جامعة محمد الخامس بالرباط
Université Mohammed V de Rabat

كلية العلوم القانونية والاقتصادية والاجتماعية السويسي-الرباط
Faculté des Sciences Juridiques Economiques et Sociales Souissi-Rabat

Master Analyse Economique et Modélisation
Master Economic Analysis and Modeling
Université Mohammed V de Rabat, Faculté des Sciences Juridiques Economiques et Sociales, Souissi

LEAM
FSJES-Souissi-UM5R

Applications in Computational Economics

By: Ahmed Kchikeche

Applications in Computational Economics: Multivariate time series analysis

The properties of time series

1. Some definitions

- A **Time Series (TS)** is a sequence of data points collected or recorded at regular time intervals.
- A **Data Generating Process (DGP)** is the real world that "generates" the observed time series data.
- A time series is a **realization** (sample path) of its data generating process.
  - A realization is **the observed sequence of outcomes produced by the DGP**, representing a single trajectory of the possible outcomes of the DGP

1.1. Components of a Time Series

- **Trend**: Long-term movement of the time series.
- **Cyclical component** : Fluctuations of the time series, of more than one year linked to business cycles, but without fixed periods.
- **The seasonal component**: Regular, repeating patterns, within a year.
- **Residual**: Random, unpredictable fluctuations in the time series.

1.2. Classical vs. Modern Time Series Analysis

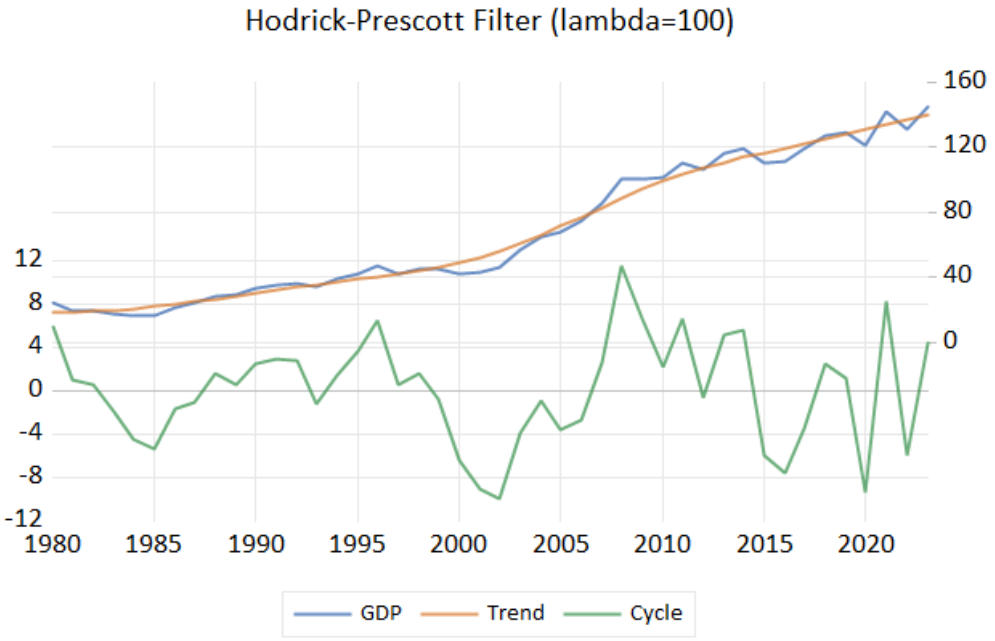
- **Classical time series** analysis traditionally assumes that **trend, cycle, and seasonality are deterministic components**, and **the only random component is the residual** part of the series.
- In contrast to classical models, **modern time series analysis** treats components like the trend, cycle, and even seasonality **as potentially stochastic** (i.e., governed by random processes rather than deterministic functions).

Application 1: Calculating the output gap using EVIEWS

- **Data**: GDP, current prices, Billions of U.S. dollar
- **Source:** International Monetary Fund, World Economic Outlook: https://www.imf.org/external/datamapper/NGDPD@WEO/MAR?zoom=MAR&highlight=MAR
- **Application using EVIEWS 13**

i) Calculating potential output using the HP filter

- Step 1: Open EViews and load the dataset containing the actual output (e.g., GDP) series
- Step 2: Select the actual output series (GDP).
  - Click on Proc → Hodrick-Prescott Filter.
- Step3: Enter the smoothing parameter (for quarterly data, λ = 1600; for annual data, λ = 100)



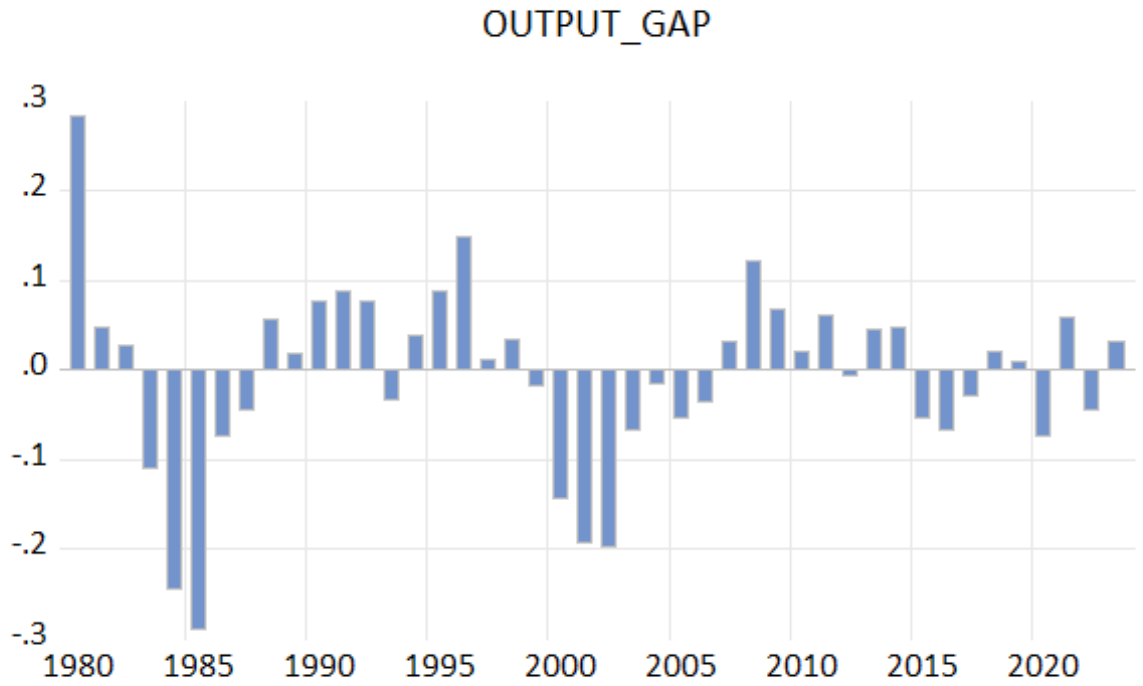
ii) Defining the output gap

- The output gap is an economic measure of the difference between the actual output of an economy and its potential output.
- Potential output is the maximum amount of goods and services an economy can turn out when it is most efficient—that is, at full capacity.
- The output gap is calculated as the percentage difference between actual output and potential output.

  - $\boldsymbol{Output\ Gap}\ (\%)\ = \boldsymbol{Log}(\boldsymbol{Actual\ Output}) - \boldsymbol{log}(\boldsymbol{Potential\ Output})$

iii) Calculating the output gap using Eviews

- **Command in EVIEWS:**
- series output_gap = log(gdp) - log(gdp_trend)



2. Seasonality

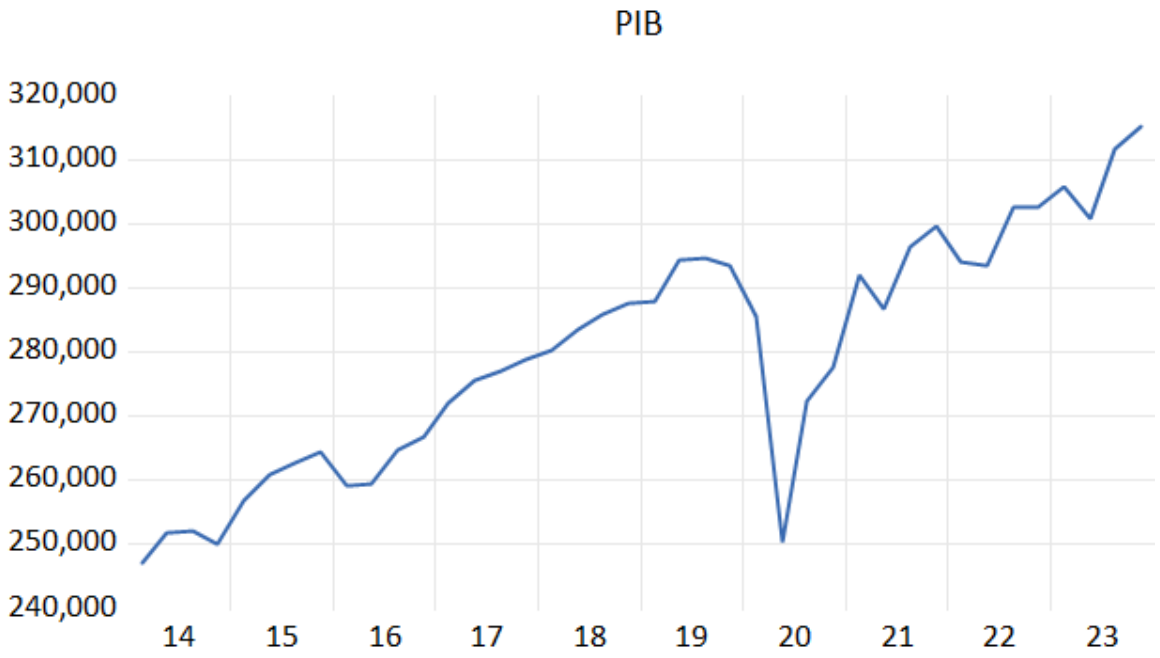
- Seasonality in a time series refers to regular, **repeating patterns or fluctuations that occur at specific intervals or periods of time**, typically within a year, month, or day.
- These patterns are driven by seasonal factors such as **weather** or **Cultural and Religious Events**, and they recur at fixed, predictable periods.

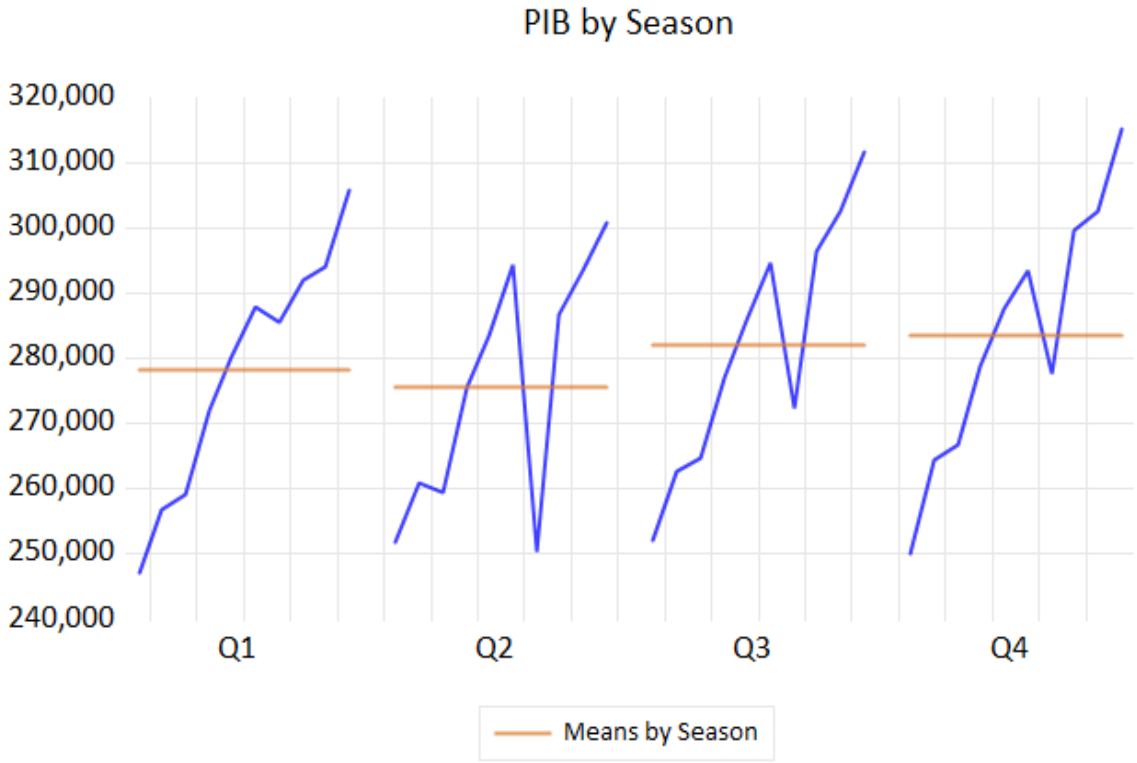
Application 2: Seasonal adjustment using the X-13 ARIMA-SEATS method

- **Data**: Produits intérieur brut prix chaînés base 2014
- **Source** : MEF, Direction des Etudes et des Prévisions Financières https://manar.finances.gov.ma/manar/Consultation_domainetableau
- **Application using EVIEWS 13**

2.1. Checking for seasonality

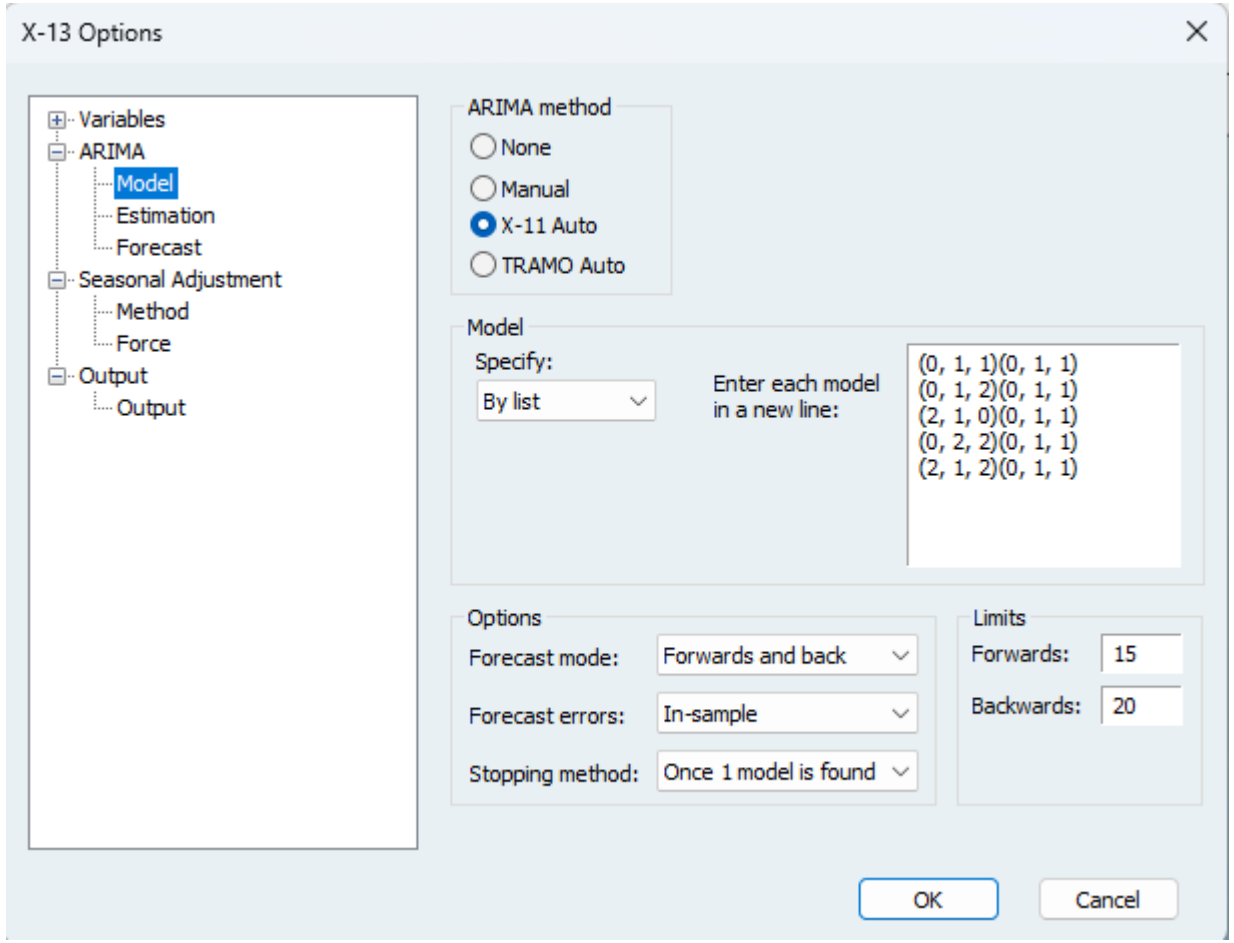
- Step 1: Open EViews and load the dataset containing the series
- Step 2: Select the actual output series (GDP).
  - Click on View → Graph → Seasonal graph
- Step 3: Compare the means





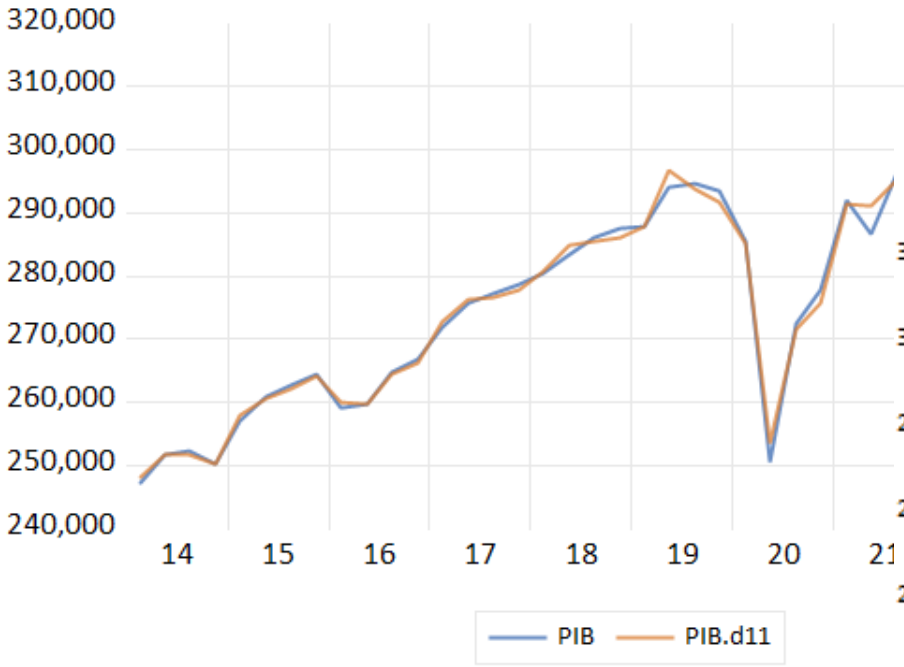
2.2. Seasonal adjustment

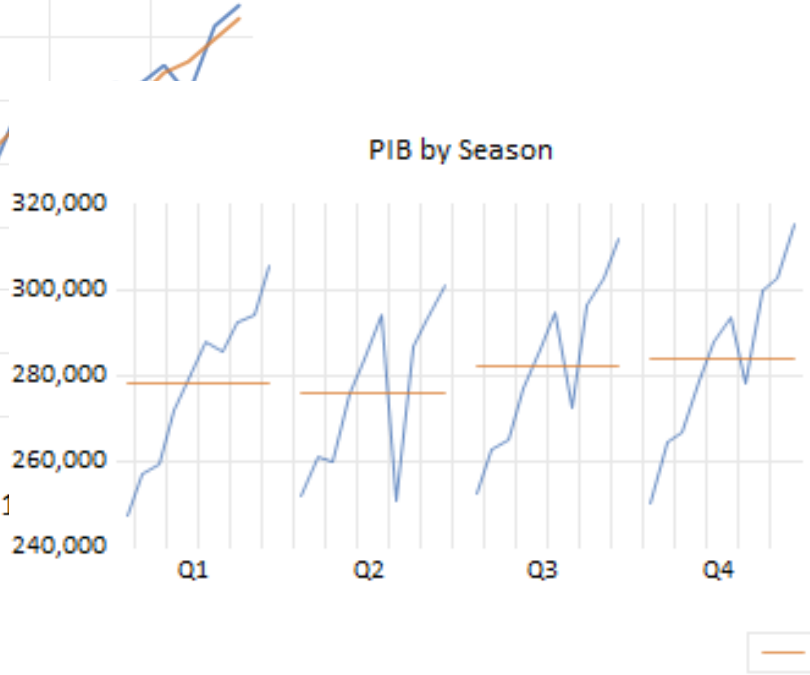
- Step 1: Open EViews and load the dataset containing the series
- Step 2: Select the series (PIB).
  - Click on Proc → Seasonal Adjustment → Census X-13
  - Check Proc → X-11 auto
  - Click ok
- Step 3: Check the new series with the suffix d_11

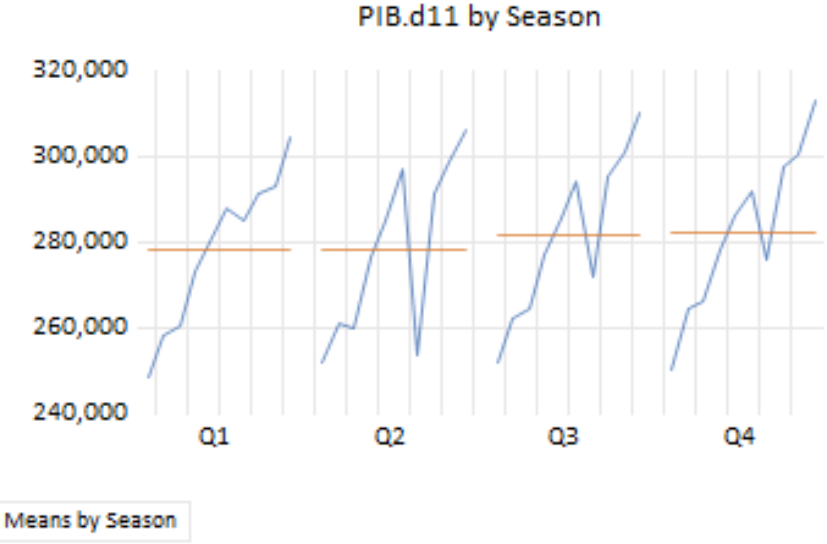


2.3. Comparing the series

- Step 1: Select both series (Ctrl + click)
- Step 2: Right click → Open → As group
- Step 3: Click on View → Graph → Seasonal graph







3. Stationarity: intuition

- A time series is stationary if its statistical properties (mean, variance, and autocovariance) are constant over time.
- Many time series models and tests assume that the underlying data is stationary.
  - These models rely on the constancy of statistical properties over time, which allows for better prediction and interpretation.
  - Statistical inference, such as **hypothesis testing** (e.g., t-tests, F-tests), assumes stationarity. Non-stationary series violate these assumptions, leading to biased or inconsistent test results.

3.1. Unit root tests: Interpretation

- Step 1: state the null (H0) and alternative hypothesis (H1)
  - The H0 of the ADF and PP tests is (the series has a unit root while the H0 for the KPSS test is (the series is stationary)
- Step 2: Calculate the test statistic (Based on the appropriate specification of the test equation : Trend & Intercept; Intercept; None)
- Step 3: Apply the decision rule either by
  - Interpreting the p-value :
    - If p-value < 5% => reject the null hypothesis (Use the P-value to interpret the ADF and PP tests)
  - Comparing the calculated and critical values of the test statistic (For the KPSS test: If the **test statistic is greater than the critical value**, reject the null hypothesis)

Application 3: Unit root tests (ADF)

- **Data**: Produits intérieur brut prix chaînés base 2014
- **Source** : MEF, Direction des Etudes et des Prévisions Financières https://manar.finances.gov.ma/manar/Consultation_domainetableau
- Application using EVIEWS 13

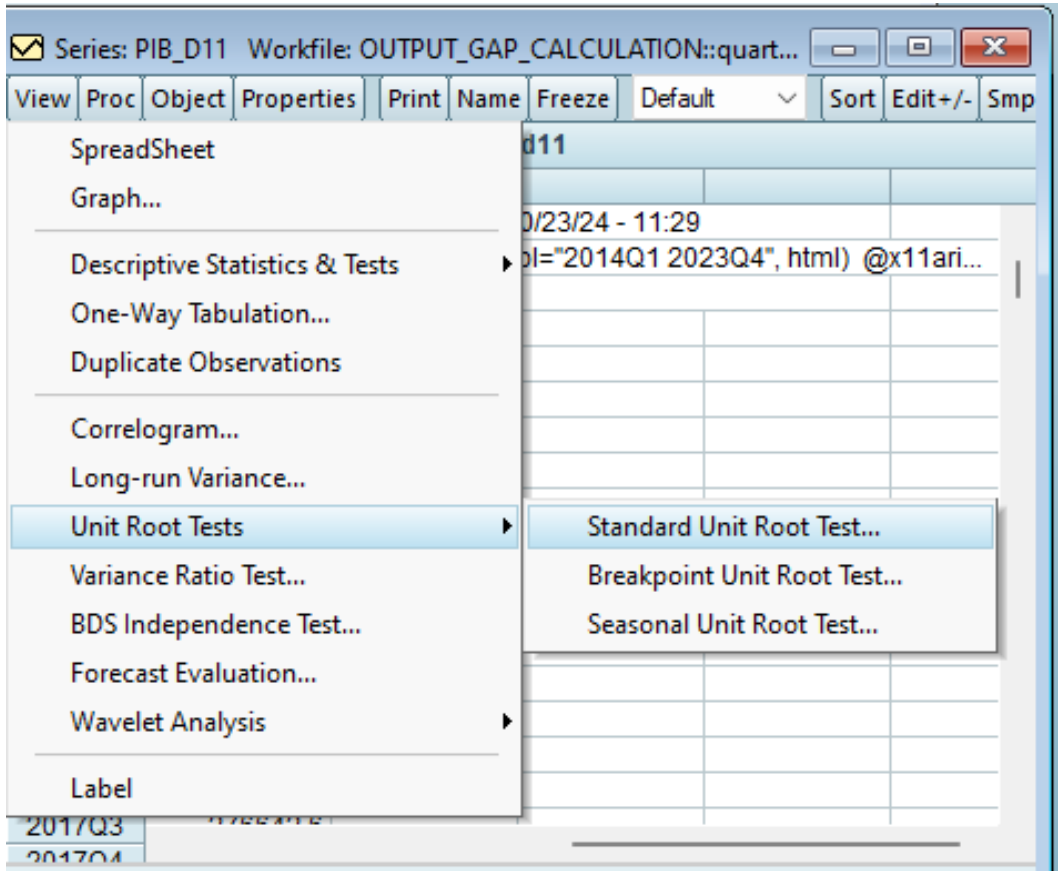
Unit root tests in EVIEWS (1)

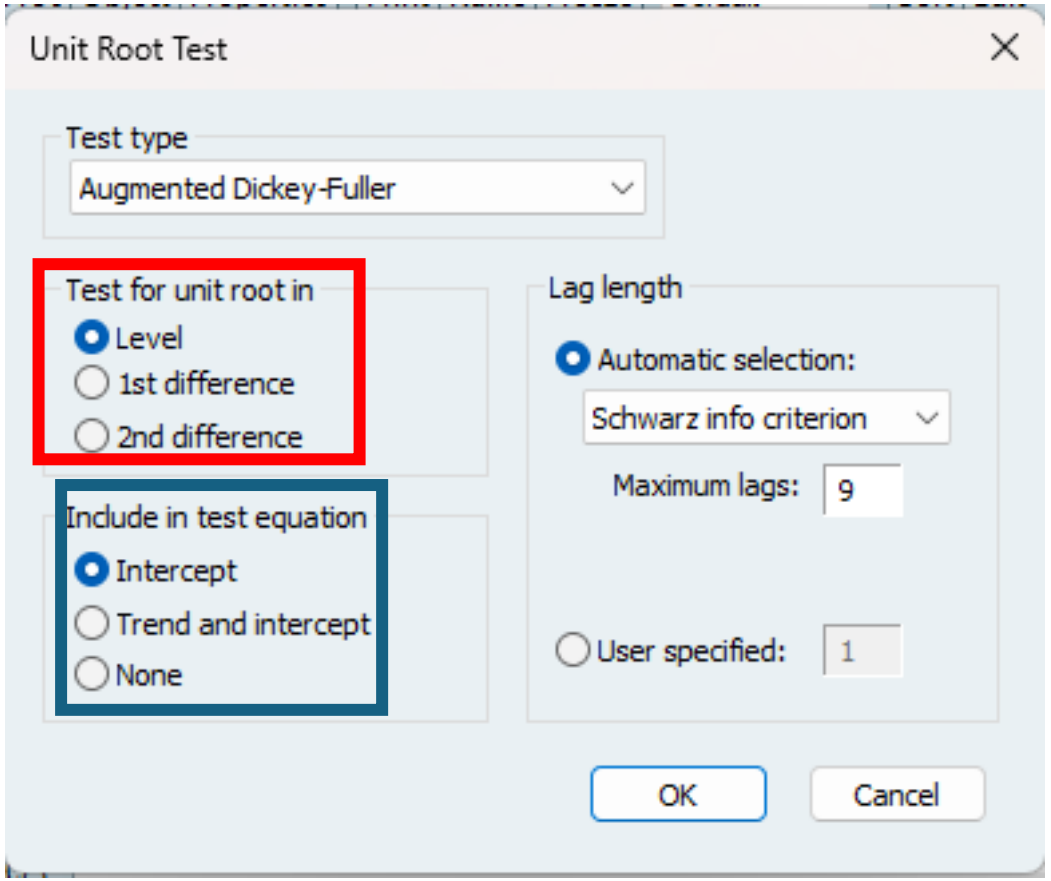
Step 1: Select the actual output series (GDP).

Click on View → Unit root tests → Standard Unit root test

Step 2: select the level of the variable (1st diff if the series is not stationary in Level)

Step 3: specify the test equation (start with Trend and intercept, and go from there)





Unit root tests in EVIEWS (2)

- **Step 1: Make sure the test equation is valid (here, the trend is significant (p-value is less than 5%), thus we can proceed. Otherwise, you redo the test with only the intercept and verify its significance before you proceed)**
- **Step 2: Interpret the test using the appropriate decision rule.**

Null Hypothesis: PIB_D11 has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.868187	0.1834
Test critical values:	1% level	-4.211868	
	5% level	-3.529758	
	10% level	-3.196411	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(PIB_D11)
Method: Least Squares
Date: 10/25/24 Time: 13:03
Sample (adjusted): 2014Q2 2023Q4
Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PIB_D11(-1)	-0.374689	0.130636	-2.868187	0.0069
C	95684.11	32889.05	2.909300	0.0062
@TREND("2014Q1")	525.8817	204.7360	2.568584	0.0145