



## THE IMPACT OF UNCONVENTIONAL MONETARY POLICY TOOLS ON INFLATION RATES IN THE USA



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### ABSTRACT

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#### Keywords

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This study analyzed the impact of unconventional monetary policy tools on the expected inflation rates that global central banks targeted as a solution for the liquidity trap that many economies fell into during the 2008 financial crisis. The US economy was adopted as a case study for the period 2003 – 2018 with quarterly time series. The study model was based on credit variables (cr), actual federal interest rates (fir), and the monetary mass (M2), as independent variables and their effect on expected inflation rates as a dependent variable using Vector Auto Regression (VAR). The study found that the impact of credit volume changes on expected inflation rates was insignificant. This can be attributed to unconventional monetary policy tools, especially credit facilitation programs, since they aimed at stabilizing financial markets rather than stimulating higher inflation expectations. The zero-interest-rate policy adopted by the US Federal Reserve as of December 2008 contributed to boosting the expected inflation rates as indicated by the results of the study. The parameters were significant, and the relationship was inverse during the second lag interval. Theoretically, this was expected, according to Paul Krugman's model.

**Contribution/ Originality:** This study contributes to the existing literature for using the VAR model to analyze the impact of unconventional monetary policy tools on the expected inflation rates in the USA. It was measured with three tools: the volume of credit, rates of interest, and the monetary base. The paper revealed that there is a robust and statistically significant negative effect of rates of interest on expected inflation rates.

## 1. INTRODUCTION

The crisis of the 2007 summer began in the United States in the market of mortgage securities, more specifically in subprime mortgages. These are mortgages granted to American households that do not meet the conditions for subscribing to a conventional mortgage. Since a subprime mortgage is a monetary tool, the Federal Reserve does not have the ability to directly set mortgage rates; it does create the monetary policies that indirectly affect these rates. The influence of the Federal Reserve can be seen in how its actions affect the price of credit, which is then reflected in the mortgage rates that lenders offer prospective borrowers. These loans, given to the most risky clients, have the particularity of being, generally, at variable rates and backed by the value of the real estate of the borrower (Bricongne, Lapègue, & Monso, 2009).

The development of this form of monetary policy tools has been favored by a relatively stable macroeconomic environment (low inflation, strong), a sustained rise in real estate prices and low-interest rates in the United States. In this environment of very low interest rates, agents have invested in risk-rewarding securities to increase their

returns (Altunbas, Gambacorta, & Marques-Ibanez, 2014). This led to the underestimation of risk by financial institutions, rating agencies, regulators, and investors. This was accelerated by the birth of a class of non-bank real estate brokers who were not subject to the same regulations as banks. These agents, called structured investment vehicles, acted like banks borrowing on a very short-term basis, and financing highly structured products. At the same time, there has been an increase in the securitization of mortgages or the proceeds of these securities (Brennan, Hein, & Poon, 2009).

The 2007 crisis began with the difficulty faced by US households in repaying their mortgage loans. With variable-rate being sub primes, the increase in the US rate of interest from 1% (in 2004) to 5.25% (in 2006) increased the financial expenses of borrowers. At the same time, the real estate bubble that had been going on since the 1980s erupted as early as February 2007 (Kanga, 2017).

The American model is considered as one of the most important successful experiments in applying unconventional monetary policy tools, due to the approach of the Euro indicators, which also defined a variation in the results achieved by member states due to the lack of economic homogeneity between them and different financing structure and the degree of presence of financial intermediation in the markets etc. (Atsushi & Barbara, 2018). However, in terms of indicators, inflation rates in the Euro area are still meager after almost ten years of actual application of unconventional monetary policy tools (Gambacorta, Hofmann, & Peersman, 2014). As for the Japanese experience, it was the first to implement unconventional monetary policy tools through the implementation of quantitative easing programs during the period 2001-2006, but the weak results and repercussions of the recent financial crisis forced the Japanese Central Bank to re-apply new packages of unconventional monetary policy tools to developing countries (Morgan, 2009).

Krugman's model is however speculated as an effective tool to help in the exit of the economy from the liquidity trap. Consequently, the central bank can reduce nominal long-term interest rates in order to influence real long-term interest rates. This can also influence economic agents' expectations, in particular, the expected inflation rate, which encourages immediate consumption and thus can potentially stimulate economic growth (Engen, Thomas, & David, 2015; Krugman, 2000). In general, it can also lead to achieving the usual objective of monetary policy in the light of financial crises and the state of the liquidity trap. This is, of course, delivered by applying an integrated blend and a mixture of unconventional monetary tools embodied in quantitative easing; credit facilitation, negative and zero interest rates; advance guidance (conditional or unconditional Central Bank announcements).

From the above, we raise the question of how unconventional monetary policy tools can impact the expected inflation rates in the US for the period 2003-2018. This study analyzed the impact of unconventional monetary policy tools on the expected inflation rates in the USA in the real estate sector. The study used three measuring tools: the volume of credit, rates of interest, and the monetary base. The findings revealed that there is a robust and statistically significant negative effect of rates of interest on expected inflation rates.

## 2. LITERATURE REVIEW

Literature shows that heterogeneity in the Eurozone is at the origin of asymmetry in the transmission of interest rate policy (Barigozzi, Conti, & Luciani, 2014; Ehrmann, Gambacorta, Martinez-Pagés, Sevestre, & Worms, 2003; Frontmatter, 2003). In particular, the structure of the banking sector plays a critical role in the transmission of monetary policy in the Eurozone (Mojon, 2000). For example, Germany and Italy would be more exposed to financial shock than Finland, France, and Spain due to a high concentration of banks and the size of the equity market as a substitute for bank loans (Semenescu-Badarau & Levieuge, 2010), the market power of banks (Berger, 1995; Sorensen & Werner, 2006) and banking competition (Corvoisier & Gropp, 2002; Sander & Kleimeier, 2004).

There are various factors that influence the transmission of bank interest rates. Bank rates adjust more quickly in countries with relatively intense banking competition or where banks have weak market power. The rate adjustment is also slow where banks are highly liquid, highly capitalized, and more exposed to interest risk (Sorensen & Werner, 2006). At the same time, credit risk accelerates the transmission of monetary policy (Valverde & Fernández, 2007). Finally, cyclical factors (growth, housing prices, and credit growth) also tend to slow the adjustment of bank rates (Sorensen & Werner, 2006).

The Federal Reserve has been criticized for not meeting its goals of greater stability and low inflation (Selgin, Lastrapes, & White, 2012). This has led to a number of proposed changes including advocacy of different policy rules (Salter, 2014).

Milton Friedman concluded that governments play a major role in monetary system (Friedman & Schwartz, 1986). He was critical of the Federal Reserve due to its poor performance and felt it should be abolished. Friedman believed that the Federal Reserve System should ultimately be replaced with a computer program. He favored a system that would automatically buy and sell securities in response to changes in the money supply (Friedman, 1996). This proposal is known as Friedman's k-percent rule (Salter, 2014).

Others have proposed NGDP targeting as an alternative rule to guide and improve central bank policy. Prominent supporters include Scott Sumner, David Beckworth, and Tyler Cowen (Cord & Hammond, 2016).

Some economists, such as Taylor (2010) have asserted that the Federal Reserve (Fed) was responsible, at least partially, for the United States housing bubble which occurred prior to the 2007 recession. They claim that the Fed kept interest rates too low following the 2001 recession (Labonte & Makinen, 2005). The housing bubble then led to the credit crunch. Then-Chairman Alan Greenspan disputes this interpretation. He points out that the Fed's control over the long-term interest rates (to which critics refer) is only indirect. The Fed did raise the short-term interest rate over which it has control (i.e., the federal funds rate), but the long-term interest rate (which usually follows the former) did not increase (Labonte & Makinen, 2005).

### 3. PROBLEM STATEMENT

Many central banks implemented unconventional policies during the 2008 financial crisis, most notably the Federal Reserve, as they initially sought to buy alternative assets to alleviate financial market distress, but their goals soon expanded to include achieving inflation targets for stimulating the real economy (Dell'Ariccia, Rabanal, & Sandri, 2018). The nature of central bank financial systems strongly influenced unconventional monetary policy methods, with the European Central Bank and Bank of Japan focused on direct lending to banks. In contrast, the Federal Reserve System and the Bank of England bought bonds to expand their monetary bases. Hence, these differences in the application of monetary policy were traditional to inter-central banks that made it difficult to generalize about their effects (Bibow, 2018).

The application of unconventional monetary policy tools emerged prominently after the 2008 global financial crisis. This affected the global financial markets and the global economy in general, including the United States of America, the Eurozone, and various emerging economies (Potter & Smets, 2019; Svensson, 2015). To contain this crisis, where the traditional monetary policy tools were used by the global central banks, economic decision-makers were prompted to urgently adopt new exceptional tools not mentioned in previous economic thinking theories. All these advantages, have increased the significance made for unconventional monetary policy tools (Engen et al., 2015).

This study addresses several issues. First is the increase in the US interest rate from 1% (in 2004) to 5.25% (in 2006) that increased the financial expenses of borrowers. Second, this study examines the impact of the real-estate bubble, which had been going on since the 1980s, but burst as early as February 2007. In order to address to such issues, this study aimed at answering the following question: How do the unconventional monetary policy tools affect inflation rates in the USA during the period 2003-2018?

#### 4. RESEARCH METHODOLOGY

We chose a combination of variables that reflect the unconventional monetary policy programs in the United States, which are indicative of all the unconventional monetary changes made by the Federal Reserve System (The Fed) in its monetary policy. These changes were brought to contain the financial crisis and exit the liquidity trap. The issues of financial crisis and the US monetary policy have been discussed in several previous studies but very few have dealt with the effects of unconventional monetary policy tools on a range of economic variables using different statistical models. Moreover, no other study has referred to theoretical and scientific aspects of these issues. Hence, in order to fill this research gap, this study was designed.

The correlation analysis in this study will enable to find whether the expected inflation rates are correlated with the change in the independent variables in terms of volume of credit, federal interest rates, and money supply in the United States during the study period.

#### 5. DATA ANALYSIS

To study the impact of unconventional monetary policy tools on inflation rates during the period 2003 to 2018 in the USA, the quarterly data for all variables based on nominal values compounded were collected from the Federal Reserve Bank:

- *The Inflation Rate (inf)*: Expected inflation rates were chosen as a dependent variable because most global economies, such as the US economy, suffered from a liquidity trap during the global financial crisis.
- *Credit (CR)*: We focused on total loans to non-financial private sector as an independent variable, where the impact of unconventional monetary policy programs on funding in the non-financial sector is a strong indicator of the impact of unconventional monetary policy.
- *The volume of money M2*: We adopted the monetary mass (M2) as an independent variable in the model to determine the extent to which the quantitative theory of money is realized in the light of the financial crisis and the contribution of changes in unconventional monetary policy. The Fed's main objective was to liquidate the budget of banks and economic institutions to increase the size of the monetary bloc in the economy and determine its impact on the expected inflation rate.
- *The current federal interest rate (fir)*: The federal funds rate is the central interest rate in the US financial market.

##### 5.1. The Model Adopted by the Study

In this study, the data were analyzed by vector autoregressive (VAR) model. The VAR (p) model without trend with k stationary endogenous variable at the level or integrated of order one, I(0) is as follows:

$$Y_t = a_0 + \sum_{i=1}^p a_i X_{t-i} + \mu_i$$

Where  $Y_t$  is endogenous variable vector,  $a_0$  is constant vector,  $a_i$  coefficient matrix, and  $\mu_i$  is white noise vector which is independently and identically distributed.

After the identification of variables and formulating the model, attempts involved the use of different formulas. Logarithmic formulation was used in order to introduce natural logarithm to the variables of the model, which took the following formulation:

$$lnf = a_0 + a_1lcr + a_2lfir + a_3lm2 + \mu_i$$

Where:  $\alpha_0$ : represents an intercept;  $\alpha_1, \alpha_2, \alpha_3$ : represent coefficient matrix and  $\mu_i$  represents the random error.

*linf*: inflation rates;

*lcr*: volume of credit;

*lfir*: rates of interest;

*lm2*: monetary base.

## 6. RESULTS AND FINDINGS

### 6.1. Studying the Stationarity of Expected Inflation Rates Series

The test results are illustrated in Table 1.

First model: without either an intercept or a trend; Second model: with an intercept; Third model: with an intercept and a general trend.

Table-1. Results of ADF for time series.

Model	<i>linf</i> series	<i>lcr</i> series	<i>lfir</i> Series	<i>lm2</i> series
at the level of				
First model	- 2.01 (1+) <sup>**</sup>	-0.81 (2)	-0.94 (1+)	4.77(1+)
Second model	-5 (1+) <sup>**</sup>	-1.36 (1)	-1.05 (1+)	0.47 (1+)
Third model	-4.98(1+) <sup>**</sup>	-4.36 (3)	-0.55 (1+)	-2.94 (1+)
at the first levels				
First model	/	/	-6.92 (1+) <sup>**</sup>	-2.09(1+) <sup>**</sup>
Second model	/	/	-6.86(1+) <sup>**</sup>	-5.36(1+) <sup>**</sup>
Third model	/	/	-6.92(1+) <sup>**</sup>	-5.36(1+) <sup>**</sup>
results of stationarity of time series	Stationary at the level	The trend level should be deleted when it is stationary	stationary at the first difference	Stationary at the first difference

\* Significant at the level of 5% according to the tabular values of MacKinnon (1996).

\*\* Significant at the level of 1% according to the tabular values of MacKinnon (1996).

Table 1 illustrates the EViews output showing:

- The *linf* time series is stationary at the level to become *dlfir*;
- The comparison of  $t_c$  which is calculated and tabulated  $t_{tab}$  by MacKinnon (1996) and is found at the level of  $\alpha = 5\%$  and  $\alpha = 1\%$  and the *lcr* series is stationary after subtracting the trend to become *lcr<sub>1</sub>*.  
Accordingly, a relationship between short-term variables is created and therefore VAR, will be to estimate the study model:
- Both the federal interest rates *lfir* and the size of the money supply *lm2* are found stationary at the first differences to become *dlfir* and *dlm2* and respectively. Therefore, they are first-order integrated series.

After studying the stationarity and the introduction of the natural logarithm ( $\ln$ ) to the model variables, the model variables were formulated as follows:

$$linf = a_0 + a_1 lcr + a_2 lfir + a_3 lm2 + \mu_i$$

Figure 1 is a graphic representation of the study variables after the first differences were made:

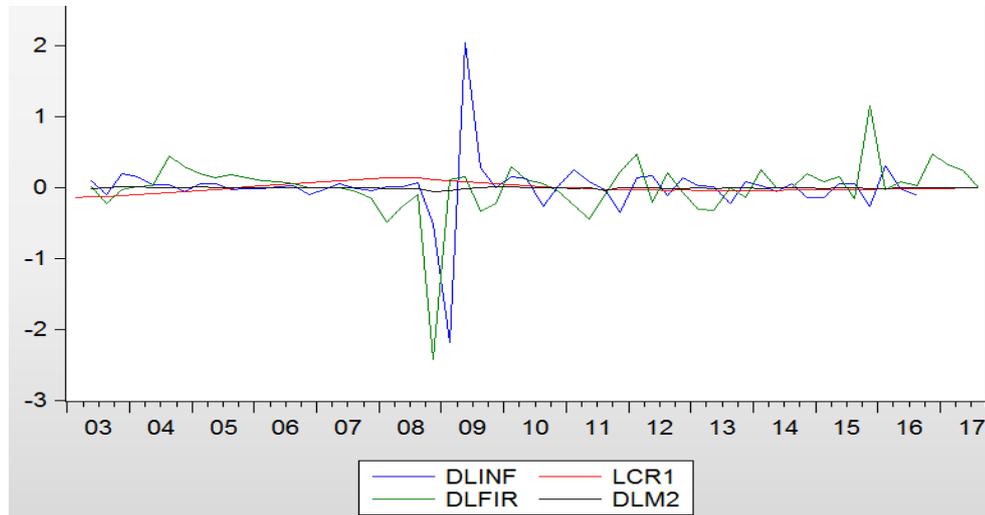


Figure-1. Graphical curve showing the variables of the study model variables using stationary series.

Source: EViews output.

### 5.2. Dynamic Stationarity Test of the Model:

To ensure the stationarity of the model, as shown in Figure 2, we made sure that all the roots were located within the unit circle, which meant that the model did not suffer from heteroskedasticity.

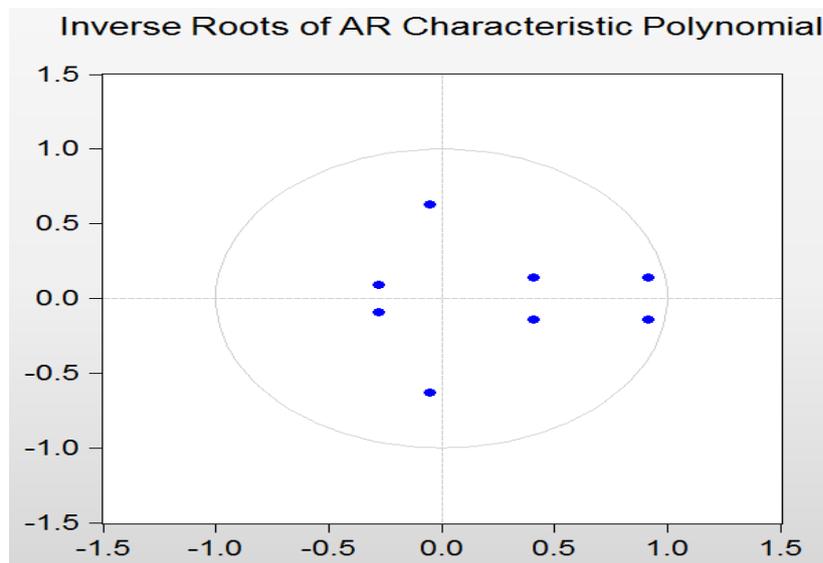


Figure-2. The unit circle of the model of the impact of unconventional monetary policy changes on expected inflation rates in the USA during the period 2003-2017.

Source: EViews output.

There were several statistical criteria for determining the lag intervals appropriate for estimating the study model, as shown in the Table 2. It also summarizes the estimation results of the criteria values for determining the length of the lag time.

Table-2. Optimal lag selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	170.80	NA	1.30	-6.80	-6.65	-6.74
1	298.30	228.98	1.37	-11.35	-10.58	-11.06
2	351.03	86.09*	3.11	-12.85	-11.46*	-12.33*
3	368.92	26.27	2.98*	-12.93	-10.92	-12.17
4	381.35	16.24	3.70	-12.79	-10.16	-11.79
5	390.03	9.914	5.60	-12.49	-9.24	-11.26

\* indicates lag order selected by the criterion, LR: sequentially modified LR test statistic (each test at 5% level), FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion.

According to the Schwarz information (SC) criterion, the minimum time lag length of the VAR model in the level was the second period ( $t+2$ ).

### 5.3. Model equation after estimation

Since all the endogenous variables of this research were integrated of order one,  $I(1)$  and not cointegrated, then the estimated VAR model was:

$$\begin{aligned} \text{DLINF} = & -0.196*\text{DLINF}(-1) - 0.096*\text{DLINF}(-2) - 1.622*\text{LCR1}(-1) + 1.54*\text{LCR1}(-2) + 0.58*\text{DLFIR}(-1) \\ & - 0.34*\text{DLFIR}(-2) + 9.678*\text{DLM2}(-1) - 11.033*\text{DLM2}(-2) + 0.003. \end{aligned}$$

Where the value of all coefficients is derived as summarized in Table 3.

Table-3. Vector auto-regression estimates.

Vector Auto regression Estimates	
	Standard Errors ( ) t-statistic [ ]
	<i>Dlinf</i>
<i>Dlinf</i> (-1)	-0.196 (0.125) [-1.57]
<i>Dlinf</i> (-2)	-0.096 (0.097) [-0.98]
<i>Lcrl</i> (-1)	-1.62 (3.87) [-0.41]
<i>Lcrl</i> (-2)	1.54 (3.93) [0.39]
<i>Dlfir</i> (-1)	0.58 (0.10) [5.71]**
<i>Dlfir</i> (-2)	-0.34 (0.13) [-2.63]**
<i>Dlm2</i> (-1)	9.67 (4.19) [2.30]**
<i>Dlm2</i> (-2)	-11.03 (3.78) [-2.91]**
<i>c</i>	0.003 (0.04) [0.07]

Source: Prepared by the researchers based on Eviews outputs.

\*\*The coefficient significance is at 5% ,which means that  $t_c > t_c (=1.67)$ .

As summarized in Table 3, the coefficient values of the variable  $Dl_{fir}(-2)$  was slowed for two periods, which carried a positive and significant 5%, indicating that there was a direct relationship between the Fed interest rates and the inflation rate. It can be said that the elasticity of the inflation rate for changes in federal interest rates was estimated at (0.58). The significance of the coefficient of the volume of money was slowed for one period  $Dlm2(-1)$ , and it carried a positive signal indicating that there was a direct relationship between the inflation rate and the size of the monetary value, so that the elasticity of the inflation rate for changes in the volume of money was estimated at about (9.67). When the results showed the non-significance of credit size, then there was no effect of the latter on the rate of inflation. The summary of these statistics are reported in Appendix 1.

Table 4, summarizes the R-squared ( $R^2$ ) coefficient ( $R^2 = .0.7420$ ) which indicates that there is a high explanatory power of the model. The changes in the explanatory variables are included in the model and explained as 74.20% of the fluctuations in the inflation rate. This suggests that expected inflation rates are strongly correlated with the change in the independent variables in terms of volume of credit, federal interest rates, and money supply in the United States during the study period. This is explained by the coefficient of determination  $R^2 = 74.20\%$  and the existence of a significant interpretative ability of the independent variables, which estimate the corrected coefficient of determination at 69.40% in attempting to interpret the evolution of expected inflation rates. The other parts are explained by other variables that do not exist in the model.

**Table-4.** Results of model estimates of inflation rates through the volume of credit, federal interest rates, and money supply.

R-Squared	74.20 %
Adj R-squared	69.40%
S.E. equation	0.24
F-statistic	15.45
Log-likelihood	4.20
Akaike AIC	0.18
Schwarz SC	0.52

Source: EViews 9 Output, 2019

As for the calculated Fischer value ( $F_{stat} = 15.45$ ), it was higher than the tabular value ( $F_{tab} = 1.67$ ) at the 5% level of significance, and it indicated the validity of the estimated model as a whole.

The study results showed the high value of Fischer's statistic model as follows:  $F_c = 15.45 >$ ,  $F_t = 2.76$ , which was higher than Fischer's statistic tabulated value of the model. After conducting a set of tests on the study, which were mentioned earlier, it was stated that the model was acceptable, both generally and statistically.

#### 5.4. Studying the Adequacy of the Model

A set of statistical diagnostic tests *Jarque-Bera Test*, *Serial Correlation LM Test* and *White heteroskedasticity test* were conducted on the model to ensure its adequacy. In other words, it was important to determine whether the model was free of standard problems and that it must not suffer from any standard problems so that the estimation results can be analyzed. The detailed findings of these tests are available in Appendix 2 and 3.

Table 5 summarizes the results of these tests

**Table-5.** The results of tests of standard problems.

Test	Estimated value	Probability
(Jarque-Bera) Normality	91.04	0.00001
Serial Correlation LM Test	$LM = 25.46$ ( $P=2$ )	0.06
	$LM = 17.52$ ( $P=3$ )	0.35
White Heteroskedasticity Test	(no cross terms):182.02	0.11
	(cross terms):454.20	0.30

Source: EViews 9 Output, 2019

Based on this, two hypotheses were framed:

1. There is autocorrelation  $H_0: \varphi = 0$
2. There is heteroskedasticity  $H_1: \varphi \neq 0$

*Serial Correlation LM Test* was conducted to find out whether there was autocorrelation or not. Since the probabilities of the model are bigger at  $(0.05 > 0.06)$  (when  $(P=2)$  and  $(0.05 > 0.35)$  when  $(P=3)$ ; therefore, we reject the hypothesis  $H_0$ , which means that there is no autocorrelation.

Similarly, *White heteroskedasticity test (Breusch-Pagan test)* was conducted to examine the heteroskedasticity

$$H_0: \sigma(1) = \sigma(2) = \sigma(3) = \sigma(n) \quad \text{pro} > 5\%$$

$$H_1: \sigma(1) \neq \sigma(2) \neq \sigma(3) \neq \sigma(n) \quad \text{Pro} < 5\%$$

Because the probability of the model was greater at 5% ( $\text{pro}=0.11 > 0.05$ ), ( $\text{pro} = 0.30 > 0.05$ ). Therefore, we accept the hypothesis  $H_1$ , which means that there is homoscedasticity.

The *Jarque-Bera Testi* was conducted to make sure that the residues follow a normal distribution. Since the probability of testing was 0.00001, which is smaller than the 5% level of significance, it was proved that the residues followed a normal distribution.

### 5.5. Studying Multi-Collinearity Matrix:

To measure the multicollinearity between interpretive variables of the second model, we used the Klein Test, where  $R^2$  calculated using this model was compared with the correlation coefficients of independent variables (volume of credit, federal interest rates, and volume of the money supply). Table 6 presents the matrix of multicollinearity among independent variables:

Table-6. Matrix of multi-collinearity among independent variables ( $x_i$ ).

Variable	<i>Dlinf</i>	<i>Lcr1</i>	<i>Dlfir</i>	<i>Dlm2</i>
<i>Dlinf</i>	1	0.0729	0.1171	0.3912
<i>Lcr1</i>	0.0729	1	0.5235	0.3113
<i>Dlfir</i>	0.1171	0.5235	1	0.5017
<i>Dlm2</i>	0.3912	0.3113	0.5017	1

Source: EViews 9 Output, 2019.

Through this matrix we found that the coefficient of determination  $R^2 = 74.20\%$  was higher than these coefficients, and therefore there was no multi-collinearity ( $x_i$ ). As a final note, the model can be said to be devoid of standard problems and can be economically analyzed. □

## 6. DISCUSSION

### 6.1. Analysis of Expected Inflation Rates

The analysis of the variance between the study variables and their impact on each other was determined by determining the amount of variance in the prediction for each variable, which was due to the prediction error in the same variable and the rest of the other variables. Table 7 illustrates the analysis of variance of expected inflation rates model:

Table-7. Analysis of variance of the study model during ten time periods

Variance Decomposition of DLINF					
Period	S.E	DLINF	LCR1	DLFIR	DLM2
1	0.245	100.000	0.000	0.000	0.000
2	0.383	41.246	14.305	39.760	4.687
3	0.474	32.861	18.227	43.464	5.446
4	0.477	32.629	18.159	42.968	6.242
5	0.479	32.452	17.999	43.031	6.516
6	0.480	32.424	18.116	42.960	6.499
7	0.480	32.359	18.208	42.902	6.529
8	0.480	32.349	18.219	42.903	6.527
9	0.480	32.336	18.256	42.883	6.524
10	0.480	32.323	18.283	42.867	6.525

Source: EViews 9 Output, 2019

The results of the analysis of the variance components of the expected inflation rates model showed that 100% of the forecast rate in the variance of inflation rates in the first period was attributed to the same variable. In contrast, in the second period, 41.24% of the forecast rate was due to the same variable. Also, the variable of the volume of credit in the non-financial private sector was at 14.30%, the federal interest rate variable was at 39.76%, and the variable of the money supply was at 4.68%. This fluctuation in the rates continued until the last period, i.e., the tenth period to become 32.32% for the same variable, 18.28% for the variable of the volume of credit, 42.86% for interest rates and 6.52% of the money supply variable. Based on this analysis, it was noted that the proportion of the contribution of the independent variables of the model in explaining the evolution of expected inflation rates was acceptable, particularly for the short, medium and long-term federal interest rate variables, which demonstrated the significant impact of changes in the volume of credit to the non-financial private sector, federal interest rates, and money supply. They together were considered as strong indicators of changes in expected inflation rates.

## 6.2. Impulse Response Analysis

Among the statistical methods used to illustrate the behavior of the model, we relied on analyzing the impulses of the response of expected inflation rates when positive shocks occur on the level of independent variables such as the dependent variable itself during ten periods and one standard deviation.

Table 8 presents the impulse response estimate of the expected inflation rates:

Table-8. The results of the impulse response estimate of the expected inflation rates. □

Period	DLINF	LCR1	DLFIR	DLM2
1	0.245	0	0	0
2	0.265	0.145	0.241	0.083
3	0.150	0.003	0.043	0.009
4	0.168	-0.014	0.040	-0.034
5	0.186	-0.008	0.073	-0.006
6	0.175	-0.027	0.064	-0.006
7	0.174	-0.044	0.056	-0.016
8	0.177	-0.051	0.062	-0.016
9	0.174	-0.061	0.061	-0.017
10	0.173	-0.070	0.059	-0.020

Cholesky Ordering: DLINF LCR1 DLFIR DLM2

Source: EViews 9 Output, 2019

The above table shows that a shock in the expected inflation rates  $D\text{linf}$  in the first period leads to a positive shock in the same variable in the first period by 0.24% and 0.26% in the second period. These are the highest and largest shock recorded during the study period, the impact of shocks positively continues throughout the remaining periods. As for the volume of credit  $\text{LCr1}$ , a shock of one standard deviation leads to a positive shock in the expected inflation rates by 0.145%, which was the biggest shock recorded in the second period. As of the fourth period, negative responses were recorded to the last period when the biggest negative shock in inflation rates was at (-0.07%).

However, when a shock in the federal interest rates  $D\text{lfir}$  takes place with one standard deviation, this led to positive shocks in the expected inflation rates during the ten periods, where the most extensive recorded shock in the second period was 0.24. Finally, when there was a shock in the volume of money supply  $D\text{lm2}$  with one standard deviation, this led to the rotation of the impact on inflation rates up and down positively and negatively, where the largest positive shock recorded in the second period was at 0.08% and the biggest negative shock recorded in the fourth period was at (-0.034%). After this period all the shocks were adverse in the very last period.

## 7. ANALYSIS OF MODEL ESTIMATION RESULTS USING VECTOR AUTO-REGRESSION (VAR)

When testing the selection of the appropriate lag interval to estimate the model, we found that it was the second lag interval ( $t + 2$ ). Thus, we looked at the analysis of the relationships between inflation rates and independent variables in general in the first and second lag intervals. But in the final analysis of the results obtained from the second model, the results of the relationships between the variables relied on those of the second lag interval.

### 7.1. Impact of Changes in Volume of Credit on the Expected Inflation Rates

We analyzed the impact of independent variables, which serve as indicators of unconventional monetary policy on the expected inflation rates. According to the outputs of the standard model, the results revealed an inverse relationship in the first lag interval and a direct relationship in the second interval.

The results of the study indicated that the changes in the volume of credit in the first and second lag intervals were insignificant and also indicate an inverse and direct relationship between the changes in the volume of credit of the non-financial private sector and the expected inflation rates in the USA as when the credit volume increases by 1% ( $t+1$ ), this leads to a decline in the expected inflation rates by -1.622% in the interval ( $t + 1$ ), and rates rose by 1.54% in the second lag interval ( $t + 2$ ).

This can be interpreted in terms of the elasticity and degree of response to the expected inflation rates to the changes in the volume of credit is big and very statistically acceptable. The increase in the volume of credit in the non-financial sector negatively impacted inflation expectations in the first lag interval, where the increase in credit volume indicated the increase in the volume of financing for the non-financial private sector and thus contributed to the increase in aggregate supply and production rather than the total demand. Thus, this stimulated a rise in the expected inflation rates. Therefore, the overall supply gap contributed to lower expected inflation rates.

In the second lag interval, the relationship between two variables was positive, where the impact of credit volume was positive to inflation expectations, which is theoretically expected. Bank loans to the private sector are one of the main pillars to increase consumption rates and overall demand in general, and thus stimulate future prices to rise. Also, providing the necessary financing for economic activity has a positive impact on stimulating the general levels of prices.

### 7.2. Impact of Changes in Actual Federal Interest Rates on Expected Inflation Rates

The results of the applied study revealed a direct relationship in the first lag interval, whereas there was an inverse relationship in the second lag interval as follows:

The results of the study indicated significant changes in interest rates in the first ( $t + 1$ ) and second ( $t + 2$ ) lag intervals at the level of 1%. It was noted that the parameters of federal interest rates were highly significant. The results referred to a direct relationship between the changes in federal interest rates and expected inflation rates in the United States during the first lag interval, whereas an inverse relationship existed in the second lag interval. When interest rates rose by 1% ( $t$ ), this led to increasing inflation rates by 0.58% ( $t + 1$ ), and (0.34%) in ( $t + 2$ ). It was noted that through the elasticity of response between the two variables, the effect of changes in interest rates contributed to stimulating an increase in expected inflation rates. When adopting unconventional monetary policy, the Federal Reserve applied the federal interest rates very close to zero (in addition to the policy of pre-orientation) to affect the long-term nominal interest rates to influence expectations and reassuring financial markets in light of the financial crisis and to find a way out of the liquidity trap that hit the US economy. This affected the borrowing costs and stimulated the volume of consumption and necessarily caused an increase in the expected inflation rates.

The inverse relationship between changes in interest rates and expected inflation rates was explained by the phenomenon of monetary hoarding among individuals and the adverse effect of quantitative easing and credit facilitation programs on inflation expectations. Despite the increase in the money supply through these programs, individuals do not prefer consumption. Instead, they prefer monetary hoarding due to the degree of risk and uncertainty that adversely affects the development of aggregate demand. This is along with the presence of short-term nominal interest rates at levels close to zero with a cash shock. Accordingly, current prices are higher than expected, causing a recession in prices. In this case, individuals would prefer consumption when prices are low in the future. So, to stimulate the individuals' immediate use and to fully exploit the economic resources, individuals' income and savings should lose their values, in general. This is achieved by influencing the long-term nominal interest rates applied through an unconventional monetary policy, where nominal interest rates are meager in the long run. This explains why the federal interest rates remain at low levels to stimulate inflation expectations.

The results revealed the existence of a direct relationship in the first lag interval, whereas it was of an inverse nature in the second one. The results of the study showed the significant changes in the money supply in the first and second lag intervals. Therefore, when the volume of money supply increased by 1%, it also led to increase the expected inflation rates by 9.67% in the first lag interval and decrease rates by 11.03% in the second lag interval. Additionally, it was noted that the elasticity or the degree of response of the expected inflation rates to the changes in the money supply was high. This indicated that the hypothesis of the quantum theory of money was achieved, where inflation rates rise when the money supply increases in the first lag interval, whereas it was reversed in the second lag interval during the period of study in the United States of America.

Through the application of both quantitative easing and credit facilitation, monetary shock contributed to the rise in the size of the money supply in the economy and the stability of production volume. This was because the goal of unconventional expansionary monetary policy is to stimulate aggregate demand and not aggregate supply. The stability of the speed of money turnover contributed to increasing expected inflation rates on a big scale in the USA.

## 8. CONCLUSION

The study reached several results, which are summarized as follows:

- The impact of credit volume changes on expected inflation rates was insignificant. Hence, this was attributed to unconventional monetary policy tools, especially credit facilitation programs since they aimed at stabilizing financial markets rather than stimulating higher inflation expectations.

- The zero-interest-rate policy adopted by the US Federal Reserve as of December 2008 contributed to stimulating the expected inflation rates as indicated by the results of the study. The parameters were significant, and the relationship was inverse during the second lag interval. Theoretically, this was expected, according to Paul Krugman's model.
- The quantitative theory of money is achieved in the study model, where the effects of the high money supply were positive on the expected high inflation rates.

## 9. RECOMMENDATIONS

- We should consider the necessity to rely on unconventional monetary policy tools in the event of economies falling into the liquidity trap.
- Central banks should focus on influencing the expectations of economic agents of the development of inflation rates by relying on the appropriate combination of unconventional monetary policy tools, as demonstrated by the Krugman (2000) model theoretically and our study model on the United States of America.

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Appendix-1. Model estimation table

R-squared	0.742001	0.994282	0.205849	0.350679
Adj. R-squared	0.694001	0.993219	0.0581	0.229875
Sum s q. resids	2.590434	0.00121	7.36663	0.004995
S.E equation	0.245444	0.005306	0.413905	0.010778
F-statistic	15.4584	934.7013	1.393234	2.902881
Log likelihood	4.200073	203.5823	-22.97344	166.7288
Akaike AIC	0.184613	-7.483936	1.229748	-6.066491
Schwarz SC	0.522328	-7.14622	1.567463	-5.728775
Mean dependent	0.001248	0.008058	-0.017337	-0.005469
S.D. dependent	0.443703	0.06443	0.426479	0.012282

Source: EViews 9 Output, 2019

<b>VECM Auto regression Leaniars</b>				
<b>Date: 06/15/2019 Time: 19:23</b>				
<b>Sample (adjusted) 2003Q4 2016Q3</b>				
<b>Included observations: 52 after adjustments</b>				
<b>Standard errors in ( ) &amp; t-statistics in [ ]</b>				
	DLINF	LCR1	DLFIR	DLM2
DLINF(-1)	-0.196595 (0.12505) [-1.57213]	-0.001699 (0.00270) [-1.62843]	-0.329471 (0.21088) [-1.56238]	0.002073 (0.00549) [0.37742]
DLINF(-2)	-0.096415 (0.09776) [-0.98624]	-0.001329 (0.00211) [-0.62884]	-0.116136 (0.16486) [-0.70446]	0.001777 (0.00429) [0.41390]
LCRA(-1)	-1.622037 (3.87906) [-0.41815]	1.803095 (0.08385) [21.5029]	-4.317474 (6.54146) [-0.66002]	0.076374 (0.17034) [0.44836]
LCRA(-2)	1.547732 (3.93098) [0.39373]	-0.828266 (0.08498) [-9.74704]	1.879843 (6.62902) [0.28358]	-0.123206 (0.17262) [-0.71374]
DLFIR(-1)	0.580253 (0.10156) [5.71333]	0.000473 (0.00220) [0.21536]	-0.084943 (0.17127) [-0.49597]	0.004202 (0.00446) [0.94215]
DLFIR(-2)	-0.345951 (0.13145) [-2.63188]	-0.001242 (0.00284) [-0.43709]	0.189714 (0.22167) [0.85586]	-0.000219 (0.00577) [-0.03789]
DLM2(-1)	9.678298 (4.19843) [2.30522]	0.030096 (0.09076) [0.33161]	2.206978 (7.08003) [0.31172]	0.327030 (0.18436) [1.77382]

Appendix-2. White heteroskedasticity test.

<b>VAR Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)</b>					
<b>Date: 06/15/2019 Time: 20:48</b>					
<b>Sample: 2003Q1 2017Q3</b>					
<b>Included observations: 52</b>					
<b>Joint test</b>					
Chi-sq	df	Prob.			
182.0236	160	0.1121			
<b>Individual components:</b>					
Dependent	R-squared	F(16,35)	Prob.	Chi-sq(16)	Prob.
res1*res1	0.679016	4.627472	0.0001	35.30881	0.0036
res2*res2	0.343077	1.14242	0.3577	17.84002	0.3333
res3*res3	0.217416	0.607727	0.856	11.30563	0.7902
res4*res4	0.245992	0.713663	0.7616	12.79159	0.6879
res2*res1	0.156309	0.405275	0.9717	8.128082	0.945
res3*res1	0.269972	0.796699	0.6794	13.88256	0.6075
res3*res2	0.286909	0.880131	0.595	14.91927	0.5306

res4*res1	0.410011	1.520199	0.1476	21.3206	0.1665
res4*res2	0.21627	0.603641	0.8593	11.25606	0.794
res4*res3	0.269138	0.805543	0.6704	13.9952	0.5991

**VAR Residual Heteroskedasticity Tests: Includes Cross Terms**

Date: 06/15/2019 Time: 20:52

Sample: 2003Q1 2017Q3

Included observations: 52

Joint test

Chi-sq	df	Prob.
454.2047	440	0.3099

**Individual components:**

Dependent	R-squared	F(44,7)	Prob.	Chi-sq(44)	Prob.
res1*res1	0.975992	0.467577	0.0075	50.7516	0.2248
res2*res2	0.925591	1.978973	0.1745	48.13074	0.3093
res3*res3	0.771401	0.536849	0.9009	40.11288	0.6389
res4*res4	0.866985	1.036945	0.5313	45.08321	0.4264
res2*res1	0.859177	0.970633	0.576	44.67721	0.4432
res3*res1	0.843542	0.857737	0.6584	43.86419	0.4774
res3*res2	0.901442	1.455102	0.3179	45.87501	0.3554
res4*res1	0.898153	1.402963	0.3386	46.70394	0.3619
res4*res2	0.860283	0.979574	0.5698	44.73472	0.4408
res4*res3	0.857742	0.959236	0.584	44.60258	0.4463

Source: EViews 9 Output, 2019

**Appendix-3. Jarque-Bera test**

Component	Jarque-Bera	df	Prob.
1	0.858494	2	0.651
2	15.92956	2	0.0003
3	44.80168	2	0
4	29.45612	2	0
<b>Joint</b>	<b>91.04586</b>	<b>8</b>	<b>0</b>

Source: EViews 9 Output, 2019.

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