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Forecasting of the economic crisis using business cycles patterns

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Abstract. *The current global economic crisis has brought to the forefront of scientific research the issues of business cycles, particularly highlighting signals that predict ruptures in the normal dynamics of macroeconomic fluctuations. In this sense a very important concern for the specialists relates to the identification of instruments capable of describing business cycles as accurately as possible. The problem is quite complicated because of the irregular (duration and amplitude) and asymmetric (by comparing recessionary gaps to inflation gaps) shapes. A very effective tool used for this purpose is the random recursive algorithm BBQ of James Engel. The authors aim to test the validity of this algorithm for the Romanian economy using monthly frequency data from 1991:01-2012:05 period for the industrial production in order to identify specific characteristics of the business cycle.*

Keywords: business cycle; recessionary gap; inflationary gap; turning points.

JEL Classification: E32.
REL Classification: 8H, 8M.

Introduction

The “business cycle analysis” has several approaches in the literature, starting with the construction of theories and analytical models and continuing with historical and statistical investigations and short-term forecast. For example, Burns and Mitchell (1946, p. 3) define business cycles as “fluctuations occurring in the aggregate economic activity of nations that organize their work in companies (“business enterprises”): a cycle consists of expansions occurring in several areas of economic activity at the same time, followed by similar periods of recession, contraction, recovery and then it goes to the expansionary phase of the next cycle.”

In order to conduct a thorough analysis of the business cycles it is necessary to consider the following elements: the type of time series that are being used (gross or processed), the analysis base (represented by the data series that undergo the identification procedure), as well as the methodology used to identify extreme points.

Aggregate data series reflect more components of the economic cycle: the business cycle itself (with a duration of 3-12 years), the secular trend, seasonal variations lasting one year at most, occasional variations attributed to forces outside the economic system and “long waves” – trend cycles covering periods of 50 years or more.

The trend appears as a regular and continuous variation (increasing or decreasing) and it can be observed only if the sample requires a sufficiently large number of observations.

Seasonality is a component with a periodical influence in the evolution of a variable, as it is can be observed over short periods of time (months, quarters) and it is relatively regular. It presents causal factors, different from those specific to the trend.

The random component includes those factors that appear and affect the system as a result of the activity of some unidentified factors.

Looking from the perspective of the business cycle definition, in the literature there are two methodological approaches:

- “Classic cycles” approach: gross series are used to identify the minimum or maximum points. Here, cyclicity is a component that appears as fluctuations around the trend (neoclassical theory); it is influenced by contextual factors but a correlation between cyclicity and trend is possible, which is why a general analysis of the two components is recommended (Fabio Canova, 1998, pp. 475-512).

- "Growth cycles" (or "deviation cycles") approach. This type of vision identifies the extremes by eliminating the trend from the specific series (Christoffersen, n.a., p. 5). Generally, various filtering techniques for the trend component are used in the case of this approach:

1. Deterministic trend: this method involves the extraction of the cycle as a residue after making a regression between the actual series and the linear trend (or linear log). The method can be applied to non-stationary series that require processing by 1st order differences (or higher) because the trend cannot be removed by linear de-trending (Scheiblecker, 2008, pp. 23-24).

2. 1st order differentiation: in order to steady the series, the values from t-1(y_{t-1}) are deducted from the values at time t(y_t). If the method is applied on a logarithmic form, the components of the series will be called growth rates. The trend is a random walk process without any constant, cycle (c_t) is stationary and there is no correlation between the cycle and the trend (Yaffee, McGee, 2000). The mathematical equation will be: $c_t = y_t - y_{t-1} + \varepsilon_t$. This methodology is used for linear series. If the stationing process requires 2nd or a higher order differences, the procedure is no longer useful.

3. Hodrick-Prescott (HP) filter: is used for non-stationary integrated series of the 4th order maximum (Kydland, Prescott, 1990, p. 8). The mathematical equation is:

$$\min \sum_{t=1}^{T} [(y_t - g_t)^{2_t} + \lambda[(g_{t+1} - g_t) - (g_t - g_{t-1})]^2], \lambda \geq 0.$$

The symbols used are: Y_t – initial series, g_t – the trend, λ – value that adjusts the deviations from the trend and it is set by the user.

The HP filter calculates the trend component, and then identifies the cycle as the difference between the initial series and the trend. The method has the disadvantage of losing the last values of the series, an issue that can be avoided by the mechanical prediction of several additional values so that by applying the HP, the values to be lost, are precisely those (Kaiser, Maravall, 2002).

*4. Baxter-King (BK) filter:*The frequency filter BK is a belt type filter optimal linear approximation that uses transformation from the time domain to the frequency domain. The equation is:

$$\tilde{b}(L) = \frac{\sin L\varpi - \sin L\omega}{L\pi} - \frac{1}{2K+1} \sum_{L=-k}^{L=k} \frac{\sin L\varpi - \sin L\omega}{L\pi}$$

The symbols used are:
ω – the lower limit of the filter,
ϖ – the upper limit,
k – the length of the filter.

The filter has the property that the identification assumptions do not require restrictions regarding the type of the trend (stochastic or deterministic), and the trend may change over time if the variations are not very frequent. It is possible to apply this filter to seasonal unadjusted series. When applying this method, it is considered that the business cycle can last between 6 and 32 quarters and the last observations are missed (Guay, St-Amant, 2005).

5. *Christiano-Fotzgerald filter:* The optimality criterion minimizes the sum of square errors of approximation by the equation:

$$\min \int_{-\pi}^{\pi} \left| B(e^{-i\omega}) - \hat{B}^{pf}(e^{-i\omega}) \right| f_x(\omega) d\omega ,$$

where fx(ω) – spectral density. The length of the filter can be changed by the user as opposed to the case of the BK filter.

In 2002, Harding and Pagan showed that the classical approach results in fewer and shorter phases of contraction compared to the other method; hence, the need to apply different stabilization policies.

Empirical analysis

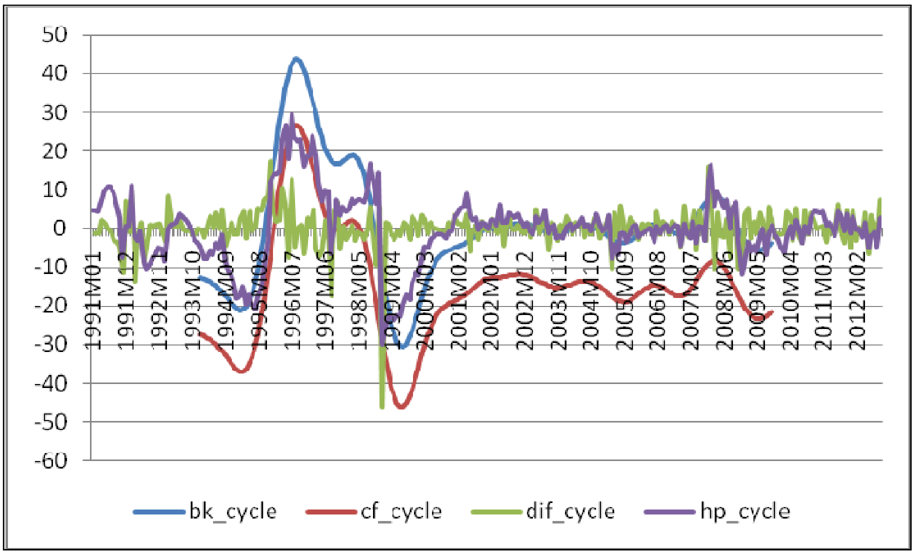
In the analysis of business cycles for Romania the monthly industrial production index with a fixed base in December 1990 was used as a reference series. The data were taken from the monthly Statistical Bulletin of the National Institute of Statistics in Bucharest for January 1991-October 2012. Later, the series was seasonally adjusted in Eviews using the CENSUS-12 procedure (Table 1).

Table 1. *Stationarity of the industrial production series*

Augmented Dickey-Fuller test statistic		Critical values	
t-statistic	-1.83	1%	-3.45
Prob.	0.3616	5%	-2.87
		10%	-2.57

Source: the test was conducted in eviews 5 using the data in the monthly bulletins of the National Institute of Statistics.

The series is not stationary (as shown in Table 1) and therefore various filtering methods will be used to extract the cyclical component. Of the above, we selected four filtering methods of the trend: the method of the 1st order difference, the Hodrick-Prescott filter, the Baxter-King filter, the Christiano-Fitzgerald filter. The cycles obtained through these methods are shown in the figure below:



Source: chart designed in eviews and exported to excel based on own calculations in eviews.

Figure 1. *The evolution of the industrial production cycles obtained through different filtering methods*

The best filtering method was selected by comparison with results in the literature. Agenor et al. (2000, pp. 251-285) calculated the standard deviation between 2-8% for emergent countries, depending on the filter used.

Table 2. *The standard deviation of the industrial production obtained through different techniques*

Filter	Volatility (%)
1st grade difference	5.05
Hodrick-Prescott filter	9.04
Baxter-King filter	14.79
Christiano-Fitzgerald filter	14.39

Source: Own calculation in Eviews.

In order to avoid methods with extreme results, the filters with the lowest, respectively the highest level of volatility have been removed. The series of the cycle obtained through the H-P method is the closest to the results of the literature. The same filter was selected by Petre Caraiani (2008, p. 67), who obtained a standard deviation of 8.7% through the second version of the HP filter.

Once we have selected the most consistent form of the cyclical dynamics, we tried to identify the local extreme points for the industrial production using the BB algorithm. The BB algorithm was first developed by Bry and Boschan (1971, pp. 21-164) using monthly data and it is recommended for simplicity, transparency and robustness of use. The algorithm detects the chronology of the business cycle stages by locating the extreme points between an expansion and a contraction, and vice versa. This is achieved as a result of identifying the local minimums and maximums depending on certain restrictions such as:

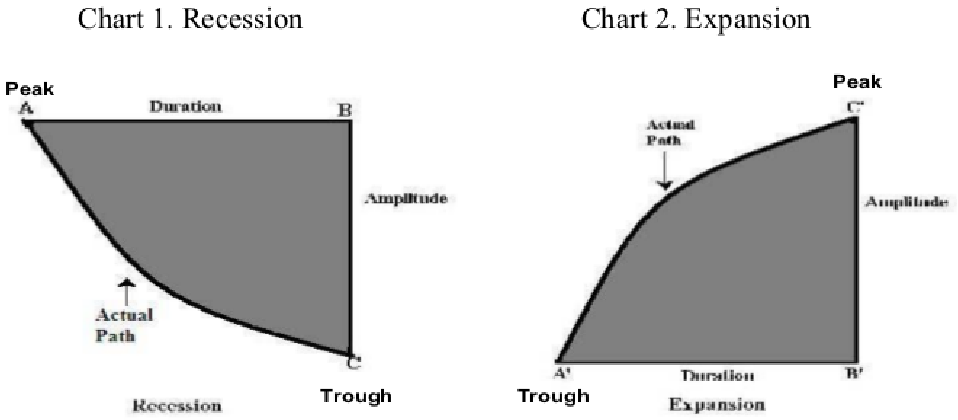
$\{y(t-k)<y(t)>y(t+k), k=1,2,...T\}$ for maximum

a minimum point involves $\{y(t-k)>y(t)<y(t+k)\}$, where k=1,2...T. T takes the value 5 for monthly data.

We have to mention the fact that the restrictions on the algorithm imply that it cannot identify the points of maximum/minimum at the beginning and at the end of the interval. This algorithm has been applied by Ekaterini Tsouma (2010) on the Greek economy in the period 1970-2010 on the series of the quarterly and monthly GDP (Gross Domestic Product). For the quarterly data in the article, the author used the BBQ algorithm. Moreover, she has used an ad hoc identification method of the extreme points modifying the conventional restriction of the two quarters of the minimum duration of the phases because she noticed that by using the traditional method, she obtains a large number of recessions. As a restriction for the minimum point, she used the GDP growth rule for at least two out of three quarters of GDP growth as opposed to the classical restriction of the two consecutive quarters of GDP growth, and, in order to identify the maximum point, she used three of the four quarters of the reduction in GDP.

Once these extreme points have been found, the intervals will be distinguished by the expansionary and the recessionary phases and the phase characteristics can be interpreted: duration, amplitude, cumulative changes and cumulative excess.

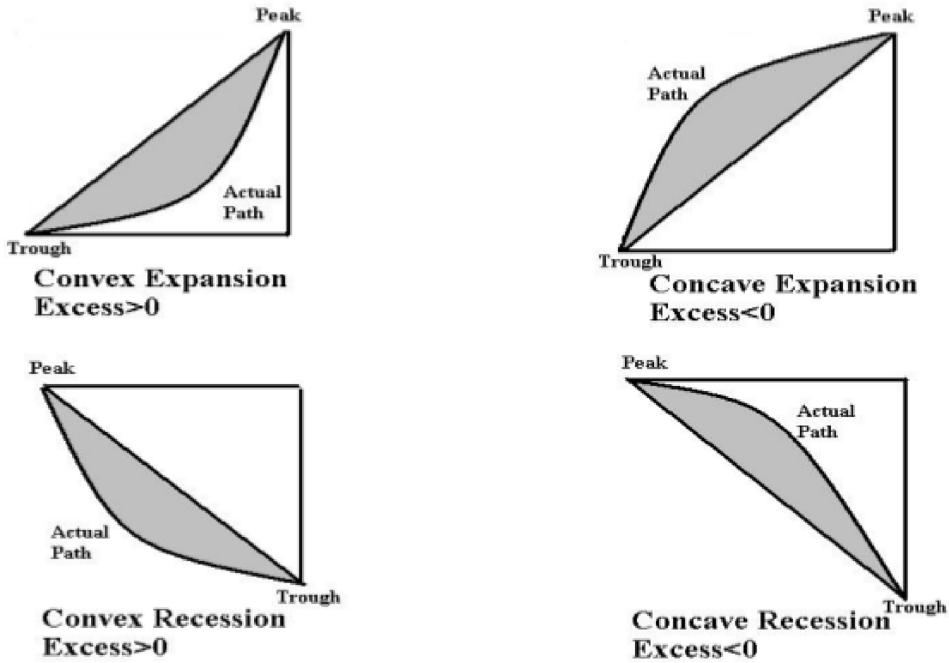
The period between two consecutive maximums/minimums is called duration of a cycle. In case of expansion, the amplitude is the production output (expressed in percentage) obtained during this phase, and in case of recession, it represents the recorded percentage loss, as shown in the figure below:



Source: Chart from Maximo Camacho et al., 2005, pp. 11-12.

Figure 2. *Amplitude, duration and cumulative movement in the description of economic cycles phases*

The cumulative movement (accumulation) represents the sum of the amplitudes calculated for each period based on the extreme point previously determined and it depends on the duration, the form and the amplitude of the phase. It has positive values in the case of expansion and negative values in the case of recession. The cumulative excess measures the difference between the actual and the hypothetical trajectory of the series if the transition between the two extreme points was a linear function; it allows the analysis of the concavity/convexity of the business cycle because it expresses an approximation of the second order derivative of the output function. Depending on the shape of the cycle, the cumulative excess may be labelled under "+" or "-": the current convex trajectories have positive slopes and record a cumulative excess with the "+" sign, while the current concave trajectories have negative paths with negative cumulative excess, as shown in the figure below:



Source: Chart from Maximo Canacho et al., 2005, p. 13.

Figure 3. *Concavity and convexity of the cumulative excess*

On the evolution index of the monthly industrial production we imposed both classic restrictions - classic parameters (the two minimum quarters to describe the phase of a cycle) but also the conditions used by Tsouma (as the Romanian economy tends to be more volatile in oscillations than the developed countries on which the classic analysis was conducted). The process of applying the BBQ algorithm for the monthly data in MATLAB was performed differentiated as follows:

1. In the first case the classic BB algorithm was applied. It holds the standard conditions of at least two quarters for the maximum/minimum points ("turnphase" – phase of the cycle of five months) and 15 months for the whole cycle duration.
2. The second case holds as a maximum point criterion a point followed by five months out of eight months of output recession, and as a minimum point, a point followed by five months out of eight months of output growth and a duration of the business cycle of at least 21 months.
3. The third case includes the maximum point criterion a point followed by eight months out of eleven months of output recession, and as minimum point, a point

followed by eight months out of eleven months of output growth and a duration of the business cycle of at least 27 months.

4. The fourth case holds as the maximum point criterion a point followed by eight months out of eleven months of output recession, and as a minimum point, a point followed by eight months out of eleven months of output growth and a duration of the business cycle of at least 27 months, with the specification that the work is done with de-trended data.

Results

Upon applying the methodology above for the trend series, the following extreme points have resulted; the first three cases represent versions of the modified BBQ for monthly data on the de-trended data:

Table 3. *Chronology of the turning points for the first case*

Maximum points	Duration from one extreme to another	Duration from extreme to minimum	Minimum points	Duration from minimum to minimum	Duration from minimum to extreme
Jun.91		19 months	Jan.93		
Aug.94	38 months	5 months	Jan.95	24 months	19 months
Jul.96	23 months	13 months	Aug.97	31 months	18 months
Sept.98	26 months	10 months	Jul.99	23 months	13 months
April.05	79 months	1 month	May 05	70 months	69 months
Feb.08	34 months	10 months	Dec.08	43 months	33 months
Oct.09	20 months	10 months	Aug.10	20 months	10 months
Nov.11	25 months				15 months

Source: data taken from the National Institute of Statistics and processed in MATLAB.

This method identified eight points of maximum and seven points of minimum. The average duration from extreme to extreme for the business cycles identified is of 35 months, and from minimum to minimum is 104.5 months according to the data provided by the NBER for the period 1991-2009. The average duration from minimum to minimum is 35.2 compared to the NBER data (between 1991 and 2009) business cycles recorded an average duration of 109.5 months. Using the interpolated monthly GDP, Tsouma obtains through the BB method, an average cycle duration between 1991-2008 of 197 months. The recessions and the expansions are asymmetric, as recessions record an average duration of the cycle of 11.7 months, and the expansions of 29.6 months. The trend of the business cycles for Romania is to maintain a relatively constant duration (except for the period 1998-2005) and the evolution of the economic activity in the analyzed period is more volatile than the studies mentioned; the Romanian economy is characterized as a small and open one, subject to both domestic and external shocks.

The method used indicates October 2009 as a maximum point and August 2010 as a minimum point, points that have not been written about in the literature as being extreme points of the business cycles in Romania. Therefore, we tested the robustness of this method by imposing more restrictive criteria to see to what extent some local extreme points of business cycles will remain and which ones will disappear and eventually selecting the option that provides the best picture of the cyclical economic activity in Romania.

Table 4. *Chronology of the turning points for the second case*

Maximum points	Duration from one extreme to another	Duration from extreme to minimum	Minimum points	Duration from minimum to minimum	Duration from minimum to extreme
			Jan. 93		
Jul. 96		13 months	Aug. 97	55 months	42 months
Sept. 98	26 months	10 months	Jul. 99	23 months	13 months
April. 05	79 months	25 months	Jul. 06	84 months	69 months
Feb. 08	34 months	12 months	Dec. 08	29 months	19 months

Source: data taken from the National Institute of Statistics and processed in MATLAB.

In the second case, the average duration of a cycle is 46.3 months from one extreme to another, from minimum to minimum is 47.8 months, which is a greater average duration than the one calculated based on the first version of the method, which can be observed in the table above (Table 4).

The average duration of a recession is 12 months, and the one of an expansion is 35.75 months, a considerable asymmetry between the two phases of the business cycle, longer in duration due to the criteria imposed, more restrictive in terms of selection of an extreme point of the business cycle. It can be noted the absence of any point of maximum/minimum after December 2008.

Below we highlight the chronology of business cycles in the third case. Here, there is a single cycle with a duration of 139 months from maximum to maximum and two cycles from minimum to minimum with an average duration of 96 months.

Table 5. *Chronology of the turning points for the third case*

Maximum points	Duration from one extreme to another	Duration from extreme to minimum	Minimum points	Duration from minimum to minimum	Duration from minimum to extreme
			Jan. 93		
Jul. 96		36 months	Jul.99	78 months	162 months
Feb. 08	139 months	11 months	Jan. 09	114 months	103 months

Source: data taken from the National Institute of Statistics and processed in MATLAB.

An average expansion takes place over 72 months and a recession over 23.5 months. Compared to this, according to the NBER, an average recession in the USA lasts 13 months for the period March 2001 – June 2009, and an expansion lasts 96.5 months from March 1991 to December 2007.

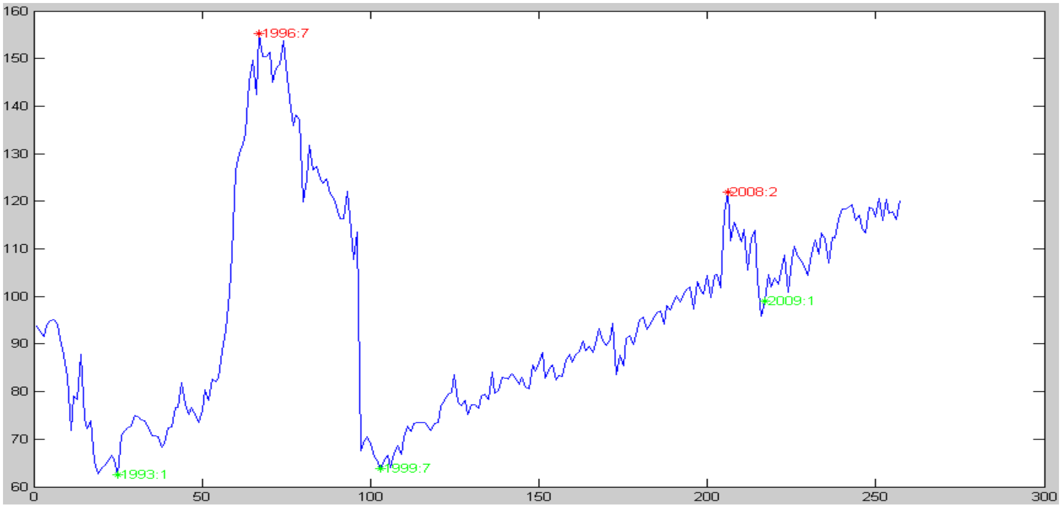
For the sake of comparison, we apply the same technique on the de-trended industrial production series using the HP filter. We obtain the fourth case.

Table 6. *Chronology of the turning points for the fourth case*

Maximum points	Duration from one extreme to another	Duration from extreme to minimum	Minimum points	Duration from minimum to minimum	Duration from minimum to extreme
			Jul. 95		
Jul. 96		30 months	Jan.99	42 months	12 months
May 01	58 months	48 months	May 05	76 months	38 months
Feb. 08	81 months	11 months	Jan. 09	42 months	33 months
Dec. 10	32 months				24 months

Source: data taken from the National Institute of Statistics and processed in MATLAB.

The average duration from one extreme to another is 57 months, the one from minimum to minimum is 56 months, from extreme to minimum 29 months, from minimum to extreme is 24 months. In this case there is an asymmetry between expansions and recessions, but this time expansions are shorter on average than recessions. The result is inconsistent with the literature that identifies expansions as having a longer duration than recessions. Therefore, we will choose the previous selection version of the extreme points (the third) which is closer to the literature results but also because this latter method better reflects the image of the Romanian economy, as shown in the chart below (Figure 4).



Source: Chart designed in MATLAB based on the data from the National Institute of Statistics

Figure 4. *Graphic representation of the turning points of the business cycles in Romania for the period 1991-2012, case 3*

Features of business cycles:

The characteristics of the cycles that the algorithm returns are: the average duration of the phase, the amplitude, the cumulative movement and the cumulative excess. Generally, there is an asymmetry between expansions and recessions in the duration except for the last case in which the average expansion lasts less than a recession.

Table 7. *Characteristics of the business cycles*

	Case 1		Case 2		Case 3		Case 4	
	R	E	R	E	R	E	R	E
D	11,17	29,67	12	35,75	23,5	72,5	29,6	24
A	-27,37	31,63	-29,98	38,28	-57,167	75,37	33	31
M.C.	-188,01	575,00	-178,21	618,97	1,0e+0,003* -0,072	1,0e+0,003* 1,71	-376,9	340,8
M.E.	2,58	31,39	448,89	24,97	-8,73	-34,13	-13,72	-6,3

D – duration, A – amplitude, M.C. – cumulative movement, M.E. – excess cumulative movement, R – recession, E – expansion. The values are averages from MATLAB.

The cumulative excess indicates the deviation of an economy from a constant evolution of the expansion/recession. A value of this indicator which tends to 0 expresses the linear dynamics of the business cycle phases. For expansion, a negative sign indicates a nonlinear behaviour with a gradual increase in earnings (concave expansion), while the "plus" sign indicates a convex expansion with a reduction in earnings in the form of output towards the end of fluctuation. During a recession, the "minus" sign indicates a concave recession in which losses are more intense towards the end of fluctuation and the "minus" sign indicates a convex recession with greater losses at the beginning of fluctuation (Cesaroni, et al., 2010, pp. 5-6).

In the first two cases the indicator is positive for expansion, but in the last two cases, the indicator becomes negative, highlighting a concave growth of the business cycle. For recession, the situation is similar in the third and the fourth case: it shows a convex recession, with great losses at the beginning of the phase.

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