Taylor rule in practice: Evidence from Tunisia

Chaouech, Olfa

FSEGT

15 February 2015

Taylor rule in practice: Evidence from Tunisia

Chaouech Olfa*

October 12, 2016

Abstract

This paper estimates the Taylor rule under the statistical version, then the dynamic version of the Central bank of Tunisia (CBT), using monthly data from 1995 M1 to 2015 M12. The empirical results indicate that the CBT follows the Taylor rule in its dynamic version.

1 Introduction

Taylor (1993)[27] was the first who proposed a simple rule to model the monetary policy for the Federal Reserve Bank (FED) of the United States.
This rule provides a focal point for discussing the reaction functions and is increasingly used as a very famous reference in monetary policy discussions, and can be used to evaluate the subsequent monetary policy and to ensure the determination of future policy. It shows an increase in interest rates when inflation is above its target level and a decline in a recession. In his study of US data, Taylor (1993)[27] assumed that both inflation target rate and equilibrium real interest rate are equal to 2%. Because the FED aimed the stability of inflation and economic activity, he granted two coefficients equal to 0.5 for the gap of inflation and output-gap. However, several theoretical[1] and empirical studies concerned by

*PhD Student at FSEGT, University of Tunis El Manar. E-mail: olfa.Chaouech@fsegt.utm.tn

[1]On the theoretical level, given a quadratic loss function of the central bank and linear curves of demand and aggregate supply, in the dynamic structure of the economy, we can get the Taylor rule by minimizing the loss function.

the exploitation of optimality conditions of this rule for the conduct of monetary policy.
Viewed its simplicity, several economists have criticized this rule because it can not be optimal for all countries, especially since the economy is more complicated and its structure varies across countries. In this context, McCallum (1993)[22], noted that this type of rule according to current data has not been operational because of its needs to the information which do not currently available.

Svensson (2003)[26], showed that although the primary objective of monetary policy is the stability of inflation and output, a simple Taylor-type rule will not be optimal in a reasonable macroeconomic model.
In the years ninety, economists have criticized the Taylor rule on variable timings. To solve this problem, the first reflections expressed the interest rate based on the values delayed in inflation and output. It's called "Backward-looking model." The fundamental principle of this type of model is to implicitly assume that private sector expectations are adaptive. It results in retrospective rules "Backward-looking". Many economists have criticized these types of rules. The most famous criticism is of Lucas (1976)[20], he studied how agents form their expectations of the future to influence their actual behavior. According to Lucas economists do not modify their behavior basing on past policies and statics to describe the agents' future behavior.

In addition to the Lucas critique, when we following a Backward-looking version rule, the instrument of monetary policy reacts only to shocks transmitted by the inflation and output. However, in the presence of other types of shocks, this rule does not lead to the price stability objective. Furthermore, a central bank adopts a Backward-looking rule can achieve short-term goals but not the long-term goals[2].

Given the limitations of the Backward-looking rule, recent research, such as Clarida, Gali et Gertler (1999)[6], Svensson (2003)[26] et Woodford (2004)[31], argue that the models based on future expectations of economic indicators are better than those that respond to the present or past variables. However, in practice central banks tend to take the expected inflation as a target. Therefore, many researchers as Gali and Gertler (1998)[13], Kozicki (1999)[18], Clarida, Gali, and

[2]the interest rate response to past changes in inflation will create more of the variability in the level of inflation than desired

Gertler (1998b)[5] and Mayes et al (2000)[21] have introduced inflation expectations and / or production to construct a Taylor rule forward-looking version.
In the late ninety, economists like Ball (1999)[2], Svensson (2000)[25] and Taylor (1999b)[28] have criticized the Taylor rule on the point of missing other key variables such as the exchange rate, which is an important variable in an open economy.
The objective of this work is to determine the nature of the rule that reflect better the behavior of central bank of Tunisia.The rest of this paper is organized as follows. Section 2 reviews the previous literature studies. Section 3 describes the data used in this paper. Section 4 introduces the basic methodology. Section 5 discusses the empirical results. Section 6 concludes.

2 Literature review

After Taylor (1993)[27], many economists estimated Taylor rule and its extensions. Indeed, McCallum (2000)[23] used historical analysis to estimate Taylor rule by using economic data of U.S and U.K for the period from 1962 to 1999, and Japan from 1972 to 1998. He suggested that rules messages are more dependent upon which instrument rather than which target variable is used.

Clarida, Gali and Gertler (1998a)[4] evaluated and tested the forward-looking monetary policy to study the behavior of central banks in the United States, Japon and some European countries. They used the Generalized Method of Moments (GMM). The result showed that the Central banks in these countries followed the Taylor rule in their interest setting behavior [3].

Following Clarida et al (1998b)[5] , Ghadha, Sarno and Valente (2004)[3] studied empirically whether asset prices and exchange rates may be included in a standard interest rate rule by using the data for United States, United Kingdom and Japan since 1979. The result showed that asset prices and exchange rates can be used as information variables for a standard Taylor rule.

Gorter, Jacobs and De Haan (2008)[16] estimated Taylor rules by using Consensus Economics data for expected inflation and output growth, for Euro area,

[3]see for example Clarida et al (1999)[6], Gerlach and Schnabel (2000)[15], Orphanides (2001)[24], Gerdesmeier and Roffia (2003)[14], Huston and Spencer(2005)[17], Taylor and Darvradakis (2006)[30]

they found that ECB takes expected inflation and output into account in the setting interest rates. They showed that the indications of accommodating behavior by the ECB implied by contemporaneous Taylor rules seem to be mainly driven by the lack of a forward-looking perspective.

Some empirical studies focused on emerging countries, have estimated monetary policy rules of central banks in these countries.

In fact, Yazgan and Yilmazkuday (2007)[8], estimated forward-looking monetary policy rules for Israel and Turkey, the results showed that forward-looking Taylor rules seem to provide a reasonable description of central bank behavior in both countries. Aklan and Nargelecekenler (2008)[1] estimated the backward-looking and forward-looking monetary policy reaction functions of the central bank of the Republic of Turkey (CBRT). They suggest that CBRT followed the Taylor rule in its interest setting behavior. The response coefficient of inflation and output gap is greater in the forward-looking model than in the backward-looking model.

De Carvalho (2012)[7], estimated Taylor rules by using the Consensus Economic Forecasts database for four largest Latin American economies, he used the GMM and real-time data of the output gap in Brazil and Mexico. He found that interest rate market forecasts can be explained by Taylor rules only for Mexico.

3 Data

In this study, we use monthly data from 1995 M1 to 2015 M12. To evaluate which Taylor type rules enunciates the Central Bank of Tunisia's behavior, we use four variables which are: The money market rate was used as a proxy for the nominal interest rate, the index of consumer prices (CPI) was used to measure the inflation rate, π_t which is then computed as: $\pi_t = 100 * ln(\frac{CPI_t}{CPI_{t-12}})$.

the industrial production index (IPI) was used to measure the output gap. That defined as the percentage deviation of actual output from its potential trend. The expression of this variable is given by:

$outputgap = 100 * (ipi - ipipotentiel/ipipotentiel)$. We use the HP filter to estimate the potential output with a coefficient (λ = 14400) because the data are monthly and the effective real exchange rate. The data are available in the database of the Central Bank of Tunisia (BCT) and the International Financial Statistic (IFS).

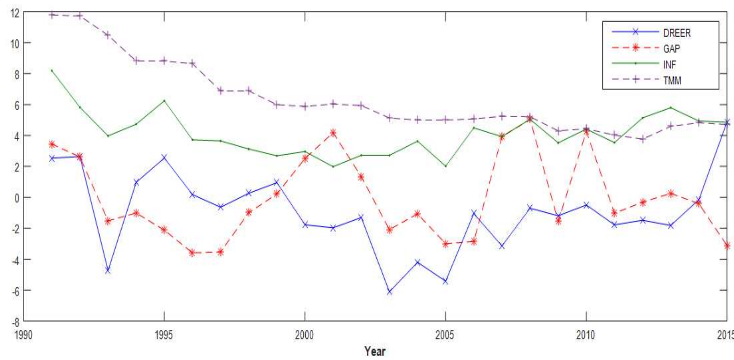

Figure 1: Annual variability of variables between 1995-2015

4 Methodology

Taylor (1993)[27] suggests a very specific and simple reaction function of monetary policy that can be described by the contemporary inflation and the output gap given by:

$$i_t{}^* = \bar{r} + \pi_t{}^* + \alpha(\pi_t - \pi_t{}^*) + \beta y_t \tag{1}$$

With: i_t^* the nominal interest rate, π_t the inflation rate, π_t^* the inflation target rate,$\bar{r}$ the long-term real interest rate,α the amount by which the central bank raises the real interest rate in ex-post response to a rise in inflation to its target level, y_t the output gap in period t, β amount by which the central bank raises the real interest rate in response to an increase in real output above its potential level.

In practice, central banks aim to smooth the interest rate. However, the reaction function is then described in terms of interest rates partial adjustment[4].The interest rate smoothing can be introduced into the model by means of the partial adjustment mechanism [5] as follows:

$$i_t = (1-\rho)i_t^* + \rho i_{t-1} + \upsilon_t \tag{2}$$

[4]Several researchers like McCallum (2000)[23] Levin et al (1999)[19] argue that a Taylor type rule with an interest rate smoothing is relatively robust.

[5] See Clarida et al (1998b)[5].

The smoothing parameter $\rho\epsilon[0.1]$,with this partial adjustment the central bank adjusts on each period its instrument to remove only a fraction $(1-\rho)$ of the gap between the current target level and some linear combination of its past values. Following Taylor (1993)[27], Clarida et al (1998a, 1998b, and 1999)[6, 5, 6] and Aklan and Nargelecekenler (2008)[1], we specify the reaction function of the central bank where i_t^* is the short term nominal interest rate target of the central bank as follows:

$$i_t{}^* = \bar{r} + \pi_{t+n}^* + \alpha[E(\frac{\pi_{t+n}}{\Omega_t}) - \pi_{t+n}^*] + \beta E(\frac{y_t - y_t^*}{\Omega_t}) \tag{3}$$

Where r̄ is the real interest rate of long-term equilibrium, π_{t+n} the inflation rate between the period t and $t+n$, π_{t+n}^* the inflation target for the period formed at the period t, α and β are the parameters that describe the response of the policy rate to deviations of inflation and output respectively from their targets. $E()$ expectation operator, Ω_t the information provided for the period t. if the equations 2 and 3 are combined, the result is as follows:

$$i_t = (1-\rho)\{\bar{r} + \pi_{t+n}^* + \alpha[E(\frac{\pi_{t+n}}{\Omega_t}) - \pi_{t+n}^*]\} \tag{4}$$

If the expression of the mathematical expectation is excluded, the result is as follows:

$$i_t = (1-\rho)\phi + (1-\rho)\alpha\pi_{t+n} + (1-\rho)\beta xt + \rho i_{t-1} + \mu_t \tag{5}$$

Where: $\phi = \bar{r} + \pi_{t+n}^*$, $x_t = y_t - y_t^*$, $\mu_t = (1-\rho)\{x(\pi_{t+n} - E[\frac{\pi_{t+n}}{\Omega_t}] + \nu_t)\}$, μ_t is an error term which is not correlated with information at the instant t. In the existing literature, equation(5) was estimated by the GMM.In order to determine which specifications represents better the policy followed by the Central Bank of Tunisia. This study want to estimate the Taylor rule in the statistical and dynamic version.

5 Results and Interpretation

We begin this empirical work by evaluating the Taylor rule in the traditional version. Then we estimate the Taylor type rule.

✓ *Traditional Taylor rule (TTR) estimation*

Table 1: estimation table

	Traditional rule	Static rule	Dynamic rule	Forward-looking rule	Exchange rate
cst	-	6.324***	0.007	0.176*	-0.101
	-	(0.000)	(0.915)	(0.098)	(0.322)
ρ	-	-	0.982***	0.974***	0.989***
			(0.000)	(0.000)	(0.000)
π	-0.010	-0.010	0.018**	-0.013	0.003**
	(0.733)	(0.737)	(0.028)	(0.166)	(0.010)
Gap	0.001	0.001	-0.011	-0.015	-0.012
	(0.426)	(0.423)	(0.413)	(0.297)	(0.374)
REER	-	-	-	-	-0.010
					(0.133)
$\bar{R}^2$	0.986	0.987	0.983	0.982	0.983
DW	1.721	1.718	1.736	1.677	1.753

* Indicate the significance level at 10%.
*** Indicate the significance level at 5%.
**** Indicate the significance level at 1%.

The aim is to determine whether the traditional Taylor rule translates the behavior of the monetary policy of the Central Bank of Tunisia.
Equation (1) is a linear rule, econometrically, this kind of rules is estimable by ordinary Least Squares method (OLS). However, the estimation results by such method leads to the presence of an autocorrelation error. In fact, The Durbin Watson statistic is equal 0.04 and we have 252 observation, it is not into the interval $[d_2, 4 - d_2]$ which means an autocorrelation problem of order 1. For this raisin, we used the AR1 regression to estimate the TTR.

The estimation results presented in table 1, show that the coefficients of inflation and output gap are not statically insignificant. This implies that the TTR does not express the central bank of Tunisia's behavior.

✓ *Estimation of Taylor Type Reaction Function*

In the last section, we showed that the TTR could not explain the behavior of the Central Bank of Tunisia. Consequently, in this section we try to estimate two reaction functions, which are the static reaction function that does not include a smoothing interest rate, then the dynamic version which will include it.

✓ *Estimation of the static reaction function*

To estimate the static rule, we inspire from the idea of Gerdesmier and Roffia (2003)[14] applied to the euro area case. Which consist to rewrite the equation (1) as follows:

$$i_t = \alpha + \alpha_\pi \pi_t + \alpha_y (y_t - \ddot{y}_t) + \xi_t \tag{6}$$

with
α : is a constant,
$\alpha_\pi = (1 + \alpha)$: the actual inflation rate coefficient,
α_y: the output gap coefficient.
Because of the autocorrelation problem, we use the AR(1) regression. The result indicate that the coefficients α_π and α_y are statistically insignificant. Accordingly, the static rule does not reflect the BCT's behavior.

✓ *Estimation of the dynamic response function*

In this section our aim is to determine whether the central bank of Tunisia adopts a partial adjustment of its interest rate.
The smoothing interest rate is an adjustment of the Taylor rule; that was adopted by Clarida, Gali and Gertler (1999)[6]. To estimate this reaction function we follow the methodology of Gerdesmeirend and Roffia (2003)[14] for the euro area and Huang. The function is written as follows:

$$i_t = a_0 + \rho i_{t-1} + \alpha_\pi \pi_t + \alpha_y y_g + \mu_t \tag{7}$$

with: $\alpha_0 = [(r^* + \pi) - \alpha_\pi \pi^*]$, $\alpha_\pi = (1 - \rho)\alpha$ et $\alpha_y = (1 - \rho)\beta$.
ρ:Partial adjustment coefficient of the interest rate $0 < \rho < 1$
It is a dynamic model, therefore we use the Generalized Method of Moment (GMM)[6]to estimate equation (7), The ADF test shows that all variables are stationary.
The application of GMM method requires the choice of instruments. In most cases, the choice of instrumental variables is determined by the economic literature. It is to select the delays of the explanatory variables to determine the vector

[6]The GMM requires that all variables should be stationary.

of instruments, without using too many instruments or too late to avoid the risk of over-identification. Gerdesmeir and Roffia (2003)[14] estimate the different specifications to determine the optimal Taylor rule which represents the behavior of the monetary authorities in the Euro area. They use GMM method, instruments are delays of one to six explanatory variables. Ftiti (2011)[12] uses four delays to estimate the optimal rule for New Zealand. Other studies with the same purpose, use delays from one to four of the independent variables. Thus, in the study we choose the delays from one to four as instruments.The results are shown in Table.1.
The econometric result show that the inflation rate coefficient is statically significant and positive (0.018), the coefficient of the output gap (-0.011) is statically insignificant, and the partial adjustment interest rate coefficient that is equal to 0.982 is significant and high. It is clear that the BCT objective focus on the inflation situation. The high level of smoothing parameter imply that the CBT makes significant effort on smoothing interest rates, which has often been interpreted like a sign of a great 'preference of gradualism' of the central banks.[7]
The adjustment coefficient ($\bar{R}^2 = 0.983$) which measures the variation degree of the short-run interest rate, is high, so the estimation rule has a great explanatory.

The estimation results show that this estimation is better and more realistic than the one of the static model. This can be explained by the inclusion of the interest rate logs as an explanatory variable.

✓ *Estimation of the Forward-looking Taylor rule*

By introducing of the inflation expectations, our approach consider that the active period of monetary policy is one year, so we assume that the BCT reacts to(π_{t+1}). We can rewrite equation (7) as follows:

$$i_t = c + \rho i_{t-1} + \Phi_\pi(\pi_{t+1} - \pi^*) + \Phi_y(y_t - \ddot{y}_t) + \xi_t \tag{8}$$

Ago the Lucas critique (1976), different statistical methods appeared to estimate the structural parameters describing the rules of economic policy. Using the orthogonality conditions related to the Euler equations, the GMM allows to estimate but also to test these models with rational expectations. (Patrick Fève, François Langot (1995)[9]. The GMM estimation result of equation (8) show that the coefficients of the inflation rate and the output gap are statistically insignificant. Hence, such rule can't expressed the CBT comportment. At this point of our analysis, the best model that reflects the CBT's behavior is the dynamic model.

[7] See Fourçan and Vranceanu (2007)[10] and Licheron (2009)[11]

✓ *The exchange rates effect on a Taylor type rule*

several researchers have criticized the Taylor rule on the failure of other key variables such as the exchange rate which is an important variable in an open economy. Thus, the purpose of this section consist to determine whether the monetary policy instrument has respond on the exchange rate fluctuation. In this framework, the exchange rate has two effects which are the direct and indirect ones.

the first one signify that the monetary policy instrument responds to the domestic indicators such as inflation and output gap in addition to the exchange rate fluctuations, and the second one means that the monetary policies do not directly react to the exchange rate fluctuations.
Taylor(2000)[29], 'concludes that the monetary policies, which directly react to the exchange rate fluctuation, do not reach a good inflation and economic stabilization. The most important finding in his study is the existence of indirect exchange rate channel, which affects the monetary policy in the absence of a direct channel'. Thus, in this part we added the exchange rate fluctuation variable to equation(7). The estimation of this new equation can determine weather the monetary policy of CBT respond directly or indirectly to the exchange rate fluctuations. We rewrite the equation(7) as follows:

$$i_t = a_0 + \rho i_{t-1} + \alpha_\pi \pi_t + \alpha_y y_g + \alpha_\gamma \Delta e_t + \mu_t \tag{9}$$

Where:
$\alpha_\pi = (1-\rho)\alpha$, $\alpha_y = (1-\rho)\beta$, $\alpha_\gamma = (1-\rho)\gamma$.
To estimate this equation, we apply the GMM, the estimated results show that the exchange rate fluctuations coefficient is negative and statically insignificant. Our results indicate that the CBT does not reply explicitly to the exchange rate fluctuations.

6 conclusion

Taylor(1993)[27] is the first who has made a rule of monetary policy expressed in terms of short-term interest rates. Several researchers have criticized this rule on many points. On the basis of these criticisms different rules resulted from the latter called 'Taylor type rule' .

Within this work, we want to determine the best rule that reflects the CBT's behavior. Indeed, using monthly data from 1995 M1 to 2015 M12, the results show that the Taylor rule in the dynamic version in its interest setting behavior can explain the monetary policy rule of CBT. Then we add the exchange rate fluctuations to this rule, the results show that the monetary policy rule of the CBT react indirectly to the exchange rate fluctuations.

Our finding confirm that the most important aim of the Tunisian monetary policy consist to stabilize the general price level in order to catch-up growth.

References

[1] Aklan, N. A., Nargelecekenler, M. (2008). Taylor rule in practice: Evidence from turkey. International Advances in Economic Research, 14(2), 156-166.

[2] Ball, L. M. (1999). Policy rules for open economies. Monetary policy rules (pp. 127-156) University of Chicago Press.

[3] Chadha, J. S., Sarno, L., Valente, G. (2004). Monetary policy rules, asset prices, and exchange rates. IMF Economic Review, 51(3), 529-552.

[4] Clarida, R., Gali, J., Gertler, M. (1998a). Monetary Policy Rules and Macroeconomic Stability: Evidence and some Theory,

[5] Clarida, R., Galı, J., Gertler, M. (1998b). Monetary policy rules in practice: Some international evidence. European Economic Review, 42(6), 1033-1067.

[6] Clarida, R., Gali, J., Gertler, M. (1999). The Science of Monetary Policy: A New Keynesian Perspective,

[7] De Carvalho, A. (2012). Interest rate market forecasts and taylor rules in latin american countries. Journal of International Business and Economics, 13(3), 40-47.

[8] Ege Yazgan, M., Yilmazkuday, H. (2007). Monetary policy rules in practice: Evidence from turkey and israel. Applied Financial Economics, 17(1), 1-8.

[9] Fève, P., Langot, F. (1995). La méthode des moments généralisés et ses extensions: Théorie et applications en macro-économie. Économie Prévision, 119(3), 139-170.

[10] Fourçans, A., Vranceanu, R. (2007). The ECB monetary policy: choices and challenges. Journal of policy Modeling, 29(2), 181-194.

[11] Licheron, J. (2009). Politique monétaire de la bce et inertie des taux d'intérêt. Revue économique, 60(3), 713-725.

[12] Ftiti, Z. (2011). Taylor rule and inflation targeting: Evidence from new zealand. International Business Economics Research Journal (IBER), 7(1)

[13] Galı, J., Gertler, M. (1999). Inflation dynamics: A structural econometric analysis. Journal of Monetary Economics, 44(2), 195-222.

[14] Gerdesmeier, D., Roffia, B. (2003). Empirical estimates of reaction functions for the euro area.

[15] Gerlach, S., Schnabel, G. (2000). The taylor rule and interest rates in the EMU area. Economics Letters, 67(2), 165-171.

[16] Gorter, J., Jacobs, J., De Haan, J. (2008). Taylor rules for the ECB using expectations data. The Scandinavian Journal of Economics, 110(3), 473-488.

[17] Huston, J. H., Spencer, R. W. (2005). International monetary policy: A global taylor rule. International Advances in Economic Research, 11(2), 125-134.

[18] Kozicki, S. (1999). How useful are taylor rules for monetary policy? Economic Review-Federal Reserve Bank of Kansas City, 84(2), 5.

[19] Levin, A. T., Wieland, V., Williams, J. (1999). Robustness of simple monetary policy rules under model uncertainty. Monetary policy rules (pp. 263-318) University of Chicago Press.

[20] Lucas, R. E. (1976). Econometric policy evaluation: A critique. Carnegie-Rochester Conference Series on Public Policy, , 1. pp. 19-46.

[21] Mayes, D. G., Virén, M. (2000). The exchange rate and monetary conditions in the euro area. Weltwirtschaftliches Archiv, 136(2), 199-231.

[22] McCallum, B. T. (1993). Discretion versus policy rules in practice: Two critical points: A comment. Carnegie-Rochester Conference Series on Public Policy, , 39. pp. 215-220.

[23] McCallum, B. T. (2000). Alternative monetary policy rules: A comparison with historical settings for the United States, the United Kingdom, and Japan (No. w7725). National Bureau of Economic Research.

[24] Orphanides, A. (2001). Monetary Policy Rules, Macroeconomic Stability, and Infla-Tion: A View from the Trenches.Board of Governors of the Federal Reserve System,

[25] Svensson, L. E. (2000). Open-economy inflation targeting. Journal of International Economics, 50(1), 155-183.

[26] Svensson, L. E. (2003). What is wrong with taylor rules? using judgment in monetary policy through targeting rules. Journal of Economic Literature, 41(2), 426-477.

[27] Taylor, J. B. (1993). Discretion versus policy rules in practice. Carnegie-Rochester Conference Series on Public Policy, , 39. pp. 195-214.

[28] Taylor, J. B. (1999). A historical analysis of monetary policy rules. Monetary policy rules (pp. 319-348) University of Chicago Press.

[29] Taylor, J. B. (2000). Low inflation, pass-through, and the pricing power of firms. European economic review, 44(7), 1389-1408.

[30] Taylor, M. P., Davradakis, E. (2006). Interest rate setting and inflation targeting: Evidence of a nonlinear taylor rule for the united kingdom. Studies in Nonlinear Dynamics Econometrics, 10(4)

[31] Woodford, M. (2004). Inflation targeting and optimal monetary policy. Review, 86