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

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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.

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

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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 Abdioğlu, 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:

$$i_t = \pi_t + \bar{r} + 0.5(\pi_t - \bar{\pi}) + 0.5\, y_t$$

where, i_t represents the central bank policy rate, π_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 relationship between the inflation rate and the equilibrium interest rate.
h5. There is a direct causal relation 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 R^2 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 overtime 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

Reg F LM2 TUF IPE						
Source	SS	df	MS		Number of Obs	175
Model	2299.78145	3	766.593817		F (3,171)	121.37
Residual	1080.06857	171	6.31619045		Prob>F	0.00000
Total	3379.85002	174	19.4244254		R-Squared	0.6804
					Adj R-Squared	0.6748
					Root MSE	2.5132
F	Coef	Std.Err.	t	P> t	(95% con.	Intervall)
LM2	-4.782504	.6160694	-7.76	0.000	-5.998566	-3.566441
TUF	1.118876	.0603538	18.54	0.000	.9997414	1.23801
IPE	.0531139	.020327	2.61	0.010	.0129897	.093238
-Cons	95.45383	11.0322	8.65	0.000	73.677	117.2307
Durbin-Watson d-statistic (4,175)=.2759026						
Dfuller LM2, Lags (1)						

Table 2: Variable results

Variable	Obs	Mean	Std. Dev.	Min	Max
T	0				
M1	175	2.58	2.10	5.79	1.10
M2	175	9.90	6.60	2.37	3.01
ENF	175	239.9739	91.9388	122.65	465.84
IPE	175	87.62449	20.04827	50.45	129.99
F	175	12.85039	4.407315	6.518	25.315
EA	175	4.428857	3.874578	-2.42	20.24
UA	175	-.3885714	3.901294	-9.7	6.1
USD	175	2.61053	1.532579	1.1616	6.9864
TUF	175	9.617429	3.550872	3.99	25.24
Date	175	638	50.66228	551	725
LM2	175	20.49517	.6710603	19.28506	21.82609
dLM2	175	.0145892	.0193269	-.0482063	.1136703
dF	174	-.0468851	.8956427	-4.02	5.8725
dTUF.	174	.0281609	1.18762	-5.75	6.62
Dipe.	174	.2661974	9.797614	-35.80762	29.70628
(e)	175	1	0	1	1

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

Vec F LM2 TUF IPE, trend (constant)

Vector error-correction model			Num. of Obs		173	
Sample: January 2005-January 2020			AIC		7.046158	
Log Likelihood			HQIC		7.245814	
Det (Sigma_ml)			SBIC		7.538291	
Equation	Parms	RMSE	R-sq	Chi2	Pchi2	
D_F	6	.691169	.4262	124.0232	0.0000	
D_LM2	6	.019298	.3882	105.9506	0.0000	
D_TUF	6	1.12865	.1285	24.62288	0.0004	
D_IPE	6	8.25951	.3025	72.43134	0.0000	
D_F	Coef.	Std. Err.	z	P>|z|	(95% Conf.	Interval)
-cel L1.	-.0535672	.0148194	-3.61	0.000	-.0826127	-.0245218
F LD.	.4366168	.068586	6.37	0.000	.3021907	.5710429
LM2 LD.	13.30592	2.743953	4.85	0.000	7.927875	18.68397
TUF LD.	.0593865	.0506369	1.17	0.241	-.0398599	.158633
IPE LD.	-.0213898	.0064905	-3.30	0.001	-.0341109	-.0086686
_Cons	-.1059373	.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.

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