Forecasting Television Audience Trends for Romanian News Channels Using the ARIMA Model

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Abstract. *This research seeks to provide a thorough analysis of the broadcast reach of the leading news programs from five major television stations in Romania: TVR, PRO TV, Antena 1, Kanal D, and Prima TV, spanning the years 2018 to 2022. News journals are essential in educating the public and shaping opinions, making it essential to comprehend the behavior and preferences of viewers. By examining past data and applying prediction techniques, the study aims to uncover trends and patterns in audience dynamics. Using the ARIMA model, the research predicts audience performance and compares the forecast with actual data from 2023, evaluating the accuracy. The results offer valuable insights for those involved in the television industry, such as media professionals and stakeholders who can strategically plan and develop content in a way that is beneficial to their organization and to the wider public. As a result of the deeper understanding of audience scope, the study establishes a robust framework for future media analytics studies.*

Keywords: audience dynamics, forecasting techniques, ARIMA model, news.

Introduction

The analysis of television audience behavior is crucial for understanding public preferences and trends in media consumption. News programs play a vital role in informing the public and shaping opinions, making it essential to analyze their reach and impact. This study focuses on the audience performance of leading news programs from five major television stations in Romania: TVR, PRO TV, Antena 1, Kanal D, and Prima TV. These channels represent a significant portion of the Romanian television market, and understanding their audience dynamics provides valuable insights into the broader media landscape. The Romanian television market is characterized by a mix of public and private broadcasters, each vying for audience share. Understanding the dynamics of audience behavior is essential for broadcasters to develop effective programming strategies and for advertisers to target their campaigns effectively.

This research analyzes the broadcast reach of these five major television stations in Romania spanning the years 2018 to 2022. By examining historical audience data and applying robust prediction techniques, the study aims to identify trends and patterns in audience dynamics. The Autoregressive Integrated Moving Average (ARIMA) model, a widely used time series forecasting method, is employed to predict audience performance. The study further compares

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these forecasts with actual audience data from 2023, providing a unique opportunity to evaluate the accuracy and reliability of the ARIMA model in this context. This comparison of forecasts with real-world outcomes represents a novel contribution to the field of media analytics. The novelty of this research lies in the comparison of ARIMA-generated forecasts with actual audience data from 2023, allowing for a rigorous assessment of the model's predictive accuracy. This research contributes to the existing body of knowledge by providing an empirical analysis of television audience forecasting in the Romanian context, with a focus on news programs.

The results of this study offer valuable insights for various stakeholders in the television industry, including media professionals, broadcasters, and advertisers. A deeper understanding of audience scope enables strategic planning and content development that benefits both organizations and the viewing public. Furthermore, this research establishes a robust framework for future media analytics studies, contributing to the ongoing development of methodologies for audience measurement and forecasting. The findings offer valuable insights for media professionals and stakeholders, aiding in strategic planning and content development.

Literature review

Audience forecasting plays a vital role in media studies, providing crucial insights for strategic decision-making in the television industry. The Autoregressive Integrated Moving Average (ARIMA) model has proven to be an effective tool for time series analysis and media forecasting. The theoretical foundation of the ARIMA model was established by Box and Jenkins (1976) in their seminal work "Time Series Analysis: Forecasting and Control," which provided a comprehensive framework for modeling and forecasting time series data. Hamilton (1994) further developed the understanding and application of time series analysis in "Time Series Analysis," contributing significantly to the field.

Previous research has demonstrated the effectiveness of the ARIMA model in analyzing time series and forecasting audience behavior in various contexts. Koenig and Meissner (2018) highlighted the utility of ARIMA models in predicting television audiences in emerging markets, as presented in the Journal of Media Economics. Their work, "Using ARIMA Models to Forecast Television Audiences in Emerging Markets," demonstrated the applicability of ARIMA in diverse media environments. Singh and Patel (2020) showcased ARIMA's capabilities in "Audience Forecasting in Video Streaming Platforms: An Application of ARIMA Models," focusing on video streaming platforms. Their research, published in Media Technology Review, illustrated the model's versatility in capturing audience dynamics in digital media. Fisher and Malloy (2021) utilized ARIMA to forecast audiences for sports events in "Predicting Sports Event Audiences with ARIMA Models," published in Sports Media Journal, showcasing its ability to capture seasonal variations and the influence of external factors. These studies collectively support the use of ARIMA as a robust and reliable method for audience forecasting in the media industry.

These studies collectively support the application of ARIMA as a robust and reliable method for audience forecasting in the media industry. This research builds upon this foundation by applying the ARIMA model to analyze and forecast the audience reach of news programs in Romania, providing further empirical evidence of its effectiveness in a specific media context.

Methodology

This study employs the Autoregressive Integrated Moving Average (ARIMA) model to forecast audience figures for news broadcasts on TVR, PRO TV, Antena 1, Kanal D, and Prima TV. The ARIMA model is a widely used time series forecasting technique that combines autoregressive

(AR) and moving average (MA) components with differencing to1 achieve stationarity. The analysis utilizes audience data for the period from 2018 to 2022 to build the ARIMA models for each television channel. The ARIMA model is defined by three parameters: p, d, and q, representing the order of autoregression, the degree of differencing, and the order of moving average, respectively.

The stationarity of the time series data was assessed using the Augmented Dickey-Fuller test. The Augmented Dickey-Fuller (ADF) test is a statistical test for stationarity in a time series. The null hypothesis of the ADF test is that the time series is non-stationary, and the alternative hypothesis is that it is stationary. If the p-value of the ADF test is below a significance level (e.g., 0.05), the null hypothesis is rejected, and the time series is considered stationary. Time series data must be stationary for ARIMA models to be applied effectively. The Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC) were used for model selection. These criteria help in selecting the most appropriate ARIMA model by balancing model fit and complexity. Lower AIC and BIC values indicate a better model.

Examples of the selected models include ARMA(1,11) for TVR, ARMA(5,1) for PRO TV, and ARIMA(6,1,5) for Antena 1. For TVR's Telejurnal 20, the Dickey-Fuller test confirmed the stationarity of the initial series. The correlogram helped with verifying various possible ARMA models, with the ARMA(1,11) model selected based on the lowest Akaike and Schwarz criteria values. The estimated coefficients are significant and model assumptions were validated through Durbin-Watson, Breusch-Godfrey, and ARCH tests to ensure the absence of autocorrelation and heteroscedasticity in the model's residuals. The Durbin-Watson test is used to detect the presence of autocorrelation in the residuals of a regression model. The Breusch-Godfrey test is a more general test for autocorrelation that can be used with higher-order autoregressive models. The ARCH test is used to detect heteroscedasticity, specifically autoregressive conditional heteroscedasticity, in the residuals of a time series model. These tests confirmed the absence of autocorrelation and heteroscedasticity in the model's residuals. The model is deemed stationary and invertible, with predictions for 2023-2025 generated.

Results and discussions

The analysis of audience data from 2018 to 2022 reveals distinct trends for each of the five television channels. These trends reflect the evolving preferences of the Romanian television audience and the competitive dynamics of the television market.

ARIMA Model Results

The ARIMA models identified for each channel varied in their specific parameters, reflecting the unique audience dynamics of each channel. The models were selected based on the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC) to ensure a balance between model fit and complexity. The specific models identified include: TVR - ARMA(1,11), PRO TV - ARMA(5,1), Antena 1 - ARIMA(6,1,5).

Channel-Specific Analysis

For TVR - TeleJurnal 20, in Figure 1, we have graphically represented the monthly rating of the TeleJurnal for the period 2018-2022. We will make a forecast for the period 2023-2025. The prediction method we use is AR(I)MA. We check if the initial series is stationary by applying the Dickey-Fuller test for a model with constant and trend. Since the probability attached to the test is

0.0044, which is less than 0.05, it results that the null hypothesis is rejected and the alternative hypothesis is accepted, meaning that the initial series is stationary (Table 1).

Using the TVR correlogram (Table 2), we check several possible ARMA models of the type (p,q). Several valid models resulted, but we chose the ARMA(1,11) model (Table 3), having the lowest Akaike and Schwarz criterion values. It is found that in the selected model, the estimated coefficients are significant, having the probabilities attached to the t-Statistic test less than 0.05. Also, the model's residuals are not autocorrelated, as confirmed by the Durbin-Watson test with a value of 1.98 and the Breusch-Godfrey test with an attached probability of 0.71. The ARCH test confirms the absence of heteroscedasticity, with the probability attached to the test being 0.32, greater than 0.05. Additionally, the model is stationary and invertible. The forecast is given in Table 4 and is graphically represented, with the confidence interval, in Figure 2.

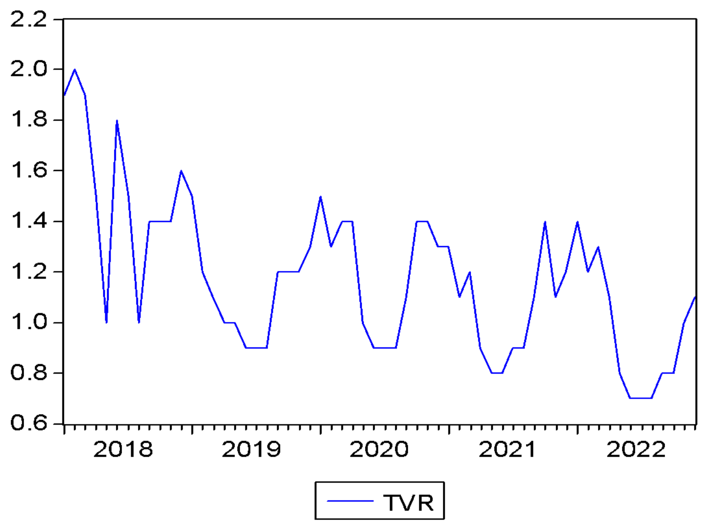

Figure 1. Monthly rating of the telejournal

Source: Authors' own research.

The probability is less than 0.05, so the null hypothesis is rejected, and the alternative hypothesis is accepted, meaning the series is stationary.

Table 1. Stationarity test results

Null Hypothesis: TVR has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.419714	0.0044
Test critical values:	1% level	-4.130526	
	5% level	-3.492149	
	10% level	-3.174802	

Source: Authors' own research.

Table 2. Correlogram for TVR, Series Date: 08/04/24, Time: 07:58, Sample: 2018:01 - 2022:12 Included Observations: 60

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |***** |</td><td>. |***** |</td><td>1</td><td>0.689</td><td>0.689</td><td>29.942</td><td>0.000</td></tr>
<tr><td>. |*** |</td><td>.*| . |</td><td>2</td><td>0.432</td><td>-0.081</td><td>41.930</td><td>0.000</td></tr>
<tr><td>. |** |</td><td>. |*. |</td><td>3</td><td>0.316</td><td>0.095</td><td>48.430</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>**| . |</td><td>4</td><td>0.098</td><td>-0.270</td><td>49.065</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. |*. |</td><td>5</td><td>0.005</td><td>0.098</td><td>49.067</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>6</td><td>-0.071</td><td>-0.150</td><td>49.416</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>. | . |</td><td>7</td><td>-0.124</td><td>0.061</td><td>50.503</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. |*. |</td><td>8</td><td>-0.046</td><td>0.095</td><td>50.657</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>. |** |</td><td>9</td><td>0.083</td><td>0.203</td><td>51.158</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>. | . |</td><td>10</td><td>0.181</td><td>0.058</td><td>53.588</td><td>0.000</td></tr>
<tr><td>. |** |</td><td>. | . |</td><td>11</td><td>0.245</td><td>0.049</td><td>58.134</td><td>0.000</td></tr>
<tr><td>. |** |</td><td>.*| . |</td><td>12</td><td>0.233</td><td>-0.079</td><td>62.343</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>.*| . |</td><td>13</td><td>0.143</td><td>-0.105</td><td>63.969</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>. | . |</td><td>14</td><td>0.091</td><td>0.021</td><td>64.645</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>15</td><td>0.046</td><td>0.026</td><td>64.819</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>16</td><td>-0.077</td><td>-0.101</td><td>65.325</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>. | . |</td><td>17</td><td>-0.166</td><td>-0.049</td><td>67.696</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>. |*. |</td><td>18</td><td>-0.132</td><td>0.109</td><td>69.250</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>19</td><td>-0.139</td><td>-0.118</td><td>70.993</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>. | . |</td><td>20</td><td>-0.089</td><td>0.058</td><td>71.728</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>. |*. |</td><td>21</td><td>0.069</td><td>0.142</td><td>72.184</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>. |*. |</td><td>22</td><td>0.156</td><td>0.093</td><td>74.551</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>. | . |</td><td>23</td><td>0.188</td><td>-0.049</td><td>78.116</td><td>0.000</td></tr>
<tr><td>. |** |</td><td>. |*. |</td><td>24</td><td>0.249</td><td>0.111</td><td>84.504</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>.*| . |</td><td>25</td><td>0.187</td><td>-0.133</td><td>88.235</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>. | . |</td><td>26</td><td>0.083</td><td>-0.046</td><td>88.993</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>.*| . |</td><td>27</td><td>-0.018</td><td>-0.121</td><td>89.028</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>. | . |</td><td>28</td><td>-0.143</td><td>0.036</td><td>91.392</td><td>0.000</td></tr>
</table>

Source: Authors' own research.

Table 3. ARMA (1.11) model with TVR as dependent variable and Least Squares method

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.976146	0.102396	9.533022	0.0000
AR(1)	0.607754	0.103520	5.870912	0.0000
MA(11)	0.910815	0.021739	41.89706	0.0000
R-squared	0.718066	Mean dependent var		1.164407
Adjusted R-squared	0.707997	S.D. dependent var		0.294058
S.E. of regression	0.158901	Akaike info criterion		-0.791564
Sum squared resid	1.413970	Schwarz criterion		-0.685926
Log likelihood	26.35113	F-statistic		71.31404
Durbin-Watson stat	1.986850	Prob(F-statistic)		0.000000

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Inverted AR Roots	.61			
Inverted MA Roots	.95+.28i	.95 -.28i	.65+.75i	.65 -.75i
	.14 -.98i	.14+.98i	-.41 -.90i	-.41+.90i
	-.83+.54i	-.83 -.54i	-.99	
Breusch-Godfrey Serial Correlation LM Test:				
F-statistic	0.340248	Probability		0.713108
Obs*R-squared	0.378654	Probability		0.827516
ARCH Test:				
F-statistic	1.001927	Probability		0.321150
Obs*R-squared	1.019470	Probability		0.312645

Source: Authors' own research.

Table 4. Forecast for TeleJurnal 20

	Estimated	Actual
2023:01	1.10622974217	0,8
2023:02	1.19785008272	0,8
2023:03	1.072809119	0,8
2023:04	0.966498145518	0,7
2023:05	0.813400115008	0,6
2023:06	0.88446237227	0,6
2023:07	0.919536237921	0,5
2023:08	0.75503992269	0,6
2023:09	0.748671449401	0,6
2023:10	0.893617697744	0,8
2023:11	0.770723764645	0,8
2023:12	0.851299611002	0,7
2024:01	0.90026994165	
2024:02	0.930031878909	
2024:03	0.948119829258	
2024:04	0.959112861903	
2024:05	0.965793926611	
2024:06	0.96985437354	
2024:07	0.972322128303	
2024:08	0.973821917287	
2024:09	0.974733420743	
2024:10	0.975287391041	
2024:11	0.975624068965	
2024:12	0.975828686478	
2025:01	0.975953043685	
2025:02	0.976028622334	
2025:03	0.976074555595	
2025:04	0.97610247174	
2025:05	0.976119437902	
2025:06	0.976129749163	
2025:07	0.976136015877	

	Estimated	Actual
2025:08	0.976139824501	
2025:09	0.976142139209	
2025:10	0.976143545984	
2025:11	0.976144400957	
2025:12	0.976144920571	

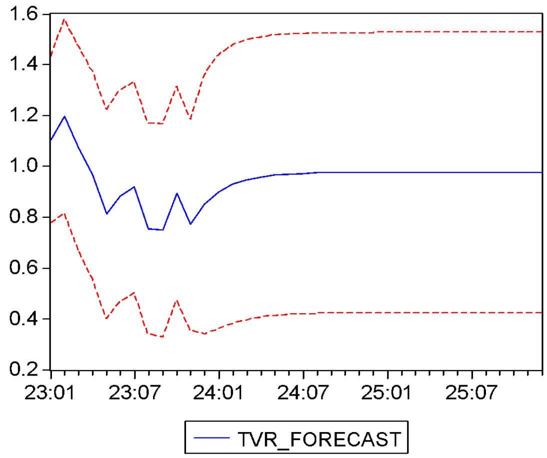

Figure 2. TVR forecast

Source: Authors' own research.

For PRO TV – Știrile PRO TV, in Figure 3, the monthly audience of the main news journal of PRO TV is graphically represented for the period 2018-2022. We will make a forecast for the period 2023-2025 using the AR(I)MA prediction method. To verify if the initial series is stationary, we applied the Dickey-Fuller test for a model with constant and trend. Since the probability associated with the test is 0.00, which is less than 0.05, the null hypothesis is rejected, and the alternative hypothesis is accepted, thus concluding that the initial series is stationary (Table 5).

Using the PRO TV correlogram (Table 6), we check several possible ARMA models of type (p,q). Several valid models resulted, but we chose the ARMA(5,1) model (Table 7), having the lowest Akaike and Schwarz criteria values. It is found that in the selected model, the estimated coefficients are significant, with the probabilities attached to the t-Statistic test being less than 0.05. Also, the model's residuals are not autocorrelated, as confirmed by the Durbin-Watson test with a value of 1.85 and the Breusch-Godfrey test with an attached probability of 0.22. The ARCH test confirms the absence of heteroscedasticity, with the probability attached to the test being 0.87, greater than 0.05. Additionally, the model is stationary and invertible. The forecast is given in Table 8 and is graphically represented, with the confidence interval, in Figure 5.

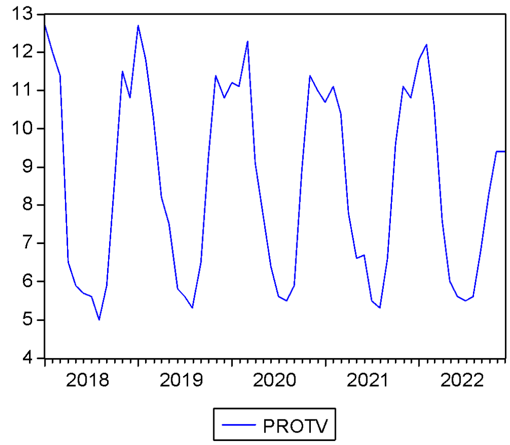

Figure 3. Monthly rating of PRO TV news journal

Source: Authors' own research.

The probability is less than 0.05, so the null hypothesis is rejected, and the alternative hypothesis is accepted, meaning the series is stationary.

Table 5. Stationarity test results

Null Hypothesis: PRO TV has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.05605	0.0000
Test critical values:	1% level	-3.555023	
	5% level	-2.915522	
	10% level	-2.595565	

Source: Authors' own research.

Table 6. Correlogram for PRO TV, Date: 08/04/24, Time: 08:24, Sample: 2018:01 2022:12
Included observations: 60

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |****** |</td><td>. |****** |</td><td>1</td><td>0.780</td><td>0.780</td><td>38.322</td><td>0.000</td></tr>
<tr><td>. |*** |</td><td>****| . |</td><td>2</td><td>0.399</td><td>-0.533</td><td>48.528</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>***| . |</td><td>3</td><td>-0.031</td><td>-0.328</td><td>48.590</td><td>0.000</td></tr>
<tr><td>***| . |</td><td>**| . |</td><td>4</td><td>-0.391</td><td>-0.190</td><td>58.749</td><td>0.000</td></tr>
<tr><td>******| . |</td><td>****| . |</td><td>5</td><td>-0.706</td><td>-0.557</td><td>92.435</td><td>0.000</td></tr>
<tr><td>******| . |</td><td>**| . |</td><td>6</td><td>-0.830</td><td>-0.197</td><td>139.85</td><td>0.000</td></tr>
<tr><td>*****| . |</td><td>. |*. |</td><td>7</td><td>-0.693</td><td>0.069</td><td>173.56</td><td>0.000</td></tr>
<tr><td>***| . |</td><td>. | . |</td><td>8</td><td>-0.359</td><td>-0.050</td><td>182.79</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>.*| . |</td><td>9</td><td>-0.002</td><td>-0.188</td><td>182.79</td><td>0.000</td></tr>
<tr><td>. |*** |</td><td>. |*. |</td><td>10</td><td>0.356</td><td>0.174</td><td>192.21</td><td>0.000</td></tr>
<tr><td>. |***** |</td><td>.*| . |</td><td>11</td><td>0.615</td><td>-0.075</td><td>220.96</td><td>0.000</td></tr>
<tr><td>. |****** |</td><td>. | . |</td><td>12</td><td>0.731</td><td>0.024</td><td>262.39</td><td>0.000</td></tr>
<tr><td>. |**** |</td><td>**| . |</td><td>13</td><td>0.578</td><td>-0.202</td><td>288.86</td><td>0.000</td></tr>
</table>

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |** |	. |*. |	14	0.304	0.091	296.33	0.000
. | . |	. | . |	15	-0.012	0.061	296.34	0.000
**| . |	.*| . |	16	-0.296	-0.070	303.76	0.000
****| . |	.*| . |	17	-0.545	-0.075	329.42	0.000
*****| . |	. | . |	18	-0.630	0.046	364.57	0.000
****| . |	. | . |	19	-0.511	0.030	388.27	0.000
**| . |	. | . |	20	-0.252	-0.051	394.18	0.000
. | . |	. |*. |	21	0.028	0.110	394.25	0.000
. |** |	.*| . |	22	0.280	-0.111	401.95	0.000
. |*** |	.*| . |	23	0.457	-0.066	422.95	0.000
. |**** |	. |*. |	24	0.543	0.195	453.45	0.000
. |*** |	.*| . |	25	0.435	-0.127	473.60	0.000
. |** |	. | . |	26	0.223	-0.004	479.03	0.000
. | . |	. |*. |	27	-0.031	0.091	479.13	0.000
**| . |	. | . |	28	-0.241	-0.042	485.88	0.000

Source: Authors' own research.

Table 7. ARMA (5,1) model with PRO TV as dependent variable and the Least Squares method

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	8.519624	0.169210	50.34932	0.0000
AR(5)	-0.744714	0.058010	-12.83764	0.0000
MA(1)	0.967126	0.022490	43.00229	0.0000
R-squared	0.801604	Mean dependent var		8.465455
Adjusted R-squared	0.793974	S.D. dependent var		2.451320
S.E. of regression	1.112657	Akaike info criterion		3.104381
Sum squared resid	64.37634	Schwarz criterion		3.213872
Log likelihood	-82.37048	F-statistic		105.0511
Durbin-Watson stat	1.854112	Prob(F-statistic)		0.000000
Inverted AR Roots	.76 -.55i	.76+.55i	-.29+.90i	-.29 -.90i
	-.94			
Inverted MA Roots	-.97			
Breusch-Godfrey Serial Correlation LM Test:				
F-statistic	1.516238	Probability		0.229458
Obs*R-squared	3.143948	Probability		0.207635
ARCH Test:				
F-statistic	0.026459	Probability		0.871415
Obs*R-squared	0.027463	Probability		0.868379

Source: Authors' own research.

Table 8. Forecast for Știrile PRO TV

	Estimated	Actual
2023:01	9.81773349214	12,2
2023:02	9.80025169026	12,7
2023:03	8.68318113959	10,4
2023:04	7.86399606909	8,3

	Estimated	Actual
2023:05	7.86399606909	6,9
2023:06	7.55290421436	6,4
2023:07	7.56592315172	6,1
2023:08	8.39782089518	5,9
2023:09	9.00787924038	6,5
2023:10	9.00787924038	8,7
2023:11	9.2395536067	10,9
2023:12	9.22985822568	10,7
2024:01	8.61033257875	
2024:02	8.15601377101	
2024:03	8.15601377101	
2024:04	7.98348269637	
2024:05	7.99070297945	
2024:06	8.45207221649	
2024:07	8.79040965699	
2024:08	8.79040965699	
2024:09	8.91889591203	
2024:10	8.9135188683	
2024:11	8.56993087651	
2024:12	8.31796634919	
2025:01	8.31796634919	
2025:02	8.22228087474	
2025:03	8.22628523288	
2025:04	8.48215991768	
2025:05	8.6698013532	
2025:06	8.6698013532	
2025:07	8.74105963695	
2025:08	8.73807753659	
2025:09	8.54752415322	
2025:10	8.40778500542	
2025:11	8.40778500542	
2025:12	8.35471798523	

Source: Authors' own research.

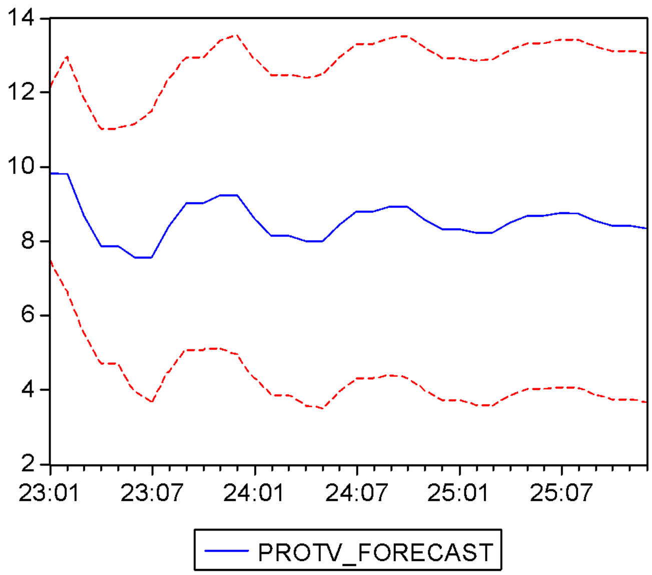

Figure 4. PRO TV forecast

Source: Authors' own research.

For ANTENA 1 – Observator 19, Figure 5, the monthly audience of the main news journal, Observator 19, is graphically represented for the period 2018-2022. We will make a forecast for the period 2023-2025 using the AR(I)MA prediction method. We check if the initial series is stationary by applying the Dickey-Fuller test for a model with a constant but without a trend. Since the probability associated with the test is 0.9315, which is greater than 0.05, the null hypothesis is accepted, concluding that the initial series is not stationary (Table 9). We calculate the first difference and obtain a new series, noted as D(ANTENA1), which is stationary because the probability associated with the Dickey-Fuller test is 0.00, leading to the rejection of the null hypothesis.

Using the ANTENA 1 correlogram (Table 10), we checked several possible ARMA models of type (p,q). Although several valid models resulted, we chose the ARIMA(6,1,5) model (Table 11), having the lowest Akaike and Schwarz criteria values. In the selected model, the estimated coefficients are significant, with probabilities associated with the t-Statistic test being less than 0.05. Also, the model's residuals are not autocorrelated, as confirmed by the Durbin-Watson tests with a value of 1.97 and Breusch-Godfrey with an associated probability of 0.99. The ARCH test confirms the absence of heteroscedasticity, with the probability associated with the test being 0.65, greater than 0.05. The model is also stationary and invertible. The forecast is presented in Table 12 and is graphically represented, with the confidence interval, in Figure 6.

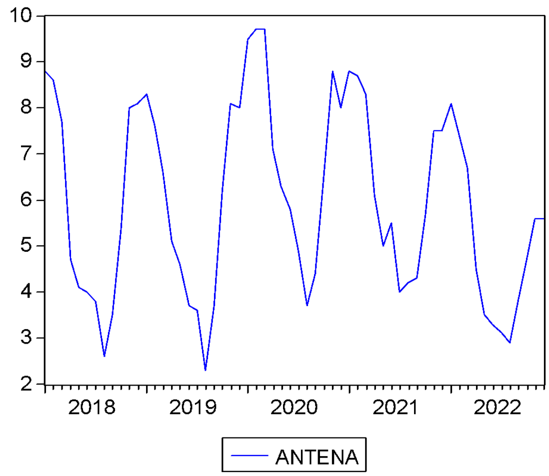

Figure 5. Monthly rating of ANTENA news journal

Source: Authors' own research.

The probability is greater than 0.05. The null hypothesis is accepted, concluding that the initial series is not stationary.

Table 9. Stationarity test results

Null Hypothesis: ANTENA 1 has a unit root
Exogenous: Constant
Lag Length: 9 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.199897	0.9315
Test critical values:	1% level	-3.568308	
	5% level	-2.921175	
	10% level	-2.598551	

Null Hypothesis: D(ANTENA1) has a unit root
Exogenous: Constant
Lag Length: 8 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.350022	0.0000
Test critical values:	1% level	-3.568308	
	5% level	-2.921175	
	10% level	-2.598551	

Source: Authors' own research.

The first difference is calculated, resulting in a new series that is stationary. This is because the probability associated with the Dickey-Fuller test is 0.00, leading to the rejection of the null hypothesis.

Table 10. Correlogram for ANTENA 1, Date: 08/04/24 , Time: 08:58 Sample: 2018:01 2022:12
Included observations: 59

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |*** |</td><td>. |*** |</td><td>1</td><td>0.421</td><td>0.421</td><td>10.982</td><td>0.001</td></tr>
<tr><td>. |*. |</td><td>. | . |</td><td>2</td><td>0.161</td><td>-0.019</td><td>12.626</td><td>0.002</td></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>3</td><td>-0.087</td><td>-0.181</td><td>13.117</td><td>0.004</td></tr>
<tr><td>.*| . |</td><td>. | . |</td><td>4</td><td>-0.058</td><td>0.058</td><td>13.334</td><td>0.010</td></tr>
<tr><td>***| . |</td><td>****| . |</td><td>5</td><td>-0.445</td><td>-0.513</td><td>26.551</td><td>0.000</td></tr>
<tr><td>*****| . |</td><td>****| . |</td><td>6</td><td>-0.657</td><td>-0.509</td><td>55.869</td><td>0.000</td></tr>
<tr><td>****| . |</td><td>.*| . |</td><td>7</td><td>-0.502</td><td>-0.139</td><td>73.280</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>. |*. |</td><td>8</td><td>-0.097</td><td>0.068</td><td>73.939</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>**| . |</td><td>9</td><td>-0.067</td><td>-0.285</td><td>74.264</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>. |*. |</td><td>10</td><td>0.151</td><td>0.139</td><td>75.947</td><td>0.000</td></tr>
<tr><td>. |*** |</td><td>. |*. |</td><td>11</td><td>0.354</td><td>0.093</td><td>85.329</td><td>0.000</td></tr>
<tr><td>. |***** |</td><td>. |** |</td><td>12</td><td>0.692</td><td>0.208</td><td>122.04</td><td>0.000</td></tr>
<tr><td>. |*** |</td><td>.*| . |</td><td>13</td><td>0.345</td><td>-0.177</td><td>131.34</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>.*| . |</td><td>14</td><td>0.120</td><td>-0.093</td><td>132.49</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>15</td><td>-0.037</td><td>0.016</td><td>132.60</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. |*. |</td><td>16</td><td>-0.016</td><td>0.083</td><td>132.63</td><td>0.000</td></tr>
<tr><td>***| . |</td><td>.*| . |</td><td>17</td><td>-0.377</td><td>-0.063</td><td>144.77</td><td>0.000</td></tr>
<tr><td>****| . |</td><td>. | . |</td><td>18</td><td>-0.525</td><td>0.018</td><td>168.95</td><td>0.000</td></tr>
<tr><td>***| . |</td><td>. |*. |</td><td>19</td><td>-0.384</td><td>0.086</td><td>182.24</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>20</td><td>-0.049</td><td>-0.042</td><td>182.46</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>21</td><td>-0.079</td><td>-0.158</td><td>183.06</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>. | . |</td><td>22</td><td>0.084</td><td>0.050</td><td>183.74</td><td>0.000</td></tr>
<tr><td>. |** |</td><td>. | . |</td><td>23</td><td>0.257</td><td>-0.040</td><td>190.32</td><td>0.000</td></tr>
<tr><td>. |**** |</td><td>.*| . |</td><td>24</td><td>0.494</td><td>-0.114</td><td>215.41</td><td>0.000</td></tr>
</table>

Source: Authors' own research.

Table 11. ARIMA(6,1,5) model for D(ANTINA 1)
as dependent variable and the Least Squares method

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.022046	0.039026	-0.564905	0.5747
AR(6)	-0.579837	0.103867	-5.582506	0.0000
MA(5)	-0.533912	0.105706	-5.050910	0.0000
R-squared	0.554590	Mean dependent var		0.033962
Adjusted R-squared	0.536774	S.D. dependent var		1.227559
S.E. of regression	0.835486	Akaike info criterion		2.533332
Sum squared resid	34.90182	Schwarz criterion		2.644858
Log likelihood	-64.13329	F-statistic		31.12807
Durbin-Watson stat	1.976654	Prob(F-statistic)		0.000000
Inverted AR Roots	.79+.46i	.79 -.46i	.00 -.91i	-.00+.91i
	-.79+.46i	-.79 -.46i		
Inverted MA Roots	.88	.27+.84i	.27 -.84i	-.71 -.52i
	-.71+.52i			

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.001390	Probability	0.998611
Obs*R-squared	0.000000	Probability	1.000000
ARCH Test:			
F-statistic	0.200876	Probability	0.655951
Obs*R-squared	0.208075	Probability	0.648280

Source: Authors' own research.

Table 12. Forecast for Observator 19

	Estimated	Actual
2023:01	6.15297159313	6,7
2023:02	6.13562571977	6
2023:03	5.7929306521	5,8
2023:04	5.1027885568	4,9
2023:05	4.62995297665	4,2
2023:06	4.59512402168	3,9
2023:07	4.23966181847	3,3
2023:08	4.21489063824	3
2023:09	4.37876887559	3,8
2023:10	4.74410966627	5,3
2023:11	4.98344815468	6,1
2023:12	4.96881430757	5,3
2024:01	5.14009539924	
2024:02	5.11962968477	
2024:03	4.98977810619	
2024:04	4.7431111366	
2024:05	4.56950493173	
2024:06	4.54316121903	
2024:07	4.40901719351	
2024:08	4.38605501179	
2024:09	4.42651877339	
2024:10	4.534716391	
2024:11	4.60055069265	
2024:12	4.58099679029	
2025:01	4.62394947035	
2025:02	4.60243483207	
2025:03	4.54414350132	
2025:04	4.44657759202	
2025:05	4.37357548992	
2025:06	4.35008460604	
2025:07	4.29035010891	
2025:08	4.26799613175	
2025:09	4.26696663223	
2025:10	4.28870997647	
2025:11	4.29621032271	
2025:12	4.27500224538	

Source: Authors' own research.

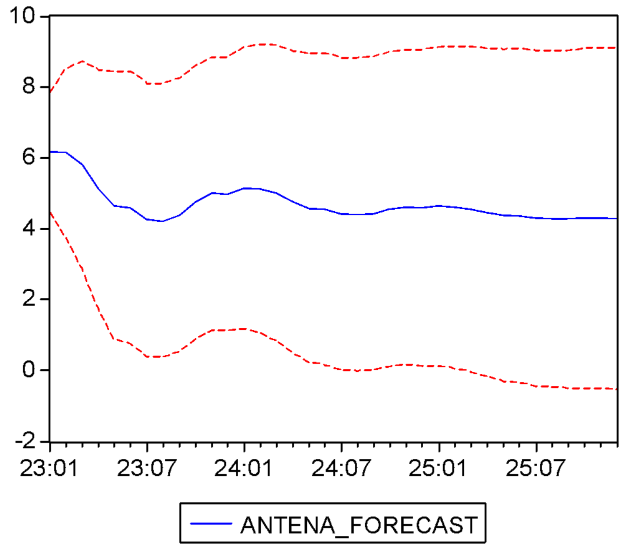

Figure 4. PRO TV forecast

Source: Authors' own research.

For KANAL D and PRIMA TV, the same methods have been applied resulting in the forecast below.

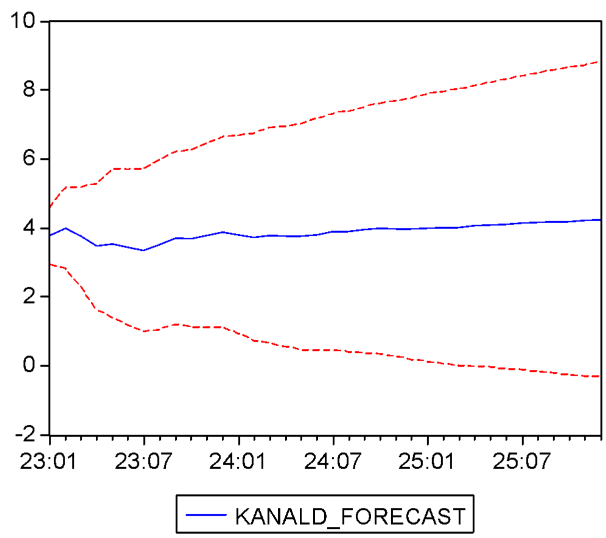

Figure 4. KANAL D forecast

Source: Authors' own research.

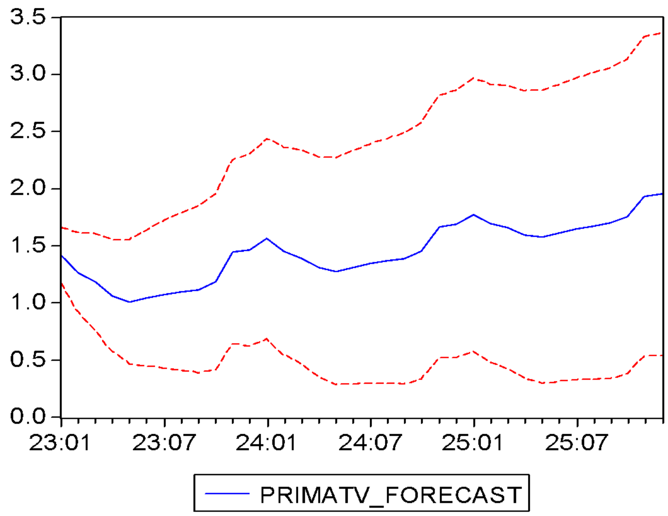

Figure 4. PRIMA TV forecast

Source: Authors' own research.

Conclusion

This study analyzed the audience performance of major news programs from five leading television stations in Romania using the ARIMA model. The analysis of audience data from 2018 to 2022 revealed distinct trends for each channel. The ARIMA models were successfully applied to forecast audience reach, and the comparison of forecasts with actual 2023 data provided insights into the model's accuracy.

The key takeaway from this research is that the ARIMA model can be a valuable tool for television audience forecasting, but its accuracy can vary across different channels and contexts. The findings have practical implications for media professionals and stakeholders in the television industry, aiding in strategic planning and content development.

Future research could explore the integration of additional factors into the forecasting models, such as social media trends, economic indicators, and major events, to further enhance the accuracy of audience predictions. Further research could also investigate the application of other time series forecasting techniques and compare their performance with the ARIMA model.

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