists of two components:

Figure 1. Balance of payment (BoP) components



Source: Prepared by the authors.

Current Account (CA); records of a country's imports and exports of goods and services and unilateral transfers and all financial flowsto and from the economy, and then we find that CA consists of two sub-groups:

1. Trade Balance: encompasses all commercial operations, which are included two sub-accounts, namely:

a. Commodity Balance: contains import and export of commodities; and

b. Service Scale: contains services that take place between countries, such as: transport services, work visas, etc.

2. Unilateral transfer: involves one way debit and credit operations, meaning that it is used for a one country only, and then other unilateral accounts are created for the rest of the world that a given countryis dealt with.

Capital Account (CapA); a record of the net-flows of capital in different nations, which leads to the establishment of real creditors and debtors for financial transactions.

3.3. Factors affecting balance of payments (BoP): The BoP curve shows at which points the balance of payments is at equilibrium.In other words, BoP Curve describes combinations of output and interest rates that ensure balance of payments financing, which means that net export that affects aggregate output must be equal to net capital outflow. The increase in imports will inevitably lead to disequilibrium in the BoP; and the decrease in interest rates will maintain equilibrium in the capital flows. However, based on capital movement extent, capital movement will have greater or smaller slope; the greater the moves, the greater the curvature.

The BoP curve represents the combinations of income (Y) and the interest rate (i) that yield balance of payments equilibrium. The balance of payments include both the current account (CA) and capital account (CapA).

The balance of trade (BoT) equals the value of a country's exports and the value of a country's imports. As mentioned earlier, a deterioration in BoT value is associated with an increase in income, while an appreciation in BoT value is accompanied by an increase in exchange rate.

The capital account's balance records the capital flows if there is a rapid movement of capital; i.e., i = i * if not the latter depends on the difference between Return on Investment (RoI) in the national territory (at the rate i) and investing in currency abroad (at the rate i*).

Once the BoP curve is derived, there is an important thing needs to be taken into account about how to use it. Any point above the BoP curve will mean a balance of payments surplus. Any points below the BOP curve will mean a balance of payments deficit. This is important since, depending on where we are, different things may affect the interest rates.Therefore, the equation can be given as: BP=BOT(y،e)+BCAPA(i-i*). For simplicity, assume that the foreign interest rate is negligible. Then, the equation BP=BOT(Y،e)+BCAPA(i) will become BOP=X(e)-λY+f(i).

The balance of trade equilibrium (BTE) is always compensated by input/output of capital, where; BOT + BCAPA = 0.

If a country has a trade surplus or positive trade balance,the country therefore pays to finance pay for the rest of the world that needs financing because its trade balance with the local state shows a deficit (zero-sum game), and accordingly, there is an inflow of capital. Conversely, if a country has a negativetrade balance, we observe the presence of capital inflows (financing the trade deficit) in the balance of payments equilibrium BP = 0, i.e.;

BOP = BOT(Y،e) + BCAPA(i) = 0;

BOP = X(e) − hY + f(i) = 0; and

$$Y = \frac{f}{h} h\, i + \frac{X}{h}$$

Hence, we obtain an equation for the BP curve, which plots the combinations of interest rate (i) and income (Y) that consistent with the BoP. Where, $\frac{f}{h}$is the slope of BoP function. That is,the higher it is,the more the BP curve is horizontal, and this implies that the curve tends to be horizontal as the movement of capital increases.

3.4. IS-LM-BoP model

In the IS-LM-BoP modelone must make distinction between perfect and imperfect capital mobility, but also between fixed and floating exchange rates regimes in a certain country. For each of these cases, we will see what happens when both an expansionary monetary and fiscal policy are applied to the economy. We will first review Mundell's model, which deals with perfect mobility. Then, we will analyse Fleming's imperfect mobility model.

4. Methods and tool

As the goal of this work is to analyze and measure the effect of exchange rate on the balance of payments in Algeria, over the period 1980-2019, the expected relationship between a number of independent variable sets will be analyzed with the dependent variable BoP(in $ billion).

4.1. Model building:

In light of the models available in literature, we have formulated a useful study model as follows:

BoP= (EXRT, GDP, GS, INF, OIL, RIR) …..... (1)

Where,

BOP: Balance of payments (in $ billion);

TCR: USD/DZD real exchange rate;

GS: Government expenditure (% of GDP);

INF: Inflation rate (%);

GDP: GDP per capita (in $ billion/Capita);

OIL: Crude Oil Price (in $/Barrel) ; and

RIR: Real interest rate, which is the difference between the nominal interest rate and inflation.

4.1.1. Nature of the relationship between variables:

Variable values have been converted to standard values in order to unify variable units to be homogeneous at the starting point. In addition, in order to visualize the relationship between these variables and check if it seems linear or nonlinear, a Ramsey's RESET test was conducted as can be seen from the following Table 1:

Table 1. outlines Ramsey's RESET test for the determination of the nature of relationship among variables

Ramsey RESET test using powers of the fitted values of bp1.

Ho: model has no omitted variables.

F(3, 30) = 5.58.

Prob > F = 0.0037<0.05.

Source: Table prepared by the author using STATA v.13.0

Based on the results, the authors note that prob-F = 0.0037 <0.05, which means that relationship between the dependent variable and the independent variables is linear. To estimate equation 1 in the long-run (LR), the authors apply the Auto-Regressive Distributed Lag (ARDL) cointegration technique, which was proposed by Pesaran and Shin (1999) and developed by Pesaran et al. (2001). What characterizes this approach is that it does not require the time series variables under study to be of the same order of integration, i.e.; static at the same level, either I(1) or I(0), or a mixture of both I(0) and I(1) time series variables, provided that the time series variables under study are not static in the second difference I(2). Also, the ARDL approach is differentiated by a set of characteristics that distinguish it from other standard methods (Nikolaos, 2011), most importantly:

- The ability to allow the explanatory variables in the model to adopt different time lags, and this not available in other standard models;
- The suitability of using small sample sizes, and the preventability of efficient and unbiased capability-auto-correlation that are resulted fromthe used test;
- The stationarity time series of any orderof integration, and the possibility of reducing short and long-run equations to a single equation; and
- The simplicity in the estimation of cointegration between the studied time series using the ordinary least squares (OLS) method after determining the maximum time lag.

The ARDL approach relies on the following steps:

- Testing for stability (Clive & Granger, 1969) (Damodar N, 2004) (Soo khoon & Koi Nyen , 2014) in a time-series: Granger causality test (Granger, 1969),and unit root and stationarity tests;

- Testing for Cointegration: Bounds Testing Approach (Soo & Koi Nyen, 2014); and
- Estimating Long-Run (LR) model and Error Correction Mechanism (ECM) approach using ARDL technique (Gujarati, 2003).

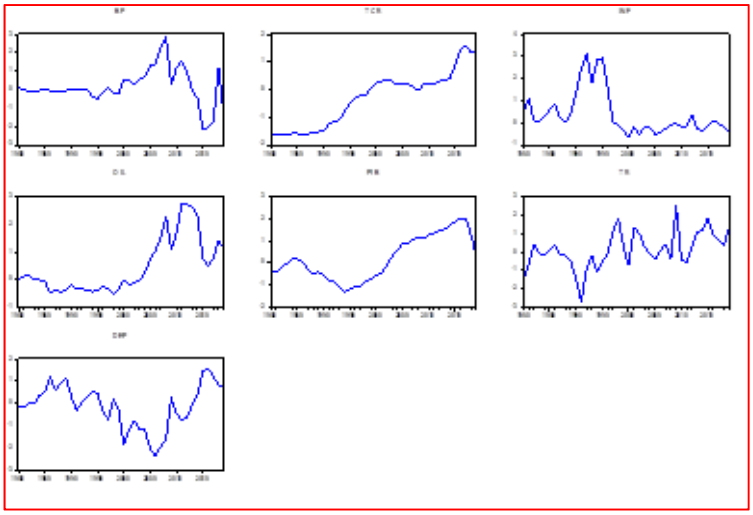
4.2. Study results

The econometric analysis of data showed many results, which can be divided into several elements and ordered as follows:

4.2.1. Statistical analysis of time series data (outcome variables):

The first step of a times series process is to draw sample observations of the variables under study to recognize the general trends. **Error! Reference source not found.** below, represents a group of time series variables. It appears from the variance values that the variables are far more insignificant, which initially explains the absence of a relationship integration among the variables.

Figure 2 . Graphical representation of the research variables



Source: prepared by the author using Eviews10.

As it can be clearly seen from Figure 3, surpluses in the balance of payments that were recorded during the first nine months of 2000, total of nearly $ 7.57 billion, amounted to the same level in 2003, and increased to a higher level of $ 36.99 billion represents nearly five times the BoP surpluses in 2008 due to an increase in fuel prices. However, the period 2008 to 2012 witnessed economic turmoil due to external shocks and exchange rate fluctuations as the balance

retreated to a deficit of 26.03 billion dollars in 2016 due to the negative balance of trade (BoT) and the depletion Algeria's foreign exchange reserves, especially after the drop in oil prices during the mid-2014.

Regarding the exchange rate (ExR) criterion, fluctuations of Algerian dinar has seen a marked decline during the period (1996-2000) with a rate ranged from 54.75 to 75.26DZD /per USD in 2000, before the value of the DZD reduced due to acontinuous devaluation of 72.74 % over the implementation period of Structural Adjustment Program (SAP).

The period 2001-2014 witnessed a relative stability of the DZD exchange rate against the USD. The Algerian dinar exchange rate falls within a limited range from 60 to 80 DZ dinars per U.S. dollar, this increase is primarily due to the significant improvement of the Algeria's Balance of Payments (BoP), which was brought about by the environment of higher oil prices and the Bank of Algeria policies to stabilize the dinar's real effective exchange rate in parallel with monetary policy implementation that is aimed at maintaining low and stable inflation level (3%) within a managed float regime.

The price of crude oil has experienced several sharp fluctuations since the early '70s oil shock, during which the price topped $30 per barrel, and followed by a severe economic recession in the 1981s, where there is an imbalance between supply and demand.

In the first half of 1986, there was a sudden drop in the per-barrel price of oil to around $13 a barrel, which had dramatically eroded the Algerian economy. In fact, the socio-economic crisis that followed the 1986 drop in oil prices led directly to a crisis affecting the external payments of the country due to a fall in oil prices, which was accompanied by a real depreciation ofthe US dollar that represented the country's hard currency earnings generated almost exclusively from hydrocarbons.

With regard to inflation rate, the above **Error! Reference source not found.** shows that there is an inflation-destabilizing rate. Rather, the inflation rate fluctuates up-and-down from year-to-year and from period-to-period. The 1980s saw some of the highest rates of inflation reached 14.6%, 10.5% and 12.3%, as in 1982, 1985 and 1986, respectively; due to several reasons, the most important of which are: (i) the seven 7 financial and structural imbalances in public sector, which required restructuration and independence; (ii) the expansionary monetary policy to stabilize budget deficits caused by a fall in oil prices; and (iii) the Algeria's currency devaluation against the US dollar as well as the recent decline in economic growth rates.

Furthermore, the 1990-95 period was marked by a sharp rise in inflation rate, along with an acceleration of monetary and financial sector reforms imposed by the international monetary institutions that was likely to bring a significant drop in the value of the dinar and prices liberalization associated with subsidy removal on

most commodities.During the period 2001-2016, inflation rates were almost stable, as the rate of inflation during this period reached nearly 4.1% due to the Bank's monetary policy that was aimed at stabilizing prices and maintaining an inflation rate within the range of 3%. However, the years 2009, 2012 and 2016 witnessed high inflation rates due to the high prices of major food commodities in world markets.

In this context, it's worth to note that a rise in nominal interest rates over inflation rates to have a positive real interest rate leads to an increase in inflation rate. This is because the rise in nominal interest rates on loans raises the borrowing costs of institutions, and accordingly costs of production, which pushes these institutions to raise prices in order to make a profit, thus liberalizing interest rates leads to an increase in inflation rates instead of encouraging savings and investments.

Seeing opportunity, the Algerian monetary authorities (AMA) began in 1990 a process that gradually lead to liberalizing interest rates, notably in view of stimulating savings, mobilizing the maximum amount of financial savings, and eventually obtaining positive real interest rates.

4.2.2. Descriptive analysis of variables:

This analysis aims to examine the time series statistical tests, including Jarque-Bera (JB) normality test, test forcalculating the mean, median, and mode, and the test for skewness, kurtosis statistics using the normal distribution as described on Table 2 below:

Table 2. Descriptive statistics for the studied variables

	BP	TCR	INF	OIL	PIB	TR	DEP
Mean	0.150100	-0.314244	0.382052	0.459138	0.215168	0.110769	-0.129500
Median	0.000000	0.000000	0.000000	6.03E-17	0.000000	0.000000	0.000000
Maximum	2.881602	1.571713	3.152965	2.752016	2.009589	2.481294	1.563311
Minimum	-2.170791	-1.624310	-0.656614	-0.528429	-1.299347	-2.718332	-2.398048
Std. Dev.	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
Skewness	0.117878	0.056091	1.566343	1.084675	0.297575	-0.116426	-0.455506
Kurtosis	4.231945	1.926448	4.404171	2.935827	1.808676	3.672334	2.559738
Jarque-Bera	2.622117	1.941830	19.64237	7.850327	2.955762	0.843755	1.706291
Probability	0.269535	0.378736	0.000054	0.019739	0.228121	0.655814	0.426073
Sum	6.004002	-12.56978	15.28209	18.36552	8.606733	4.430774	-5.180006
Sum Sq. Dev.	39.00000	39.00000	39.00000	39.00000	39.00000	39.00000	39.00000
Observations	40	40	40	40	40	40	40

Source: Prepared by the author using Eviews10.

4.2.3. Correlation matrix between variables:

In order to calculate the normally distributed random variables, a correlation matrix of input variables is given as follows:

Table 3. Correlation matrix between input variables

	BP	TCR	INF	OIL	PIB	TR	DEP
BP	1,000	-0,076	-0,193	0,368	0,063	-0,246	-0,765
TCR	-0,076	1,000	-0,463	0,530	0,627	0,532	-0,117
INF	-0,193	-0,463	1,000	-0,419	-0,563	-0,540	0,280
OIL	0,368	0,530	-0,419	1,000	0,803	0,241	-0,227
PIB	0,063	0,627	-0,563	0,803	1,000	0,407	0,012
TR	-0,246	0,532	-0,540	0,241	0,407	1,000	0,163
DEP	-0,765	-0,117	0,280	-0,227	0,012	0,163	1,000

Source: Prepared by the author using Eviews10.

As can be seen in Table 3, it is found that there is a negative correlation between real exchange rate and balance of payments as the increase in the price of domestic currency in terms of foreign currency makes domestic exports relatively more expensive, with the result that the balance of trade is negative, which indicates a balance of payments deficit (BP = X-M + BK). Also, there is a negative correlation between inflation rate and balance of payments, as an increase in domestic prices leads to an increase in demand for foreign goods (imports), and thereby enlarges the country's trade balance deficit (X-M).Moreover, there is evidence here of a direct correlation between oil prices and balance of payments, as the rise in oil prices on the global markets leads to an increase in the country's revenues from exports. Additionally, high interest rates ensure a significant inflow of capital and a rise in exchange rate, which makes domestic exports relatively more expensive and imports cheaper, and accordingly leads to a deficit in the current account.

4.3. Stationarity test (PP Test)

After performing Phillips-Perron (PP) test, results were reported in the estimation results Table 4 below.

What can be drawn from the results of stability testing using PPT for Unit Roots based on ARIMA model, the real interest rate is at zero, and is hence fairly stable. For the rest of the variable, the dependent variable BoP, and the independent variable sets; USD/DZD real exchange rate, Government Expenditure (% of GDP), Inflation rate (%),GDP per capita (in $ billion/Capita), and Crude Oil Price (in $/Barrel), are not static at the same level and have a different order of integration. However, the time series variables are static after the point when the first difference was made; i. e., stationary in the first difference I(1).

Table 4. Study of variants stationarity using PP

		At Level						
		BP	TCR	INF	OIL	PIB	TR	DEP
With Constant	t-Statistic	-2.7353	-0.0269	-1.9263	-1.3379	-1.2393	-3.9730	-1.9584
	Prob.	***0.0773***	***0.9502***	***0.3172***	***0.6022***	***0.6476***	***0.0038***	***0.3033***
	decision	*	n0	n0	n0	n0	***	n0
With Constant & Trend	t-Statistic	-2.6317	-1.9369	-2.2917	-2.0734	-1.4326	-4.5896	-1.8129
	Prob.	***0.2693***	***0.6163***	***0.4284***	***0.5439***	***0.8352***	***0.0038***	***0.6792***
	decision	n0	n0	n0	n0	n0	***	n0
Without Constant & Trend	t-Statistic	-2.7615	-0.9577	-1.8794	-1.0560	-1.1701	-3.9386	-1.9984
	Prob.	***0.0070***	***0.2962***	***0.0581***	***0.2577***	***0.2167***	***0.0002***	***0.0449***
	decision	***	n0	*	n0	n0	***	**
	At First Difference							
		d(BP)	d(TCR)	d(INF)	d(OIL)	d(PIB)	d(TR)	d(DEP)
With Constant	t-Statistic	-7.8197	-3.7521	-5.6718	-5.4986	-1.2588	-22.5557	-6.1486
	Prob.	***0.0000***	***0.0070***	***0.0000***	***0.0000***	***0.6385***	***0.0001***	***0.0000***
	decision	***	***	***	***	n0	***	***
With Constant & Trend	t-Statistic	-7.8389	-3.7042	-5.5872	-5.4199	-1.1017	-21.9246	-6.2042
	Prob.	***0.0000***	***0.0342***	***0.0003***	***0.0004***	***0.9155***	***0.0000***	***0.0000***
	decision	***	**	***	***	n0	***	***
Without Constant & Trend	t-Statistic	-7.9398	-3.2844	-5.7301	-5.5650	-1.4248	-14.4099	-6.2323
	Prob.	***0.0000***	***0.0017***	***0.0000***	***0.0000***	***0.1413***	***0.0000***	***0.0000***
	decision	***	***	***	***	n0	***	***

Source: Prepared by the author using Eviews10.

4.4. Degree of integration of the variables:

The purpose (Belloumi, 2013) of stability testing is to ensure that the degree of integration of the variables is not in the second difference I(2) for avoiding estimating errors. The presence of I(2) variables does not allow us to interpret the F-stat provided by Pesaran et al. (2001). The following Table 5 summarizes the results:

Table 5. Degree of integration of variables

Degree of integration	Stationarity at first difference	Stationarity at level	variables
I(1)	stationary	Not stationary	BP
I(1)	stationary	Not stationary	TCR
I(1)	stationary	Not stationary	INF
I(1)	stationary	Not stationary	OIL
I(1)	stationary	Not stationary	PIB
I(0)	Not stationary	stationary	TR
I(1)	stationary	Not stationary	DEP

4.5. Determination of lag length (ARDL-based Approach) :

As long as the independent variables are a mixture of both I(0) and I(1) static series (Emeka & Aham Kelvin , 2016), the authors can employ the autoregressive distributed lag (ARDL) bounds testing technique. But before that, the lag length of each variable must be determined by ARDL bounds testing procedure according to the lagged values of the dependent variable (max lag of y) and the lagged values of the independent variables (max lag of x). Testing results are summarized in the following Table 6:

Table 6. Determination of lag length (optimal model selection)

	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6	MODEL 7
max lag x	4	4	4	4	4	2	2
max lag y	4	0	1	2	3	2	1
ardl	4.4.4.4.4.4.4	1.0.0.0.0.0.0	4.1.0.1.1.0.1	2.0.0.2.1.0.2	2.3.2.3.3.3.2	2.0.0.2.1.1.1	2.1.0.1.1.0.1
sc	-1.45	1.93	1.105	0.909	0.662	0.872	1.264
R2	0.99	0.73	0.92	0.93	0.97	0.93	0.89
prob-F	0.19	0.000	0.000	0.0000	0.0000	0.000	0.000
BOUND	Ok	Ok	Oui	Oui	Oui	Oui	Oui
normalité	0.50	0.000**	0.41	0.91	0.86	0.90	0.41
LM1	NO*	0.37	0.21	0.12	0.0007	0.044*	0.02*
LM2	NO*	0.63	0.32	0.068	0.003	0.021*	0.035*
Q-stat	NO*	Ok	Ok	Ok	NO*	Ok	Ok
ARCH		0.43	0.53	0.96	0.76	0.70	0.01*
CUSUM		Ok	Ok	Ok	Ok	Ok	Ok
CUSUM SQUARED		96--18	05--18	02--17	Ok	03--17	01--18
Validity of the model	**unacceptable**	**unacceptable**	**acceptable**	**acceptable**	**unacceptable**	**unacceptable**	**unacceptable**

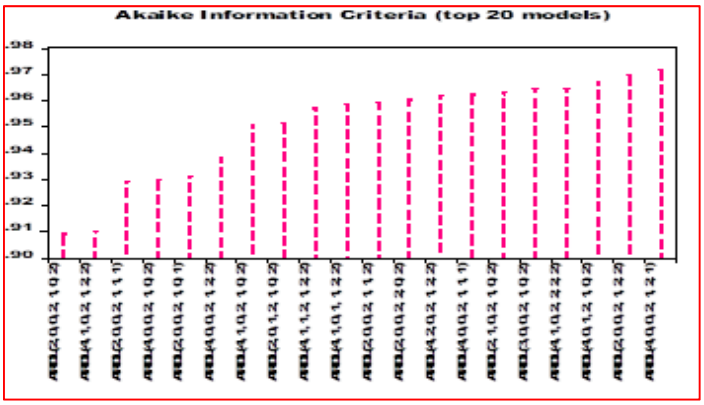
** Statistically inappropriate modelling approach

Source: Prepared by the author using Eviews10 outputs.

The results (Cf. Table 6) can be summarized as follows: (i) ARDL bounds tests were performed using different lags; (ii) Models that do not meet the specification of modelling integrity (normal distribution of residuals, stability of residuals,

correlation of residuals, and nonuniformity error) have been cancelled; (iii) After cancelling the process, the optimum model is chosen from the remaining models depending on the lowest SC value (0.909); and (iv) The chosen model is highlighted in the frame and matches ardl (2.0.0.2.1.0.2) model, as shown in the following **Error! Reference source not found.**

Figure 3. Optimal ARDL (2.0.0.2.1.0.2) model



Source: Prepared by the author using Eviews10 outputs.

As can be seen from Figure 4, it appears that the lowest value of the Akaike Information Criterion (AIC) scoresis 0.909, and is directly proportional to ARDL (2.0.0.2.1.0.2) model.

4.6. Estimation of ARDL model

After testing stability and making sure that the variables are a mixture of both I(0) and I(1) static series, as well as choosing the optimal ardl model according to the lowest criterion value, we can therefore estimate the ARDL (2.0.0.2.1.0.2) model. The results are summarized in the Table 7 below.

Following the estimation results generated from ardl (2.0.0.2.1.0.2) model, it is found that interest rate adversely affects balance of payments by -0.0511 units, as a rise in interest rate by one unit leads to a decrease in BoP by 0.0511 units, due to the fact that higher interest rates tend to increase capital flows and thereby, increase exchange rate, which makes domestic exports relatively more expensive and imports cheaper, and thus leads to a current account deficit.

Results also found that there is an adverse impact of real exchange rate on the balance of payments by -0.148097 units, since the high exchange rate of domestic currency against the foreign currency makes domestic products relatively more expensive, causing the balance of trade to become negative, and therefore definitely indicating balance of payments deficit.

Table 7. Estimation of ARDL (2.0.0.2.1.0.2) Model

Dependent Variable: BP				
Method: ARDL				
Date: 12/23/20 Time: 16:09				
Sample (adjusted): 1982 2019				
Included observations: 38 after adjustments				
Maximum dependent lags: 4 (Automatic selection)				
Model selection method: Akaike info criterion (AIC)				
Dynamic regressors (2 lags, automatic): TCR INF OIL PIB TR DEP				
Fixed regressors: C				
Number of models evalulated: 2916				
Selected Model: ARDL(2, 0, 0, 2, 1, 0, 2)				
Note: final equation sample is larger than selection sample				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
BP(-1)	-0.557182	0.177725	-3.135086	0.0045
BP(-2)	0.674784	0.182421	3.699047	0.0011
TCR	-0.148097	0.118752	-1.247113	0.2244
INF	-0.077097	0.112415	-0.685825	0.4994
OIL	1.221923	0.193809	6.304775	0.0000
OIL(-1)	-0.314085	0.329791	-0.952376	0.3504
OIL(-2)	-1.179472	0.294672	-4.002656	0.0005
PIB	-1.045718	0.334448	-3.126696	0.0046
PIB(-1)	1.261247	0.323674	3.896652	0.0007
TR	-0.051154	0.155483	-0.329004	0.7450
DEP	0.103269	0.206376	0.500394	0.6214
DEP(-1)	-0.517120	0.211444	-2.445656	0.0222
DEP(-2)	-0.195370	0.171568	-1.138734	0.2661
C	0.069059	0.120018	0.575405	0.5704
R-squared	0.933839	Mean dependent var		0.155402
Adjusted R-squared	0.898001	S.D. dependent var		1.026338
S.E. of regression	0.327784	Akaike info criterion		0.884384
Sum squared resid	2.578612	Schwarz criterion		1.487705
Log likelihood	-2.803301	Hannan-Quinn criter.		1.099041
F-statistic	26.05770	Durbin-Watson stat		2.245629
Prob(F-statistic)	0.000000			

Source: Prepared by the author using Eviews10 outputs.

Those results further show that inflation rate has an inverse correlation with balance of payments, as referred to earlier,by -0.077 unit, because an increase in domestic prices would lead to an increase in demand for foreign goods (imports), and would in turn result in a trade balance deficit.

While recorded in the Table 7, the results moreover indicate that there is a positive and direct correlation between the per-barrel price of oil and balance of payments by 1.22 unit, since oil is the primary source of revenues and contributes around 97% of Algeria's total exports, which currently permit a positive trade balance.

Additionally, the coefficient of determination (R2 = 0.93) implies that 93% of the variation in the dependent variable y is explained by the independent variable x. The Fisher equation (Prob> F^f = 0.000) implies that the model is statistically appropriate, and, eventually, the value of Durbin-Watson's statistic (dw = 2.24) indicates that there is no autocorrelation between errors.

4.7. ARDL bounds (2.0.0.2.1.0.2) test

For the purpose of testing the existence of co-integration between the dependent and the independent variables, we will perform bounds test using the F-statistic as shown in Table 8 below:

Table 8. ARDL bounds testing

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	$I_{(0)}$	$I_{(1)}$
F-statistic	**7.539268**	10%	1.99	2.94
k	6	5%	2.27	3.28
		2.5%	2.55	3.61
		1%	2.88	3.99

Source: Prepared by the author using Eviews10 outputs.

As can be noticed from Table 8 above that show the test results of bounds testing for cointegration critical value bounds of the F statistic, the upper critical values of the F distribution for F-Stat tocompare (M. Hashem , Yongcheol , & Richard , 2001) bothI(0) and I(1) levels revealed the following:

- F-Stat>I(1);
- F-Stat> I(0); and
- I(0)<F-Stat<I(1).

Where,

If the F-Stat is greater than the upper band I(1), there's cointegration; if it is less than the lower bound I(0), there's no cointegration; and if it falls within I(0) and I(1), there is inconclusiveness. The values of F-stat=7.53>I(1)= 2.94, 3.28,3.61, 3.99,thus, it can be reasonably concluded that there exists a co-integrating relationship between the dependent variable y and the independent variable x.

4.8. VECM-ARDL approach

After bounds testing has shown that there exists a co-integrating relationship between the variables, we will now try to find if there is a possibility to correct

error and move from the short-run to the long-run (Jonas KIBALA , 2018) using the error correction mechanism C (1), as shown in the following Table 9:

Table 9. Testing for error correction and long-run relationship

Conditional Error Correction Regression				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.069059	0.120018	0.575405	0.5704
BP(-1)*	-0.882398	0.187603	-4.703541	0.0001
TCR**	-0.148097	0.118752	-1.247113	0.2244
TR**	-0.051154	0.155483	-0.329004	0.7450
PIB(-1)	0.215529	0.158380	1.360828	0.1862
OIL(-1)	-0.271635	0.179190	-1.515906	0.1426
INF**	-0.077097	0.112415	-0.685825	0.4994
DEP(-1)	-0.609221	0.172293	-3.535957	0.0017
D(BP(-1))	-0.674784	0.182421	-3.699047	0.0011
D(PIB)	-1.045718	0.334448	-3.126696	0.0046
D(OIL)	1.221923	0.193809	6.304775	0.0000
D(OIL(-1))	1.179472	0.294672	4.002656	0.0005
D(DEP)	0.103269	0.206376	0.500394	0.6214
D(DEP(-1))	0.195370	0.171568	1.138734	0.2661
Lon run				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
TCR	-0.167834	0.124543	-1.347600	0.1904
TR	-0.057972	0.173718	-0.333714	0.7415
PIB	0.244253	0.204561	1.194039	0.2441
OIL	-0.307837	0.249484	-1.233896	0.2292
INF	-0.087372	0.126014	-0.693354	0.4947
DEP	-0.690416	0.115594	-5.972773	0.0000
C	0.078263	0.140424	0.557330	0.5825

Source: Prepared by the author using Eviews10 outputs.

Following the results of ARDL-ECM-based approach, it is clear that the error correction term C (1) = -0.882 is negative and significant, indicating the existence of a long-run relationship between the dependent and independent variables, meaning that the occurrence of any shock in the dependent variable in period t-1 will be adjusted by 88.2% in period t, that is to say, the balance of Payments (BoP) will need 1 / 0.882 = 1.13 year to return to its equilibrium level after each shock that occurs randomly in time.

The long-run equilibrium relationship is interpreted by the equation:

EC=BP-(-0.1678*TCR-0.0580*TR+0.2443*PIB-0.3078*OIL-0.0874*INF-0.6904*DEP+0.0783)

- The exchange rate has a positive and insignificant effect on the balance of payments;

- The inflation rate also has a positive and insignificant effect on the balance of payments;
- The per-barrel price of oil has a positive and insignificant effect on the balance of payments, which emphasises the importance of this primary source in the national economy as it contributes around 97% of the country's total exports; and
- Government spending has a positive and significant impact on the balance of payments in the long run, because the increase in public investment projects would be able to attract more foreign capital in the form of foreign investment that would in turn lead to a surplus in the capital balance, and thus surpluses in the balance of payments (bop = bot + bocapa).

4.9. ARDL (2.0.0.2.1.0.2) Model validity

4.9.1. ARDL (2.0.0.2.1.0.2) Model residual serial correlation test

After we estimate the model, we make sure that it is free from any auto-correlated error. The following Figure 4 shows the test results:

Figure 4. ARDL (2.0.0.2.1.0.2) Model residual serial correlation test

Date: 12/23/20 Time: 16:16
Sample: 1980 2019
Included observations: 38
Q-statistic probabilities adjusted for 2 dynamic regressors

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
.*| . |	.*| . |	1	-0.158	-0.158	1.0206	0.312
.*| . |	**| . |	2	-0.203	-0.234	2.7595	0.252
. | . |	. | . |	3	0.058	-0.020	2.9033	0.407
.*| . |	**| . |	4	-0.163	-0.220	4.0938	0.393
.*| . |	.*| . |	5	-0.105	-0.193	4.6028	0.466
.*| . |	**| . |	6	-0.082	-0.277	4.9218	0.554
. |*. |	. | . |	7	0.163	-0.004	6.2185	0.514
. | . |	.*| . |	8	0.003	-0.119	6.2190	0.623
**| . |	***| . |	9	-0.278	-0.418	10.282	0.328
. |*. |	**| . |	10	0.099	-0.318	10.816	0.372
. |** |	. | . |	11	0.280	-0.003	15.225	0.172
. |*. |	0 . |*. |	12	0.080	0.137	15.598	0.210
. | . |	. |*. |	13	0.030	0.124	15.654	0.268
.*| . |	.*| . |	14	-0.071	-0.075	15.976	0.315
. | . |	. | . |	15	-0.040	0.045	16.083	0.377
**| . |	. | . |	16	-0.226	-0.003	19.620	0.238

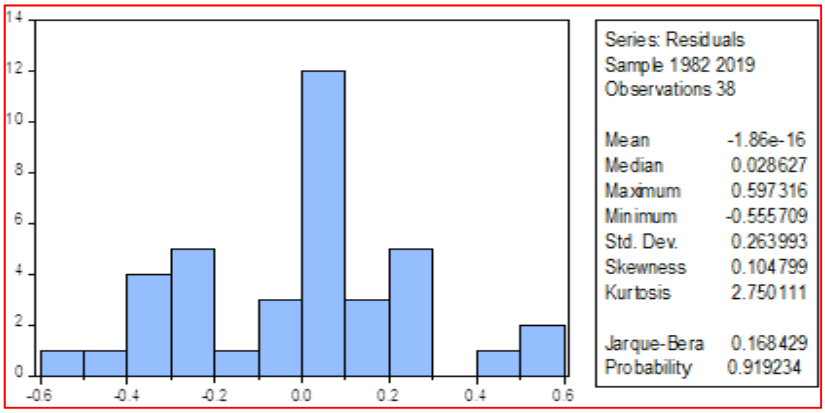
Source: Prepared by the author using Eviews10 outputs.

Following the results presented in **Error! Reference source not found.**, the residual autocorrelation functions for the ARDL (2.0.0.2.1.0.2) model demonstrates an uncorrelated error due to the fact that P-value is greater than 0.05(> 0.05), and this index confirms the acceptability of the model from a statistical standpoint.

4.9.2. ARDL (2.0.0.2.1.0.2) Model residual normality test:

This test for normality includes the Jarque-Bera normality test (JB) using the skewness and kurtosis coefficients.The results are demonstrated in figure5 below:

Figure 5. ARDL-Residual Normality Test



Source: Prepared by the author using Eviews10 outputs.

As can be seen, Figure 5 above shows perfectly symmetrical data set; a skewness of 0.104, near to zero, with a kurtosis of 2.75, closeto the expected value of 3, and a probability of 0.91 greater than JB(PValue<0.05), and hence, it can be concluded that the residuals follow the normal distribution.

Conclusion

This paper econometrically investigates the extent to which the exchange rate policy has an impact on Algeria's balance of payments (BoP) over the period 1980-2019, using the Auto-Regressive Distributed Lag (ARDL) model and the Error Correction Mechanism (ECM) approach. Many countries rely on various methods and techniques to correct BoP after disequilibrium occurs, and in this regard, the importance of exchange rate policy emerges clearly as a mechanism for the re-equilibrium as it represents a reflective mirror of the country's financial and economic strength. Algeria has been suffering for a prolonged period from structural disequilibria in balance of payments, which has led to the multiplicity of exchange-rate policies and the devaluation of the national currency value, as this

negatively affected the overall short- and long-run economic growth of the country.

Based on an econometric investigation, a set of results were obtained, which can be summarized as:

- All variables are static in the first difference I(1) after performing the PP unit root test, except for the real interest rate variable, which is determined to be static at the level;
- Interest rate adversely affects balance of payments due to the fact that higher interest rates tend to increase capital flows and thereby, increase exchange rate, which makes
- domestic
- exports relatively more expensive and imports cheaper;
- Real exchange rate has a negative impact on balance of payments, because the high exchange rate of domestic currency against the foreign currency makes domestic products relatively more expensive, causing the balance of trade to become negative, and therefore
- definitely indicating balance of payments deficit;
- Inflation rate has an inverse correlation with balance of payments, because an increase in domestic prices would lead to an increase in demand for foreign goods (imports), and would in turn result in a trade balance deficit;
- Per-barrel prices have a positive and insignificant effect on balance of payments;
- Based on ECM approach, the findings indicate the existence of a long-run equilibrium relationship between balance of payments and the interpreted variables; and
- Exchange rate, inflation rate, oil prices and government spending have a long lasting positive impact on balance of payments.

Clearly, further research of the issue would be of interest.

References

Belloumi, M. (2013). Belloumi,The relationship between trade, FDI and economic growth in Tunisia: An application of the autoregressive distributed lag model. Economic Systems, 38(2), 269-287. doi:https://doi.org/10.1016/j.ecosys.2013.09.002

Clive , W., & Granger, J. (1969). Investigating Causal Relations by Econometric Models and Cross-Spectral Methods. Econometrica, 37(3), 424-438. doi:https://doi.org/10.2307/1912791

Damodar N, G. (2004). BASIC ECONOMETRICS (éd. 4). NEW YORK: Gary Burke.

Emeka , N., & Aham Kelvin , U. (2016). Autoregressive Distributed Lag (ARDL) cointegration technique: application and interpretation . 5(4), 63-91.

Iyoboyi, M., Muftau, O., & McMillan, D. (2014). Impact of Exchange Rate Depreciation on the Balance of Payments: Empirical Evidence from Nigeria. Economics &

Finance, 2(1), 1-23.
doi: https://doi.org/10.1080/23322039.2014.923323
Jonas KIBALA , K. (2018). Modélisation ARDL, Test de cointégration aux bornes et Approche de Toda-Yamamoto : éléments de théorie et pratiques sur logiciels. Université de Kinshasa.
doi:https://hal.archives-ouvertes.fr/cel-01766214
Josette, P. (1990). Gestion financière internationale. 5ème édition (éd. 5). paris: Vuibert.
M. Hashem , P., Yongcheol , S., & Richard , J. (2001). Bounds Testing Approaches to the Analysis of Level Relationships. Journal of Applied Econometrics, 16(3), 289-326. doi:www.jstor.org/stable/2678547
Nawaz, A., Rizwan, A., Khoso, I., & Palwishah, R. (2014). Impact of Exchange Rate on Balance of Payment: An Investigation from Pakistan. Research Journal of Finance and Accounting, 5(13), 32-42.
doi:https://www.researchgate.net/publication/264419205
Nikolaos, D. (2011). Demand for Money in Hungary: An ARDL Approach. Review of Economics & Finance, 1-16.
doi:https://www.researchgate.net/publication/274386318
Odili, O. (2014). Exchange Rate and Balance of Payment: An Autoregressive Distributed Lag (Ardl) Econometric Investigation on Nigeria. IOSR Journal of Economics and Finance, 4(6), 21-30.
doi:10.9790/5933-0462130
Priyatharsiny, S. (2017, december 7-8). THE IMPACT OF EXCHANGE RATE ON BALANCE OF PAYMENT: AN. SEUSL, pp. 580-592.
Soo khoon , G., & Koi Nyen , W. (2014). Could Inward FDI Offset the Substitution Effect of Outward FDI on Domestic Investment? Evidence from Malaysia. 4, 413-425. doi:10.18267/j.pep.491

UTICAJ DEVIZNOG KURSA NA PLATNI BILANS U ALŽIRU: PRISTUP ARDL MODELA

Apstrakt: Ova studija ima za cilj da ispita u kojoj meri devizni kurs utiče na platni bilans u Alžiru (BoP) tokom perioda 1980-2019, koristeći model auto-regresivnog distribuiranog kašnjenja (ARDL) i model ispravljanja grešaka (ECM). Ovaj pristup testira prisustvo dugoročne veze između varijabli. Skup relevantnih varijabli, pored deviznog kursa, kreiran je tako da uključi realnu kamatnu stopu, cenu nafte, BDP po glavi stanovnika, državnu potrošnju i stopu inflacije, zasnovanu na na prethodnim studijama iz ove oblasti. Rezultati ukazuju na postojanje dugoročne ravnotežne veze između zavisnih i nezavisnih varijabli. Devizni kurs ima negativan uticaj na platni bilans na kratak rok.

Ključne reči: Platni bilans; devizni kurs; kamatna stopa; stopa inflacije; ECM pristup, ARDL model

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