Validity of Taylor's rule for Turkey: An empirical study

Dilek Tokel 1,*, Saltuk Ağralioğl 2, Lamıha Öztürk 2

1Department of Economics, Faculty of Economics, Marmara University, Istanbul, Turkey
2Department of International Trade and Logistic Management, Faculty of Economics, Administrative and Social Sciences, Hasan Kalyoncu University, Gaziantep, Turkey

ARTICLE INFO

Article history:
Received 6 January 2021
Received in revised form 21 March 2021
Accepted 11 April 2021

Keywords:
Taylor rule
Interest rate
Monetary policy
Vector autoregressive model
Reaction function
Forward guidance

ABSTRACT

The aim of this paper is to propose an estimate of the reaction function of Turkey’s monetary policy for the periods from January 2005 to January 2020. In this perspective, a VAR (Vector Autoregressive) model is set up. The VAR model was estimated using Stata software. In this study, the Taylor rule is extended by implicating the industrial production index and the monetary aggregate M2 into policy reaction function. By doing so, the Taylor rule is investigated for the Turkish economy, and the validity of the rule is tested. The results of the ADF test show for all the observed variables that the null hypothesis of a unit root is rejected. In other words, the condition of stationarity seems to be satisfied. In the short term, it seems that a change in the behavior of the variable M2 has an impact of 1% on the level of the current inflation rate as well as the current real interest rate. For the period studied, the results of the VAR modeling indicate that Taylor’s rule is partly true for the short term but that it is not for the long term. The choice of the period studied seems to be the main reason for the non-cointegration between the inflation rate and the bank rediscount rate.

© 2021 The Authors. Published by IASE. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

1. Introduction

Many academic studies have popularized Taylor’s rule. Taylor (1993) in his article proposed to model a reaction function that aims to define a line of conduct in the choice of monetary policy to be implemented by the central bank. This simple equation connected most often the rate of interest short-term (assumed optimal) with the objective of stability of prices of Bank Central. The model has the aim to compare the estimated short-term interest rate with that actually realized. He also tries to understand these effects on inflation as well as the output gap. Taylor’s rule is therefore often used by researchers and economists to discuss the monetary policy strategy that should be implemented by the central bank. The Taylor (1993) rule estimates that the short-term interest rate must increase when expected inflation is higher than the inflation targeted by the central bank. The success of Taylor’s rule lies above all in the simplicity of its model and above all in the precision of its results. In fact, this rule accurately describes the behavior which should be adopted by the bank Central (Penot, 1998).

The work presented by Taylor (1993) and Stuart (1996) showed that the monetary policy implemented by the FED is relatively close to a Taylor rule. Although academic studies on the effectiveness of this rule are quite mixed, it remains a benchmark model for many researchers. Indeed, researchers such as Sibi (2002), Judd and Rudebusch (1998), Clarida et al. (1998), Bec et al. (2002), Akalın and Totucu (2007), Hofmann and Bogdanova (2012), and many others have focused on this rule in their empirical work.

Taylor's rule is often used in academic studies that seek to assess the effectiveness of this rule for developed countries such as the United States or the euro area. But there is a diversification of research that takes as an example to other developing countries. In fact, in the first years of the dissemination of this new model, Judd and Rudebusch (1998) made an estimate of the reaction function of the monetary policy carried out by the FED (between the years 1970-1997). According to the results of their estimation, Taylor’s rule is valid when the FED is chaired by Alan Greenspan but is much less when the FED is chaired by Burns. Sibi (2002) in his doctoral thesis also showed that the European Central Bank follows a Taylor rule for
the estimated periods (i.e., January 1990 to February 2000). Hofmann and Bogdanova (2012) constructed several reaction functions due to their sample size. Indeed, the authors of this research attempt to demonstrate the effectiveness of the Taylor rule for eleven developed countries and seventeen developing countries. The results of this study show that the rule is insufficient in the goal of maintaining macroeconomic equilibrium values.

Mésonnier and Renne (2004) in their work proposed a reaction function by taking as a reference the methodology proposed by Gerlach-Kristen (2003). The study by Clarida et al. (1998) appeared to be one of the first papers to attempt to model a reaction function for a future period. Like Bec et al. (2002) showed that the reaction function of monetary policy behaves asymmetrically. These authors show that the German central bank has a significant influence on the behavior of the French central bank. They seem that the effectiveness and validity of the Taylor rule also depend on the methodology and variables taken into effect in the modeling of the reaction function. Indeed, we see that the authors use different estimation techniques depending on whether the estimation is ex-ante or ex-post. Among the many studies carried out on the subject, two methodologies seem to be particularly favored in the modeling of the reaction function. These are the least-squares method and the generalized method of moments (Albayrak and Abdöoğlu, 2015).

For Gauss-Markov the least-squares method is the most appropriate method in the analysis of linear regression. This method has the advantage of being able to compare the data obtained from the model and that proposed by the Taylor rule. The method of generalized moments makes it possible, on a database containing a certain number of observations, to define a confidence interval for the estimate. With regard to the work carried out for Turkey, there has been an increase in academic work from 2002. Among the work carried out for Turkey, we can cite in particular the study of Akat (2004), Çağlayan (2005), Aktemur and Öztürk (2019), Akalin and Tokucu (2007), Onur (2008), Fuat and Bayat (2011), Yapraklı (2011), Demirbaş and Kaya (2012), Pehlivanoğlu (2014), or even Akdeniz and Çatık (2019).

The aim of this paper is to provide an estimate of the reaction function of Turkey’s monetary policy for the periods from January 2005 to January 2020. The year 2005 is chosen as the base year for all variables.

2. Methodology

In this perspective, a VAR (Vectorial Autoregressive) model is set up. As Sims and Zha (1998) pointed out, VAR models have the advantage of estimating the economic relations of several variables where each variable has an equation modeling its evolution over time. Among the empirical work done for Turkey Kayhan et al. (2013) as well as Fuat and Bayat (2011) also opted for VAR modeling in their estimation. Taylor’s equation is proposed as follows:

\[ i_t = \pi_t + \bar{r} + 0.5(\pi_t - \bar{\pi}) + 0.5y_t \]

where, \( i_t \) represents the central bank policy rate, \( \pi_t \) the current inflation rate, \( y_t \) the output gap (as a percentage of potential GDP), \( \bar{\pi} \) the long-term inflation target and \( \bar{r} \) the real equilibrium interest rate.

In the formulation of the model, the variables proposed by Taylor (1993) are added the industrial production index (denoted by IPE) and the monetary aggregate M2 (denoted simply by M). The extended equation proposed for this model is as follows:

\[ i_t = f(y_t, infd, M) \]

The data for the variables are taken from the Turkish Statistical Institute (TURKSTAT). This work covers Turkey over the period 2005: 01–2020: 01. The data used for this model are monthly data. To study the stationarity of the series: the augmented Dickey-Fuller test (ADF) was applied. In addition, the Johansen (1991) procedure was favored to determine the number of cointegrating relations that can be extracted from the series. A vector error correction model was also applied to the data. The VAR model was estimated using the Stata software.

Several hypotheses are tested as part of this study. First of all, the main hypothesis is the following:

**H0**: Taylor's rule is verified in the short term
**H1**: Taylor's rule is verified in the long term

In order to respond to these two hypotheses a certain number of sub-hypotheses must be posed and which are as follows:

h1. There is a direct causal relationship between the variables M2 and IPE.

h2. There is a direct causal relation between the variables M2 and the equilibrium interest rate.

h3. There is a direct causal relation between the variables M2 and the inflation rate.

h4. There is a direct causal relation between the inflation rate and the equilibrium interest rate.

h5. There is a direct causal relationship between the variables IPE and the equilibrium interest rate.

h6. There is a direct causal relation between the variables IPE and the inflation rate.

3. Results

The results of the various estimates of the Turkish central bank's reaction function are summarized below and we immediately notice that all the regressions have an adjusted R² greater than 0.5 but less than 0.85. Combined with a value close to the unit of the smoothing coefficient in the interest rate, this average value of the coefficient of determination is not necessarily a sign of a medium...
quality regression but can be an indicator of the stationarity of the series. As a reminder, $R^2$ is a coefficient of determination that explains how the variance of one variable explains the variance of the second variable. In order to test the stationarity of the model, the Dickey-Fuller test was applied. The Dickey-Fuller augmented test (ADF) or Dickey-Fuller unit root test makes it possible to understand whether a time series is stationary, that is to say, whether its statistical properties vary over time or not.

The results of the ADF test indicate that for all the observed variables that the null hypothesis of a unit root is rejected. In other words, the condition of stationarity seems to be satisfied. The Jarque-Bera tests and the eigenvalue stability condition indicate that there is no autocorrelation in the model and that the model has a normal distribution. The Johansen cointegration test indicates that there is a correlation between the variables of the model in the short run. As a reminder, cointegration makes it possible to detect the long-term relationship between two or more time series. Granger causality test indicates that in the short term there is indeed a direct causal relationship between the M2 variable, IPE, and the equilibrium real interest rate. In the short term, it seems that a change in the behavior of the variable M2 has an impact of 1% on the level of the current inflation rate as well as the current real interest rate. We observe a similar result for the variable IPE. Indeed, it seems that the fluctuation of the monetary aggregate still has an impact of 1% on the IPE industrial production index. However, over the long term, the causal relationship between variables is not demonstrated. The correlation of the variables is also not established when the cointegration test is applied over the long term. Whether short term or long term, the model failed to establish a causal link, nor a direct relationship between the rate of inflation and the current real interest rate. In other words, apart from hypothesis number 4, the other sub-hypotheses are verified in the short term. Hypothesis number four does not hold true either over the long term or the short term. The model’s basic assumption (H0) appears to be valid, but the H1 hypothesis is not verified. The results were shown in Tables 1-3.

### Table 1: Durbin Watson test result

| Source | df | MS | Number of Obs | RegF | LM2 | TUF | IPE | -Cons |
|--------|----|----|---------------|------|-----|-----|-----|-------|
| Model  | 3  | 766.593817 | 175 | F(5,171) | 121.37 | 121.37 |
| Residual | 171 | 174 | 19.4244254 | R-Squared | 0.6804 | 0.6748 |
| Total  | 3379.85002 | 174 | 19.4244254 | Adj R-Squared | 0.6748 | 2.5123 |

Durbin-Watson d-statistic (4,175) = 2.759026
Fuller LM2 Lags (1)

### Table 2: Variable results

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|----------|-----|------|-----------|-----|-----|
| $T$      | 0   | 2.10 | 5.79      | 1.10| 1.10|
| M1       | 175 | 2.37 | 3.01      | 3.01| 3.01|
| M2       | 175 | 6.60 | 122.65    | 465.84| 465.84|
| ENP      | 175 | 9.19 | 122.65    | 465.84| 465.84|
| IPE      | 175 | 20.04827 | 50.45 | 129.99| 129.99|
| F        | 175 | 4.407315 | 6.518 | 25.315| 25.315|
| EA       | 175 | 3.874578 | -2.42  | 20.24| 20.24|
| UA       | 175 | 3.901294 | -9.7 | 6.1 | 6.1 |
| USD      | 175 | 1.532579 | 1.1616 | 6.9864| 6.9864|
| TUF      | 175 | 3.550872 | 3.99 | 25.24| 25.24|
| Date     | 175 | 50.66228 | 551 | 725 | 725 |
| LM2      | 175 | 19.28506 | 21.82609 | 21.82609| 21.82609|
| dLM2     | 175 | 0.0193269 | -0.482063 | 0.1136703| 0.1136703|
| df       | 174 | -0.408696 | 4.02 | 5.8725| 5.8725|
| dTUF     | 174 | 1.18762 | 1.18762 | 6.62| 6.62|
| Dipe.    | 174 | 9.797614 | -35.8762 | 29.76628| 29.76628|

### 4. Conclusion

In this article, an estimate of the reaction function of Turkey’s monetary policy for the periods from January 2005 to January 2020 was proposed. For the period studied, the results of the VAR modeling indicate that Taylor’s rule is partly true for the short term but that it is not for the long term. This can be partly explained by the introduction of the M2 monetary aggregate as variables in the proposed model. In their work by Fuat and Bayat (2011) the effectiveness of the Taylor rule is proven for the short term as well. On the other hand, the exchange rate is one of the variables of the model proposed by these two authors for Turkey. The proposed model resulted in the existence of a strong correlation.
between the central bank rediscount rate and the rate of inflation. The result is not consolidated in this paper. The choice of the period studied seems to be the main reason for the non-cointegration between the inflation rate and the bank rediscount rate. Indeed, when Fuat and Bayat (2011) analyzed the period from 1986 to 2010, the rediscount rate applied by the central bank is very high (41% on average for the period considered) while it is significantly lower between 2005 and 2020 (13.1% on average). In other words, the bank rediscount rates no longer seem to be as effective a tool as they could have been in the past. In the short term to achieve its price stability target Turkey’s central bank should arm itself with other financial and monetary instruments. The implementation of the forward guidance tool could perhaps help orient interest rate expectations without the need to modify them. However, it is obvious that the central bank, which uses forwards guidance as a tool for adjusting its monetary policy, must respect these commitments at the risk of losing its credibility in the long term.

### Table 3: Vector error correction model

| Equation | Vec | LM2 | TUF | IPE | trend (constant) |
|----------|-----|-----|-----|-----|------------------|
| D_F      | 6   | .691169 | .4262 | 124.0232 | .0000 |
| D_LM2    | 6   | .019298 | .3882 | 105.9506 | .0000 |
| D_TUF    | 6   | 1.12865 | .1285 | 24.62288 | .00004 |
| D_IPE    | 6   | 8.25951 | .3025 | 72.43134 | .0000 |
| D_Cons   | -105.9373 | .0714547 | -1.48 | 0.138 | -.2459859 | .0341113 |

| Coef. Std. Err. | z | P>|z| | (95% Conf. Interval) |
|-----------------|---|-------|---------------------|
| -.05.35672      | .0148194 | -3.61 | 0.000 | -.0826127 | -.0245218 |
| .4366168        | .068586 | 6.37 | 0.000 | .3021907 | .5710429 |
| 13.30592        | 2.743953 | 4.85 | 0.000 | 7.927875 | 18.68397 |
| .05.93865       | .0506369 | 1.17 | 0.241 | -.0398599 | .158633 |
| -.02.13898      | .0064905 | -3.30 | 0.001 | -.0341109 | -.0086686 |
| -105.9373       | .0714547 | -1.48 | 0.138 | -.2459859 | .0341113 |

### Compliance with ethical standards

**Conflict of interest**

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

### References

Akalin G and Tokucu E (2007). Kurala dayalı-takdirle dayalı para politikaları Taylor kuralı ve Türkiye’de enflasyon hedeflemesi uygulamasi. Marmara Üniversitesi İktisadi ve İdari Bilimler Dergisi, 22(1), 37-55.

Akat AS (2004). Dalga kur ve para politikası: Bir parasal kural öncesi İstanbul Bilgi Üniversitesi Yayınları, İstanbul, Turkey.

Akdæniz C ve Çatik AN (2019). Finansal koşulların taylor kuralının geçerliliğini üzerindeki etkisi: Türkiye üzerinde ampirik bulgular. TESAM Akademi, 6: 107-126. https://doi.org/10.30626/tesamakademi1584301

Aktemur O ve Öztürk S (2019). Taylor kuralının geçerliliği üzerinde bir analiz: Türkiye uygulamasi. Sosyal Bilimler Enstitüsü Dergisi, 12: 81-110.

Albayrak N ve Abdыйolu Z (2015). Geriye ve ileriye dönük para politikasi reaksiyon fonksiyonlarının tihmini: Taylor kuralı. Suleyman Demirel University Journal of Faculty of Economics and Administrative Sciences, 20(4): 141-163.

Bec F, Salem MB, and Collard F (2002). Asymmetries in monetary policy reaction function: Evidence for US French and German central banks. Studies in Nonlinear Dynamics and Econometrics, 6(2): 1-22. https://doi.org/10.2202/1558-3708.1006

Çağlayan E (2005). Türkiye’de taylor kuralının geçerliliğinin ekonometrik analizi. Marmara Üniversitesi İktisadi ve İdari Bilimler Dergisi, 20(1): 379-392.

Clarida R, Galı J, and Gertler M (1998). Monetary policy rules in practice: Some international evidence. European Economic Review, 42(6): 1033-1067. https://doi.org/10.1016/S0014-2721(98)00016-6

Demirbağ E ve Kaya MV (2012). Testing the validity of taylor principle for Turkey from a different perspective. Abant İzzet Baysal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 12: 81-110. https://doi.org/10.2307/2938278

Fuat LEBE ve Bayat T (2011). Taylor kuralı: A vector autoregressive model analysis for Turkey. Ege Akademik Baku Dergisi, 11(5): 95-112.

Gerlach-Kristen P (2003). Interest rate reaction functions and the Taylor rule in the euro area. Available online at: https://kssrn.com/abstract=457526

Hofmann B ve Bogdanova B (2012). Taylor rules and monetary policy: A global Great Deviation? BIS Quarterly Review September 2012, Bank for International Settlements, Basel, Switzerland.

Johansen S (1991). Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. Econometrica: Journal of the Econometric Society, 59(6): 1551-1580. https://doi.org/10.2307/2938278

Judd JP ve Rudebusch GD (1998). Taylor’s rule and the fed: 1970-1997. Economic Review-Federal Reserve Bank of San Francisco, 3: 3-16.
Kayhan S, Bayat T, and Koçyiğit A (2013). Enflasyon hedeflemesi rejiminde öğrenme süreci ve asimetri: Markov Switching yaklaşımı. Eskişehir Osmangazi Üniversitesi İktisadi ve İdari Bilimler Dergisi, 8(1): 191-212.

Mésonnier JS and Renne JP (2004). Règle de Taylor et politique monétaire dans la zone euro. Banque de France, Paris, France.

Onur S (2008). Türkiye ekonomisinde faiz oranları-enflasyon ilişkisi üzerine bir model denemesi (1980-2005). Journal of Qafqaz University, (24): 123-145.

Pehlivanoğlu F (2014). Optimal para politikası çerçevesinde taylor tipi faiz oranı reaksiyon fonksiyonu tahmini: Türkiye örneği. Bilgi Ekonomisi ve Yönetimi Dergisi, 9(1): 115-126.

Penot A (1998). La politique monétaire française à travers la règle de Taylor. Revue d’Économie Financière, 49: 135-154. https://doi.org/10.3406/eco.1998.3729

Sibi F (2002). Règle de Taylor et application à la zone-euro. Ph.D. Dissertation, Université Paris I Panthéon Sorbonne et CNRS, Paris, France.

Sims CA and Zha T (1998). Bayesian methods for dynamic multivariate models. International Economic Review, 39(4): 949-968. https://doi.org/10.2307/2527347

Stuart A (1996). Simple monetary policy rules. Bank of England Quarterly Bulletin, 36(3): 281-287.

Taylor JB (1993). Discretion versus policy rules in practice. Carnegie-Rochester Conference Series on Public Policy, 39: 195-214. https://doi.org/10.1016/0167-2231(93)90009-L.

Yapraklı S (2011). Türkiye’de açık ekonomi para politikası kuralının geçerliliği: Snur testi yaklaşımı. The Journal of Industrial Relations and Human Resources, 13(1): 127-142. https://doi.org/10.4026/1303-2860.2011.0167.x