INFLUENCE OF INFLATION ON OUTPUT FLUCTUATIONS: EMPIRICAL STUDY IN CASE OF ALGERIA USING ARDL MODEL

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SUMMARY

The purpose of this paper is to empirically investigate the effect of inflation on GDP fluctuation in Algeria using ARDL model during the period 1980-2018. We have found that Bank of Algeria didn't succeed in reducing inflation rates, even after its adoption of the inflation targeting policy starting in 2011. The empirical study showed that there is a negative and significant effect of inflation on output gap in the long-run, when the inflation rate falls, the output gap increases significantly, making inflation affect negatively on output fluctuations. Also, the results showed that the increase of money supply lead to the expansion of output gap.

KEY WORDS

Inflation, GDP fluctuation, ARDL Model, Algeria.

JEL CLASSIFICATION: E52, E23,C22.

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INFLUENCE DE L'INFLATION SUR LES FLUCTUATIONS DU PIB : ÉTUDE EMPIRIQUE DU CAS DE L'ALGÉRIE EN UTILISANT LE MODÈLE ARDL

RÉSUMÉ

L'objectif de ce document est d'étudier empiriquement l'effet de l'inflation sur la fluctuation du PIB en Algérie en utilisant le modèle ARDL pendant la période 1980-2018. Nous avons constaté que la Banque d'Algérie n'a pas réussi à réduire les taux d'inflation, même après l'adoption de la politique de ciblage de l'inflation à partir de 2011. L'étude empirique a montré que l'inflation avait un effet négatif et significatif sur l'écart du PIB à long terme, lorsque le taux d'inflation diminue, l'écart du PIB augmente de manière significative, ce qui a un effet négatif sur les fluctuations du PIB. En outre, les résultats ont montré que l'augmentation de la masse monétaire conduit à l'expansion de l'écart du PIB.

KEY WORDS

Inflation, Fluctuation du PIB, modèle ARDL, Algérie.

أثر التضخم على تقلبات الناتج: دراسة قياسية لحالة الجزائر باستخدام نموذج ARDL

ملخص

يهدف هذا المقال إلى قياس أثر التضخم على تقلبات الناتج المحلي الإجمالي في الجزائر من خلال دراسة قياسية باستخدام نموذج ARDL خلال الفترة 1980–2018، توصلنا إلى نتائج مفادها أن بنك الجزائر لم ينجح في تخفيض معدلات التضخم حتى بعد تبنيه سياسة استهداف التضخم بداية من عام 2011، بينت الدراسة القياسية وجود أثر سالب ومعنوي لمعدل التضخم على فجوة الناتج في الأجل الطويل، فعندما ينخفض معدل التضخم، فإن فجوة الناتج تزيد بشكل معتبر مما يجعل تأثير التضخم سلبي على تقلبات الناتج،كما أظهرت النتائج أن زيادة العرض النقدي يؤدي إلى توسيع فجوة الناتج.

كلمات مفتاحية:

التضخم، تقلب الناتج المحلي الإجمالي، نموذج ARDL، الجزائر

تصنيف جال: E52, E23, C22

INTRODUCTION

Inflation constitutes a real risk for the whole economic activity as a whole in the developed and developing countries; therefore, monetary policy makers were convinced that price stabilization must be the long-term purpose for monetary policy. It also appeared since the end of the eighties that indirect impact on inflation through the traditional approach based on the control of the intermediate variables (traditional intermediate targeting) such as interest rates, exchange rate and monetary aggregates were not efficient to achieve such goals which led to the adoption of a modern method for the management of the monetary policy based on direct control to reduce inflation either by certain developed or developing countries. This method is known as Inflation Targeting Policy (ITP). New Zealand is considered as the first country which adopted inflation rate targeting in 1990, and paved the way for the other industrialised and emerging countries in order to follow this policy with the aim of reducing inflation rates to acceptable levels. Yet, the achievement of such goal did not take into account the other goals of monetary policy. This hence resulted in the occurrence of other specific fluctuations at the overall level such as growth of gross domestic product. Considering the aforementioned, does Inflation affect on output fluctuations in Algeria during the period 1980-2018?

This article aims to identify the impact of inflation on output fluctuations in Algeria during the period 1980-2018 using ARDL model, with this impact on the case of Algeria.

1- THEORICAL INTERPRETATION OF THE RELATIONSHIP "INFLATION-OUTPUT FLUCTUATION"

Theoretical relationship between the monetary policy and the economic growth, especially between the inflation-inflation rate being considered as one of the monetary policy results because its stability expresses the extent of its efficiency on controlling the price level- and economic growth rate received a significant consideration from several economists who addressed the nature of this relationship and how inflation or monetary base affects economic growth through the

creation of mathematical models to prove this relationship, or through experimental studies of many countries using statistic models or their study in a particular country. (Bennabi, 2009)

1.1- Analysis of the relationship between inflation and output fluctuation

The topic of the relationship between inflation and output fluctuation has received great attention from researchers and economic policy makers, based on the relationship between inflation and how it affects the rate of economic growth.

The most important approach that claims the existence of a positive relationship between inflation and the growth is the Phillips Curve approach. This approach assumes that the high inflation causes low rates of unemployment therefore affects growth positively. The empirical studies made afterwards showed that the relationship between inflation and the unemployment rate is valid in the short-term in case of unanticipated inflation. According to another approach, rising inflation results in contraction of the individual's wealth. In this context, individuals increase their savings to reach their pre-inflation wealth level and therefore interest rates fall with rising investments. (Yismaw, 2019).

Tobin model (1956) is considered as the first model to demonstrate how money may affect the activity level by adjusting the households' portfolios. He also highlighted the positive impact of inflation increase on the activity level in the long-run and considered money as a financial asset. If money return does not decline under the inflation effect, then agents prefer to keep real assets in their portfolio and this is explained by the increase of investment, and consequently, higher increase, i.e. inflation participates indirectly in increasing the product.

On the other hand, there is a theoretical analysis of the correlation "inflation - economic growth" by Gylfason (1991)who took a position contrary to Tobin's.He found a negative correlation between inflation rate and product growth rate in the long-run. A third opinion is different from bothTobin and Gylfason,by Sidrauski (1967), He assumed that money is among the components of the utility function for households because it gives services flow derived from money

holdings; consequently, results revealed great neutrality of money. In such case, money has no effect in the short-run or in the long-run, or on the product growth. In this model, product growth rate is defined externally through the inhabitant development rate.

The idea of whether inflation can be an indicator or obstacle for economic growth is contradictory. Some economists argue that inflation can be the indicator of economic growth through encouraging investment in non-monetary capital project this directly mean that inflation encourage people became concern central bank can adjust real interest rate and this lead to encourage investment in nonmonetary. While others believe that inflation cannot be indicator of economic growth rather it could be the obstacle of economic growth there by increasing the opportunity cost of holding money and this lead to uncertainty over future inflation which discourage both investment saving and likely economic growth.(Yismaw, 2019)

We note, through the theoretical interpretation of the relationship "inflation- output fluctuation" that there is a lack of conceptual agreement of the nature of this relationship. Opinions differed whether inflation is a positive indicator or an obstacle to economic growth.

1.2- Revue of practical studies of the relationship "inflation- output fluctuation"

If the theoretical studies differed regarding the results of the relationship between inflation and output fluctuation; is the same applied to the practical studies which experienced this relationship? Experimental studies of both Patrick Villieu and Taoufik Rajhi (1993) using a statistical model composed of 61 countries for the period 1960-1985, and the United-States of America for the period 1950-1987 showed negative effects of inflation on economic growth, and continuity of the monetary shocks impact in the long-run on the gross domestic product (Rajhi and al, 1993), while Mc Candlessand Weder (1995) note that there is a positive correlation between monetary base growth and economic growth in the long-run for countries which average inflation rate is poor (Countries of the Organisation for Economic Co-operation and Development).

Olivier Bruno and Patrick Musso (2000) created a model that shows relationship between money and economic growth by focusing on the relationship 'inflation-growth'. They found that inflation targeting (reducing inflation rate to zero) may produce a crucial decrease of the family savings rate, and consequently, a deceleration of economic growth and the existence of a negative relationship between inflation fluctuation and economic growth especially if inflation rates are high. (Olivier and al., 2000).

In a study conducted by Scott Roger (2010) about inflation fluctuations and output during the periods (1991-2000) and (2001-2009) i.e. since the initial adoption of Inflation Targeting Policy for twenty years, many results were reached such as: (Roger, 2010)

− He pointed out that the central banks cannot achieve the different conflicting targets (Kaldor square) through monetary policy, and hence, they must not focus on reducing inflation rate at any time, but rather achieve other targets in the medium-run the main of which is to increase output.

− Both inflation-targeting and non-inflation-targeting low-income economies experienced major reductions in inflation fluctuation and output, and countries which adopted inflation targeting realized higher reductions especially in inflation fluctuation.

− Among high-income economies, inflation-targeting countries knew a poor change in output fluctuation between the two periods. Yet, non-inflation-targeting countries knew higher output fluctuation.

In addition to all this previous result, the study of Yismaw, T. G. (2019) presented the effect of inflation on economic growth ofEthiopia, it concluded that economic growth can cause for inflation but inflation doesn't cause economic growth during the study period in Ethiopia 1975-2016.

Considering the above, we may say that there is no theoretical and practical agreement on the relation of inflation rate change impact on GDP fluctuation. This relation may have a positive or negative, or even a neutral impact. So, we can't determine the nature of the relationship and influence in the absence of full and clear explanation of the relationship "inflation-output fluctuation". We will hence in our

turn experience through the present study the effect of Inflation on output fluctuation of Algeria during the period 1980-2018.

2- THE EVOLUTION OF THE PATH OF MONETARY POLICY OF BANK OF ALGERIA

Relationship of the Algerian economy with the hydrocarbon sector and the international economic conditions, leaving varying effects on inflation, Bank of Algeria had then to apply an effective monetary policy for achieving price stability.

2.1- The diagnosis of inflation in Algeria and its face-policies

The price system in Algeria new several changes particularly after declaration of Algeria to move from command economy- where prices were administratively supported and fixed and inflation repressed- to a market-based economy. Actually, the period 1989-1993 knew liberalization of prices of some goods and services. Yet, the support character remained existent for large categories of products, and the price system during this period was characterized by an insufficient flexibility. Then Algeria gradually depended on price liberalization system according to the economic reform program with the International Monetary Fund 1994-1998, and after three years only, all the prices were liberalized and consumption goods and energy price support was definitively eliminated except for very few types of products.[1]

The economic reform program left positive impacts on inflation in the medium term. Inflation rates knew a continuous decrease from 1995 until 2000 and their rate reached 5% at the end of the program. Year 2000 knew the lowest level of inflation rate in Algeria after price liberalization, it reached 0, 3%. Decrease of inflation rate was due to the application of a deflating monetary policy before 2000 as part of the economic reform programs due to the measures taken under this

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[1] Decrease of inflation rate in Algeria led to the achievement of real interest rates starting from year 1997 which enabled the mobilization of the financial savings for financing investment and accordingly, the achievement of acceptable growth rates, see: (Belazzouz and al, 2008).

program such as price liberalization, increase of the interest rates, reduction of the monetary mass growth and abandonment of money supply for financing the deficit budget.

The period 2001-2018 represents an opposite phase in the orientation of monetary policy in comparison with the previous period. The Bank of Algeria adopted a rigorous deflating monetary policy during the period 1994-2000; especially during the period of adoption of the economic reform program that aimed to reduce the monetary mass growth within the limits of 14% (Belazzouz and al, 2008), while the monetary authority adopted, during the period 2001-2019, an expansionary monetary policy, where inflation rates began to increase since 2001to the increase of food products prices which constituted a great rate in the price index range, and the world prices of these products noticeably raised during this period, in addition to the increase of flexibility of the rising import of consumption goods demand and transfer of inflation imported by the major commercial partners suppliers to Algeria[2].

The expansionary monetary policy in this period aimed to achieve considerable economic growth rates within acceptable limits of inflation. In 2017, the growth of the monetary mass amounted to 8.1% as a result of the increase in net credits to the State by 74.9%, rising from 2682.2 billion dinars at the end of 2016 to 4691.9 billion dinars at the end of 2017. This increase comes after the Bank of Algeria adopted the open market policy from March 2017 to inject liquidity. It has also adopted a Quantitative Easing Policy since November 2017. (Bank of Algeria, 2018).

Algeria has treated largely the monetary causes of inflation by the application of austerity economic policies especially the deflating monetary policy as part of the economic reform programs through the reduction of aggregate demand. Nevertheless, inflation rates began to rise during the period 2001-2018 which impeded economic growth,

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[2] The same study conducted by the Bank of Algeria on inflation determinants pointed that imported inflation measured by the indicator variation of price of products highly imported inflated by the nominal effective exchange rate contributes to inflation with a rate of 21%, see:(Bank of Algeria, 2011)

and resulted in the causes of inflation in Algeria ; they are several such as monetary, institutional and structural, controlling the monetary causes which create inflation is required but insufficient for the achievement of a permanent price stability as long as the other causes that still constitute a threat to the financial stability have not been eliminated. (Belazzouzand al, 2008)

2.2- Inflation targeting with nearly absent requirements

Article 35 of The Ordonnance 03-11 related to money and credit fixed the ultimate targets of the monetary policy, and maintained the same mission of the Bank of Algeria provided for by Article 55 ofLaw 90-10related to money and credit. Such targets are numerous according to the same Article which comprises the target of achieving a regular economic growth rate primarily besides the achievement of complete operating. As for the price stability target and maintain of the currency stability externally, they come in second place. Ultimate monetary policy targets were characterized by pluralism and inconsistency between these objectives such as the economic growth and operating objective with price stability, and not giving priority to the price stability target as a main monetary policy target. (Belazzouz andal, 2008)

Furthermore, The Ordonnance 10-04 gave a great importance to price stability considering it as a target among monetary policy targets. It gave it priority but maintained the remaining targets unchanged. Despite this qualitative and positive development noticed in the monetary policy targets, yet, price stability should be the sole target of the monetary policy of the Bank of Algeria especially under its orientation towards inflation targeting. (Taiba, 2014).

Figure 1. Évolution of inflation rate and GDP growth in Algeria (1980-2018)
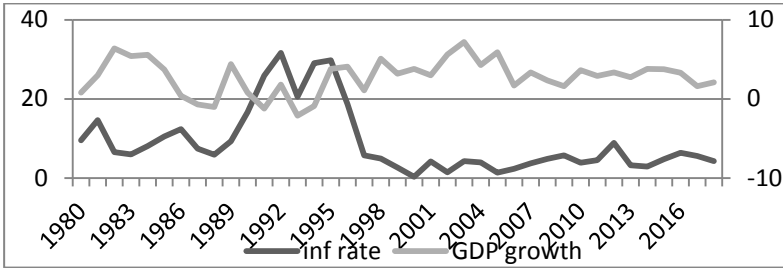
The right measure in figure1 refers to GDP Growth(%), while the left measure refers to the inflation rate(%).

Source: Preparedon the basis of the International Bank
Datahttps://data.albankaldawli.org/country/algeria?view=chart (20-03-2020)

The Bank of Algeria considered that 2011 was the first year of the management of its monetary policy with Inflation Targeting Policy. Starting from that year, inflation target was fixed at 4% and growth rate of the monetary aggregate M2 was between 13-14% in 2011, then stabilized between 9-11% starting from 2013, Falling to 7.4% in 2017 as a result of the beginning of the application of prudent monetary policy starting from 2015 on the back of the oil shock in June 2014, and the growth rate of loans on economy was between 16,5-17,5% in 2011 then flexibly raised to reach a growth rate between 25-27% in 2015, and then fell to 13.5% in 2017 (Bank of Algeria, 2018) after the upward trend observed on inflation rates starting in 2015. As it had to reduce any difference between inflation forecasts in the short-run and the planned objective by amending the management of its monetary policy operations. (Bank of Algeria, 2016).

If we wonder about the effectiveness of the Bank of Algeria in achieving the price stability target fixed by Article 35 of Ordonnance 03-11, and based on the previous analysis about the inflation rates evolution, noticeable increase of price evolution makes the monetary policy ineffective in the achievement of the price stability during the period 2001-2018.

3- ANECONOMETRIC MODEL FOR ESTIMATING THE EFFECT OF INFLATION RATES ON OUTPUT FLUCTUATIONS IN ALGERIA

After we discussed previously in our article to the theoretical relationship between inflation and output fluctuation, we try in this axis to measure the impact of inflation on output fluctuation in Algeria during the period 1980-2018.

3.1- Methodology and Model Study

Our empirical study is based on an annual data series for the Algerian economy during the period (1980-2018). We rely on the use of econometric methods to identify the impact of inflation on output gap in Algeria, and we use the Autoregressive Distributed Lag (ARDL), this is by studying the stationarity of the time series and testing the cointegration, then estimating the equation for the cointegration in the long and short term, and finally testing the validity of the estimated model, depending on annual data for all study variables from the statistics published by the World Bank and OPEC.

We have taken in the building of the model to some of the peculiarities of the Algerian economy as an oil economy, where the hydrocarbon sector contributes significantly in the composition of GDP by more than an average of 30%, making fluctuations in Oil prices affect the fluctuation of output. We also took into consideration another monetary variable that has an effect on the real sector and on the GDP is the money supply. Based on what we mentioned, the model will be as follows:

$$GDP_t = \alpha + \beta_1 INF + \beta_2 M2_t + \beta_3 PP_t + \varepsilon_t$$

Where these variables indicate:

GDP: it is expressed as the annual change in the volume of real GDP.

α: Intercept, represent the value of output fluctuation if all three independent variables were equal to zero (no inflation rate, no money supply, and zero oil prices).

β: Regression coefficients for independent variables.

INF: Inflation rate, expressed in the Consumer Prices Index(CPI).

M2: Money supply.

PP: Oil prices.

ϵ_i: Random variable represents the effect of variables not included in the model on output fluctuation and measurement errors.

3.2- Stationarity and Cointegration Tests

3.2.1. Stationarity tests:

The following table summarizes the different stationarity test results for study variables using (ADF:Augmented Dickey-Fuller test).

Table1: Stationarity tests for the study variables

variables	With cst and trend	With constant	Without cst and trend
	Stationarity I(0)		
GDP	0.0323	0.0060	0.1198
INF	0.5230	0.3717	0.1754
PP	0.6546	0.4897	0.1224
M2	0.0013	0.0004	0.0433
	Stationarity I(1)		
GDP	0.000	0.000	0.000
INF	0.0003	0.000	0.000
PP	0.0020	0.0005	0.000

Source: prepared by researchers based on the Eviews10.0 program.

According to the table1, results of level stationarity tests in the three models indicate that all-time series are non-stationary at level, where the probability of these tests in most models was greater than the significance level of 5%, except the variable M2 it is stationary at level I (0). After using stationarity tests at the first differences, Results indicate that all other time series are stationary type I(1) in all models.

The stationarity of time series types I(0) and I(1) makes a possibility of existence of a cointegration relationship between these time series. In this case, ARDL models are a modern approach for addressing the problem of cointegration between non-stationary and integrated time series types I (0) or I (1) developed by Pesaran and al (2001), which combines autoregressive models, AR(p) and Distributed Lag models, that depends on OLS estimation method. Therefore, the dependent variable is a function of its time-lag values and the values

of the current and past explanatory variables with certain of lag period.

3.2.2. Cointegration test (Bounds Test):

This test is based on the following hypothesis test:

$$\begin{cases} H_0 : \beta_1 = \beta_2 = \cdots = \beta_{10} \\ H_1 : \beta_1 \neq \beta_1 \neq \cdots \neq \beta_{10} \end{cases}$$

Accepting the null hypothesis means no cointegration relationship between the variables of the study (long-term equilibrium relationship), As for the accepting of the alternative hypothesis, means that there is a cointegration relationship, this test is performed by comparing the calculated Fischer statistic with the critical values proposed by Pesaranand al (2001), if it is:

$F_{cal} > F_{upper\ critical}$ the null hypothesis is rejected and the alternative hypothesis is accepted, i.e. there is a cointegration (long-term relationship);

$F_{cal} < F_{lower\ critical}$ the null hypothesis is accepted (no cointegration);

however, if it is found that: $F_{lower\ critical} < F_{cal} < F_{upper\ value}$ in this case the test is considered to be undetermined (zone of doubt).

Table 2: Results of the Bounds Test

Significance level	Lower critical	Upper critical	decision
10%	2.72	3.77	there is a cointegration
5%	3.23	4.35	there is a cointegration
2.5%	3.69	4.89	there is a cointegration
1%	4.29	5.61	there is a cointegration
F-statistic = 5663113			

Source: prepared by researchers based on the Eviews10.0 program.

Based on the results from the table2, we find that $F_{cal} > F_{upper\ critical}$ at various degrees of significance, and therefore we reject the null hypothesis and accept the alternative hypothesis which means that there is a cointegration relationship (long-term equilibrium relationship).

3.3- Estimation Results

3.3.1. Estimation Results of the coefficients in Long-Term

The estimation results of cointegration relationship showed in the table below through the probability corresponding of Student's statistic that most of the coefficients were significantly different from zero in the long run at the significance level of 5%, except the variable coefficient (PP) it is not significant.

Table 3: Estimation Results of the coefficients in Long-Term

Variable	Coefficient	Std. Error	t-Statistic	Prob
INF	-0.120647	0.054611	-2.209200	0.0349
PP	0.001542	0.006754	0.228279	0.8210
M2	0.187091	0.084693	2.209053	0.0349

Source: prepared by researchers based on the Eviews10.0 program.

Through the results shown in the table 3, it is evident that in the long term there is a negative effect of changes in inflation rates on the GDP fluctuations in Algeria. This is compatible with results of the previous studies: Gylfason (1991), Patrick Villieu and Taoufik Rajhi (1993), Scott Roger (2010), which found a negative impact of inflation on output fluctuations, while it is clear that money supply has a positive effect on the output fluctuation, this means that a rise in the money supply by 1% leads to an output fluctuation in the same direction by 0.18%, this is compatible with results of McCandless and Weder(1995). As for Oil prices it had a very weak impact on output fluctuations and not significant statistically (In the framework of the study model approved), when Oil prices rise by 1%, output fluctuations are affected by 0.0015%.

3.3.2. Results of Estimating Error Correction Model

Through the results of the estimation in Table (4), the determination coefficient indicates that 43,21% of the output fluctuations are explained by independent variables in the model. It was also found through the corresponding probability of Student's statistic that the Error Correction Term ECT coefficient is very significant, where the probability is (Prob = 0.0000), so it has a negative sign, which confirms the existence of a long-

term equilibrium relationship between the variables of the study (cointegration relationship), It's equal to (-0.8201), and it indicates the amount of real GDP fluctuation due to the deviation of the value of independent variables in the short term from their long-term equilibrium values by one unit.

The error correction term indicates that output fluctuation corrects its remaining equilibrium value from each past period about (82.01%), this means that in the short term, the relationship between the output and the rest of the explanatory variables integrated in the estimated model may be unbalanced, when the output deviates during the short term in the period (t-1) from its equilibrium value in the long run, the equivalent of (82.01%) of this deviation is corrected in the period (t). On the other hand, this correction ratio reflects a very high adjustment speed towards equilibrium. So that the output fluctuation takes about 1.21years to return in its equilibrium value as a result of any shock in the model. The procedures taken to reduce the output fluctuation are not required to achieve a big-time gap. In the short term, the independent variables in the model do not affect the output fluctuation, with the exception of money supply D (M2 (-1)), which was significant and affected output fluctuations in the opposite direction. In other words, decreasing the money supply with a single lag period (t-1) increases the fluctuations in output in the subsequent period t.

Table 4: Estimation Results of Error Correction Model according to ARDL approach

Short term Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.009495	0.003603	2.635574	0.0132
D(M2)	0.032574	0.034222	0.951847	0.3488
D(M2(-1))	-0.074307	0.038184	-1.946021	0.0611
CointEq(-1)*	-0.820158	0.164302	-4.991763	0.0000
F-statistic	8.370448	**R-squared**=0.43212		
Prob(F-statistic)	0.000281	**Adjusted R-squared** = 0.380500		

Source: prepared by researchers based on the Eviews10.0 program.

In conclusion, the estimation results of the ARDL model showed a cointegration relationship between real GDP fluctuation and

independent variables in the model in the long and short term. These results are statistically significant, as it was found that there was a negative effect on the inflation rate on the output fluctuation and a positive impact of money supply on output fluctuation in Algeria in the long-term during the period 1980-2018. While in the short term, there is no effect of independent variables on output fluctuations except the effect of money supply in one lag period on output fluctuation in the opposite direction, the rate of adjustment towards equilibrium was very large, as it was estimated at 1.21 years.

3.4- Economic interpretation

The results of the empirical study largely explain the nature of the Algerian economy and its structural imbalances, especially that the study included different stages in the economic orientation of Algeria from its approach of centrally planned economy before the mid-eighties, and then the beginning of the transition to a market economy and the implementation of economic reform programs in the 1990s. Then, implementing a several development programs starting in 2001 until now. This has affected the effectiveness of the economic policies adopted, especially monetary policy, and its impact on the real sector in the short and long term.

The results of our current study have shown significant effectiveness of monetary policy on short-term output fluctuations, so that the expansionary policy of Bank of Algeria(increasing the money supply growth)has not widened the output gap, but has contributed to reducing the gap and stabilizing output, this is compatible with results of McCandless and Weder (1995) which reached a positive correlation between monetary base growth and output in the long-term for countries which average inflation rate is poor (Countries of the Organisation for Economic Co-operation and Development) (Eric, 2000), this led the Bank of Algeria to believe that controlling monetary causes would reduce inflation, and accept the scenario of stimulating economic growth in light of acceptable inflation rates. However, the expansionary policy of Bank of Algeria during the period 2001-2018 negatively affected the output fluctuation in the long term, that why we

have reachedan negative effect of changes in inflation rates on the GDP fluctuations. This is compatible with results of the previous studies: Gylfason (1991), Patrick Villieu and Taoufik Rajhi (1993), Scott Roger (2010). The most important mechanisms that have been the source of monetary expansion is the adoption of an open market policy from March 2017 to inject liquidity. And a Quantitative Easing Policy since November 2017. (Bank of Algeria, 2018). These results confirm that inflation in Algeria remains a problem with structural causes, which must be faced with a combination of coordinated economic policies so that the Bank of Algeria can achieve the target impact on the real sector (Belazzouz and al, 2008).

The Bank of Algeria has tried to correct the high inflation rates by implementing an inflation targeting policy starting in 2011. However, it hasn't been able to reach the target inflation rate at 4%, this confirms once again that the monetary expansion (a structural phenomenon) was a direct and strong structural cause of inflation in Algeria, so it also requires institutional reforms that address the non-monetary causes of inflation. (Taiba, 2014).

3.5- Test the validity of the estimated model

We test the validity of the estimated model through the following statistical tests:

3.5.1. Test of Normal distribution of residuals

Through the appendix3, we find that the probability corresponding to the Jaque-Bera test (Prob = 0.967) is greater than the level significance of 5%, so the residual follows the normal distribution.

3.5.2. Test the Heteroscedasticity

According to both appendix4 and appendix5, we find that the probability corresponding to the ARCH test and Breusch-Pagan-Godfrey test were Prob =0.4325 and Prob =0.0517 respectively, it was greater than the level significance of 5%, and therefore we accept the null hypothesis which means that the error variances are all equal, and this is good for the model and the results.

3.5.3. Error autocorrelation test

Using the Breusch-Godfrey Serial Correlation LM test and at a number of lags (P = 4), we found that the corresponding probability of this test is greater than the significance level of 5%, so we reject the null hypothesis that refers to no autocorrelation. (see the appendix6)

3.5.4. Test for structural stability of the model

For the purpose to test the structural stability of the estimated model coefficients, we use the cumulative sum test of the recursive residual (CUSUM). As the structural stability of the estimated coefficients for the formula of the error correction equation is achieved if the graph of the CUSUM statistic falls within critical bounds at a significance level of 5%. The coefficients are unstable if the graph of the previous two statistics move outside critical bounds.

Through the results of this test, it is clear that the model is characterized by stability in most of the study periods, where the graphic form occurred within the critical bounds at the significance level of 5%. So, the model parameters are structurally stable and there is no structural change in them as shown in the figure below.

Figure 2: test for structural stability of the model
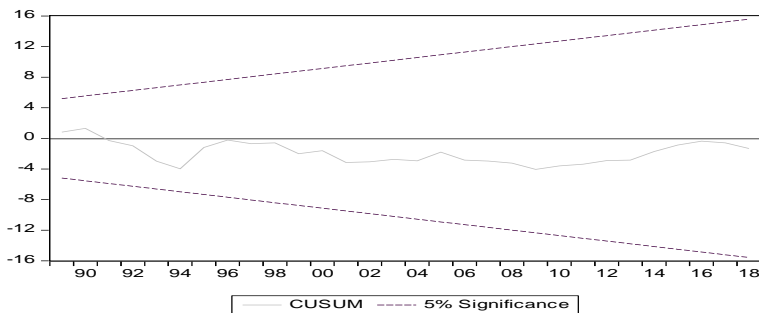
Source: prepared by researchers based on the Eviews10.0 program.

CONCLUSION

Our main question in this study was: does Inflation affect on output fluctuations in Algeria during the period 1980-2018?And we reached the following results:

- Bank of Algeria has treated the monetary causes of inflation by the application of strict deflationary monetary policy in the framework of economic reform programs, but its monetary policy was ineffective in achieving price stability during 2001-2018.

- Bank of Algeria didn't succeed in reducing inflation rates even after its adoption of the inflation targeting policy starting in 2011at a targeted rate of 4%.

- The results of the empirical study showed that there is a negative and significant effect of inflation on output gap in the long-run,when the inflation rate falls, the output gap increases significantly, making inflation affect negatively on output fluctuations.

- We have also found a positive effect of monetary supply on output fluctuation in the long-run,in contrast, there was no short-run effect except for the money supply, which had an impact of one lag.

Finally, we suggest some recommendations that enable Bank of Algeria to reduce inflation, such as:

- Charging the Bank of Algeria with the mission of price stability only as an ultimate and sole target for its monetary policy, and granting it with greater independence in order to submit it to accountability andto guarantee more effectiveness of its monetary policy.

- Reinforcing the permanent monetary stability at the general level of prices by completion of the structural reforms of the aggregated supply, and making the institutional reforms in order to control the non-monetary causes which create inflation.

- Enabling credits on economy to be an important source of monetary expansion and ensuring its successes without being regardless of the security and stability of the financial and bank system.

- Reconsidering the traditional monetary policy tools in affecting the situation of liquidity by providing the reasons and conditions of

its effectivenessto ensure that its impact is transmitted positively to the output fluctuation.

- Coordination between the monetary policy and the other economic policies regarding diversification of the financing sources of the national economy.

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Appendix

Appendix 1. Long-term model

ARDL Long RunForm and Bounds Test
Dependent Variable: D(GDP)
Selected Model: ARDL(1, 0, 0, 2)
Case 3: Unrestricted Constant and No Trend
Date: 03/22/20   Time: 16:24
Sample: 1980 2018
Included observations: 37

Conditional Error Correction Regression				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.009495	0.012201	0.778233	0.4425
GDP(-1)*	-0.820158	0.185892	-4.412009	0.0001
INF**	-0.098949	0.053681	-1.843274	0.0752
PP**	0.001265	0.005477	0.230903	0.8190
M2(-1)	0.153445	0.067188	2.283791	0.0296
D(M2)	0.032574	0.042555	0.765458	0.4500
D(M2(-1))	-0.074307	0.045102	-1.647521	0.1099

 * p-value incompatible with t-Bounds distribution.
** Variable interpreted as Z = Z(-1) + D(Z).

Levels Equation				
Case 3: Unrestricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
INF	-0.120647	0.054611	-2.209200	0.0349
PP	0.001542	0.006754	0.228279	0.8210
M2	0.187091	0.084693	2.209053	0.0349

EC = GDP - (-0.1206*INF + 0.0015*PP + 0.1871*M2)

F-Bounds Test		NullHypothesis: No levelsrelationship		
Test Statistic	Value	Signif.	I(0)	I(1)
		Asymptotic: n=1000		
F-statistic	5.663113	10%	2.72	3.77
k	3	5%	3.23	4.35
		2.5%	3.69	4.89
		1%	4.29	5.61
ActualSample Size	37	FiniteSample: n=40		

	10%	2.933	4.02
	5%	3.548	4.803
	1%	5.018	6.61
	FiniteSample: n=35		
	10%	2.958	4.1
	5%	3.615	4.913
	1%	5.198	6.845

t-Bounds Test		NullHypothesis: No levelsrelationship		
Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-4.412009	10%	-2.57	-3.46
		5%	-2.86	-3.78
		2.5%	-3.13	-4.05
		1%	-3.43	-4.37

Source: Prepared on the basis of the International Bank Data and the Bank of Algeria
https://data.albankaldawli.org(20-03-2020)
https://www.bank-of-algeria.dz(20-03-2020)

Appendix 2. Short term model

ARDL Error Correction Regression
Dependent Variable: D(GDP)
Selected Model: ARDL(1, 0, 0, 2)
Case 3: Unrestricted Constant and No Trend
Date: 03/22/20   Time: 16:26
Sample: 1980 2018
Included observations: 37

ECM Regression				
Case 3: Unrestricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.009495	0.003603	2.635574	0.0132
D(M2)	0.032574	0.034222	0.951847	0.3488
D(M2(-1))	-0.074307	0.038184	-1.946021	0.0611
CointEq(-1)*	-0.820158	0.164302	-4.991763	0.0000
R-squared	0.432125	Meandependent var		-0.000423
Adjusted R-squared	0.380500	S.D. dependent var		0.023250
S.E. of regression	0.018300	Akaike info criterion		-5.062025
Sumsquaredresid	0.011051	Schwarz criterion		-4.887872
Log likelihood	97.64746	Hannan-Quinn criter.		-5.000628
F-statistic	8.370448	Durbin-Watson stat		1.957144
Prob(F-statistic)	0.000281			
* p-value incompatible with t-Bounds distribution.				
F-Bounds Test		NullHypothesis: No levelsrelationship		
Test Statistic	Value	Signif.	I(0)	I(1)

F-statistic	5.663113	10%	2.72	3.77
k	3	5%	3.23	4.35
		2.5%	3.69	4.89
		1%	4.29	5.61
t-Bounds Test		NullHypothesis: No levelsrelationship		
Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-4.991763	10%	-2.57	-3.46
		5%	-2.86	-3.78
		2.5%	-3.13	-4.05
		1%	-3.43	-4.37

Source: Prepared on the basis of the International Bank Data and the Bank of Algeria
https://data.albankaldawli.org(20-03-2020)
https://www.bank-of-algeria.dz(20-03-2020)

Appendix 3. Natural residual distribution test
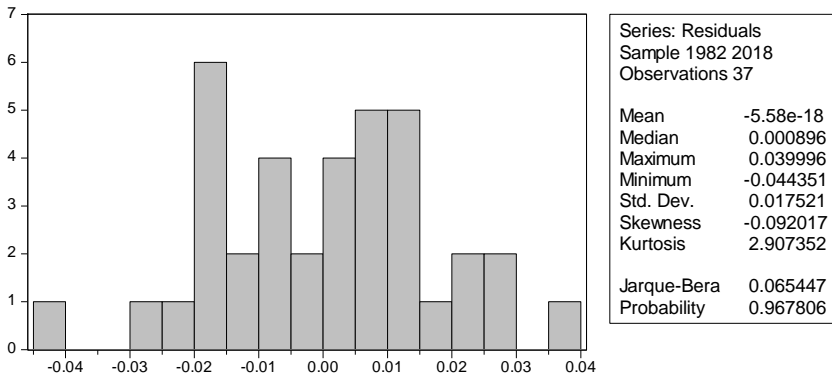
Series: Residuals	
Sample 1982 2018	
Observations 37	
Mean	-5.58e-18
Median	0.000896
Maximum	0.039996
Minimum	-0.044351
Std. Dev.	0.017521
Skewness	-0.092017
Kurtosis	2.907352
Jarque-Bera	0.065447
Probability	0.967806

Source: Prepared on the basis of the International Bank Data and the Bank of Algeria
https://data.albankaldawli.org(20-03-2020)
https://www.bank-of-algeria.dz(20-03-2020)

Appendix 4. ARCH test

Heteroskedasticity Test: ARCH

F-statistic	1.830408	Prob. F(4,28)	0.1510
Obs*R-squared	6.840393	Prob. Chi-Square(4)	0.1446

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 03/26/20   Time: 10:07
Sample (adjusted): 1986 2018

Included observations: 33 afteradjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000183	0.000110	1.670521	0.1060
RESID^2(-1)	0.118709	0.188485	0.629806	0.5339
RESID^2(-2)	0.463574	0.187771	2.468823	0.0199
RESID^2(-3)	-0.098604	0.188935	-0.521892	0.6058
RESID^2(-4)	-0.082606	0.184712	-0.447217	0.6582
R-squared	0.207285	Meandependent var		0.000306
Adjusted R-squared	0.094040	S.D. dependent var		0.000431
S.E. of regression	0.000411	Akaike info criterion		-12.61873
Sumsquaredresid	4.72E-06	Schwarz criterion		-12.39199
Log likelihood	213.2091	Hannan-Quinn criter.		-12.54244
F-statistic	1.830408	Durbin-Watson stat		1.953177
Prob(F-statistic)	0.150983			

Source: Prepared on the basis of the International Bank Data and the Bank of Algeria
https://data.albankaldawli.org(20-03-2020)
https://www.bank-of-algeria.dz(20-03-2020)

Appendix 5**-** Breusch-Pagan-Godfrey test

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	2.399186	Prob. F(6,30)	0.0517
Obs*R-squared	11.99725	Prob. Chi-Square(6)	0.0620
Scaledexplained SS	7.521796	Prob. Chi-Square(6)	0.2753

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 03/26/20   Time: 10:06
Sample: 1982 2018
Included observations: 37

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000306	0.000239	1.277431	0.2112
GDP(-1)	-0.004869	0.003647	-1.334812	0.1920
INF	0.001862	0.001053	1.767549	0.0873
PP	-5.46E-05	0.000107	-0.507662	0.6154
M2	-0.001242	0.000835	-1.487384	0.1473
M2(-1)	0.001193	0.000852	1.401313	0.1714
M2(-2)	-8.73E-05	0.000885	-0.098603	0.9221
R-squared	0.324250	Meandependent var		0.000299
Adjusted R-squared	0.189100	S.D. dependent var		0.000418
S.E. of regression	0.000377	Akaike info criterion		-12.76220
Sumsquaredresid	4.25E-06	Schwarz criterion		-12.45743

Log likelihood	243.1007	Hannan-Quinn criter.	-12.65475
F-statistic	2.399186	Durbin-Watson stat	2.429280
Prob(F-statistic)	0.051701		

Source: Prepared on the basis of the International Bank Data and the Bank of Algeria
https://data.albankaldawli.org(20-03-2020)
https://www.bank-of-algeria.dz(20-03-2020)

Appendix 6. Error correlation test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.570320	Prob. F(2,28)	0.5718
Obs*R-squared	1.448276	Prob. Chi-Square(2)	0.4847

Test Equation:
Dependent Variable: RESID
Method: ARDL
Date: 03/26/20   Time: 10:05
Sample: 1982 2018
Included observations: 37
Presamplemissing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP(-1)	0.188719	0.426041	0.442959	0.6612
INF	0.010215	0.067399	0.151561	0.8806
PP	0.000319	0.005576	0.057216	0.9548
M2	0.001009	0.043710	0.023075	0.9818
M2(-1)	-0.007630	0.044797	-0.170314	0.8660
M2(-2)	-0.012509	0.053133	-0.235432	0.8156
C	-0.003468	0.015004	-0.231171	0.8189
RESID(-1)	-0.194742	0.431063	-0.451772	0.6549
RESID(-2)	-0.212157	0.200807	-1.056522	0.2998

R-squared	0.039143	Meandependent var	-5.58E-18
Adjusted R-squared	-0.235388	S.D. dependent var	0.017521
S.E. of regression	0.019474	Akaike info criterion	-4.831684
Sumsquaredresid	0.010619	Schwarz criterion	-4.439839
Log likelihood	98.38615	Hannan-Quinn criter.	-4.693540
F-statistic	0.142580	Durbin-Watson stat	1.961984
Prob(F-statistic)	0.996293		

Source: Prepared on the basis of the International Bank Data and the Bank of Algeria
https://data.albankaldawli.org(20-03-2020)
https://www.bank-of-algeria.dz (20-03-2020)