

Building a Monthly Chronology of Recessions for the State of Espírito Santo

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ABSTRACT

The state of Espírito Santo has short-term fluctuations in its activity level ("business cycles") that are on average twice more volatile than fluctuations occurring in Brazil. In addition, there are differences in terms of duration between cycles occurring in the state and country. Because of this, the objective of this work is to build a monthly chronology of recessions for the Espírito Santo over the period between January 1991 and March 2012. In terms of means durations it was found that over the period analyzed the Espírito Santo went through a larger number of recessions than Brazil. On the other hand, in terms of median durations, it was noted that recessions tend to last less in the state than in the country, despite its greater relative volatility. Together, these results provide the first empirical characterization of the recessions that occurred in the state in the last 20 years as well as a comparison with the national context.

Keywords: Business cycles. Recessions. Espírito Santo.

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1 INTRODUCTION

The state of Espírito Santo has short-term fluctuations in its activity level ("business cycles") which magnitudes correspond, on average, twice the fluctuations occurring in the level of activity in Brazil. In addition, there are differences in terms of duration, between cycles occurring in the state and country. For example, expansion periods usually last on average three trimesters in Brazil, with its duration being only two trimesters for Espírito Santo. In fact, a first look at the data shows that the expansions and recessions in the state activity levels tend to be more volatile *vis-à-vis* with the national case (MAGALHÃES; RIBEIRO, 2011).

Because of these differences in terms of duration and magnitude of fluctuations, the objective of this work is to build a monthly chronology for the recessions in the Espírito Santo over the period of 1991: 01 / 2012: 03. Therefore, we chose to use the algorithm proposed by Bry and Boschan (1971), because of its widespread adoption in the literature related to the measurement of business cycles at the national level (eg, CHAUVET, 2002; DUARTE; ISSLER; SPACOV, 2004).

In economic terms, a recession can be defined as two consecutive declines at an activity level measured as the Gross Domestic Product (GDP), for example, with this concept often being used as a "rule of thumb" in applied analysis, as well as throughout the formulation and implementation of public policies (ABBERGER; NIERHAUS, 2008). In this context, the use of Bry-Boschan algorithm can serve the function of providing an alternative definition of recessions for the state and national contexts.

To conduct this empirical exercise, aggregate time series data were used that could capture, in some degree, the level of activity of the Espírito Santo's economies and Brazil over the analyzed period. Specifically, in a first stage, the industrial production indices were used (General Industry) of the Espírito Santo and Brazil, derived from the Monthly Industrial Survey - Physical Production of the Brazilian Institute of Geography and Statistics (*Pesquisa Industrial Mensal – Produção Física do Instituto Brasileiro de Geografia e Estatística - PIM-PF / IBGE*).

In a second step, regarding the implementation of robustness tests, we used an index of commodity prices, from the Institute of Applied Economic Research (*Instituto de Pesquisa Econômica Aplicada - IPEA*), as well as a leading indicator of the state activity level, coming from the Jones Santos Neves Institute (*Instituto Jones dos Santos Neves - IJSN*) (more details

below). In addition, the study aimed to compare the chronology built for this state framework with timelines for the national context and obtained from different methodologies, in order to verify the occurrence of any differences between the underlying economic structures.

The advantages related to work along these lines are basically two. First, due to the higher volatility on the level of economic activity of the state compared to that of the country (MAGALHÃES; RIBEIRO, 2011; MAGALHÃES; TOSCANO, 2012), it becomes interesting to draw up a chronology of specific recessions to local conditions, in contrast to timelines built for the country as a whole, as the case of the *Comitê de Datação de Ciclos Econômicos* (CODACE) of the Brazilian Institute of Economics - Getulio Vargas Foundation (*Instituto Brasileiro de Economia da Fundação Getúlio Vargas FGV-IBRE*)¹.

Second, the use of dating recessions methodologies for state economies may represent an important methodological innovation in the analysis of regional issues, to enable the identification of specific features to these locations, helping to identify the main existing economic differences between state and country in the short term and constituting at the same time, an important ingredient in the formulation and implementation of policies for the Espírito Santo's context. In particular, the knowledge related to economic fluctuations can be useful because of its impact on important economic issues such as those related to Public Budget and Social Welfare².

Overall, the results reported in this study can be interpreted as a first attempt at dating recessions or, in a broader sense, measurement of specific business cycles to the state economy of the Espírito Santo. Ultimately, the work adds to previous research efforts aimed both to describe the main stylized facts of business cycles at the regional level (CUNHA; MOREIRA, 2006; MAGALHÃES; RIBEIRO, 2011) and for the construction and the analysis of indicators history of the state activity level (BONELLI; BASTOS; ABREU, 2009; LIMA, 2009).

Following this introduction, the work is divided into four sections. The second section presents a partial review of the literature related to business cycles and construction of associated timelines. The third section describes the database and methodology used in the study. The fourth section presents the results obtained and the robustness tests. Finally, the fifth section contains the main conclusions and future research proposals.

¹ For information related to this proposed chronology, held nationwide, see CODACE (2009, 2010).

² Where an analysis along these lines, applied to the Espírito Santo's context, see, for example, Ribeiro (2010) and Salomão (2010)

2 THEORETICAL REFERENCE

The literature relating to dating business cycles has shown in recent decades a number of contributions related to the identification of empirical regularities, although there are differences in terms of construction methods used in some cases. This section of the study aims to present a partial review of contributions along these lines³.

Analyzing a sample containing annual data related to ten developed countries, over the 1850/1986 period, Backus and Kehoe (1992) documented some of the main stylized facts related to business cycles. The results obtained by the authors demonstrate that, despite considerable differences occurring between countries and time periods, in terms of volatility and the reported degree of co-movement cycles, one can check the occurrence of a relatively uniform pattern in case of macro-economic variables, a result that tends to corroborate ultimately to Lucas (1977) hypothesis, in which the author takes the view that, given the occurrence of empirical regularities related to business cycles, it would be possible to formulate and test generic theories related to this phenomenon⁴.

Basu and Taylor (1999) extended the original analysis of Backus and Kehoe (1992), highlighting the importance of theoretical and empirical aspects related to the study of business cycles at the international level. In addition to confirming the occurrence of several stylized facts, the authors stressed the importance of country-specific factors inherent in explaining cycles, with an emphasis on empirical pattern of exchange rates and real wages. The results call attention to the importance of historical and institutional aspects in explaining business cycles on an international scale.

The study by Stock and Watson (2000) corresponds to a research effort focused on the American case during the postwar period. In particular, the authors verify the occurrence of the main stylized facts of business cycles in the American economy, while seeking evidence related to the Phillips curve and the long-term relationships focused on the monetary and financial markets. Additionally, we list a number of empirical regularities related to the economy, while confirming the stability of the Phillips curve and long-term relationships analyzed.

³ For a summary of some of the main theoretical and empirical contributions related to the study of business cycles, see, for example, Lucas (1977), Zarnowitz (1985), Cooley and Prescott (1995), Woodford (1999) and Blanchard (2000). For reviews in Portuguese on the subject, see Magalhães (2000; 2005)

⁴ In the case of approaches in a similar manner to Lucas' proposals (1977, 1980), see Cooley and Prescott (1995) and King and Rebelo (2000). A critical view of this approach is contained in Harding and Pagan (2002).

Employing different dating techniques, Chauvet (2002) seeks to identify the phases of the business cycle that occurred in the Brazilian economy during the twentieth century (quarterly and annual data). The author compares the results obtained from Markov switching model with non-parametric rules of dating (the Bry-Boschan algorithm, for example), coming to the conclusion that all methodologies implemented tend to generate on average similar chronologies. On the other hand, it is emphasized the asymmetrical character of the fluctuations occurring in the national economy, since recessions tend to be generally shorter and more volatile, unlike expansive periods of longer duration and gradual occurrence. In general, the results of Chauvet (2002) can be seen as a first attempt of dating the business cycles in Brazil, and the results reported been previous to CODACE (2009), for example.

In Chauvet and Silva (2004), the authors construct leading indicators of recessions to the national context, from the use of a dynamic factor model with Markov changes and Probit models. In this case, the main goal is to predict turning points in real time in business cycles. After selecting the best indicators (in terms of forecast), the authors conclude that these represented an important tool for anticipating Brazilian recessions.

Duarte, Issler and Spacov (2004) discuss alternative indices of economic activity for the national context over the 1985-2002 period, while building a chronology of recessions, from the use of Bry-Boschan algorithm. Their results demonstrate that the Brazilian economy was in recession for approximately 30% of the analyzed period, and that can be considered relatively high, since the comparison with the US economy points to a ratio of 16% in the post-war period.

Interested in detecting periods of expansion and recession in the industry, Hollauer, Issler and Notini (2009) construct coincident indicators based on dual-frequency series, remaining attentive to differences between different methodologies. The authors conclude that there are significant differences between the Brazilian and North American economies, with emphasis on the frequency and amplitude of the recessions in the country during the period under review (1981:06/2004:03).

The work of Cunha and Moreira (2006) has a regional focus, since the authors analyze cyclical properties of GDP *per capita* measures of Federative Units (FUs) over the period 1985/2002 (annual data). For these units, the authors obtain two basic results: First, compared to Brazil, the states have, in general, more volatile and less persistent cycles; Then, according to these results, there appears to be a matching standard for periods of expansion and recession occurred both in the case of the country as the states.

Along similar lines, Magalhães and Ribeiro (2011) sought to identify the main stylized facts of business cycles occurred in the state of the Espírito Santo over the period 1991:01/2009:02 (quarterly data). The results reported by the authors show that the fluctuations occurring in the state economy over the analysis period tend to be, on average, two times more volatile than those occurring on the national scene, with this result working for several macroeconomic variables. In addition, according to them, although the state economy does not produce a coincident standard with the national, in terms of recessions in the period, is more compliance in the case of expansion periods.

The above references, in addition to emphasizing the importance of identifying the characteristics associated with business cycles and the construction of chronologies of recessions, will constitute the basis for the analysis conducted in subsequent sections.

3 DATA BASE AND METHODOLOGY

3.1 DATA

The data used in this study correspond to measures of level of activity for the state of Espírito Santo and Brazil. Specifically, the variables used to build the chronology corresponding to the recessions in the industrial production index of each unit. The primary source of data is the Monthly Industrial Survey - Physical Production (*Pesquisa Industrial Mensal – Produção Física PIM-PF*) of the Brazilian Institute of Geography and Statistics (IBGE).

In the section of robustness tests, we opted for the use of alternative measures that represent the level of state activity. Thus, we employed a commodities price index and leading indicator of Gross Domestic Product (GDP) on a quarterly basis.

The basic intention of that exercise was to verify if the chronology of recessions proposed presented a good fit to variables that reflect, in some way, the oscillations in the level of state activity. The data source corresponding to these measures is the *Instituto de Pesquisa Econômica Aplicada* (IPEA) and the Instituto Jones dos Santos Neves (IJSN), respectively (more details below).

The sample period analyzed corresponds to 1991:01/2012:03, having monthly data throughout most of the analysis⁵. We opted for the monthly frequency because of issues related to the size of the sample analyzed. In total, the sample contains 255 observations⁶.

⁵ In this case, the exception is the GDP indicator of IJSN, which has quarterly basis. For further details on this, see Bonelli, Bastos and Abreu (2009).

3.2 METHODOLOGY

As stated earlier, the methodology used to construct the chronology of recessions used in this study was the Bry-Boschan algorithm (BRY; BOSCHAN, 1971).

The main steps related to the algorithm are the following⁷:

1. In the first instance, it is determined the outliers of the analyzed series, and having as base 3.5 standard deviations of the means.

2. The outliers are replaced by values derived from a Spencer curve corresponding to a moving mean with seven observations of past and future series, according to the following expression:

$$S_t = \frac{1}{320} (-3x_{t-7} - 6x_{t-6} - 5x_{t-5} + 3x_{t-4} + 21x_{t-3} + 46x_{t-2} + 67x_{t-1} + 74x_t + 67x_{t+1} + 46x_{t+2} + 21x_{t+3} + 3x_{t+4} - 5x_{t+5} - 6x_{t+6} - 3x_{t+7}) \quad (1)$$

3. It is determined the maximum and minimum local moving mean series in 12 months. In this context, a maximum (minimum) local shall be the higher (lower) observation of five previous observations and five subsequent observations. In the event of two maximum (minimum) consecutive, you select the highest (lowest).

4. Inflection points determined in the previous step are refined based on the use of the Spencer curve. Specifically, for each maximum (minimum) determined previously, you select the higher (lower) observation of the Spencer curve, that of it employment is up to five observations. In the event of two maximum (minimum) consecutive, you select the highest (lowest). Additionally, are eliminated maximum and minimum so that the distance between two maxima (minima) is greater than or equal to 15 months.

5. It is computed the statistic denominated "Month of Cyclic dominance" (MDC), obtained as the lowest value MDC(j) that is less than the unity, obtained from the difference between the original series and the Spencer curve.

6. Inflection points determined in the previous step are refined from the moving mean series in MDC months.

⁶ Readers interested in obtaining the database used in this work can do so by contacting the authors.

⁷ The present disclosure is based on Hollauer, and Issler Notini (2009, Appendix A2). Readers interested in obtaining the Matlab routine used in the construction of monthly chronology of recessions based on the Bry-Boschan algorithm can do so by contacting directly the authors.

7. Is identified, for each maximum (minimum) determined in the previous step, the highest (lowest) observation of the series is located at a distance of up to Max (4, MDC) observations.

In general terms, Bry-Boschan algorithm is a series of procedures used in the detection of inflection points of a time series that the preparation was funded by the *National Bureau of Economic Research* (NBER). As previously mentioned, the main advantage related to this algorithm is due to its wide use in applied analysis⁸.

4 RESULTS

This section describes the main results of this work and is divided into three parts. The first reports results of unit root tests, while the second presents results related to monthly chronology of recessions built for the state of Espírito Santo. The third presents results of robustness tests.

4.1 UNIT ROOT TEST

At first the empirical analysis are reported results of unit root tests. Basically, running tests in this way justified by checking for any patterns of non-stationary in the analyzed series. Because of this, Table 1 presents the results of unit root tests of Dickey and Fuller (1981) (ADF) and Phillips and Perron (1988) (PP). In addition, they also reported results related to the tests proposed by Elliott, Rothenberg and Stock (1996) (ADF-GLS) and Kwiatkowski *et al.* (1992) (KPSS). The null hypothesis of the first three tests (ADF, PP and ADF-GLS) corresponds to the presence of a unit root examined in each series. In turn, the KPSS test the null hypothesis corresponds inversely to the stationarity of each series. The last two tests results are presented in order to generate greater robustness to the results related to the first two tests, given its known low power.

⁸For information, we used a six-month window in the definition of phase employed in the Bry-Boschan algorithm. Further details in this regard are in the section of work robustness tests.

Table 1 - Unit Root Tests Sample period: 1991:01/2012:03 (monthly data)

Variable	Test			
	ADF	PP	ADF-GLS	KPSS
Industrial Production - Brazil	-1.18 (3)	-1.27 (7)	0.45 (3)	1.99 *** (12)
Δ (Industrial Production - Brazil)	-9.42 *** (2)	-23.14 *** (3)	-1.32 (5)	0.03 (11)
Industrial production - Espírito Santo	-0.87 (1)	-0.94 (2)	0.87 (1)	2.03 *** (12)
Δ (Industrial Production - Espírito Santo)	-19.76 *** (0)	-19.76 *** (0)	-19.80 *** (0)	0.02 (3)

Source: Authors' calculations, based on data from the IBGE.

Notes:

(A) All series are expressed in natural logarithmic scale.

(B) The number of lags used in each test (reported in parentheses) were chosen according to the Schwarz Information Criterion.

(C) The null hypothesis of the first three tests (ADF, PP and ADF-GLS) corresponds to the presence of a unit root examined in each series. In turn, the null hypothesis of the KPSS test corresponds to the stationarity in each series.

(D) The terms (*), (**) and (***) denote rejection of the null hypothesis for each test to the levels of 10%, 5% and 1% significance level, respectively.

The results reported in the table allow to note that in the case of the vast majority of tests corresponding to the series state and national industrial production rates may be characterized as an integrated first-order (I(1)), since it features unit roots in levels, although the first difference of the natural logarithms are stationary.

4.2 MONTHLY CHRONOLOGY OF RECESESSES

Chart 1 shows the evolution of industrial production indices of Brazil (left chart) and Espírito Santo (right chart) over the period 1991:01/2012:03 and recessions obtained from Bry-Boschan algorithm (areas shaded in each chart):

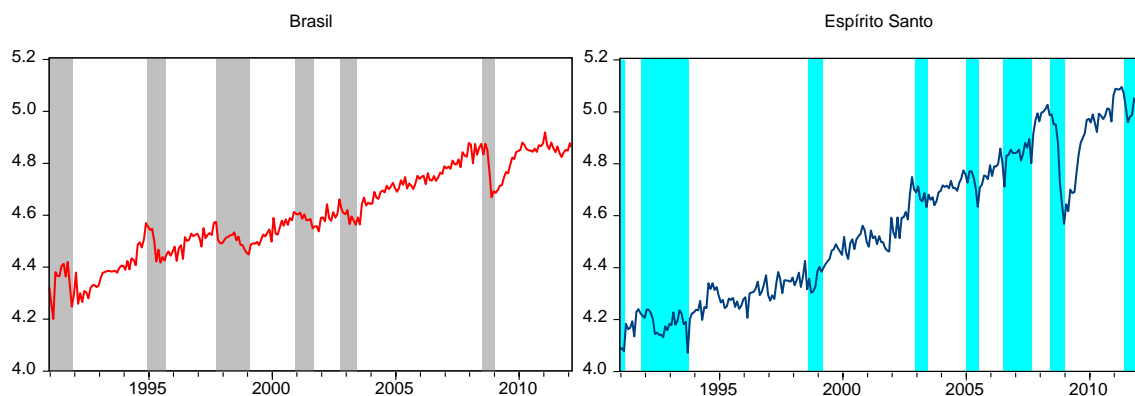


Chart 1 - Recessions' chronology (Bry-Boschan Algorithm) Brazil and Espírito Santo, 1991:01/2012:03

Source: Authors' calculations, based on data from the IBGE.

A first visual inspection reveals that, over the period under review, the Espírito Santo had a greater number of recessions (eight) compared to Brazil (six). Highlighting the heightened volatility in the oscillations reported in the state case against the national case, especially during the period following the international financial crisis of 2007-2008. Table 1 identifies the dates associated with each of the featured recessions in the chart referring to the state context:

Table 2 - Recessions in the Espírito Santo, 1991:01/2012:03

Begin	End
1991: 01	1991: 03
1991: 11	1993: 10
1998: 08	1999: 03
2002: 12	2003: 06
2005: 01	2005: 07
2006: 07	2007: 09
2008: 06	2009: 01
2011: 06	2012: 01

Source: Authors' calculations from the IBGE.

Notes:

(A) the dates of recessions contained in the table were built from Bry-Boschan algorithm (Bry and Boschan 1971) (phase = 06 months).

According to the results reported in the table, there were eight recessions in the state since the early 1990s, which durations and amplitudes varied according to the specific period considered. Thus, there is the occurrence of relatively short recession periods (three months), as is the case of the recession that occurred between January and March 1991, as well as periods longer than one year, case of the next recession, which began in November 1991 and ended in October 1993. In the recent period (2008 and 2011), we highlight two recessions, coincidentally the same duration (seven months), with each having started in June and ended in January of the same year⁹.

In order to explore in more detail the characteristics of recessions in the state and in the country over the analysis period, Table 3 presents the descriptive associated statistics:

⁹ The differences reported in terms of chronology of recessions built for the state and the country, are probably due to differences related to the economic structures of each unit of analysis. In principle, a possibility of analysis in this sense would correspond to the attempt to associate specific historical events to recession dates built for the Espírito Santo. Although interesting, the authors chose not to perform an analysis along these lines, given the relative lack of studies related to the performance of the state economy (Magalhães 2013) and the space constraint in the present work. Still, we would like to thank an anonymous opinion giver of this journal, for calling our attention to this point.

Table 3 - Recessions duration in Brazil and Espírito Santo 1991:01/2012:03

	Brazil (1)	Espírito Santo (2)	(2) / (1)
Number of Recessions	06	08	1.33
Mean Duration	8.31	9.15	1.10
Median Duration	8.17	7.13	0.87
Standard Dev.	4.44	6.66	1.50
Maximum Duration	15.27	23.37	1.53
Minimum Duration	2.00	2.00	1.00
Coef. Variation	0.54	0.73	1.36

Source: Authors' calculations from the IBGE.

Notes:

(A) the dates of recessions contained in the table were built from Bry-Boschan algorithm (Bry and Boschan 1971) (phase = 6 months).

The table summarizes the main characteristics associated with recessions in Brazil and in the Espírito Santo during the period considered. The second column of the table presents information relating to the national context, while the third column shows information regarding the state context. For comparison, the fourth column gives the ratio between the previous statistics.

In terms of average duration, state recessions have a higher value than national recessions (9.2 months versus 8.3 months, respectively). On the other hand, in terms of median duration, national recessions have a higher value (8.2 to 7.1 months). That is, once disregarding the outliers, you get a result where recessions tend to last less in the Espírito Santo than in Brazil, although increasing their volatility (measured by standard deviation).

This last point is confirmed by examining the other statistics available, since, during the period considered, the state had a maximum duration of recessions corresponding to almost two years (23.4 months), while the country posted a result considerably lower (15.3 months). According to the figures for the standard deviation and coefficient of variation confirms the heightened volatility in the fluctuations in the level of state activity, since the statistics are approximately 1.5 times higher than the statistics available for the level measurement of national activity.

Considering the total number of months of the recessions that occurred in the country and state, Table 4 shows the percentage of time that both units of analysis met in recession over the analysis period¹⁰:

Table 4 - Recession time in Brazil and Espírito Santo 1991: 01/2012: 03

	Brazil	Espírito Santo
Recession Time (TR)	19.78%	29.06%
Average interval between Recessions	5 Months	3.3 Months

Source: Authors' calculations from the IBGE.

Notes:

(A) the dates of recessions contained in the table were built from Bry-Boschan algorithm (Bry and Boschan 1971) (phase = 6 months).

Basically, the results for the time recession show that Brazil was in recession periods for 20% of the sample period considered, with this proportion being higher in the Espírito Santo's case, and corresponding to 30%. That is, on average, every five consecutive months of a year, the country went through a recession, with the frequency being higher for the state (3.3 months).

Figure 2 shows the co-evolution of industrial production indices of Brazil and Espírito Santo, as well as the associated recessions. In this chart, light areas represent recessions for the national context, while dark areas represent recessions for the state context.

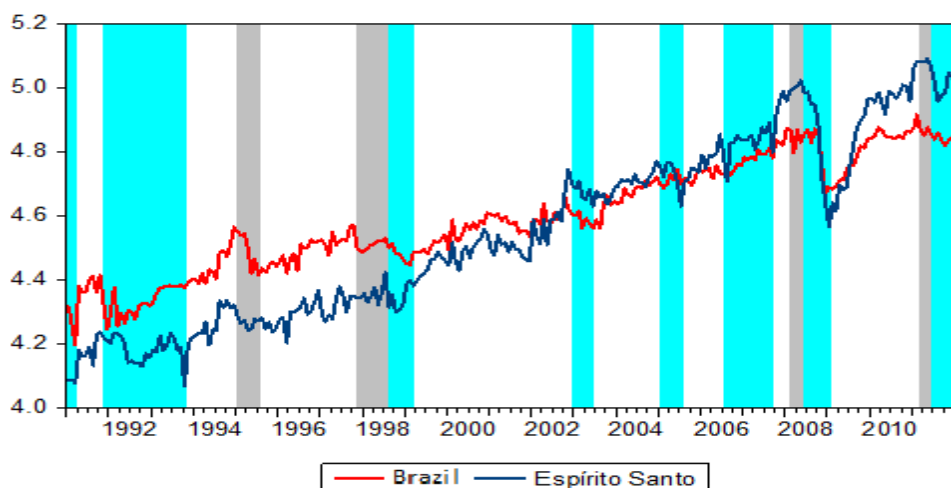


Chart 2 - Comparison Between Recessions Brazil and Espírito Santo, 1991:01/2012:03

Source: Authors' calculations, based on data from the IBGE.

Notes:

(A) the dates of recessions contained in the table were built from Bry-Boschan algorithm (BRY; BOSCHAN, 1971) (phase = 06 months).

¹⁰ Recession Time (TR) of each unit of analysis was obtained from the following formula: $TR = \sum_r M_r / (\text{Total de Meses da Amostra})$, wherein M_r denotes the term in a recession months.

The chart confirms two basic facts: first, more recessions occurring in the state; second, the higher relative volatility of its industrial production index. Overall, these results are consistent with the findings reported in other studies related to the Espírito Santo's context (MAGALHÃES; RIBEIRO, 2011; MAGALHÃES; TOSCANO, 2013), for example.

Additionally, it can be noted that, although there is overlap between country and state recessions, part of the state recessions (three) show a lagged pattern behind the national recessions. This result calls attention to the occurrence of contractions in national activity level as a potential explanatory factor of the oscillations suffered by the level of state activity, although this is still an exploratory hypothesis at the moment¹¹.

The results regarding the recessions of chronologies constructed for the country and the state from Bry-Boschan algorithm allow us to infer that Espírito Santo has its own economic characteristics, which ultimately affects even the number, amplitude and duration of recessions occurred in the state. Ultimately, these results call attention to specific local conditions when analyzing the Espírito Santo's economic structure.

4.3 ROBUSTNESS TESTING

In this section, are exposed results of robustness tests related to previous results. The basic intention of these tests is to verify that the main empirical results described above are robust to variations in methods of analysis and/or data.

For the sake of simplicity, robustness tests set forth below were divided into two basic categories: (i) changes in Bry-Boschan algorithm; (ii) use of alternative measures activity level for the state of Espírito Santo.

4.3.1 *Bry-Boschan algorithm*

In implementing the Bry-Boschan algorithm, there are implementation of alternatives related to the definition of recessions¹². For example, one can define a phase of a business cycle corresponding to six to nine months. The above analysis has exposed a chronology of recessions built from a definition corresponding to six months. Because of this, this robustness test changes this initial hypothesis, considering a definition of recession corresponding to a nine-month window. Related results are contained in Figure 3 and Table 5:

¹¹ For information, it is noteworthy that Granger causality tests were performed involving recession dates of of Espírito Santo and Brazil over the analysis period. The results (not reported) indicate a temporal precedence standard at the national level of activity over the level of state activity. That is, on average, recessions occurred in Brazil tend to precede those occurring in Espírito Santo.

¹² For further details in this respect see, beyond the original reference (Bry and Boschan 1971), *Matlab* routine associated with the algorithm.

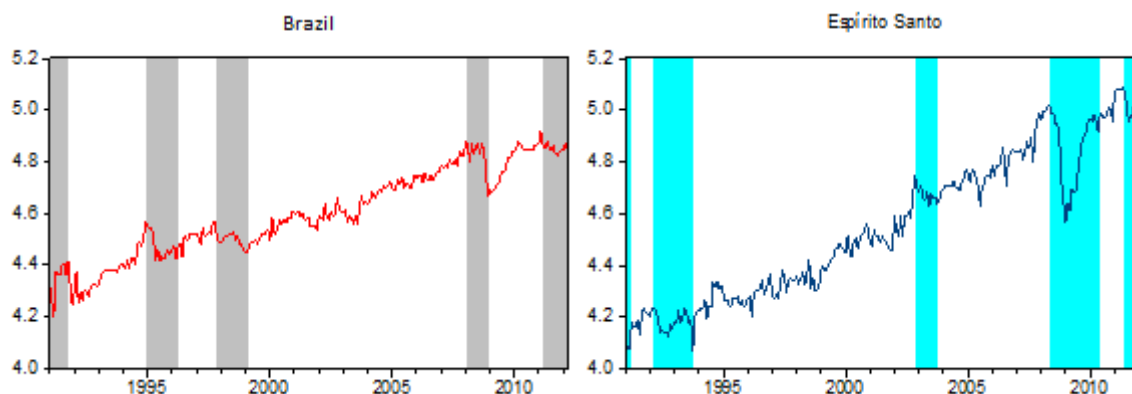


Chart 3 - Robustness: Changes in Bry-Boschan Algorithm (Phase = 09 Months) Brazil and Espírito Santo, 1991:01/2012:03

Source: Authors' calculations, based on data from the IBGE.

Notes:

(A) the dates of recessions contained in the table were built from Bry-Boschan algorithm (Bry and Boschan 1971) (phase = 09 months).

Table 5 - Robustness: Recessions Duration in Brazil and Espírito Santo Algorithm Bry-Boschan (Phase = 09 Months) Brazil and Espírito Santo, 1991: 01/2012: 03

	Brazil (1)	Espírito Santo (2)	(2) / (1)
Number of Recessions	0 5	0 5	1, 00
Mean Duration	11, 59	11, 68	1, 01
Median duration	11, 38	9, 67	0 85
Standard Dev.	2, 87	8, 10	2, 82
Maximum Duration	15, 27	23, 33	1, 53
Minimum Duration	8, 13	2, 00	0 25
Coef. Variation	0 25	0, 69	2, 80

Source: Authors' calculations from the IBGE.

Notes:

(A) the dates of recessions contained in the table were built from Bry-Boschan algorithm (Bry and Boschan 1971) (phase = 9 months).

The reported results indicate a reduction in the number of recessions in the state when we employ the alternative setting for the phase of the Bry-Boschan algorithm. In particular, in this case, the display state becomes the same number of recessions of the country (five recessions). On the other hand, it is interesting to note that, even so, there are still occurring differences in the timing and magnitude of recessions built, with the Espírito Santo in distinct periods than with respect to Brazil.

In terms of descriptive statistics related to the duration of recessions in the country and in the state, there is a qualitative maintenance of the previous results. That is, although the state begins produce an means duration substantially equal to the statistics reported to the country (11,6 months), yet has a higher volatility in its recessions (coefficient of variation of

0.7 and 0.3, respectively). A similar conclusion is the case of the maximum and minimum duration of recessions.

On the other hand, in the median duration, there is, once again, the occurrence of a smaller value relative to the state *vis-à-vis* of the country, these lines with a result showing that although recessions are relatively volatile in the state, they tend to be of shorter duration.

The reported results call attention to the importance of the value of the parameters used in the construction of chronologies of recessions in the case of Bry-Boschan algorithm¹³. On the other hand, it shows a maintenance of previous results; that is, the differences between country and state in terms of occurrence and magnitude of recessions.

4.3.2 Alternative Measures of Activity Level

In the case of this robustness test, we chose to verify the adequacy of the chronology of recessions offered in the case of alternative measures of activity level, since the IBGE industrial production index corresponds to a small indicator to some specific sectors only.

Basically, we chose to use measures that could reflect, in some way, the oscillations of state activity level. In this case, the objective of this robustness test is to verify if the chronology of recessions proposed is relatively good fit of alternative measures of activity level. For this, two variables were used: an index of commodities prices, from the Applied Economic Research Institute (*Instituto de Pesquisa Econômica Aplicada* - IPEA), as well as a leading indicator of the state activity level, coming from the *Instituto Jones dos Santos Neves* (IJSN).

The choice of the first variable was based on the characterization of the state economic structure as a small open economy and the consequent impacts that commodity prices tend to have on its activity level, in accordance with the available empirical evidence¹⁴. For the second variable, its choice is due to the fact that it represents an estimate of activity level with approximately two years prior in relation to official disclosure of IBGE Regional Accounts¹⁵.

¹³ Already, we suggest this topic for future research.

¹⁴ See, in this regard, Magalhães (2011), which presents an empirical analysis related to commodity prices impact on the level of activity of Espírito Santo. In the case of analyzes that try to characterize the state economy as a small open economy, see, in addition to the previous reference, Pereira and Maciel (2010) and Magalhães and Toscano (2012, 2013).

¹⁵ This indicator is prepared and published by *Instituto Jones dos Santos Neves* (IJSN), with data available for the period 2004:01/2011:04 (quarterly frequency) only. For more information about its construction and estimation, see Bonelli, Bastos and Abreu (2009). In the case of Figure 5, the dates of state recessions were added to the quarterly frequency, since this frequency corresponds to the preceding indicator IJSN.

Ultimately, it is expected that, given the methodological differences between each of these measures and the industrial production index, it is possible to capture the adequacy of the proposed chronology. Table 6 contains estimated correlation coefficients between the industrial production index of the Espírito Santo and the variables considered. The basic purpose of the table is to highlight the degree of linear association between these variables.

To provide more robustness to the results, there are two considered stationary transformations of the original series: first differences of natural logarithms and cyclical components obtained from the Hodrick-Prescott filter (Hodrick and Prescott 1997).

Table 6 - Robustness: Correlation Coefficients Between Activity Level Measures

First-Differences of Natural Logarithms			
	□(Industrial Prod.)	□(Quarterly GDP)	□(Commodities Price)
ΔΔ(Industrial Prod.)	1		
ΔΔ(Quarterly GDP)	0.85 *** (0.00)	1	
ΔΔ(Commodities Price)	0.70 *** (0.00)	0.71 *** (0.00)	1
Cyclical components (Hodrick-Prescott)			
	Industrial Prod.	Quarterly GDP	Commodities Price
Industrial Prod.	1		
Quarterly GDP	0,92 *** (0.00)	1	
Commodities Price	0,79 *** (0.00)	0,87 *** (0.00)	1

Source: Author's calculations.

Remarks:

(a) Sample period: 1991:01/2012:03.

(b) The terms (*), (**) and (***) denote rejection of the null hypothesis for each test to the levels of 10%, 5% and 1% significance level, respectively.

The results show, at first, that there is a high degree of linear association between the variables, since the estimated correlation coefficients are all statistically significant (at 1%), and in the range from 0.70 to 0,92. At first, these results point to the possibility of the considered variables represent *proxies* appropriate for the level of Espírito Santo's activity.

Figures 4 and 5 expose the temporal evolution of the two measures considered: the price index of commodities (Chart 4) and the leading indicator of quarterly GDP of the Espírito Santo (Chart 5). In the case of both graphs, it was decided to expose the series in log-levels (left) and first differences of natural logarithms (right). The basic intention from that choice was to pay attention to short-term fluctuations of the series, captured by the transformations performed, as well as possible adaptation of the short-term movements in relation to the chronology proposed.

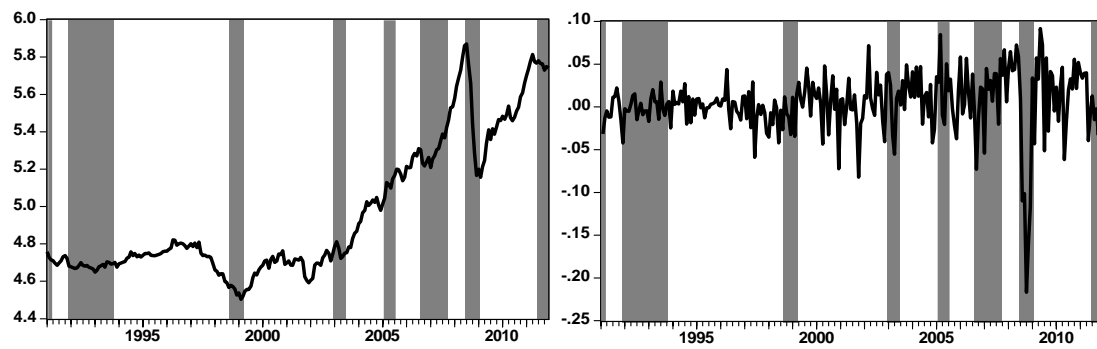


Chart 4 - Robustness: Alternatives Measures of Activity Level, Commodities' Price Index Espírito Santo, 1991:01/2012:03 (Monthly Data)

Source: Authors' calculations, based on IBGE and IPEA data.

Notes:

- (a) The dates of recessions contained in the table were built from Bry-Boschan algorithm (Bry and Boschan 1971) (phase = 6 months).
- (b) The series used as a proxy for activity level is the IPEA commodity price index. In this case, it was decided both by the inclusion of the series in log-levels (left chart) and in first differences of natural logarithms (right chart).

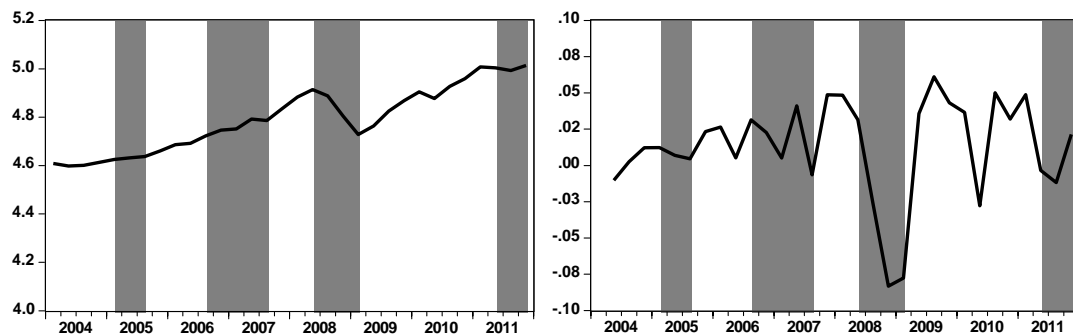


Chart 5 - Robustness: Alternative Measures of Activity Level, Background indicator of Quarterly GDP Espírito Santo, 2004:01/2011:04 (quarterly data)

Source: Authors' calculations, based on IBGE and IJSN data.

Notes:

- (a) The dates of recessions contained in the table were built from Bry-Boschan algorithm (Bry and Boschan 1971) (phase = 6 months).
- (b) The series used as a proxy for activity level is the leading indicator of quarterly GDP of the Espírito Santo of the *Instituto Jones dos Santos Neves* (IJSN). In this case, it was decided both by the inclusion of the series in log-levels (left chart) and in first differences of natural logarithms (right chart).

Overall, the results for the two years considered point to a relatively good adaptation of the chronology of recessions prepared for the state, given the antecedent character of both indicators (commodities price index and quarterly GDP indicator). That is, when analyzing the charts relating to the first differences of the series, we note that contraction movements of the analyzed series tend in general to anticipate the occurrence of recessions built from the proposed methodology.

5 CONCLUSIONS AND FUTURE RESEARCH AGENDA

The aim of this work was to construct a monthly chronology of recessions in the state of Espírito Santo over the period 1991:01/2012:03, from the use of Bry-Boschan algorithm, comparing the results with those of the national context.

The results show that over the analysis period, the Espírito Santo went through a larger number of recessions than Brazil. Specifically, the state recessions had a mean duration around nine months, while the national recession had a mean duration of around 8 months. On the other hand, in terms of median duration, there was the occurrence of a shorter time in context state *vis-à-vis* the domestic context, although there is a greater volatility of recessions in the first case. Than the maximum durations, the Espírito Santo showed an amount corresponding to two years (23.37 months), considerably higher than the value for the Brazil (15.27).

These results are robust to the use of alternative measures to capture the level of state activity (commodities' price index and leading indicator of quarterly GDP of Espírito Santo), although there are differences when modifying parameters related to Bry-Boschan algorithm dating. Still, the results of the experiments conducted showed that the main results concerning the timing of recessions are kept in qualitative terms. In particular, it is worth highlighting the differences occurred between state and country with respect to the timing and scale of fluctuations in their level of activity.

For one thing, these results confirm incidents reported in previous research efforts (e.g., MAGALHÃES; RIBEIRO, 2011). On the other hand, it draws attention to the specific differences of the Espírito Santo's economy, with emphasis on high volatility of its level of activity and the asymmetric nature of the phases of business cycles, results in accordance with studies related to other contexts (e.g., CHAUVET; SILVA, 2004; CUNHA; MOREIRA, 2006).

An important limitation of the results reported in this paper relates to the mechanical nature of the construction recessions monthly chronology, since it is a purely statistical procedure was used. Because of this, the development of alternative timelines, based on historical events and alternative construction methods can generate new insights related to the duration and amplitude of business cycles occurred in Espírito Santo.

In terms of future research, there are two basic suggestions. First, it would be interesting to build timelines of business cycles based on alternative methodologies such as Markov regime switching model regime and/or coincident indicators of economic activity, as do

Chauvet (2002), Duarte, Issler and Spacov (2004) and Hollauer, Issler and Notini (2009), for example.

Second, gains importance in this context the formulation of hypotheses related to why the state economy has distinct economic characteristics from the national economy and other Federal States (FUs). In this sense, explanations based on historical evidence and theoretical models that concentrate on the key features of the state economy (small open economy with the exports concentrated in commodities), could represent the first step in identifying the strengths and weaknesses of Espírito Santo's economy in the short and medium term¹⁶.

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¹⁶ In the case of attempts on these lines, see Magalhães and Toscano (2012, 2013).

<http://portalibre.fgv.br/main.jsp?lumChannelId=4028808126B9BC4C0126BEA1755C6C93>
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