Money supply as an intermediate variable to investigate the impact of exchange rate on inflation in Algeria during the period 2002-2018.
العرض النقدي كمتغير وسيط لدراسة تأثير معدل الصرف على التضخم في الجزائر

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Abstract:

The purpose of this research is to investigate the relationship between exchange rate and inflation over the period 2002-2018 by taking into consideration the impact of money supply. The researcher used some statistical tools such as: partial correlation, Person correlation and regression analysis.

The research concluded that the exchange rate didn't affect directly the inflation rate recorded over the studied period, but it had an impact on increasing, firstly, the excess liquidity of money. That's why it's very important for the bank of Algeria to use the monetary policy tools as long as the exchange rate is expected to get down in the market.

Keywords: exchange rate; inflation; money supply; monetary policy.

Jel Classification Codes: E51, F31.

ملخص:

هدف البحث إلى اختبار العلاقة بين معدل الصرف والتضخم في الجزائر خلال الفترة 2002-2018 مع الأخذ في الحسبان تأثير العرض النقدي. في هذا السياق، استعمل الباحث بعض الأدوات الإحصائية مثل: معدل الارتباط الجزئي، معدل ارتباط بارسون وكذا تحليل الانحدار.

وقد خلص البحث إلى أن معدل الصرف لم يؤثر بشكل مباشر في معدلات التضخم المسجلة خلال الفترة محل الدراسة، ولكن كان له تأثير في الرفع من فائض السيولة النقدية أولا. ولهذا، فإنه لمن الضروري على بنك الجزائر استعمال أداوت السياسة النقدية كلما كان من المتوقع أن يشهد معدل الصرف انخفاض في السوق.

كلمات مفتاحية: ك معدل صرف، تضخم، عرض نقدي، سياسة نقدية.

E51, F31. : **JEL تصنيف**

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1. INTRODUCTION:

Exchange rate has an important place in the macroeconomic policies of all the countries of the world. It has a huge impact in promoting foreign trade since the prices of all the goods and services is enormously affected by the fluctuation of this variable. Also, this rate is considered as one of the most important determinants of inflation because, on one hand, it directly affects the prices of any imported merchandise and, on the other hand, it can influence the amount of money supply because the great part of foreign currencies owned by any country will be changed to the local currency using its exchange rate.

So, inflation volume is hugely related to the changes of exchange rate. That's why in Algeria this issue is among the critical economic problems that should be studied and iinvestigated, especially with the continuous decrease of the value of the Algerian currency and, also, the decrease of the oil income owned by the country during the recent years, knowing that this income is the main source of the foreign currency for Algeria. Otherwise, owing to the decrease of the international oil prices, the Algerian exchanged rate is expected to cut down further and it may hugely affect inflation in the upcoming years if the Algerian monetary authorities will not intervene as soon as possible to take the right decisions aiming to reduce the impact of the exchange rate on the amount of money supply.

For this reason, this research aims to investigate the relationship between exchange rate and inflation in Algeria over the period 2002-2018 by taking into consideration the impact of money supply and its relationship with the tow previous variables.

1.1. Problematic of the research:

The problematic of the research is related to the nature of the relationship between the studied variables. It has been shaped as follows:

- Did exchange rate affect directly inflation in Algeria over the period 2002-2018 or its huge impact on it is related to its influence on money supply?

1.2. Hypotheses of the research:

The followings are the main hypotheses of the research:

H1: there is a direct impact of exchange rate on inflation in Algeria statistically proven during the studied period 2002-2018.

H2: there is an indirect impact of exchange rate on inflation in Algeria, by taking into account the impact of the exchange rate on money supply, then on inflation, statistically proven during the studied period 2002-2018.

1.3. Purpose of the research:

The research aims to study the relationship between exchange rate and inflation over the period 2002-2018 by taking into consideration the impact of money supply. Such study is very important to understand the power of exchange rate in affecting inflation and, consequently, determine the best way of reducing inflation trend caused by the fluctuation of exchange rate.

1.4. Methodology of the research:

The study is an analytical research aiming to investigate the impact of money supply on inflation in Algeria over the studied period (2002-2018).

1.5. Previous studies:

Many studies aimed to highlight the impact of exchange rate, inflation, money supply and the related topics in Algeria and all over the world. Among theme are the following studies:

-(Hamedani & Pedram, 2013): the purpose of this study is to investigate the optimal monetary policy strategy for the economy of Iran by focusing on the impact of oil price shock. The research concluded that domestic inflation targeting rules can be taken as the optimal monetary policy in terms of stabilization performance and welfare cost. Also, the study illustrated that the addition of exchange rate to domestic inflation targeting rules was unsuccessful to enhance the welfare measure and stabilization in comparison to domestic inflation targeting rule. (Rabee Hamedani, 2013)

-(Si Mohamed & others: 2015): the research tried to find a non-linearity model in the real exchange rate in Algeria during 1994-2015. The research used an application of logistic smooth transition autoregressive (LSTAR), and exponential smooth autoregressive (ESTAR). The results rejected linearity null hypothesis in favour of nonlinearity alternative hypothesis. This study highlighted some recommendations that should be taken into account in Algeria in order to adopt an efficient forecasting method. (Kamel Si Mohamed and others, 2015)

- (ASARI & others, 2011): the purpose of this research is to investigate the relationship between interest rate, inflation rate and exchange rate volatility in Malaysia during the period 1999-2009. The researchers used Vector Error

Correction Model (VECM) as a principal statistical tool. They concluded that in the long term interest rate moves positively while inflation rate goes negatively towards exchange rate volatility in Malaysia over the studied period. (Fizari, ASARI, & others, 2011)

-(KHIN & others): the research aimed to investigate the impact of exchange rate volatility on macroeconomic determinants in Malaysia from January to august 2016. The researchers used Vector Error Correction Model (VECM). The research concluded that more efforts on structural and institutional reforms are needed for financial sectors in order to deal with the changes caused by exchange rate volatility. (KHIN & others, 2017, pp. PP 36-45)

-(Lacheheb & Sirag, 2016): the purpose of the research is to investigate the relationship between oil price changes and inflation rate recorded in Algeria during the period 1970-2014. The researchers used a nonlinear autoregressive distributed lags (NARDL). The results proved a significant relationship between oil price increases and inflation rate. However, the research didn't prove such significant relationship between oil price reduction and the inflation. In fact, the research concluded to the existence of nonlinear effect of oil price on inflation. (Miloud Lacheheb & Abdalla Sirag, 2016)

-(Ennemri, 2018): the researcher tried to analyse the main determinants of inflation in Algeria during the period 2002-2017. In this context, the researcher focused on three variables influencing inflation: money supply, global domestic product and foreign exchange reserve available at the bank of Algeria. The research concluded that the volatility of the last variable has been among the most influencing determinants of inflation since it affects the amount of inflation, and it is affected by the volume of global domestic product. (Ennemri, 2018)

2- Method:

The purpose of this research is to investigate the relationship between money supply and inflation in Algeria by taking into account the impact of exchange rate, firstly, on money supply and, subsequently, on inflation.

2.1. Variable of the research:

The main variables of the research are those included in the title, which are highlighted as follows:

- Inflation (INF): it's a macroeconomic indicator requiring a continuous control in order to make it as low as possible because it represents one of the most negative factors for the entire economy. Its negative impact can especially appeared in reducing consumers' purchasing power. This negative impact may

influence the efficiency of the entire economy since it negatively influences the profits of all the producers and obliges them to reduce their production and, obviously, the economy may know a huge decrease in the amount of global domestic product.

- Money supply (M2): this indicator represents the amount of liquidity of money put into circulation in the economy in order to perform all the transactions init. It's a very sensitive indicator since it may, negatively, influence consumers' buying power by influencing inflation if its amount is above the reasonable level. That's why it's critical to control this variable especially to take all the necessary measures in order to remove the excess liquidity of money.

- Global domestic product (GDP): each time inflation and money supply are to be investigated, this variable is crucial to be included as well because the inflation can't be influenced by money supply if the additional amount of this last variable is put into circulation simultaneously with the increase of global domestic product.

-M2/GDP: in order to determine whether money supply is adequate to the amount of global domestic product, this indicator (M2) is crucial to be calculated by dividing money supply on global domestic product (money supply/global domestic product). It shows whether the increase of money supply is not above the increase of global domestic product because inflation is always stimulated by the excess liquidity of money.

-Exchange rate (EXCH): this indicator can play the role of the independent variable because it influences directly inflation. Also, it influences firstly money supply, and then this last variable influences inflation. In fact, there is a mutual relationship between inflation and exchange rate because the decrease of the exchange rate increases inflation since it increases money supply. Then the internal inflation conducts the exchange rate toward a decrease, especially in the long run because the internal inflation makes people increase their demand of foreign goods and services which, in a certain period, causes the decrease of the exchange rate.

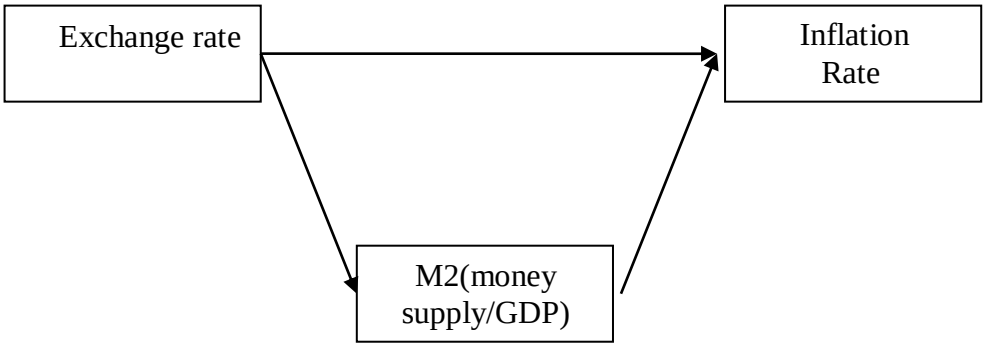
2.2. Data of the research:

The research covered the period 2002-2018. That's why the researcher used some reports of the bank of Algeria published in the same period and still available on its website. Also, especially for exchange rate, the researcher used some reports of the Arabic monetary fund to get the data of this variable.

2.3. Model design:

The model of the research is presented as follows:

Fig. 01: Model design



Source: prepared by the researcher

The figure illustrates the role of all the variables of the research. In fact, the direct relationship between exchange rate and inflation rate shows the direct impact of exchange rate on inflation. In this relationship the exchange rate is considered as an independent variable while the inflation rate represents the dependent variable. Then, M2 has been taken as an intermediate variable because the exchange rate has as well an indirect impact on inflation since it affects firstly the amount of money supply which affects in turn the volume of inflation.

3. Results and discussion:

The results of the research are presented as follows:

3.1. Amounts of the research variables:

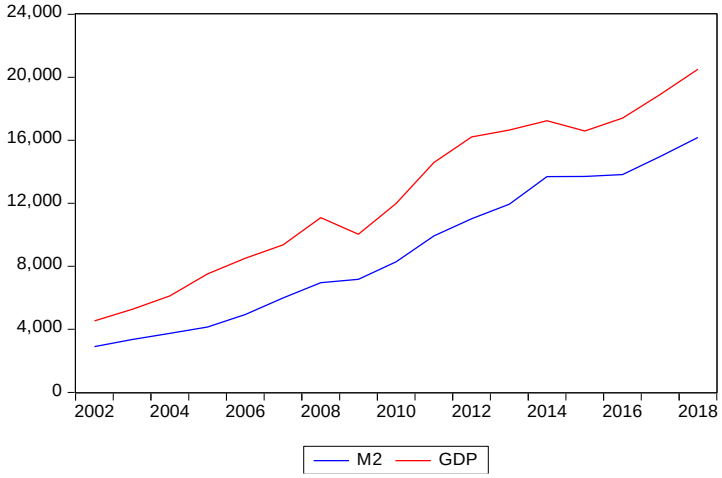
Table 01: the amounts of the research variables

Year	Inflation rate	GDP	Exchange rate	M2
2002	2.2	4537.700	79,68	2901,5
2003	3.5	5264.200	77,39	3354,4
2004	4.6	6126.700	72,06	3738
2005	1.9	7519.000	73,27	4146,9
2006	1.8	8514.800	72,64	4933,7
2007	3.9	9366.600	69,29	5994,6
2008	4.4	11090.00	64,58	6955,9
2009	6.1	10034.30	72,64	7173,1
2010	4.1	11991.00	74,39	8280,7
2011	5.7	14588.50	72,93	9929,2
2012	9.7	16208.70	77,53	11015,1
2013	4.15	16643.80	79,36	11941,5
2014	3.8	17242.50	80,57	13686,7
2015	4.4	16591.90	100,46	13704,5
2016	6.4	17406.80	109.5	13816.3
2017	5.9	18906.60	111.00	14974.6
2018	4.27	20509.5	115.00	16177.06

Source: the reports of the bank of Algeria (2002-2017)
Arabic Monetary found report
World Bank data.

The development of these variables can be much clearer using the following graphs:

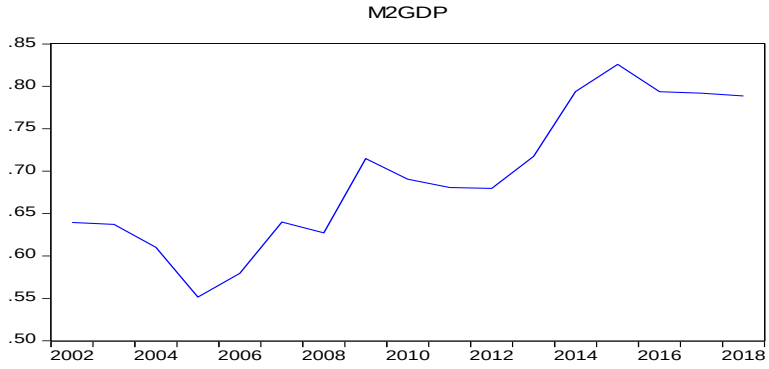
Fig. 02: the development of money supply (M2) and global domestic product in Algeria over the period 2002-2018



Source: from EVIEWS using the research data (table 01)

The figure illustrates the ascending trend of both money supply and global domestic product during the studied period. This trend is not enough to conclude that there is an acceptable equilibrium between the tow variables in order to reduce inflation. For this reason, it's critical to follow the development of the ratio (M2/GDP). This development is presented using the following graph:

Fig. 03: the development of the ratio (M2/GDP) over the period 2002-2018

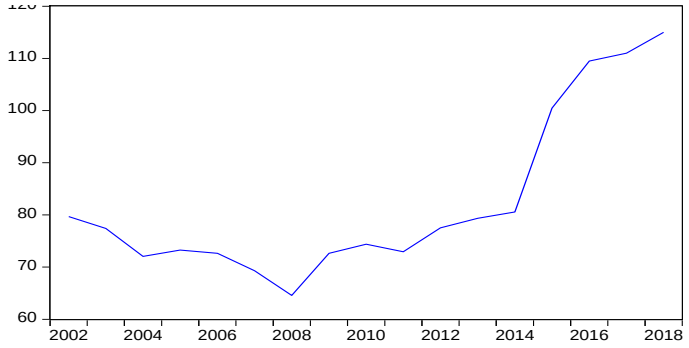


Source: from EVIEWS using the research data (table 01)

The figure shows the fluctuation of this ratio over the studied period with an ascending trend in general. This situation provides an idea about the huge instability of the impact of money supply on inflation. It may refer as well to the non efficiency of the bank of Algeria in managing the excess liquidity of money and, subsequently, requires more effort by the bank in order to rightly intervene so as to rebalance the situation.

Fig.04: the development of the exchange rate over the period 2002-2018

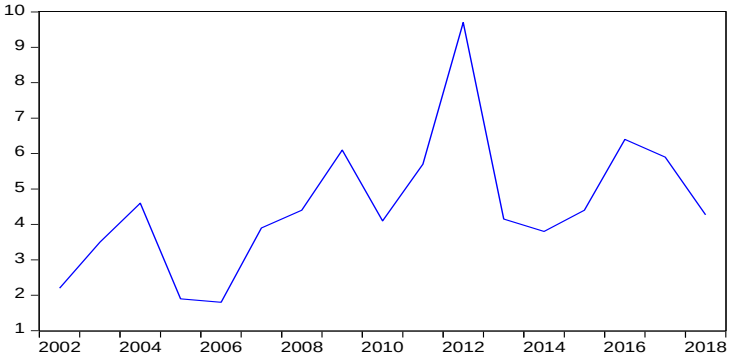
Fig. 04: the development of exchange rate over the period 2002-2018



Source: from EVIEWS using the research data (table 01)

The figure shows the fluctuation of the exchange rate recorded in Algeria until 2014, and then this variable knew an ascending trend until 2018. In fact, such development may refer to the different impact of the exchange rate on the inflation rate from the first to second period.

Fig.05: the development of the inflation rate over the period 2002-2018



Source: from EVIEWS using the research data (table 01)

The figure enhances the former analysis concerning the impact of the previous variables on inflation since it illustrates a huge fluctuation of the inflation rate recorded in Algeria during the studied period. Otherwise, the kind of the development of the different variables highlighted in this research as well as their instable impact on inflation conducts to such fluctuation and, subsequently, the bank of Algeria must keep using its tools as long as the inflation is affected by those variables in order to eradicate their negative impact on inflation.

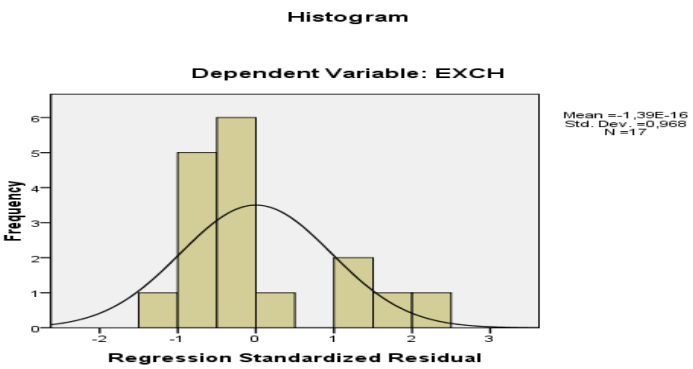
3.2. Test for normality:

Since the research investigates the relationship between exchange rate and inflation in Algeria bay taking into account the impact of an intermediate variable (M2/GDP), test for normality has been curry out as follows:

3.2.1. Test for normality of the relationship between exchange rate and inflation rate:

The following figure shows the result of this test:

Fig. 06: test for normality 01



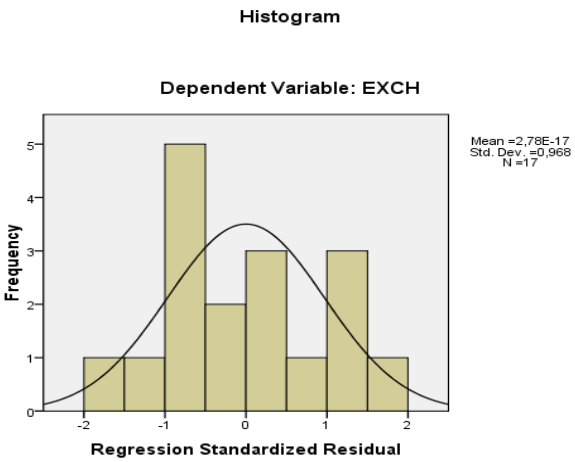
Source: from SPSS using table 01

The figure provides evidence that the research data follows normal distribution. So, in this relationship exchange rate has been taken as a dependent variable, while inflation has been considered as an independent variable.

3.2.2. Test for normality of the relationship between exchange rate and (M2/GDP):

The following figure shows the result of this test:

Fig. 07: test for normality 02



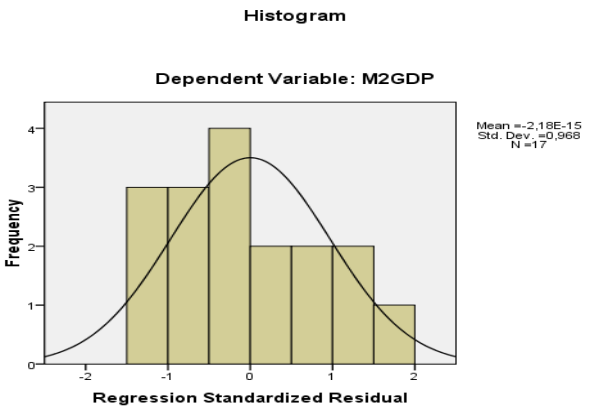
Source: from SPSS using table 01

In this model, the exchange rate is considered as a dependent variable, while (M2/GDP) has been taken as an independent variable. The figure shows that the research data follows normal distribution.

3.2.2. Test for normality of the relationship between (M2/GDP) and inflation rate:

The following histogram shows the result of this test:

Fig. 08: test for normality 03



Source: from SPSS using table 01

This time, (M2/GDP) is considered as a dependent variable while inflation rate is considered as an independent variable. The histogram proves that the research data of this model follows normal distribution.

4. Correlation analysis:

The nature of the research and the relationship between the variables of the model makes the researcher use tow kinds of correlation test, Person and partial correlation:

4.1. Person correlation:

The results are presented in the following table:

Table02: Person correlation

		INF	EXCH	M2GDP
INF	Pearson Correlation	1	,218	,413
	Sig. (2-tailed)		,401	,099
	N	17	17	17
EXCH	Pearson Correlation	,218	1	,773**
	Sig. (2-tailed)	,401		,000
	N	17	17	17
**. Correlation is significant at the 0.01 level (2-tailed).				

Source: from SPSS using table 01

The table illustrates that the correlation between the inflation rate and the exchange rate is weak a lit bit, while it's relatively stronger between inflation and (M2/GDP) which means that the inflation is mainly affected by the excess liquidity of money rather then by the amount of exchange rate. This relationship may refer that the exchange rate doesn't affect directly inflation but it affects firstly money supply, then this last variable affects inflation. This analysis is proven by the high correlation between exchange rate and the ratio (M2/GDP) (0.773 in the table).

4.2. Partial correlation:

The purpose of this test is to neutralize the impact of (M2/GDP) in order to determine the degree of exchange rate impact on inflation:

Table 03: Partial correlation

Control Variables			INF	EXCH
M2GDP	INF	Correlation	1,000	-,176
		Significance (2-tailed)	.	,515
		df	0	14
	EXCH	Correlation	-,176	1,000
		Significance (2-tailed)	,515	.
		df	14	0

Source: from SPSS using table 01

The table illustrates that the correlation between the exchange rate and the inflation rate is weaker after naturalizing (M2/GDP). For this reason, it's acceptable to confirm that the exchange rate doesn't affect directly the amount of inflation but it affects money supply which affects in turn inflation. Also, these results as well as the previous results provide evidence that the inflation trend recorded in Algeria during the studied period is not mainly due to the imported inflation, but it's due to the excess liquidity. This situation requires the continuous intervention of the bank of Algeria in order to get the best equilibrium between money supply and global domestic product.

4.3. Regression analysis:

The purpose of this analysis is to confirm the previous analysis concerning whether there is a significant relationship between exchange rate (independent variable) and (M2/GDP) (dependent variable). Then, it's important to examine the

relationship between (M2/GDP) (independent variable) and inflation rate (dependent variable) so as to control the indirect impact of exchange rate on inflation rate. The results of the tow models are presented in the tow upcoming tables:

Table 04: ANOVA[b] 1

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	,066	1	,066	22,206	,000[a]
	Residual	,045	15	,003		
	Total	,111	16			
a. Predictors: (Constant), EXCH						
b. Dependent Variable: M2GDP						

Source: from SPSS using table 01

The results prove there is a significant relationship between exchange rate (dependent variable) and (M2/GDP) (independent variable) since (sig.) in the table is under (0.05), which confirm the impact of the first variable on the second one.

Table 05: ANOVA[b]2

Model		Sum of Squares	df	Mean Square	F	Sig.
2	Regression	9,934	1	9,934	3,090	,099[a]
	Residual	48,225	15	3,215		
	Total	58,159	16			
a. Predictors: (Constant), M2GDP						
b. Dependent Variable: INF						

Source: from SPSS using table 01

The table illustrates that there is a significant relationship between (M2/GDP) (dependent variable) and inflation rate (dependent variable) since (sig.) in the table is less then (0.05). That's why it's very clear to prove the impact of money supply on inflation and, subsequently, criticize the weakness of the bank of Algeria in using its monetary tools in order to reduce the excess liquidity.

5. Conclusion:

This research highlights a very important economic topic especially in Algeria with the inflation trend existing in the county since many years, and still expected to characterise the economic scene for many upcoming years as well, if the Algerian monetary authorities don't multiply their efforts, as much as possible, to reduce it. This inflation is due to many factors the most important of them are those affecting money supply. For this reason, the research tried to investigate the relationship between exchange rate and inflation by taking into account the impact of the excess money supply on inflation. The research concluded that exchange rate doesn't affect directly inflation rate, but it has some negative impacts on it by increasing the excess liquidity of money. This excess provides evidence that the intervention of the bank of Algeria in reducing it is not enough.

5.1. Results:

The following elements represent the main results of the research:

- Any decrease of exchange rate could have a direct impact of exchange rate on inflation. This impact hasn't strongly been proven in Algeria by the present research during the studied period 2002-2018.
- the decrease of exchange rate has as well an indirect impact of exchange rate on inflation since it's affect firstly money supply, then inflation. Such impact has been statistically proven in Algeria by the present research during the studied period 2002-2018.
- The present research confirms that the inflation trend recorded in Algeria during the studied period is not mainly caused by the imported inflation, but it's due to its impact on money supply. This result may refer that even when there is an imported inflation, the influence of money supply caused by the decrease of exchange rate is much higher.

5.2-Recommendations:

According to the results of the research, the researcher suggests the following recommendation:

- It's critical, for the bank of Algeria, to anticipate the impact of exchange rate on money supply by taking some decisions, aiming to reduce the excess liquidity such as: discount rate, open market operation, reserve requirement..., etc., each time the exchange rate is expected to be lower.
- The tow possible kinds of impact on inflation caused by the decrease of

exchange rate require avoiding the decrease as much as possible. For this reason, it's preferable to use a financial policy so as to cover the public budget deficit by increasing taxation.

- In any case, the monetary authorities should adopt a gradual decrease of exchange rate to avoid a huge impact on inflation, especially, if this policy is expected to be used as a way of reducing the public budget deficit.

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