Inflation and Exchange Rate Pass-Through in Algeria

Zakaria SEHAILIA [*], Boubakeur SAKHI [**]

Received: 17/12/2020
Accepted: 28/04/2021
Published: 09/10/2021

Abstract:

The objective of this research paper is studying and analysing the reaction of inflation, resulting from fluctuations in Nominal Exchange Rate in Algeria during the period 1990-2018, and know the extent to which exchange rate fluctuations affect inflation, via building a Vector Auto Regression model. Where we adopted for: Nominal Exchange Rate, Money Supply and Oil Prices as independent variables.

The results of research show that Exchange Rate Pass-through during the studied period is significant, and plays a role very important in explaining the behaviour of inflation rates in Algeria. In addition, the shocks of Exchange Rate have a long and short term effects on inflation. It also turns that the rest of variables are very important tools to control the general price level.

Keywords: *Pass-through; Exchange rate; Inflation; Vector Auto Regression*

JEL Classification: E31, F31, C22.

ملخص :

الهدف من هذه الورقة البحثية هو دراسة وتحليل ردة فعل التضخم، تبعا لتقلبات سعر الصرف في الجزائر خلال الفترة 1990-2018، ومعرفة إلى أي مدى تؤثر تقلبات سعر الصرف على التضخم، وذلك من خلال بناء نموذج للانحدار الذاتي. حيث تم الاعتماد فيه على سعر الصرف الاسمي، الكتلة النقدية وأسعار البترول كمتغيرات تابعة.

وقد أظهرت نتائج الدراسة أن نفاذية سعر الصرف خلال الفترة المدروسة في غاية الأهمية، وتلعب دورا هاما في تفسير سلوك التضخم في الجزائر. أضف الى ذلك أن صدمات سعر الصرف لها أثر على المديين الطويل والقصير، وتبين أيضا أن المتغيرات الأخرى هي كذلك أدوات مهمة للتحكم في المستوى العام للأسعار.

الكلمات المفتاحية : النفاذية، سعر الصرف، التضخم، الانحدار الذاتي.

تصنيف JEL : E31، F31، C22.

[*] Company Laboratory, Human Resource Management & Sustainable Development, Blida 2 University,Algeria, ez.sehailia@univ-blida2.dz ……. **(Coresponding author)**

[**] Blida 2 University, Algeria, bakresakhi@yahoo.fr

1. Introduction :

Inflation is among the most common and repeated words in economic literature, as different countries of the world seek to reduce its severity by dedicating research teams and laboratories scientists that work hard, to establish development programs and economic policies which slow down the exacerbation of this violent phenomenon.

This leads to a deterioration in the standard of living of the individual and a decrease in his purchasing power, by increasing the general level of prices.

There are many tools that help control and stabilize inflation, Taylor believes that the main reason is monetary policy (Taylor, low inflation,pass-through and the pricing power of firms, 2000, p. 1390).

On the other hand, the exchange rate as one of the most important channels for the transmission of monetary policy (Mishkin, 1996, p. 94). Because it occupies an important space in the middle and economic research, as the main instrument having a direct impact on the relationship between internal and external prices.

This brings to the concept of fluctuations in exchange rate to prices, or what is called "Exchange Rate Pass-Through». The ERPT is the degree of sensitivity in domestic prices to changes in the exchange rate, and it varies depending to its passage, either partial, total or no Pass-Through (Termprasertsakul, 2015, p. 3).

Here, we must be asked the following problematic:

"To what extent do exchange rate fluctuations affect inflation in Algeria?"

To answer this problematic, we make the following hypothesis:

H1: There is two-way causal relationship between the exchange rate and inflation.

H2: Inflation rates are directly proportional to exchange rate.

The objective of this paper is to empirically measure the degree of transmission of monetary policy, through the exchange rate channel (Pass-Through) and examine the reaction of inflation, due to changes in the nominal exchange rate.

This paper work is structures as follow, in section two we present economic literature, theories and some empirical work in the same subject. In section three we describe empirical methodology. In section four we show and discuss the results.

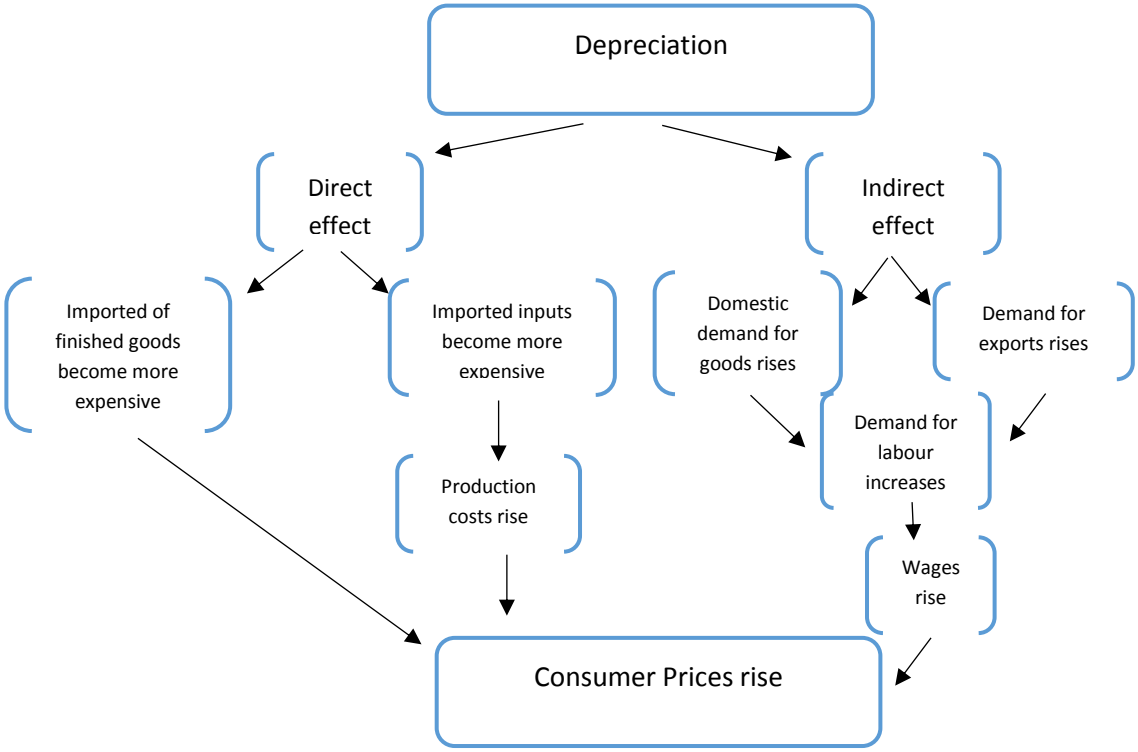
2. Literature and Review:

2.1. Review of the theoretical literature: Until this year, 50 years ago, since Milton Friedman laid out his views the monetary policy transmission mechanism in a paper entitled "A Theoretical Framework for Monetary Analysis". The mechanism of the impact of monetary policy is represented in the channels that transfer the impact to production and prices. There are three transmission channels: the traditional interest rate, the credit and the price channel of other assets (Mishkin, 1996, p. 92). This latter contains the exchange rate channel, which is considered to be one of the main channels responsible for transmitting the impact of monetary policy, and especially in open economies, and they emphasized its importance Mundell and Fleming by IS-LM-BP Model.

The exchange rate channel plays an important role in how monetary policy affects the national economy (Taylor, 1995, p. 11).

Meaning that: the increase in the money supply leads to a fall in interest rates, which reduces the attractiveness of deposits in national currency compared to deposits in foreign currency. As a result, a decrease in the value of the national currency (an increase in the exchange rate), which results in a decrease in the value of the local commodity abroad, so the demand for it increases. So the exports increase, which translates into an increase in total production. And this is what Fisher reached, a depreciation makes domestic producers lower-cost producers (Fisher, 1989, p. 121). So, we deduced what Dornbush also concluded: activity and the real exchange rate appear as significant determinants of changes in the real commodity price (Dornbush, 1985, p. 9).

We can summarize it's in the following schema:



Source: Bank of Canada Review Winter January, 11, 1997

Figure (1): Pass-through from an exchange rate depreciation to consumer price

The change in exchange rates are now a key part of the monetary transmission mechanism, and the Pass-through exchange rate to domestic prices is a key factor of transmission of shocks and the adequate policy response in open economy (Taylor, 1995, p. 24) (Bacchetta & wincoop, 2002, p. 1). Finally; inflation is a purely monetary phenomenon this is who see Friedman and Schwartz, and any increase in the money supply would be followed by an increase in the general level of prices in long term (IMFReports, 2017, p. 69).

2.2. Previous empirical studies:

2.2.1. Goldfajn, Werlang (2000): The paper studies the relationship between exchange rate depreciations and inflation, using a sample of 71 countries in the period 1980 – 1998. They are found that: the pass-through coefficients increase the larger is horizon measured and the most robust determinants that affect the Pass-through are real exchange rate and Inflation.

2.2.2. Choudhri, Hakura (2001): The paper tests a hypothesis suggested by Taylor that a law inflationary environment leads a law exchange rate pass-through to domestic prices, using a large database that includes 1979- 2000 data for 71 countries. They are found: strong evidence that the relationship between the Pass-through and the average inflation rate is positive and significant across regimes.

2.2.3. Campa, Goldberg, Gonzalez & Minguez (2005): This paper presents an empirical analysis of transmission rates from exchange rate movements to import prices in Euro Area over the last fifteen years. The results show that: transmission rates from exchange rates to import Prices is high in the short run and are higher in the long run.

2.2.4. Takotoski, Kiyotaka (2006): The objective of this paper is to examine the pass-through effects of exchange rates on the domestic prices in 5 East Asian Economics, using a VAR analysis. They are found that: the degree of exchange rate pass-through to import prices was quit high in the crisis hit economics and the Import Price Index is the largest effect of Pass-through.

2.2.5. Si Mohamed & Others (2015): the paper examines the exchange rate pass-through on producer and consumer price indexes in the Algerian economy, using a VAR model upon quarterly data for the 2002-2011. The most result demonstrates that monetary shocks (exchange rate and supply money) are important source of CPI variance, and the oil important is nevertheless less strong contribution than monetary shocks.

2.2.6. Ait yahia, Rais (2017): The paper examines the degree of exchange rate fluctuations on Algerian consumer prices between 1995-2015, using VECM model. The model estimate showed that a depreciation of 1 percent of the exchange rate resulting in 1,59 percent increase in the CPI. The study also revealed that transmission of exchange rate was more important to explain the increase in the phenomenon of inflation in Algeria.

2.2.7. Alvarez, Shoja, Uddin & Yillmazkuday (2018): The article estimates the exchange rate pass-through by using good level daily data on wholesale prices of imported agricultural products, where the identification is achieved by using daily data on the domestic inflation rate. The results show that: There is positive relationship between frequency of price changes and Exchange Rate Pass-through.

2.2.9. Toubine, Benadda and Benslimane (2019): The purpose of paper is to determine empirically the impact of the exchange rate on inflation in Algeria during the period 1990-2016, using a VAR model with four variables. The model indicates that nominal exchange rate and credit which causes inflation in Algeria and any depreciation in exchange rate leads low inflation.

3. Empirical Methodology:

3.1. Variables and Data Sources: Those data are variable in the database Fund's International Monetary (FMI), The Data World Bank and OPEC; we use yearly data covering 1990 – 2018. Following reports of FMI, we choose the most important determinants of inflation: Nominal Effective Exchange Rate, Monetary Supply and Oil Prices.

3.2. Methodology:

This study follows the general empirical approach used in the economic literature, reflecting the theoretical underpinnings of the link between inflation and exchange rate. Taking into consideration the features of Algeria's Economy as well as data availability, this promotes a Vector Auto Regression model.

In its structural from, the VAR model is represented by the following equation (Bourbonais, 2015, p. 276):

$$\mathbf{B}\mathbf{y}_{\mathbf{t}} = \mathbf{A}_{\mathbf{0}} + \sum_{i}^{L} \mathbf{A}_{\mathbf{i}}\ \mathbf{y}_{\mathbf{t-i}} \quad + \quad \boldsymbol{\varepsilon}_{\mathbf{t}}$$

And in matrix form (Bourbonais, 2015, p. 277):

$$\begin{bmatrix} y_{1\,t} \\ \vdots \\ y_{K\,t} \end{bmatrix} = \begin{bmatrix} A_1^0 \\ \vdots \\ A_K^0 \end{bmatrix} + \begin{bmatrix} A_{1\,i}^1 & \cdots & A_{1\,i}^K \\ \vdots & \ddots & \vdots \\ A_{K\,i}^1 & \cdots & A_{k\,i}^K \end{bmatrix} * \begin{bmatrix} y_{1\,t-i} \\ \vdots \\ y_{K\,t-i} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1\,t} \\ \vdots \\ \varepsilon_{K\,t} \end{bmatrix}$$

4. Results & Discussion:

4.1. Stationarity Study:

The stationarity study of time series is very important to determinate the model optimum. So, we choose the unit root test to achieve our objective, depends on Augmented Dickey Fuller Test.

The results show that all variables have a unit root at level, but at the first difference will be stationary except NEER, which will be stationary at the second difference.

We note that the variables of model are not co-integrate in same order, in the sense of Granger: there is no co-integration relationship.

4.2. Lag Selection:

The majority of criteria showed that order of model is 3, so we estimate a VAR (3).

4.3. Model Function Estimation:

Using the Ordinary Least Squares method and according to VAR model estimation, we can estimate the following function:

$$\begin{aligned}\boldsymbol{Inf} = {} & 0{,}029\boldsymbol{Inf}(-\mathbf{1}) - 0{,}1946\boldsymbol{Inf}(-\mathbf{2}) + 0{,}2495\boldsymbol{Inf}(-\mathbf{3}) \\ & + 0{,}0015\boldsymbol{Neer}(-\mathbf{1}) + 0{,}093\boldsymbol{Neer}(-\mathbf{2}) \\ & + 0{,}056\boldsymbol{Neer}(-\mathbf{3}) + \mathbf{0{,}0265}\boldsymbol{Ms}(-\mathbf{1}) \\ & + 0{,}0826\boldsymbol{Ms}(-\mathbf{2}) + 0{,}0816\boldsymbol{Ms}(-\mathbf{3}) + 0{,}033\boldsymbol{Op}(-\mathbf{1}) \\ & - 0{,}079\boldsymbol{Op}(-\mathbf{2}) + 0{,}066\boldsymbol{Op}(-\mathbf{3}) + 26{,}5998.\end{aligned}$$

INF: Inflation is the rate of increase in prices over the study period. And its the overall increase in the cost of living in Algeria.

NEER: Nominal Effective Exchange Rate is a measure of the value of a currency (Algerian Dinars against US Dollars).

MS: Money Supply is the percentage of the increase in money supply compared to GDP in Algeria.

OP: Oil Prices is the price of Algerian oil approved in OPEC.

The Statistical Explain of Model:

Through the estimation results, we note R^2 value=0,9679 which translate that the variables chosen explains Inflation by 96,79%.

The Economic Explain of Model:

NEER: from the equation, we note that the flexibility of exchange rate is positive in all periods, in other words, there is a direct relationship between exchange rate and inflation. Meaning that ever increase of exchange rate (depreciation of Dinar) result increase of inflation, which match with economic theories.

MS: the flexibility of this variable is positive too, meaning that any increase in the money supply is offset by an increase in inflation, this is what is proven economically.

OP: Oil prices has a variable flexibility, so that it was positive in the first and third period, because higher oil prices increase liquidity and this lead to an increase in inflation rate. In the second period, it was negative, meaning that low oil prices result a decrease in Exchange Reserves volume, so that value of national money will decrease. Thereby increasing level prices and deterioration of purchasing power.

4.4. Model Quality Test:

Model Stability Test:

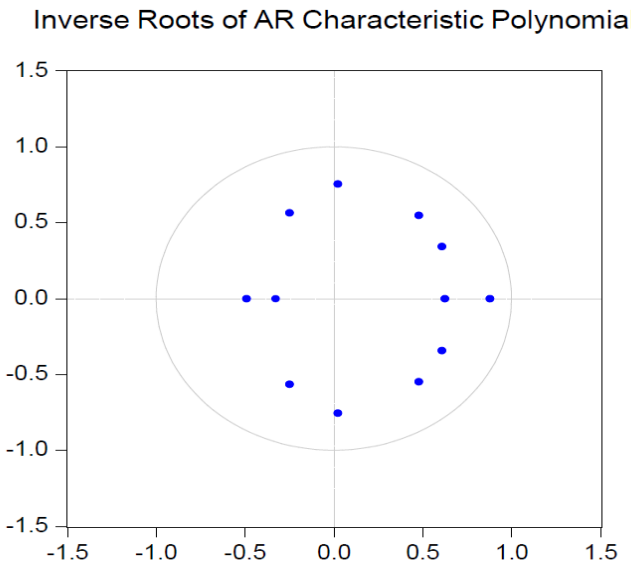


Figure (2): Results of stability test

Via results of stability test, that shows: the model estimated fulfils the condition of stability because all roots are into the unit circle, and all the confession is less than one.

Residual autocorrelation Test (LM-Test):

VAR Residual Serial Correlation LM Tests
Date: 11/23/20 Time: 13:41
Sample: 1990 2018
Included observations: 26

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	15.33860	16	0.5000	0.954569	(16, 19.0)	0.5326
2	10.33671	16	0.8485	0.579623	(16, 19.0)	0.8624
3	23.33357	16	0.1051	1.726138	(16, 19.0)	0.1279
4	16.49477	16	0.4190	1.052003	(16, 19.0)	0.4531
5	17.95637	16	0.3265	1.181552	(16, 19.0)	0.3606
6	16.62760	16	0.4101	1.063477	(16, 19.0)	0.4443
7	19.23079	16	0.2569	1.300617	(16, 19.0)	0.2896
8	10.58527	16	0.8343	0.596599	(16, 19.0)	0.8494
9	16.15264	16	0.4424	1.022718	(16, 19.0)	0.4761
10	14.42545	16	0.5671	0.880621	(16, 19.0)	0.5975
11	16.61235	16	0.4111	1.062157	(16, 19.0)	0.4453
12	25.25430	16	0.0655	1.949663	(16, 19.0)	0.0830

Figure (3): Results of Autocorrelation test

Via results of LM Test, the P value is more than 5% in the all degrees of lag, meaning that we accept null hypothesis "there is not autocorrelation".

Residual Heteroscedasticity Test (No cross terms):

VAR Residual Heteroskedasticity Tests (Levels and Squares)
Date: 11/23/20 Time: 13:43
Sample: 1990 2018
Included observations: 26

Joint test:

Chi-sq	df	Prob.
241.5540	240	0.4597

Figure (4): Results of Heteroscedasticity test

Via results, we note that P= 0,4597 meaning that residual have some homogeneous variances because P value of Chi-Square is more than 5%.

Normality Test: To testing Residuals are distributed normally or no, we must make two hypotheses:

-Null Hypothesis: H_0: P> 5%: residuals are distributed normally.

-Alternative Hypothesis: H_1: P< 5%: residuals are not distributed normally.

The next histogram shows results of normality test:

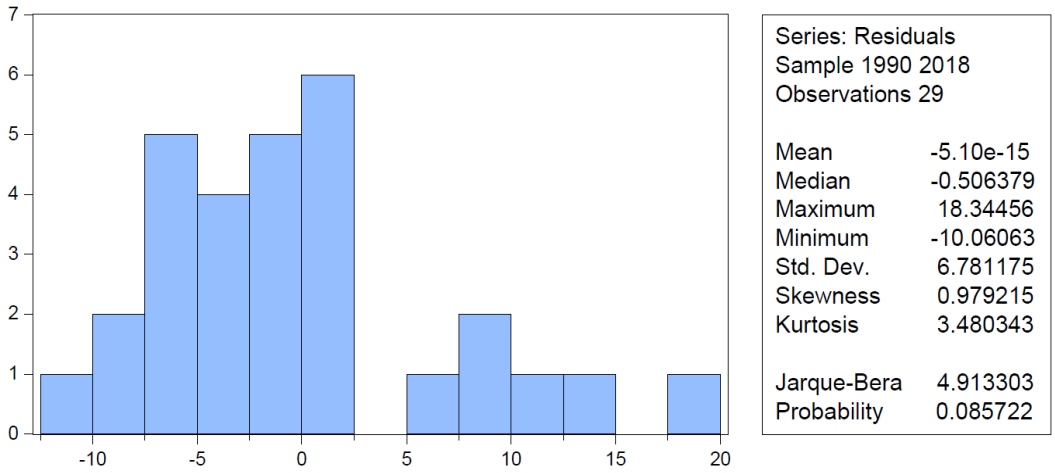


Figure (5): Histogram of Normality Test

Via results of Jarque Bera Test, we note that Probality value is more than 5%, so we cannot reject null hypothesis therefore residual are distributed normally.

4.5. Impulse Responses Function:

Examining the magnitude of Exchange Rate Pass-through shocks, we must estimate the Impulse Responses Function from a horizon of 10 years:

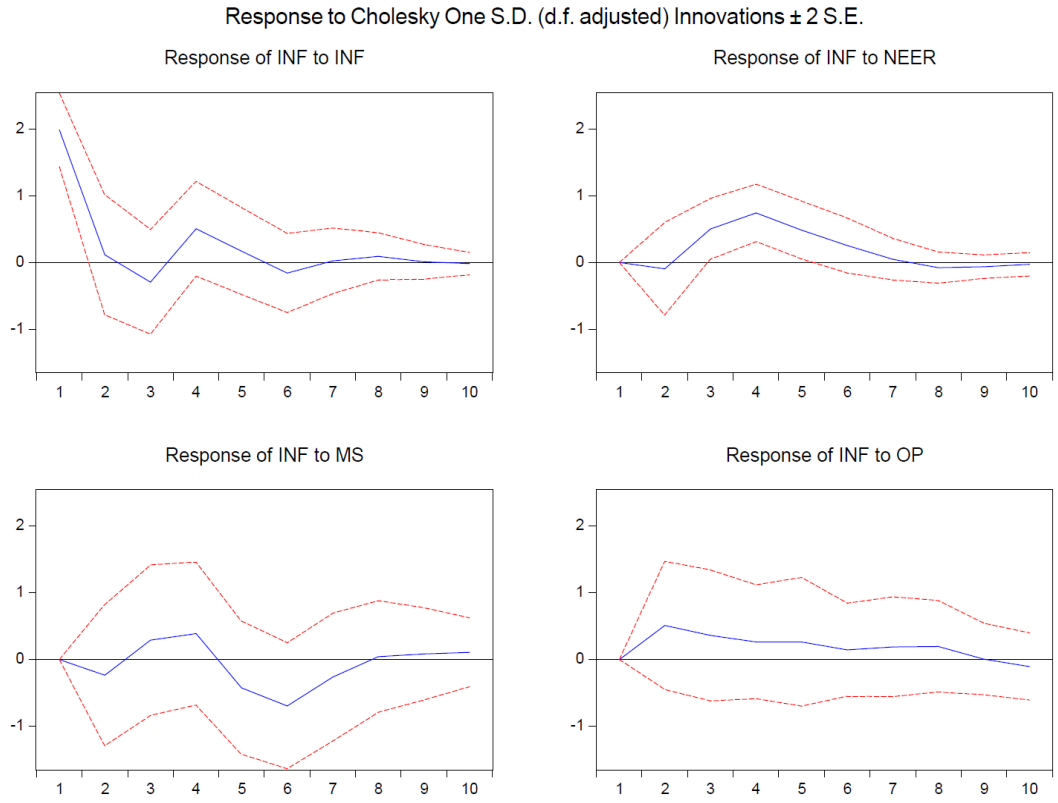


Figure (6): Graphs of Impulse Responses

Via graphs, we note that impact of shocks on the variables as follow:

Nominal Effective Exchange Rate(NEER): A sudden shock in Exchange Rate by one standard deviation leads to a negative effect in inflation in the period immediately following, then returns into a positive effect which continues until the eight period. After, it returns for reach negative effect until the end of horizon which means that Exchange Rate has a short and long term effect.

Money Supply(MS): A sudden shock in Money Supply by one standard deviation leads to a negative effect on inflation in the second period, then it will disappear in the next three periods, and returns in 5^{th}, 6^{th} and 7^{th} period.

Oil Prices(OP): Any sudden shock in oil prices doesn't give an immediate answer on inflation, but its negative effect on inflation appears at the end of horizon.

4.6. Variances Decomposition:

The results of variances decomposition (Appendix n°1) indicate that the direct effect of inflation on itself is high in the beginning (92,43%) and only (0,20%, 1,29% and 6,05%) of variation explain by exchange rate, Money Supply and Oil Prices respectively.

And declines slowly as the forecast horizon expands, reaching after ten years to (60,88%) of variance of Inflation forecast error is to its own innovations.

Exchange Rate becomes significant and represents (15,64%), as well Money supply which is increased its percentage has (14,58%). As for Oil Prices, they almost maintained the ratio with a small increase to be (8,88%).

4.7. Causality Test:

To testing causality, depend on Granger Causality Test, we can make two Hypothesis:

-Null Hypothesis: H_0: P> 5%: X does not Granger Cause Y.

-Alternative Hypothesis: H_1: P< 5%: X does Granger Cause Y.

According to the table in appendix n°2, twelve hypotheses were tested simultaneously, namely the causality between the four variables taken in pairs.

We thus tested the hypothesis of knowing if the Exchange Rate does not cause Inflation and vice versa.

Via results of test, those appear in the appendix n°2, we find:

- Nominal Effective Exchange Rate Granger causes Inflation and vice versa.

- Money Supply Granger causes Nominal Effective Exchange Rate.

- Inflation Granger causes Money Supply.

So we can summarize in the following schema:

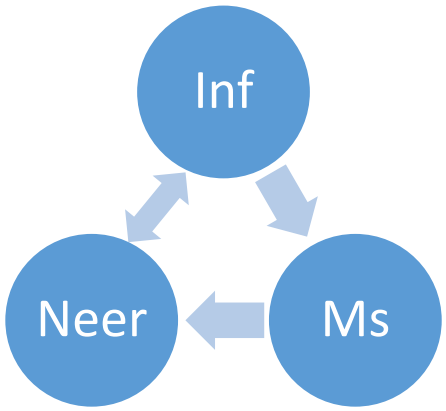


Figure (5): Schema of Causality

5. Conclusion:

This research paper studies the degree of transmission of Exchange rate fluctuations to Inflation in Algeria, during the period of 1990 to 2018, using a Vectorial Auto Regressive Model with four variables: Inflation, Nominal Effective Exchange rate, Money Supply, Oil Prices. The indicators of modelling show that the estimate model is a VAR (3), which is globally significant, stationary, so it is valid.

The results of modelling show: Exchange rate and Inflation have causal relationship in two-way, according to Granger causality which proves the validity of the first hypothesis. We found too that Inflation rates are directly proportional to Exchange Rate meaning that: the shocks of Exchange Rate have effects in short and long terms on inflation, and any change in Exchange Rate has response and degree of repercussion on Inflation, around 15% in the medium and long term, which proves validity of the second hypothesis

References & Bibliography:

- Ait yahia. S, Rais, F. (2017). Exchange Rate Pass-Through to Consumer Prices case of Algeria. ***El-Bahith Review***, N 17, P: 197-208.
- Alvarez. Renzo, Shoja. Amin, Uddin. Syed, Yillmazkuday. Hakan. (2018). Daily Exchange Rate Pass-through into Micro Prices. *Economics Research Working Paper Series*, 126, P: 1-6.
- Bacchetta. P, Van Wincoop. E. (2002). Why do consumer prices react less than import prices to exchange rate? ***National Bureau of Economic Research***, N 9352, P: 1-26.
- Bank of Canada Review. Winter (1996-1997), P: 21-31.
- Bourbonnais. R. (2015). *Econométrie* (9e Edition). Paris: ***Dunod***.
- Camp. J, Goldberg. L, Gonzalez-Minguez. (2005). Exchange Rate Pass through to import prices in the Euro Area. ***National Bureau of Economic Research***, N 11632, P: 1-37.
- Choudhri. E, Hakura. D. (2001). Exchange Rate Pass Through to Domestic Prices: Does the Inflationary Environment Matter. International Monetary Fund, N 01/194, P: 1-35.
- Dornbusch, R. (1985). Exchange Rates and Prices. ***National Bureau of Economic Research***. N 1796- 9, P: 1-32.
- Fisher. E. (1989). A Model of Exchange Rate Pass through. ***Journal of International Economic***, N 26, P :119-137.
- Goldfajn. I, Werlang. S. (2000). The Pass- through from Depreciation to Inflation: Panel study. ***Banco Central Do Brazil***, N 5, p 1-47.
- Ito. T, Salto. K. (2006). Exchange Rate & Inflation in post-crisis Asian economies: VAR analysis of the Exchange Rate Pass Through. ***National Bureau of Economic Research***, N 12395, P: 1-49.
- Mishkin. F.S. (1996). Les cannaux de transmission monétaire : leçons pour la politique monétaire. ***Bulletin de la Banque de France***, N 27, P : 91-105.
- Reports FMI. (2017). IMF country reports (Algeria). Determinants of inflation, N 17/142, P: 1-79.
- Si Mohamed & Others. (2015). Exchange Rate Pass-Through in Algeria. ***Mediterranean Journal of Social Sciences***, Vol 6, N 2, P: 195-201.
- Taylor. J. (1995). The Monetary Transmission Mechanism. ***Journal of Economic Perspectives***, Vol 9, N 4, P: 13-47.
- Taylor. J. (2000). Low inflation, pass-through and the pricing power of firms. ***European Economic Review***, 44, P: 1398-1408.
- Termprasertsakul. S. (2015). Essays on exchange rate exposure and exchange rate pass-through. ***Thesis of Doctor of Philosophy***. University of Essex. England 3.
- Toubine. A, Benadda. M, Benslimane. H. (2019). Pass-Through Exchange Rate and Inflation in Algeria: a VAR Model analysis (1990-2016). ***Journal of the New Economy***, Vol 10, N 01, P: 637-655.

Appendices:

Appendix I: Results of Variances Decomposition

Period	S.E.	INF	NEER	MS	OP
1	1.984697	100.0000	0.000000	0.000000	0.000000
2	2.067664	92.43421	0.209936	1.297987	6.057867
3	2.197072	83.67428	5.399828	2.876213	8.049674
4	2.418445	73.36523	13.84464	4.951912	7.838210
5	2.521800	67.92055	16.39370	7.376321	8.309430
6	2.636817	62.49767	15.90237	13.69806	7.901906
7	2.657276	61.54651	15.68766	14.47356	8.292268
8	2.667491	61.18633	15.65530	14.38900	8.769363
9	2.669645	61.08848	15.69016	14.46583	8.755531
10	2.674162	60.88731	15.64903	14.58236	8.881290

Cholesky Ordering: INF NEER MS OP

Appendix II: Results of Causality Test

Pairwise Granger Causality Tests
Date: 06/28/20 Time: 12:01
Sample: 1990 2018
Lags: 3

Null Hypothesis:	Obs	F-Statistic	Prob.
MS does not Granger Cause INF	26	1.51264	0.2435
INF does not Granger Cause MS		3.42393	0.0382
NEER does not Granger Cause INF	26	7.08279	0.0022
INF does not Granger Cause NEER		4.61322	0.0138
OP does not Granger Cause INF	26	0.13816	0.9360
INF does not Granger Cause OP		1.00948	0.4103
NEER does not Granger Cause MS	26	3.53383	0.0346
MS does not Granger Cause NEER		7.15282	0.0021
OP does not Granger Cause MS	26	2.30405	0.1095
MS does not Granger Cause OP		0.72873	0.5475
OP does not Granger Cause NEER	26	1.98327	0.1507
NEER does not Granger Cause OP		0.42838	0.7350