

Applying Mathematical Monetary Policy Rules in Algeria: Tylor's Rule

Yousouf Chemseddin Khaldoun^{1*}, Abdelkader Bouali², Yassine Meliani³

¹ Markets, Employment, Legislation and Simulation in the Maghreb laboratory,
University of Belhadj Bouchaib, Ain temouchent (Algeria),
yousouf.khaldoun@univ-temouchent.edu.dz

² Markets, Employment, Legislation and Simulation in the Maghreb laboratory,
University of Belhadj Bouchaib, Ain temouchent (Algeria),
Abdelkader.bouali@univ-temouchent.edu.dz

³ Markets, Employment, Legislation and Simulation in the Maghreb laboratory,
University of Belhadj Bouchaib, Ain temouchent (Algeria),
yassimel@yahoo.fr

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Abstract:

In this paper, we studied how far the monetary policy in Algeria is submitted to mathematical rules, and if the Bank of Algeria really adopt the augmented Taylor rule in the inflation targeting process and its effectiveness.

We concluded that the latter is ineffective and that the Taylor rule does not explain the behaviour of monetary policy in Algeria due to the absence of the success factors, such as a high degree of transparency and accountability about monetary policy, in addition to the credibility of the central bank and its independence from all pressures that would deviate monetary policy from the desired objectives.

Keywords: Taylor rule; Inflation targeting; Monetary policy; Exchange rate.

(JEL) Classification : XN2 ,XN1.

1. Introduction:

John Taylor's economic research for more than 40 years in the field of monetary policy focused on monetary rules, where the inflation target occupied a prominent place in it due to the existence of a link between them (the rules of monetary

* Corresponding author

policy and inflation targeting), so that Taylor explained the type of this relationship in a speech about targeting inflation in economies Emerging as an important symbiotic relationship, the monetary policy rule cannot be designed or evaluated without the inflation rate target, at the same time the inflation target cannot be achieved without the monetary policy rule.

At the beginning of Taylor's research in 1968, the focus was on the money supply as a tool for monetary policy, where Taylor built and estimated a model for determining prices / wages and rational expectations, through which he was able to calculate a specific monetary base in a numerical way for the growth rate of the money supply, as this rule raises the growth rate of The money supply at a certain value if the inflation rate falls below the target rate, or gross domestic production falls below its potential value, and vice versa.

Since the goal was to find a good rule for monetary policy tools to achieve goals, including the inflation target, the research was continued and the result was moving towards another more reliable monetary policy tool which is the focus of our study represented in the interest rate, and the research that pointed to this tool was the original Taylor's rule in 1993.

The Bank of Algeria is among the central banks that announced its adoption of inflation targeting, which leads us to evaluate the experience of Algeria in this context.

1.1. Research Problematic:

"Have the Algerian monetary authorities adopted the augmented Taylor rule in the inflation targeting process?"

1.2. Hypothesis :

- Indeed, the Central Bank of Algeria has targeted inflation based on the augmented Taylor rule.
- The augmented Taylor rule does not explain the behavior of monetary policy in Algeria.

1.3. Research aims:

This study aims to:

- Evaluation and clarification of Algeria's experience in inflation targeting

- Finding the interest rate rule that can explain the behavior of monetary policy in Algeria

1.4. The importance of the study

The decision-making by the monetary authority represented by the Central Bank needs monetary information, procedures and rules that show the type of tool used to achieve balances in the macroeconomy internally and externally, and we find that all of the above is included in the inflation targeting policy.

1.5. The methodology

The study relied on an analytical descriptive approach in the theoretical aspect to treat concepts in general about inflation targeting and to address literature reviews. It was also relied on a case study approach to give the applied side to the research the Algerian economy data according to econometrics models in the field of monetary policy.

2. Literature review:

After continuing research in the field of monetary policy, the money supply policy was bypassed and moved towards the interest rate tool, which (Taylor J. B., 1993) considered it as an effective tool, and he explained that through a simple mathematical relationship that combines the gross domestic product, inflation and the interest rate, But since the economy is not isolated from the outside world and therefore is vulnerable to external variables, which led it to think about monetary policy reactions towards external indicators like the exchange rate which (Taylor J. B., 2001) saw it as the most important one, and It raises a question about the role of the latter in the base of monetary policy.

Taylor showed that not all countries have a direct reaction to changes in the exchange rate, but this is not considered as a negative feature in his view, because sometimes monetary policy rules that respond indirectly to the exchange rate, work in a better way in stabilizing inflation and the GDP than those rules which respond in a direct manner, because they result in lower interest rate fluctuations.

With regard to the study of this modern behavior in emerging economies, (Mohanty & Klau, 2005) attempted to test the interaction of monetary authorities

with changes in inflation, output and exchange rates in Greece, Korea, South Africa, Mexico, Thailand, and Brazil. Chile, Taiwan, Peru, the Czech Republic, India, Poland and the Philippines. And he concluded that in most of these economies, the interest rate responds strongly to the exchange rate, and in some cases it showed a higher response than the output gap or the inflation rate, and from it we conclude the significant impact of the exchange rate on interest rates.

The same results were reached by (Moura & De Carvalho, 2010) in his research on the way in which monetary policy was implemented in some Latin American countries, where they found a disparity between the countries of this region in the interest in the variables of the augmented Taylor rule, and they confirmed that The exchange rate is related to interest rate decisions in Mexico, furthermore (Cermeño & Polo, 2012) found that the Mexican central bank responds to the real exchange rate in a nonlinear manner and also works to achieve A near-zero output gap with stable inflation around target.

Regarding the behavior of monetary policy in advanced economies, (Lubik & Schorfheide, 2007) extracted the responsiveness of the Canadian central bank to the exchange rate, unlike New Zealand, Britain and Australia, in addition the absence of a direct change in interest rates as a response to the change in The value of the currency, and they pointed out that this does not mean that the decision-making process does not take into account the exchange rate, because it is an indicator that carries important informations about the conditions in the future, especially in developed countries. and more in-depth in the experience of the Reserve Bank of New Zealand, given that it has great experience in the inflation targeting process, (Ftiti, 2008) found in his study that the original Taylor rule does not describe the behavior of monetary policy in New Zealand, but the augmented rule does it. That is why (Froyen & Guender, 2018) gave importance to the stability of the exchange rate as a goal of monetary policy and studied specific issues related to the role of the real exchange rate in the various embodiments of the Taylor rule, as the inclusion of the real exchange rate resulted in a significant improvement In performing the rule, even if it is a secondary goal.

3. Inflation targeting:

In the following, we will try to provide definitions that explain the different angles for targeting inflation, because the latter is not as simple as it appears in the first impression.

“Inflation targeting includes the official establishment of price stability as a primary goal of monetary policy” (Pétursson, 2005, p09) . This definition focuses on the idea of indicating a clear message about the main task of monetary policy, but the problem is that price stability is considered as a primary goal for most central banks, as they publicly declare numerical goals. , but generally not called inflation-targeted .

The distinguishing feature of inflation targeting countries may be the emphasis provided by their central banks on more transparency and accountability, which has been identified as important characteristics of inflation targeting (Pétursson, 2005, p09), because this would provide all economic data that affects inflationary developments because inflation is not linked to only one variable.

"Inflation targeting is an effective framework for managing monetary policy" (Taylor J. B, 2019), said economist Jose De Gregorio, who served as governor of the Central Bank of Chile from 2007 to 2011.

The following is a table showing some of the inflation targeting countries and the date they adopted this framework:

Table (01): Some countries and the date they adopted inflation targeting policy.

Countries	The date of adoption of the inflation targeting policy	Countries	The date of adoption of the inflation targeting policy
Australie	avril 1993	Nouvelle-Zélande	Mars 1990
Brésil	juin 1999	Norvège	Mars 2001
Canada	Février 1991	Pérou	janvier 2002
chilien	Septembre 1990	Les Philippines	janvier 2002
colombie	Septembre 1999	Pologne	Octobre 1998
République Tchèque	Janvier 1998	Afrique du Sud	février 2000

Grèce	Janvier 2001	Suède	Janvier 1993
Islande	Mars 2001	Suisse	janvier 2000
Mexique	Janvier 1999	Thaïlande	Mai 2000
Corée	avril 1998	Grande-Bretagne	Octobre 1992

Source: (Pétursson, 2005, p14)

4. The Tylor's rule

4.1 Taylor's original rule

Many researchers have paid attention to the rules of monetary policies, led by (John Taylor, 1993) who developed in 1993 a simple interest rate rule for selecting and evaluating the tools that manage monetary policy. The Taylor rule shows that the nominal interest rate is a function of inflation and the equilibrium real interest rate in addition to two deviations (the inflation gap and the output gap).

This rule makes recommendations to raise the interest rate when the inflation rate and real income rise above the target level, and vice versa (reduce it if the general level of prices and real income falls below the target).

Taylor's rule is written as follows:

$$i = \pi + r^* + \alpha YG + \beta(\pi - \pi^*)$$

Where :

i : interest rate

π : inflation rate

r^* : the equilibrium interest rate

$YG=(y-y^*)$: Output gap (the difference between the level of real gross domestic product and the expected level of it)

$\pi - \pi^*$: Inflation gap (the difference between the current level of inflation and its target level)

α and β : gaps coefficients

4.1.1 Homogeneity of interest rates according to the Taylor rule (Backward looking rule):

Through this formula, interest rates are looked back and changed depending on the past movements of inflation. It also takes into account the principle of homogeneity of interest rates on the part of the monetary authorities, which was

neglected by the original relationship of the Taylor rule, and this is what made changes to it, and (Williams, 1999) addressed it in his study as follows:

$$it = \rho it^{-1} + (1 - \rho) (\pi t + rt^{\circ} + \alpha(\pi t - \pi t^{\circ}) + \beta(yt - yt^{\circ}))$$

it : The short-term nominal interest rate or the Taylor rate.

rt° : The equilibrium real interest rate.

$\pi t - \pi t^{\circ}$: The difference between the current inflation rate and the target inflation rate.

$yt - yt^{\circ}$: Production differences or the difference between the real gdp and its expected level.

α and β : are the marginal coefficients of the inflation rate differential and the output rate differential, respectively.

ρ : It expresses the criterion for measuring the homogeneity of interest rates, which is specified between 0 and 1.

4.2 The augmented version of Taylor's rule:

Taylor rule (original or modified) that was discussed previously is a rule that is valid in the case of a closed economy, and it is a term that has been eliminated by the development of global trade exchanges and financial globalization, so that openness changed the economic structure and its reactions towards monetary policy, and this is what led to The emergence of new studies that criticized this rule, pointing to its disregard of variables that have an important role in the open economy and that affect the behavior of monetary policy, and on top of these variables, which the majority of economists cared about is the exchange rate.

Subsequent studies of (Clarida & Gertler, 1998), (Ball, 1999), (Taylor J. B., 2000, 2001) suggested that changes should be made to the original Taylor rule in testing open economies by including the real exchange rate in The equation in order to become:

$$\dot{i} = h_0 \pi_t + h_1 Y_t + h_2 E_t + h_3 E_{t-1}$$

Where :

E_t : The exchange rate.

With regard to the discussion about the Taylor rule for open economies in the current environment and the question about whether monetary policy should respond to the exchange rate (nominal or real), the majority of studies supported the viewpoint of (Taylor J. B., 2001) which concluded that Exchange rate responsiveness improves performance, but it can make performance worse (Froyen & Guender, 2017).

The empirical study of (Moura & De Carvalho, 2010) and (Lubik & Schorfheide, 2007) proved that the exchange rate has a relationship with the behavior of monetary policy in Mexico, Canada and England because the central banks of these countries change the interest rate in response to the exchange rate movements.

5. The empirical study:

5.1 Data and variables

Discussing the applied side in addressing the problem in terms of the variables, we used gross domestic product, exchange rate, inflation rate, interest rate in the empirical study, and to achieve that, we used data released by the World Bank and the International Monetary Fund, and the same for auxiliary variables.

5.2 The econometric tests applied to Taylor's rule:

The method of least squares (OLS) is one of the estimation methods widely used by researchers in estimating the Taylor rule model and the reason is that the original equation created by Taylor 1993 is a simple linear equation.

However, after that, the researchers faced problems in using this method (least squares) for estimation, as :

- a. Instability of variables.
- b. Autocorrelation problems (because the rate of inflation and the output gap are variables that tend to be correlated.
- c. Endogeneity problem (When there is a correlation between residuals and exogenous variables)

For these reasons, the researchers moved from using the (OLS) method to the generalized moment method (GMM) according to (Nielsen, 2005) and (Greene, 2011).

5.3 Estimation results

5.3.1 The stationarity of time series:

a. ADF test at the level

Table (02): ADF test results at the level

P-value	Tt			Tc	Variable
	10%	5%	1%		
0.9999	-2.595565	-2.915522	-3.555023	2.315963	Gross domestic production
0.0092	-2.591799	-2.908420	-3.538362	-3.568997	Inflation rate
0.0231	-2.591799	-2.908420	-3.538362	-3.225498	Interest rate
0.9318	-2.592645	-2.910019	-3.542097	-0.204377	Nominal exchange rate

Source: Prepared by researchers based on eviews 10.

b. ADF test at the first difference

Table (02) : ADF test results at the first difference

P-value	Tt			Tc	Variable
	10%	5%	1%		
0.2671	-2.595565	-2.915522	-3.555023	-2.045748	Gross domestic production
0.0000	-2.592645	-2.910019	-3.542097	-6.632151	Nominal exchange rate

Source: Prepared by researchers based on eviews 10.

The gross domestic product and the nominal exchange rate are not stationary at the level, so we retest them at the first difference, and it appears that they are stationary .

5.3.2 The augmented Taylor rule test according to the Backward-looking Model:

a. The period (Q1-2003, Q4-2018)

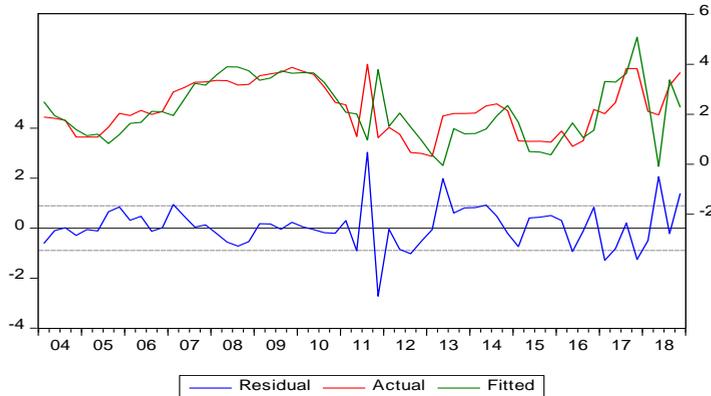
**Table (06): The Taylor rule test according to the interest rate
homogenization model 2003-2018**

Dependent Variable : MMR				
Method: Generalized Method of Moments				
Date : 05/30/19 Time : 00 :23				
Sample (adjusted) : 2004Q1 2018Q4				
Instrument specification : LNCPI(-2) LNIP(-2) LNM2(-2) LNNFA LNPPPI(-4)				
OIL(-4) TBR(-1) LNREER				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-6.457445	3.957198	-1.631823	0.1084
MMR(-1)	0.991717	0.170692	5.809970	0.0000
INF-INFC	0.144484	0.151356	0.954594	0.3440
GDP-GDPP	-0.697278	0.213489	-3.266103	0.0019
LNNEER	1.397137	0.833931	1.675363	0.0995
R-squared	0.308681	Mean dependent var		2.215680
Adjusted R-squared	0.258404	S.D. dependent var		1.039409
S.E. of regression	0.895098	Sum squared resid		44.06598
Durbin-Watson stat	2.200464	J-statistic		2.117051
Instrument rank	8	Prob(J-statistic)		0.548471

Source: Prepared by researchers based on eviews 10.

When we tested Taylor's rule on the Algerian economy according to the homogeneity of interest rates and through the use of eight (08) independent auxiliary variables, the results showed that the interest rate is affected by its previous values by 0.99, while the percentage of its vulnerability to the nominal exchange rate is estimated at 1.39, while it is affected by the inflation gap and the output gap by 0.14 and 0.69 - respectively, so that the latter does not apply to the Taylor rule model for that negative relationship between the gross domestic product gap and the Taylor rate because it did not respect the condition stipulated by the Taylor rule (the coefficients > 0).

Figure (05): Results of applying Taylor's rule according to the Backward-looking model during 2003-2018



Source: Prepared by researchers based on eviews 10.

The figure shows the existence of homogeneity between the real interest rates and the calculated interest rates with small differences during the length of the period, with the exception of some periods in which significant differences were recorded beginning in the year 2008 due to the global crisis, and then the year 2011 coinciding with the announcement of the devaluation of the currency that caused perturbation in the model, up to the stage in which the monetary authorities took a decision regarding quantitative easing in 2017.

b. The period (Q1-2010, Q4-2018)

Table (08): Taylor rule test according to the interest rate homogeneity model 2010-2018

Dependent Variable: MMR		
Method: Generalized Method of Moments		
Date: 05/30/19 Time: 00:39		
Sample (adjusted): 2011Q1 2018Q4		
Instrument specification: OIL(-4) LNCPI(-3) LNIP(-2) LNM2 LNREER(-3)		
LNNFA LNPPI TBR		

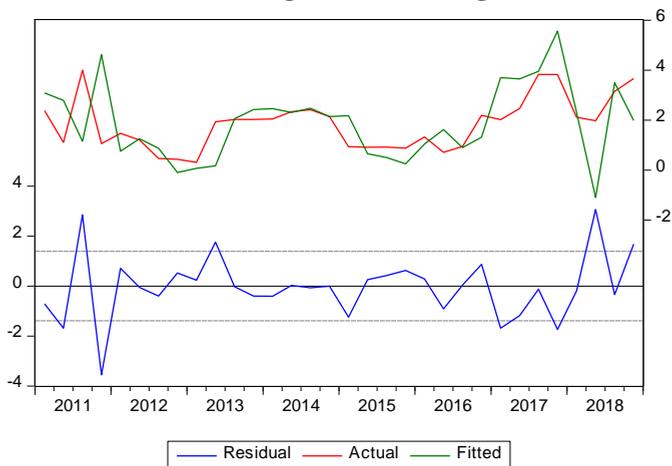
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-19.12861	10.59216	-1.805922	0.0821
MMR(-1)	1.198150	0.301754	3.970615	0.0005
INF-INFC	-0.117343	0.066874	-1.754695	0.0907
GDP-GDPP	-0.903447	0.252190	-3.582404	0.0013
LNNEER	4.166043	2.328671	1.789022	0.0848
R-squared	-0.576115	Mean dependent var		1.852084
Adjusted R-squared	-0.809613	S.D. dependent var		1.032074
S.E. of regression	1.388365	Sum squared resid		52.04407
Durbin-Watson stat	2.584167	J-statistic		3.544916
Instrument rank	9	Prob(J-statistic)		0.471082

Source: Prepared by researchers based on eviews 10.

After narrowing the study period to (2010 – 2018), which is the period of Algeria's adoption of the inflation targeting policy, we re-estimated taylor rule according to the homogeneity of interest rates (backwards looking) with the use of 8 auxiliary tools included in the composition of the model, and the results shown in the table above turn out that the coefficients of each of the inflation gaps and the output gaps, respectively, are -0.11 and -0.9. Since these coefficients are negative, the model is not accepted because it didn't respect the condition of Taylor's rule, which states that the coefficients must be positive.

These results appear in the following figure through the opposite trends of real interest rates and calculated rates, especially the estrangement in the year 2011, which was the result of the devaluation of the currency by the Algerian monetary authorities , in addition to the estrangement in the year 2018, which was the result of the process of printing money for free, which has direct effect on the exchange rate. It is also shown through the auxiliary variables that each of the oil price and the real exchange rate are considered to be particularly influential in the model, because compensation of lagged periods confirms the ideality of the model, that is, foreign reserves contribute significantly to monetary stability.

Figure No. (07): Results of applying Taylor's rule according to the
Backward-looking model during 2010-2018



Source: Prepared by researchers based on eviews 10.

6. Conclusion:

The hypothesis n° 01 : ‘ the Central Bank of Algeria has targeted inflation based on the augmented Taylor rule’.

Despite Algeria's announcement about following the inflation targeting policy, the results showed the ineffectiveness of this latter, which was confirmed by the second model in our empirical study, knowing that this model pertains to the period from the first trimester of 2010 until the last trimester of 2018, i.e. the period which the bank of Algeria announced the adoption of targeting inflation. So the first hypothesis is refused.

The hypothesis n° 02 : ‘ The augmented Taylor rule does not explain the behavior of monetary policy in Algeria’.

The second hypothesis is accepted, indeed the Taylor rule does not explain the behavior of monetary policy in Algeria due to the absence of some conditions, including the independence and credibility of the Central Bank from all pressures that would impede the functioning of monetary policy mechanisms and keep them

away from their goals, in addition to the high degree of transparency and accountability about Monetary policy.

Finally, the reactions of monetary policy in Algeria do not conform to the requirements of achieving monetary stability.

7. Bibliographie

- Ball, L. (1999). Efficient rules for monetary policy. . *International finance* , 2 (1), pp. 63-83.
- Cermeño, R. V., & Polo, J. O. (2012). Monetary policy rules in a small open economy: An application to Mexico. *Journal of Applied Economics* , 15 (2), pp. 259-286.
- Clarida, R. G., & Gertler, M. (1998). Monetary policy rules in practice: Some international evidence. *European economic review* , 42 (6), pp. 1033-1067.
- Froyen, R. T., & Guender, A. V. (2017). The real exchange rate in Taylor rules: A Re-Assessment. *Economic Modelling* , pp. 1-12.
- Froyen, R. T., & Guender, A. V. (2018). The real exchange rate in Taylor rules: A Re-Assessment. *Economic Modelling* , 73, pp. 140-151.
- Ftiti, Z. (2008). Taylor rule and inflation targeting: Evidence from New Zealand. *International Business & Economics Research Journal (IBER)* , 7 (1).
- Greene, W. (2011). *Économétrie* (éd. Édition francophone dirigée par Didier Schlachter.).
- Lubik, T. A., & Schorfheide, F. (2007). Do central banks respond to exchange rate movements? A structural investigation. *Journal of Monetary Economics* , 54 (4), pp. 1069-1087.
- Mohanty, M. S., & Klau, M. (2005). Monetary policy rules in emerging market economies: issues and evidence. In *Monetary policy and macroeconomic stabilization in Latin America*. Springer , pp. 205-245.
- Moura, M. L., & De Carvalho, A. (2010). What can Taylor rules say about monetary policy in Latin America? *Journal of Macroeconomics* , 32 (1), pp. 392-404.
- Nielsen, H. B. (2005). Generalized Method of Moments (GMM) Estimation. *Lecture Notes* .
- Pétursson, T. G. (2005). *Inflation Targeting And Its Effects On Macroeconomic Performance*. Vienna: SUERF Studies.
- Taylor, J. B. (1993, December). Discretion versus policy rules in practice. In *Carnegie-Rochester conference series on public policy* , 39, pp. 195-214.
- Taylor, J. B. (2019). Inflation targeting in high inflation emerging economies: lessons about rules and instruments. *Journal of Applied Economics* , 22 (1), pp. 102-115.
- Taylor, J. B. (2000). The Monetary Transmission Mechanism and the Evaluation of Monetary Policy Rules. *Working Papers Central Bank of Chile* 87 .
- Taylor, J. B. (2001). The role of the exchange rate in monetary-policy rules. *American Economic Review* , 91 (2), pp. 263-267.