Central bank intervention and Exchange rate: Toda and Yamamoto causality test in ALGERIA

Hadji Abir
University of Dr. Tahar Moulay Saida –Algeria
Laboratory ITMAM
abir.hadji@univ-saida.dz

Djebbouri Mohammed
University of Dr. Tahar Moulay Saida–Algeria
mohammed.djebouri@univ-saida.dz

Reçu le :10 /05/2023 **Accepté le :**13/06/2023 **Publié le :**30/06/2023

Abstract:

The study aimed to identify the impact of central bank intervention on exchange rate by examining the causal relationship between the central bank intervention and exchange rate in Algeria. Through an empirical analysis using Toda-Yamamoto Causality upon annual data for the period 1990 to 2020.

Our main results find an existence of the causal relationship between central bank intervention and exchange rate in Algeria. a unidirectional causality from central bank intervention to Algerian Dinar exchange rate/US Dollar. This suggests that the currency intervention policy in Algeria is effective and have significant impact on the dinar's exchange rate.

Keywords: Central bank intervention; Exchange rate; Toda-Yamamoto Causality; Algeria.
Jel Classification Codes : E58 ; F31; C32.

ملخص:

تهدف الدراسة إلى تحديد تأثير تدخل البنك المركزي على سعر الصرف من خلال دراسة العلاقة السببية بين تدخل البنك المركزي وسعر الصرف في الجزائر.من خلال دراسة قياسية باستخدام سببية Toda-Yamamotoعلى بيانات سنوية للفترة من 1990 إلى 2020.

أظهرت النتائج الرئيسية وجود علاقة سببية بين تدخل البنك المركزي وسعر الصرف في الجزائر. سببية أحادية الاتجاه من تدخل البنك المركزي إلى سعر صرف الدينار مقابل الدولار.وهذا يشير إلى أن سياسة التدخل في الصرف الأجنبي في الجزائر فعالة ولها تأثير كبير على سعر صرف الدينار.

الكلمات المفتاح : تدخلات البنك المركزي ؛ سعر الصرف ؛ سببية Toda-Yamamoto ؛ جزائر.
تصنيف JEL : C32 ؛ F31؛ E58

Auteur correspondant: Hadji Abir, Email: abir.hadji@univ-saida.dz

I. Introduction:

Exchange rate and central bank intervention is an important topic, in maintaining the exchange rate and in reducing exchange rate volatility. Central banks systematically intervene to contain exchange rate volatility (Basu & Varoudakis, 2013). The volatility is one of the prevalent features of financial data including exchange rates. Excessive exchange rate volatility is believed to interfere with the efficiency of the foreign exchange market, the international flow of goods, services, investment capital and the conduct of monetary policy (Abbuy, 2018).

The exchange rate is a highly sensitive variable. Any disturbance or fluctuation in the exchange rate would create undesirable macroeconomic repercussions on various macroeconomic variables such as gross product, price level, international trade volume and foreign investment, thus affecting the economy as a whole.

This reality creates a role for central bank intervention to keep the rate in line with the economic environment and to stabilize market expectations. Exchange rate stability is still a major policy objective especially in developing markets given that the pass-through from exchange rate movements to inflation is higher in these markets compared to developed economies (Mongkol, 2011)**.**

The official intervention of monetary authorities in the foreign exchange market to influence the exchange rate fluctuation is a worldwide phenomenon. The monetary authorities intervene with the objective of maintaining orderly market conditions, which ultimately help to achieve the overall macroeconomic goals (Fayyaz & Abdul, 2007).

Central banks intervene when they target particular levels of the exchange rate. Even when they do not target a particular rate, they may intervene when there is excessive volatility in the exchange rate, which can be destabilizing for traders and ordinary consumers. When faced with current account surpluses or capital inflows, central banks that target the exchange rate end up accumulating large amounts of FX reserves. Accumulation of reserves can also be a symptom of an undervalued exchange rate that some governments have used to promote exports—or to prevent an appreciation that could undermine competitiveness.

Until very recently, economists have not reached a consensus as to whether the intervention by the Central Bank does offer effective or lasting instruments to determine exchange rates (Mongkol, 2011)**;** where the Studies that attempt to measure the effectiveness of intervention in terms of exchange rate trends and volatility have had mixed results. Given the importance of intervention, it is perhaps not surprising that this literature has been the venue for a substantial and ongoing economic controversy (Sarno & Taylor, 2001).

I.1 Problematic Research:

After Algeria adopted the managed float system, the Central Bank of Algeria had broader functions in the management of exchange rate policy. Exchange rate and central bank intervention is an important topic in the exchange rate determination. Exchange rates are volatile after the breakdown of the Bretton Woods system of fixed exchange rate in the year 1973. Central banks especially those in economies adopted a managed exchange rate regime actively intervene in the exchange rate market to maintain their exchange rates and to reduce their exchange rate volatility, which can affect international trade, financial flow and economic growth.

Therefore, the purpose of this work is to investigate the empirical relationship between central bank intervention and exchange rate. To put it another way, the main aim of this paper is to answer the following question:

"Can intervention operations of central bank of Algeria influence the level and volatility of the exchange rate?"

I.2 Research hypothese:

In order to answer our research problematic, we suppose the following:

This study aims to test a basic hypothesis represented in the existence of a relationship between the interventions of the Central Bank of Algeria and the exchange rate.

I.3 Research Objectives:

This paper attempts to provide a comprehensive overview of what is known about the effect of central bank interventions on the exchange rate. To put it another way, the present study investigates whether causality exist among central bank intervention and exchange rate. The study also aims to estimate and analyze the effect of the interventions of the Central Bank of Algeria on the exchange rate during the period of 1990–2020. The study employs the methodology of Toda and Yamamoto (1995) modified WALD (MWALD) test statistics based on augmented VAR framework.

I.4 Previous studies:

Because of the great importance of the Exchange rate and Central bank interventions, there is a substantial literature, to deal with the topic. As a result, there are many publications treating the central bank interventions and their impact of exchange rate, and their changes over time are discussed. There are also a number of articles proposing various methodologies in order to deal with this topic.

- Balakrishnan & Deo (2021): "Central bank intervention and monetary approach of exchange rates"

The aim of the study is to investigate the relationship between the exchange rate and the currency intervention in forex market using the ARDL method. The volatility of the exchange rate is found using the ARMA, GARCH (1, 1) model. The result indicates that there is a clear evidence of asymmetric relation of the intervention even though intervention is having a short-term relationship impact in the volatility of the exchange rates.

- Rishad & others (2021): "Official intervention and exchange rate determination"

This study seeks to find empirical evidence on the intensity to which the monetary authority was able to achieve its policy objective of directing exchange rate in the anticipated trail. The study employed an Autoregressive Distributed Lag (ARDL) model to estimate the central bank reaction function in this regard. It was found that 1% purchase of foreign exchange reserve (net intervention) depreciated Indian Rupee by 0.255% for long-term. Whereas in short-term, intervention followed "leaning against the wind" policy to curb market vagueness. The findings of the study recommend that there should be more coordinated approach between official intervention policy and monetary policy formulation in consonance with the economic fundamentals for increasing the effectiveness and sustainability of the intervention operations.

I.5 Structure and Plan of Research:

The paper is organized as follows: The first section is the introduction. Section 2 discusses theoretical and empirical issues on the relationship between the central bank intervention and exchange rate (examines the theoretical background of central bank intervention. describes various literatures reviewed). Section 3 explains the used data, methodology and econometric model, Section 4 reports empirical results. Finally, section 5 concludes the paper.

II. Theoretical of central bank intervention:

Intervention is narrowly defined as any official sale or purchase of foreign assets against domestic assets in the foreign exchange market. In general, foreign exchange market intervention is any transaction or announcement by an official agent of government intended to influence the value of the exchange rate (Chipili, 2014).

Official exchange rate intervention in the foreign exchange market occurs when the authorities buy or sell foreign exchange, normally against their own currency and in order to affect the exchange rate (Sarno & Taylor, 2001).

Foreign exchange intervention is the practice by monetary authorities or finance ministries of buying and selling foreign currency to influence exchange rates. In the United States, for example, the U.S. Treasury and the Federal Reserve generally collaborate on foreign exchange intervention decisions, and the Federal Reserve Bank of New York usually conducts such operations on behalf of both (Neely, 2011).

Intervention is generally defined as those foreign exchange transactions of monetary authorities that are designed to influence exchange rates, but can more broadly refer to other policies for that purpose (Neely, 2001).

Central banks may decide to intervene in the foreign exchange market for various reasons and with various styles. In a fixed exchange rate regime, the central bank must intervene to maintain the fixed international price of the currency. In a dirty float, the central bank has the option to intervene and often does so in an attempt to correct imbalances in the current account (Morana & Beltratti, 2000).

The central bank can choose the method of intervention; Foreign exchange intervention can either be sterilized or unsterilized. An intervention occurs when a monetary authority buys (sells) foreign exchange, this action will affect the monetary base (by increasing for purchase or decreasing for sale), the interest rates, the market expectations and intimately the exchange rate. This type of intervention is called non-sterilized intervention. On the other hand, intervention is said sterilized if the monetary authority offsets or sterilizes the effect of the foreign exchange operation on the monetary base by selling or buying domestic bonds. This sterilization aims to keep the monetary policy unchanged (Ben Maatoug, Fatnassi, & Omri, 2011).

Official intervention is said to be sterilized when the authorities simultaneously or with a very short lag take action to offset or "sterilize" the effects of a change in official foreign asset holdings on the domestic monetary base. On the other hand, non-sterilized intervention occurs when the authorities buy or sell foreign exchange, normally against their own currency without such offsetting actions. However, the means by which central banks intervene in foreign exchange markets vary across a number of dimensions. Intervention can be rule-based or discretionary. According to Canales-Kriljenko (2003), central banks need discretion to determine when to intervene. Discretion has the advantage of allowing the central bank to adapt to market conditions and to plan strategies. Some others theoretical studies support that "rule-based" intervention can be more effective (Abbuy, 2018).

In order to affect the level of their local exchange rate. There are three channels through which official intervention might affect the foreign exchange market indirectly: the portfolio balance channel, the signaling channel, and the coordination channel.

The portfolio balance channel: The Portfolio-balance channel suggests that a sterilized purchase of foreign currency increases the amount of publicly held domestic bonds relative to the foreign bond, inducing a depreciation of the domestic currency and vice versa (Fayyaz & Abdul, 2007).

The portfolio-balance channel may be explained through the Portfolio Balance model of the exchange rate in which trader's portfolio compositions is based on the expected return of domestic and foreign assets (Ben Maatoug & Fatnassi, 2009).

The portfolio-balance channel has received the most attention in the literature (Cavallino 2019; Gabaix and Maggiori 2015; Fatum 2015; Dominguez and Frankel 1993). The channel works through investors portfolio shocks, which affect the amount of bonds in circulation and their risk premia and by doing so affect the exchange rate (Reitz & Taylor, 2008).

The portfolio-balance channel assumes that economic agents are risk averse, and that foreign and domestic bonds are imperfect substitutes for each other in an agent's portfolio. It operates when there is imperfect substitutability between domestic and foreign assets and the risk premium increases with the supply of domestic assets. That means that in closed financial markets the substitutability between domestic and foreign assets is likely to be low. If the central bank, as a major market player, influences the supply or demand of financial assets through its own trading activities, this is likely to result in other market participants rebalancing their financial asset portfolios (Abbuy, 2018).

The signaling channel: The second channel is the signaling or expectations channel. Mussa (1981) suggests that central banks might give indications regarding future, unanticipated changes in monetary policy through their sterilized interventions, with sales or purchases of foreign exchange implying monetary tightening or easing respectively. This would have direct implications for future fundamentals and traders would immediately adjust spot exchange rate quotations. Mussa suggests that such signals could be particularly strong—more so than a mere announcement of monetary policy intentions—because interventions give monetary authorities open positions in foreign currencies that would result in losses if they failed to confirm their signal. Reeves (1997) has formalized Mussa's approach and demonstrates that if the signal is not fully

realistic or if the market does not use all available information, then the response of the exchange rate intervention will be low. However, Edison (1993) argues that intervention is effective and occurs through both the portfolio balance and signaling channels (Simwaka & Mkandawire, 2012).

This channel works through the adjustment of expectations about future central bank policy. A highly-publicised transaction in foreign exchange markets may be interpreted as setting a precedent for future interventions, or revealing information about the level of the exchange rate that is considered desirable by policymakers (Chutasripanich & Yetman, 2015).

In essence, the signaling channel assumes that intervention affects exchange rates by providing the market with new relevant information, under the implicit assumption that the authorities have superior information to other market participants and that they are willing to reveal this information through their actions in the foreign exchange market. More precisely, the effect of sterilized intervention through the signaling channel occurs because private agents change their exchange rate expectations either because they change their view with regard to the likely future actions of the monetary authorities or because they change their view with regard to the impact of certain actions of the monetary authorities (Sarno & Taylor, 2001).

In this channel, oral communications or actual interventions affect expectations of investors and asset prices by either signaling private information of the monetary authorities about relevant economic fundamentals and/or revealing the authorities' intentions about future policy (Fratzscher, 2004).

The coordination channel: The coordination channel was introduced by Sarno and Taylor (2001), Taylor (2004, 2005) and Reitz and Taylor (2008) in addition to the traditional channels: the signaling channel and the portfolio balance channel. In fact the exchange rate may be misaligned due to irrational speculative bubbles brought by traders like chartists and technical traders. Once the exchange rate is away from its fundamental equilibrium, it would be very difficult to other traders to revert the exchange rate. Moreover, due to this misalignment, smart speculators having important losses may be reluctant to trade into this uncoordinated fashion. The central bank, by their announced interventions operations, encourage smart money traders to enter the market in order to sell over evaluated currency and then, bringing the exchange rate to its fundamental level. This effect is called coordination channel. The central bank is not only revealing information about the fundamental exchange rate (like in the signaling channel) but also serving as focal point for market traders (Ben Maatoug & Fatnassi, 2009).

Sterilized intervention can work as a coordination mechanism. When the market is thin and traders have lost confidence in the ability of macroeconomic fundamentals to inform the price, the central bank can step in and provide direction (Naef, 2020).

The coordination channel, suggests that intervention might be important in coordinating the expectations of market participants. This channel has received increasingly greater importance in the literature, because intervention communicates the authorities' belief about the exchange rate being misaligned from its long-run value. During such periods, individual traders are subject to greater risk if they invest capital in hopes of a return to the long-run equilibrium even though the exchange rate can persist to deviate from its long-run equilibrium level for an extended time period. Be that as it may, foreign exchange intervention can facilitate the convergence in the expectations of market participants and lead traders so as to align the exchange rate closer to its long-run equilibrium (Chang, Suardi, & Chang, 2017).

III. Data and Methods:

This part highlights the econometrics model used to study the relationship between exchange rate and central bank intervention in Algeria. That is, the extent to which one variable scientifically influences changes in another variable by observing the connection of previous values of a particular variable on another variable. And to achieve this, the main econometric technique adopted was developed by Toda and Yamamoto (1995).

The data employed in this study were mainly sourced from the World Development Indicators (WDI), Financial Statistics of International Monetary Fund (IMF) and Central Bank of Algeria (CBA) Statistical Bulletin. This study employs annual time series data spanning from 1990

to 2020. The variables are measured as follows: The annually data on dinar's exchange rate against the US dollar, central bank intervention is proxy by exchange reserve, balance of payments, money supply and interest rate.

To investigate the causal relationship between dinar's exchange rate against US dollar and central bank intervention, this study applied Toda and Yamamoto causality approach modified Wald test statistics based on augmented Vector Autoregressive VAR (dmax+p) framework.

The analysis considers a model with impact of central bank intervention on the stability of exchange rate with International Reserves as proxy for intervention and other control variables including balance of payments, money supply and interest rate, which have direct impact on the exchange rate stability in Algeria.

The model used five variables that hypothesized exchange rate variable as the function of exchange reserve, money supply, balance of payment and interest rate respectively.

$EXR_t = F (RES_t, M2_t, BoP_t, IR_t)$

Where EXR represents the annual dinar exchange rate per US Dollar, RES stands for annual exchange reserve (the proxy of central bank intervention variable), which is similar to Adler and Mora (2011) and Adler et al. (2019). M2 represents the annual growth of money in Algerian economy (proxy as the money supply variable), BoP represents balance of payments, and IR representing the interest rate variable. The t-sign denotes the time trend.

IV. EMPIRICAL RESULTS AND DISCUSSION:

This section present firstly, the econometric methodology adopted to achieve the objective of this paper and secondly, the empirical results.

The use of the Toda and Yamamoto (TY) causality approach involves 3 stages:

IV.1 Unit root tests

The first stage in estimating the Toda-Yamamoto causality approach (TY) begins by evaluating unit root tests. To establish the order of integration in the variables under consideration (Okafor, Ugochukwu, & Chijindu, 2016). The methodology proposed by Toda and Yamamoto (1995) is applicable irrespective of the integration order of the variables (Toda & Yamamoto, 1995). However, it is necessary to determine the appropriate order of integration as pre-requisite for estimating Toda–Yamamoto causality (3). This is to determine the maximum order of integration (dmax) as T-Y test will consider all the variables irrespective of their order of integration(Okafor, Ugochukwu, & Chijindu, 2016).

There are many ways of conducting unit root test, but this study uses the Augmented Dickey-Fuller (ADF) unit root test of stationarity to examine the integrating order of the variables under consideration. Our results, represented in table 1:

Table 1 : results of augmented Dickey-Fuller test

Variables	Augmented Dickey-Fuller			Order of integration I(d)
	At level	At 1st difference	At 2nd difference	
EXR	-0.969686	-3.898653* ** ***	/	I(1)
RES	-2.187417	-3.959710	-4.431547* ** ***	I(2)
M2	-4.281981* ** ***	/	/	I(0)
IR	-8.174165* ** ***	/	/	I(0)
BOP	-1.485057	-5.699239* ** ***	/	I(1)

Source: prepared by the researcher, depending on the program eviews10

Note: *, ** and *** imply statistical significance at 1%, 5% and 10% levels respectively.

The above table 1 present the unit root test results conducted on the variables in their level and difference forms. The significance of this test is to know the highest order of integration of the variables (dmax). The unit root test results indicates that EXR and BOP are integrated of order one I(1) while M2 and IR are integrated of order zero I(0) and RES are

integrated of order two I(2). Based on this result, the maximum order of integration is two (dmax=2).

IV.2 The Optimal Lag Length Selection

The next step in the Toda and Yamamoto test is to determine the optimal order of lag length. an optimal lag length test was conducted to avoid the risks associated with under-specification or over-specification of the model.

Once, established the order of integration, the study process requires the estimation of the relationships among the variables included. However, before estimating this relationship need to identify. we determine the optimum lag length (k) using some of the information criteria such as Akaike Information criterion (AIC), Hannan-Quinn information criterion (HQ), Schwarz Information Criterion (SIC) and Final prediction error (FPE). Table 02 shows the selected lag length by all the criteria (LR, FPF, AIC, SC and HQ).

Table 2: Optimal lag length selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-555.9847	NA	1.74e+11	40.07033	40.30823	40.14306
1	-385.0610	268.5944	5344404.	29.64721	**31.07457***	30.08357
2	-352.6363	**39.37282***	3800578.	29.11688	31.73371	29.91687
3	-319.5334	28.37388	**3726005.***	**28.53810***	32.34440	**29.70173***

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion
Source: prepared by the researcher, depending on the program eviews10

Table 2 indicates the output of the lag selection criteria based on VAR framework. Lag selection is selection is one of the important aspects in time series analysis and also it is necessary to determine the appropriate the optimal order of lag length as pre-requisite for estimating Toda–Yamamoto causality. This is to determine the optimum lag length (k). This research chooses Akaike Information Criterion due to the nature of the small sample characterise by the research as recommended by Liew (2004).

Liew (2004) found that AIC and FPE give better predictions than other criteria if the number of observations is less than 60. He further explains that AIC and FPE lessen the possibility of underestimations and improve the chances of arriving at a true lag length (Fernando, 2020).

The lag length selection results are provided in the Table (2): The result shown in the table (2) of the optimal order of lag length selection indicates that the optimal lag length is 3 using both AIC, FPE and HQ information criteria are adopted to determine the optimal lag length. Based on this result, the optimum lag length is 3 (k=3). This lag length will be relied upon to test Toda-Yamamoto Causality.

IV.3 Toda-Yamamoto Granger Causality Test

The Granger causality proposed by Granger (1969) has probable shortcomings of specification bias and spurious regression. To mitigate these problems, Toda and Yamamoto (1995) developed a procedure based on augmented VAR modeling, by introducing a modified Wald test statistic (MWALD). This procedure has been found to be superior to ordinary Granger-causality tests since it does not require pre-testing for the co-integrating properties of the system and thus avoids the potential bias associated with unit roots and co-integration tests as it can be applied regardless of whether a series is I(0), I(1) or I(2), non-co-integrated (Okafor, Ugochukwu, & Chijindu, 2016).

To apply Toda and Yamamoto causality method firstly, it is necessary to determine maximum order of integration of series say dmax; since Toda and Yamamoto method is valid for integrated and co-integrated variables. Secondly, it is necessary to determine optimal lag of vector auto-regression (VAR) model using Akaike Information Criterion (AIC), say k. Thirdly it is

necessary to estimate (dmax + k) the order of VAR model with seemingly unrelated regression. Lastly, the hypothesis is tested using a standard Wald statistic test which has an asymptotic Chi-square distribution with p degrees of freedom. The final step in this study is to verify if central bank intervention Cause exchange rate using the Toda and Yamamoto causality test.

In an attempt to test the causal relationship between exchange rate and central bank intervention (proxy by exchange reserve) while controlling for money supply, interest rate and balance of payments, the study uses H.Y. Toda and T. Yamamoto (1995) modified Wald test statistics based on augmented Vector Autoregressive VAR (dmax+k) framework. Following H.Y. Toda and T. Yamamoto (1995); J. Shan and F. Sun (1998) and H.O. Zapata and A.N. Rambaldi (1997) methodology, the following VAR system is estimated:

$$\begin{bmatrix} EXR \\ RES \\ M2 \\ BOP \\ IR \end{bmatrix} = \begin{bmatrix} a_0^{EXR} \\ a_0^{RES} \\ a_0^{M2} \\ a_0^{BOP} \\ a_0^{IR} \end{bmatrix} + \begin{bmatrix} a_{11} & a_{12} & a_{12} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \\ a_{41} & a_{42} & a_{43} & a_{44} \\ a_{51} & a_{52} & a_{53} & a_{55} \end{bmatrix} \begin{bmatrix} EXR_{t-1} \\ RES_{t-1} \\ M2_{t-1} \\ BOP_{t-1} \\ IR_{t-1} \end{bmatrix} + \begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33}a_{34} \\ a_{41}a_{42} & a_{43} & a_{44} \\ a_{51} & a_{52} & a_{53}a_{55} \end{bmatrix} \begin{bmatrix} EXR_{t-2} \\ RES_{t-2} \\ M2_{t-2} \\ BOP_{t-2} \\ IR_{t-2} \end{bmatrix} + \begin{bmatrix} \varepsilon_{EXR_t} \\ \varepsilon_{RES_t} \\ \varepsilon_{M2_t} \\ \varepsilon_{BOP_t} \\ \varepsilon_{IR_t} \end{bmatrix}$$

To test the null hypothesis of whether central bank intervention (proxy by exchange reserve) causes exchange rate, the following restriction is specified H0: a12 = 0, where a12 is the coefficient of the restricted lag value of exchange reserve variable in the model. Similarly, the second hypothesis that exchange rate does not cause exchange reserve is tested by imposing the following restrictions: H0: a11 = 0, where a11 is the coefficient of the lag value of the exchange rate. The significance of the MWALD statistics on lagged values of explanatory variables in the two hypotheses respectively indicate the rejection of the null hypothesis of no Granger causality from exchange reserve to exchange rate and vice versa (Umar & Dahalan, 2016).

After the determination of level of cointegration dmax=2 and the choice of the optimal lag length according to the Akaike Information Criterion (AIC) which corresponds to third lag k=3. , we construct VAR (2+3) model then we apply Toda-Yamamoto Causality test in order to study the relationship among the variables. The empirical results base on Toda and Yamamoto (1995) methodology is estimated through MWALD test and reported in Table 3. The estimates of MWALD test show that the test result follows the chi-square distribution with 3 degrees of freedom in accordance with the appropriate lag length along with their associated probability. The causal link between the variables based on p-values for the Modified Wald (MWald) statistics. The results were as follow:

Table (3): Toda-Yamamoto Causality

Dependent variable: BOP

Excluded	Chi-sq	Df	Prob.
EXR	12.81347	3	0.0051
IR	11.45609	3	0.0095
M2	2.130141	3	0.5458
RES	75.40607	3	0.0000
All	98.70858	12	0.0000

Dependent variable: EXR

Excluded	Chi-sq	df	Prob.
BOP	11.69057	3	0.0085
IR	3.421462	3	0.3311
M2	2.547254	3	0.4668
RES	17.76711	3	0.0005
All	25.87905	12	0.0112

Dependent variable: IR

Excluded	Chi-sq	df	Prob.
BOP	1.991549	3	0.5742
EXR	3.773502	3	0.2870
M2	1.498635	3	0.6826
RES	2.637114	3	0.4510
All	13.76577	12	0.3159

Dependent variable: M2

Excluded	Chi-sq	df	Prob.
BOP	0.715257	3	0.8696
EXR	1.394549	3	0.7068
IR	2.749736	3	0.4318
RES	1.327039	3	0.7227
All	10.50992	12	0.5713

Dependent variable: RES

Excluded	Chi-sq	df	Prob.
BOP	10.24374	3	0.0166
EXR	3.359349	3	0.3395
IR	2.794348	3	0.4244
M2	0.042320	3	0.9977
All	23.14410	12	0.0265

Source: prepared by the researcher, depending on the program eviews10

The table (3) above shows the causal relationship between the variables of the study and the Dinar exchange against Dollar in significant level 5%. The results will be analyzed and discussed hereunder:

It is clear, from Table 03 According to the estimation results, dinar exchange rate against dollar USD/DZD and exchange reserve RES are a strong one way causally related in the long-run, and the Toda and Yamamoto causality is uni-directional running from exchange reserve to dinar exchange rate against dollar USD/DZD at 5% significant whereas the probability values of Wald statistic is lower than 0.05. Hence, changes in RES affect and cause changes in USD/DZD but in the opposite changes in USD/DZD don't have an impact on RES.

These assets (exchange reserve) considered a means of achieving an optimal level of exchange rates and to defend the currency exchange rate or maintaining orderly trading conditions in foreign exchange markets, to meet the balance of payments financing needs. Several countries have preferred to hold a significant amount of foreign exchange reserves; the aim is to protect the country's economy against internal and external shocks and to increase confidence in this country in international financial markets. Where in Algeria the level of reserves obtained in recent years has exceeded the accepted adequacy levels. This has enabled Algeria to face various external shocks and maintain its external stability so far.

The other estimation results are as follows:

With respect to money supply M2 and dinar exchange rate against dollar USD/DZD, this study found that there is no causality between the two variables. Is because; the probability values of causality running from M2 to USD/DZD and from USD/DZD to M2 are greater than 0.05 significance levels respectively. Hence the money supply does not affect or cause in dinar exchange rate against dollar USD/DZD. This finding is not in line with the economic theory.

This can be interpreted as the Bank of Algeria's control over the monetary base is weak, and therefore over the money supply as an intermediate objective of monetary policy, and this is due

to the weak management of monetary policy effectively with insufficient development of the financial system in Algeria. This leads us to the fact that the monetary policy adopted by the Bank of Algeria is ineffective in achieving exchange rate stability.

The result of causality test also shows that there is no causality between IR and USD/DZD at 5% significant because the probability value of Wald statistic is greater than 0.05. Therefore, a change in IR does not affect or cause changes in USD/DZD dinar exchange rate against dollar. This result disagrees with the economic theory.

Although interest rates are one of the main factors affecting the value of a currency and its exchange rate. However, the interest rate channel is currently silent and does not respond to changes in monetary conditions due to excess liquidity caused by the recovery in oil prices. Excess liquidity dampens interest rates and complicates monetary policy by preventing monetary policy instruments from using the interest rate transmission channel.

The interest rate does not have the necessary flexibility to affect the exchange rate of the dinar against the dollar.

The result of Toda and Yamamoto causality also reveals that there is a bi-directional causality relationship between balance of payments Bop and dinar exchange rate against dollar USD/DZDat 5% significant. This is because; the probability values of causality running from balance of payments to dinar exchange rate against dollar and from dinar exchange rate against dollar to balance of payments are less than 0.05 significance levels respectively. Therefore, changes in Bop affect and cause changes in USD/DZD; also changes in USD/DZD affect and cause changes in Bop.

The effect of the balance of payments on the exchange rate is indirect; In the event of a deficit in the balance of payments, the state resorts to devaluation of its currency. The exchange rate is used as an important tool to address imbalances in the balance of payments.

V. Conclusion:

This paper offers a analysis of the effect of central bank intervention on the stability of exchange rate for Algeria with International Reserves as proxy for intervention and other control variables including (money supply, balance of payments and interest rate) for the period 1990 to 2020. This paper further uses Toda Yamamoto causality test to trace the relationship and the nature of causality between the Algerian dinar exchange rate against US dollar and the intervention of central bank. We employed the use of ADF test to ascertain the order of integration of the variable; the result indicate that EXR and Bop are integrated of order 1 I (1) while IR and M2 are integrated of order 0 I (0) and RES are integrated of order 2 I (2), Also, The results of the optimal order of lag length selection indicate that the optimal lag length selected by the criteria is 3. Moreover, the Toda-Yamamoto causality test affirms that there is unidirectional causality running from central bank interventions as proxy by exchange reserve to dinar's exchange rate against the US dollar in Algeria within the period.

Under study. This suggests that the currency intervention policy in Algeria is effective and have significant impact on the dinar's exchange rate.

The result also revealed that there is a bidirectional causality running from balance of payments to dinar's exchange rate against the US dollar. Also, there are no causal relationships between dinar's exchange rate against the US dollar and money supply and interest rate and that contradicts the economic theory.

After the results obtained we can come up with some recommendations represented in the following points:

For intervention operation to be successful and effective, Central Bank of Algeria must accumulate and maintain a reasonable amount of for foreign reserve. Foreign reserves are in most countries used to intervene in the foreign exchange market. Diversifying the structure of foreign exchange reserves i.e. its constituent currencies, taking into account the fluctuations occurring in these currencies. In addition, the trade relationship with other countries also it should well employ these reserves to maintain the stability of the purchasing power.

There must be a harmony between the monetary and intervention policies. This will increase the effectiveness of all the policies because they are targeting and aiming at achieving the same goal. Consequently, a stable and relatively valuable dinar's can be guaranteed.

Algeria must work constantly trying to equalize the exchange rate between the parallel market and the official market, therefore to ensure the monetary mass in the parallel market and in order to retrieval it in the official market. In addition encouraging migrants to transfer money through the official market, this contributes to raising national savings. Accordingly, it increases the ability of investment and raises the level of foreign currency reserves.

Referrals and references:

1. Abbuy, K. E. (2018). An empirical test for the effectiveness of central bank intervention in foreingn exchange markets: An application to the Canadian and Swiss Central Banks. *Journal of Economics and Political Economy, 5*(4).
2. Basu, K., & Varoudakis, A. (2013). How to move the exchange rate if you must: the diverse practice of foreign exchange intervention by central banks and a proposal for doing it better. *Policy Research Working Paper 6460*.
3. Ben Maatoug, a., & Fatnassi, I. (2009). The effecteveness of central bank intervention through the noise trading channel: evidence from the Australian and japan case. *SSRN Electronic Journal*.
4. Ben Maatoug, A., Fatnassi, I., & Omri, A. (2011). Sterilised intervention within a heterogeneous expectation exchange rate model: evidence from the reserve bank of Australia. *The Australian Economic Review, 44*(3), 256-268.
5. Chang, M.-C., Suardi, S., & Chang, Y. (2017). Foreign exchange intervention in Asian countries: What determine the odds of success during the credit crisis ? *International Review of Economics and Finance, 51*, 370-390.
6. Chipili, J. M. (2014). Central bank intervention and exchange rate volatility in zambia. *Journal of African Business, 15*(2), 114-121.
7. Chutasripanich, N., & Yetman, J. (2015). Foreign exchange intervention: strategies and effectiveness. *No 499, BIS Working Papers*.
8. Fayyaz, H., & Abdul, J. (2007). Effectiveness of foreign exchange intervention: evidence from Pakistan. *SBP Research Bulletin, 3*, 191-208.
9. Fernando, W. N. (2020). Foreign Direct Investment and Economic Growth: Evidence from Sri Lanka. *Central Bank of Sri Lanka, Staff Studies, 50*(2).
10. Fratzscher, M. (2004). Communication and exchangz rate policy. *ECB Working paper, No. 363*.
11. Mongkol, K. (2011). Is intervention effective after all ? *Journal of Economics and International Finance, 3*(1), 29-36.
12. Morana, C., & Beltratti, A. (2000). Central bank intervention and exchange rates: an analysis with hight frequency data. *Journal of International Financial Markets, Institution and Money, 10*, 349-362.
13. Naef, A. (2020). Blowing against the wind ? a narrative approach to central bank foreign exchange intervention. *EHES Working paper, No. 188*.
14. Neely, C. J. (2001). The practice of central bank intervention: looking under the hood. *Federal Reserve Bank of ST. LOUIS*.
15. Neely, C. J. (2011). A foreign exchange intervention in an ere of restraint. *Federal Reserve Bank of ST. Louis Review*.
16. Okafor, I. G., Ugochukwu, U. S., & Chijindu, E. H. (2016). Foreign capital inflows and nigerian economic growth nexus: A Toda Yamamoto Approach. *European Journal of Accounting, Auditing and Finance Research, 4*(3), 16-26.
17. Reitz, S., & Taylor, M. (2008). The coordination channel of foreign exchange intervention: a nonlinear microstructural analysis. *European Economic Review, 52*(1), 55-76.
18. Sarno, L., & Taylor, M. P. (2001). Official intervention in the foreign exchange market: Is it effective and, if so, how does it work ? *Journal of Economic Literature, 39*(3), 839-868.
19. Simwaka, K., & Mkandawire, L. (2012). The efficacty of official intervention in the foreign exchange market in malawi. *African Development Review, 24*(2), 125-136.
20. Toda, H. Y., & Yamamoto, T. (1995). Statistical inference in vector autoregressive with possibly integrated processes. *Journal of Econometrics, 66*, 225-250.
21. Umar, M., & Dahalan, J. (2016). Asymmetric real exchange rate and inflation causality based on Toda-Yamamoto dynamic granger causality test. *Actual Problems of Economics, 5*(179).