Journal of Applied Economic Sciences
Volume XIX, Winter, Issue 4(86)

The Tunisian Central Bank's Efficiency Benchmarks: A Dynamic Approach

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Article's history:

Received 3rd of September, 2024; *Received in revised form* 4th of October, 2024; *Accepted* 14th of October, 2024; *Available online*:15th of October, 2024. *Published* as article in the Volume XIX, Winter, Issue 4(86), 2024.

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Suggested citation:

Bouhouch, F. (2024). The Tunisian Central Bank's efficiency benchmarks: A dynamic approach. *Journal of Applied Economic Sciences*, Volume XIX, Winter, 4(86), 405 – 416. https://doi.org/10.57017/jaes.v19.4(86).04

Abstract:

The topic of banking performance and efficiency has received considerable attention, yet there is a noticeable gap in examining the performance and efficiency of central banks. Moreover, there is a scarcity of studies on central bank efficiency. This paper aims to investigate the factors that influenced the efficiency of the Central Bank of Tunisia from 2000 to 2020, using an Autoregressive Distributed Lag Model. The appropriate econometric methodology was first established to achieve this goal, after which the model's results were presented and interpreted.

The study's findings indicate that the Tunisian Central Bank's efficiency is influenced by several macroeconomic (inflation, public deficit, growth rate), international (exchange rate, foreign debt), and political variables (political and government instability, conflict of interest), each with a varying degree of impact. Interestingly, the transition of the Central Bank of Tunisia from a dependent to an independent institution in 2016 did not yield a notable change in efficiency.

Keywords: central banking, ARDL, efficiency, Tunisia, Central Bank independence.

JEL Classification : E52, E58, C510, D610.

Introduction

With the increasing financial globalization and the expansion of the global banking sector, it has become more important to assess the performance of banking institutions. The evaluation process has evolved by adapting the concept of efficiency, originally applied to firms by Farrell in 1957, to the context of banking. Berger and Mester (1997) and Otero et al. (2020) argue that a comprehensive evaluation of banking efficiency should not solely focus on the technical aspects of production technology. Instead, it should consider economic optimization, considering market prices, and the competitive environment. This broader perspective ensures a more accurate and holistic understanding of a bank's effectiveness.

The study of banking performance and efficiency has received considerable attention, yet there is a noticeable gap when it comes to examining the performance and efficiency of central banks. Existing literature lacks a clear definition and precise measurement of central bank performance and efficiency. Moreover, there is a scarcity of studies on central bank efficiency, despite the abundance of research on the determinants of efficiency in commercial banks. Assessing the efficiency of central banks is complex due to the unique nature of their operations and the multiple objectives they pursue (Mester, 2003; Veyrune & Zerbo, 2023). Unlike commercial enterprises or banks, profitability is not suitable for central banks, as they are non-profit public institutions. It is, therefore, necessary to understand the concept of central bank efficiency in terms of the most efficient manner in which the central bank is creating its output concerning the inputs used (Blix et al., 2003; Mester, 2003).

This paper aims to fill this gap by identifying the key determinants of the efficiency of the Central Bank of Tunisia (CBT). First, we will thoroughly review the relevant literature to determine the appropriate methodology. We will then use an Autoregressive Distributed Lag (ARDL) model to identify the determinants of the CBT's efficiency scores and interpret the results. This research will contribute to the current academic interest in understanding central bank efficiency and provide valuable insights for policymakers and researchers in this area.

1. Literature Review

This first section aims to identify, through a literature review, the various methods used to identify the main factors influencing central bank efficiency. This development will facilitate the selection of an appropriate methodology for the empirical study aimed at determining the efficiency of the Central Bank of Tunisia.

A review of the literature reveals that the question of the determinants of efficiency has been approached from a static perspective, both for commercial and central banks. Conversely, the same question has only been addressed dynamically in the case of commercial banks.

Furthermore, research on the determinants of central bank efficiency is relatively scarce and recent (see Table 1). The initial analysis was conducted by Gomez Gallego (2020), who employed the Data Envelopment Analysis (DEA) method to calculate efficiency scores for a sample of 20 OECD central banks over the period 2010-2012. Subsequently, the author employs econometric regression to ascertain the factors that exert an influence on these scores. The analysis demonstrates that economic development and the legal and institutional environment of the country are the primary factors responsible for the observed differences in efficiency scores.

The second analysis is that of Faroq Dar et al. (2021a), which concerns the banks of 17 Asian countries over the period 2016-2018. The authors initially calculated efficiency scores using the Data Envelopment Analysis (DEA) method. Secondly, the Tobit method was employed to identify the effective determinants of efficiency. The results indicate a positive correlation between exports and efficiency, and a negative correlation between GDP, imports, and the exchange rate. Faroq Dar et al. (2021, b) recalculated efficiency scores using Stochastic Frontier Analysis (SFA) for the same sample to extend their findings. Subsequently, these scores were incorporated into a simultaneous equations model. The authors corroborate the positive impact of international trade and the negative impact of GDP and the exchange rate on central bank efficiency.

In a more recent study, Veyrune & Zerbo (2023) sought to identify the determinants of the efficiency of 75 central banks over the period 2008-2021. The authors conclude, based on linear regression, that the status of independence and the ratio of bank deposits to GDP have a positive impact on the efficiency score. However, the effect of trade openness is inversely proportional.

Drawing on existing research, we propose to elucidate the underlying factors that contribute to the efficiency of CBT. Our approach diverges from previous methodologies by employing a dynamic model.

Table 1. The existing literature on the determinants of central bank efficiency

Publication	Sample and period	Efficiency score	Determinants Research	Results
Impact of international trade on central bank efficiency (2021)	17 Asian Central Banks 2016-2018	DEA	Tobit	Exports (+) Imports (-) GDP (-) Exchange rate (-)
Evaluation and investigation: the determinants of central bank efficiency (2021)	17 Asian Central Banks 2016-2018	SFA	Structural equation model	Exports (+) Imports (-) GDP (-) Exchange rate (-)
Efficiency in European Union: the role of economic freedom (2020)	20 OECD Central Banks 2010-2012	DEA	Linear regression	GDP (+) Corruption (-)
Estimation and Determinants of Cost Efficiency: Evidence from Central Bank Operational Expenses (2023)	75 central banks 2008-2021	SFA	Linear regression	Independence (+) Deposits/GDP (+) Commercial opening (+)

Source: Author

The objective of this research is to identify the factors influencing the efficiency of CBT. To this end, we propose to employ the ARDL (Autoregressive Distributed Lag) model as proposed by Agovino et al. (2022). ARDL is a dynamic approach that estimates short and long terms relationships between integrated series at different orders. It is also suitable for small samples (Shrestha & Bhatta, 2018).

According to Kuma (2018) and Kripfganz and Schneider (2023), the basic equation of an ARDL model is then written as follows:

$$Y_t = f\left(X_t, Y_{t-p}, X_{t-q}\right) \quad (1)$$

where: Y_t: the dependent variable, X_t: the independent variable, Yt_{-p}: lagged dependent variable, X_{t-q}: lagged dependent variable.

In its explicit form, an ARDL model is written:

$$Y_t = \varphi + a_1 Y_{t-1} + \cdots + a_p Y_{t-p} + b_0 X_t + \cdots + b_q X_{t-q} + e_t \quad (2)$$

Or:

$$Y_t = \varphi + \sum_{i=1}^{n} a_i Y_{t-i} + \sum_{i=1}^{n} b_j X_{t-j} + e_t \quad (3)$$

where: e_t: the error term, b_0: the short-term effect of X_t on Y_t.

The stationarity of the variables must first be defined to estimate an ARDL model. The stationarity of a time series is examined by performing unit root tests, including the Dickey-Fuller test (1979), the Dickey-Fuller Augmented test (1981) and the Philip-Perron test (1988). The literature suggests that the use of the ADF test is more frequent, as it has the advantage of taking into account the autocorrelation of errors (Nkoro & Uko, 2016). This test is as follows:

$$\Delta y_t = (\alpha - 1) y_{t-1} + \sum_{i=1}^{p} \gamma_1 \Delta y_{t-1} + \varepsilon_t \quad (4)$$

If the null hypothesis (H_0: α =1) is retained in the following three models, it can be concluded that the series has a unit root. If the null hypothesis is rejected, the alternative hypothesis of stationarity (H_1) is accepted.

- Autoregressive model no constant, no trend: $\Delta y_t = (\alpha - 1) y_{t-1} + \varepsilon_t$ (5)
- Autoregressive model with constant: $\Delta y_t = c + (\alpha - 1) y_{t-1} + \sum_{i=1}^{p} \gamma_1 \Delta y_{t-1} + \varepsilon_t$ (6)
- Autoregressive model with constant and trend: $\Delta y_t = c + \beta_t + (\alpha - 1) y_{t-1} + \sum_{i=1}^{p} \gamma_1 \Delta y_{t-1} + \varepsilon_t$ (7)

In the second step, the optimal lag is specified in accordance with the criteria of Akaike (AIC), Schwarz (SIC) or Hannan and Quinn (HQ). The values of these criteria are calculated as follows:

$$AIC\ (p) = \log\left|\widehat{\sum}\right| + \frac{2}{T} n^2 p \quad (8)$$

$$SIC\ (p) = \log\left|\widehat{\sum}\right| + \frac{\log T}{T} n^2 p \quad (9)$$

$$HQ\ (p) = \log\left|\widehat{\sum}\right| + \frac{2 \log T}{T} n^2 p \quad (10)$$

where: $\widehat{\sum}$: the matrix of variances-covariances of the estimated residues, T: the number of observations, p: the optimal lag , n: the number of regressors.

The Autoregressive Distributed Lag (ARDL) modeling approach facilitates the examination of long-run relationships between integrated time series of varying orders through the Bound Test (Pesaran et al., 2001). The following cointegrated ARDL specification is established between Y_t and X_t:

$$\Delta Y_t = \pi_0 + \pi_1 + \sum_{i=1}^{p} a_i\, \Delta Y_{t-1} + \sum_{j=0}^{q-1} b_j\, \Delta X_{t-j} + \theta u_{t-1} + e_t \ldots \quad (11)$$

The existence of a cointegration relationship is confirmed when: $0 < \left|\hat{\theta}\right| < 1, \widehat{\theta} < 1, (\theta$ is the error correction term).

2. Empirical Investigation

The methodology that underlies this econometric investigation by ARDL comprises two key elements. The first is the specification of the underlying variables and models. The second is conducting various tests and an in-depth examination of their implications.

2.1.Specifications of variables and preliminary tests

The annual statistical data used for Tunisia range from 2000 to 2020 (Table 2). They were extracted from the World Bank Development Indicators website and CBT reports. Institutional variables are derived from the bases of the International Country Risk Guide (ICRG) and the Worldwide Governance Indicators (WGI).

The variables in question can be divided into two categories: monetary and financial variables, which are considered to be short-term variables, and real and institutional variables, which are treated as long-term variables. The differentiation of the horizon implies that the variables evolve neither in the same regularity nor in the same amplitude. This suggests mixed levels of stationarity.

Table 2. Definition of variables

Variable	Definition	Source
GDP	Annual growth rate of GDP	(WDI)
INF	Annual inflation rate as measured by CPI	(WDI)
DB	Budget deficit as % of GDP	(WDI)
UN	Unemployment rate as % of labour force	(WDI)
MMR	Money market rate	CBT Reports
EXC	Exchange rate	CBT Reports
CAP	Market capitalization: value of all listed shares by the value of each share	CBT Reports
DET	External debt: the sum of public long-term debt guaranteed by the state and private unsecured, the use of IMF credits and short-term debt	(WDI)
EXP	Export of goods and services by volume	(WDI)
IMP	Imports of goods and services by volume	(WDI)
FDI	Foreign direct investment: net inflows of foreign capital	(WDI)
IC	Internal Conflicts: Evaluation of political violence in the country	(ICRG)
SGOV	Government stability: Assessment of the government's ability to implement the program(s) it has declared and its ability to remain in power	(ICRG)
PS	Political stability and absence of violence/terrorism measure perceptions of the likelihood of political instability and/or politically motivated violence, including terrorism	(WGI)
STA	A binary variable of status: 0 for CBT dependency and 1 for independent CBT	Attributed by author
EFF	CBT efficiency score	Calculated by author

Source: author

As evidenced in Appendix 1, the unit root test results indicate that the variables are integrated into different orders, providing a rationale for using the ARDL method. For the four groups of variables, the cointegration relationship was studied by the cointegration Bound test. This test was preceded by the search for the optimal lag according to the Akaike criterion. These tests show that the optimal model to be estimated is an ARDL (2.1) for the groups of macroeconomic, monetary, and international economic variables. On the other hand, for the variables of international economic conditions, the optimal number of delays is (2.2), see Appendix 2.

The Pesaran et al. (2001) test enables the identification of cointegration relationships, as indicated by a value for the F-statistic exceeding the one-percent limit. In our case, there are three cointegration relationships, except for institutional variables, as presented in Appendix 3.

2.2. Models' specifications and robustness tests

The initial tests conducted have indicated a need for the development of four distinct models. The model is written for macroeconomic variables as:

$$\Delta EFF = \beta_0 + \sum_{i=1}^{p} \beta_1 \Delta EFF_{t-i} + \sum_{i=1}^{q} \beta_2 \Delta GDB_{t-i} + \sum_{i=1}^{q} \beta_3 \Delta DB_{t-i} + \sum_{i=1}^{q} \beta_4 \Delta INF_{t-i} + \sum_{i=1}^{q} \beta_5 \Delta UN_{t-i} + \theta_1 EFF_{t-1} + \theta_2 GDP_{t-1} + \theta_3 DB_{t-1} + \theta_4 INF_{t-1} + \theta_5 UN_{t-1} + u_t \quad (12)$$

where: Δ: the first difference operator, β_0: the constant, $\beta_1, \ldots\ldots, \beta_5$: short – term effects, $\theta_1, \ldots\ldots, \theta_5$: long-term effects, u_t: the error term, p: the number of lags of explained the variable (p=2), q: the number of lags of the explanatory variables (q=1).

The model is written for monetary variables as:

$$\Delta EEF = \beta_0 + \sum_{i=1}^{q} \beta_1 \Delta EFF_{t-i} + \sum_{i=1}^{q} \beta_2 \Delta MMR_{t-i} + \sum_{i=1}^{q} \beta_3 \Delta EXC_{t-i} + \sum_{i=1}^{q} \beta_4 \Delta CAP_{t-i} + \theta_1 EFF_{t-1} + \theta_2 MMR_{t-1} + \theta_3 EXC_{t-1} + \theta_4 CAP_{t-1} + u_t \quad (13)$$

where: Δ: the first difference operator, β_0: the constant, $\beta_1, \ldots \ldots, \beta_3$: short-term effects, $\theta_1, \ldots \ldots, \theta_3$: long-term effects, u_t: the error term, p: the number of lags of explained the variable (p=2), q: the number of lags of the explanatory variables (q=1).

For the variables of international economic conditions, we specify the model below:

$$\Delta EEF = \beta_0 + \sum_{i=1}^{q} \beta_1 \Delta EFF_{t-i} + \sum_{i=1}^{q} \beta_2 \Delta DET_{t-i} + \sum_{i=1}^{q} \beta_3 \Delta EXP_{t-i} + \sum_{i=1}^{q} \beta_4 \Delta IMPt_{t-i} + \sum_{i=1}^{q} \beta_5 \Delta FDI_{t-i} + \theta_1 EFF_{t-1} + \theta_2 DETt_{t-1} + \theta_3 EXP_{t-1} + \theta_4 IMP_{t-1} + \theta_5 FDI_{t-1} + u_t \quad (14)$$

where: Δ: the first difference operator, β_0: the constant, $\beta_1, \ldots \ldots, \beta_5$: short − term effects, $\theta_1, \ldots \ldots, \theta_5$: long-term effects, u_t: the error term, p: the number of lags of explained the variable (*p*=2), *q*: the number of lags of the explanatory variables (q=1).

The institutional variable model is defined by:

$$\Delta EEF = \beta_0 + \sum_{i=1}^{q} \beta_1 \Delta EFF_{t-i} + \sum_{i=1}^{q} \beta_2 \Delta IC_{t-i} + \sum_{i=1}^{q} \beta_3 \Delta SGOV_{t-i} + \sum_{i=1}^{q} \beta_4 \Delta PS_{t-i} + \sum_{i=1}^{q} \beta_5 \Delta STA_{t-i} + u_t \quad (15)$$

where: Δ: the first difference operator, β_0: the constant, $\beta_1, \ldots \ldots, \beta_5$: short-term effects, $\theta_1, \ldots \ldots, \theta_5$: long-term effects, u_t: the error term, p: : the number of lags of explained the variable (*p*=2), *q*: the number of lags of the explanatory variables (*q*=1).

Regarding the robustness tests (Appendix 4), we note the absence of autocorrelation of the errors, the absence of homoscedasticity of the residuals, and the normality of the distribution of the residuals. The CUSUM test indicates that the residual statistic is within the confidence interval. This test confirms the stability of the coefficients. We therefore conclude that the models are well specified.

3. Benchmarks of CBT's Efficiency: Results and Discussion

The results of the ARDL estimations are presented in two sections. The first section deals with the macroeconomic and monetary variables, while the second section deals with the international and institutional variables.

3.1. Macroeconomic and Monetary Variables

The estimation results presented in Table 3 demonstrate a positive correlation between the CBT's efficiency score and the level of GDP growth in both the short and long term. The results presented here corroborate those obtained by Dogru (2012) for the case of the Turkish central bank and those found by Gomez Gallego (2020) for 20 OECD central banks. Conversely, the results presented in this study contradict those of Faroq Dar et al. (2021b), which demonstrate a negative correlation between the efficiency score and economic growth.

Table 3. Results of ARDL estimation of macroeconomic variables

Short run and ECM			
Variables	Coefficient	t-stat	Proba.
D (EFF (-1))	0,41	2,10	0,07**
D (GDP)	0,02	1,92	0,09**
D (INF)	0,02	1,32	0,22
D(DB)	0,089	4,05	0,00*
D (DB (-1))	-0,02	-1,18	0,27
D (UN)	0,02	0,88	0,40
CoinEq (-1)	-0,98	-5,66	0,00
Long run			
Variables	Coefficient	t-stat	Proba
GDP	0,06	2,33	0,05*
INF	0,02	1,46	0,18
DB	0,08	3,75	0,00*
UN	-0,04	-1,54	0,16
C	0,89	2,14	0,06

Note:*: Values are significant at the 5% threshold. **: Values are significant at the 10% threshold.

This positive correlation can be explained by the fact that economic growth generates high tax revenues, thereby reducing government borrowing and monetary creation and subsequently leading to disinflation, resulting in enhanced efficiency of the CBT. Additionally, the positive consequences of economic growth can be observed in a surplus of production that is frequently exported, generating a flow of foreign currency and consequently augmenting the central bank's revenue and efficiency.

Moreover, our results indicate a positive correlation between the improvement in the budget deficit and the level of efficiency in both short-term and long-term periods. A reduction in the budget deficit signals an enhancement in the government's financial management, which subsequently results in the appreciation of the dinar, a decrease in the costs of debt financing, a narrowing of the crowding-out effect, and consequently an augmentation in the efficiency of the central bank's monetary policy.

Furthermore, the results of the ARDL modeling indicate that the efficiency score for the current year is positively influenced by the efficiency score for the previous period. This result underscores the autoregressive character of the efficiency process, suggesting that the efficiency score is to some degree determined by its historical values. Table 8 also demonstrates that the adjustment coefficient (-0.98) is statistically significant at the 1% level, exhibiting a negative value between zero and one. This result corroborates the presence of an error correction mechanism, thereby substantiating a long-term relationship between the variables. This suggests that the speed of adjustment back to equilibrium is 98%.

In both the short and long term, the CBT's efficiency score is negatively correlated with MMR in both current and past years (Table 4). This expected result confirms the conclusions regarding the origin of inflation in Tunisia and the ineffectiveness of the interest rate channel in combating rising inflation since the latter is fundamentally due to an increase in the cost of imported inputs. The aforementioned monetary tightening has not had a significant impact on inflation. As Alimi (2019) notes, a 0,1% increase in the interest rate resulted in a mere 0,005% reduction in inflation.

In addition, the exchange rate exerts a positive impact on efficiency over the long term. A depreciation of the dinar serves to amplify imported inflation and the cost of external debt, given that the Tunisian economy is no longer as competitively positioned in terms of exports. Consequently, the monetary policy is ineffective in combating imported inflation.

The results demonstrate that market capitalization exerts a negative influence on the efficiency score over the long term. These results are to be expected, given the poor development of the Tunisian financial market, which is expected to facilitate savings, attract investors, improve banking efficiency, and stimulate economic growth. Such a relationship aligns with the economic theory underlying financial investment choices and the trade-off between stock market investment and bank investment.

Table 4. Results of ARDL estimation of monetary variables

Short run and ECM			
Variables	Coefficient	t-stat	Proba.
D (EFF (-1))	0,27	1,53	0,15
D (MMR)	-0,06	-2,05	0,06**
D (MMR (-1))	0,11	3,64	0,01*
D(EXC)	0,15	1,72	0,11
D (CAP)	-0,01	-2,64	0,02*
CoinEq (-1)	-0,73	-4,26	0,00*
Long run			
Variables	Coefficient	t-stat	Proba.
MMR	-0,18	-2,95	0,01*
EXC	0,21	1,75	0,10**
CAP	-0,02	-2,28	0,04*
C	1,88	5,55	0,00

Note:*: Values are significant at the 5% threshold. **: Values are significant at the 10% threshold.
Source: Authors' estimates on Eviews.

3.2. International and Institutional Variables

The estimation results presented in Table 5 demonstrate that the CBT's efficiency score is negatively correlated with exports in both the short and long term. Our findings align with those of Faroq Dar et al. (2021,b) for Asian central banks over the 2016-2018 period. The negative relationship can be attributed to the effects of export instability, which was a prominent feature of the Tunisian economic landscape during this period.

Furthermore, our findings indicate that the CBT efficiency score is positively correlated with imports in both the short and long term. Compared to Faroq et al.'s (2021, b) findings, which demonstrate a positive yet insignificant correlation, our estimation establishes a positive and significant relationship. We believe that these results are particularly noteworthy due to the pivotal role played by these imports in national production, which in turn contributes to a more efficient CBT.

Nevertheless, the coefficient of adjustment of -0,27 is not statistically significant. This implies that market mechanisms, both national and international, are not sufficient to ensure a return to equilibrium (reflect a partial adjustment process to the equilibrium). This result can be attributed to the fact that, since the floating of the dinar, the CBT has ceased to intervene actively on the foreign exchange market. Consequently, the dinar has been unable to withstand its depreciation, particularly given the adverse national and international economic circumstances, which have contributed to an aggravation of the balance of payments and external debt ills.

Furthermore, ARDL modeling demonstrates that the present year's efficiency score is adversely affected by the preceding year's efficiency score. This is indicative of an autoregressive process, whereby the efficiency score is predicated on its historical values.

Table 4. Results of ARDL estimation of international variables

Short run and ECM			
Variables	Coefficient	t-stat	Proba.
D (EFF (-1))	-0,46	-1,76	0,12
D(DET)	0,00	1,74	0,13
D (DET (-1))	0,01	3,35	0 ,01*
D (FDI)	0,00	0,49	0,63
D (IMP)	0,01	3,02	0,02*
D (IMP (-1))	0,00	2,63	0,03*
D (EXP)	-0,02	-3,08	0,02*
CoinEq (-1)	-0,27	-0,96	0,37
Long run			
Variables	Coefficient	t-stat	Proba.
DET	0,01	0,71	0,50
EXP	-0,10	-0,86	0,09**
IMP	0,02	8,39	0,07**
FDI	0,00	0,70	0,60
C	0,21	1,65	0,34

Note:*: Values are significant at the 5% threshold. **: Values are significant at the 10% threshold.
Source: Authors' estimates on Eviews.

The lack of a long-term relationship between the efficiency score and the institutional variables implies the absence of an error correction mechanism (Table 5). Consequently, our analysis reveals that, when an imbalance arises from an institutional shock, the efficiency score of the CBT does not return to its equilibrium level. This lack of a long-term effect of institutional variables on efficiency can be attributed to multiple factors. Over the past two decades, the succession of ten different governments and four CBT governors has likely contributed to a lack of continuity and stability. Additionally, there has been a notable decline in institutional quality over the last fifteen years. These factors collectively hinder the ability of the CBT's efficiency to stabilize after institutional disturbances, underscoring the challenges faced in maintaining institutional robustness and operational consistency.

The results demonstrate a negative correlation between the CBT's efficiency score and the government instability. This outcome is anticipated, given that Tunisia has undergone a series of governmental transitions since 2011, leading to a succession of acute political instabilities. These have had a detrimental impact on the primary macroeconomic variables and, consequently, on the determinants of the CBT's efficiency.

Table 5. Results of ARDL estimation of institutional variables

Short run			
Variables	Coefficient	t-stat	Proba.
C	0,91	1,40	0,19
EFF (-1)	0,98	3,57	0,00*
EFF (-2)	-0,34	-1,51	0,16
IC	0,23	2,11	0,06**
IC (-1)	0,06	1,07	0,31
SGOV	-0,21	-2,52	0,03*
SGOV(-1)	0,08	1,41	0,19
SGOV(-2)	-0,21	-3,38	0,00
PS	0,53	1,67	0,13
STA	0,32	1,83	0,12
STA (-1)	-0,22	-1,72	0,12

Note:*: Values are significant at the 5% threshold. **: Values are significant at the 10% threshold.
Source: Authors' estimates on Eviews.

The ARDL model also indicates a positive correlation between internal conflicts in the country and the CBT's efficiency. This result may be regarded as surprising, given that previous studies have consistently identified an inverse relationship between political instability due to internal conflicts and the performance of the central bank. This outcome is not entirely unanticipated, given that the BCT has consistently positioned itself above the fray of political parties, conflicts, and the main political deadlines since 2011. The CBT has consistently maintained its political neutrality.

Ultimately, our findings indicate no correlation between the status of our BCT (dependent/independent) and its efficiency score. This suggests that the CBT's efficiency is not contingent on its status.

Conclusion

This study aims to identify the primary determinants of the efficiency of the Central Bank of Tunisia over the period from 2000 to 2020. To achieve this, we deploy the autoregressive distributed lag (ARDL) dynamic estimation method. Our analysis reveals that the CBT's efficiency score for the current year is significantly influenced by the score from the previous year (t-1), indicating an autoregressive process across the four variable groups under consideration. Additionally, the results support the cointegrating relationships between the variables and the CBT's efficiency score, except for institutional variables, which exhibit only short-term relationships.

Our findings also demonstrate that GDP, budget deficit, and imports exert a positive impact on CBT's efficiency in both the short and long term. In contrast, exports and the money market rate negatively affect CBT's efficiency in both the short and long term. The analysis further shows that, in the long term, the exchange rate is positively correlated with efficiency. In the short term, external debt and internal conflicts are positively correlated with the CBT's efficiency score. However, political stability negatively impacts efficiency in the short term. The ARDL model does not establish a significant relationship between CBT efficiency and central bank independence, confirming that the benchmarks of CBT efficiency are, essentially, macroeconomic, monetary, and international variables.

Credit Authorship Contribution Statement

The author was responsible for the conceptualization of the study, developing the research idea and framework, as well as establishing the conceptual foundation related to the efficiency benchmarks of the Tunisian Central Bank. F. B. managed the data collection and analysis, ensuring the accuracy and consistency of the findings throughout the process.

Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Appendix 1.

ADF stationary tests

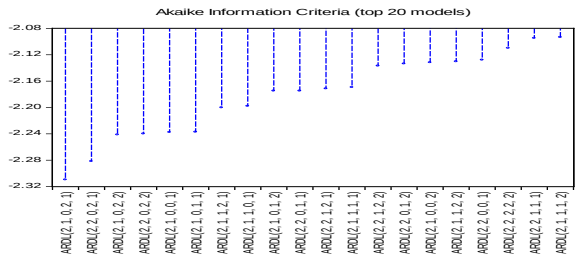
Variable	At level t-statistic (Prob.)	In difference 1st t-statistic (Prob.)	Results
EFF	-2,39* (0,15)	-5,76 (0,00)	Stationary in level I (1)
GDP	-2,56 (0,29)	-4,43* (0,00)	Stationary in first difference I (1)
DB	0,14 (0,71)	-4,04* (0,00)	Stationary in first difference I (1)
INF	-5,89* (0,00)		Stationary in level I (0)
UN	-1,85 (0,34)	-4,21* (0,00)	Stationary in first difference I (1)
MMR	-0,29 (0,56)	-3,85* (0,00)	Stationary in first difference I (1)
CAP	-2,75 (0,22)	-5,18* (0,00)	Stationary in first difference I (1)
EXC	2,98 (0,99)	-2,15* (0,03)	Stationary in first difference I (1)
DET	-1,19 (0,88)	-4,14* (0,02)	Stationary in first difference I (1)
FDI	-3,46* (0,02)		Stationary in level I (0)
EXP	-2,73 (0,08)		Stationary in level I (0)
IMP	-2,43 (0,14)	-4,75* (0,00)	Stationary in first difference I (1)
PS	-2,35 (0,16)	-2,92* (0,00)	Stationary in first difference I (1)
IC	-2,21 (0,45)	-5,41* (0,00)	Stationary in first difference I (1)
SGOV	-1,18 (0,20)	-3,83* (0,00)	Stationary in first difference I (1)

Note:*: Values are significant at the 5% threshold.
Source: Authors' estimates on Eviews.

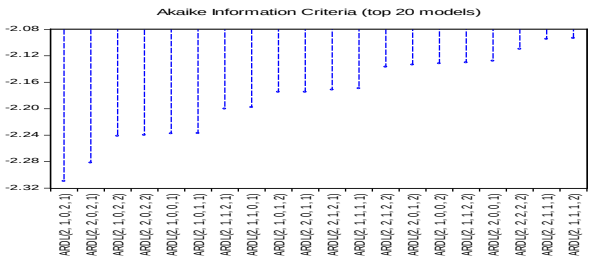
Appendix 2.

Optimal lags

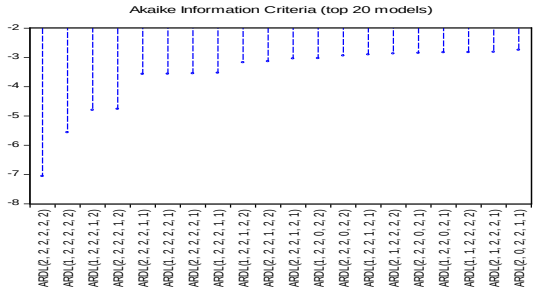
Macroeconomic variables



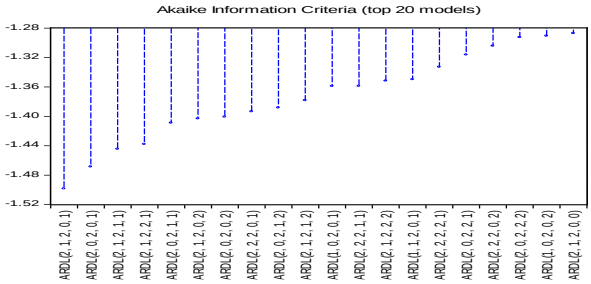
Monetary variables



International variables



Institutional variables



Source: Authors' estimates on Eviews.

Appendix 3.

The Bound tests of cointegration

Macroeconomic variables

Variables	EFF, GDP, INF, DB, UN	
F statistic	**10,29**	
Critical value bounds	I (0) bound	I (1) bound
10%	2,45	3,52
5%	2,86	4,01
1%	3,74	**5,06***

Monetary variables

Variables	EFF, MMR, EXC, CAP	
F statistic	**5,77**	
Critical value bounds	I (0) bound	I (1) bound
10%	2,72	3,77
5%	3,23	4,35
1%	4,29	**5,61***

International variables

Variables	EFF, DET, FDI, EXP, IMP	
F statistic	**191,97**	
Critical value bounds	I (0) bound	Bornes supérieure
10%	2,26	3,35
5%	2,62	3,79
1%	3,41	**4,68***

Institutional variables

Variables	EF, IC, SGOV, PS, STA	
F statistic	**3,36**	
Critical value bounds	I (0) bound	I (1) bound
10%	2,45	3,52
5%	2,86	4,01
1%	3,74	**5,06***

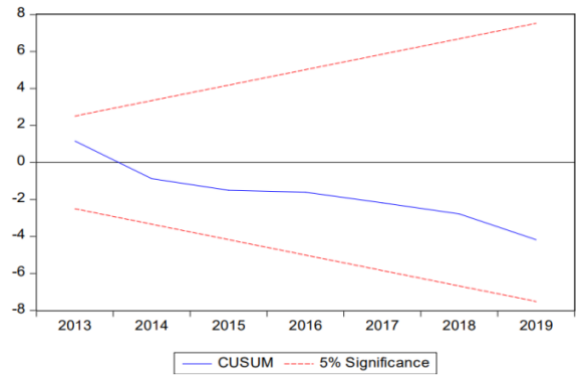
Note:*: Values are significant at the 5% threshold.
Source: Authors' estimates on Eviews.

Appendix 4.

Robustness tests of ARDL models

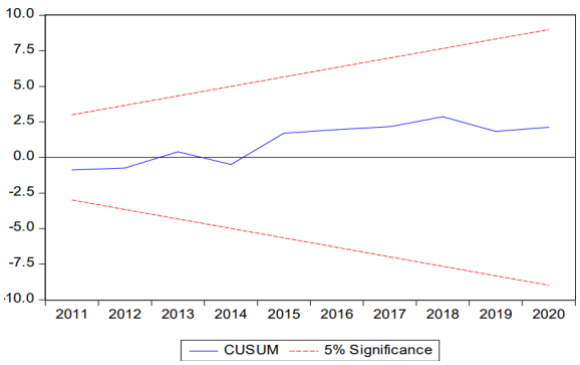
Macroeconomic variables

Tests	F-stat (Proba)	Decision
Normality (Jarque-Berra)	0,5 (0,87)	Normal distribution
Breusch-Godfrey Test	3,85 (0,09)	No Autocorrelation
Breusch-Pagan-Godfrey Test	6,96 (0,08)	Heteroscedasticity



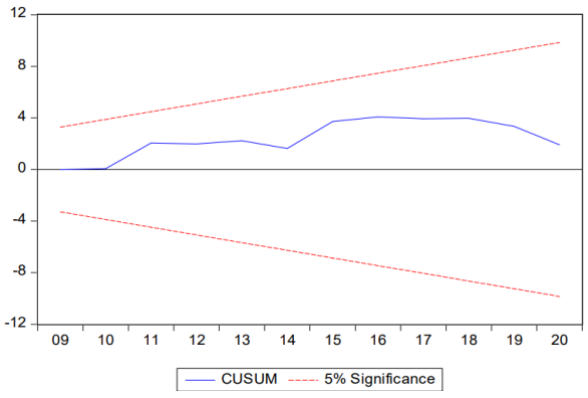
Monetary variables

Tests	F-stat (Proba)	Decision
Normality (Jarque-Berra)	0,71 (0,70)	Normal Distribution
Breusch-Godfrey Test	4,04 (0,05)	No Autocorrelation
Breusch-Pagan-Godfrey Test	3,81 (0,06)	Heteroscedasticity



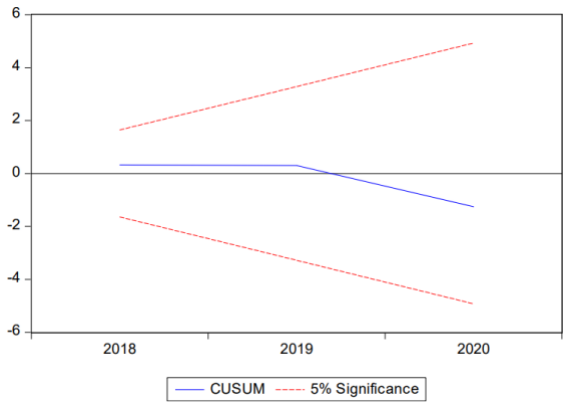
International variables

Tests	F-stat (Proba)	Decision
Normality (Jarque-Berra)	1,34 (0,51)	Normal distribution
Breusch-Godfrey Test	0,64 (0,54)	No Autocorrelation
Breusch-Pagan-Godfrey Test	0,54 (0,67)	Heteroscedasticity



Institutional variables

Tests	F-stat (Proba)	Decision
Normality (Jarque-Berra)	1,11 (0,57)	Normal distribution
Breusch-Godfrey Test	3,05 (0,52)	No Autocorrelation
Breusch-Pagan-Godfrey Test	1,41 (0,27)	Heteroscedasticity



Source: Authors' estimates on Eviews.