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ANALYSIS OF THE MOVEMENT OF FLUCTUATIONS AND TRENDS OF THE GROSS DOMESTIC PRODUCT IN THE REPUBLIC OF NORTH MACEDONIA AND FORECASTS

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Abstract. In this paper, an analysis will be made of the movement of fluctuations and trends in the gross domestic product, in the period from 2000 to 2024 by quarter with current prices expressed in millions of denars in North Macedonia, using time series. The analysis will be done using the Python program. In the end, with the help of the previously prepared program and model, a prediction is made for the movement of trends and fluctuations in GDP in the period from 2024 to 2028.

1. Introduction

Gross domestic product (GDP) is one of the basic indicators of the size and success of an economy. In fact, GDP represents the market value of final goods and services produced in a country in a certain period divided by the total number of inhabitants in that country. GDP is an indicator that shows us how much each inhabitant is allocated, on average, a share of the national income if it were equally distributed among all citizens in the country. GDP has great importance for a country. The influence of GDP on the MBI 10 stock exchange index in North Macedonia has been examined in [9]. [1]

A trend is a function that changes gradually and appears whenever the values of the variable under consideration increase or decrease over a long period of time. Fluctuation represents changing economic phenomena, relationships and processes. GDP fluctuations are characterized by short-term and long-term variables that can be caused by various factors such as:

- Economic shocks such as increasing energy prices, supply disruptions or financial crises.
- Financial policy and monetary policy: Changes in tax policy or interest rates have a direct impact on the economy, as well as low inflation and stimulating economic activities through monetary policy can boost the economy.
- Trading partners: North Macedonia, as a country that relies on exports, feels the impact of changes in international trade, so changes in demand for products from important export markets (especially the European Union) have a major impact on the country's GDP.

The analysis of the movement of fluctuations and trends in the gross domestic product in the Republic of North Macedonia includes a review of the economic factors that influence the growth or decline of GDP, as well as analyzing long-term and short-term trends. To prepare an analysis of the movement of fluctuations and trends in the gross

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domestic product (GDP) of the Republic of North Macedonia from 2000 to 2024 (data taken from the State Statistical Office [11]) using time series, it is important to consider how various economic shocks and trends have affected the economy in the specified period. More about time series analysis can be found in [1]-[5]. By using time series, we can analyze the GDP data and identify important phases in growth, declines, seasonal effects and structural changes in the economy. In the following, we will list the crisis periods from 2000 to 2024 and analyze the trends and fluctuations that appear.

Period 2000 – 2008: Post-conflict recovery and moderate growth

- GDP growth: During this period, the country began to integrate into European and global economic structures, with the signing of the Stabilization and Association Agreement with the European Union in 2001. This opened the possibility for better trade and investment.
- Trend: The initial period from 2000 to 2004 was marked by stabilization of the economy, which is reflected in moderate GDP growth of 3-4% per year.
- Fluctuations: We have the occurrence of small fluctuations that were caused by global economic factors and the domestic political situation. That is, we have moderate GDP growth with small short-term fluctuations.
- Time analysis: The application of the method for identifying trends shows a constant growth from 2004 to 2008, with small short-term declines due to global financial trends.

Period 2008 – 2013: Global Financial Crisis and Recession

- GDP decline: This decline was the result of reduced demand for products, reduced exports and difficulties in accessing financial resources.
- Recovery: After 2013, the economy began to recover, with moderate GDP growth, driven by new economic policy and stimulus measures.
- Trend: In 2009, Macedonia felt the global recession with a GDP decline of around 0.9%, and in 2012 the recession was even more pronounced, with a GDP decrease of 0.5%.
- Fluctuations: The recession manifested itself with a slight decline in 2009 and 2012, but a slow recovery followed.
- Time analysis: The time series shows large cyclical fluctuations in this period, the decline in GDP is clearly shown in time.

Period 2014 – 2019: Growth and Stabilization

- Growth trend: The country's GDP grew at rates of around 2-3% per year and in some years with higher growth rates of 3.8%. This period was also marked by the start of negotiations for membership in the European Union, which increased the investment fund.
- Fluctuations: Although growing, the economy shows insignificant fluctuations from year to year, with 2018 being the year with the highest growth of 3.8%.

- Time analysis: Trends in this period are characterized by stable growth, without major declines or seasonal fluctuations.
- Structural changes: Significant investments in infrastructure projects are emerging, especially in road and energy infrastructure, which is driving the growth of industry and construction.

Period 2020 – 2022: COVID-19 Pandemic and Economic Recession

- Trend decline in GDP: In 2020, Macedonia recorded a significant decline in GDP of around 4.5%, which is the result of the global economic crisis, closure of economic sectors, disrupted supply chains and reduced demand.
- Fluctuations: 2020 has the largest decline due to economic closures, but the economy begins to stabilize in 2021 and 2022.
- Time analysis: GDP fluctuations are very large, with declines and gradual recoveries. Applying seasonal adjustments to the time series shows a short-term recovery.
- Stabilization: After 2020, with the gradual unlocking of the economy and the vaccination, GDP began to recover, but the growth rate remains lower than in the previous period of stability.

Period 2023 – 2024: Post-pandemic recovery and new challenges

- GDP growth: Expectations for GDP growth in these years were in the range of 2-3%, in conditions of increased inflation, high energy prices and inflationary pressures. Despite these challenges, the country is trying to stabilize the economy by deepening its integration into the European Union, as well as by supporting private sector investments in green energy.
- Trend: The time series shows a gradual recovery of the economy, with stable growth, but with negative pressures from global economic changes.
- Fluctuations: This period marks moderate fluctuations, with GDP stabilizing, but with the impact of new geopolitical and economic instabilities such as the conflict in Ukraine.

2. Application of ARIMA models and a Python program to analyze trends and fluctuations in gross domestic product presented by the quarter from 2000 to 2024.

The data table in which the gross domestic product is distributed by quarter can be seen in Table 1.

Table 1. *GDP by quarter from 2000 to 2023*

GDP at current prices presented in million denars by quarter				
year	Q1	Q2	Q3	Q4
2000	54631	63879	62788	67348
2001	59975	62746	60549	69123
2002	59654	63153	64128	71646
2003	62164	66781	66647	73101
2004	60543	66188	69696	84360
2005	63787	76726	78512	89422
2006	72877	85149	85150	91663
2007	80430	90934	97015	104510
2008	90085	100492	106461	117852
2009	92764	102853	105203	113802
2010	98696	108117	114553	115931
2011	103633	117241	118947	124365
2012	103984	115463	123505	123751
2013	109082	127693	131072	134044
2014	120690	134262	134107	138572
2015	128439	138814	143587	148114
2016	135707	146029	154079	158979
2017	143436	150672	159617	164381
2018	151105	162905	167471	179396
2019	157790	173219	177844	183830
2020	162126	144502	173208	189443
2021	166196	179371	183982	199895
2022	176826	199595	206345	233318
2023	199061	218893	230330	249409

Using the Python program provided below in Appendix A, we will transform the data from the table into a time series form, from which we will obtain the following graph.

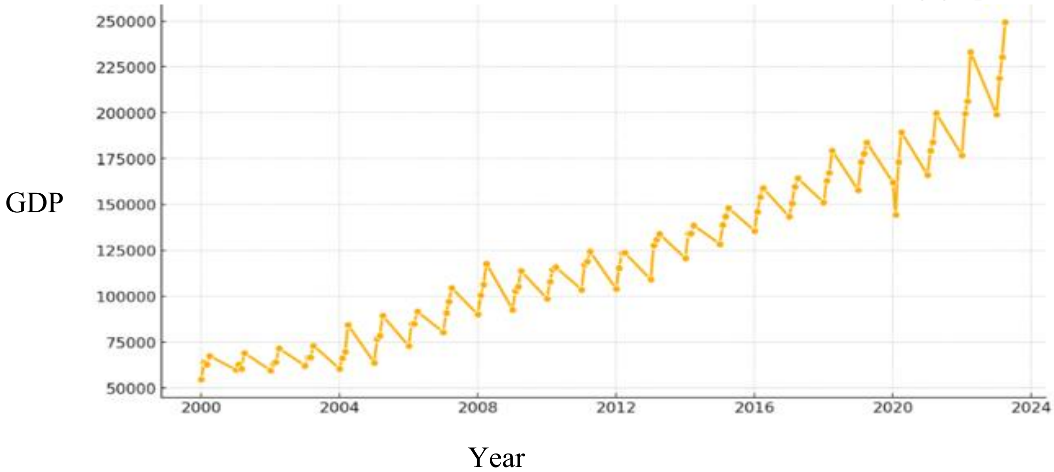

Figure 1. Graph with time series

This graph shows a clear upward trend and seasonality in GDP. More about identification of seasonality in time series is contained in [7]. We will also perform a stationarity test (ADF test) to determine whether differentiation is needed for the ARIMA model. More about ARIMA models can be found in [8]. We perform the stationarity testing of the time series with a Python program attached below as Appendix A. The results of the ADF test program give the following values: the ADF statistics have a value of 1.75132, while the p value is 0.99825, which is much higher than 0.05. The critical values of the test are for 1% = -3.511712, for 5% = -2.89705 and for 10% = -2.5857. This would mean that the time series is not stationary, so we will apply the first differentiation before continuing with the ARIMA model. After the first differentiation, the ADF statistic gives us a result of -1.35152, while the p value is 0.60529, which is still greater than 0.05, so it follows that the series is not stationary yet. Therefore, we will also do a second differentiation of the series. After the second application of the difference, we get that the p value is 6.82e-05, which is much smaller than 0.05. This would mean that the series is now stationary. Now we will continue with the identification of the ARIMA parameters. From here we get the following two graphs of the model.

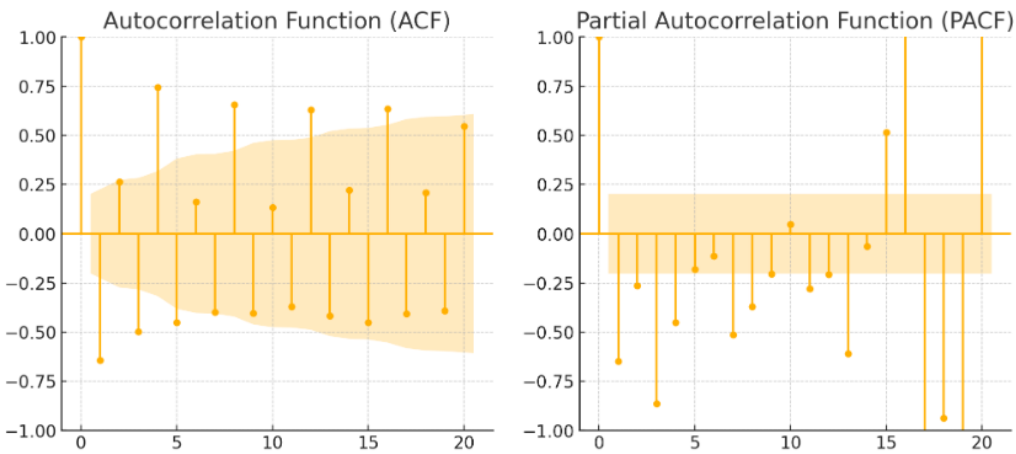

Figure 2. ACF and PACF

The ACF plot shows significant lags, suggesting the presence of an MA (q) component, while the PACF plot indicates an AR (p) component. These two plots will help us to choose the best ARIMA model. If we test ARIMA models with different parameters based on the ACF and PACF plots, we can choose the most appropriate model that will have the lowest AIC values. The model can be selected most easily using a Python program for automatic selection of the best ARIMA model using pmdarima as part of the program.

The best ARIMA model is the (3,2,3) model which would mean:

p=3 (autoregressive lags)

d=2 (second differentiation for stationarity)

q=3 (moving average lags).
Once the appropriate ARIMA model has been found, it is necessary to perform an analysis of the residuals to determine the model. The analysis produces the following two graphs:

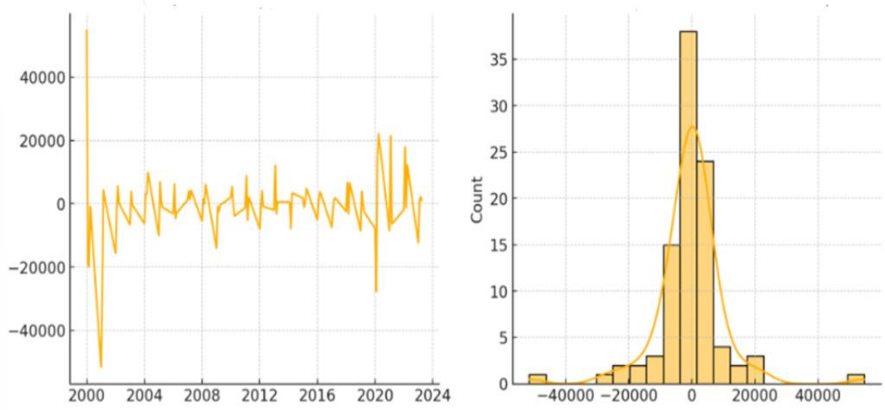

Figure 3. Residuals of the model (left image) and distribution of the residuals (right image)

The left graph shows that the residuals are randomly distributed around zero, the right graph shows that the residuals have an almost normal distribution although there are some extreme values.

3. Forecasting fluctuations and trends in gross domestic products in the Republic of Macedonia

Using the ARIMA and GARCH models, forecasts can be made for future GDP growth, considering current fluctuations and trends. We will make these forecasts for the period from 2024 to 2028 using special programs written in Python that will include ARIMA models. Forecasting risk in the banking sector using econometric methods and time series [6] is an interesting idea for research. More about forecasting can be found in [2], [4] and [10].

Using the above program and the created ARIMA model, we can make a forecast for GDP by quarter until 2028. The forecasts show a growth trend with some seasonal fluctuations. To be able to make a forecast of future trends, fluctuations and how much GDP would be, we will again use a Python program that will generate the results for us according to previous data. The program will draw the data from the table with GDP data from 2000 to 2024. The program with which the forecasts were made is attached as Appendix B. The results obtained from the testing are given in Table 2.

Table 2. The results obtained from the testing for forecasts for the period from 2024 to 2028

quarter	forecasted GDP	lower limit	upper limit
2024-Q1	228.189	211.527	244.851
2024-Q2	238.521	217.510	259.532
2024-Q3	255.633	228.982	282.284
2024-Q4	268.497	238.072	298.922
2025-Q1	253.594	213.466	293.723
2025-Q2	259.950	212.013	307.887
2025-Q3	279.080	224.055	334.106
2025-Q4	289.184	227.511	350.857
2026-Q1	277.690	205.824	349.556
2026-Q2	282.357	200.745	363.968
2026-Q3	301.742	211.539	391.945
2026-Q4	310.593	211.770	409.416
2027-Q1	301.191	191.255	411.128
2027-Q2	305.167	184.100	426.233
2027-Q3	324.082	193.035	455.129
2027-Q4	332.340	191.137	473.543

From the data we can see that there is a general trend. GDP shows a clear upward trend in the coming years. In addition, there is the occurrence of seasonal fluctuations that are like historical data.

4. Conclusion

The movement of GDP is affected by a conflict period in one country, post conflict recovery, recession, stable period, pandemic and post-pandemic recovery. GDP is very important for the economic situation of a country.

In this paper, we analyze the impact of fluctuations and trends on the gross domestic product in North Macedonia for the period from 2000 to 2024. For this purpose, data from the official website of the State Statistical Office was used.

Mathematical models, including statistical analyses, the ARIMA model, and Python programming were used as tools for analysis. The attached analysis for forecasts of GDP in North Macedonia at the end of the paper gives us a clear picture of what we could expect for the economy in our country in the coming period if nothing unforeseen arises.

The results of this research can be useful for financial institutions in creating strategies for managing trends and fluctuations and ensuring stability in the economic development of the country, for the population to live without finance crisis and etc., by predicting their occurrence in the future.

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Appendix A.

```
# Loading the Excel file

File_path = "C:\Users\Pc\Desktop\Master\Time series analysis\ GDP by quarters for ARIMA analusis.xlsx"

# Reading all sheets to identify where the data is

Xls = pd.ExcelFile(file_path)
```

```
Xls.sheet_names
# Load data from Sheet1
Df = pd.read_excel(file_path, sheet_name=”Sheet1”)
# Display the first few rows for review
Df.head ()
# Transfer data as a time series
Df_melted = df.melt(id_vars=[“year”], var_name=”quarter”, value_name=”GDP”)
Df_melted[“date”] = df_melted[“year”].astype(str) + ”-” + df_melted[“quarter”]
Df_melted[“date”] = pd.to_datetime(df_melted[“date”].str.replace(“Q” , “”), format=”%Y-%m”)
# Sort by date
Df_melted = df_melted.sort_values(“date”).set_index(“date”)
# Display the first few rows
Df_melted.head()
# Visualize the time series
Plt.figure(figsize=(12,6))
Sns.lineplot(data=df_melted, x=df_melted.index, y=”GDP”, marker=”o”, linewidth=2)
Plt.title(“GDP by Quarter (2000-2023)”)
Plt.xlabel(“Year”)
Plt.ylabel(“GDP”)
Plt.grid(True)
Plt.show()
# ADF (Augmented Dickey-Fuller) stationarity test
Adf_test = adfiller(df_melted[“GDP”])
Adf_result = {
“ADF statistic” : adf_test [0],
“p - value” : adf_test [1],
“Critical values” : adf_test [4]
}
Adf_result
# First differentiation to make the series stationary
Df_melted[“GDP_diff”] = df_melted[“GDP”].diff().dropna()
# Re-run the ADF test after differentiation
Adf_test_diff = adfiller(df_melted[“GDP_diff”])
```

```
Adf_result_diff = {
“ADF statistic” : adf_test_diff [0],
“p - value” : adf_test_diff [1],
“Critical values” : adf_test_diff [4]
}
Adf_result_diff
# Second differentiation
Df_melted[“GDP_diff2”] = df_melted[“GDP_diff”].diff().dropna()
# Rerun the ADF test after the second differentiation
Adf_test_diff2 = adfiller(df_melted[“GDP_diff2”].dropna())
Adf_result_diff2 = {
“ADF statistics” : adf_test_diff2 [0],
“p-value” : adf_test_diff2 [1],
“Critical values” : adf_test_diff2 [4]
}
Adf_result_diff2
# Автокорелација (ACF) и парцијална автокорелација (PACF) за избор на параметрите p и q
Fig, axes = plt.subplots(1, 2, figsize=(12, 5))
# ACF графикон
Plot_acf(df_melted[“GDP_diff2”].dropna(), ax = axes[0])
Axes[0].set_title(“Autocorrelation Function (ACF)”)
# PACF графикон
Plit_pacf(df_melted[“GDP_diff2”].dropna(), ax = axes[1])
Axes[1].set_title(“Partial Autocorrelation Function (PACF)”)
Plt.show()
# Импортирање на потребните функции
From statsmodels.graphics.tsapolts import plot_acf, plot_pacf
# Повторно генерирање на ACF и PACF графиконите
Fig, axes = plt.subplots(1, 2, figsize=(12, 5))
Plot_acf(df_melted[“GDP_diff2”].dropna(), ax=axes[0])
Axes[0].set_title(“Autocorrelation Function (ACF)”)
Plot_pacf(df_melted[“GDP_diff2”].dropna(), ax=axes[1])
Axes[1].set_title(“Partial Autocorrelation Fuction (PACF)”)
```

```
Plt.show()

From statsmodels.tsa.arima.model import ARIMA

# Тестирање на неколку ARIMA модели

Order_list = [(2, 2, 2), (1, 2, 1), (3, 2, 3), (2, 2, 1), (1, 2, 2)]

Best_aic = float("inf")

Best_model = None

Best_order = None

For order in order_list :

Try :

        Model = ARIMA(df_melted["GDP"], order = order).fit()

        If model.aic<best_aic :
```

Appendix B.

Python program for forecasting GDP movement from 2024 to 2028

```
# Forecast until 2028 (total 16 quarters from 2024 to 2028)

Forecast_steps = 16

Forecast = best_model.get_forecast(steps=forecast_steps)

Forecast_index = pd.date_range(start="2024-Q1", periods=forecast_steps, freq="Q")

# Download the forecast

Forecast_mean = forecast.predicted_mean

Conf_int = forecast.conf_int()

# Display the forecast

Plt.figure(figsize=(12, 6))

Plt.plot(df_melted["Year_Quartet"], df_melted["GDP"], label="Historical Data", color="blue")

Plt.plot(forecast_index, forecast_mean, label="Forecast", color="red")

Plt.fill_between(forecast_index, conf_int.iloc[:, 0], conf_int.iloc[:, 1], color="pink", alpha=0.3)

Plt.xlabel("Year")

Plt.ylabel("GDP")

Plt.title("GDP forecast by quarters until 2028")

plt.legend()

plt.grid()

plt.show()

# Display of forecast values
```

```
Forecast_df = pd.DataFrame({"Quarter" : forecast_index, "Predict_GDP" : forecast_mean})

Forecast_df

# Check columns in dataframe

Df_melted.head()

# Create index for quarters

Df_melted[“Year_Quarter”] = df_melted[“year”].astype(star) + “-” + df_melted[“quarter”]

# Redraw forecast

Plt.figure(figsize=(12, 6))

Plt.plot(df_melted[“Year_Quartet”], df_melted[“GDP”], label=”Historical data”, color=”blue”)

Plt.plot(forecast_index, forecast_mean, label=”Forecast”, color=”red”)

Plt.fill_between(forecast_index, conf_int.iloc[:, 0], conf_int.iloc[:, 1], color=”pink”, alpha=0.3)

Plt.xticks(rotation =45)

Plt.xlabel("Year-Quarter")

Plt.ylabel("GDP")

Plt.title("GDP forecast by quarters until 2028")

plt.legend()

plt.grid()

plt.show()

# Display of forecast values

Forecast_df = pd.DataFrame ({"Quarter" : forecast_index.strftime("%Y-Q%q"), "Predict_GDP" : forecast_mean})

Forecast_df

# Checking forecasts to see if they contain invalid values

forecast_df.info()

forecast_df.head()

Print(forecast.predicted_mean)

print(conf_int)
```