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Same, but different? A state-level chronology of the 2014-2016 Brazilian economic recession and comparisons with the GFC and (early data on) COVID-19

Jéfferson A. Colombo
Getulio Vargas Foundation (FGV EESP, Brazil)

Martinho R. Lazzari
Planning Secretariat of the State of Rio Grande do Sul (Brazil)

Abstract

This paper identifies and discusses the regional heterogeneity of the Brazilian great economic recession of 2014-16. Specifically, we outline a state-level chronology of the recession by applying the Bry-Boschan algorithm, using the states' monthly index of economic activity as reference variables. The results indicate that the recession lasted 32 months, and the economic activity fell (peak to trough) 11.8% for the average Brazilian state. However, we find a significant heterogeneity regarding timing, duration, and magnitude of the recession -- on average, more industrialized states (with greater participation of the agricultural sector) entered before (after) and stayed more (less) in a state of recession. We also find the dispersion, severity, and diffusion of the 2014-16 recession across states was far more significant than in the 2008-09 economic recession. Finally, preliminary data suggests that the significant and widespread drop in regional economic activity following the COVID-19 shock is 12.7% and 77.1% larger than those observed in the 2014-16 and the 2008-09 recessions, respectively. Our results have critical implications for policymakers.

1   Introduction

The Brazilian recession of 2014-16 was the country's worst economic downturn since the 1980s. In 11 quarters, Gross Domestic Product (GDP) shrank 8.6% (see Figure 1), while the global economy grew at a rate of 3.5% per year (International Monetary Fund, 2019). Unlike the 2008-09 recession, which stemmed from the international financial crisis, the recession of 2014-16 was a consequence of internal factors. During these three years, the fall in output resulted from interventionist economic measures that led to an increase in public debt, inflation, and interest rates (see, for example, Barbosa Filho (2017)). Some researches also argue that the recession was fostered by the austerity program initiated in 2015 (see Dweck and Teixeira (2017)).

Figure 1. Volume index of GDP and economic recessions in Brazil, 1st quarter of 2002 to 1st quarter of 2020
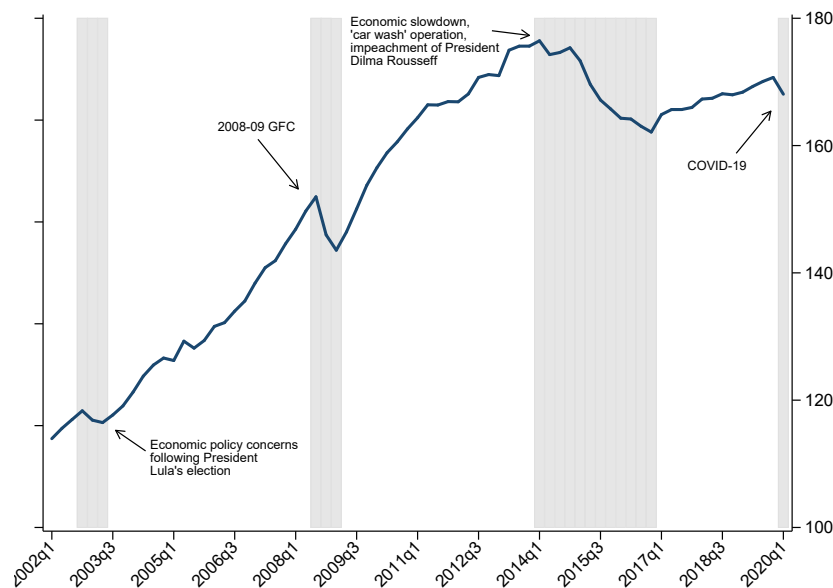
Note: the real GDP series comes from the Brazilian Quarterly System of Accounts (IBGE) and is seasonally adjusted (1995=100). The shaded areas (gray) identify periods of economic recession diagnosed by the Cycle Dating Committee of Brazil - CODACE/IBRE.

Although one can find several articles (such as those cited above) discussing the causes, characteristics, and consequences of the 2014-16 recession, there is still no evidence of how the recession spread among the federal states (UFs). This article attempts to fill this gap by using the Bry-Boschan algorithm (Bry and Boschan, 1971) to establish the beginning and end, duration, and magnitude of the recession in different states (a procedure used, for example, by OECD (2012)). Further, we discuss the idiosyncrasies, commonalities, and diffusion of the recessionary phase. Finally, we compare each characteristic of the estimated chronology of cycles – timing, magnitude, and duration – of the 2014-16 recession with those from the 2008-09 recession and preliminary data from the COVID-19 shock.

The importance of analyzing the behavior of state economies during the recession is anchored in two main reasons. First, analyzing the regional heterogeneity of the recession

(where it began, where it lasted the most, where it was most intense, and so on), one can better understand the national recession itself. Specifically, a country's economic performance is a composition of (potentially) very different regional economic performance (Porter, 2003). Second, besides being the 8th largest economy in the world (International Monetary Fund, 2019), Brazil is a country of continental dimensions, with significant heterogeneity in the productive matrix of its 27 states. These differences suggest that there may be significant differences between states in terms of the characteristics of the economic recession of 2014-2016, a hypothesis we test in this paper.

We use the Regional Economic Activity Index of the Central Bank of Brazil (IBCR) as reference indices (Central Bank of Brazil, 2020). The IBCR is a coincident monthly index for both the aggregate economy and selected states and regions. Its purpose is to replicate the short-term movements of GDP, but monthly. Besides the higher frequency, the IBCR has other advantages over quarterly GDP. First, while GDP is available on a quarterly basis for a few Brazilian states only, the IBCR has broader coverage. Second, the fluctuations of the IBC-BR – the series that represents the aggregate Brazilian economy – are highly correlated with the national quarterly GDP (.9862 and highly significant). Finally, the peaks and troughs (beginning and end of a recession, respectively) of the IBC-BR almost overlap with the peaks and troughs dated by the Economic Cycle Dating Committee (CODACE).

In the analysis, we use all state-level available IBCR series: Amazonas (AM), Bahia (BA), Ceará (CE), Espírito Santo (ES), Goiás, (GO), Minas Gerais (MG), Pará (PA), Paraná (PR), Pernambuco (PE), Rio de Janeiro (RJ), Rio Grande do Sul (RS) and São Paulo (SP). We also use the IBC-BR, that represents the national economy. The 13 states in the sample sum 87.0% of Brazil's GDP (Brazilian Institute of Geography and Statistics, 2016).

The remainder of the article is organized as follows: section 2 describes the methodological procedures. Section 3 presents the results, followed by a discussion between the 2008-09, 2014-16, and (early data from) the COVID-19 economic recessions (section 4). Finally, section 5 concludes.

2 Methodological Aspects

In order to detect the turning points of the cycles of the variables, we follow the approach of Brown et al. (2017) and Pagan (2010) and apply the Bry and Boschan (1971) algorithm on the log-transformed monthly state-level coincident series $(y_{i,t} = 100 * log(Y_{i,t}))$.[1] The Bry-Boschan Algorithm is a way of automatizing the cycle dating procedure according to the tradition of the National Bureau of Economic Research (NBER). In a nutshell, the method considers some rules imposed on the behavior of the series to classify peaks and troughs. A recession occurs from peak to trough, and an expansion occurs from trough to peak. First, a window is chosen in order to identify local maximums $(y_{t-k}, ..., y_{t-1} < y_t > y_{t+1}, ..., y_{t+k})$ and minimums $(y_{k-t}, ..., y_{t-1} > y_t < y_{t+1}, ..., y_{t+k})$ in the reference series. Second, a minimum period is required for the duration of a phase of the cycle, i.e., the time elapsed between a peak (trough) and a (peak) trough. Third, the algorithm also requires a parameter for the minimum duration of the complete cycle (peak to peak or trough to trough). Together,

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[1]The application was performed in Stata 15, using the "sbbq" package, created by Philippe Bracke.

these restrictions aim to suppress noises not related to the business cycle.

Specifically, we follow Pagan (2010) and use the following parameters (suggested for monthly data):

$$
\text{Parameters} =
\begin{cases}
\text{Window} & \text{Equal to 5 months } (k = 5) \\
\text{Minimum phase length} & \text{Greater than or equal to 5 months} \\
\text{Minimum cycle length} & \text{Greater than or equal to 15 months}
\end{cases}
$$

Finally, because some falls in economic series are substantial but quite short (e.g., the effects of the great financial crisis of 2008 in Brazil), we impose a particular case that overrules the minimum phase restriction (Pagan, 2010). It is called the "threshold parameter": very severe falls, although rapid, are classified as recession periods.

Besides being robust and straightforward (Berge and Jordà, 2013), we justify the choice of this algorithm because it also generates results that closely match the NBER recessionary periods in the U.S. (Brown et al., 2017). Before running the analysis, we experimentally applied the BB algorithm to the quarterly GDP of Brazil (at constant prices), and we got peaks and troughs that almost replicated the recessionary periods dated by the CODACE (see Figure 1)[2]. Our tests also suggest that the algorithm not only overlaps with the CODACE's chronology of recessions, but the algorithm does not present "false positives". Thus, we felt a lot confident in applying the method to the Brazilian states.

3   Results

After applying the parameters presented in Section 2 to national and state monthly economic indicators (IBCBR and IBCR, respectively), we identified the local minimums (troughs) and maximums (peaks) for each observational unit. Next, we establish the timing (when it started), the duration (months), and the depth of the 2014-2016 recession (percentage variation from peak to trough).

3.1   Chronology and timing of the recession by observational unit

Table I shows that the start and end dates of state recessions were quite heterogeneous. The first state to reach a peak in its activity level (and consequently to start a recession) was MG (2013m6), followed by SP (2013m9) and RS (2013m10). These states are relatively more industrialized, diversified economies, with significant participation in the national GVA. As a result, the IBC-BR itself signaled a peak in 2013 (2013m12). All other states in the sample went into recession in 2014, except for RS, which entered only in 2015. The last states to reach a peak in activity level were CE (2014m9), ES (2014m11), and RJ (2015m1).

Figure 2 reveals the exact timing and exit from the recession for all observational units. As for the end of the recession, the results indicate that AM (2016m4) and ES (2016m8)

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[2]One crucial difference should be noted. Because the BB algorithm needs the symmetric window condition to be satisfied, it can not identify the COVID-19 recession using data up to May 2020. The CODACE identified an economic recession in Brazil beginning in the 1st quarter of 2020 (Economic Cycle Dating Committee – CODACE, 2020).

Table I. Chronology, duration and magnitude of the 2014-16 recession across states

This table summarizes the results of the cyclical dating performed for Brazil and its states, applying the Bry-Boschan algorithm. The reference series are the Indices of Economic Activity of the Central Bank of Brazil (IBCs). The duration of the recession is the period between the peak and the trough diagnosed around the time of the national recession (2014-2016). The magnitude of the recession is the percentage difference in the series's level from peak to trough.

| State	Abbrev.	Peak	Trough	Duration (months)	Depth (%)
Amazonas	AM	2014m3	2016m4	25	-18.4
Bahia	BA	2014m7	2017m7	36	-13.1
Ceará	CE	2014m9	2016m8	23	-10.7
Espírito Santo	ES	2014m11	2016m8	21	-17.7
Goiás	GO	2014m7	2016m11	28	-9.3
Minas Gerais	MG	2013m6	2016m10	40	-11.2
Pará	PA	2014m12	2016m12	24	-6.8
Paraná	PR	2014m1	2016m12	35	-9.9
Pernambuco	PE	2014m1	2017m2	37	-12.5
Rio de Janeiro	RJ	2015m1	2017m7	30	-9.3
Rio Grande do Sul	RS	2013m10	2016m12	38	-13.9
São Paulo	SP	2013m9	2016m12	39	-11.6
Santa Catarina	SC	2014m2	2016m12	34	-9.4
Brazil	BR	2013m12	2016m12	36	-10.7
Mean	**-**	**-**	**-**	**32**	**-11.8**
DP	**-**	**-**	**-**	**6.5**	**3.2**
Median	**-**	**-**	**-**	**34**	**-11.0**
Min	**-**	**-**	**-**	**21**	**-18.4**
Max	**-**	**-**	**-**	**40**	**-6.8**

were the first to reach a local minimum (consequently, to enter an expansive phase of the cycle). BA (2017m7) and RJ (2017m7) were the last two to emerge from the recession.

The results suggest, therefore, that there is a 19-month interval between the first (MG, 2013m6) and the last state to dive into recession (RJ, 2015m1). However, significant asymmetry is also observed at the end of the recession: from AM (2016m4) to BA and RJ (2017m7), there are 15 months. A map-based representation of the start and end of the recession across states is shown in the Appendix (Figure 4).

3.2   Duration and magnitude of the recession across states

Analyzing the data from Table I, we infer that the average duration of the recession was 32 months, with a standard deviation of 6.5 months. In general, the recession was relatively longer in the states with the most extensive participation in the national economy (SP, MG, RS, and PR) and shorter in the states at the bottom of economic participation. Geographically, the recession lasted longer in the Southeast and South regions and lasted less time in

Figure 2. Timeline of entrance and exit from the recession for all states
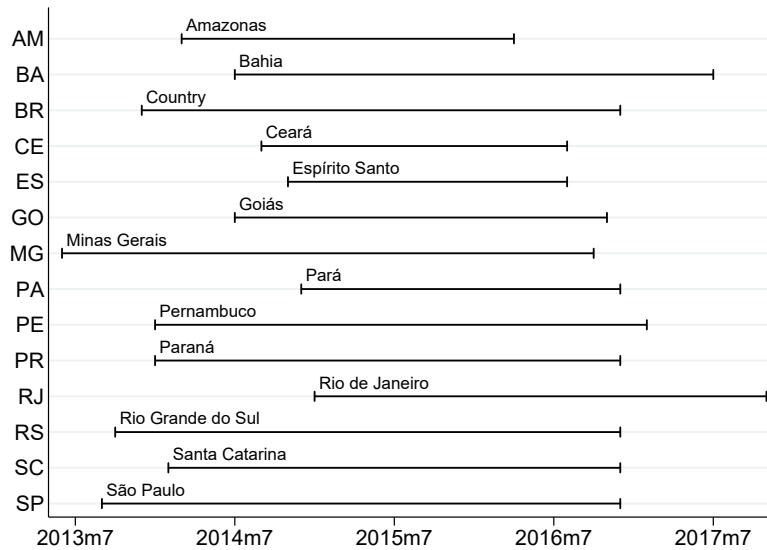
the North, Northeast, and Midwest.

Regarding the magnitude of the recession, Table I shows that the average decline of state economies was 11.8%, with a standard deviation of 3.2 percentage points. PA, where the mining sector plays a vital role in the local economy, is the state in which the reduction of production was milder (-6.8%). RJ, GO, SC, and PR also underwent a recession in a better than average situation. CE had a drop equal to that of Brazil, and all other states had more considerable economic activity losses. The most prominent falls occurred in ES (-17.7%) – largely affected by the rupture of the Vale dam in Mariana in 2015 – (Instituto Jones, 2016) and AM (-18.4%) – a state with a significant electronics industry. For a more in-depth discussion on how ex-ante economic characteristics shaped the magnitude of the decline in each state, see Colombo and Lazzari (2018).

## 3.3 Relationship between characteristics: duration vs magnitude of the recession

The left part of Figure 3 shows the dispersion of the duration and magnitude data in 13 states plus Brazil (Panel a – Full sample). A first look on the linear fit suggests that the longer the duration, the lower the magnitude of the recession, on average.

However, we have some critical idiosyncrasies that affect this association. The first one is related to the economic effects on the mining industry of Espírito Santo following the rupture of the Vale dam in Mariana in 2015 (Instituto Jones, 2016). With the shutdown of VALE's operation, the ES had a deeper recession than it would have in the absence of the event. Another outlier in the analysis is the state of Amazonas and the over-represented participation of the electronics manufacturing in its economy (because of the "Free Zone of Manaus", the state capital), which made the recession in this state relatively more profound.

Because of these singularities of ES and AM, we also show in Figure 3 the relationship

between duration and magnitude with the linear adjustment disregarding these states (Panel b – Sample without outliers). Without these two states in the sample, the relationship between duration and magnitude of the recession becomes positive: the larger the recession's duration, the larger the fall in economic activity from peak to trough.

Figure 3. Relationship between duration and magnitude of the recession

(a) Full sample

(b) Sample without outliers
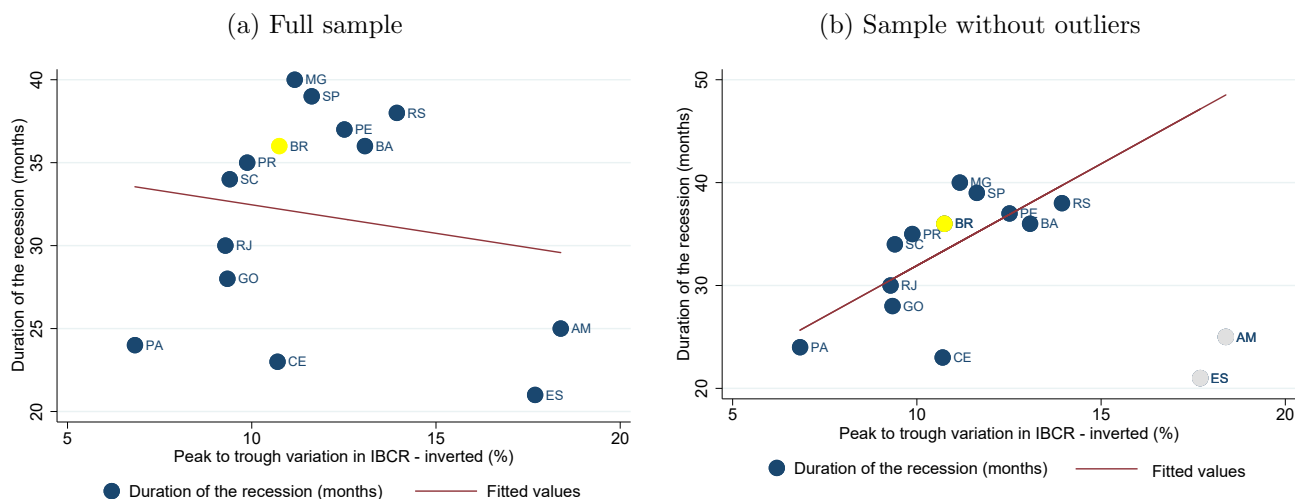
4 Discussion: the 2014-16 *vs* the 2008-09 economic recession *vs* early impacts of the COVID-19 shock in Brazilian states

Brazil has recently undergone two major economic recessions: 2008-09 and 2014-16. In 2020, when the economy was still recovering from the last recession, the COVID-19 shock induced the aggregate – and regional – output to shrink. Even though we do not have sufficient data to detect a turning point, preliminary information from IBCR (up to April 2020) suggests that it is very likely that all states entered a recession. Further, on the aggregate level, the CODACE already identified a recession in Brazil starting in the 1st quarter of 2020 (Economic Cycle Dating Committee – CODACE, 2020). Table II shows a comparison between these three recessionary phases. While the 2008-09 episode was global and originated in the international financial crisis, the domestic recession of 2014-16 was much more severe in both duration and intensity. Measured by the IBC-BR, the economic activity diminished 10.7% in the 2014-16 recession – higher than the fall of 7.8% from peak to trough in 2008-09. Further, the duration of the 2014-16 recession was much longer: 34 months versus 5 months.

Even though we can observe just two months of regional economic activity data following the COVID-19 shock (March and April 2020), 100% of the states registered a decline in the economic activity (see Table II). Furthermore, the median state's drop in economic activity seems to be even more significant than in the 2014-16 period: -12.4% vs. -11.0% (a 12.7% higher decline in economic output despite covering only one and a half month following the

global pandemics). Further data on regional economic activity will allow us to establish a chronology of the COVID-19 induced recession in the Brazilian states and perform a more accurate comparison with the previous two recessions.

Table II. Core characteristics of the 2008-09, 2014-16, and COVID-19 economic recessions in Brazil

This table summarizes the cyclical dating results for Brazil and its states in two different periods: the 2008-09 and the 2014-16 economic recessions. We also include preliminary data regarding the widespread drop in economic activity following the COVID-19 shock. The reference series are the Indices of Economic Activity of the Central Bank of Brazil (IBCs). Duration is the period between a peak and a trough. Magnitude is the percentage difference in the level of the series from peak to trough. Diffusion measures the fraction of states that entered the recession in our sample.

	2008-09		2014-16		COVID-19*	
	Duration (months)	Magnitude (%)	Duration (months)	Magnitude (%)	Duration (months)	Magnitude (%)
Brazil	5	-7.8	34	-10.7	?	-15.3
States						
...Mean	5.4	-7.7	31.7	-11.8	?	-12.0
...SD	2.9	3.3	6.5	3.2	?	5.0
...Median	4	-7.0	34	-11.0	?	-12.4
...Min	3	-16.3	21	-18.4	?	-22.1
...Max	11	-4.3	40	-6.8	?	-4.4
...Diffusion	76.9% of states		100.0% of states		100.0% of states	
...Spread**	5 months		19 months		9 months	

* Preliminary data, up to April 2020. The magnitude is the percentage drop from the year-month likely to be the peak before the COVID-19 shock (not dated by the BB algorithm because of lacking data to satisfy the window constraint) to April 2020. ** Spread measures the difference (in months) from the first to the last state to enter the recession. Regarding the COVID-19-induced recession, one state (Rio Grande do Sul) was already presenting declining economic output due to a severe drought, which explains the nine months of spread during this particular recession.

5   Concluding remarks

To the best of our knowledge, this is the first study to outline a chronology of the economic recession of 2014-16 in the Brazilian Federate States. It was the most prolonged, most severe national economic recession in the country at least since the 1980s (and before the COVID-19 global health crisis). Understanding regional characteristics of such a critical phenomenon is crucial for policy-making.

Our empirical evidence supports the view that the recession occurred in a significantly heterogeneous way across states in the three main dimensions of the recession: timing, duration, and magnitude. The higher the duration, the higher the decline in economic activity (magnitude), on average. Furthermore, the 2014-16 economic recession in Brazil was not only longer-lasting for the average state, but its effects were more widespread and

severe than the 2008-09 recession. While the latter showed lower dispersion across states, the former seems to be associated with idiosyncrasies at the regional level.

Using preliminary data from the COVID-19 period, we find that it is very likely that 100% of the states entered a new recession. In only two months of data (March and April 2020), the economic activity of the median state of our sample shrank 12.4% (a 12.7% increase over the 11.0% contraction in the 2014-16 recession).

This study contributes to a growing literature regarding the causes, consequences, and characteristics of regional economic cycles. We also add by analyzing the first available local data regarding the economic impact of the COVID-19. We believe our results have critical policy implications. Further research may explore the role of different regional characteristics – such as economic concentration, trade openness, and fiscal imbalances – on determining the features of the 2014-16 recession at the local level. Future studies may also test other methods to identify the recession across states and compare the results with ours.

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Appendix - Results: timeline of the 2014-16 national recession

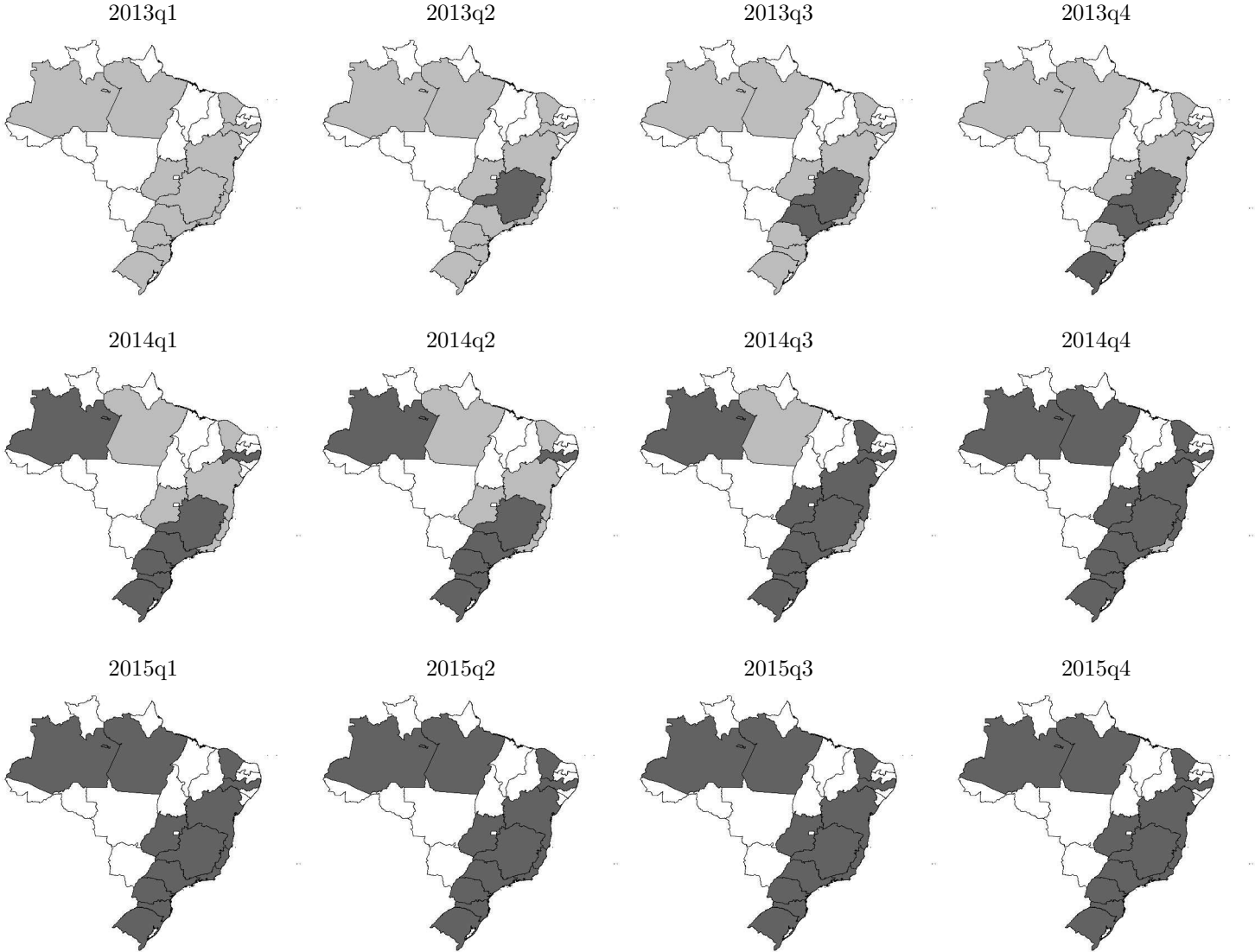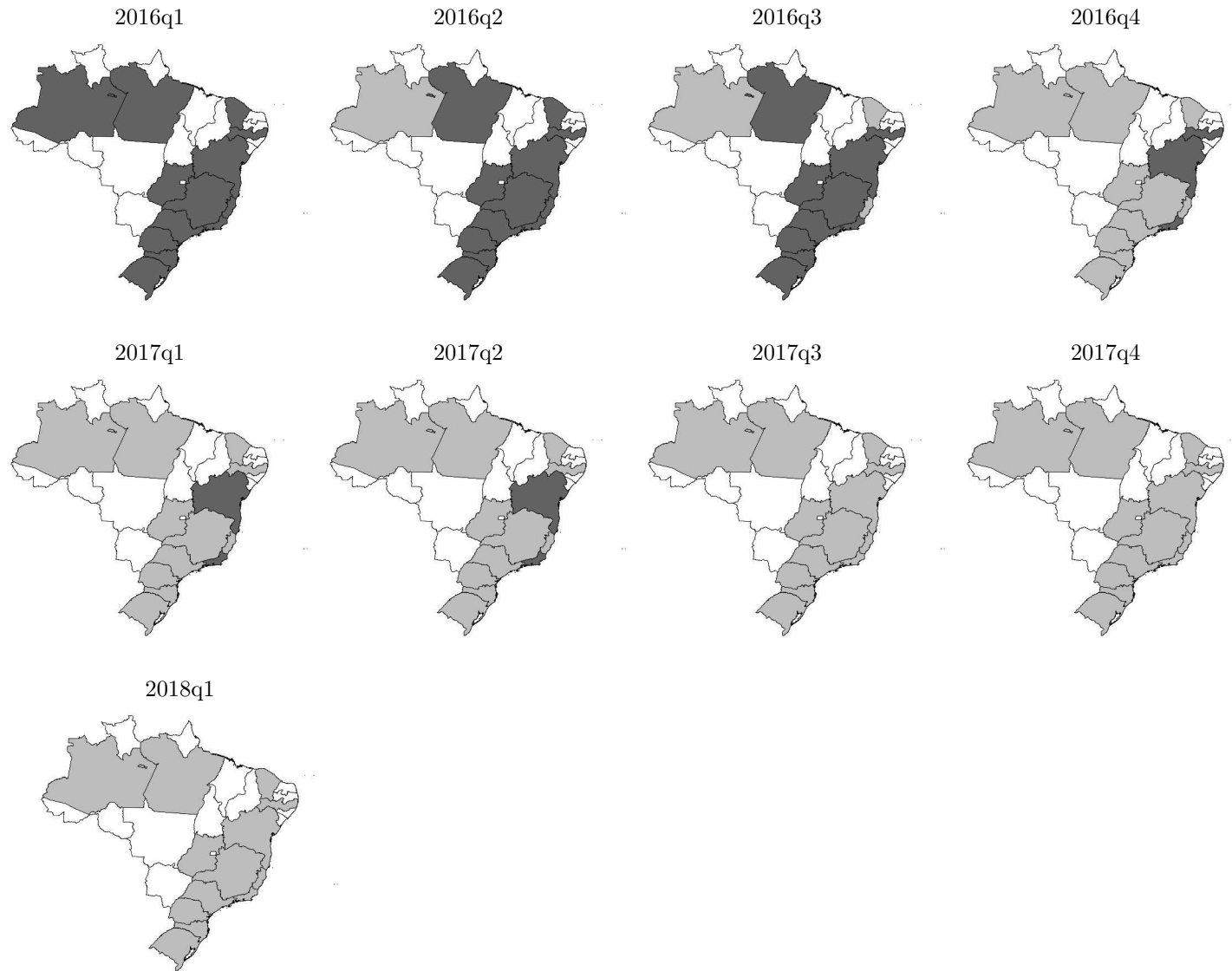Figure 4. Development and spread of the recession, by state

Figure 4. Development and spread of the recession, by state (cont.)

Note: Light gray indicates the state is in an expansionary phase of the cycle; dark gray, recessionary phase; white, no available information. The 13 states where information is available at a monthly basis accounts for 87.0% of the national GDP (Brazilian Institute of Geography and Statistics, 2016).