Analysis of the Growth Dynamics of the Turkish Economy using Statistical Methods (2000-2024)

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1. Introduction and Purpose of the Study Turkey, classified as a developing economy, possesses high growth potential but has frequently encountered economic fluctuations and crises throughout history. Is the sustainability of economic growth (GDP) directly related to macroeconomic indicators such as inflation, unemployment, foreign trade balance, and foreign investments? The main purpose of this study is to examine the factors affecting the growth performance of the Turkish economy in light of data between 2000-2024 using Data Mining and Statistical Analysis methods.

2. Data Set and Variable Definitions In this study, time-series data obtained from the World Bank database were used to analyze Turkey's macroeconomic performance between 2000-2024. The variables used are as follows:

- **Growth (gdp_growth):** Dependent variable. Expresses the annual real growth rate of the country's economy in percentage (%).
- **Inflation (inflation):** The annual rate of increase in consumer prices. Included in the model as an indicator of economic stability.
- **Unemployment (unemployment):** The percentage of unemployed persons within the total labor force. Indicates the health of the job market.
- **Foreign Investment (fdi):** The ratio of net inflows of foreign direct investment to GDP. It represents international confidence in the country's economy and external capital flow contributing to production capacity.
- **Exports (exports):** The ratio of goods and services exports to GDP. Represents the level of openness of the economy.

3. Descriptive Statistics and Visualization Descriptive statistics (mean, median, standard deviation, minimum and maximum values) for the variables subject to analysis are presented in Table 1 below.

	gdp_growth	inflation	unemployment	fdi	exports
Mean	5,0350	21,7054	10,5468	1,5139	26,0325
Median	5,5334	10,4441	10,432	1,4204	24,3608
St. Dev.	4,2213	20,7161	1,624	0,7854	4,7635
Min	-5,75	6,2509	6,488	0,358	19,8811
Max	11,4393	72,3088	14,024	3,6233	38,5842

Tablo 1: Descriptive Statistics of Variables

Findings and comments regarding Table 1 are as follows:

- **Economic Growth:** Between 2000-2024, the Turkish economy recorded an average growth of 5.03%. However, the high standard deviation of 4.22% and a minimum value of -5.75% indicate that the economy has high volatility. These negative values and volatility are statistical evidence that Turkey has faced serious crises at certain times.

- **Inflation:** The most striking finding is in the inflation data. While the average inflation is 21.70%, the median is 10.44%. The average being so much higher than the median indicates a right-skewed distribution in the data set. The maximum value reaching 72.30% clearly reveals that past hyperinflationary periods pulled the average up.
- **Unemployment:** The unemployment rate realized at an average of 10.54%, and the low standard deviation of 1.62% indicates that unemployment has not changed much over the years.
- **Foreign Investment:** Foreign direct investments remained at an average of 1.51%, exhibiting a relatively low performance.
- **Exports:** The share of exports in GDP averaged 26.03% and reached a maximum of 38.58%, showing that the economy's openness has increased.

Examining the time series graph (Figure 1), the previously mentioned volatility is clearly visible. The sharp downward breaks in the graph reflect the economic crisis periods Turkey experienced in recent history (2001 and the 2009 Global Crisis). The frequent oscillation of growth rates between positive and negative zones indicates that the economy exhibits a structure sensitive to cyclical shocks rather than a sustainable and stable growth trend.

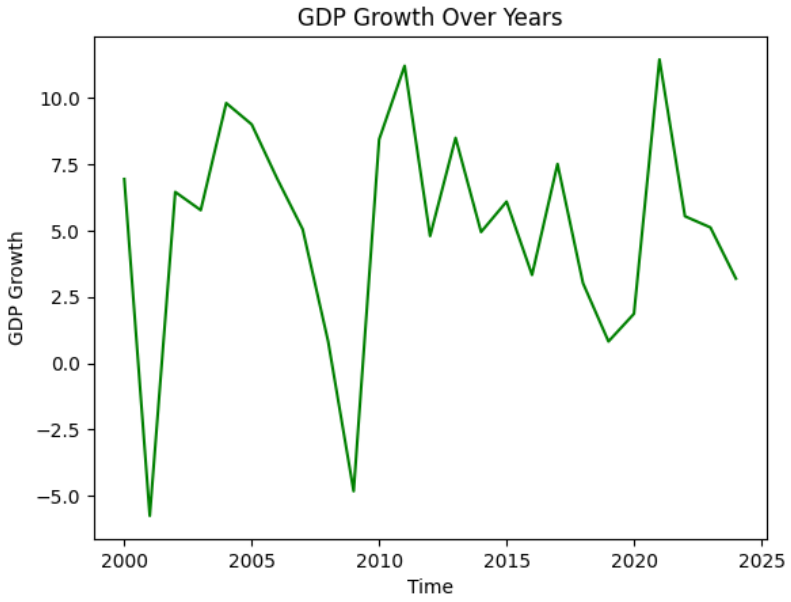

Figure 1: Change in Growth Rates Over Years

The boxplot for inflation data shows distinct deviations from the normal distribution. Points appearing at the top of the graph and outside the box area are statistically accepted as outliers. These points indicate Turkey's past hyperinflationary periods. The median line being closer to

the bottom of the box visually proves that inflation historically harbors upward risks.

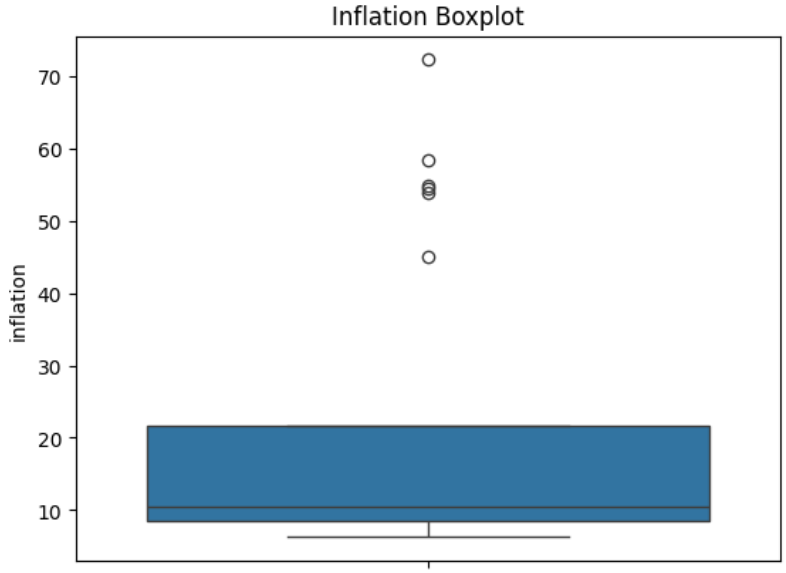

Figure 2: Distribution of Inflation Rates (Boxplot)

Upon examining the correlation matrix, several preliminary findings regarding the relationships between variables were reached:

- **Red Tones (Positive Relationship):** Values above 0 indicate variables moving in the same direction. For example, the expected positive relationship between exports and growth indicates that foreign trade supports growth.
- **Blue Tones (Negative Relationship):** Values below 0 indicate variables moving in the opposite direction. The negative coefficient between inflation and growth supports the theory that price instability suppresses economic growth.
- **Multicollinearity Control:** No very high correlation (e.g., above 0.80) was observed between independent variables. This is important as it indicates a low risk of multicollinearity problems in the regression model to be established.

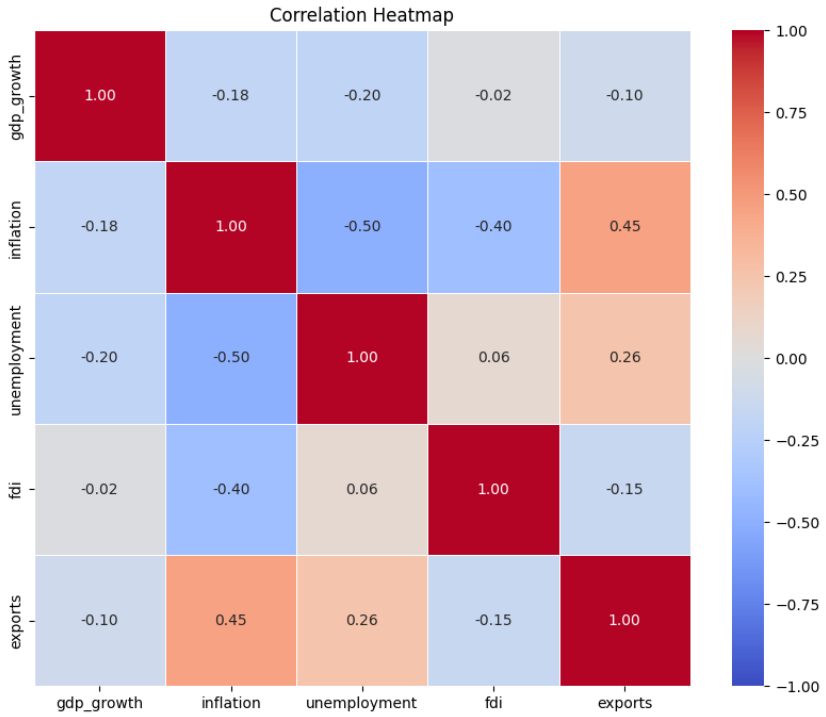

Figure 3: Correlation Heatmap

4. Hypothesis Testing

In this section, whether the theory known in the literature as "Okun's Law"—"As economic growth increases, unemployment decreases"—is valid for the Turkish economy was analyzed using the **Independent Samples T-Test**. The data set was divided into two groups: years where the growth rate was above the period average and years where it was below.

Hipotezler:

- $\boldsymbol{H_0}$**:** There is no statistically significant difference between average unemployment rates in low and high growth periods.
- $\boldsymbol{H_1}$**:** Unemployment rates between the two periods are different.

Results:

- **High Growth Period Unemployment Average**: 10.25%
- **Low Growth Period Unemployment Average**: 10.99%

According to the Levene test (which checks for homogeneity of variances), variances were found to be homogeneous ($p > 0.05$). The calculated t-statistic was 1.1328 and the significance value was found to be $\mathbf{p = 0.269}$. Since the p-value is greater than 0.05, the **H0 hypothesis was not rejected**. Statistically, it is observed that there is no significant difference in unemployment rates whether the economy grows fast or slows down in Turkey. This suggests that unemployment in the Turkish economy carries a **structural and rigid (hysteresis effect)** character rather than being cyclical.

5. Regression Analysis

Analysis was performed using the Ordinary Least Squares (OLS) method. The **R2 value was calculated as 0.242**. This indicates that the selected variables explain approximately 24.2% of the growth changes in Turkey . although the model's general explanatory power remained on the statistical borderline (F-statistic p-value: 0.213) due to the limited number of observations (N=25), significant and critical relationships were detected on a variable basis.

	coef	std err	t	P>|t|
inflation	-0,1623	0,07	-2,303	0,032
unemployment	-1,7718	0,774	-2,29	0,033
fdi	-1,2539	1,175	-1,067	0,299
exports	0,3544	0,253	1,4	0,177

Table 2: Regression Analysis Variable Results

Findings from Table 2**:**

- **Inflation:** Coefficient -0.1623 and p-value = 0.032 (<0.05). This proves a strong negative relationship between inflation and growth in Turkey.
- **Unemployment:** Coefficient -1.7718 and p-value = 0.033 (<0.05). It is observed that every 1 unit increase in unemployment reduces growth by approximately 1.77 units.
- **Exports and Foreign Investment:** No statistically significant effect of these variables on growth was detected in this model and data set.

6. Difference Between Hypothesis Testing and Regression Analysis

The most striking finding of this study is the difference between the "Hypothesis Test" in Section 4 and the "Regression Analysis" results in Section 5. While no significant difference was found in unemployment rates when data was categorized (T-Test), a significant and negative relationship (Okun's Law) was detected when data was processed without categorization in Regression Analysis. This shows that grouping data can lead to **information loss**. Regression analysis revealed the **structural relationship** that the T-Test could not catch.

7. General Conclusion and Evaluation

- The growth path has high volatility, and the economy is fragile against internal and external shocks.
- High inflation creates a statistically significant and negative pressure on growth ($p<0.05$).
- Both structural rigidity (Hysteresis effect) and Okun's Law are valid in the labor market.
- It was concluded that for sustainable development, reforms aimed at ensuring **price stability** and resolving structural problems in the labor market should be implemented rather than solely growth-oriented policies.
- The effects of Exports and FDI on growth were not found to be statistically significant ($p>0.05$), suggesting their contribution might be long-term or overshadowed by cyclical uncertainties.

To view the codes used and analyses performed: Link to GitHub Repository