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TESTING EUROPEAN BUSINESS CYCLES ASYMMETRY

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Testing European business cycles asymmetry

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Abstract

Research background: One of business cycles stylised facts is that contractions are shorter than expansions, but less persistent, more volatile and therefore asymmetric. Investigating existence and type of business cycles asymmetry is important for analysis of economic policy and statistical modeling. Economic implication of business cycles asymmetry is that economic policy should be different in period of contractions than expansion. Statistical implication is that linear models of business cycles cannot capture this stylised fact.

Purpose of the article: The article has two objectives: extend the literature on the business cycles asymmetry by testing data from 36 European countries including countries never been analysed before and test robustness of the results to extraction methods and asymmetry tests used.

Methodology/methods: Quarterly GDP series from Eurostat database covering period 2000q1-2016q3 were used. Series were prepared by removing seasonal component using X13-ARIMA procedure. To assess robustness of asymmetry tests results to alternative methods of detrending business cycles were extracted using two filters: Corbae-Ouliaris ideal band filter and double Hodrick-Prescott filter. For testing the deepness and steepness asymmetry three tests were used: Mills, Mira and Sichel tests.

Findings: Weaker evidence of deepness asymmetry was found in Cyprus, Montenegro and Turkey cycles where all three tests statistics for both filters have negative sign. However, only for one of the tests in each country the result was statistically significant. For two other countries, Germany and Sweden, four of six tests indicated deepness asymmetry, but only one of these tests results was statistically significant. Most of the cycles show steepness asymmetry, with

exception of Ireland business cycles and to certain extent cycles of Poland, Malta, Montenegro and Spain.

Introduction

One of the business cycle stylised facts is that recessions are shorter than expansions, but less persistent, more volatile and therefore asymmetric. Investigating existence and type of business cycles asymmetry is important for analysis of economic policy and statistical modeling. Economic implication of business cycles asymmetry is that economic policy should be conditional on the stage of the cycle. Statistical implication is that linear models of business cycles cannot capture this stylised fact and therefore would be inefficient when applied. The main objective of this study is to explore whether European business cycles are asymmetric. More specifically the time series from the Eurostat database were used to achieve the following objectives:

- extend the literature on the business cycles asymmetry by testing data from 36 European countries including countries never been analysed before
- test robustness of the results to extraction methods and asymmetry tests used.

Research Methodology

There are three methodological problems that have to be addresses when conducting research on business cycle asymmetry. They are related to preparation of time series, selection of cycle extraction methods and selection of asymmetry tests.

The quarterly time series of GDP at market prices (chain linked volumes, index 2010 = 100) seasonally unadjusted are extracted from the Eurostat Database. The sample period for most of the GDP series used in this study runs from 2000q1 to 2016q3. For Bosnia & Herzegovina and Montenegro quarterly GDP time series were not available, so the quarterly index of industrial production was used instead. Series were prepared by removing seasonal component using X13-ARIMA procedure. The logarithm of seasonally adjusted real GDP was used, so that the deviations around trend are expressed as percentages.

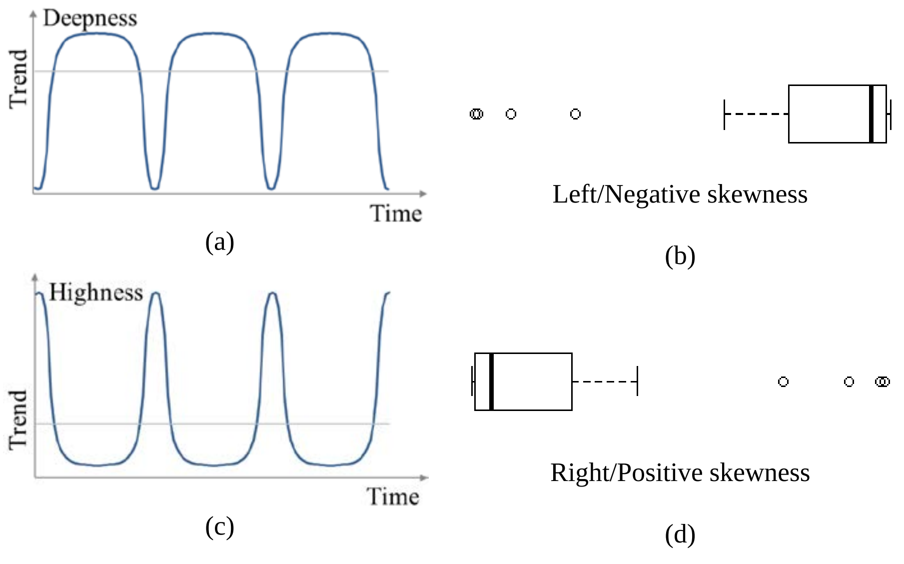
Cycle extraction methods

In order to assess how robust are the asymmetry tests results on using different extraction methods two filters were applied: Hodrick-Prescott (hereafter HP) and Corbae-Ouliaris (hereafter FD) filters. When applying HP filter the two-step procedure was used. For the smoothing parameter $\lambda = 1600$ was used. Since the extracted cycles still contain random component HP filter was applied for the second time. This time smoothing parameter $\lambda = 10$ was used. The other cycle extraction method used is FD filter (Corbae & Ouliaris, 2006). The advantage of FD filter over other filters is that it can handle series with nonstationarity (e.g. unit root and heteroscedasticity) without prior testing for type of nonstationarity.

Asymmetry tests

Sichel (1993) considers two different types of asymmetric patterns of cycle, i.e. deepness (business cycle troughs are deeper than peaks are tall) and steepness (business cycle contractions are shorter and sharper than expansions). Deepness asymmetry of business cycle is illustrated in Figure 1(a) and cycle highness on panel (c). Boxplots on panels (b) and (d) illustrate how asymmetric distributions are when there is deepness or highness in business cycles.

Figure 1. Deepness and Highness in business cycles



Steepness asymmetry is illustrated in Figure 2. The first difference of the cycle series would have the same graph as the graph in Figure 1(a). The null hypothesis in these tests is that a given distribution is symmetric about some unknown median, against a very broad class of asymmetric alternatives. More specifically, null hypothesis is that the business cycles have no deepness/steepness asymmetry against the alternative that cycles do have deepness/steepness asymmetry.

Figure 2. Steepness in business cycles

Sichel test

The asymmetry test proposed by Sichel (1993) is based on skewness of a cyclical series:

$$S = \frac{\frac{1}{N}\sum_{t=1}^{N}(c_t - \bar{c})^3}{\sigma(c)^3} = \frac{\mu_3}{\mu_2^{3/2}} \qquad (1)$$

where c_t is a cyclical component of time series; N is the length of time series; $\bar{c}$ and $\sigma(c)$ are mean value and standard deviation of a cyclical component c_t respectively and μ_j is j-th central moment of series c_t. When calculating the standard error of the test statistic (1) Sichel addressed the issue of possible autocorrelation and heteroscedasticity by using the following variable in the regression on a constant:

$$z_t = \frac{(c_t - \bar{c})^3}{\sigma(c)^3} \qquad (2)$$

Estimated regression coefficient is identical to S statistic, and for testing its significance Newey-West standard error was used. Though, as pointed out by Mills (2001), this adjustment still does not adjust variance for non-normality. Such modified t statistic follows an asymptotic normal distribution.

Mills test

Mills (2001) suggested two corrections in the Sichel's test. The first correction addresses the problem of non-normality, and the variance of the test statistics is:

$$\sigma_S^2 = \frac{1}{N}\left(\frac{\mu_6}{\mu_2^3} - 6K + 9 + \frac{S^2}{4}(9k+35) - \frac{3\mu_5\mu_3}{\mu_2^4}\right) \tag{3}$$

where S is the measure of skewness and $K = \frac{\mu_4}{\mu_2^{3/2}}$ is the measure of kurtosis. The second correction addresses the problem of autocorrelation by using the Newey-West adjustment. The variance of the test statistic S at lag l is:

$$\sigma_S^2(l) = \sigma_S^2\left(1 + \frac{2}{N}\sum_{j=1}^{l}\omega_j\rho_j\right) \tag{4}$$

where ρ_j is the j-th autocorrelation of series $\frac{c_t^3}{(\mu_2)^{3/2}}$ and ω_j is the weight $\omega_j = 1 - \frac{j}{l+1}$, with $l = 4\left(\frac{N}{100}\right)^{2/9}$. Statistic $Z_S = \frac{S}{\sigma_S(l)}$ has an asymptotic normal distribution. Statistically significant negative value of this statistic indicates deepness, while positive value indicates highness of the business cycle.

Mira test

Mira (1999) proposed the test based on the following statistic:

$$Z_g = \frac{g}{\sigma_g} \tag{5}$$

with $g = \bar{c} - c_{med}$, where $\bar{c}$ and c_{med} are mean and median respectively. Mira shown that Z_g statistic is asymptotically standard normal with $\sigma_g = \frac{(4\hat{\sigma}^2 + D^2 - 4DE)}{4N}$, with $\hat{\sigma}^2 = \frac{\sum_{t=1}^{N}(c_t - \bar{c})^2}{(N-1)}$, $E = \bar{c} - \frac{2}{N}\sum_{t=1}^{N} c_t I(c_t \le c_{med})$ and $D = N^{1/5}\left(c_{1/2(N+N^{4/5})} - c_{1/2(N-N^{4/5}+2)}\right)$.

The first difference of business cycles would show negative skewness if the cycle shows steepness. So, the same three tests could be used to test the hypothesis of steepness asymmetry by simply replacing c_t with its first difference, i.e. Δc_t.

Results

Table 1 shows the results of the deepness asymmetry tests conducted for 36 European countries plus cycles of European Union (EU28) and Euro Area (EA19). Results vary across the tests and filters used. Negative values of the test statistics are in bold font. Only a few countries has all negative values for both filters and for all three tests. They are Cyprus, Montenegro and Turkey. For two other countries (Germany and Sweden), four of six tests indicated deepness asymmetry. However, as the *p*-values in parenthesis show, not all of these tests results are statistically significant. For instance, significant results were observed for the following countries: Cyprus (Mills test & HP filter), Germany (Mills & HP), Montenegro (Mira & FD), Portugal (Mills & HP) and Turkey (Mira & HP).

Overall, we can conclude that the business cycles for majority of European countries exhibit cycle symmetry and that the evidence of deepness asymmetry is very weak, depending on the tests and filters used.

Table 2 shows the results of the steepness asymmetry tests where negative values of the test statistics are in bold font. With a few exceptions (most prominent case is Ireland) a majority of European countries have a negative sign for all three tests and for both filters. That would strongly support the claim that European cycles exhibit steepness asymmetry. However, such claim should be made with caution because not all these negative values are indicating statistically significant result. For example, Sichel test for both filters shows that none of the results are significant. This could be a result of the test weakness and its sensitivity to outliers. As pointed out by Mills (2001) less evidence of asymmetries of Sichel test could be the result that the variance in the test statistic is not adjusted for non-normality.

Overall, Mills test does not reject the null hypothesis of symmetric distribution in 19% (FD filter) and 11% (HP filter) cases, while this percentages raise to 83% in case of Mira's test for both filters. Two tests (Mills and Mira) yielded for both filters statistically significant result indicating steepness asymmetry only for Czech Republic, Macedonia FRY and Turkey cycles.

Table 1. Deepness asymmetry tests of the business cycles (2000q1-2016q3)

Country	Mills test		Mira test		Sichel test	
	FD	HP	FD	HP	FD	HP
Austria	2.68 (0.00)	15.52 (0.00)	**-0.61** (0.54)	1.05 (0.30)	0.23 (0.89)	0.33 (0.91)
Belgium	15.40 (0.00)	5.05 (0.00)	1.13 (0.26)	1.78 (0.07)	0.34 (0.83)	0.35 (0.87)
Bosnia & Herz.	0.43 (0.33)	**-1.31** (0.10)	1.05 (0.29)	1.37 (0.17)	0.27 (0.79)	**-0.47** (0.51)
Bulgaria	2.73 (0.00)	52.18 (0.00)	3.20 (0.00)	2.64 (0.01)	0.77 (0.84)	1.31 (0.74)
Croatia	5.85 (0.00)	801.5 (0.00)	0.89 (0.37)	3.71 (0.00)	0.89 (0.78)	1.40 (0.76)
Cyprus	**-0.25** (0.40)	**-5.41** (0.00)	**-0.78** (0.44)	**-0.68** (0.50)	**-0.04** (0.97)	**-0.47** (0.93)
Czech Republic	2.32 (0.01)	6.85 (0.00)	3.72 (0.00)	0.58 (0.56)	0.66 (0.83)	0.71 (0.84)
Denmark	1.01 (0.16)	3.67 (0.00)	0.88 (0.38)	0.57 (0.57)	0.16 (0.93)	0.13 (0.96)
Estonia	0.06 (0.48)	0.12 (0.45)	0.89 (0.37)	0.87 (0.38)	0.09 (0.98)	0.13 (0.98)
Finland	1.11 (0.13)	2.90 (0.00)	0.60 (0.55)	1.97 (0.05)	0.32 (0.86)	0.41 (0.90)
France	0.54 (0.30)	0.26 (0.40)	0.79 (0.43)	1.55 (0.12)	0.00 (1.00)	0.02 (0.99)
Germany	**-0.55** (0.29)	**-1.68** (0.05)	1.06 (0.29)	0.37 (0.71)	**-0.09** (0.96)	**-0.07** (0.98)
Greece	0.12 (0.45)	**-0.91** (0.18)	0.72 (0.47)	1.38 (0.17)	0.05 (0.98)	**-0.22** (0.96)
Hungary	1.18 (0.12)	4.93 (0.00)	2.64 (0.01)	1.83 (0.07)	0.26 (0.85)	0.27 (0.92)
Iceland	1.08 (0.14)	2.54 (0.01)	1.26 (0.21)	0.95 (0.34)	0.73 (0.81)	0.87 (0.82)
Ireland	0.50 (0.31)	**-0.28** (0.39)	1.11 (0.27)	0.55 (0.58)	0.38 (0.83)	**-0.14** (0.97)
Italy	1.70 (0.04)	8.49 (0.00)	0.72 (0.47)	0.51 (0.61)	0.10 (0.95)	0.15 (0.94)
Latvia	0.33 (0.37)	0.51 (0.31)	2.44 (0.01)	2.05 (0.04)	0.47 (0.91)	0.53 (0.91)
Lithuania	0.44 (0.33)	0.78 (0.22)	0.42 (0.67)	0.50 (0.62)	0.49 (0.87)	0.57 (0.89)
Luxembourg	2.78 (0.00)	11.93 (0.00)	0.55 (0.58)	1.32 (0.19)	0.97 (0.74)	1.21 (0.77)
Macedonia, FRY	1.80 (0.04)	5.22 (0.00)	0.95 (0.34)	**-1.04** (0.30)	0.64 (0.62)	0.72 (0.20)
Malta	1.98 (0.02)	60.80 (0.00)	2.15 (0.03)	0.26 (0.79)	0.30 (0.82)	0.21 (0.93)
Montenegro	**-0.29** (0.38)	**-0.06** (0.48)	**-1.68** (0.09)	**-1.36** (0.17)	**-0.44** (0.72)	**-0.05** (0.95)
Netherlands	1.07 (0.14)	29.23 (0.00)	2.12 (0.03)	0.82 (0.41)	0.20 (0.90)	0.43 (0.83)
Norway	12.89 (0.00)	3.25 (0.00)	0.32 (0.75)	**-0.74** (0.46)	0.24 (0.92)	0.24 (0.94)
Poland	2.17 (0.02)	3.40 (0.00)	3.10 (0.00)	1.00 (0.32)	0.36 (0.86)	0.25 (0.90)
Portugal	0.66 (0.25)	**-38.26** (0.00)	0.39 (0.69)	**-0.44** (0.66)	0.09 (0.95)	**-0.26** (0.91)
Romania	0.77 (0.00)	43.74 (0.00)	1.41 (0.16)	1.92 (0.06)	0.51 (0.86)	1.47 (0.73)
Serbia	1.39 (0.08)	**-1.12** (0.13)	1.86 (0.06)	0.36 (0.72)	0.49 (0.92)	**-0.11** (0.92)
Slovakia	9.37 (0.00)	10.02 (0.00)	4.19 (0.00)	3.43 (0.00)	1.69 (0.68)	1.79 (0.73)
Slovenia	3.01 (0.00)	8.74 (0.00)	1.35 (0.18)	1.65 (0.10)	1.05 (0.74)	1.15 (0.77)
Spain	2.08 (0.02)	2.49 (0.01)	**-0.06** (0.95)	0.16 (0.88)	0.33 (0.90)	0.12 (0.99)
Sweden	**-0.60** (0.27)	**-0.84** (0.20)	2.01 (0.04)	0.65 (0.51)	**-0.15** (0.94)	**-0.07** (0.98)
Switzerland	3.57 (0.00)	26.31 (0.00)	1.38 (0.17)	1.36 (0.17)	0.33 (0.87)	0.34 (0.89)
Turkey	**-0.27** (0.39)	**-1.01** (0.16)	**-1.19** (0.23)	**-3.08** (0.00)	**-0.19** (0.91)	**-0.38** (0.88)
UK	4.06 (0.00)	11.35 (0.00)	2.10 (0.04)	2.69 (0.01)	0.49 (0.83)	0.40 (0.91)
EU28	8.71 (0.00)	20.83 (0.00)	0.60 (0.55)	1.03 (0.30)	0.63 (0.79)	0.55 (0.86)
EA19	6.19 (0.00)	28.55 (0.00)	0.76 (0.45)	0.61 (0.54)	0.48 (0.81)	0.47 (0.86)

Note: Negative values (bold font) indicate the deepness asymmetry. In case of Bosnia and Herzegovina and Montenegro industrial cycles were used in period 2006q1-2016q3 and 2010q1-2016q3 respectively. In case of Poland quarterly GDP series was available in period 2002q1-2016q3. Test results with *p*-values within parenthesis are based on cycles extracted using Corbae-Ouliaris (FD) and Hodrick-Prescott (HP) filters.

Table 2. Steepness asymmetry tests of the business cycles (2000q1-2016q3)

Country	Mills test		Mira test		Sichel test	
	FD	HP	FD	HP	FD	HP
Austria	**-4.13** (0.00)	**-3.21** (0.00)	**-0.11** (0.91)	**-0.45** (0.65)	**-0.91** (0.66)	**-0.85** (0.76)
Belgium	**-3.39** (0.00)	**-3.31** (0.00)	**-1.42** (0.15)	**-1.48** (0.14)	**-0.71** (0.63)	**-0.80** (0.64)
Bosnia & Herz.	**-4.52** (0.00)	1.19 (0.12)	**-1.48** (0.14)	**-0.87** (0.38)	**-0.36** (0.71)	0.26 (0.72)
Bulgaria	**-14.0** (0.00)	**-17.3** (0.00)	**-1.94** (0.05)	**-1.55** (0.12)	**-1.41** (0.67)	**-1.45** (0.69)
Croatia	**-15.4** (0.00)	**-4.81** (0.00)	**-0.41** (0.68)	**-0.69** (0.49)	**-1.42** (0.58)	**-0.92** (0.74)
Cyprus	**-1.02** (0.15)	**-0.19** (0.42)	**-0.41** (0.68)	0.40 (0.69)	**-0.15** (0.92)	**-0.04** (1.00)
Czech Republic	**-15.3** (0.00)	**-6.41** (0.00)	**-2.01** (0.04)	**-2.84** (0.00)	**-1.28** (0.57)	**-0.98** (0.65)
Denmark	**-5.53** (0.00)	**-4.43** (0.00)	**-0.67** (0.50)	**-1.86** (0.06)	**-1.08** (0.69)	**-0.92** (0.74)
Estonia	**-36.5** (0.00)	**-161** (0.00)	**-1.14** (0.25)	0.54 (0.59)	**-1.65** (0.68)	**-1.15** (0.74)
Finland	**-7.09** (0.00)	**-5.33** (0.00)	**-0.94** (0.35)	**-0.57** (0.57)	**-0.91** (0.68)	**-0.97** (0.72)
France	**-4.16** (0.00)	**-3.43** (0.00)	0.16 (0.87)	**-2.16** (0.03)	**-0.94** (0.62)	**-0.88** (0.72)
Germany	**-6.03** (0.00)	**-2.89** (0.00)	**-0.29** (0.77)	**-0.40** (0.69)	**-1.14** (0.69)	**-0.74** (0.77)
Greece	**-2.29** (0.01)	**-3.93** (0.00)	**-1.19** (0.23)	**-0.60** (0.55)	**-0.15** (0.88)	**-0.52** (0.87)
Hungary	**-132** (0.00)	**-13.5** (0.00)	**-1.77** (0.08)	**-1.23** (0.22)	**-1.71** (0.59)	**-1.41** (0.57)
Iceland	**-15.2** (0.00)	**-5.65** (0.00)	**-0.91** (0.36)	**-1.64** (0.10)	**-0.42** (0.83)	**-0.76** (0.82)
Ireland	53.39 (0.00)	13.25 (0.00)	1.71 (0.09)	0.20 (0.84)	1.27 (0.59)	1.03 (0.67)
Italy	**-4.20** (0.00)	**-3.03** (0.00)	**-2.36** (0.02)	**-1.09** (0.28)	**-0.87** (0.64)	**-0.67** (0.75)
Latvia	**-152** (0.00)	**-46.9** (0.00)	**-1.76** (0.08)	0.25 (0.80)	**-1.50** (0.72)	**-1.06** (0.80)
Lithuania	**-5.0** (0.00)	**-45.5** (0.00)	**-2.19** (0.03)	**-1.28** (0.20)	**-2.27** (0.64)	**-1.64** (0.68)
Luxembourg	**-12.0** (0.00)	**-4.74** (0.00)	**-1.65** (0.10)	**-0.18** (0.86)	**-0.97** (0.71)	**-0.97** (0.75)
Macedonia, FRY	**-12.6** (0.00)	**-8.13** (0.00)	**-1.93** (0.05)	**-2.31** (0.02)	**-0.98** (0.65)	**-1.08** (0.47)
Malta	**-2.40** (0.01)	**-1.35** (0.09)	0.06 (0.95)	0.04 (0.97)	**-0.27** (0.77)	**-0.33** (0.83)
Montenegro	**-0.32** (0.38)	10.32 (0.00)	0.00 (1.00)	**-0.49** (0.63)	**-0.18** (0.86)	0.21 (0.85)
Netherlands	**-1.06** (0.14)	**-3.08** (0.00)	**-0.70** (0.48)	**-1.33** (0.18)	**-0.20** (0.89)	**-0.59** (0.72)
Norway	**-2.61** (0.00)	**-2.28** (0.01)	**-1.86** (0.06)	**-1.62** (0.11)	**-0.45** (0.96)	**-0.55** (0.78)
Poland	**-0.33** (0.37)	0.63 (0.26)	0.68 (0.50)	0.71 (0.48)	**-0.06** (0.97)	0.12 (0.94)
Portugal	**-1.10** (0.14)	**-3.42** (0.00)	**-0.83** (0.41)	**-1.97** (0.05)	**-0.14** (0.90)	**-0.51** (0.73)
Romania	**-29.5** (0.00)	**-9.86** (0.00)	**-0.48** (0.63)	**-1.36** (0.17)	**-1.19** (0.60)	**-1.38** (0.69)
Serbia	**-0.52** (0.30)	**-3.37** (0.00)	1.37 (0.17)	**-0.11** (0.92)	**-0.04** (0.97)	**-0.60** (0.78)
Slovakia	**-16.3** (0.00)	**-5.09** (0.00)	**-1.14** (0.26)	**-1.31** (0.19)	**-1.34** (0.60)	**-1.19** (0.65)
Slovenia	**-12.5** (0.00)	**-4.79** (0.00)	**-0.48** (0.63)	0.92 (0.36)	**-0.98** (0.62)	**-0.84** (0.74)
Spain	**-1.46** (0.07)	**-1.05** (0.15)	1.72 (0.09)	0.64 (0.52)	**-0.23** (0.83)	**-0.17** (0.92)
Sweden	**-3.22** (0.00)	**-2.12** (0.02)	**-0.83** (0.41)	**-2.15** (0.03)	**-0.79** (0.77)	**-0.57** (0.82)
Switzerland	**-4.81** (0.00)	**-4.08** (0.00)	**-0.47** (0.64)	**-1.72** (0.09)	**-0.84** (0.58)	**-0.80** (0.66)
Turkey	**-22.9** (0.00)	**-13.9** (0.00)	**-2.55** (0.01)	**-2.91** (0.00)	**-1.22** (0.39)	**-1.04** (0.63)
UK	**-8.28** (0.00)	**-15.2** (0.00)	**-1.63** (0.10)	**-1.54** (0.12)	**-2.15** (0.52)	**-1.85** (0.66)
EU28	**-14.3** (0.00)	**-5.05** (0.00)	**-2.23** (0.03)	**-0.88** (0.38)	**-1.43** (0.57)	**-1.05** (0.70)
EA19	**-6.35** (0.00)	**-3.79** (0.00)	**-2.05** (0.04)	**-0.75** (0.45)	**-1.12** (0.60)	**-0.85** (0.72)

Note: Negative values (bold font) indicate the deepness asymmetry. In case of Bosnia and Herzegovina and Montenegro industrial cycles were used in period 2006q1-2016q3 and 2010q1-2016q3 respectively. In case of Poland quarterly GDP series was available in period 2002q1-2016q3. Test results with *p*-values within parenthesis are based on cycles extracted using Corbae-Ouliaris (FD) and Hodrick-Prescott (HP) filters.

Three tests results were significant for Bulgaria, France, Italy, Lithuania, Sweden, EU28 and EA19 indicating that for these countries the contraction period in the economic activities were generally faster and shorter than expansionary phases

When comparing our results with results in other studies it is evident that results even for the same country depend on the period covered, changing nature of asymmetry, series, filters and tests used. However, the overall results confirmed the results and main conclusion of Astolfi et al (2015), Chirila (2012) and Chirila & Chirila (2012) studies.

Conclusions

This paper analysis 36 European countries GDP data in order to detect the presence and type of asymmetries in their business cycles. Two cycle extraction methods were used: HP and FD filters, with three asymmetry tests to address the second objective of the study, i.e. robustness of the results. In spite of differences in the period covered and countries include between our study and other studies, our results confirm previous results that only a few European countries cycles show deepness asymmetry. At the same time most of the countries cycles show steepness asymmetry.

More specifically, weaker evidence of deepness asymmetry relative to trend was found in Cyprus, Montenegro and Turkey cycles where all three tests statistics for both filters have negative sign. However, only for one of the tests in each country the result was statistically significant. For two other countries, Germany and Sweden, four of the six tests indicated deepness asymmetry, but only one of these tests results was statistically significant. Most of the cycles show contractionary steepness relative to trend, with exception of Ireland business cycle and to certain extent cycles of Poland, Malta, Montenegro and Spain.

Variations in the test results across three tests and two filters indicated sensitivity of the test results suggesting that the results should be interpreted and used with great caution.

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