**1. Literature and news search to decide on the variables**

*(i) Find academic articles that investigate the relation between some of the given*

*variables. These academic articles should be focusing on relationships be-*

*tween climate/economic variables.*

*(ii) Decide on a research question that you want to investigate in this assign-*

*ment. Note that the research question should involve at least one climate*

*variable and one economic variable and at least three variables in total. It*

*is important to understand that this assignment requires you to have a clear*

*intuition/model in mind because you are going to investigate the existence*

*of possible long run relationships between the variables you choose.*

**2. Graphical analysis of the data**

*Now it is time to work with the data. Start with a graphical analysis of the time series. By graphical analysis we mean plotting the data (levels, logs, first differences). Using these graphics, you should already be able to address, at least partly, issues such as*

*(i) Do you see any evidence in favor or against the assumption of covariance stationarity? Do you suspect them to* be *I(2), I(1), I(0)?*

*(ii) Do you see any evidence in favor or against for the presence of deterministic components such as a constant or a linear trend?*

*(iii) Decide whether you want to use logarithms of any of the variables. Please write your detailed comments and interpretations of the results you obtain.*

Mean temperature  
Looks like the time serie shows a linear trend. Expected to be stationary after time serie is detrended. Time serie has a constant. The time serie looks like its stationary after taking first differences. Therefore, time serie could be I(1). However, taking first differences instead of detrending could result in loss of information.

Deterministic components: constant, linear trend

Mean rainfall  
Looks like time serie has a constant mean and variance. Therefore time serie is expected to be already stationary and I(0).

Deterministic components: constant

Population  
Time series is obviously not stationary. Time serie has an upward trend. After taking first difference the time serie shows seasonal trends. Therefore, time serie is possibly I(2).

Deterministic components: constant, linear trend

Agricultural GDP  
Looks like the time serie shows a linear trend. Expected to be stationary after time serie is detrended. Time serie has a constant. The time serie looks like its stationary after taking first differences. Therefore, time serie could be I(1). However, taking first differences instead of detrending could result in loss of information.

Deterministic components: constant, linear trend

**3. Analysis of the order of integration**

*Consider now the issue of testing formally for the presence of unit roots in your series. Try to carefully apply and design a sequence of tests that enables you coherently address the issue of I(2) vs I(1) vs I(0). You may start with simple Dickey Fuller tests but there is no need to limit yourself to DF tests. On the contrary, you should look for some other tests.*

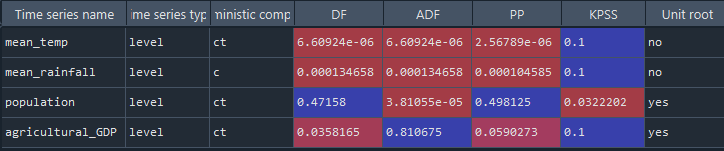
*(i) Discuss carefully your choice of the deterministic components.*Testing whether the levels data has a unit root or not, we first look at the graphs to determine which deterministic components to incorporate. See Part 2.

*(ii) Discuss the possible evidence of serial correlation in the residuals of your Dickey Fuller regression.*When performing Durbin-Watson tests, no strong evidence emerges of autocorrelation between the residuals of the time series mean\_temp, mean\_rainfall, and agricultural\_GDP. However, for the population variable, there appears to be positive autocorrelation in the residuals.

*(iii) Taking into account the presence of possible serial correlation, consider various extensions such as Augmented Dickey Fuller test, Phillips-Perron tests.*

*(iv) Use some other tests that are robust to, for example, structural breaks. You need to find the test from the literature yourself.*

*(v) Present the results of the various tests and compare these results.*



The p-values for DF, ADF, and PP tests for mean\_temp and mean\_rainfall are all below 5%, rejecting the null-hypothesis of the existence of a unit root in the time series. Moreover, the KPSS test has a stationary time series under the null-hypothesis. Therefore mean\_temp and mean\_rainfall are already stationary and I(0).

Most unit root tests for the population variable show that the time serie is non-stationary. The DF and PP tests cannot reject the null-hypothesis of a unit root time serie. Also, KPSS rejects the null-hypothesis of a stationary process and points to a unit root in the time series. This is confirmed from what we can see from the graph.

After correcting for a constant and linear trend, almost all tests show that agricultural\_GDP is stationary and I(0). This is also consistent with what we expected. looking at the graph is the agricultural\_GDP goes up more wavy compared to the population variable (which goes up more uniformly). If we did not correct for the linear trend in the agricultural\_GDP, it would probably be defined as a unit root process. If we then took first differences, we would remove more (than necessary) information from the time series.

