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CORRUPTION IN THE EU-27. TIME ANALYSIS OF THE CORRUPTION PERCEPTION INDEX

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Abstract. One of the most targeted issues in the world today is the reduction of corruption. As efforts to combat this deeply damaging phenomenon stagnate around the world, human rights and democracy are under attack. According to studies, most countries in the world have not seen significant declines in corruption in the last decade. The global pandemic with COVID-19 virus has also been used in many countries as an excuse to avoid both medical and financial controls. Based on these considerations, this article proposes an econometric analysis of the evolution of the corruption perception index over time for five EU-27 Member States, namely Denmark, Germany, Poland, Romania and Bulgary. Based on the econometric models analyzed for each state, short-term forecasts of 3 years will be made.

1. Introduction

One of the most discussed issues at the international level at the moment (in addition to the war by Ukraine) is the fight against corruption in all public sectors. Even if the states of the world issue and recommend a series of measures regarding the fight against this extremely harmful phenomenon for the society, unfortunately, the corruption fails to be eradicated. In order to have a control over the level of corruption, over time one has tried measure this phenomenon in one form or another.

Thus, Transparency International (TI) has managed to measure corruption worldwide through the so-called Corruption Perceptions Index. Transparency International processes and collects data on the global level of this indicator. According to them, the aim of compiling statistics and rankings on the level of corruption in 180 countries is not "to reach a world without corruption (utopia), but to fight for social and economic justice, for the rights of for peace and security... . We hold the powerful and corrupt accountable by exposing the systems and networks that allow corruption. We advocate for policies and build coalitions to change the status quo." [7]

The Corruption Perceptions Index (CPI) was established in 1995 and is currently the leading global indicator of public sector corruption. Until 2011, this indicator was calculated taking into account a scale from 0 (very corrupt) to 1 (very clean). Depending on the value of this indicator, Transparency International has conducted an annual ranking based on the level of corruption for 180 states worldwide. This ranking allows the comparison of the scores obtained by the analyzed countries from one year to another. Since 2012, the results have been quantified on a scale from 0 (very corrupt) to 100 (very clean).

The latest analysis by Transparency International shows that protecting human rights is essential in the fight against corruption. It has been observed that states with well-protected civil liberties have a score closer to the higher level of the CPI, while states that violate these civil liberties generally get a lower score for this indicator [7].

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Globally, in 2021, according to Transparency International, 131 countries have made no progress in reducing and combating corruption. Two-thirds of the countries analyzed scored below 50, which shows a fairly high level of corruption, with another 27 states having the lowest score ever. Leading the world ranking (the lowest level of corruption) are countries such as Denmark, Finland and New Zealand with a score of 88, followed by Norway, Singapore and Sweden with a score of 85 . On the other hand, the last three places in the ranking are with countries such as Somalia and Syria with a score of 13 points and Sudan with a score of 11 points.

At the level of the European Union, according to Transparency International's 2021 report, the worst results are obtained in Bulgaria (78th place), Hungary (73rd place) and Romania (66th place). Germany ranks 10th for the fourth year in a row (with a score of 80 points). However, the European Union remains the least corrupt region in the world, averaging 66 points (out of 100 possible). Among the least corrupt countries in the EU-27 are Denmark and Finland (88 points both). As specified above, these two countries are also at the top of the international rankings (1st and 2nd place) [5].

According to TI, Poland is the country that has reached the lowest position of the ICC, ranking 45th internationally, after occupying a satisfactory 29th place in 2015. Factors such as the erosion of the rule of law, judicial independence and democratic oversight have made for corruption to grow, making Poland one of the 'significant declines' of the European Union (19th place in 2021).

"Recently, the Polish ruling party has been constantly promoting reforms that weaken judicial independence," Transparency International wrote in this year's report.

The TI analysis shows that the COVID-19 pandemic has given the governments of the EU-27 member states and not only, the opportunity to expand their executive power, to hide public information about various purchases of equipment, masks, vaccines, etc. and to restrict from citizens' rights. Thus, the pandemic has affected transparency and accountability by raising concerns about the setbacks made even by the countries at the top of the rankings.

Romania, occupies in 2021 the 66th place out of 100, climbing a position in the ranking compared to the previous year. However, the perception of public sector corruption in Romania has remained virtually unchanged for ten years. Romania's score in this ranking is 45 points in 2021. However, if we look at the statistics on the CPI over the last 25 years, our country has made some progress in the fight against corruption. The turning point was the year 2012, when Romania climbed in the ranking on the 66th place (with a score of 44 points) compared to 2011, when Romania was on the 75th position (with a score of 36 points) [6].

On the other hand, the most vulnerable area affected by corruption in Romania in 2021 was that of public procurement, amid the pandemic with COVID-19. In order to draw attention to this aspect, Transparency International Romania (TIR) proposes a series of recommendations regarding the efficiency and transparency in public procurement [6]:

- Inclusion of Integrity Pacts as a mandatory mechanism for public monitoring of procurement procedures;
- Introduction of Integrity Pacts as a measure in projects financed by structural and investment funds.
- Improving SICAP with the information needed to understand the weaknesses of the procurement system and procedures
- Transposition into national law of the EU-27 Directive on warning in the public interest of high standards of compliance.

2. Literature review

The literature brings to light a number of studies and research on the phenomenon of anti-corruption, both globally and in Europe. Thus, Brașoveanu et.al. analyzes in the paper [2] the evolutions and the correlation between corruption and the general fiscal burden. The analysis was carried out for the EU-27 Member States over the period 1995-2008.

Another research on the subject approached here, is the one proposed by Feruni, et. al. in [3]. The authors of the article empirically test the impact of corruption, economic freedom and urbanization on the economic development of the Western Balkan states and the EU for the period 2009-2018. A comparison between the analyzed groups is also made.

Pázmándy aims in Article [4] to gain a more detailed understanding of how socio-economic factors influence the perception of corruption, both at the individual and at the country level. The author performed a multi-level regression analysis. The study includes 26663 citizens from 27 European countries. The conclusion he reached was that at the country level the perception of corruption is influenced by the level of GDP and the average years of education in a country, and at the individual level, corruption is mainly influenced by social status and unemployment.

Another article that investigates the relationship between corruption and the health of the population is the one proposed by Achim, et. al. [1]. The research provides clear evidence of the extent to which it affects corruption, physical and mental health in the context of economic and cultural development in 185 countries. The analyzed period is 2005-2017.

3. Time series analysis

This article proposes a time-lapse analysis of the Corruption Perceptions Index for five EU-27 Member States: Denmark (DK), Germany (DE), Poland (PL), Romania (RO) and Bulgaria (BG). The analyzed time horizon is 1997-2021. The choice of the states for which the level of corruption is to be analyzed was made according to the score obtained for the corruption perception index. Thus, in 2021, Denmark ranks first in the ranking of EU-27 Member States on the level of corruption, followed by Germany (Rank 7), Poland (Rank 19), and at the bottom of the ranking, Romania (25 Rank) and Bulgaria (27 Rank).

As can be seen, in Figure 1, the states under analysis were chosen according to their place in 2021 in terms of CPI (first place - DK, middle places -DE and PL and last places -RO and BG).

The data series for the five states analyzed for the CPI were collected from the Transparency International website [7]. Until 2011, the corruption perception index was between 0 (very corrupt) and 10 (very clean). In order to have continuity in these series and to adapt these values to those after 2012 (0- very corrupt and 100 - very clean), in the period 1997-2011 the values of this indicator were multiplied by 10.

The evolutions in time of the six states subject to analysis in terms of the level of corruption measured by the CPI are represented in Figure 2.

In the following, we will perform the econometric analysis of the time series of the Corruption Perceptions Index (CPI) for the five EU-27 Member States. Models applied in this article are time series specific models. The parameters of the analyzed models were estimated using the least squares method. Also, the values of the statistical tests and parameters were obtained by using the Eviews software package.

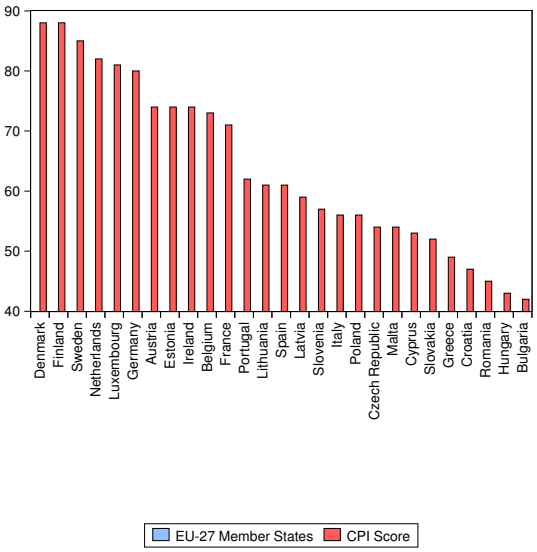


FIGURE 1. Representation of the CPI by its score for EU-27

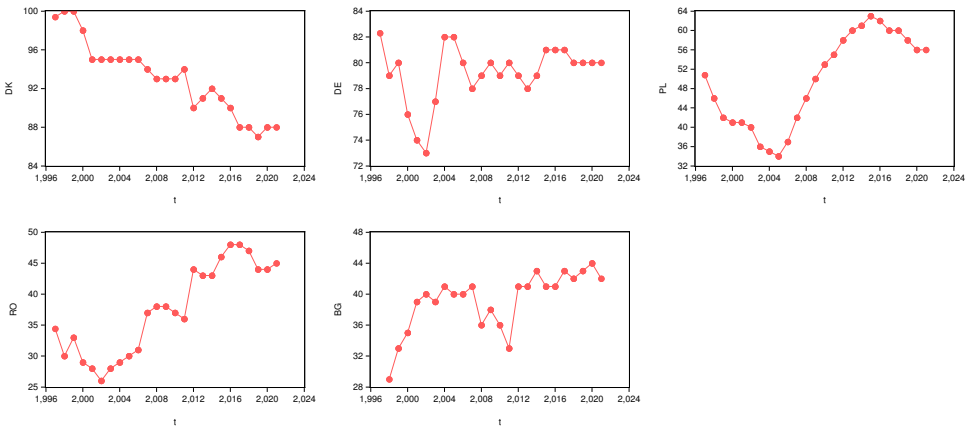


FIGURE 2. The evolution of the CPI over time for the five countries analyzed

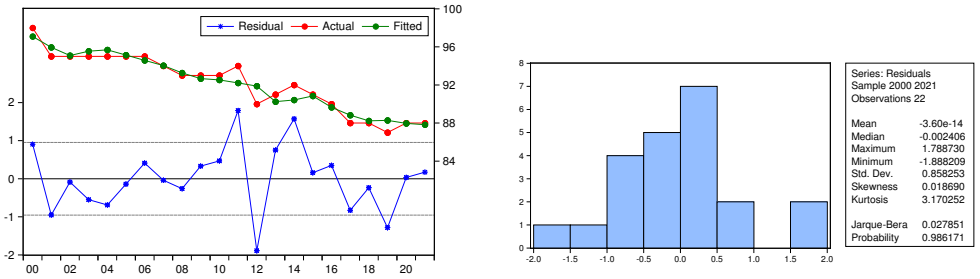
Model 1.Time series analysis for Denmark

In this model, the analyzed time period 1997-2021, is denoted with $t = \overline{1,T}, T = 25$, and $Y = (y_t), t = \overline{1,25}$, represent the dependent variable of the CPI characteristic for Denmark.

The Auto Regressive Model AR(3), has in this case the following representation:

$$y_t = c_1 + c_2 \cdot t + u_t \tag{1}$$

where $u_t = c_3 \cdot u_{t-1} + c_4 \cdot u_{t-2} + c_5 \cdot u_{t-3} + e_t$ and e_t is the error of the model.



(A) (B)

FIGURE 3. (A) Graph of the real curve (red), in tandem with the graph of the approximate curve by the model AR(3) (green) with the highlighting of the residue (blue); (B) Histogram and characteristics of the estimated residue

The coefficients c_1, c_2, c_3, c_4 and c_5 are found in the following table:

Table 1. The coefficients obtained for Model 1 and the values of the applied statistical tests

Dependent Variable: Y-Model 1
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1024.317	57.45663	17.82765	0.0000
T	−0.463603	0.028584	−16.21925	0.0000
AR(1)	0.227219	0.212220	1.070679	0.2993
AR(2)	−0.184135	0.215051	−0.856238	0.4038
AR(3)	−0.230049	0.209657	−1.097266	0.2878

R-squared	0.922375	Mean dependent var	92.18182
Adjusted R-squared	0.904110	S.D. dependent var	3.080451
S.E. of regression	0.953895	Akaike info criterion	2.940189
Sum squared resid	15.46856	Schwarz criterion	3.188154
Log likelihood	−27.34208	Hannan-Quinn criter.	2.998602
F-statistic	50.50036	Durbin-Watson stat	2.275119
Prob(F-statistic)	0.000000		

Inverted AR Roots	.34+.62i	.34-.62i	-.46

Model 2.Time series analysis for Germany

In this model, the analyzed time period 1997-2021, is denoted with $t = \overline{1,T}, T = 25$, and $Y = (y_t), t = \overline{1,25}$, represent the dependent variable of the CPI characteristic for Germany. Following the distribution of points in the plan, the best model found approximating the data series for CPI Germany is an Auto Regressive Model.

The Auto Regressive Model of order 4, has in this case the following representation:

$$y_t = c_1 + c_2 \cdot t + c_3 \cdot t^2 + c_4 \cdot y_{t-1} + c_5 \cdot y_{t-2} + c_6 \cdot y_{t-3} + c_7 \cdot y_{t-4} + e_t \qquad (2)$$

where e_t is the error of the model.

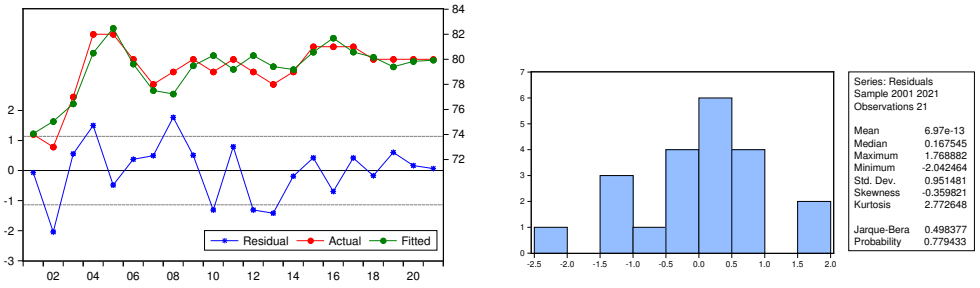
The coefficients $c_1, c_2, c_3, ..., c_7$ are found in the Table 2.

Table 2. The coefficients obtained for Model 2 and the values of the applied statistical tests

Dependent Variable: Y-Model 2
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	−53472.85	35598.76	−1.502099	0.1553
T	53.09727	35.38981	1.500355	0.1557
T^2	−0.013161	0.008793	−1.496670	0.1567
Y2(-1)	0.673706	0.266696	2.526117	0.0242
Y2(-2)	−0.493838	0.246050	−2.007062	0.0645
Y2(-3)	−0.183198	0.236113	−0.775888	0.4507
Y2(-4)	−0.034610	0.166694	−0.207628	0.8385

R-squared	0.824616	Mean dependent var	79.19048
Adjusted R-squared	0.749451	S.D. dependent var	2.271983
S.E. of regression	1.137237	Akaike info criterion	3.356283
Sum squared resid	18.10633	Schwarz criterion	3.704457
Log likelihood	−28.24097	Hannan-Quinn criter.	3.431845
F-statistic	10.97080	Durbin-Watson stat	2.050498
Prob(F-statistic)	0.000132		



(A) (B)

FIGURE 4. (A) Graph of the real curve (red), in tandem with the graph of the approximate curve by the AR(4) (green) with the highlighting of the residue (blue); (B) Histogram and characteristics of the estimated residue

Model 3.Time series analysis for Poland

In this model, the analyzed time period 1997-2021, is denoted with $t = \overline{1,T}, T = 25$, and $Y = (y_t), t = \overline{1,25}$, represent the dependent variable of the CPI characteristic for Poland.

Following the distribution of points in the plan, the best model found approximating the data series for CPI Poland is an Auto Regressive Model of order 3.

The Auto Regressive Model of order 3 has in this case the following representation:

$$y_t = c_1 + c_2 \cdot t^2 + u_t \tag{3}$$

where $u_t = c_3 \cdot u_{t-1} + c_4 \cdot u_{t-2} + c_5 \cdot u_{t-3} + e_t$ and e_t is the error of the model.

The coefficients c_1, c_2, c_3, c_4 and c_5 are determined using the Eviews 10.1 software packageare and are found in the following table:

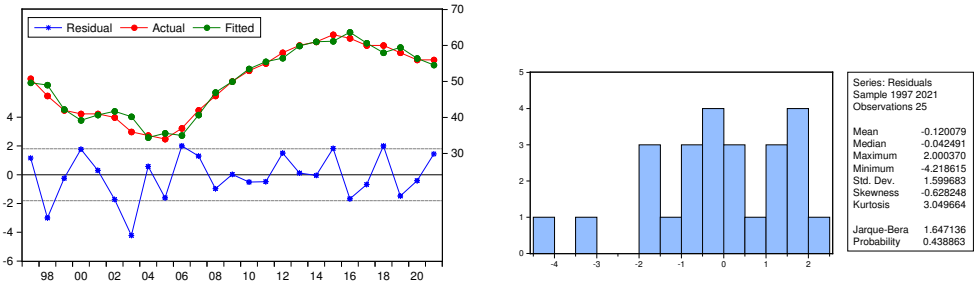
Table 3. The coefficients obtained for Model 3 and the values of the applied statistical tests

Dependent Variable: Y-Model 3
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	−462.4934	562.5357	−0.822158	0.4212
T^2	0.000127	0.000139	0.915010	0.3717
AR(1)	1.631440	0.295581	5.519428	0.0000
AR(2)	−0.671085	0.530920	−1.264005	0.2215
AR(3)	−0.073981	0.287078	−0.257703	0.7994
SIGMASQ	2.471045	0.922376	2.678999	0.0148

R-squared	0.972354	Mean dependent var	49.71200
Adjusted R-squared	0.965079	S.D. dependent var	9.649193
S.E. of regression	1.803157	Akaike info criterion	4.390295
Sum squared resid	61.77612	Schwarz criterion	4.682825
Log likelihood	−48.87868	Hannan-Quinn criter.	4.471430
F-statistic	133.6536	Durbin-Watson stat	2.196880
Prob(F-statistic)	0.000000		

Inverted AR Roots	.86+.29i	.86-.29i	-.09



(A) (B)

FIGURE 5. (A) Graph of the real curve (red), in tandem with the graph of the approximate curve by the model AR(3) (green) with the highlighting of the residue (blue); (B) Histogram and characteristics of the estimated residue

Model 4.Time series analysis for Romania

In this model, the analyzed time period 1997-2021, is denoted with $t = \overline{1,T}, T = 25$, and $Y = (y_t), t = \overline{1,25}$, represent the dependent variable of the CPI characteristic for Romania. Following the distribution of points in the plan, the best model found approximating the data series for CPI Romania is an Auto Regressive Model.

The Auto Regressive Model of order 4, has in this case the following representation:

$$y_t = c_1 + c_2 \cdot t + c_3 \cdot t^2 + c_4 \cdot y_{t-1} + c_5 \cdot y_{t-2} + c_6 \cdot y_{t-3} + c_7 \cdot y_{t-4} + e_t \qquad (4)$$

where e_t is the error of the model.

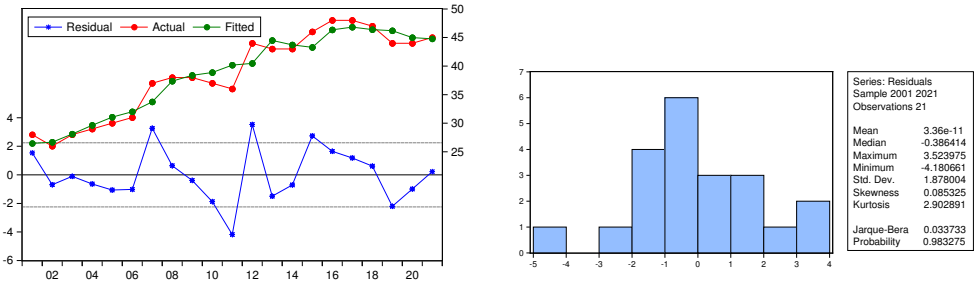
The coefficients $c_1, c_2, c_3, ..., c_7$ are found in the following table:

Table 4. The coefficients obtained for Model 4 and the values of the applied statistical tests

Dependent Variable: Y-Model 4
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	−208981.4	96387.58	−2.168136	0.0479
T	207.3336	95.93131	2.161271	0.0485
T^2	−0.051419	0.023870	−2.154138	0.0491
Y4(-1)	0.441446	0.256762	1.719284	0.1076
Y4(-2)	−0.058340	0.254753	−0.229007	0.8222
Y4(-3)	−0.056403	0.254817	−0.221347	0.8280
Y4(-4)	0.204679	0.230460	0.888133	0.3895

R-squared	0.935235	Mean dependent var	38.57143
Adjusted R-squared	0.907479	S.D. dependent var	7.379508
S.E. of regression	2.244644	Akaike info criterion	4.716172
Sum squared resid	70.53796	Schwarz criterion	5.064346
Log likelihood	−42.51981	Hannan-Quinn criter.	4.791735
F-statistic	33.69455	Durbin-Watson stat	2.112473
Prob(F-statistic)	0.000000		



(A) (B)

FIGURE 6. (A) Graph of the real curve (red), in tandem with the graph of the approximate curve by the AR(4) (green) with the highlighting of the residue (blue); (B) Histogram and characteristics of the estimated residue

Model 5.Time series analysis for Bulgary

In this model, the analyzed time period 1998-2021, is denoted with $t = \overline{1,T}, T = 24$, and $Y = (y_t), t = \overline{1,24}$, represent the dependent variable of the CPI characteristic for Bulgary. The time series for CPI Bulgary is approximated in this case by a 3rd order AR type model (AutoRegressive Model).

The Auto Regressive Model of order 3 has in this case the following representation:

$$y_t = c_1 + c_2 \cdot t + c_3 \cdot t^2 + u_t + e_t \tag{5}$$

where $u_t = c_4 \cdot u_{t-1} + c_5 \cdot u_{t-2} + c_6 \cdot u_{t-3} + c_7 \cdot u_{t-4}$, and e_t is the error of the model.

The coefficients $c_1, c_2, c_3, ..., c_7$ are found in the following table:

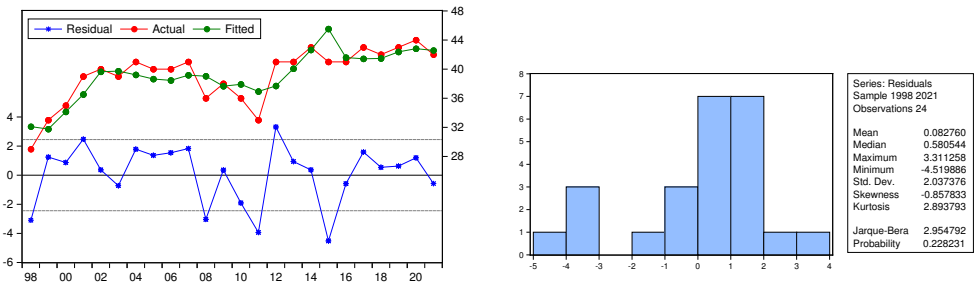
Table 5. The coefficients obtained for Model 5 and the values of the applied statistical tests

Dependent Variable: Y-Model 5
Method: ARMA Maximum Likelihood (OPG - BHHH)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	−66503.62	82938.08	−0.801847	0.4344
T	65.85244	82.66398	0.796628	0.4373
T^2	−0.016292	0.020598	−0.790949	0.4405
AR(1)	0.470828	0.225392	2.088933	0.0530
AR(2)	0.205596	0.375215	0.547941	0.5913
AR(3)	0.053995	0.220821	0.244517	0.8099
AR(4)	−0.444643	0.140345	−3.168204	0.0060
SIGMASQ	3.984794	1.732132	2.300513	0.0352

R-squared	0.704792	Mean dependent var	39.20833
Adjusted R-squared	0.575639	S.D. dependent var	3.753018
S.E. of regression	2.444829	Akaike info criterion	4.945028
Sum squared resid	95.63505	Schwarz criterion	5.337712
Log likelihood	−51.34033	Hannan-Quinn criter.	5.049207
F-statistic	5.457013	Durbin-Watson stat	1.937530
Prob(F-statistic)	0.002400		

Inverted AR Roots	.75+.46i	.75-.46i	-.52-.55i	-.52+.55i



(A) (B)

FIGURE 7. (A) Graph of the real curve (red), in tandem with the graph of the approximate curve by the model AR(4) (green) with the highlighting of the residue (blue); (B) Histogram and characteristics of the estimated residue

4. INTERPRETATION OF THE RESULTS

In the previous paragraph, the models that approximate the time series of the Corruption Perceptions Index (CPI) for the five analyzed states were represented. Analyzing the results obtained for each model, the following information can be detach:

- Comparing the graphs of the real curves with those of the curves adjusted for the five models, it is observed that they are quite close, so to say that these models approximate well enough the data series of the corruption perception index;
- As for the determination report R^2, we note that for all five models analyzed, it has sufficiently high values (close to 1), such that to say that the estimated equations successfully manage to explain the values of the analyzed dependent variables;

- The values of the indicators based on information theory (Hannan-Quinn, Akaike and Schwartz) are small enough (close to zero), such that to say that the five models analyzed give very good results, being performing by point of view econometricaly ;
- On the other hand, the high value of Durbin-Whatson statistics shows that for all five models, the residues are not correlated with each other, so the phenomenon of self-correlation of errors does not appear in any case analyzed;
- The calculated values of the Jarque-Bera (JB) test are compared for each model with a tabulated statistical value $\chi^2_{2,0.05} = 5,991$, for a significance threshold of $\alpha = 5$ percentages. If the following inequality is satisfied $JB < \chi^2_{2,0.05}$, then the condition of normalization of the residues is verified. Analyzing the values of this statistic for each model, we see that this hypothesis is verified.
- On the other hand, checking the values of the indicator that measures asymmetry (Skewness), we notice that the values of the residual variable of the specific models of Denmark, Germany and Romania show a slight asymmetry to the right (values are positive), respectively the values of the residual variable of specific models of Poland and Bulgaria has a slight asymmetry to the left (negative values). In general, relatively normal distributions are those for which the value of this indicator does not exceed ± 1.96, its value should be as close as possible to zero;
- Regarding the vaulting indicator (Kurtosis), comparing the values obtained for the five models, it is observed that the value of this indicator is less than 3 for Germany, Romania and Bulgary, which shows that the distribution of residues is more flattened, and for Denmark and Poland, the value of the indicator is higher than 3, which shows that the residue distribution is with a higher hump.

5. Short Term Forecasts

This paragraph presents the short-term forecasts (3 years - 2022-2024) for the corruption perception index for the five analyzed states. Thus, the models are used mathematics given by the relations (1) - (5). In order to make forecasts, we must first make sure that the parameters of the model remain unchanged and for the period for which the forecast is made, ie at the level of the evolution over time of the analyzed characteristics, no special phenomena occurred. The real-time corruption index for the five EU-27 Member States, as well as their forecasts values, are shown in Table 6.

Analyzing the values obtained in this table, for Denmark corruption is kept under control in the period 2022-2024, there are no significant changes in the CPI. The most important reasons for this low level of corruption are: awareness of the repercussions of this phenomenon not only among officials but also among citizens, money movements in the country are transparent, civil servants have a high level of social protection, the increasing and the tightening the legislation on corruption, etc.

As far as Germany is concerned, the score obtained in terms of the level of corruption shows a slight decrease in the next three years. This suggests a sufficiently "clean" perception of corruption in the public sector, and beyond. Consolidated democracy, strong

Table 6. The Forecast CPI values for the five EU-27 member states

The contry	Denmark			Germany			Poland		
Years	2022	2023	2024	2022	2023	2024	2022	2023	2024
CPI	87,7	87,9	88	79,6	80,1	81,2	56,5	57	57,9
The contry	Romania			Bulgary					
Years	2022	2023	2024	2022	2023	2024			
CPI	42,1	43,2	44,4	41,9	41,2	40			

Table 7. Statistical measures for assessing the quality of forecasts

The contry	**Denmark**	**Germany**	**Poland**	**Romania**	**Bulgary**
Root Mean Squared Error	0,865	1,289	0,968	1,289	2,322
Mean Absolute Error	0,701	1,458	0,624	1,458	1,650
Mean Abs. Procent Error	0,763	2,785	0,536	2,785	2,294
Theil Inequality Coeff.	0,004	0,023	0,003	0,023	0,028
Bias Proportion	0,00003	0,00002	0,00002	0,00002	0,0026
Variance Proportion	0,028	0,024	0,046	0,024	0,171
Covariance Proportion	0,973	0,975	0,896	0,975	0,825
Theil U2 Coefficient	0,653	0,643	0,721	0,643	0,858

public institutions, with a well-founded rule of law, keep Germany in a good position in terms of corruption in the EU-27.

Poland is a country where the criminal law is quite strict. Even if in recent years, this country has faced a higher level of corruption, the results obtained show a slight revival of this phenomenon. The identification, detection and investigation of bribery and corruption offenses, as well as the punishment of such offenses, are effective solutions to eradicate corruption not only in Poland but also in other EU-27 member states.

The problem of corruption arises when we talk about countries like Romania or Bulgaria. In the last places occupied in the EU ranking in this chapter, the two states manage in the next period a slight revival in terms of corruption. However, the perception regarding the corruption in the public sector and not only makes both Romania and Bulgaria to be two states with quite few chances of success in this respect.

As can be seen, the values of these statistical measures from Table 7, which assess the quality of the predictions made above, are very small for all models analyzed. The closer the values of these statistical measures, which assess the quality of the forecasts, are closer to zero, the more the quality of the forecasts made by the model is assessed. Theil coefficient takes values between $[0, 1]$. Also, the Bias proportion tells us how far the average of the forecast is to the average of the effective series. If the value of this proportion is small, then the forecast made is a "good" one.

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