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ANALYSIS OF THE DIFFERENCES BETWEEN THE RATES OF INFLATION ASSOCIATED WITH TWO AGGREGATE PRICE LEVEL

The case of the euro area and United States

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1. INTRODUCTION

This project focuses on two indicators of prices, the GDP deflator and the consumer price index (CPI), and analyzes the differences and similarities they present. These price indexes have been chosen taking into account its great representativeness and importance to economic and social level, and its direct relationship to the overall functioning of the economy and, in particular, inflation. It should be also mentioned that this study was conducted for cases of the euro area and the United States, as the impact of these economies in the economic and social situation at international level is very significant.

There are previous studies that made comparisons among various price indexes that are made in different economic zones such as the US and Australia. For example, Lane (2006) performed an analysis on the applicability of the methodology when calculating the harmonized price index that makes the European Central Bank (ECB) whis is applied to the US economy. Another example is the study of Miller (2011), which presents a study of the differences between the retail price index and consumer price index. Richards and Rosewall (2010), meanwhile, compared the measurements of core inflation in Australia subtracting changes in perishables and energy, with estimates that refer to an adjustment of the price index instability.Thus, although it has not developed any work that has tried to answer why the differences between inflation rates of the economies of the United States and the Euro zone, so this study provides genuine and relevant information.

This work is structured according to three main sections: a descriptive analysis, econometric analysis and conclusions.

Firstly, the evolution over time of the two above price indicators, their average values and deviations, the correlation, etc. is analyzed. Likewise, and based on the above, a comparative study of both economies inflation is made.

Secondly, using econometric techniques, econometric models will be estimated and studied (simple single equation models) through which it seeks to answer the question why the GDP deflator and CPI are different. So, some working hypothesis —relatively the economic cycle and the value of imports— will be presented and will be developed to determine whether or not they can answer that question. Similarly, possible similitudes and differences in the behaviour of the two economies they will work with, eurozone and the United States, will be beheld.

Finally, the conclusions of this study, where we can highlight in a very succinct way that the results show that the GDP deflator and the CPI have very different behavior caused in part by the influence of the price of imports which are presented, as CPI, unlike the GDP deflator, which is included in its calculation.

2. DESCRIPTIVE ANALYSIS

For the descriptive analysis, first, they have to define and explain the deflator terms of GDP, indexes of consumer prices (CPI), inflation and deflation, for which it has followed the definitions in Mankiw (2006).

The GDP deflator is a weighted average of prices relative to a base of all final goods and services produced that consumers demand in an economy, so that prices of imported goods and the goods are not included yearly intermediates. Therefore, the variation of this indicator, which is a Paasche index, to calculate and measure the average behaviour of prices of different goods and services produced in a country.

Deflator calculation is based on the following:

$$\text{GDP Deflator } = \frac{\text{Nominal GDP}}{\text{Real GDP}}.$$

As can be seen, the GDP deflator can be used to deflate nominal GDP and real GDP gain, since it reflects the general level of prices in the economy.

The CPI, meanwhile, is used to measure changes in the prices of goods and services representative of the expenditure on household consumption of a given region. To do this, 484 items, classified into 12 groups, which represent the price development of all consumer goods and services are selected. All these items are commonly called a shopping cart. Said cart excludes investments by these households, any expenditure operation imputed (consumption, imputed rent, wages in kind, subsidized consumption, etc.), intermediate goods and services, exported products, among other items.

To calculate the CPI for the period, Laspeyres index is used. To facilitate understanding of this index, please follow this example:

Suppose an economy where consumers who buy 3 sacks of potatoes and 4 loaves are analyzed. If the base year is 2005, the CPI would:

$$\text{CPI} = \frac{(\text{3 x current price of potatoes })+(\text{4 x current price of bread })}{(\text{3 x current price of potatoes in 2005})+(\text{4 x price of bread in 2005})}.$$

Thus, given that the CPI does not include the prices of intermediate consumption of enterprises or exported goods, it is limited to define a price level associated with the goods and services consumed by a representative consumer economic analysis.

Another important aspect in this work is the analysis of the inflation rate associated with the concepts of the GDP deflator and CPI.

In a market economy the prices of goods and services are subjects to change. Some increase and others decrease. There is talk of inflation as a general rise in prices occurs. As a result, fewer goods can be purchased and services for each euro or dollar spent, that is, the purchasing power is reduced due to this monetary[1] phenomenon. It is important to note that for the calculation of inflation rates are weighted, i.e. some articles that spending more, such as electricity, have greater weight than others that spent less, as is sugar.

Conversely, deflation is a general decline in the price level. This phenomenon is worrying from an economic point of view, because consumers can postpone their consumption decisions pending a sharper fall in prices, which will mean a significant loss of revenue for companies, which can lead to the bankruptcy of many of them and reduced economic activity, with corresponding consequences.

In general, recessions are accompanied by a decline in the price level, as consumers lose much of their income and corporations must reduce their prices in order to adapt them to the purchasing power of consumers. Also, this kind of economic phenomenon generates great uncertainty and distrust among the population.

Once these concepts, it is necessary to specify some of the methodological aspects of this study. So, first, it must be noted that for the graphical representation of the series of inflation obtained on the CPI and the GDP deflator were applied natural logarithms. Therefore, inflation rates have been calculated according to the following formula to express them in annualized percentage terms:

$$\pi_t = (\ln P_t - \ln P_{t-1}) * 4 * 100$$

Moreover, the data obtained from the various sources mentioned in the bibliography appeared with a seasonal component. Therefore, we have used the Census-X13 program to seasonally adjusted data. This process is necessary because the seasonal series have certain characteristics that may hinder the objective of the data analysis or skew the analysis performed, leading to errors. So, Pareja (2015) concrete some of these features usually including the time series.

i. The trend component, which are long-term movements in the series.

ii. The cyclical component, that is, periodic fluctuations in the medium and/or long around the trend caused by the general economic conditions.

iii. The seasonal component, which contains annual fluctuations around the trend, which are repeated monthly or quarterly over a period of one year. Among the factors that drive climate seasonal component, calendar (working days, movable feasts and holidays), the decision by the agents and their expectations...

They find that once defined those key concepts that are used throughout this study and commented on the most relevant methodological aspects that surround the analysis to be

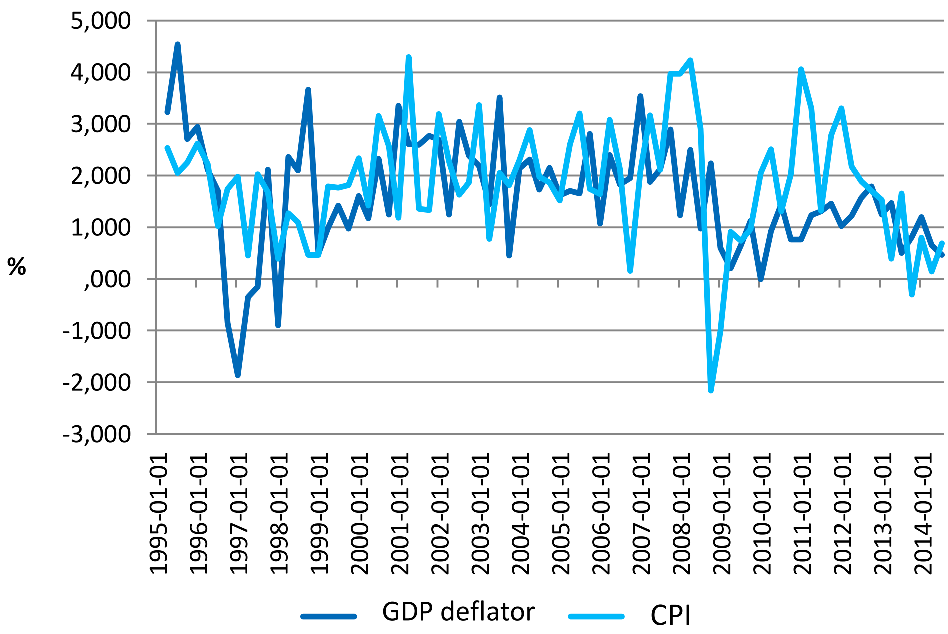
[1] Eurozone is the Harmonised In Index of Consumer Prices (HICP) in charge of measuring inflation in consumer prices since the harmonizing prices comparability of data between countries in the Euro Zone is guaranteed, as they will be calculated using the same methodology.

developed later, you can proceed with the descriptive analysis, to explore the causality of the two variables with which they work.

The euro area

In graph 1 you can see the important differences between the GDP deflator and the CPI for the eurozone collected for different periods, which at first glance does not appear to be a pattern of behavior among them.

Graph 1. Comparison of inflation rates associated with the GDP deflator and the CPI quarterly euro area from 1995 to 2014.



Source: Compiled from data from the European Central Bank.

Thus, the inflation rate of the GDP deflator has positive values almost throughout all periods considered, being the highest value recorded 4,53% in the third quarter of 1996. This contrasts with the negative data present to late 1996 and early 1997 and 1998. However, in the start of the deep recession that would begin globally in late 2008 – early 2009[2], it is clear that this indicator suffers a drop in their values, but in no time negative data is recorded.

Moreover, the CPI inflation rate has, like the one that is associated with the GDP deflator, a positive trend over time, finding just three semesters in which there was deflation. These correspond with the last quarter of 2008 (–2,16%) and the first of 2009 (–1,01%) —

[2] The economic and financial crisis that began in late 2008 originated in the United States, but acted as a trigger for vulnerabilities that were common to many countries and regions including the eurozone.

which coincide with the start of the economic crisis that has hit the euro area from then—fourth quarter of 2013 in which there was a weak deflation of –0.31%.

Another striking aspect is the inflation rate above 3% over different fiscal years, becoming close to or above 4% in the period before the outbreak of the economic crisis. This is particularly remarkable in these regions, as in the Eurozone (and the European Central Bank) there is a big commitment as far as inflation control and price stability is concerned.

On the behavior of the indicators and their volatility, it is remarkable as until 1999 the inflation rate of the GDP deflator showed more volatile securities-hence onward to stabilize, presenting a less accentuated peak. The rate of CPI inflation, meanwhile, showed some instability throughout all periods, but from 2009 to the beginning of the financial and economic crisis, the volatility of this indicator has been remarkable with major ups and downs.

One possible explanation for this behavior of the inflation rate of the CPI is that the consumption of imported products grew over the years, thus increasing its relevance to nationals. Moreover, in this same period the euro began to appreciate against the dollar, which made imported products were relatively cheaper and thus more competitive.

Finally, we have to analyze some statistical issues on both indicators naked eye cannot be determined graphically as the media are, the standard deviation or coefficient of variation as well as the correlation between these indicators and the autocorrelation or degree of persistence each one of them.

Table 1. Mean, standard deviation and coefficient of variation of inflation linked to the GDP deflator and the CPI for the euro area.

	GDP deflator	CPI
Mean	1,60	1,85
Standard deviation	1,11	1,15
Coefficient of variation	0,69	0,62

Source: Data from the European Central Bank calculations.

So you can see that the mean and standard deviation of the rate of CPI inflation are higher than the inflation rate of the GDP deflator, although there is a big difference between the two, the difference is only of 0,25 and 0,04, respectively. It has also been noted that the coefficients of variation, although they are not very high, they indicate that there is some heterogeneity between the values collected.

If the correlation between periods and, specifically, the contemporaneous correlation is analyzed, it can be seen that the value is 0,21434, i.e., the linear relationship between two variables is small, something that can be seen in the chart 1. Similarly, it occurs if the advanced correlations are analyzed and delayed, with the highest recorded value of 0,36225 for Y_{t-2} and X_t where X is the inflation rate and the GDP deflator and Y the rate of CPI inflation.

Table 2. Delayed Correlation between inflation rates associated with the GDP deflator and the CPI for the euro area.

$\rho(X_{t-8},Y_t)$	$\rho(X_{t-7},Y_t)$	$\rho(X_{t-6}, Y_t)$	$\rho(X_{t-5}, Y_t)$	$\rho(X_{t-4}, Y_t)$	$\rho(X_{t-3}, Y_t)$	$\rho(X_{t-2}, Y_t)$	$\rho(X_{t-1}, Y_t)$
0,00128	-0,04794	0,08017	0,06952	0,07139	0,19054	0,15227	0,20598

Source: Own elaboration.

Table 3. Contemporary Correlation between inflation rates associated to the GDP deflator and the CPI for the euro area.

$\rho(X_t, Y_t)$
0,21434

Source: Own elaboration.

Table 4. Correlation between forward inflation rates associated with the GDP deflator and the CPI for the euro area.

$\rho(Y_{t-1}, X_t)$	$\rho(Y_{t-2}, X_t)$	$\rho(Y_{t-3}, X_t)$	$\rho(Y_{t-4}, X_t$	$\rho(Y_{t-5}, X_t)$	$\rho(Y_{t-6}, X_t)$	$\rho(Y_{t-7}, X_t)$	$\rho(Y_{t-8}, X_t)$
0,21790	0,36225	0,14093	0,02109	0,11183	-0,00243	-0,07974	-0,07919

Source: Own elaboration.

Leaving aside the correlation among both indicators and focusing on the autocorrelation, it can be beheld how the inflation's persistence for both of the price's measurement is relatively low.

Table 5. Autocorrelation of inflation linked to the GDP deflator for the euro area.

$\rho(X_{t-8},X_t)$	$\rho(X_{t-7},X_t)$	$\rho(X_{t-6}, X_t)$	$\rho(X_{t-5}, X_t)$	$\rho(X_{t-4}, X_t)$	$\rho(X_{t-3}, X_t)$	$\rho(X_{t-2}, X_t)$	$\rho(X_{t-1}, X_t)$
–0,12531	–0,15007	–0,16946	–0,07943	0,16514	0,19418	0,45298	0,37997

Source: Own elaboration.

Table 6. Autocorrelation of inflation associated with the CPI for the euro area.

$\rho(Y_{t-8},Y_t)$	$\rho(Y_{t-7},Y_t)$	$\rho(Y_{t-6}, Y_t)$	$\rho(Y_{t-5}, Y_t)$	$\rho(Y_{t-4}, Y_t)$	$\rho(Y_{t-3}, Y_t)$	$\rho(Y_{t-2}, Y_t)$	$\rho(Y_{t-1}, Y_t)$
–0,13199	–0,06109	–0,18249	–0,19102	–0,02421	0,21755	0,09586	0,35751

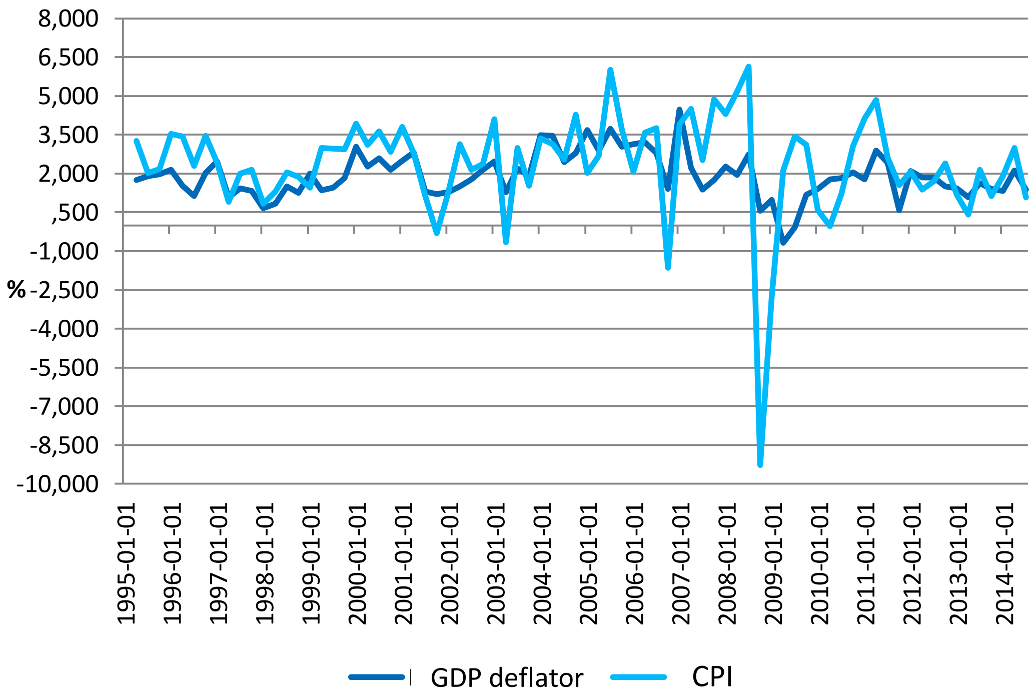
Source: Own elaboration.

The United States

In this section, as it was done previously with the euro area, a graphical analysis will be studied, the average, standard deviation and coefficient of variation, plus correlation and autocorrelation, the similarities and differences between the two indicators of inflation.

Thus, in graph 2 these similarities, or rather the differences-that offer inflation rates in the GDP deflator and the CPI over time are analyzed.

Graph 2. Comparison of the inflation rates of the GDP deflator and the CPI quarterly United States from 1995 to 2014.



Source: Compiled from the data of Federal Reserve Bank of St. Louis.

The inflation rate of the GDP deflator has positive values throughout all periods analyzed, with the exception of 2009, in which there was a significant fall reaching values around –1%.

In contrast, the rate of CPI inflation has shown a fairly steady trend over time, but usually the values of this measure of inflation have been positive. Noteworthy is the period between late 2008 and early and mid-2009, because in the first case the higher value of the entire series was recorded, while in 2009 —coinciding with the start of the economic and financial crisis worldwide— there was a collapse of the CPI inflation rate of about 15 percentage points, bringing its values to around –10%.

It has also been mentioned that the very different behaviour of both series have shown inflation as to volatility concerns. This difference between them can be attributed to the price of imported products, since the CPI for products from abroad are valued. Thus, an increase in imported products will increase the values of the CPI, but the GDP deflator will not experience any change. They are imported and these cause these differences between the two measures of inflation analyzed and, most likely, these differences are caused by changes occurred in the exchange rates products.

As for table 7, one can distinguish the data corresponding to the average, standard deviation and coefficient of variation of inflation rates in the GDP deflator and the CPI.

Table 7. Mean, standard deviation and coefficient of variation of inflation rates in the GDP deflator and the CPI United States.

	GDP deflator	CPI
Mean	1,91	2,33
Standard deviation	0,86	2,03
Coefficient of variation	0,45	0,87

Source: Compiled from the data of Federal Reserve Bank of St. Louis.

Thus, the mean and standard deviation of CPI inflation rate is higher than the inflation rate of the GDP deflator, there is a noticeable difference between the two variables. Also noteworthy is the significant differences between the standard deviations and coefficients of variation of the two measures of inflation, with the rate associated with very high CPI inflation, indicating that the CPI inflation rate has increased volatility.

Moreover, the correlation between both variables is significantly higher than in the three cases considered in the euro zone (table 2, 3 and 4), i.e., changes in one of the US variables affect moving the other more than in the euro area.

Table 8. Delayed correlation between inflation rates in the GDP deflator and the CPI United States.

$\rho(X_{t-8},Y_t)$	$\rho(X_{t-7},Y_t)$	$\rho(X_{t-6}, Y_t)$	$\rho(X_{t-5}, Y_t)$	$\rho(X_{t-4}, Y_t)$	$\rho(X_{t-3}, Y_t)$	$\rho(X_{t-2}, Y_t)$	$\rho(X_{t-1}, Y_t)$
–0,06699	–0,27856	0,13680	0,19983	0,13023	0,14884	0,08909	0,09674

Source: Own elaboration.

Table 9. Contemporaneous correlation between inflation rates in the GDP deflator and the CPI United States.

$\rho(X_t, Y_t)$
0,49284

Source: Own elaboration.

Table 10. Correlation between forward inflation rates in the GDP deflator and the CPI United States.

$\rho(Y_{t-1}, X_t)$	$\rho(Y_{t-2}, X_t)$	$\rho(Y_{t-3}, X_t)$	$\rho(Y_{t-4}, X_t$	$\rho(Y_{t-5}, X_t)$	$\rho(Y_{t-6}, X_t)$	$\rho(Y_{t-7}, X_t)$	$\rho(Y_{t-8}, X_t)$
0,24306	0,37578	0,26867	–0,04497	–0,04777	0,00290	–0,11910	–0,13264

Source: Own elaboration.

The contemporaneous correlation between inflation rates in the GDP deflator and the CPI is 0,4921, that is, the linear relationship between two variables is small, although higher than in the euro area.

Finally, having both indicators autocorrelation decreases as considered furthest from the delay time t. This situation occurs for both variables, although persistence is considerably higher for the inflation rate of the GDP deflator, unlike what happened in the eurozone, where persistence is similar for both measures of inflation.

Table 11. Autocorrelation of inflation in the GDP deflator United States.

$\rho(X_{t-8},X_t)$	$\rho(X_{t-7},X_t)$	$\rho(X_{t-6}, X_t)$	$\rho(X_{t-5}, X_t)$	$\rho(X_{t-4}, X_t)$	$\rho(X_{t-3}, X_t)$	$\rho(X_{t-2}, X_t)$	$\rho(X_{t-1}, X_t)$
0,020592	–0,00672	0,23873	0,19983	0,28799	0,367692	0,42035	0,50280

Source: Own elaboration.

Table 12. Autocorrelation of inflation in the CPI United States.

$\rho(Y_{t-8},Y_t)$	$\rho(Y_{t-7},Y_t)$	$\rho(Y_{t-6}, Y_t)$	$\rho(Y_{t-5}, Y_t)$	$\rho(Y_{t-4}, Y_t)$	$\rho(Y_{t-3}, Y_t)$	$\rho(Y_{t-2}, Y_t)$	$\rho(Y_{t-1}, Y_t)$
–0,13264	–0,07869	0,05920	0,04577	–0,15261	–0,06641	–0,12348	0,18484

Source: Own elaboration.

3. ECONOMETRIC ANALYSIS

The objective of this analysis is to check using econometric techniques if the business cycle and prices of imports can explain the differences found between both indicators of inflation.

Thus, it will leave specific models that have been developed specifically for this study, but, as these models of Vera should be tailored to meet specific requirements to be imposed, that is, the models will be modified to throughout the procedure in order to improve their skills and their representativeness explanatory around looking to study phenomena.

To understand this analysis more easily several previous sections explaining some of the most important and complex calculations of this process, to further deepen the proper econometric calculations are presented.

The theory of stationary

Time series econometrics encounters a problem when measuring the relationship between those variables that have a temporary trend. This problem may involve significant, what are considered completely spurious relationships.

The variables that have no defined time trend are called "stationary". So, one can say that a series is stationary when its average value is stable. In contrast, the variable is not stationary when it systematically increases or decreases over time. Regression estimates with non-stationary variables are spurious unless they are cointegrated[3].

Algebraically, it is said that a time series x_t is stationary (weakly) if:

$$E(x_t) = cte. \quad \forall t$$

$$Var(x_t) = cte. \quad \forall t$$

$$Cov(x_t, x_{t-k}) = cte. \quad \forall t$$

There are several methods to analyze whether a series is stationary or not, among which may be mentioned the following:

i. Visual analysis. It is to observe if, -correlogram graphic level, periodogram, etc., the variable increase / decrease monotonically, if shocks are persistent or if, on the

[3] Two nonstationary variables are cointegrated when a linear combination thereof is stationary (i.e., regress error terms of one variable on the other are stationary). In this case, estimates of the parameters that describe the linear relationship between nonstationary variables are superconsistentes.

contrary, you can not establish a definite pattern of behavior. The disadvantage of this process is that it gives final results. (Montero, 2013)

ii. Test Dicky-Fuller (ADF test). The ADF test allows, unlike other methods to discriminate a non-stationary series of a stationary series with a time trend. It also has the advantage that the null hypothesis is not whether the series is not stationary, but if you have a unit root. (Dickey-Fuller, 1979)

iii. Dickey-Fuller test modified (DF-GLS test). The results of this test have many similarities to the ADF test, although it differs in that automatically includes a trend, which in turn makes the specification is different.

iv. B of Bartlett, Q of Pormateau, and Z of Phillips-Perron. The first two tests mentioned work on the null hypothesis that the variable is stationary, while the third H_0 is that the series is composed of order 1.

All test described are inefficient in the case of structural change, that is a stationary series with structural change may appear as stationary and vice versa. (Montero, 2013).

For this study, all methods considered, is to make the Dickey-Fuller test increased, given the advantages it presents. It is therefore important to define in greater extent is this test and its main features.

Dickey-Fuller (ADF)

Test Dickey-Fuller built a parametric correction for higher order correlation assuming that the series follows an AR (p) and the addition of p lagged terms of the first difference dependent variable. Thus, the ADF test involves estimating the following equation:

$$\Delta y_t = \alpha + \gamma\, y_{t-1} + \delta_1\, \Delta y_{t-1} + \delta_2\, \Delta y_{t-2} + \ldots + \delta_{p-1}\, \Delta y_{t-p+1} + \varepsilon_t,$$

Where, $y_t = y_t - y_{t-1}$, α is a constant, p is the order of the autoregressive lag, and the coefficients δ are the coefficients of the explanatory variables and εt is the error term. Moreover, this contrast considers the following hypotheses:

H_0: $\gamma = 0$, the series has a unit root and, therefore, is not stationary.

H_1: $\gamma < 0$, the series has no unit root and, therefore, is stationary.

It is important to note that lags in the equation are included in order to capture the entire dynamic structure in the endogenous variable and this way, to have assured that the term is autocorrelated disturbance ε_t.[4] Therefore, it is important to decide the number of lags included in the test. One way to decide the number of lags is used to enter the number of lags that minimize the Akaike Information Criterion (AIC) or Bayesian Information Criterion

[4] It is necessary that the error term is white noise to take for valid analysis.

Schwarz.[5] In addition, correlogram must check the error term of the test to verify that these are white noise, since otherwise is to increase the number of lags including as many as needed.

Estimation procedure stationary time series

Once it has checked the model with which you are working is stationary or can not proceed with its estimate. Thus, Montero (2013) distinguishes the following cases to define the estimation algorithm:

i. If the series are stationary, it is estimated by OLS or MLG.

ii. If the series are not stationary in order distinct from each other, it can not estimate the relationship between the two.

iii. If the series are not stationary in the same order but are not cointegrated, it can not be estimated because the relationship between them is spurious regression. You can try seasonally adjusted series or regress by first differences and the result will indicate if the correlation exists or not.

iv. If the series are not stationary but are cointegrated, you can perform an OLS regression to estimate the MLG or long-term effects and the error correction model to estimate the short term.

In this particular study, you will work with a stationary model and therefore, OLS estimates will be made as below will.

Analysis of the stationarity of the series

As previously mentioned, you need to determine if the model that is going to work is stationary or not, so that is to be applied —and analyze—the unit root Dickie-Fuller the series which are arranged.[6]

[5] The Akaike Information Criterion (AIC) and Bayesian Information Criteria Schwarz (BIC) are two measures of the relative quality of two or more statistical models given a set of data, i.e., none of the two approaches provides a As the quality of the models in an absolute sense. Therefore, if all candidate models do not explain correctly the phenomena studied, the AIC and BIC will not give any warning. As such, the AIC and BIC provide a means for selecting between models, driving a trade-off between the goodness of fit and complexity, that is, you can increase the likelihood of a model by adding parameters, but this can result in overshooting. Both the AIC as the BIC solve this problem by introducing a penalty term to the number of parameters in the model-the penalty term is larger than the BIC in the AIC. Thus, both are based on information entropy, ie a relative estimate of the loss information is provided when a specific model is used to represent the process that generates the data. (Akaike, 1977; Schwarz, 1978).

[6] To Perform the calculations for stationarity, autocorrelation, etc. e-views the program is used throughout the study.

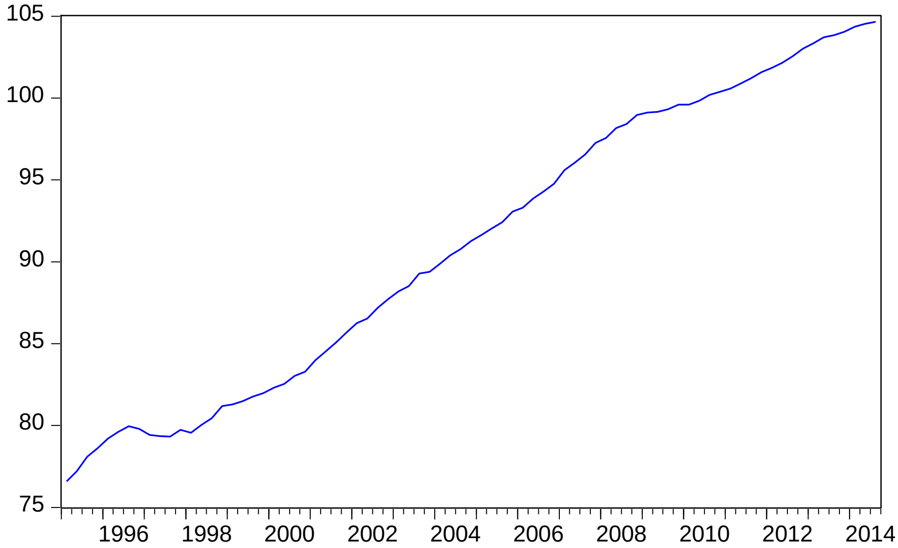
To facilitate relevant analyzes and smooth data collected defined the following relationship:

$$\pi_t = (\ln P_t - \ln P_{t-1}) * 4 * 100$$

The euro area

Before starting with the analysis of the stationarity of the series through the ADF test is interesting, and important, to see the trend behavior the series in question.

Graph 3. GDP deflator euro area.



Source: data from the European Central Bank calculations.

Thus, one can see no problem as the trend GDP deflator is deterministic (or non-stochastic) and, in this case, this tendency is increasing over the time.

That which can be passed to check the stationarity, the order of integration of the time series analyzed, the autocorrelation... For this, as already mentioned above, the unit root test of Dickey-Fuller will take place.[7]

Table 13. Test ADF inflation rate of GDP deflator in the euro area.

Null Hypothesis: DEFLACTORSEAADJEU has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic - based on SIC, maxlag=11)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.461569	0.3459

[7] The e-views automatically introduce such number of lags and differences that improve the goodness of fit of the model it.

Test critical values:	1% level	-4.085092
	5% level	-3.470851
	10% level	-3.162458

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DEFLACTORSEAADJEU)
Method: Least Squares
Sample (adjusted): 1996Q1 2014Q3
Included observations: 75 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DEFLACTORSEAADJEU(-1)	-0.065431	0.026581	-2.461569	0.0163
D(DEFLACTORSEAADJEU(-1))	0.171766	0.116413	1.475486	0.1446
D(DEFLACTORSEAADJEU(-2))	0.399290	0.107964	3.698369	0.0004
D(DEFLACTORSEAADJEU(-3))	0.090640	0.117928	0.768602	0.4448
C	5.036354	1.990291	2.530461	0.0137
@TREND(1995Q1)	0.025729	0.010452	2.461514	0.0163

R-squared	0.288431	Mean dependent var	0.347067
Adjusted R-squared	0.236868	S.D. dependent var	0.225944
S.E. of regression	0.197379	Akaike info criterion	-0.330765
Sum squared resid	2.688132	Schwarz criterion	-0.145366
Log likelihood	18.40367	Hannan-Quinn criter.	-0.256737
F-statistic	5.593771	Durbin-Watson stat	1.989179
Prob(F-statistic)	0.000220		

Source: Data from the European Central Bank calculations.

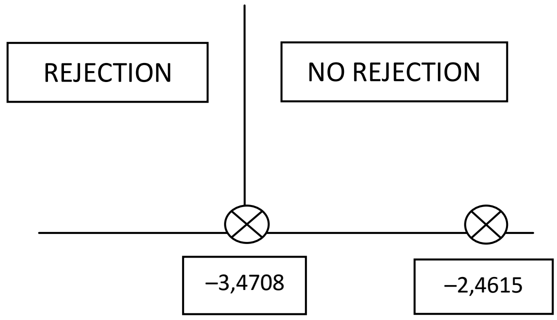
While referring to the table 13 can be seen as using the data on the variation of the GDP deflator for the eurozone, we have obtained an auxiliary regression in which this indicator as a dependent variable and explanatory variables are constant, the variable delayed period, the trend and three additional lags of the dependent variable.

As can be seen, the third delay introduced in the model is not significant, since 0,4448 is greater than 0,05. However, this delay model is not removed, as it has been included in order to avoid a possible problem of autocorrelation.

The problem of autocorrelation is more serious than the fact that there is no significant delay, since the latter would lose the test power, as in this case, but the problem of autocorrelation invalidates the model.

To avoid the presence of autocorrelation the Durbin-Watson must be between 1,85 and 2,15 and, as anticipated above, this model does not present problems of autocorrelation, as the value of this statistic is 1,989179. Thus, one can conclude that the contrast of this equation is valid.

Once all these issues are viewed, you can find out if they are stationary or not displaying the following graph:



Clearly -3,4708 is less than -2,4615, indicating that it has to reject the null hypothesis that indicates that the model is non-stationary. From another perspective, but with similar results, the p-value is 0,3459, the value that is greater than the preset level of significance (0,05), then we do not reject H_0. The series has a unit root, therefore it is not stationary.

Then, to solve the problem of the non-stationarity of the model is going to proceed to differentiate the model and apply again the ADF test to this series, following the same procedure explained above. However, this time will not be added a variable trend, as the trend disappears to be differentiated the series.

Table 14. ADF test for the inflation rate of the GDP deflator of the euro area (first difference).

Null Hypothesis: D(DEFLACTORSEAADJEU) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.629480	0.0073
Test critical values:	1% level	-3.519050	
	5% level	-2.900137	
	10% level	-2.587409	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DEFLACTORSEAADJEU,2)
Method: Least Squares
Sample (adjusted): 1995Q4 2014Q3
Included observations: 76 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DEFLACTORSEAADJEU(-1))	-0.441505	0.121644	-3.629480	0.0005
D(DEFLACTORSEAADJEU(-1),2)	-0.365382	0.105553	-3.461610	0.0009

C	0.146546	0.049710	2.948033	0.0043

R-squared	0.446545	Mean dependent var	-0.010000
Adjusted R-squared	0.431382	S.D. dependent var	0.265456
S.E. of regression	0.200171	Akaike info criterion	-0.340612
Sum squared resid	2.925007	Schwarz criterion	-0.248609
Log likelihood	15.94325	Hannan-Quinn criter.	-0.303843
F-statistic	29.44941	Durbin-Watson stat	1.988764
Prob(F-statistic)	0.000000		

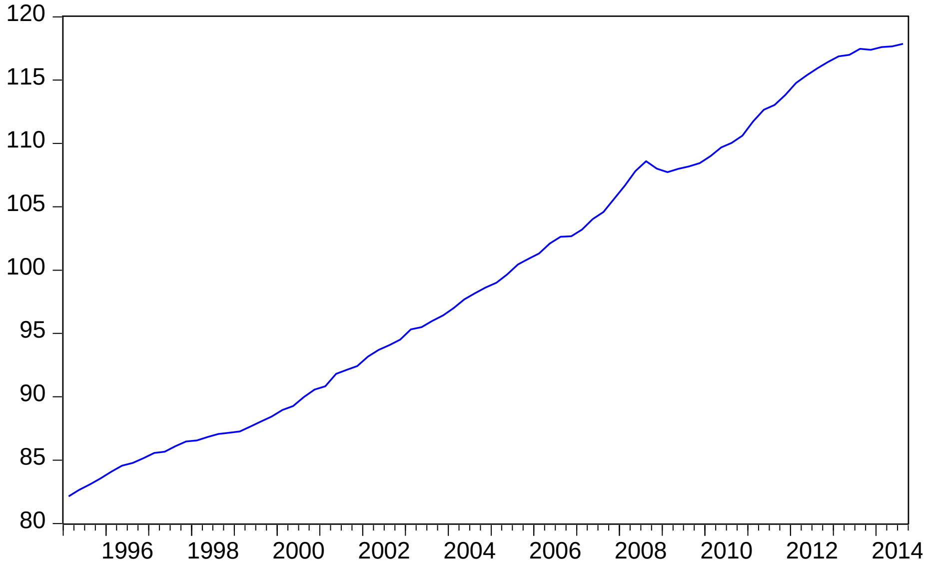
Source: Calculations based on data from the European Central Bank.

The variable that figures as a dependent is the first difference of the GDP deflator and appear as independent variables constant and variable a delayed period, in addition to an additional delay.

On this occasion, you get it to reject the null hypothesis of unit root —0,0073 is less than the predetermined level of significance 0,05—and, therefore, the series is stationary in first differences, then it is integrable order 1.

In the same way as has developed this analysis for the GDP deflator, it is also necessary to conduct the relevant analysis for the CPI. Thus, as in the case above, it is to start with the trend analysis of the behaviour of the series in question.

Graph 4. IPC of the euro area.



Source: Calculations based on data from the European Central Bank.

In this graph you can see clearly the deterministic trend you follow, as the GDP deflator, is growing.

Once you have seen the graph, and using the same steps as in the previous case, you can proceed to analyze the following table.

Table 15. ADF test for the level of inflation of the IPC in the euro area.

Null Hypothesis: IPCSEADJEU has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.526296	0.3150
Test critical values:	1% level	-4.081666	
	5% level	-3.469235	
	10% level	-3.161518	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(IPCSEADJEU)
Method: Least Squares
Sample (adjusted): 1995Q3 2014Q3
Included observations: 77 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
IPCSEADJEU(-1)	-0.081412	0.032226	-2.526296	0.0137
D(IPCSEADJEU(-1))	0.410579	0.104512	3.928532	0.0002
C	6.736454	2.568853	2.622359	0.0106
@TREND(1995Q1)	0.040584	0.015848	2.560850	0.0125

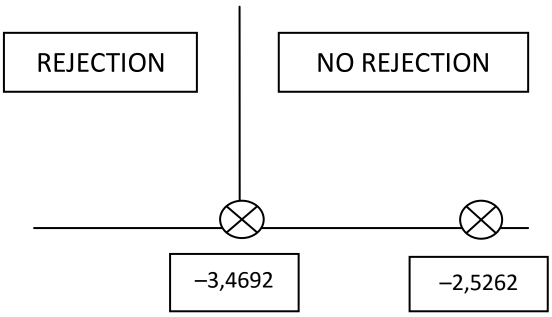
R-squared	0.224648	Mean dependent var	0.457181
Adjusted R-squared	0.192784	S.D. dependent var	0.303081
S.E. of regression	0.272304	Akaike info criterion	0.286752
Sum squared resid	5.412898	Schwarz criterion	0.408509
Log likelihood	-7.039969	Hannan-Quinn criter.	0.335454
F-statistic	7.050269	Durbin-Watson stat	2.011195
Prob(F-statistic)	0.000316		

Source: Calculations based on data from the European Central Bank.

In this table is defined as dependent variable the CPI and the explanatory variables constant, the variable of a delayed period, the trend and an additional delay of the dependent variable —which is significant—.

In regard to the test of Durbin-Watson statistic, this is within the limits laid down in order to assert that in this model there is no autocorrelation, so the contrast is valid.

The next step is to study the stationarity of the model and how they can appreciate it is not possible to reject the null hypothesis, which states that the series has unit root and, therefore, is not stationary (0,3150 > 0,05 or –3,4692 < –2,5262). In other words, the probability of making the wrong decision if it rejects H_0 is higher than what you are willing to allow, then we do not reject, so that the series is not stationary.



The same way as was done in the case of the GDP deflator, it is necessary to differentiate the variable, then applying the Dickey-Fuller test increased.

Table 16. ADF test for the rate of CPI inflation in the euro area (first difference)[8].

Null Hypothesis: D(IPCSEADJEU) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.676596	0.0000
Test critical values:	1% level	-3.517847	
	5% level	-2.899619	
	10% level	-2.587134	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(IPCSEADJEU,2)
Method: Least Squares
Sample (adjusted): 1995Q3 2014Q3
Included observations: 77 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(IPCSEADJEU(-1))	-0.605559	0.106676	-5.676596	0.0000
C	0.275207	0.058691	4.689102	0.0000

[8] From now on it will represent only the tables definitely provide the stationary model, that is, as the similar process in all cases, those models that really provide the information needed to advance the study being be shown developing.

R-squared	0.300528	Mean dependent var	-0.004167
Adjusted R-squared	0.291202	S.D. dependent var	0.333282
S.E. of regression	0.280590	Akaike info criterion	0.321789
Sum squared resid	5.904820	Schwarz criterion	0.382667
Log likelihood	-10.38886	Hannan-Quinn criter.	0.346139
F-statistic	32.22374	Durbin-Watson stat	1.968188
Prob(F-statistic)	0.000000		

Source: Calculations based on data from the European Central Bank.

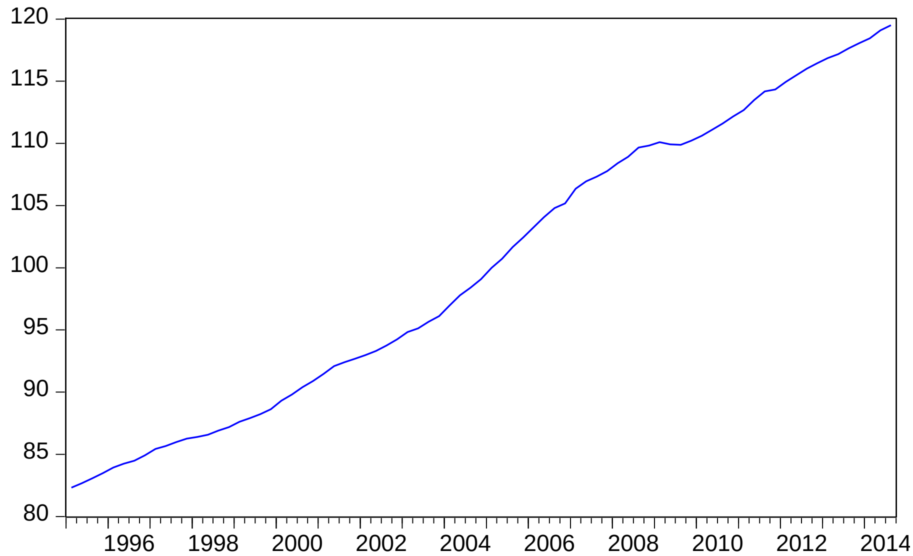
In this case, one can observe how the variable explained is the first difference of the CPI series, now being the independent variables constant and a delay of the dependent variable.

With this, it has obtained a series stationary, or what is the same, has been accepted the alternative hypothesis once the test has been performed with a difference.

The United States

Continuing with the analysis of the stationarity, in the US case it came to begin, as has been done so far, with a study of the trend of the series.

Graph 5. Deflactor of PIB in the United States.



Source: Calculations based on data from Federal Reserve Bank of St. Louis.

The trend of the US GDP deflator, as expected, it is deterministic, still this growing trend.

Then proceed to analysis of the stationarity of the series that, as explained above, will be based on the analysis of the final model, which in this case is consistent with the model that has been applied the first difference.

Table 17. ADF test for the inflation rate of the GDP deflator for the United States (first difference).

Null Hypothesis: D(DEFLACTUSASEADJ) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.992817	0.0001
Test critical values:	1% level	-3.517847	
	5% level	-2.899619	
	10% level	-2.587134	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DEFLACTUSASEADJ,2)
Method: Least Squares
Sample (adjusted): 1995Q3 2014Q3
Included observations: 77 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DEFLACTUSASEADJ(-1))	-0.497771	0.099697	-4.992817	0.0000
C	0.238398	0.052592	4.532937	0.0000

R-squared	0.249461	Mean dependent var	0.000623
Adjusted R-squared	0.239454	S.D. dependent var	0.224536
S.E. of regression	0.195817	Akaike info criterion	-0.397646
Sum squared resid	2.875810	Schwarz criterion	-0.336768
Log likelihood	17.30937	Hannan-Quinn criter.	-0.373295
F-statistic	24.92822	Durbin-Watson stat	2.022542
Prob(F-statistic)	0.000004		

Source: Calculations based on data from Federal Reserve Bank of St. Louis.

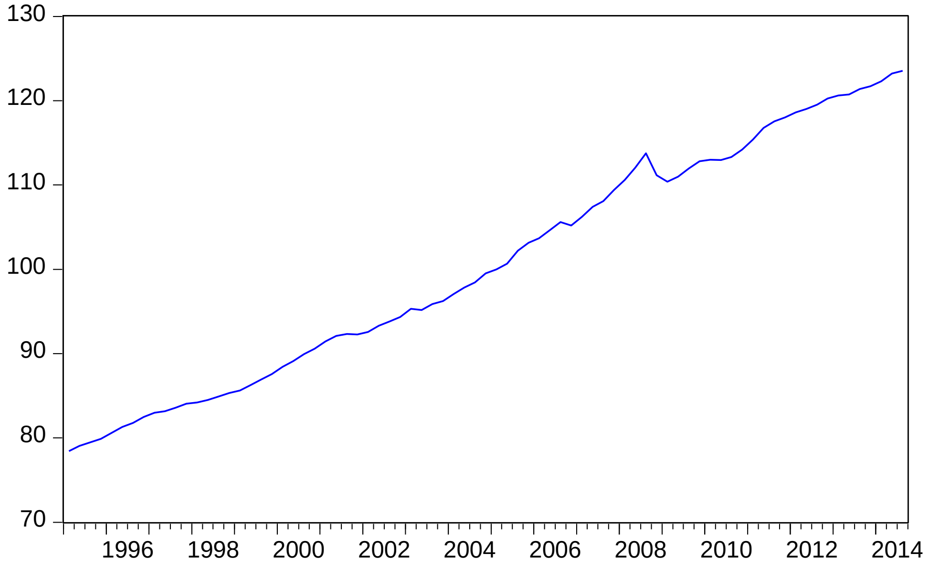
Also, to perform the analysis of the series of the GDP deflator is defined as dependent variable the first difference of the series and as explanatory variables appear the constant and a delay of the dependent variable.

In addition, there are no problems of autocorrelation in this model (1,85 < 2,022542 < 2,15), then it is concluded that it is a valid model to work with it.

Finally, there is a steady model (0,0001 < 0,05), having resolved the problem of non-stationarity that is given before applying the first difference.

Once commented out all these issues about the US GDP deflator, has been to focus on its CPI, thus developing again the corresponding trend analysis, and autocorrelation stationarity.

Graph 6. IPC of the United States.



Source: Calculations based on data from Federal Reserve Bank of St. Louis.

The tendency of the CPI in the USA is similar to that of its GDP deflator and equal to the trend of these same two indicators in the European case, i.e. the trend is deterministic, specifically increasing.

In terms of the model used to study the stationarity, this defined as variable explained the difference of the first series of the CPI and the explanatory variables constant, and a delay of the dependent variable.

Table 18. ADF test for the rate of CPI inflation in the United States (first difference).

Null Hypothesis: D(IPCSEAADJUSAUSA) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.223528	0.0000
Test critical values:	1% level	-3.517847	
	5% level	-2.899619	
	10% level	-2.587134	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(IPCSEAADJUSAUSA,2)
Method: Least Squares
Date: 05/05/15 Time: 15:33
Sample (adjusted): 1995Q3 2014Q3
Included observations: 77 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(IPCSEAADJUSAUSA(-1))	-0.821765	0.113762	-7.223528	0.0000
C	0.473952	0.090834	5.217803	0.0000

R-squared	0.410282	Mean dependent var	-0.003961
Adjusted R-squared	0.402419	S.D. dependent var	0.706481
S.E. of regression	0.546134	Akaike info criterion	1.653725
Sum squared resid	22.36965	Schwarz criterion	1.714603
Log likelihood	-61.66840	Hannan-Quinn criter.	1.678075
F-statistic	52.17936	Durbin-Watson stat	1.927040
Prob(F-statistic)	0.000000		

Source: Calculations based on data from Federal Reserve Bank of St. Louis.

As you can see, there are no problems of autocorrelation in the model with a difference and, in addition, this is stationary (0.0000 < 0.05).

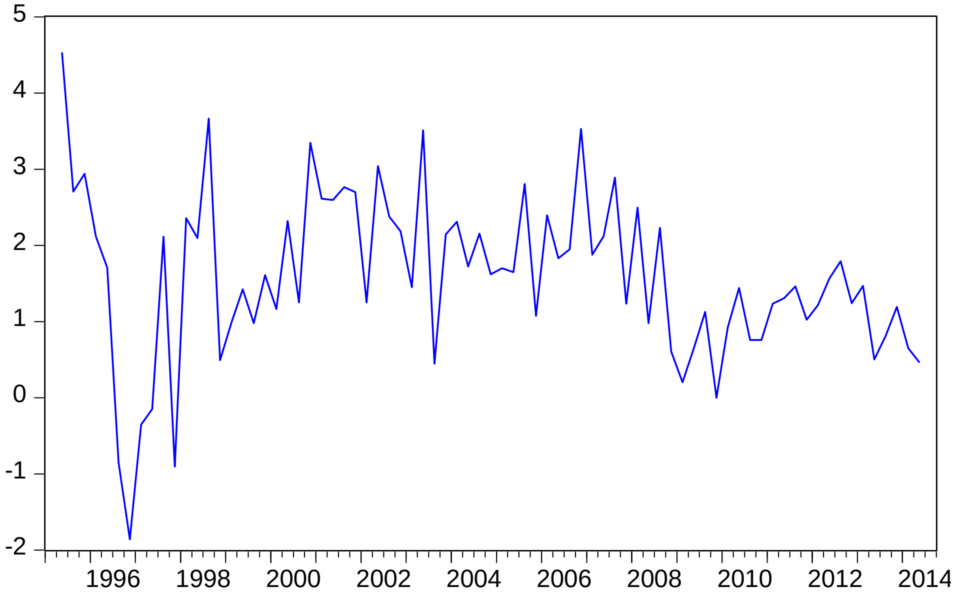
In the final analysis, if you have account in the analysis that has been done for both the US and the eurozone for both indicators, similar results were obtained, so that all the series involved in this analysis are integrable of order 1.

Difference between the rates of inflation of the price indicators

All the econometric analysis with which it has worked so far considered separately both the GDP deflator as the CPI. However, it is also important to know if the difference between the rates of inflation associated with both, or either, $\Pi_{DPIB} - \pi_{IPC}$, is stationary or if, on the contrary, it is not. This relationship has been defined of that will be of great significance in the study, since in subsequent analysis it will be used to test certain hypothesis of why there are differences between the two indicators studied.

In such a way, this difference for the European case would be graphically represented as follows.

Graph 7. Difference between the rates of inflation of the GDP deflator and CPI for the euro area.



Source: Calculations based on data from the European Central Bank.

In regard to the analysis of the autocorrelation and stationarity of the model used, this is contained in table 19.

Table 19. ADF test of the difference between the rates of inflation of the GDP deflator and CPI for the euro area.

Null Hypothesis: INFLACION_EU has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.598071	0.0080
Test critical values:	1% level	-3.520307	
	5% level	-2.900670	
	10% level	-2.587691	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INFLACION_EU)
Method: Least Squares
Sample (adjusted): 1995Q4 2014Q2
Included observations: 75 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.

INFLACION_EU(-1)	-0.443630	0.123297	-3.598071	0.0006
D(INFLACION_EU(-1))	-0.355296	0.104962	-3.384988	0.0012
C	0.641616	0.222605	2.882305	0.0052

R-squared	0.427527	Mean dependent var	-0.029956
Adjusted R-squared	0.411625	S.D. dependent var	1.216698
S.E. of regression	0.933275	Akaike info criterion	2.738945
Sum squared resid	62.71218	Schwarz criterion	2.831644
Log likelihood	-99.71042	Hannan-Quinn criter.	2.775958
F-statistic	26.88511	Durbin-Watson stat	1.957189
Prob(F-statistic)	0.000000		

Source: Calculations based on data from the European Central Bank.

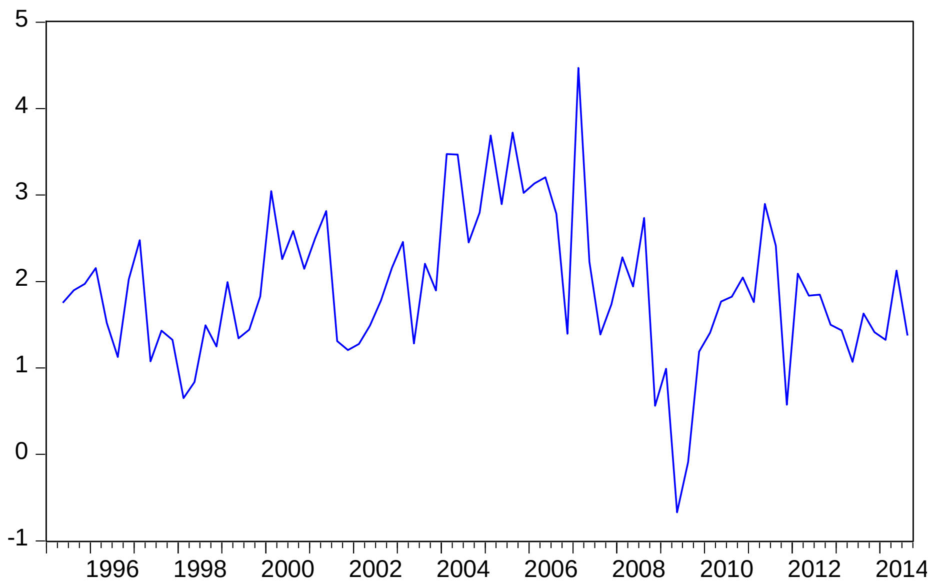
In this model, whose variable explained is the difference between the rates of inflation of the GDP deflator and the CPI of the eurozone and whose independent variable is the dependent variable of a delayed period, to what there is to add an additional delay.

In the statistic of Durbin-Watson statistic problems of autocorrelation are no longer visible, because the value of the statistical is within preset limits.

In terms of the stationarity, you can mention that it accepts the alternative hypothesis, i.e., the difference between these two measures of the rate of inflation is stationary (given that the p-value 0,0080 is less than 0,05).

In the US case, highlights the following chart for the same difference between the two indicators of the rate of inflation.

Graph 8. Difference between the rates of inflation of the GDP deflator and CPI for United States.



Source: Calculations based on data from Federal Reserve Bank of St. Louis.

In regard to table 20, it is presented as dependent variable in the model the difference between the rates of inflation of the GDP deflator and CPI for USA and as explanatory variables of the same a constant and variable explained a delayed period.

Table 20. ADF test of the difference between the rates of inflation of the GDP deflator and CPI for United States.

Null Hypothesis: INFLACION______USA has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.957920	0.0001
Test critical values:	1% level	-3.517847	
	5% level	-2.899619	
	10% level	-2.587134	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INFLACION______USA)
Method: Least Squares
Sample (adjusted): 1995Q3 2014Q3
Included observations: 77 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INFLACION______USA(-1)	-0.496018	0.100045	-4.957920	0.0000
C	0.946926	0.210499	4.498490	0.0000

R-squared	0.246844	Mean dependent var	-0.004937
Adjusted R-squared	0.236802	S.D. dependent var	0.866981
S.E. of regression	0.757405	Akaike info criterion	2.307793
Sum squared resid	43.02465	Schwarz criterion	2.368671
Log likelihood	-86.85003	Hannan-Quinn criter.	2.332144
F-statistic	24.58097	Durbin-Watson stat	2.021291
Prob(F-statistic)	0.000004		

Source: Calculations based on data from Federal Reserve Bank of St. Louis.

In addition, there are no problems detected in this autocorrelation and, to be the p-value (0,0001) lower than 0,05, it can be said that the model is stationary.

Therefore, the results obtained in the augmented Dickey-Fuller tests of the difference between the rates of inflation of the GDP deflator and CPI for both economies (tables 19 and 20) it can be concluded that the series involved in these analyzes are integrable of order 0, I(0).

In the next section these results will be used in greater depth, as it has been pointed out above, watching as well if the economic cycle affects the differences existing between the two indicators.

Subsequently it will also be the case if the fact that the CPI include imports can be motivating these differences between the two indicators, although in this paragraph shall not require the results obtained in the tables 17, 18, 19 and 20.

Analysis of the economic cycle

Economic cycles are recurrent fluctuations that occur in the economies and that affect the growth rates of output, employment and various macroeconomic variables. We can say that a cycle is composed of four phases: trough, expansion, peak and recession. It is not possible to establish the duration of each of the stages, since each cycle varies and presents some characteristics, causes and consequences different from those of other previous or subsequent cycles in time.

Thus, one of the possible causes of the differences between the price indicators analyzed in this work which may be the economic cycle —another possible cause are imports that will be analyzed later—.

To verify this assertion, it will then conduct a regression with differences in inflation rates associated with the two indicators of the overall level of prices used in this study to the case of the eurozone, on the one hand, and the USA, on the other.

It should be taken into account that at all time series have a number of components such as: the long-term trend, the seasonality in the short term (variations in periods of less than a year) and medium-term cycles (variations in periods of more than a year but less than eight or ten years).

In order to raise that regression and represent such components the following equations will be used:

(1) $Y_t = \alpha + \beta\, t + \Upsilon\, t^2 + \mu_t$, being Y_t the GDP, a constant α, t the time variable, β and Υ the coefficients associated with the explanatory variables that define the linear and quadratic components of the long-term trend, respectively; and μ_t is the cyclical component (error term).[9]

[9] The error term, which is not the part explained by a model, reflects that there are other variables that may explain the dependent variable in the model you are working with, but which are not listed in this at that time. The GDP, to be a variable considered in the course of time, it has a trend component and a cyclical component. Thus, equation (1) has the trend variable as an explanatory variable, but not the same thing happens with the economic cycle, which is not as an independent variable. Then, the error term of this relationship is consistent with the economic cycle.

(2) $\Pi_{DPIB,\,t} - \pi_{IPC,\,t} = \lambda + \delta\,\mu_t + \varepsilon_t$, where Π_{DPIB} is the inflation rate of the GDP deflator, π_{IPC} is the rate of CPI inflation, λ is the constant, μ_t is the component cyclical[10], δ is the coefficient of the independent variable and ε_t estimation error.

As has been pointed out above, the rate of quarterly inflation in both indicators of the general level of prices is stationary, as well as the difference between the rates of inflation.

Under these premises, and with the equations to use already defined, then the analysis to determine if the evolution of the economic cycle affects or not the difference between the rates of inflation of the GDP deflator and the CPI.

Table 21. Estimate of the cyclical component of GDP.

Dependent Variable: GDPEUS_AADJ
Method: Least Squares
Date: 05/16/15 Time: 14:49
Sample: 1995Q1 2014Q3
Included observations: 79

Variable	Coefficient	Std. Error	t-Statistic	Prob.
T	0.396069	0.019035	20.80705	0.0000
t_2	-0.000127	0.000231	-0.551228	0.5831
C	75.48922	0.329956	228.7858	0.0000

R-squared	0.988845	Mean dependent var	91.06253
Adjusted R-squared	0.988552	S.D. dependent var	8.906142
S.E. of regression	0.952926	Akaike info criterion	2.778677
Sum squared resid	69.01321	Schwarz criterion	2.868656
Log likelihood	-106.7577	Hannan-Quinn criter.	2.814725
F-statistic	3368.632	Durbin-Watson stat	0.060790
Prob(F-statistic)	0.000000		

Source: Own elaboration.

In the table 21 can be seen, as its name indicates, the estimate of the first of the equations that have been defined. This estimate could be commenting on many issues (the meaningfulness of the coefficients, the multicollinearity caused by the variable t^2, the value of the statistics, etc.), however, what is most important for this study are the errors obtained such an estimate, which will be included as an independent variable in the second equality.

So, once removed that information and inserted in the following equation, you can proceed to its estimate by OLS.

[10] The errors obtained in (1), which represent the cyclical component, are used as an independent variable in (2). In such a way, (2) seeks to demonstrate that the differences between the rates of variation of both indicators can be explained through the cyclical component.

Table 22. OLS estimate of the difference between the rates of inflation of the GDP deflator and the CPI.

Dependent Variable: TASADEFLAEUSADJ-INFLACION_EU
Method: Least Squares
Date: 05/16/15 Time: 14:59
Sample (adjusted): 1995Q2 2014Q2
Included observations: 77 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESTEND	0.070333	0.149183	0.471457	0.6387
C	0.333796	0.138881	2.403464	0.0187

R-squared	0.002955	Mean dependent var	0.334372
Adjusted R-squared	-0.010339	S.D. dependent var	1.212380
S.E. of regression	1.218631	Akaike info criterion	3.258964
Sum squared resid	111.3796	Schwarz criterion	3.319842
Log likelihood	-123.4701	Hannan-Quinn criter.	3.283315
F-statistic	0.222271	Durbin-Watson stat	1.410987
Prob(F-statistic)	0.638683		

Source: Own elaboration.

This estimate as the dependent variable sets the difference between the rates of inflation of the GDP deflator and the CPI, using a constant as regressors and the error term of the prior regression (restend), which measures the cyclical component of GDP once eliminated the trend component of the same. The latter variable is not significant at the 5% level of significance. Therefore, it can be concluded that the economic cycle does not explain the difference between the rates of inflation associated with the price indexes analyzed.

On the other hand, it is going to proceed to adjust an autoregressive process to the difference between the two rates of inflation, that is to say, is going to return the difference between the two rates of inflation on a constant and the first four lags of the same difference. All this will allow us to draw if the difference between the two rates of inflation is a persistent problem in the time, or in other words, if the future behaviour of the difference in the rates of inflation contemporary explained in part by the past behavior of the same.

Table 23. Autoregressive process of the difference between the rates of inflation of the GDP deflator and CPI for the euro area.

Dependent Variable: DIFTASASEU
Method: Least Squares
Date: 05/19/15 Time: 14:55
Sample (adjusted): 1996Q2 2014Q2
Included observations: 73 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.

C	-0.239533	1.012621	-0.236547	0.8137
DIFTASASEU(-1)	0.593756	0.120556	4.925147	0.0000
DIFTASASEU(-2)	0.270028	0.138789	1.945597	0.0558
DIFTASASEU(-3)	0.212700	0.138527	1.535445	0.1293
DIFTASASEU(-4)	-0.071920	0.123380	-0.582920	0.5619

R-squared	0.992924	Mean dependent var	-98.36008
Adjusted R-squared	0.992508	S.D. dependent var	10.73970
S.E. of regression	0.929576	Akaike info criterion	2.757858
Sum squared resid	58.75957	Schwarz criterion	2.914739
Log likelihood	-95.66181	Hannan-Quinn criter.	2.820378
F-statistic	2385.632	Durbin-Watson stat	2.017801
Prob(F-statistic)	0.000000		

Source: Own elaboration.

Seeing the results obtained for the case of the eurozone, it is possible to say that the difference between the rates of inflation of the GDP deflator and the CPI is persistent in time, that is to say, the difference between the two contemporary measures of the rate of inflation has been explained by past differences, then also explain the differences future.

Similarly, it is necessary to perform this analysis for the case of the United States.

Table 24. Autoregressive process of the difference between the rates of inflation of the GDP deflator and CPI for United States.

Dependent Variable: DIFTASASUSA
Method: Least Squares
Date: 05/19/15 Time: 14:59
Sample (adjusted): 1996Q2 2014Q2
Included observations: 73 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.907260	1.113735	-0.814610	0.4181
DIFTASASUSA(-1)	0.512963	0.121273	4.229800	0.0001
DIFTASASUSA(-2)	0.457430	0.136301	3.356025	0.0013
DIFTASASUSA(-3)	0.007740	0.136020	0.056900	0.9548
DIFTASASUSA(-4)	0.022161	0.120206	0.184359	0.8543

R-squared	0.991772	Mean dependent var	-100.1300
Adjusted R-squared	0.991288	S.D. dependent var	13.10782
S.E. of regression	1.223452	Akaike info criterion	3.307265
Sum squared resid	101.7848	Schwarz criterion	3.464146
Log likelihood	-115.7152	Hannan-Quinn criter.	3.369785
F-statistic	2049.139	Durbin-Watson stat	2.001771
Prob(F-statistic)	0.000000		

Source: Own elaboration.

Observing the result of the autoregressive process can be obtained US conclusions similar to those of the European case, or the difference between the rates of inflation of the GDP deflator and the CPI is persistent in time.

In the final analysis, this analysis of the possible influence of the economic cycle on the difference between the two indicators has been negative, i.e., δ is not significant in any of the two areas, which implies that the economic cycle is not responsible and cannot explain the difference between these two measures of the rate of inflation.

The next step is, as has been already discussed, to find out if the imports can explain this difference between the two measures of the rate of inflation, that the economic cycle cannot explain, because imports are included in the CPI, which doesn't happen in the case of the GDP deflator, which considers only the goods produced in the interior of the economy.

Analysis of imports

This new analysis will be developed through the estimation of a model in which we evaluate the influence of the price of imports into the difference between the rates of inflation indicators associated with both the general price level. Algebraically:

(3) $\Pi_{DPIB,\,t} - \pi_{IPC,\,t} = \lambda + \delta\, I_t + u_t,$

where Π_{DPIB} is the inflation rate of the GDP deflator, π_{IPC} is the rate of CPI inflation, λ is a constant, it is the index of prices of imports, δ is the coefficient of the independent variable and ut is the random disturbance.[11]

This model, as will be seen later, has some drawbacks that should be corrected to comply with the assumptions in the desirable estimate by ordinary least squares.

Having said that, you can then proceed with the analysis of the explanatory power of the prices of imports on the difference between the two measures of the rate of inflation studied.

<u>The euro area</u>

The first step to check the possible effect of imports on the differences between the studied indexes is to estimate the model that has been raised—model (3)—.

Table 25. OLS estimation of the static model of the euro area.

Dependent Variable: DIFTASASEU
Method: LeastSquares
Date: 06/09/15 Time: 16:20
Sample (adjusted): 1995Q2 2014Q2

[11] Given the characteristics of this model, from here on will be referred to as "static model".

Includedobservations: 77 afteradjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
IMPINDEEU	-1.310048	0.052831	-24.79719	0.0000
C	35.36006	5.373617	6.580309	0.0000

R-squared	0.891289	Mean dependentvar	-97.48209
Adjusted R-squared	0.889839	S.D. dependentvar	11.11524
S.E. of regression	3.689202	Akaikeinfocriterion	5.474328
Sum squaredresid	1020.766	Schwarzcriterion	5.535206
Log likelihood	-208.7616	Hannan-Quinncriter.	5.498679
F-statistic	614.9007	Durbin-Watson stat	0.214868
Prob(F-statistic)	0.000000		

Source: Calculations based on data from the European Central Bank.

The dependent variable on this table is the difference among the rates of inflation of the GDP deflator and the CPI and the explanatory variables are a constant and the index of prices of imports. Also, you can appreciate how this model presents problems of autocorrelation of the error term, as the value of the statistical of Durbin-Watson statistic is outside of the established goals and functions for the case.

This fact can be seen in a more graphic form on the following table of autocorrelations.

Table 26. Autocorrelations of the error term from the static model of the euro area.

Date: 06/09/15 Time: 16:28
Sample: 1995Q2 2014Q2
Includedobservations: 77

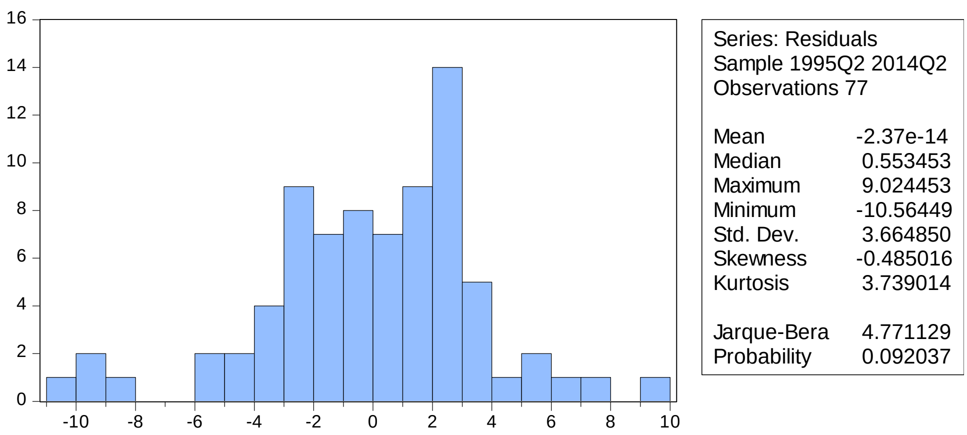
<table>
<tr><th>Autocorrelation</th><th>PartialCorrelation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |******|</td><td>. |******|</td><td>1</td><td>0.882</td><td>0.882</td><td>62.278</td><td>0.000</td></tr>
<tr><td>. |***** |</td><td>***| . |</td><td>2</td><td>0.681</td><td>-0.437</td><td>99.897</td><td>0.000</td></tr>
<tr><td>. |*** |</td><td>.*| . |</td><td>3</td><td>0.455</td><td>-0.125</td><td>116.93</td><td>0.000</td></tr>
<tr><td>. |** |</td><td>.*| . |</td><td>4</td><td>0.223</td><td>-0.165</td><td>121.07</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>5</td><td>0.028</td><td>0.027</td><td>121.14</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>. |*. |</td><td>6</td><td>-0.092</td><td>0.110</td><td>121.87</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>**| . |</td><td>7</td><td>-0.186</td><td>-0.209</td><td>124.87</td><td>0.000</td></tr>
<tr><td>**| . |</td><td>. | . |</td><td>8</td><td>-0.239</td><td>0.029</td><td>129.89</td><td>0.000</td></tr>
<tr><td>**| . |</td><td>.*| . |</td><td>9</td><td>-0.265</td><td>-0.103</td><td>136.16</td><td>0.000</td></tr>
<tr><td>**| . |</td><td>. | . |</td><td>10</td><td>-0.263</td><td>0.067</td><td>142.42</td><td>0.000</td></tr>
<tr><td>**| . |</td><td>.*| . |</td><td>11</td><td>-0.264</td><td>-0.167</td><td>148.86</td><td>0.000</td></tr>
<tr><td>**| . |</td><td>. | . |</td><td>12</td><td>-0.252</td><td>0.016</td><td>154.80</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>. |*. |</td><td>13</td><td>-0.204</td><td>0.151</td><td>158.75</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>. |*. |</td><td>14</td><td>-0.116</td><td>0.105</td><td>160.05</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>15</td><td>-0.025</td><td>-0.042</td><td>160.11</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>. |*. |</td><td>16</td><td>0.090</td><td>0.110</td><td>160.92</td><td>0.000</td></tr>
</table>

. |*. |	. | . |	17	0.184	-0.054	164.35	0.000
. |** |	. |*. |	18	0.253	0.112	170.93	0.000
. |** |	. | . |	19	0.291	-0.014	179.80	0.000
. |** |	. |*. |	20	0.319	0.129	190.67	0.000
. |** |	. | . |	21	0.314	-0.017	201.37	0.000
. |** |	. | . |	22	0.288	0.011	210.55	0.000
. |** |	. | . |	23	0.250	0.062	217.62	0.000
. |*. |	.*| . |	24	0.200	-0.068	222.23	0.000
. |*. |	. | . |	25	0.128	0.018	224.13	0.000
. | . |	. | . |	26	0.053	-0.033	224.47	0.000
. | . |	. | . |	27	-0.020	0.046	224.52	0.000
.*| . |	. |*. |	28	-0.072	0.086	225.16	0.000
.*| . |	.*| . |	29	-0.120	-0.119	226.98	0.000
.*| . |	**| . |	30	-0.179	-0.207	231.11	0.000
**| . |	. | . |	31	-0.237	-0.010	238.52	0.000
**| . |	.*| . |	32	-0.296	-0.137	250.34	0.000

Source: Calculations based on data from the European Central Bank.

As you can see, the problem of autocorrelation is evident, but another issue that is of interest is whether the error term of this model respect the hypothesis of normality, for which it is applied the Jarque-Bera test.

Graph 9. Jarque-Bera test of the error term from the static model of the euro area.



Source: Calculations based on data from the European Central Bank.

The graphical representation of the test for normality of the Jarque-Bera error term estimate shows as, clearly, these behave as a normal distribution.

Another of the supposed desirables for this model —more specifically for the term of disturbance— is the one concerning the homoscedasticity. The fact that the disturbance is homocedastica implies that the variance of the same is kept constant in time, i.e., var $[u_t]$ = E $[u_t^2] = \sigma^2 \; \forall t = 1, \ldots, n$. In the event that it is not checked the indicated, there is a need to affirm that there is a problem of heteroscedasticity.

Table 27. Heteroscedasticity test the error term of the static model of the euro area.

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.262637	Prob. F(1,75)	0.6098
Obs*R-squared	0.268700	Prob. Chi-Square(1)	0.6042
Scaledexplained SS	0.349119	Prob. Chi-Square(1)	0.5546

Test Equation:
Dependent Variable: RESID^2
Method: LeastSquares
Date: 06/09/15 Time: 16:29
Sample: 1995Q2 2014Q2
Includedobservations: 77

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	29.77127	32.32380	0.921033	0.3600
IMPINDEEU	-0.162862	0.317790	-0.512482	0.6098

R-squared	0.003490	Mean dependentvar	13.25670
Adjusted R-squared	-0.009797	S.D. dependentvar	22.08366
S.E. of regression	22.19158	Akaikeinfocriterion	9.062933
Sum squaredresid	36934.95	Schwarzcriterion	9.123811
Log likelihood	-346.9229	Hannan-Quinncriter.	9.087284
F-statistic	0.262637	Durbin-Watson stat	0.399237
Prob(F-statistic)	0.609820		

Source: Calculations based on data from the European Central Bank.

Given that 0,6042 is greater than the significance level of the preset 5%, you can accept H_0, or, the disturbance is homocedastica.

Now, the same way as these have been carried out analysis for the eurozone, has been to study the US case.

The United States

In this case, the order to be followed in the analysis will be the same, i.e. estimation by OLS and study of the autocorrelation, normality and homoscedasticity of the term of disturbance of the model.

Thus, you can proceed with the first of the steps.

Table 28. OLS estimation of the static model of United States.

Dependent Variable: DIFTASASUSA
Method: LeastSquares
Date: 06/09/15 Time: 16:18
Sample (adjusted): 1995Q2 2014Q2
Includedobservations: 77 afteradjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
USAINDE2005B	-0.922560	0.050181	-18.38459	0.0000
C	-2.811251	5.270579	-0.533386	0.5953

R-squared	0.818399	Mean dependentvar	-98.91219
Adjusted R-squared	0.815978	S.D. dependentvar	13.79489
S.E. of regression	5.917709	Akaikeinfocriterion	6.419407
Sum squaredresid	2626.446	Schwarzcriterion	6.480285
Log likelihood	-245.1472	Hannan-Quinncriter.	6.443757
F-statistic	337.9930	Durbin-Watson stat	0.164357
Prob(F-statistic)	0.000000		

Source: Calculations based on data from Federal Reserve Bank of St. Louis.

In this model, the dependent variable and independent are already known, presents problems of autocorrelation, because the statistical of Durbin-Watson statistic is not within the band 1,85 and 2,15, then there is evidence of positive autocorrelation. It is also remarkable the meaningfulness of the explanatory variable index of prices of imports (0,0000 < 0,05), although the already mentioned autocorrelation overshadows this fact.

This phenomenon can be viewed on table 29, which represents the evolution of the autocorrelations corresponding to this case.

Table 29. Autocorrelations of the error term from the static model of United States.

Date: 06/10/15 Time: 15:28
Sample: 1995Q2 2014Q2
Includedobservations: 77

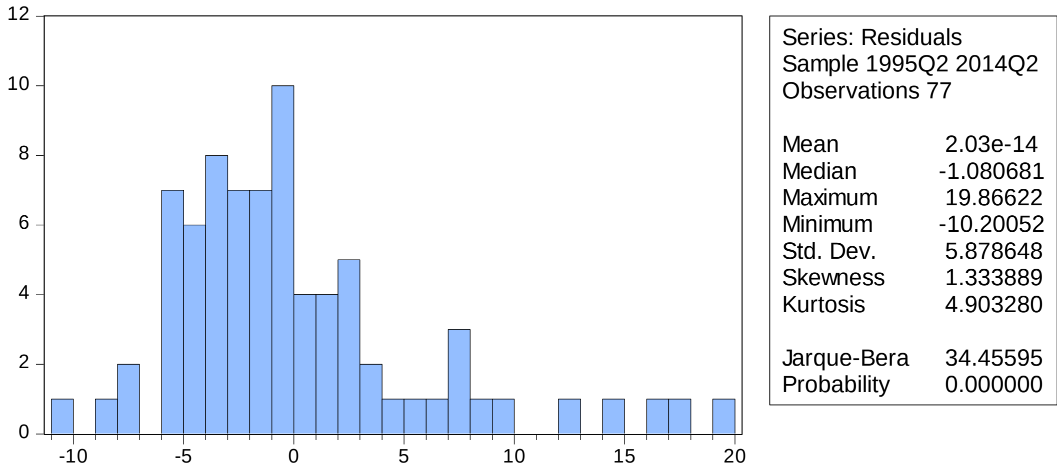
Autocorrelation	PartialCorrelation		AC	PAC	Q-Stat	Prob
. |******|	. |******|	1	0.838	0.838	56.166	0.000
. |***** |	.*| . |	2	0.662	-0.132	91.759	0.000
. |**** |	. | . |	3	0.512	-0.018	113.34	0.000
. |*** |	. | . |	4	0.401	0.026	126.75	0.000
. |** |	. | . |	5	0.312	-0.013	134.97	0.000
. |** |	. |*. |	6	0.274	0.110	141.41	0.000
. |** |	. | . |	7	0.236	-0.043	146.25	0.000
. |*. |	.*| . |	8	0.168	-0.114	148.74	0.000
. |*. |	. |*. |	9	0.133	0.099	150.33	0.000

<table>
<tr><td>. |*. |</td><td>. | . |</td><td>10</td><td>0.104</td><td>-0.031</td><td>151.30</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>. |*. |</td><td>11</td><td>0.107</td><td>0.099</td><td>152.35</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>.*| . |</td><td>12</td><td>0.088</td><td>-0.089</td><td>153.07</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>13</td><td>0.072</td><td>-0.007</td><td>153.57</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>14</td><td>0.051</td><td>0.008</td><td>153.81</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>15</td><td>0.045</td><td>0.036</td><td>154.01</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>16</td><td>0.030</td><td>-0.040</td><td>154.11</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>17</td><td>0.018</td><td>-0.012</td><td>154.14</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>18</td><td>0.008</td><td>-0.018</td><td>154.14</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>19</td><td>-0.022</td><td>-0.049</td><td>154.19</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>20</td><td>-0.059</td><td>-0.051</td><td>154.57</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>. | . |</td><td>21</td><td>-0.090</td><td>-0.012</td><td>155.46</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>22</td><td>-0.140</td><td>-0.141</td><td>157.62</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>23</td><td>-0.204</td><td>-0.077</td><td>162.32</td><td>0.000</td></tr>
<tr><td>**| . |</td><td>. | . |</td><td>24</td><td>-0.232</td><td>0.033</td><td>168.52</td><td>0.000</td></tr>
<tr><td>**| . |</td><td>. | . |</td><td>25</td><td>-0.239</td><td>-0.004</td><td>175.23</td><td>0.000</td></tr>
<tr><td>**| . |</td><td>. | . |</td><td>26</td><td>-0.245</td><td>-0.045</td><td>182.40</td><td>0.000</td></tr>
<tr><td>**| . |</td><td>. | . |</td><td>27</td><td>-0.222</td><td>0.060</td><td>188.37</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>. | . |</td><td>28</td><td>-0.170</td><td>0.066</td><td>191.94</td><td>0.000</td></tr>
</table>

Source: Calculations based on data from Federal Reserve Bank of St. Louis.

In regard to the normality of residuals, graph 10 is very illustrative, because we can easily see how the term disturbance follows a normal distribution.

Graph 10. Jarque-Bera test of the error term from the static model of United States.



Source: Calculations based on data from Federal Reserve Bank of St. Louis.

Finally, it comes to make the last of analysis discussed above, or the relative to the homoscedasticity of the term of disturbance.

Table 30. Heteroscedasticity test the error term of the static model of United States.

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.244740	Prob. F(1,75)	0.2681
Obs*R-squared	1.257070	Prob. Chi-Square(1)	0.2622
Scaledexplained SS	2.327556	Prob. Chi-Square(1)	0.1271

Test Equation:
Dependent Variable: RESID^2
Method: LeastSquares
Date: 06/10/15 Time: 15:29
Sample: 1995Q2 2014Q2
Includedobservations: 77

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	100.8507	60.31673	1.672018	0.0987
USAINDE2005B	-0.640707	0.574276	-1.115679	0.2681

R-squared	0.016326	Mean dependentvar	34.10969
Adjusted R-squared	0.003210	S.D. dependentvar	67.83147
S.E. of regression	67.72252	Akaikeinfocriterion	11.29435
Sum squaredresid	343975.5	Schwarzcriterion	11.35522
Log likelihood	-432.8323	Hannan-Quinncriter.	11.31870
F-statistic	1.244740	Durbin-Watson stat	0.174045
Prob(F-statistic)	0.268122		

Source: Calculations based on data from Federal Reserve Bank of St. Louis.

For the case of the United States, is that the model presents homoscedasticity, because 0,2622 is greater than 0,05, which implies not reject the null hypothesis.

As it has been seen so far, both the model selected for the case of the euro area and for the case of the United States, met with the assumptions of normality and homoscedasticity of error term. However, disruptions are correlation serial.[12] This is a major problem for analysis, the fact that there is autocorrelation in the model is overridden.

Thus, the next step in this study is based on solving this problem to see if actually the price index for imports can explain the difference between the two indices are considered.

Correction of autocorrelation.

To cope with the problem of autocorrelation which presents the first model considered —equation (3)—, you are working with a new model that include as many lags as

12 $cov\ [u_i\ u_j] = E\ [u_i\ u_j] = 0\ \forall i \neq j$ con $i = 1, \ldots, n$ y $j = 1, \ldots, n$.

necessary so as to achieve enclosed disturbances and the meaningfulness of the index variable of prices of imports. In such way, the model to estimate would be the following:

$$(4) \qquad \partial\pi_t \equiv \Pi_{DPIB} - \pi_{IPC} = \alpha + \beta_1 (\partial\pi_{t-1}) + \beta_2 (\partial\pi_{t-2}) + \ldots + \beta_k (\partial\pi_{t-k}) + \Upsilon I_t + \varepsilon_t,$$

being Π_{DPIB} the inflation rate of the GDP deflator, π_{IPC} the inflation rate of CPI, $\partial\pi_t$ the difference between the two rates of inflation, a constant α, I_t the index of prices of imports, β and Υ the coefficients of the independent variables and ε_t stocastic disturbance.[13]

Once submitted this relationship, you can proceed to develop the relevant analysis, which are similar to those made so far. In such a way, the first step is to estimate by ordinary least squares and, continuing with the structure followed so far, it will begin with the case of the euro area.

Table 31. OLS estimation of the dynamic model of the euro area.

Dependent Variable: DIFTASASEU
Method: LeastSquares
Date: 06/16/15 Time: 17:05
Sample (adjusted): 1996Q1 2014Q2
Includedobservations: 74 afteradjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
IMPORINDEXEU	-0.159460	0.033546	-4.753415	0.0000
DIFTASASEU(-1)	0.390721	0.110326	3.541506	0.0007
DIFTASASEU(-2)	0.251232	0.117091	2.145620	0.0354
DIFTASASEU(-3)	0.254410	0.105757	2.405601	0.0188
C	5.283856	1.464688	3.607496	0.0006

R-squared	0.994755	Mean dependentvar	-98.14677
Adjusted R-squared	0.994451	S.D. dependentvar	10.82258
S.E. of regression	0.806223	Akaikeinfocriterion	2.472264
Sum squaredresid	44.84970	Schwarzcriterion	2.627944
Log likelihood	-86.47377	Hannan-Quinncriter.	2.534367
F-statistic	3271.374	Durbin-Watson stat	2.020269
Prob(F-statistic)	0.000000		

Source: Calculations based on data from the European Central Bank.

Table 31 presents as variably explained the difference between the rates of inflation of the GDP deflator and the CPI —as expected— and as explanatory variables constant, the price index for imports and three lags.

Worthy of note is the fact that the index variable of prices of imports is significant, but it is worth noting that there have been needed three lags to eliminate the problems of autocorrelation in the existing modelo (3).[14]

13 Given the characteristics of this model, from here on will be referred to as "dynamic model".

This fact can be viewed with greater ease in table 32, where you can observe the behaviour of the error term in a way more graphic.

Table 32. Autocorrelations of the error term of the dynamic model of the euro area.

Date: 06/16/15 Time: 17:06
Sample: 1996Q1 2014Q2
Includedobservations: 74

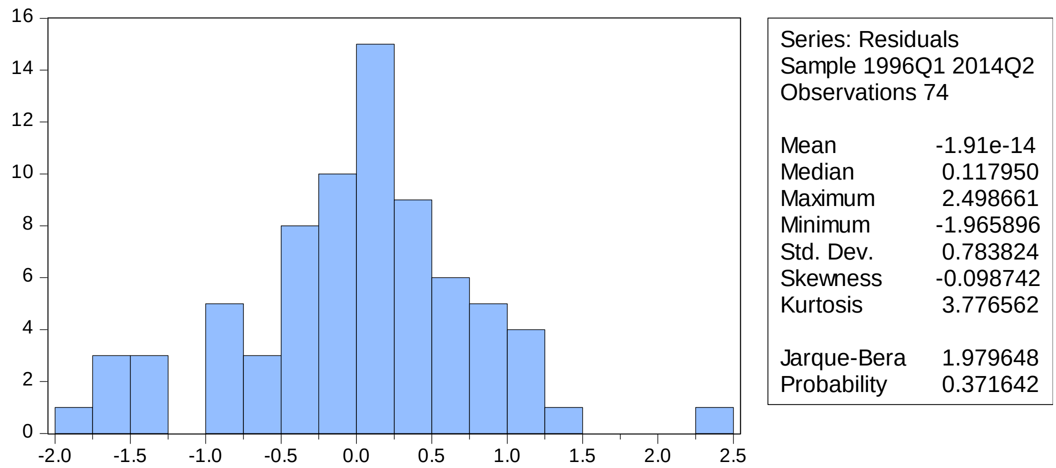
Autocorrelation	PartialCorrelation		AC	PAC	Q-Stat	Prob
. | . |	. | . |	1	-0.014	-0.014	0.0154	0.901
. | . |	. | . |	2	-0.017	-0.018	0.0389	0.981
. | . |	. | . |	3	0.023	0.023	0.0812	0.994
. |*. |	. |*. |	4	0.153	0.154	1.9664	0.742
. |*. |	. |*. |	5	0.075	0.083	2.4310	0.787
. |*. |	. |*. |	6	0.198	0.212	5.6648	0.462
.*| . |	.*| . |	7	-0.096	-0.092	6.4356	0.490
. |*. |	. |*. |	8	0.141	0.131	8.1359	0.420
. | . |	.*| . |	9	-0.026	-0.069	8.1951	0.515
.*| . |	.*| . |	10	-0.100	-0.168	9.0740	0.525
. | . |	. | . |	11	0.060	0.045	9.3991	0.585
. |** |	. |** |	12	0.319	0.277	18.648	0.097
.*| . |	.*| . |	13	-0.151	-0.121	20.741	0.078
. | . |	. | . |	14	0.028	0.034	20.815	0.106
.*| . |	.*| . |	15	-0.143	-0.143	22.762	0.089
. |*. |	. | . |	16	0.120	0.073	24.169	0.086

Source: Calculations based on data from the European Central Bank.

Another important issue, as we have already seen above, is the relative to the normality of the term of disturbance and, as the graph 11 shows error terms of the dynamic model European comply with the assumption of normality.

[14] The model with one and two lags presented problems of autocorrelation and model four lags was less significant than the three lags.

Graph 11. Jarque-Bera test of the error term of the dynamic model of the euro area.



Source: Calculations based on data from the European Central Bank.

In regard to the assumption of homoscedasticity, the following table presents the data needed to determine whether to accept the null hypothesis or if, on the contrary, it should be rejected, which would imply the existence of heteroscedasticity.

Table 33. Heteroscedasticity test the error term of the dynamic model of the euro area.

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.560965	Prob. F(4,69)	0.6917
Obs*R-squared	2.330666	Prob. Chi-Square(4)	0.6752
Scaledexplained SS	2.813146	Prob. Chi-Square(4)	0.5896

Test Equation:
Dependent Variable: RESID^2
Method: LeastSquares
Date: 06/16/15 Time: 17:07
Sample: 1996Q1 2014Q2
Includedobservations: 74

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.235598	1.869879	0.125996	0.9001
IMPORINDEXEU	-0.000478	0.042827	-0.011167	0.9911
DIFTASASEU(-1)	-0.187792	0.140847	-1.333305	0.1868
DIFTASASEU(-2)	0.074559	0.149483	0.498782	0.6195
DIFTASASEU(-3)	0.110360	0.135014	0.817395	0.4165

R-squared	0.031495	Mean dependentvar	0.606077
Adjusted R-squared	-0.024650	S.D. dependentvar	1.016801
S.E. of regression	1.029256	Akaikeinfocriterion	2.960727

Sum squaredresid	73.09645	Schwarzcriterion	3.116407
Log likelihood	-104.5469	Hannan-Quinncriter.	3.022830
F-statistic	0.560965	Durbin-Watson stat	1.924615
Prob(F-statistic)	0.691743		

Source: Calculations based on data from the European Central Bank.

For the dynamic model of the eurozone accepts H_0 and, therefore,the error terms are homoscedastics.

In the absence of autocorrelation and the presence of normality and homoscedasticity it can be said that the disturbances of this model are spherical.

Thus, the European model complies with the expectations of this study, but it is now necessary to check if the United States also confirms.

Table 34. OLS estimation of the dynamic model of United States.

Dependent Variable: DIFTASASUSA
Method: LeastSquares
Date: 06/16/15 Time: 17:08
Sample (adjusted): 1995Q4 2014Q2
Includedobservations: 75 afteradjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
IMPORTINDEUSA	-0.081500	0.024354	-3.346408	0.0013
DIFTASASUSA(-1)	0.405976	0.102296	3.968635	0.0002
DIFTASASUSA(-2)	0.516037	0.096722	5.335257	0.0000
C	-0.150738	1.005356	-0.149935	0.8812

R-squared	0.993368	Mean dependentvar	-99.53258
Adjusted R-squared	0.993088	S.D. dependentvar	13.43095
S.E. of regression	1.116620	Akaikeinfocriterion	3.110349
Sum squaredresid	88.52571	Schwarzcriterion	3.233948
Log likelihood	-112.6381	Hannan-Quinncriter.	3.159701
F-statistic	3545.057	Durbin-Watson stat	1.970954
Prob(F-statistic)	0.000000		

Source: Calculations based on data from Federal Reserve Bank of St. Louis.

On this table the dependent variable is still the usual ($\partial\pi_t$), while the independent variables are the constant, the price index for imports and two lags.

As expected, the index variable of prices of imports is significant, as well as the two lags, which have been included and that can be used to solve the problem of autocorrelation that dragged the model (3) —and the model (4) with a delay—. So, in the United States the difference in the rates of inflation of the indices corrects the autocorrelation faster, with only 2 lags, while in the euro area is required of 3.

Continuing with the analysis of the autocorrelation, table 35 presents the evolution of the disturbance in a more graphic way.

Table 35. Autocorrelations of the error term of the dynamic model of United States.

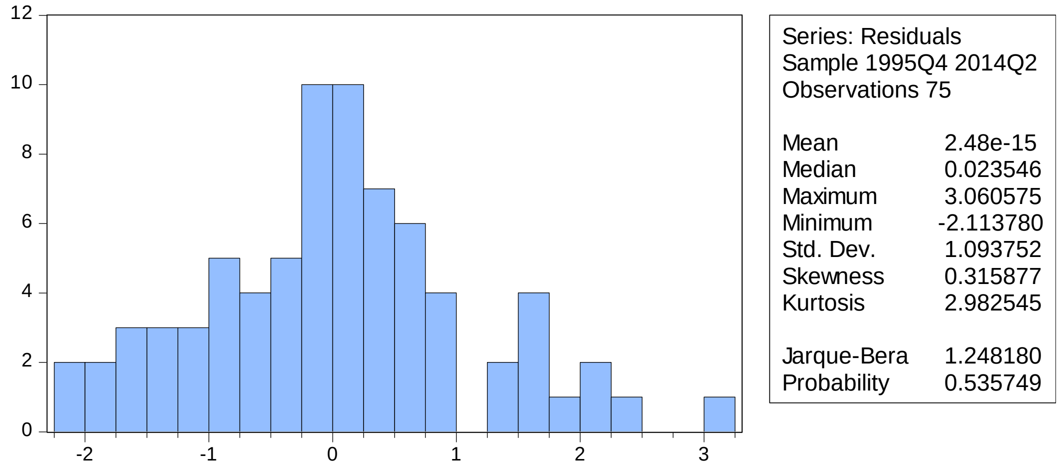
Sample: 1995Q4 2014Q2
Includedobservations: 75

Autocorrelation	PartialCorrelation		AC	PAC	Q-Stat	Prob
. | . |	. | . |	1	0.007	0.007	0.0035	0.953
.*| . |	.*| . |	2	-0.066	-0.066	0.3453	0.841
. | . |	. | . |	3	0.018	0.019	0.3724	0.946
. | . |	. | . |	4	0.015	0.011	0.3909	0.983
. | . |	. | . |	5	0.048	0.051	0.5821	0.989
. | . |	. | . |	6	0.021	0.022	0.6193	0.996
.*| . |	.*| . |	7	-0.120	-0.115	1.8414	0.968
. | . |	. | . |	8	-0.011	-0.009	1.8522	0.985
. |** |	. |** |	9	0.226	0.214	6.3174	0.708
. | . |	. | . |	10	0.032	0.032	6.4104	0.780
. | . |	. |*. |	11	0.064	0.093	6.7839	0.816
. | . |	. | . |	12	-0.040	-0.040	6.9340	0.862
. | . |	. | . |	13	-0.020	-0.014	6.9709	0.904
. |*. |	. |*. |	14	0.188	0.161	10.302	0.740
. | . |	. | . |	15	-0.030	-0.051	10.389	0.795
.*| . |	. | . |	16	-0.108	-0.052	11.532	0.776
. | . |	. | . |	17	0.014	0.018	11.551	0.827
.*| . |	**| . |	18	-0.156	-0.219	14.012	0.728
. | . |	. | . |	19	0.042	0.032	14.198	0.772
. | . |	.*| . |	20	-0.051	-0.129	14.466	0.806
. | . |	. | . |	21	-0.013	0.052	14.485	0.848
.*| . |	.*| . |	22	-0.152	-0.178	16.993	0.764
. | . |	. | . |	23	0.041	-0.037	17.181	0.800
. | . |	. | . |	24	-0.051	-0.063	17.477	0.828
. | . |	. | . |	25	-0.010	-0.031	17.489	0.863
.*| . |	.*| . |	26	-0.097	-0.099	18.604	0.853
.*| . |	. | . |	27	-0.103	-0.016	19.877	0.836
. |*. |	. | . |	28	0.098	0.056	21.064	0.823
.*| . |	.*| . |	29	-0.145	-0.122	23.717	0.743
.*| . |	.*| . |	30	-0.151	-0.160	26.650	0.642
. | . |	. | . |	31	-0.041	0.012	26.876	0.678
. | . |	. | . |	32	-0.050	-0.024	27.214	0.708

Source: Calculations based on data from Federal Reserve Bank of St. Louis.

As usual, the next step is the study of the normality of residuals that, like in all the cases seen so far, it is a course that meets.

Graph 12. Jarque-Bera test of the error term of the dynamic model of United States.



Source: Calculations based on data from Federal Reserve Bank of St. Louis.

Finally, make sure that this model meets with the null hypothesis that the shocks are homoscedastic variables was carried out by. If so, this model will comply with all the assumptions imposed, which clearly is desirable in any econometric study.

Table 36. Heteroscedasticity test the error term of the dynamic model of United States.

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	3.481145	Prob. F(3,71)	0.0202
Obs*R-squared	9.617198	Prob. Chi-Square(3)	0.0221
Scaledexplained SS	8.543500	Prob. Chi-Square(3)	0.0360

Test Equation:
Dependent Variable: RESID^2
Method: LeastSquares
Date: 06/16/15 Time: 17:09
Sample: 1995Q4 2014Q2
Includedobservations: 75

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.286585	1.435941	3.681617	0.0004
IMPORTINDEUSA	0.006709	0.034785	0.192860	0.8476
DIFTASASUSA(-1)	0.205337	0.146109	1.405370	0.1643
DIFTASASUSA(-2)	-0.157754	0.138147	-1.141924	0.2573

R-squared	0.128229	Mean dependentvar	1.180343
Adjusted R-squared	0.091394	S.D. dependentvar	1.673148
S.E. of regression	1.594859	Akaikeinfocriterion	3.823306
Sum squaredresid	180.5938	Schwarzcriterion	3.946905

Log likelihood	-139.3740	Hannan-Quinncriter.	3.872658
F-statistic	3.481145	Durbin-Watson stat	1.719994
Prob(F-statistic)	0.020246		

Source: Calculations based on data from Federal Reserve Bank of St. Louis.

Seeing the results obtained cannot accept H_0, i.e. error terms are restrained term according. However, this fact does not invalidate the model presented.

In short, between the two economies are given certain differences as has already been commented on. Well, the European economy requires a autoregressive process of order 3, incorporating a constant and the price of imports, to explain how imports affect the differences between both price indexes, while the United States only requires an autoregressive process of order 2. In addition, the disruption of this first economy is spherical, something that the second does not have because of the failure of the assumption of homoscedasticity (constant variance of perturbations).

However, what is important is that you can confirm that the imports are one of the main causes of the differences between both price indexes —something that was not the case of the economic cycle—.

4. CONCLUSIONS

From a purely theoretical perspective it is easy to appreciate the differences between the GDP deflator and the CPI, then we only have to compare the definitions of both indicators. Thus, the differences between the two indexes are:

i. The GDP deflator measures the prices of all goods and services produced in an economy, then imported goods and intermediate goods are not included. The CPI, meanwhile, only measures the prices of 484 commodities that are purchased more frequently by families and, therefore, the prices of intermediate consumption of enterprises or exported goods are not included.

ii. The GDP deflator is measured through a Paasche index with variable weights, while CPI is formulated through a chained Laspeyres index that assigns fixed weights.

iii. Following the second point, the algebraic definition of both indicators is different.

However, on a more practical level arithmetic differences are diluted and not easy to distinguish. Therefore, throughout this study we have worked with series of data on both indexes and with various econometric models in which there have been many changes. This whole process has been divided into two blocks, the descriptive and econometric.

The first of these blocks can be noted that both the inflation rate of the GDP deflator and the CPI in both economic areas show positive values in almost all the periods. Moreover, inflation rates calculated from these price indexes do not show a pattern of common behaviour, that is, the behaviour has been highly uneven, and their volatilities.

As for the mean and standard deviation of these rates of inflation in the eurozone, the data show that, in comparison, there is a great variability, a phenomenon that has not occurred in the United States, where differences were significant. It has also been mentioned that the coefficients of variation, despite not being high, indicating that there is little consistency between the values collected —this is most remarkable heterogeneity in a US—.

Moreover, the correlation between two measurements of the inflation rate is significantly higher in the U.S. case, although the value is relatively small.

Finally, autocorrelation having inflation rates associated with the two indicators of the general level of prices in the euro area is similar. However, in the USA case, persistence is higher in the inflation rate as measured by the GDP deflator which is calculated through the IPC.

Once the descriptive analysis is reviewed, attention can be focused on the results of the second section, i.e., in the econometric analysis.

This section has been made and dissociated set of price indicators to see their behavior analysis.

The disintegrated study obtained that both the GDP deflator and the CPI for each of the economic regions have a deterministic trend, absence of autocorrelation and presence of stationarity is the first difference, which means that the series considered are integrated of order 1.

As for the joint analysis (difference between inflation rates in the GDP deflator and CPI), results for the euro area and the United States are similar, ie, the series are stationary (integrated of order 0) and show autocorrelation.

These results are applicable to a new analysis as to whether the economic variables and the index of import prices cycle can explain the difference between the two indicators of inflation.

The first of these two variables, after running over its relevant processes, we can say that it fails to explain the difference between the two measures of inflation. Then, the economic cycle is not the cause of the observed difference.

The index of import prices, meanwhile unlike the variable business cycle itself can explain the difference between the two measurements of inflation.

However, European and US models have certain disparities. The model of the eurozone is characterized by sustaining as variable explained the difference between inflation rates in the GDP deflator and the CPI and as explanatory variables constant, the price index of imports and three lags. Also, its error term is enclosed and homoscedastic and meet the assumption of normality.

The U.S. model, however, is characterized by having as a dependent variable the difference between inflation rates in the GDP deflator and the CPI and as independent variables constant, the price index of imports and two lags. Therefore, in the United States the difference in inflation rates autocorrelation corrects a number of minor lags, 2 lags, while in the eurozone it requires 3, which implies that the difference between inflation rates in the US is less persistent than in the euro area. In addition, the random error in the model of the US it differs from the European model associated with the presence of heteroscedasticity, but also exhibits no autocorrelation and presence of normality.

In short, we can say that the activity of international markets, and more specifically the importation sector, affects the differences between the two measurements of inflation associated with the alternative price indicators analyzed.

5. BIBLIOGRAPHY

Akaike, H. (1977). On entropy maximization principle. *Applications of Statistics*, 27-41.

Asteriou, D., & Hall, S. G. (2007). *Applied econometrics: A modern approach using eviews and microfit revised edition*. Palgrave Macmillan.

Brooks, C. (2014). *Introductory econometrics for finance*.Cambridge university press.

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American statistical association*, *74*(366a), 427-431.

Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: representation, estimation, and testing. *Econometrica: journal of the Econometric Society*, 251-276.

European Central Bank. (02 de 12 de 2014). *European Central Bank: ECB*. Obtenido de European Central Bank: ECB: http://www.ecb.europa.eu/home/html/index.en.html

Federal Reserve Bank of St. Louis. (02 de 12 de 2014). *Federal Reserve Bank of St. Louis*. Obtenido de Federal Reserve Bank of St. Louis: http://www.stlouisfed.org

Gonzalo, J. (1994). Five alternative methods of estimating long-run equilibrium relationships. *Journal of econometrics*, *60*(1), 203-233.

Granger, C. W. (1969).Investigating causal relations by econometric models and cross-spectral methods. *Econometrica: Journal of the Econometric Society*, 424-438.

Granger, C. W., & Newbold, P. (1974).Spurious regressions in econometrics.*Journal of econometrics*, *2*(2), 111-120.

Gujarati, D. (1997). *Econometría*. Ed. McGraw Hill. Capítulos 11 y 12.

Hamilton, J. D. (1994). *Time series analysis* (Vol. 2). Princeton: Princeton university press.

Johansen, S. (1988).Statistical analysis of cointegration vectors. *Journal of economic dynamics and control*, *12*(2), 231-254.

Johansen, S., & Juselius, K. (1990).Maximum likelihood estimation and inference on cointegration with applications to the demand for money. *Oxford Bulletin of Economics and statistics*, *52*(2), 169-210.

Lane, W. (2006). Comparing US and European inflation: the CPI and the HICP.*Monthly Lab. Rev.*, *129*, 20.

Mankiw, N. G. (2006). Macroeconomía.Barcelona: Antoni Bosch editor. Capítulo 2.

Miller, R. (2011). The long-run difference between RPI and CPI inflation. *Office for Budget Responsibility (OBR), Working Paper*, (2).

Montero. R (2013). Variables no estacionarias y cointegración. Documentos de Trabajo en Economía Aplicada. Universidad de Granada. España.

Pareja, J. (15 de 01 de 2015). *Ciencia de la Economía.* Obtenido de Ciencia de la Economía. http://cienciaeconomica.blogspot.com.es/2009/09/series-desestacionalizadas-como-se.html

Richards, T., & Rosewall, T. (2010). Measures of underlying inflation. *RBA Bulletin, March*, 7-12.

Stock, J. y Watson, M. (2012). *Introducción a la Econometría*. Ed. Pearson. Capítulo 6 y 18.

Schwarz, G. (1978). Estimating the dimension of a model. *The annals of statistics*, *6*(2), 461-464.

Wooldridge, J. M. (2006). *Introducción a la econometría: un enfoque moderno*. Editorial Paraninfo. Capítulos 2, 3 y 6.