



Is the monetary policy of Algeria's central bank describable by a linear (extended) Taylor rule?

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Abstract:

The study explores the Central Bank of Algeria's management of interest rates within an inflation targeting strategy. It analyzes the extended linear Taylor rule, which incorporates the exchange rate and integrates forward-looking behavior to target expected inflation. The generalized method of moments (GMM) is used for the analysis from Q1 2000 to Q4 2021. The findings suggest that the response of inflation is insufficient for achieving stability, and the Algerian monetary policy is responsive to exchange rate fluctuations. However, the "fear of floating" undermines the policy response.

Keywords: Inflation targeting; Taylor's extended rule; Model (GMM).

JEL Classification: C22; E17; E43; E52; E58.

Introduction

Ensuring price stability is crucial for fostering long-term economic growth. Governments have implemented monetary policies to combat inflation, using monetary aggregates or exchange rates as intermediary tools to influence the inflation rate. However, due to the persistent challenge of maintaining price stability over extended periods, central banks have embraced direct inflation targeting. This strategy involves setting a specific inflation rate target and employing suitable monetary and fiscal policies to achieve it. New Zealand was the first country to adopt this approach in 1990, and its success has inspired other nations like Finland, Sweden, Canada, and Spain to adopt similar inflation targeting policies.

Monetary policy rules are considered vital tools for guiding the economy and achieving financial and economic stability. Several researchers have emphasized this (Barro & Gordon, 1983a, 1983b; Kydland & Prescott, 1977) the necessity of employing monetary policy rules to achieve price stability. These rules rely on the interest rate set by central banks to manage inflation rates. The problem lies in precisely determining these rates and how they can respond to changes in the economy. This is the primary objective of monetary policy rules, and (Taylor, 1993) proposed a linear mathematical rule for determining the interest rate based on changes in GDP and inflation. However, this rule is not immune to criticism, particularly regarding its vulnerability to external factors. For instance, fluctuations in oil prices can have substantial effects on a country's economy, diminishing the effectiveness of implementing these monetary policy rules (Manogaran & Sek, 2016).

(Clarida et al., 1998) extended the traditional Taylor Rule by proposing a forward-looking version that targets expected inflation and the expected production gap, rather than relying on current or past values. This forward-looking approach takes into account future expectations, making it a more dynamic and proactive method for guiding monetary policy. The expanded base of the Taylor Rule distinguishes itself from the original version by considering factors beyond inflation and GDP, including exchange rate fluctuations, asset prices, and other relevant variables. As a result, utilizing the expanded base enables central banks to make more precise and comprehensive decisions. In recent times, this approach has gained prominence for its ability to enhance the effectiveness of monetary policy.

Several studies have been conducted to shed light on the influence of additional variables on the conduct of monetary policy, leading to the development of the expanded Taylor Rule. In this regard, a group of researchers suggested incorporating the exchange rate into the Taylor Rule

for both private and public open market economies (Ball, 1999, 2000; Caglayan et al., 2016; Calvo & Reinhart, 2002; Froyen & Guender, 2017, 2018; Galimberti & Moura, 2013; Garcia et al., 2011; Ghosh et al., 2016; Leitemo & Söderström, 2005; Obstfeld & Rogoff, 2000; Svensson, 2000). While some authors advocate for the inclusion of asset prices in the analysis, they provide compelling evidence to support this proposition (Bernanke & Gertler, 2001; Borio & Lowe, 2002; Cecchetti et al., 2000; Chadha et al., 2004; Driffill et al., 2006; Gertler & Bernanke, 1999; Goodhart & Hofmann, 2000).

The researcher (Castro, 2011) developed a financial conditions index, which combines a range of financial variables. This concept had been previously studied by (Montagnoli & Napolitano, 2005) and was later adopted in Asia by (Gonzales & Bautista, 2013) and in Europe by (Angelopoulou et al., 2014). Furthermore, the researcher (Kajuth, 2010) suggested incorporating house prices as an additional variable in the analysis.

Another version of the traditional Taylor Rule was proposed by a group of researchers (Ball, 1999; Carlstrom & Fuerst, 2000; Rudebusch & Svensson, 1999; Taguchi & Kato, 2011). In this variant, the rule utilizes previous values of the production gap and inflation, making it a backward-looking approach. The disadvantage of this model is that it relies on historical data and does not consider expected changes in the economy. As a result, it may lack accuracy in guiding monetary policy during periods of rapid economic changes.

Given the previously conflicting results, this paper examines whether the Central Bank of Algeria indeed follows the Taylor extended linear rule and whether the exchange rate has any impact on interest rate setting. There are numerous studies on this subject in developed countries, but there are few studies focusing on emerging economies (Beju & Ciupac-Ulici, 2015; Caporale et al., 2018; Lamia & Djelassi, 2020; Manogaran & Sek, 2016; Taguchi & Khishigjargal, 2018). In Algeria, there are numerous studies that utilize the traditional Taylor rule, but only a few studies that employ the extended Taylor rule, which incorporates the exchange rate. The aim of this study is to fill this gap in the literature by testing the extended Taylor rule with the inclusion of the exchange rate using the generalized method of moments (GMM).

The study will be divided as follows: Section 2 reviews previous studies on the topic. Section 3 explains the econometric model and data

analysis. Section 4 presents the experimental results. Section 5 concludes with observations.

2- Literature review

In 1993, Taylor-type monetary policy rules were introduced by Taylor in his research. These rules, known as the Taylor Rule, proved to be a valuable tool for monetary policymakers, as highlighted by Orphanides in 2001. Over time, the Taylor Rule gained widespread popularity and was extensively employed as an evaluation tool for assessing the effectiveness of monetary policies in different countries.

The researchers (Beju & Ciupac-Ulici, 2015) found that the Romanian central bank reduced the inflation rate to 3.75%, the best level in the last 23 years. The study was conducted during the period 2003-2013, using the traditional Taylor rule. In a study conducted by researchers (Taguchi et al., 2020), they utilized the forward-looking Taylor rule and employed Bayesian estimations of the new Keynesian dynamic stochastic general equilibrium (DSGE) model and the Generalized Method of Moments (GMM) in five emerging economies (Indonesia from Q3 2005 to Q3 2019, the Philippines from Q1 2002 to Q4 2018, and Thailand from Q3 2000 to Q3 2019). The results indicated that the extended Taylor rule was helpful and effective in their analysis.

(Svensson, 2000, 2003) argued that due to the abundance of external shocks in an open economy, the traditional Taylor rule is not suitable. In such cases, it becomes necessary to incorporate other variables, such as the exchange rate. In a study conducted by researchers (Taguchi & Khishigjargal, 2018) in Mongolia from Q3 2007 to Q4 2017, they used the extended Taylor rule (forward-looking) and found that the Mongolian monetary policy rule responds to exchange rate movements. The estimation was carried out using the Generalized Method of Moments (GMM). The researchers (Caporale et al., 2018) found that the monetary authorities in economies such as Indonesia, Israel, South Korea, and Thailand respond to the real exchange rate using the extended Taylor rule and estimation through GMM. Furthermore, the researchers (Manogaran & Sek, 2016) discovered that Asian countries, including Indonesia, Malaysia, the Philippines, Thailand, and Singapore, actively respond to exchange rate changes from 1980 to 2015 using the extended Taylor rule, and they compared the results.

In another study conducted by (Tawadros, 2020), it was concluded that the extended Taylor rule, which incorporates the exchange rate, provides a good explanation for the monetary policy behavior in Australia during the period 1993 to 2018 through estimation using GMM. In a

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separate study by (Taguchi & Wanasilp, 2018) using both forward-looking and backward-looking Taylor rules and incorporating the same variable (exchange rate) through the application of Vector Autoregression (VAR) and Structural Vector Autoregression (SVAR) models in Thailand from Q2 2000 to Q2 2017, the results indicated that the monetary policy in Thailand responds to inflation and the exchange rate. (Paranavithana et al., 2020) included the same variable (exchange rate) and used the backward-looking Taylor rule in 18 inflation-targeting emerging economies and 22 non-inflation-targeting emerging economies. Meanwhile, the study conducted by researchers (Lamia & Djelassi, 2020) using the same rule and incorporating the same variable in Tunisia from Q1 2000 to Q4 2018 showed that the monetary policy in Tunisia cannot be well-described through the linear model.

(Castro, 2011) conducted a study on the Eurozone (from January 1999 to December 2007), the United States of America (from October 1982 to December 2007), and the United Kingdom (from October 1992 to December 2007) using the extended Taylor rule (forward-looking) supported by a financial conditions index through the application of the Generalized Method of Moments (GMM). The results showed that the European Central Bank interacts with financial conditions in a manner opposite to that of the United Kingdom and the United States of America. Will be summarized in the table 01

Table number (01): Literature review

Author	Data Frame	Sample size	Method	Findings
(Castro, 2011) (C)	1982-2007	The Eurozone, United States of America, and Britain	GMM	The European Central Bank interacts with financial conditions in an opposite manner to that of Britain and the United States of America, which do not interact.
(Beju & Ciupac-Ulici, 2015) (A)	2003-2013	Romania	ols	They found that the Romanian central bank lowered the inflation rate to 3.75%, the best level in the last 23 years.

(Manogaran & Sek, 2016) (D)	1980-2015	Indonesia, the Philippines, Thailand, Singapore, and Malaysia	NARDL	Asian countries (Indonesia, Malaysia, the Philippines, Thailand, and Singapore) actively respond to changes in the exchange rate.
(Caporale et al., 2018) (D)	1997-2015	Indonesia Thailand Israel South Korea Turkey	GMM	The monetary authorities in the economies of Indonesia, Israel, South Korea, and Thailand respond to the exchange rate.
(Taguchi & Wanasilp, 2018) (F)	2000-2017	Thailand	VAR S-VAR	Monetary policy in Thailand responds to inflation and exchange rate
(Taguchi & Khishigjargal, 2018) (F)	2007-2017	Mongolia	GMM	The monetary policy of Mongolia responds to the movement of the exchange rate.
(Paranavithana et al., 2020) (E)	1996-2017	18 emerging economies are inflation-targeting, and 22 emerging economies are non-inflation targeting.	S-GMM	In both inflation-targeting and non-inflation targeting economies, inflation and exchange rates appear as crucial components of the extended Taylor rule's interactive functions
(Lamia & Djelassi, 2020) (D)	2000-2018	Tunisia	GMM	Monetary policy in Tunisia is not well described by the linear model.
(Taguchi et al., 2020) (B)	2000-2019	Indonesia Philippines Thailand	GMM DSGE	Taylor's extended rule is helpful and effective in analysis.
(Tawadros, 2020) (D)	1993-2018	Australia	GMM	Taylor's extended rule, which includes the exchange rate, well explains the behavior of monetary policy in Australia.

- **OLS : Method of Ordinary Least-squares**
- **VAR : Vector Autoregression**
- **SVAR : Vector Autoregression Structural**
- **GMM : Generalized Method of Moments**
- **S-GMM :System Generalized Method of Moments**
- **IT : Inflation Targeting**
- **DSGE : Dynamic Stochastic General Equilibrium**
- **NARDL: Nonlinear Autoregressive Distributed Lag**

- (A) : Traditional
- (B) : Forward-looking
- (C) : Forward-looking With the inclusion of an FCI
- (D) : Forward-looking With the inclusion of the exchange rate variable
- (E) : Backward-looking With the inclusion of the exchange rate variable
- (F) : Forward-looking and Backward-looking With the inclusion of the exchange rate variable.

Source: Authors' identification following individual literature

3- Methodology and data

3-1 Methodology

Taylor-type monetary policy rules first appeared in 1993 (Taylor, 1993), The Taylor Rule was a valuable tool for monetary policymakers (Orphanides, 2001), and during that time, it was extensively used as an assessment tool for the monetary policy of various countries.

$$i_t = r^* + \beta(\pi_t - \pi^*) + y(y_t - y_t^*) \dots \dots \dots (01)$$

- i_t : **The Federal Reserve rate is called the Taylor rate.**
- r^* : **Real interest rate**
- π_t : **The inflation rate .**
- π^* : **The target inflation rate .**
- y : **Real domestic product**
- y_t^* : **Estimated domestic product.**
- β : **Parameters**

The traditional Taylor rule takes into account the deviation of inflation from its target. However, in practice, central banks tend to target not past or current inflation but rather expected inflation. For this reason,

researchers (Clarida et al., 2000; Clarida et al., 1998) have proposed using a forward-looking version of the Taylor rule. This type allows the central bank to consider various relevant variables when calculating its own inflation forecasts. In this study, we will estimate the following linear Taylor rule using the Generalized Method of Moments (GMM) approach, which was developed by (Hansen, 1982). We will follow the same method used by researchers (Clarida et al., 2000; Clarida et al., 1998).

$$r_t = \alpha_0 + \alpha_1 r_{t-1} + \alpha_2 \sum_{k=1}^3 (E_{t-1} \pi_{t+k} - \pi^t) + \alpha_3 \sum_{k=1}^3 (E_{t-1} y_{t+k}) + \alpha_4 \sum_{k=1}^3 (E_{t-1} rer_{t+k}) + \varepsilon_t \quad \dots(2)$$

- r_t : Short-term interest rate.
- π_{t+k} : The general consumer price index (CPI).
- π^t : Target inflation.
- y_{t+k} : Output gap.
- rer_{t+k} : Real exchange rate.
- E : Expectations factor.

3-2 Data

We estimate the extended Taylor rule (forward-looking version) using the Generalized Method of Moments (GMM) approach in Algeria. The data analysis covers the first quarter of the year 2000 until the fourth quarter of the year 2021. The money market rate (MMR) is used as an alternative to the interest rate. The nominal Gross Domestic Product (NGDP) data is obtained from the World Bank and is further processed to calculate the output gap using the Hodrick-Prescott (HP) filter, as proposed by (Ravn & Uhlig, 2002). All variables are described in Table 02 .

Title number 02 : List of Variables and Data Source

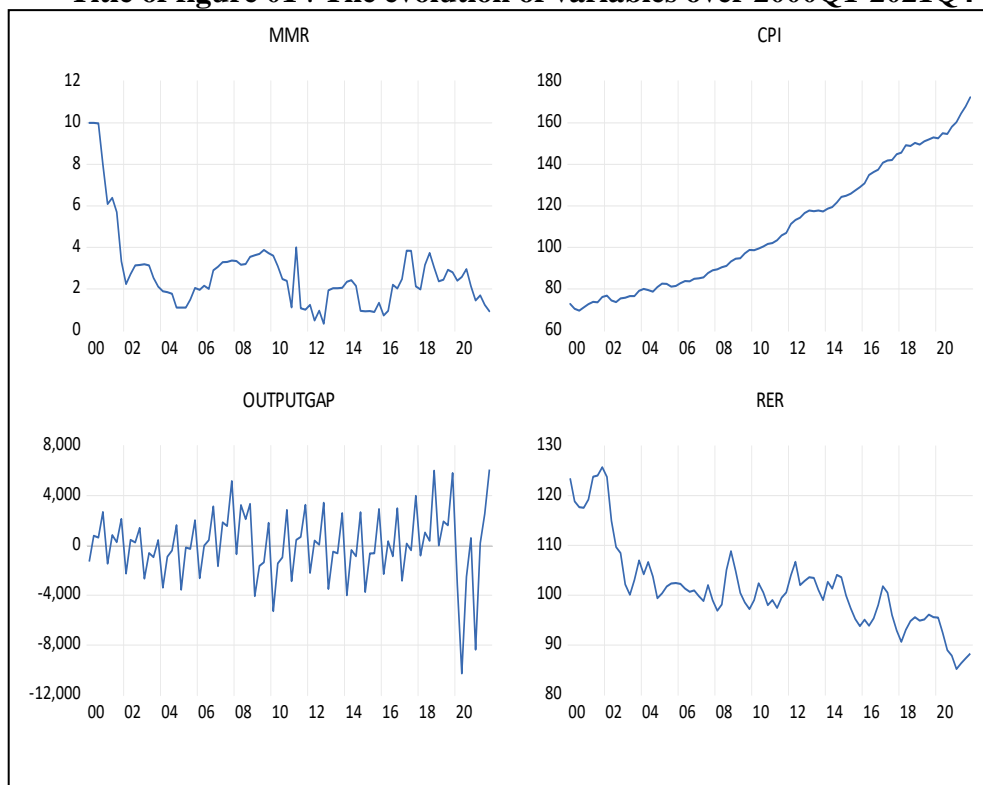
	Variables	Data source (IMF/WB)
MMR	The money market rate	This rate includes the rediscount rate, interbank borrowing interest rate, certificate of deposit interest rate, commercial paper interest rate, and other related rates.
CPI	General Consumer Price Index	The rate is expressed as an annual percentage change (when predicting inflation, actual inflation data is used based on logical forecasts) with a base year of 2010, where the index value is set to 100.
NGDP	nominal GDP	The GDP gap or output gap is further analyzed using the Hodrick-Prescott filter

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rer_{t+k}	Real exchange rate	The real effective exchange rate, based on the Consumer Price Index (CPI) data from the International Financial Statistics (IFS)
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Source: Authors' description

Title of figure 01 : The evolution of variables over 2000Q1-2021Q4



Source : Made by Authors'

The Money Market Rate (MMR) is characterized by significant fluctuations over the specified time period. Its highest value was recorded in the first quarter of 2000 at 9.99%, while its lowest value was observed in the fourth quarter of 2012 at 0.31%. The substantial increase in the general Consumer Price Index (CPI) at the beginning of the specified period indicates significant inflation, attributed to money printing and wage increases without a corresponding increase in production capacity. The Output Gap also exhibits significant fluctuations over the specified time period, influenced by external factors such as rising oil prices and economic and political crises.

4- Empirical results

Before starting the estimation of the Taylor rule, it is essential to examine the characteristics of the series. The stability of the variables was tested using unit root tests such as the Kwiatkowski-Phillips-Schmidt-Shin (KPSS), Augmented Dickey-Fuller (ADF), and Phillips-Perron (PP) tests. The results are presented in Table 03.

When the sample size is small, testing for unit roots becomes challenging. However, the KPSS test can provide evidence of stationarity for all the variables. We observe that all the variables are stationary.

Table number (03): Linear unit roots tests

Unit root tests,		ADF Test		PP Test		KPSS Test	
Variables		Intercept	Intercept and Trend	Intercept	Intercept and Trend	Intercept	Intercept and Trend
MMR	t-Statistic	-4.0754	-3.8464	-4.1858	-3.8612	0.4671	0.1396
	Prob.	0.0017 ***	0.0186 **	0.0012 ***	0.0179 **	**	*
CPI	t-Statistic	3.7299	-1.1532	3.7299	-1.1532	1.1878	0.2962
	Prob.	1.0000 n0	0.9132 n0	1.0000 n0	0.9132 n0	***	***
Outputgap	t-Statistic	-3.3802	-3.3859	-9.3925	-9.3365	0.0330	0.0330
	Prob.	0.0146 **	0.0606 *	0.0000 ***	0.0000 ***	n0	n0
rer	t-Statistic	-2.2063	-3.5156	-2.3350	-3.2386	0.9775	0.1451
	Prob.	0.2056 n0	0.0440 **	0.1635 n0	0.0838 *	***	*

note : The lag length for the ADF test is chosen based on the AIC criterion. The PP and KPSS tests are estimated on the basis of the Bartlett-kernel, using the Newey-West bandwidth (Newey and West, 1994). The null hypothesis of the ADF and PP tests is that the series is nonstationary, while the null hypothesis is stationarity against the alternative of a unit root for the KPSS test. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Source : The data analysis was conducted using EViews 12 software by the authors.

After estimating the model using the Generalized Method of Moments (GMM) approach, Table 04 presents the results of the model estimation. We observe that the model's quality is good (the R-squared value is close to one). Finally, there is no evidence of autocorrelation or heteroscedasticity in the estimated extended linear Taylor rule residuals.

We observe that the coefficient α_1 of the lagged money market rate MMR_{t-1} is statistically significant, indicating that the monetary authorities in Algeria adjust the interest rate using this coefficient to determine the extent of adjustments made to the targeted interest rate. It helps to mitigate the impact of short-term changes on the interest rate. There is also evidence that the monetary authorities respond to deviations of inflation from its target. We observe that the estimation of coefficient α_2 is statistically significant and positive. Regarding coefficient α_3 it is negative and statistically insignificant. As for the exchange rate, there is a small response ($\alpha_4 = -0.0103$). Overall, the study's results support the existence of a Taylor rule in Algeria. We observe that the Central Bank of Algeria adopts an approach that focuses on monetary stability and exchange rate preservation, achieved through a set of measures aimed at achieving monetary and economic stability in the country. There exists an agreement between monetary and fiscal policies in Algeria that includes various mechanisms and measures aimed at achieving a balance between monetary and fiscal policies and maintaining economic stability in the country.

The estimation results can be summarized as follows: The current monetary policy rule in Algeria, within the framework of inflation targeting, can be described as forward-looking. However, the response to inflation is weak. The Algerian monetary rule is influenced by the exchange rate due to "fear of floating" (Calvo & Reinhart, 2002), which affects the monetary policy's response to inflation control and output gap reduction. This approach differs from the monetary rules followed in other emerging market economies. Therefore, the obtained results demonstrate that the linear model may not fully capture the behavior of monetary policy in specific circumstances. Thus, a nonlinear model might have better predictive power and could provide a more accurate description of the behavior of the Central Bank of Algeria.

Table number (04): The estimation results using (GMM) approach are as follows

	Coefficient	t-Statistic	Std. Error	Prob
α_0	1.181457	1.063583	1.110827	0.2906
α_1	0.817209*	13.65333	0.059854	0.0000
α_2	0.158768***	0.053881	2.946652	0.0042
α_3	-3.5506	2.0014	-0.177078	0.8599
α_4	-0.005913	0.011665	-0.506872	0.6136

R-squared	0.837698
Durbin-Watson stat	2.310800

Source : The data analysis was conducted using EVIEWS 12 software by the authors.

Conclusion

In recent times, several studies have been conducted to examine the behavior of the Central Bank of Algeria in setting interest rates within the framework of inflation targeting, using the traditional Taylor rule. The results have varied, with some supporting and others opposing the ability of this model to provide accurate predictions.

This study contributes to the existing literature by describing the behavior of monetary policy in Algeria using the forward-looking linear Taylor rule, which includes the exchange rate. The results demonstrate that the linear model (extended Taylor rule) can significantly describe the behavior of the Central Bank of Algeria. However, they also indicate a weak response of the monetary policy to inflation and the output gap, suggesting that the exchange rate affects the monetary policy's behavior, reducing its effectiveness in responding to inflation. These findings can be used to assess whether improvements or updates are needed in the framework of the Algerian Central Bank's policy, considering current economic variables and future changes. Furthermore, the results can help determine whether non-linear models should be used to enhance predictions of monetary policy behavior in Algeria. By incorporating these results, policymakers can enhance the Central Bank of Algeria's policy and improve economic stability in the country.

The main findings from the estimation results of the monetary policy reaction functions are as follows: Firstly, the current monetary policy rule in Algeria, under inflation targeting, is characterized as a forward-looking rule that responds to inflation. Secondly, the response to inflation is not strong enough to achieve stability in inflation, which differs from the monetary policy reactions in advanced economies. Thirdly, the Algerian monetary policy rule also responds to exchange rate movements, but due to the "fear of floating" (Calvo & Reinhart, 2002), this response may weaken the policy's ability to effectively combat inflation.

Finally, monetary policy in this system requires a different policy response when determining interest rates, indicating that there may be a need for more discretionary power in monetary policy management. This includes considering a range of factors that cannot be accommodated by a simple rule when setting interest rates, such as local and international economic variables, political, and social conditions. These indicators may help improve the effectiveness of monetary policy and address various economic challenges.

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