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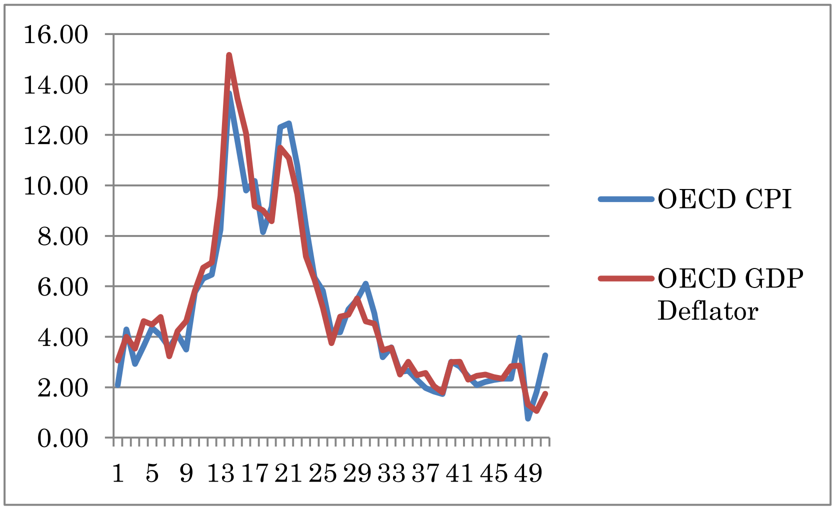
Is the inflation rate normally distributed? An empirical investigation

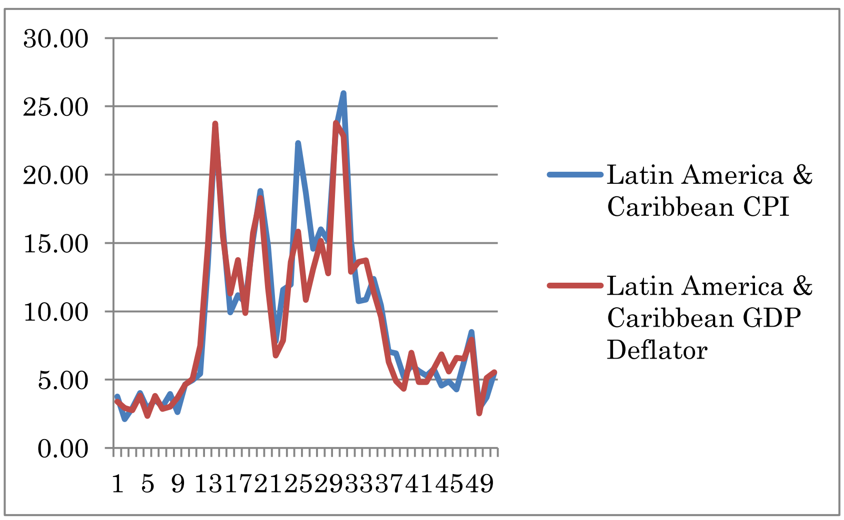
Abstract: The purpose of this project is to determine whether the inflation rate of a specific set of countries and regions can be described by a normal distribution and how their descriptive statistics – such as mean, standard deviation, kurtosis, skewness – behave. A secondary purpose of this project is to determine whether the consumer prices index (CPI) and the gross domestic product (GDP) deflator differ in this regard. Finally this project will test both the CPI and the GDP deflator for autocorrelation of order 1, using E-Views.

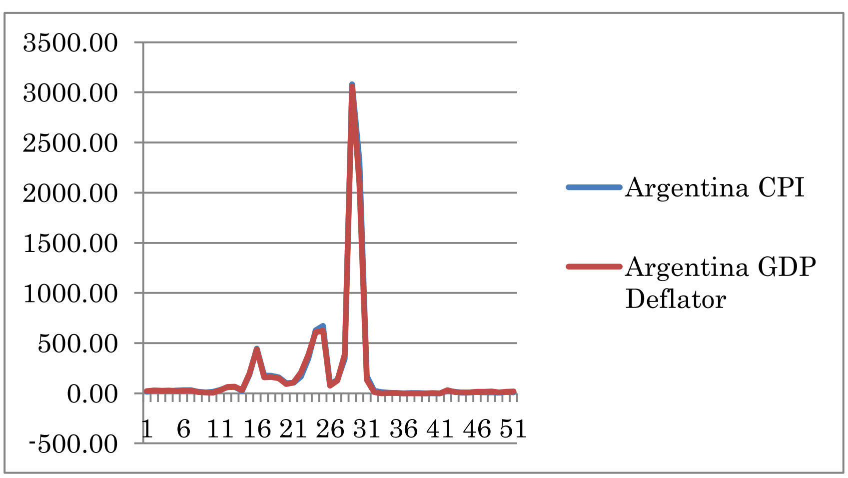
Word count: 3.004

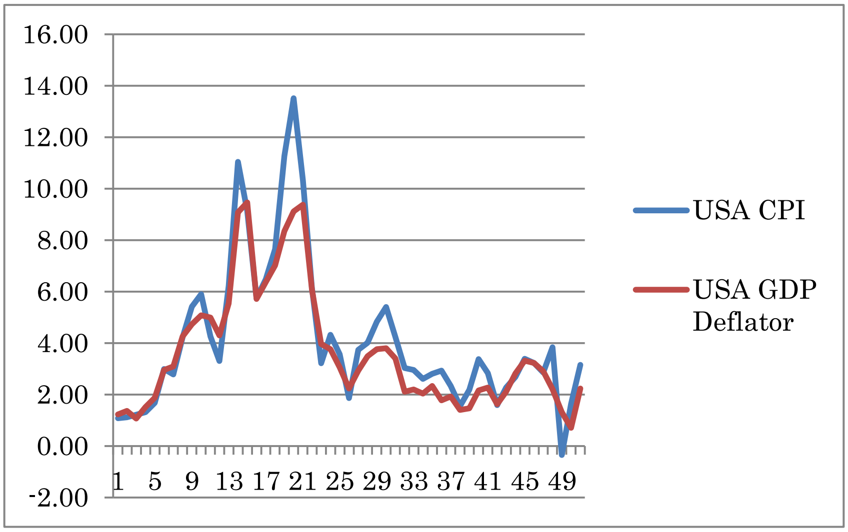
London, UK – April, 2013

Joint graph of the time series evolution of the CPI and GDP deflator





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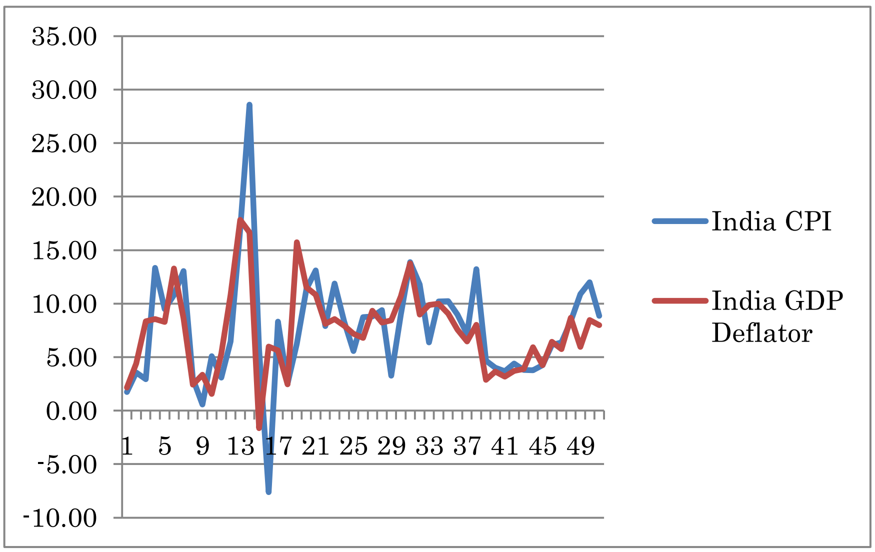
USA GDP Deflator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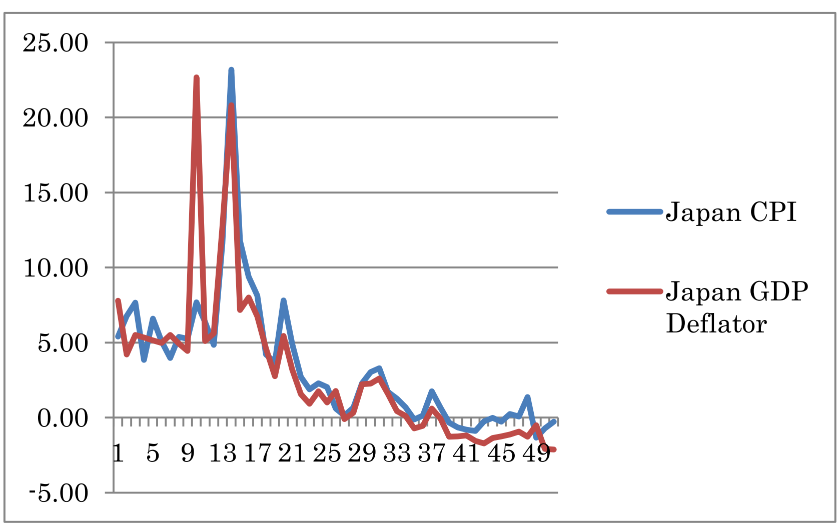
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Japan CPI
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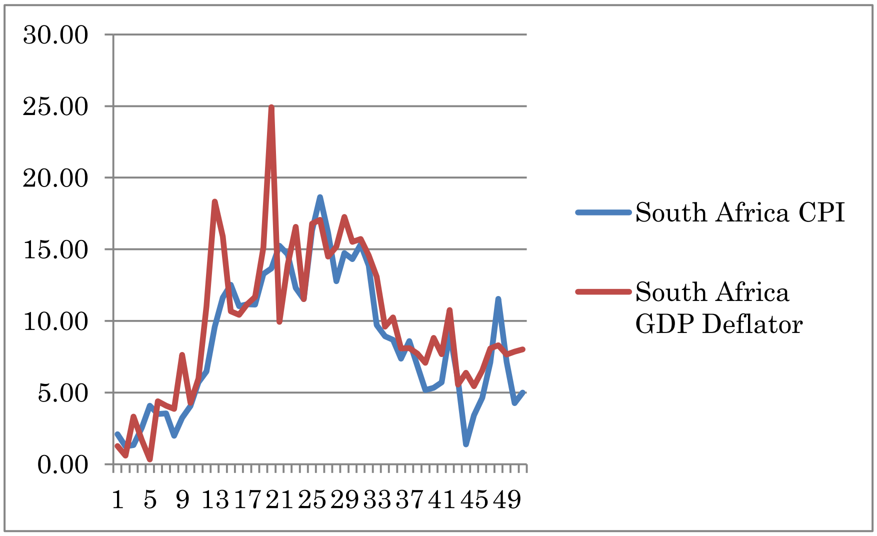
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South Africa CPI
South Africa GDP Deflator

Behaviour of the descriptive statistics of the inflation rate indexes

Firstly and foremost, it is important to clarify that both the Consumers Price Index (CPI) and the Gross Domestic Product (GDP) deflator have been computed in EViews in level, not in log, simply because many of the countries and set of countries analysed had deflation during the period. Since it is not possible to take logs of negative numbers, we treated the variables in level.

The CPI is a weighted average of the price level of the main goods consumed in the economy and the inflation rate reads as follows:

$$\pi_t = 100.\frac{(P_t - P_{t-1})}{P_{t-1}}$$

The GDP deflator is the implicit price deflator of the GDP, being a measure of prices of all final and domestically produced goods and services in the economy. It doesn't represent what a typical family consumes, because it evaluates all the goods in the economy, contrary to the CPI. The GDP deflator is as follows:

$$P_t = 100.\frac{Nominal\ GDP}{Real\ GDP} = 100.\frac{\sum_{i=1}^{N} P_{it}.Q_{it}}{\sum_{i=1}^{N} P_{i0}.Q_{it}}$$

Below follows an interpretation of the descriptive statistics estimated for the two indexes of the inflation rate considered in this project: the CPI and the GDP deflator.

1. **Mean (Average):** obtained by adding all the observations of each country or series of countries and dividing by the number of observations as in $\mu = \frac{\sum_{i=1}^{i=N} Xi}{N}$. Since we are measuring the mean from a sample, not from the population, the more appropriate formula is as follows: $\bar{X} = \frac{\sum X}{N-1}$; (BARROW, 2009, p. 25)

2. **Standard Deviation:** the bigger the standard deviation is, the bigger the volatility of inflation will be, bringing about unpredictability to the policy makers and to the consumers – inflation expectations tend to be wrong. In arithmetical terms, the standard deviation, which is a measure of dispersion, is the squared root of the variance. The purpose of taking the square root of the variance is to yield a number in a definite measure, not in its squared form. The formula is as follows: $\sigma = \sqrt{\frac{\sum(x-\mu)^2}{N}}$. Since we are measuring the standard deviation from a sample, not from the population, the more appropriate formula is as follows: $s = \sqrt{\frac{\sum(x-\bar{x})^2}{n-1}}$; (BARROW, 2009, p. 36)

3. **Skewness:** a certain distribution is generally skewed either to the left (negatively skewed) or to the right (positively skewed), meaning that it has a long tail to the left(right)-hand side of the distribution. The skewness measures the asymmetry of a distribution, whose coefficient are a cubed deviation from the mean. A negatively skewed distribution would have a negative coefficient for a left-skewed one and vice versa, yielding a zero coefficient for a symmetric distribution, considering that it is normal. The formula of the coefficient is as follows: $S = \frac{\sum_{i=1}^{n}(x_i - \bar{x})^3}{N.\sigma^3}$. (BARROW, 2009, p. 42) The importance of the skewness for the inflation rate lies on the irregularity of rates lying too far away from the zero symmetric standard, which could be interpreted as if the inflation has an irregular process, with many variations. A positively or negatively skewed inflation rate indicates the following

3.1. A volatile business cycle which has so many fluctuations in the product affecting the inflation through its impact on unemployment (the Okun's Law inserted in a Phillips Curve). The Phillips Curve being: $\pi_t = \pi_t^e + \bar{v}.\widetilde{Yt} + \bar{o}$, with $\pi_t^e = \pi_{t-1}$ with adaptative expectations. The term $\bar{v}.\widetilde{Yt}$ is the current state of the economy (aggregate demand), and $\bar{o}$ being prices shocks to inflation, affecting hence the aggregate supply. Then, to complete the model, the Okun's Law is: $u - \bar{u} = -1/2.\widetilde{Yt}$, in which the first two terms denote the unemployment gap, i.e., the difference between current unemployment and the natural rate of unemployment, and the second term being the effect of the unemployment gap to the GDP. A volatile business cycle would have a sufficient number of price shocks and aggregate demand shocks impacting the inflation rate, yielding an asymmetric distribution and a bigger standard deviation. It is important to state that this volatility in the business cycle might be due to successive government interventions or by disrupting market forces, which is not the object of analysis in this project.

4. **Kurtosis:** as well as the skewness, the kurtosis measures the shape of a probability distribution with the following formula: $K = \frac{\sum_{i=1}^{n}(x_i - \bar{x})^4}{N.\sigma^4}$, with the upper term being the fourth moment of the mean. (DECARLO, 1997, p. 292) This coefficient can be standardised for a normal distribution: by subtracting three from it, we obtain the excess kurtosis. It there is excess kurtosis for either side, then the coefficient will deviate from nullity: a low kurtosis distribution has shorter and thinner tails and a rounded peak whereas a high kurtosis distribution has the opposite. For a symmetric distribution (as said, with zero skewness), kurtosis evaluates how heavy the tails of the distribution are as well as how high the level of its peaks can be. The implications of the kurtosis for the inflation rate are quite similar to those of the skewness.

Table 1: CPI Descriptive Statistics	Mean	SD	Skewness	Kurtosis	Jarque-Bera	P-value
Argentina	192,61	537,87	4,37	21,9	921,38	0
OECD	5,04	3,26	1,09	3,18	10,14	0,006292
India	7,73	5,22	0,84	7,35	46,24	0
Latin America & Caribbean	9,55	6,26	0,89	2,9	6,81	0,033185
Japan	3,43	4,38	2,06	9,36	122,12	0
South Africa	8,54	4,74	0,19	1,89	2,94	0,229828
USA	4,09	2,84	1,5	5,06	28,05	0,000001

Table 2: GDP Deflator Descriptive Statistics	Mean	SD	Skewness	Kurtosis	Jarque-Bera	P-value
Argentina	187,02	516,91	4,45	23,08	1024,82	0
OECD	5,13	3,33	1,25	3,82	14,74	0,000628
India	7,49	3,87	0,43	3,53	2,15	0,341475
Latin America & Caribbean	9,2	5,69	0,89	3,1	6,75	0,034179
Japan	2,95	5,04	2,12	8,51	102,93	0
South Africa	9,81	5,2	0,37	2,97	1,18	0,553368
USA	3,63	2,33	1,2	3,58	13,02	0,001488

These tables above summarise the main data from the descriptive statistics of the CPI and the GDP deflator of each country or set of countries.

The values of the descriptive statistics computed for the Argentinian CPI and the GDP deflator are remarkably similar, however the CPI is slightly higher, both in mean and standard deviation.

For both, we reject H_0, at the 5% significance level, that their distributions are normal.

The values of the descriptive statistics computed for the OECD CPI and the GDP deflator are remarkably similar, however the CPI is slightly smaller, both in terms of mean and standard deviation. Again, for both, we reject, at the 5% significance level, that their distributions are normal.

The values of the descriptive statistics computed for the Indian CPI and the GDP deflator are similar, however the CPI is slightly higher, both in mean and standard deviation. It is important to notice that the difference of the standard deviations is more pronounced in the Indian case, indicating a higher volatility of the inflation rate. We reject H_0, at the 5% significance level, that the CPI distribution is normal, however, we do not reject normality in the case of the GDP deflator. It clearly bodes well for the GDP deflator as a more efficient inflation measure, considering this discrepancy.

The values of the descriptive statistics computed for Latin America and Caribbean's CPI and GDP deflator are quite similar, however the CPI is slightly higher, both in mean and standard deviation – again with a bigger difference in the latter statistic. For both, we reject H_0, at the 5% significance level, that their distributions are normal.

The values of the descriptive statistics computed for Japan's CPI and GDP deflator are similar, however the CPI has a slightly higher mean and has a smaller standard deviation. Again, for both, we reject H_0, at the 5% significance level, that their distributions are normal.

The values of the descriptive statistics computed for South Africa's CPI and GDP deflator are quite similar, however the CPI is slightly smaller, both in terms of mean and standard deviation. For both, we do not reject H_0, at the 5% significance level, that their distributions are normal.

The values of the descriptive statistics computed for the USA's CPI and GDP deflator are very much similar, however the CPI is slightly higher, both in mean and in standard deviation. For both, we reject H_0, at the 5% significance level, that their distributions are normal.

Normality Test of the Inflation Rate Indexes

The purpose of this project is to determine if the inflation rate (CPI and GDP deflator) can be determined by a normal distribution. The question whether this is valid or not is important for monetary policy, in the sense that the more "well behaved" the inflation is, the easier it is to implement an inflation targeting macroeconomic programme and, as well, the less toll the inflation tends to exact from the consumers, both in terms of inflation tax – defined by $\pi.M/P$, or the inflation rate (the "tax rate") times the monetary base (the "tax base") –, and of diminishing purchasing power.

The empiric statistical test used will be the Jarque-Bera test for normality, which measures how good the fit of sample data of the statistical model described is regarding values of kurtosis and skewness matching a normal distribution, as said, 0 and 3, respectively. (GUJARATI and PORTER, 2008, p. 148) The statistic of the test is

$JB = \frac{n-k}{6}.[S^2 + \frac{1}{4}.(K-3)^2]$, where n is the number of observations, S is the sample skewness, K is the sample kurtosis, and k is the number of regressors, with both S and K defined as:

- Kurtosis -> $K = \frac{\sum_{i=1}^{n}(x_i - \bar{x})^4}{N.\sigma^4}$;
- Skewness -> $S = \frac{\sum_{i=1}^{n}(x_i - \bar{x})^3}{N.\sigma^3}$.

Null Hypothesis, H_0: joint hypothesis of excess kurtosis and skewness being zero, indicating normality.

Alternative Hypothesis, H_A: either or both excess kurtosis and skewness being different from zero, excluding normality.

For the CPI, according to the data extracted from the descriptive statistics tables in the annex, for Argentina, India, Japan, OECD, USA and Latin America & Caribbean we reject H_0, at the 5% significance level, that their distributions are normal. However, we do not reject H_0, at the 5% significance level, that the distribution of South Africa is normal.

For the GDP deflator, according to the data extracted from the descriptive statistics tables in the annex, for Argentina, Japan, OECD, Latin America & Caribbean and the USA we reject H_0, at the 5% significance level, that their distributions are normal. However, we do not reject H_0, at the 5% significance level, that the distributions of India and South Africa are normal.

The only inconsistency found was in India, which has a normally distributed GDP deflator, but not a normally distributed CPI, indicating that the GDP deflator is a better inflation rate index, with respect to normality.

AR(1) Unit Root Test:

The unit root test checks the stationarity of a time series. Testing the CPI and the GDP deflator for autocorrelation of order 1 explains if this inflation measures have a memory, if they are correlated with themselves, i.e., past variables are carried on to future variables and explain them in a certain amount – in this case, it is expected that it would explain less than 100%, indicating a non-explosive process. The model for an AR(1), in which the output variable depends linearly on its own previous values, is a random walk with drift (a constant):

$\pi_t = \alpha + \beta.t + \phi_1. \pi_{t-1} + E_t$

With α being the drift, t being the linear time trend, β being the parameter of the linear time trend, π_t being the rate of inflation today (in time t), π_{t-1} being the rate of inflation yesterday (in time t-1) and with ϕ_1 being the autoregressive parameter. Finally, E_t is the random term, the white noise, with $E[E_t] = 0$, $Var(E_t) = E[E_t^2] = \sigma_E^2$ (constant variance), $Cov(E_t, E_{t-k}) = E[E_t.E_{t-k}] = 0$, for $k \neq 0$. For this AR(1) process to be weakly stationary, the absolute value of the autoregressive parameter has to be less than 1: $|\phi_1| < 1$. (ENDERS, 2009, p. 55) Being stationary means that the AR(1) process feeds itself with its previous values up to a point, i.e., it is not an explosive process. More formally, a weakly stationary process has to follow certain necessary conditions:

- $E[\pi_t] = \mu$, constant mean;
- $Var[\pi_t] = E[\pi_t - \mu] = \sigma^2$, constant variance;
- $Cov(\pi_t, \pi_{t-k}) = E[(\pi_t - \mu).(\pi_{t-k} - \mu)]$, autocovariance depends on the distance between the points, not on the time of them.

Considering the AR(1) process as a random walk, $\pi_t = \phi_1. \pi_{t-1} + E_t$, we shall apply a simple unit root test to determine if this process is integrated: the Dickey-Fuller Test. This procedure must be done to avoid a spurious regression, that is, a regression with high R^2 and significant t-statistics, but its results do not have any economic meaning. We can make the following modification in the random walk model, so it becomes integrated of order 1 [I(1)], as follows:

- $\pi_t - \pi_{t-1} = \alpha + \beta.t + \phi_1. \pi_{t-1} - \pi_{t-1} + E_t$
- $\Delta\pi_t = \alpha + \beta.t + (\phi_1 - 1). \pi_{t-1} + E_t$
- $\Delta\pi_t = \alpha + \beta.t + \gamma. \pi_{t-1} + E_t$

Now we proceed to define the hypothesis:

- Null hypothesis, H_0: $\gamma = 0$ (likewise, $\phi_1 = 1$, hence the “unit root” name);
- Alternative hypothesis, H_A: $\gamma < 0$, with $\gamma = \phi_1 - 1$.

If H_0 is not rejected (p-value greater than the level of significance), then there are no evidences pointing to the fact that there is no unit root, therefore it is an integrated process. The critical value does not have a t-Student distribution, under the null hypothesis, hence Dickey-Fuller and MacKinnon derived asymptotic results whilst testing a group of critical values for different sample sizes, resulting in the following modified critical value:

$$\hat{\tau} = \frac{\hat{\gamma}}{se(\widehat{\gamma})}$$

where $\hat{\gamma}$ is the estimate of γ, and $se(\widehat{\gamma})$ is the coefficient standard error. (ENDERS, 2009, p. 206)

For evaluating the correct model, the Dickey-Fuller's critical values will be used (ENDERS, 2009, p. 488), considering a sample size of 50 and a 5% significance level. The estimates of the unit root test of the inflation's AR(1) process are in the annex, and below follows a summary of the main results.

Table 3: CPI Unit Root Test Data	Lagged Coefficient	t-statistic	p-value	Persistency
Argentina	-0,62375	-4,63	0,0027	0,37625
OECD	-0,16298	-2,34	0,4038	0,83702
India	-0,951415	-5,67	0,0001	0,048585
Japan	-0,422652	-3,59	0,0408	0,577348
Latin America & Caribbean	-0,208946	-2,36	0,3927	0,791054
South Africa	-0,106582	-1,67	0,7499	0,893418
USA	-0,302336	-3,35	0,0696	0,697664

Table 4: GDP Deflator Unit Root Test Data	Lagged Coefficient	t-statistic	p-value	Persistency
Argentina	-0,626153	-4,59	0,003	0,373847
OECD	-0,157363	-2,31	0,4184	0,842637
India	-0,647154	-4,88	0,0013	0,352846
Japan	-1,162715	-4,07	0,0135	-0,162715
Latin America &	-0,234942	-2,53	0,3111	0,765058

Caribbean				
South Africa	-0,266665	-2,8	0,2047	0,733335
USA	-0,200615	-2,8	0,2034	0,799385

Regarding the CPI, according to these tables we will reject H_0, so the process doesn't have a unit root implying stationarity, for the cases of Argentina, India and Japan. On the other hand, we will not reject H_0, so the process has a unit root implying that it is integrated, for the cases of OECD, Latin America & Caribbean, South Africa and USA.

Regarding the GDP deflator, according to these tables we will reject H_0, so the process doesn't have a unit root implying stationarity, for the cases of Argentina, India and Japan. On the other hand, we will not reject H_0, so the process has a unit root implying that it is integrated, for the cases of OECD, Latin America & Caribbean, South Africa and USA.

The degree of persistency, ρ, is calculated by $\rho = \phi_1 + 1$, with ϕ_1 being the coefficient computed by the EViews estimate for the lagged variable, and ρ being the variable of interest which is the *ceteris paribus* impact of the lagged variable in the current variable, i.e., in our case it indicates the percentage (if multiplied by 100) of the inflation of the last period which is carried on to the next period.

Conclusions

The case of Argentina is peculiar, because the country underwent a quasi-hyperinflationary process during the late 1980s and the beginning of the 1990s. This is evidenced by the graph, which doesn't even allow us to notice the significant difference between the CPI and the GDP deflator, because of the huge scale. As expected, the degree of persistency of the inflation is low for both the CPI and the GDP deflator, around 37%, which indicates that an AR(1) process is not a very good representation of the Argentinian inflation. Also India falls in this category, with low degrees of persistency, especially for the CPI.

Japan is an intermediary case regarding persistency of the CPI, with 58% approximately. Definitely it is not the case for the GDP deflator, which even has negative persistency, perhaps due to the deflationary process Japan is still trapped into. All other countries have degrees of persistency for both the CPI and the GDP deflator above the threshold of 70%, indicating that an AR(1) process is a good representation of these inflation indexes.

There aren't significant differences in the descriptive statistics (majorly the mean and the standard deviation) of the CPI and the GDP deflator for all countries. However, there is one curiosity regarding India; it was the only country analysed whose results for normality of the CPI and GDP deflator's distributions were different. In the case of India, we rejected H_0 in the Jarque-Bera test for the CPI, indicating non-normality, but in the case of the GDP deflator, we didn't reject H_0, indicating normality.

Considering the other countries analysed, we rejected H_0 in the Jarque-Bera test for the CPI and the GDP deflator, indicating non-normality, for Argentina, OECD, Latin America & Caribbean, Japan and USA. Only for South Africa we didn't reject H_0 for both the indexes, indicating normality.

Finally, the analysis of the joint graphs of the time series evolution of the CPI and the GDP deflator allows us to notice a marked disconnection between these two indices mainly in the mid-1970s and in the beginning of the 1990s, a gap which is wider in the case of the USA, South Africa and India.

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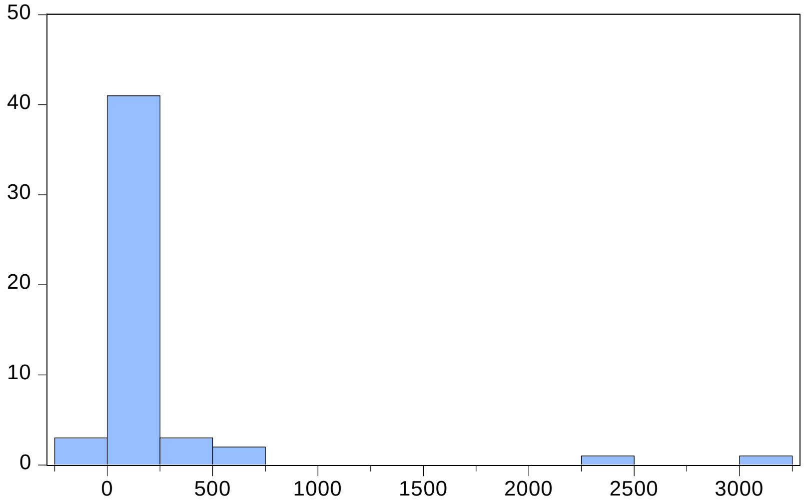
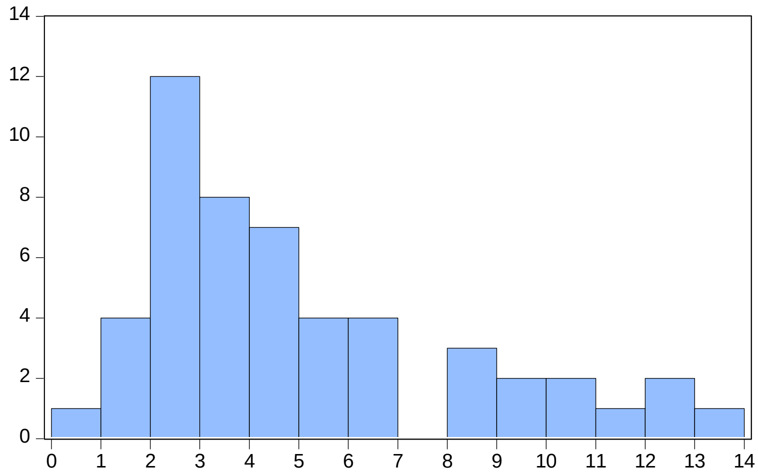
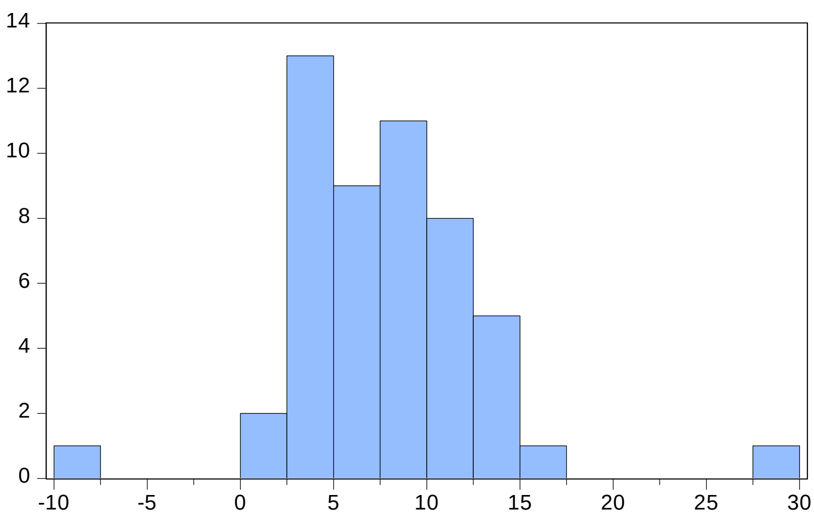
Annex A: CPI Descriptive Statistics



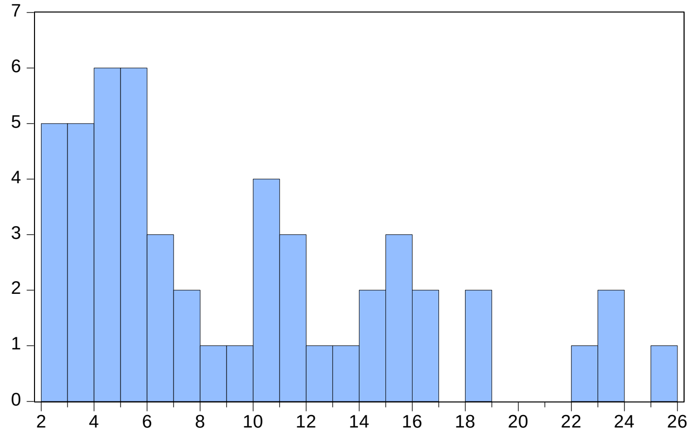
Series: ARGENTINA	
Sample 1961 2011	
Observations 51	
Mean	192.6079
Median	24.89995
Maximum	3079.810
Minimum	-1.166895
Std. Dev.	537.8728
Skewness	4.365936
Kurtosis	21.90351
Jarque-Bera	921.3754
Probability	0.000000



Series: HIGH_INCOME__OECD	
Sample 1961 2011	
Observations 51	
Mean	5.043425
Median	4.055026
Maximum	13.64932
Minimum	0.750149
Std. Dev.	3.264580
Skewness	1.088362
Kurtosis	3.179287
Jarque-Bera	10.13683
Probability	0.006292



Series: INDIA	
Sample 1961 2011	
Observations 51	
Mean	7.728693
Median	7.887271
Maximum	28.60169
Minimum	-7.634381
Std. Dev.	5.218434
Skewness	0.839462
Kurtosis	7.352108
Jarque-Bera	46.23921
Probability	0.000000



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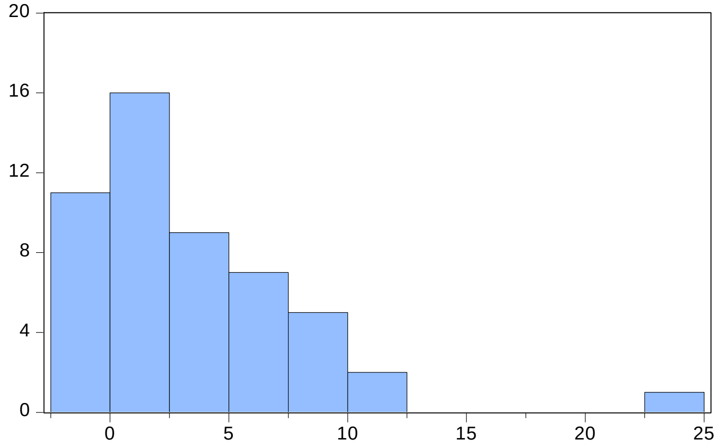
Sample 1961 2011	
Observations 51	
Mean	9.550925
Median	7.047339
Maximum	25.96746
Minimum	2.100840
Std. Dev.	6.264510
Skewness	0.893773
Kurtosis	2.900008
Jarque-Bera	6.811305
Probability	0.033185



Series: JAPAN	
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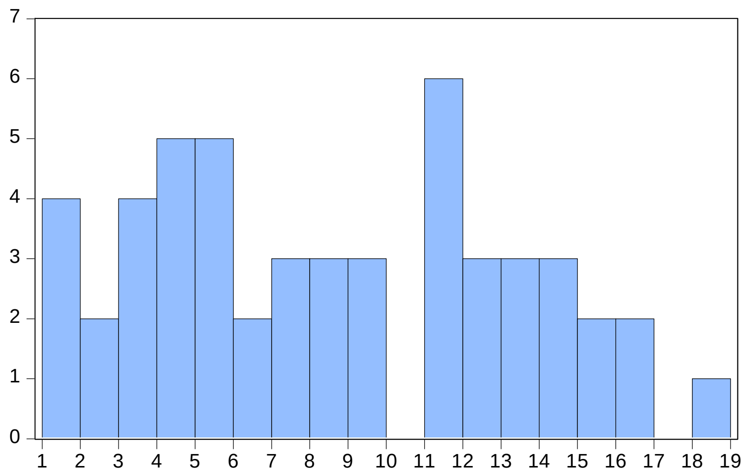
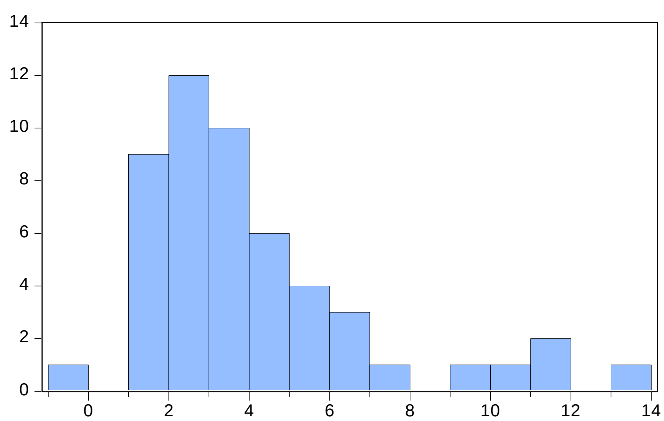
Observations 51	
Mean	3.425250
Median	2.276740
Maximum	23.17623
Minimum	-1.346719
Std. Dev.	4.376236
Skewness	2.063119
Kurtosis	9.359390
Jarque-Bera	122.1188
Probability	0.000000



Series: SOUTH_AFRICA	
Sample 1961 2011	
Observations 51	
Mean	8.539770
Median	8.597770
Maximum	18.65492
Minimum	1.246275
Std. Dev.	4.735916
Skewness	0.188665
Kurtosis	1.885751
Jarque-Bera	2.940845
Probability	0.229828



Series: UNITES_STATES_OF_AMERICA	
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Observations 51	
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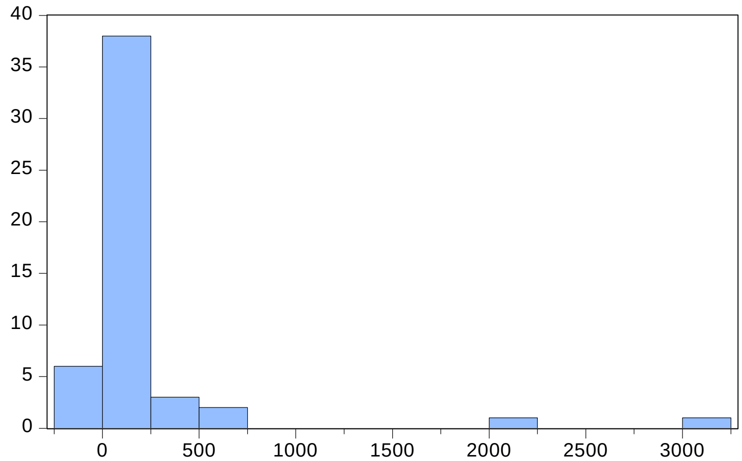
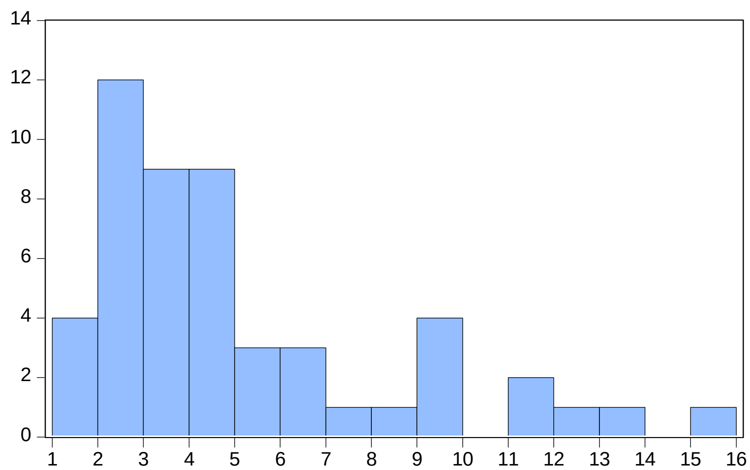
Median	3.225944
Maximum	13.50937
Minimum	-0.355546
Std. Dev.	2.840258
Skewness	1.495838
Kurtosis	5.061085
Jarque-Bera	28.04616
Probability	0.000001

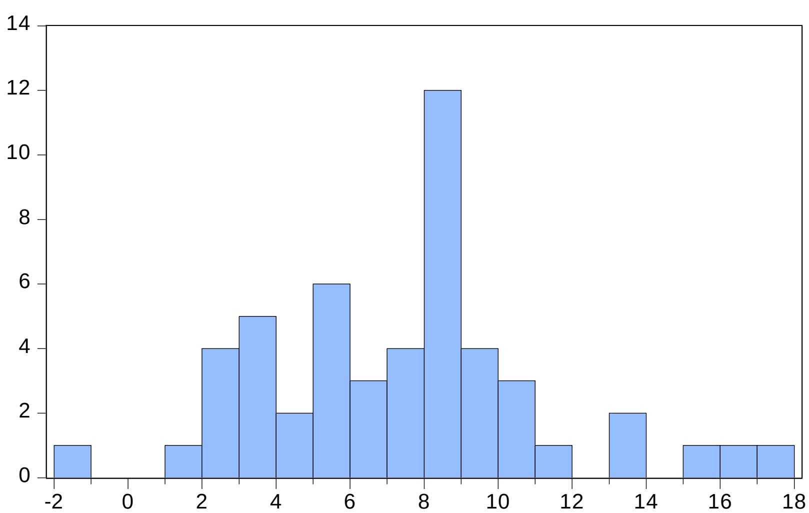
Annex B: GDP Deflator Descriptive Statistics



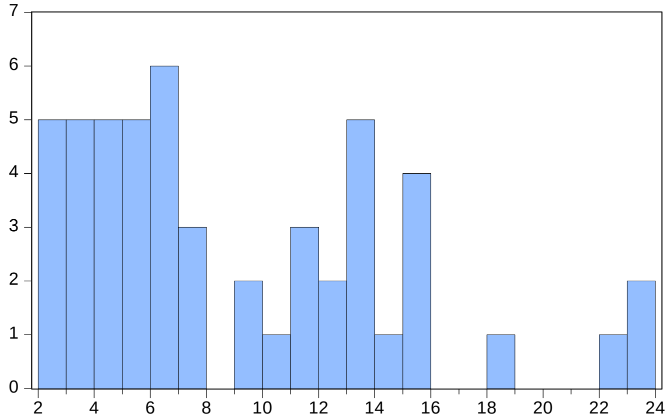
Series: ARGENTINA	
Sample 1961 2011	
Observations 51	
Mean	187.0156
Median	25.60346
Maximum	3057.629
Minimum	-1.836587
Std. Dev.	516.9088
Skewness	4.448446
Kurtosis	23.07774
Jarque-Bera	1024.824
Probability	0.000000



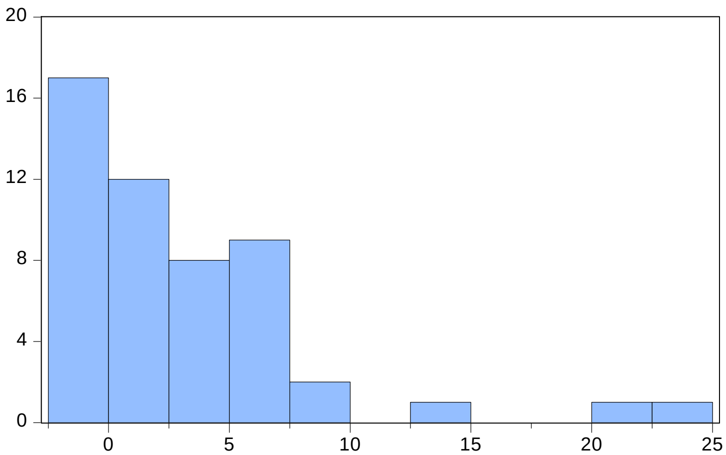
Series: HIGH_INCOME__OECD	
Sample 1961 2011	
Observations 51	
Mean	5.121839
Median	4.228283
Maximum	15.17096
Minimum	1.056922
Std. Dev.	3.334970
Skewness	1.252196
Kurtosis	3.816498
Jarque-Bera	14.74462
Probability	0.000628



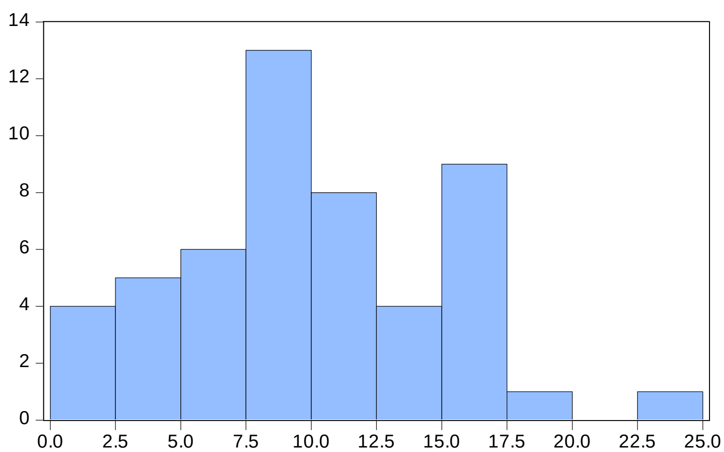
Series: INDIA	
Sample 1961 2011	
Observations 51	
Mean	7.486029
Median	7.993818
Maximum	17.82972
Minimum	-1.648682
Std. Dev.	3.868305
Skewness	0.425980
Kurtosis	3.534265
Jarque-Bera	2.148959
Probability	0.341475



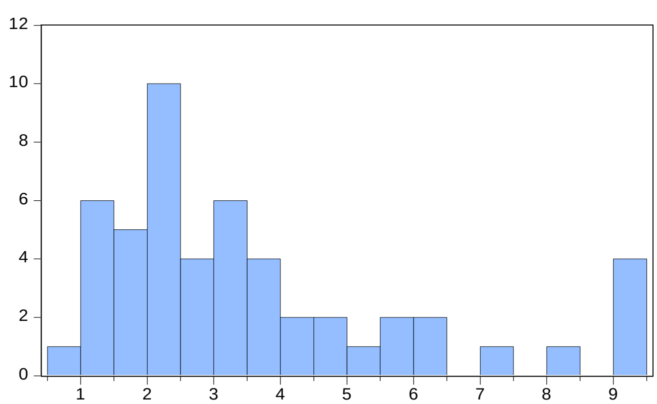
Series: LATIN_AMERICA___CARIBBEA	
Sample 1961 2011	
Observations 51	
Mean	9.200077
Median	6.976528
Maximum	23.78818
Minimum	2.337117
Std. Dev.	5.688446
Skewness	0.889885
Kurtosis	3.099816
Jarque-Bera	6.752276
Probability	0.034179



Series: JAPAN	
Sample 1961 2011	
Observations 51	
Mean	2.954657
Median	1.743513
Maximum	22.66433
Minimum	-2.120228
Std. Dev.	5.039295
Skewness	2.124403
Kurtosis	8.512183
Jarque-Bera	102.9276
Probability	0.000000



Series: SOUTH_AFRICA	
Sample 1961 2011	
Observations 51	
Mean	9.806697
Median	8.809545
Maximum	24.91463
Minimum	0.318915
Std. Dev.	5.202696
Skewness	0.372834
Kurtosis	2.969972
Jarque-Bera	1.183463
Probability	0.553368



Series: UNITES_STATES_OF_AMERICA	
Sample 1961 2011	
Observations 51	
Mean	3.627866
Median	2.952815
Maximum	9.468233
Minimum	0.706319
Std. Dev.	2.328970
Skewness	1.202704
Kurtosis	3.584240
Jarque-Bera	13.02057
Probability	0.001488

Annex C: Augmented Dickey-Fuller Unit Root Test for the CPI

Argentina

Null Hypothesis: ARGENTINA has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.626295	0.0027
Test critical values:	1% level	-4.156734	
	5% level	-3.504330	
	10% level	-3.181826	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ARGENTINA)
Method: Least Squares
Date: 05/10/13 Time: 14:22
Sample (adjusted): 1963 2011
Included observations: 49 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ARGENTINA(-1)	-0.623760	0.134829	-4.626295	0.0000
D(ARGENTINA(-1))	0.344456	0.139987	2.460632	0.0178
C	138.7189	136.3899	1.017076	0.3146
@TREND(1961)	-0.551213	4.530014	-0.121680	0.9037

R-squared	0.323430	Mean dependent var	-0.384780
Adjusted R-squared	0.278326	S.D. dependent var	527.6545
S.E. of regression	448.2500	Akaike info criterion	15.12669
Sum squared resid	9041764.	Schwarz criterion	15.28112
Log likelihood	-366.6038	Hannan-Quinn criter.	15.18528
F-statistic	7.170664	Durbin-Watson stat	1.863418
Prob(F-statistic)	0.000491		

OECD

Null Hypothesis: HIGH_INCOME__OECD has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.343217	0.4038
Test critical values:	1% level	-4.152511	
	5% level	-3.502373	
	10% level	-3.180699	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(HIGH_INCOME__OECD)
Method: Least Squares
Date: 05/10/13 Time: 14:25
Sample (adjusted): 1962 2011
Included observations: 50 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
HIGH_INCOME__OECD(-1)	-0.162980	0.069554	-2.343217	0.0234
C	1.556090	0.670487	2.320834	0.0247
@TREND(1961)	-0.027632	0.015687	-1.761473	0.0847

R-squared	0.115980	Mean dependent var	0.023700
Adjusted R-squared	0.078363	S.D. dependent var	1.500508
S.E. of regression	1.440517	Akaike info criterion	3.626006
Sum squared resid	97.52923	Schwarz criterion	3.740728
Log likelihood	-87.65015	Hannan-Quinn criter.	3.669693
F-statistic	3.083120	Durbin-Watson stat	1.796433
Prob(F-statistic)	0.055189		

India

Null Hypothesis: INDIA has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.668387	0.0001
Test critical values:	1% level	-4.156734	
	5% level	-3.504330	
	10% level	-3.181826	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INDIA)
Method: Least Squares
Date: 05/10/13 Time: 14:26
Sample (adjusted): 1963 2011
Included observations: 49 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INDIA(-1)	-0.951415	0.167846	-5.668387	0.0000
D(INDIA(-1))	0.312097	0.139991	2.229410	0.0308
C	7.953325	1.986352	4.003986	0.0002
@TREND(1961)	-0.017825	0.049647	-0.359025	0.7213

R-squared	0.431478	Mean dependent var	0.107790
Adjusted R-squared	0.393576	S.D. dependent var	6.307915
S.E. of regression	4.912175	Akaike info criterion	6.099418
Sum squared resid	1085.826	Schwarz criterion	6.253853
Log likelihood	-145.4358	Hannan-Quinn criter.	6.158011
F-statistic	11.38420	Durbin-Watson stat	1.992808
Prob(F-statistic)	0.000011		

Japan

Null Hypothesis: JAPAN has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.590928	0.0408
Test critical values:	1% level	-4.152511	
	5% level	-3.502373	
	10% level	-3.180699	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(JAPAN)
Method: Least Squares
Date: 05/10/13 Time: 14:27
Sample (adjusted): 1962 2011
Included observations: 50 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
JAPAN(-1)	-0.422652	0.117700	-3.590928	0.0008
C	3.657700	1.276696	2.864974	0.0062
@TREND(1961)	-0.089899	0.035431	-2.537317	0.0145

R-squared	0.215633	Mean dependent var	-0.113761
Adjusted R-squared	0.182255	S.D. dependent var	2.956009
S.E. of regression	2.673097	Akaike info criterion	4.862477
Sum squared resid	335.8360	Schwarz criterion	4.977198
Log likelihood	-118.5619	Hannan-Quinn criter.	4.906164
F-statistic	6.460446	Durbin-Watson stat	1.877308
Prob(F-statistic)	0.003321		

Latin America & Caribbean

Null Hypothesis: LATIN_AMERICA___CARIBBEA has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.364949	0.3927
Test critical values:	1% level	-4.152511	
	5% level	-3.502373	
	10% level	-3.180699	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LATIN_AMERICA___CARIBBEA)
Method: Least Squares
Date: 05/10/13 Time: 14:29
Sample (adjusted): 1962 2011
Included observations: 50 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LATIN_AMERICA___CARIBBEA(-1)	-0.208946	0.088351	-2.364949	0.0222
C	2.564585	1.380910	1.857170	0.0696
@TREND(1961)	-0.020298	0.038190	-0.531494	0.5976

R-squared	0.113044	Mean dependent var	0.034453
Adjusted R-squared	0.075301	S.D. dependent var	4.049022
S.E. of regression	3.893592	Akaike info criterion	5.614666
Sum squared resid	712.5227	Schwarz criterion	5.729387
Log likelihood	-137.3666	Hannan-Quinn criter.	5.658352
F-statistic	2.995101	Durbin-Watson stat	1.738125
Prob(F-statistic)	0.059663		

USA

Null Hypothesis: UNITES_STATES_OF_AMERICA has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.354993	0.0696
Test critical values:	1% level	-4.156734	
	5% level	-3.504330	
	10% level	-3.181826	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(UNITES_STATES_OF_AMERICA)
Method: Least Squares
Date: 05/10/13 Time: 14:32
Sample (adjusted): 1963 2011
Included observations: 49 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
UNITES_STATES_OF_AMERICA(-1)	-0.302336	0.090115	-3.354993	0.0016
D(UNITES_STATES_OF_AMERICA(-1))	0.302764	0.138608	2.184323	0.0342
C	1.930431	0.702098	2.749517	0.0086
@TREND(1961)	-0.024234	0.017294	-1.401306	0.1680

R-squared	0.227782	Mean dependent var	0.041648
Adjusted R-squared	0.176300	S.D. dependent var	1.798675
S.E. of regression	1.632439	Akaike info criterion	3.896135
Sum squared resid	119.9186	Schwarz criterion	4.050570
Log likelihood	-91.45531	Hannan-Quinn criter.	3.954727
F-statistic	4.424557	Durbin-Watson stat	1.835258
Prob(F-statistic)	0.008263		

South Africa

Null Hypothesis: SOUTH_AFRICA has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.669776	0.7499
Test critical values:	1% level	-4.152511	
	5% level	-3.502373	
	10% level	-3.180699	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(SOUTH_AFRICA)
Method: Least Squares
Date: 05/10/13 Time: 14:30
Sample (adjusted): 1962 2011
Included observations: 50 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
SOUTH_AFRICA(-1)	-0.106582	0.063830	-1.669776	0.1016
C	1.468181	0.765794	1.917201	0.0613
@TREND(1961)	-0.019317	0.020828	-0.927463	0.3584

R-squared	0.081965	Mean dependent var	0.057863
Adjusted R-squared	0.042899	S.D. dependent var	2.148650
S.E. of regression	2.102057	Akaike info criterion	4.381834
Sum squared resid	207.6762	Schwarz criterion	4.496556
Log likelihood	-106.5459	Hannan-Quinn criter.	4.425521
F-statistic	2.098140	Durbin-Watson stat	1.715890
Prob(F-statistic)	0.134029		

Annex D: Augmented Dickey-Fuller Unit Root Test for the GDP Deflator

Argentina

Null Hypothesis: ARGENTINA has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.588509	0.0030
Test critical values:	1% level	-4.156734	
	5% level	-3.504330	
	10% level	-3.181826	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ARGENTINA)
Method: Least Squares
Date: 05/10/13 Time: 15:04
Sample (adjusted): 1963 2011
Included observations: 49 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ARGENTINA(-1)	-0.626153	0.136461	-4.588509	0.0000
D(ARGENTINA(-1))	0.330842	0.140703	2.351351	0.0231
C	135.7210	132.4864	1.024415	0.3111
@TREND(1961)	-0.558642	4.397387	-0.127040	0.8995

R-squared	0.319341	Mean dependent var	-0.236558
Adjusted R-squared	0.273964	S.D. dependent var	510.6874
S.E. of regression	435.1453	Akaike info criterion	15.06734
Sum squared resid	8520815.	Schwarz criterion	15.22178
Log likelihood	-365.1499	Hannan-Quinn criter.	15.12594
F-statistic	7.037470	Durbin-Watson stat	1.885974
Prob(F-statistic)	0.000559		

OECD

Null Hypothesis: HIGH_INCOME__OECD has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.314606	0.4184
Test critical values:	1% level	-4.156734	
	5% level	-3.504330	
	10% level	-3.181826	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(HIGH_INCOME__OECD)
Method: Least Squares
Date: 05/10/13 Time: 15:06
Sample (adjusted): 1963 2011
Included observations: 49 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
HIGH_INCOME__OECD(-1)	-0.157363	0.067987	-2.314606	0.0253
D(HIGH_INCOME__OECD(-1))	0.204271	0.142174	1.436767	0.1577
C	1.514929	0.692234	2.188465	0.0339
@TREND(1961)	-0.028042	0.015730	-1.782673	0.0814

R-squared	0.138381	Mean dependent var	-0.045955
Adjusted R-squared	0.080939	S.D. dependent var	1.374695
S.E. of regression	1.317887	Akaike info criterion	3.468045
Sum squared resid	78.15722	Schwarz criterion	3.622479
Log likelihood	-80.96709	Hannan-Quinn criter.	3.526637
F-statistic	2.409081	Durbin-Watson stat	1.991006
Prob(F-statistic)	0.079417		

India

Null Hypothesis: INDIA has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.879768	0.0013
Test critical values:	1% level	-4.152511	
	5% level	-3.502373	
	10% level	-3.180699	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INDIA)
Method: Least Squares
Date: 05/10/13 Time: 15:07
Sample (adjusted): 1962 2011
Included observations: 50 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INDIA(-1)	-0.647154	0.132620	-4.879768	0.0000
C	5.655864	1.492502	3.789518	0.0004
@TREND(1961)	-0.027484	0.035544	-0.773262	0.4432

R-squared	0.337318	Mean dependent var	0.116968
Adjusted R-squared	0.309119	S.D. dependent var	4.345716
S.E. of regression	3.612127	Akaike info criterion	5.464595
Sum squared resid	613.2307	Schwarz criterion	5.579317
Log likelihood	-133.6149	Hannan-Quinn criter.	5.508282
F-statistic	11.96196	Durbin-Watson stat	1.938438
Prob(F-statistic)	0.000063		

Japan

Null Hypothesis: JAPAN has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 7 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.068344	0.0135
Test critical values:	1% level	-4.186481	
	5% level	-3.518090	
	10% level	-3.189732	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(JAPAN)
Method: Least Squares
Date: 05/10/13 Time: 15:08
Sample (adjusted): 1969 2011
Included observations: 43 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
JAPAN(-1)	-1.162715	0.285796	-4.068344	0.0003
D(JAPAN(-1))	0.183820	0.255563	0.719274	0.4770
D(JAPAN(-2))	0.113542	0.241632	0.469896	0.6415
D(JAPAN(-3))	0.226081	0.227833	0.992307	0.3283
D(JAPAN(-4))	0.728878	0.225032	3.239000	0.0027
D(JAPAN(-5))	0.574232	0.222901	2.576177	0.0147
D(JAPAN(-6))	0.568375	0.188893	3.008975	0.0050
D(JAPAN(-7))	0.379457	0.152062	2.495404	0.0178
C	13.29514	3.490690	3.808742	0.0006
@TREND(1961)	-0.342695	0.090683	-3.779021	0.0006

R-squared	0.652819	Mean dependent var	-0.163700
Adjusted R-squared	0.558133	S.D. dependent var	4.848650
S.E. of regression	3.223048	Akaike info criterion	5.378956
Sum squared resid	342.8053	Schwarz criterion	5.788537
Log likelihood	-105.6476	Hannan-Quinn criter.	5.529997
F-statistic	6.894573	Durbin-Watson stat	2.107114
Prob(F-statistic)	0.000016		

Latin America & Caribbean

Null Hypothesis: LATIN_AMERICA___CARIBBEA has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.534364	0.3111
Test critical values:	1% level	-4.152511	
	5% level	-3.502373	
	10% level	-3.180699	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LATIN_AMERICA___CARIBBEA)
Method: Least Squares
Date: 05/10/13 Time: 15:10
Sample (adjusted): 1962 2011
Included observations: 50 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LATIN_AMERICA___CARIBBEA(-1)	-0.234942	0.092703	-2.534364	0.0147
C	2.697783	1.340764	2.012123	0.0500
@TREND(1961)	-0.018663	0.036389	-0.512863	0.6104

R-squared	0.126853	Mean dependent var	0.043289
Adjusted R-squared	0.089698	S.D. dependent var	3.887246
S.E. of regression	3.708811	Akaike info criterion	5.517424
Sum squared resid	646.4981	Schwarz criterion	5.632146
Log likelihood	-134.9356	Hannan-Quinn criter.	5.561111
F-statistic	3.414154	Durbin-Watson stat	1.883488
Prob(F-statistic)	0.041262		

South Africa

Null Hypothesis: SOUTH_AFRICA has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.798412	0.2047
Test critical values:	1% level	-4.152511	
	5% level	-3.502373	
	10% level	-3.180699	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(SOUTH_AFRICA)
Method: Least Squares
Date: 05/10/13 Time: 15:11
Sample (adjusted): 1962 2011
Included observations: 50 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
SOUTH_AFRICA(-1)	-0.266665	0.095292	-2.798412	0.0074
C	3.002064	1.270123	2.363600	0.0223
@TREND(1961)	-0.009508	0.034313	-0.277097	0.7829

R-squared	0.151498	Mean dependent var	0.134898
Adjusted R-squared	0.115391	S.D. dependent var	3.671778
S.E. of regression	3.453442	Akaike info criterion	5.374744
Sum squared resid	560.5341	Schwarz criterion	5.489466
Log likelihood	-131.3686	Hannan-Quinn criter.	5.418431
F-statistic	4.195855	Durbin-Watson stat	2.379540
Prob(F-statistic)	0.021055		

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Null Hypothesis: UNITES_STATES_OF_AMERICA has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.802484	0.2034
Test critical values:	1% level	-4.156734	
	5% level	-3.504330	
	10% level	-3.181826	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(UNITES_STATES_OF_AMERICA)
Method: Least Squares
Date: 05/10/13 Time: 15:13
Sample (adjusted): 1963 2011
Included observations: 49 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
UNITES_STATES_OF_AMERICA(-1)	-0.200615	0.071585	-2.802484	0.0075
D(UNITES_STATES_OF_AMERICA(-1))	0.284813	0.141291	2.015782	0.0498
C	1.246305	0.490927	2.538674	0.0147
@TREND(1961)	-0.018551	0.011546	-1.606747	0.1151

R-squared	0.194947	Mean dependent var	0.017588
Adjusted R-squared	0.141277	S.D. dependent var	1.130401
S.E. of regression	1.047513	Akaike info criterion	3.008822
Sum squared resid	49.37773	Schwarz criterion	3.163256
Log likelihood	-69.71613	Hannan-Quinn criter.	3.067414
F-statistic	3.632307	Durbin-Watson stat	1.799326
Prob(F-statistic)	0.019762		