Paradigma económico | Año 18 Núm. 1 | Enero - Junio 2026 | ISSN: 2007-3062 | pp. 5-34

Expansions and recessions in the Mexican states: a classical business cycles approach, 1980.I-2023.III

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Abstract

The objective of this paper is to identify and characterize the business cycle regimes of the thirty-two Mexican states over the period 1980.I-2023.III by using a modified version of the classical business cycle methodology proposed by Artis, Kontolemis and Osborn (1997). The results suggest the existence of asymmetries in mean, volatility and duration between expansions and recessions as well as different degrees of synchronization of the cycle regimes across the Mexican states and with the national and the United States cycles which suggests the need of local stabilization policies.

Keywords: classical business cycles, recessions, expansions, synchronization, Mexico.

JEL classification: E32, E23, C10.

Resumen

Expansiones y recesiones en los estados mexicanos: un enfoque clásico de los ciclos económicos, 1980.I-2023.III

El objetivo de este trabajo es identificar y caracterizar los regímenes de ciclo económico de los treinta y dos estados mexicanos durante el periodo 1980.I-2023.III, utilizando una versión modificada de la metodología del ciclo económico clásico propuesta por Artis, Kontolemis y Osborn (1997). Los resultados sugieren la existencia de asimetrías en media, volatilidad y duración entre expansiones y recesiones, así como diferentes grados de sincronización de los regímenes de ciclo entre los estados mexicanos y con los ciclos nacionales y de Estados Unidos, lo que sugiere la necesidad de políticas de estabilización locales.

Palabras clave: ciclos económicos clásicos, recesiones, expansiones, sincronización, México.

Clasificación JEL: E32, E23, C10.

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Recepción: 20/02/2025 Aceptación: 21/05/2025

Introduction

The analysis of business cycles has been a major concern of Macroeconomics since its birth with the *General Theory* of Keynes (1936). The determination of their sources, transmission mechanisms and effects as well as the role of stabilization macroeconomic policies have called the attention of scholars. However, their study was abandoned for some decades under the dominance of the Keynesian view.

The oil crisis of the mid-seventies provoked a revival of its analysis after the publication of the seminal paper of Lucas (1977), who introduced the growth cycle approach.[1] Alternatively, because of their opposite effects on employment, income, investment and welfare, among other variables, a branch of literature has underlined the need of studying the differences between episodes of sustained rises (expansions) and falls (recessions) in the level of economic activity distinguishing distinct regimes of the cycle, in the same spirit of the classical view of Mitchell (1927) and Burns and Mitchell (1946). Indeed, this perspective claims that the dynamics of economic variables and their relationships vary depending on the business cycle regime the economy is, namely expansions and recessions. Therefore, this approach underlines the dating of the turning points that indicate the beginning and end of those regimes and their characterization in terms of their magnitude, volatility and duration (Sichel, 1993; Artis *et al*., 1997).[2]

Indeed, the relatively scarce studies on this line provide evidence about recessions being deeper, shorter and more abrupt and volatile than expansion, according to the views of Mitchell (1927) and Keynes (1936). The algorithms of Bry and Boschan (1971) (BB), and its quarterly version of Harding and Pagan (2002) (BBQ), and Artis, Kontolemis and Osborn (1997) (AKO) have been popularly used to identify the turning points of the cycles of several countries and its subnational geographical units. Particularly, on the one hand, Gadea *et al*. (2012),

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[1] Lucas (1977) associated the cycle to the movements of Gross National Product around its underlying trend, introducing the alternative growth cycle approach, which highlights the relevance of analyzing the co-movement between the cycle and the cyclical components of other macroeconomic variables.

[2] There are several methodologies to date turning points. Because of their simplicity, several papers have applied the non-parametric algorithms initially advanced by Bry and Boschan (1971) and improved later by Artis *et al*. (1997) and Harding and Pagan (2002) among other.

Delajara (2013) and Colombo y Lazzari (2021) apply the BB approach to characterize the cycles of the regions (states) of Spain, Mexico and Brazil, respectively, while Mondaca and Rojas (2017) use the BBQ methodology to determine the synchronization between the region of Magallanes and the national cycle of Chile. On the other hand, Mejía (1999, 2004) and Stiblarová and Sinicáková (2019) utilize the AKO methodology to study the cycles of several Latin American and European countries, respectively. All these papers report asymmetries in the characteristics of expansions and recessions in terms of magnitude, duration and volatility as well as different degrees of synchronization between the cycle regimes both in countries and regions (states), which calls for specific stabilization policies.

A related research area has highlighted the synchronization between the business cycle of different countries or regions within countries[3] in order to determine whether they respond homogeneously to different shocks and, hence, whether common national stabilization policies are appropriate for groups of countries or regions.[4] In fact, the analysis of regional business cycles[5] has become very important in the literature since, as specific manifestations, they can differ from the aggregate one due to factors such as the structure of production, local economic policies or financial conditions, infrastructure, and weather, among others. Hence, the synchronization of the regional cycles may be different across the geographical units of countries, as reported by Kouparitsas (2001) and Beraja *et al*. (2019) for the US (commonly used as benchmark); Artis and Okubo (2009) for the United Kingdom; Poncet and Barthélemy (2008) for China; Artis and Okubo (2011) for Japan; and Mejía *et al*. (2019) for Mexico, among others. A general conclusion of these papers is that common national economic policies may not always be suitable for all regions within a country.

In the case of Mexico, some papers have characterized the co-movement between the national business cycle and other macroeconomic variables while others have measured its synchronization with the US

[3] Some studies have measured the co-movement between cycle indicators by means of correlation coefficients (growth cycle approach), while others have computed contingency coefficients (Artis *et al*., 1997) or concordance coefficients (Harding and Pagan, 2002) to measure the association between cycle regimes.

[4] This topic became popular to analyze the co-movement of business cycles as an approximation to determine whether a group of countries meet the optimum currency area (OCA) criteria in the discussion of the creation and enlargement of the Euro Zone (Barrios and de Lucio, 2003; Arčabić y Škrinjarić, 2021).

[5] Although regional business cycles is the terminology used in the literature, subnational business cycles could be a more appropriate denomination since their analyses generally study these phenomena on the basis of the subnational geographical units for which statistical information is available.

cycle.[6] Other studies have analyzed the business cycles at a state level; their results have consistently reported a high heterogeneity both in their sources and co-movement: the Northern states are largely synchronized to the dynamics of the US economy, the Central ones respond to fiscal and external shocks and the Southern ones are largely independent (Cuevas *et al*., 2003; Mejía and Campos, 2011; Mejía *et al*., 2018). Furthermore, Mejía *et al*. (2019) find only moderate co-movements among the Mexican states' cycles suggesting that despite the inexistence of barriers to the free flow of goods and productive factors they do not meet the OCA criteria, which implies the need for specific countercyclical policies to mitigate idiosyncratic shocks.

It is interesting to underline that most of these papers have based their results on the growth cycle approach and that analyses using the classical business cycle view are scarce. According to this approach, Erquizio (2007) analyzes the dynamics of the cyclical fluctuations of several states and defines a coincident index for each one; he concludes that state cycles differ from each other and with respect to the national cycle. Whilst Mejía (2007) characterizes the cycle regimes of manufacturing production in 17 Mexican states between 1993 and 2006 in terms of their mean, duration and volatility and measures their degree of synchronization. His main findings suggest that recessions are indeed shorter and more volatile than expansions, but the evidence of asymmetry in mean is less clear. In turn, the regimes of the cycles of the northern and central states as well as of those with similar industrialization patterns are more correlated. Yet, there is no evidence of a national business cycle. Delajara (2013), in turn, studies the concordance of the cycle regimes of formal permanent employment in the Mexican states over the period from 1997.07 to 2011.12. He finds a high degree of concordance between the corresponding regimes in 12 out of 32 states located on the Northern border with the US, the Midwest, and the Central regions of the country; the sources of their fluctuations come mainly from the US economy. The cycle regimes of the Southern and Southeastern regions are largely idiosyncratic.

Although all these papers have contributed to have a better understanding of aggregate and specific cyclical fluctuations in Mexico, most

[6] See, for example, Mejía (2003) and Albarrán *et al*. (2022) and references there in.

of them have used methodologies that are linear in essence, which may be inappropriate to address turbulent economic episodes (recessions) or structural changes (see Potter, 1999; Granger and Teräsvirta, 1993), patterns especially relevant in the experience of Mexico (and other developing countries) during the last decades when deep recessions have affected the economy.

Hence, this paper seeks to identify and characterize the business cycle regimes (in terms of their mean, duration and volatility) of the Mexican states as well as measure the co-movement among them and with those of the national and US economies over the period 1980.I-2023.III in order to determine their degree of integration. In line with this research area, our central hypothesis states that recessions are shorter, deeper and more volatile than expansion in the Mexicana states, which implies that their economies function differently along the cycle, and that the synchronization of the business cycle regimes is highly heterogeneous across the states, suggesting that specific state economic policies are needed, especially to mitigate the effects of recessions.[7]

The contribution to the literature of this paper is twofold. On the one hand, it introduces a few modifications to the methodology proposed by Artis *et al*. (1997) that allow to deal both with quarterly data and the existence of larger and more erratic fluctuations in disaggregated data that can distort the identification of the turning points. On the other hand, it extends the existing literature on the Mexican states business cycles by using the Quarterly Indicator of State Economic Activity (QISEA), which is a broader measure of economic activity and is available since 1980.[8]

The rest of this paper is organized as follows. Section 1 describes the data set and shows the general characteristics of the series; section 2 presents the methodology, while section 3 applies it to analyze the classical business cycles of the Mexican states. Finally, the main conclusions are stated.

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[7] The full explanation of these patterns is beyond the aim of this paper. Yet, their identification sets a basis for further research as it is stated in the conclusions.

[8] In that sense, this paper introduces a methodological improvement to the AKO algorithm that may be useful in the analysis of the business cycles of developing countries characterized by high volatility. In the case of Mexico, it analyses a longer period and uses a wider measure of economic activity than in previous studies (manufacturing production by Mejía, 2007, and formal permanent employment by Delajara, 2013).

1. Main characteristics of the Mexican states' production

This paper studies the experience of the 32 Mexican states listed in table 1. The analysis is performed by using the QISEA for each state reported by the National Institute of Statistics and Geography (INEGI) over the sample period, 1980.I-2023.III. On the basis of the main sources of the business cycle regimes, the sample is divided into two subperiods. The first one, from 1980.I to 1995.II, includes the first three recessions registered in Mexico (Business Cycle Dating Committee of Mexico [CFCEM], 2022), which may be largely associated to internal economic problems, such as fiscal and financial imbalances (see Mejía and Erquizio, 2012). The recessions of this century occurred over the second subperiod, from 1995.III to 2023.III and were primary caused by external factors (US recessions) or exogeneous events (pandemia of Covid-19) (see Mejía *et al*., 2017, 2022).[9]

Table 1 summarizes the descriptive statistics of the annualized growth rates (AGR) of the QISEA of the Mexican states which are organized according to the regions defined by Banco de Mexico (2024) for a better visualization of the results.[10] These figures show a great heterogeneity across the Mexican states and over the two subperiods. In the first one, the AGR average has a more homogeneous and less volatile behavior by region, with rates ranging from 2.2 to 2.4% and having normal distributions in 23 out of 32 states.[11] These results contrast with those of the second subperiod, when normality can be assumed only in one case due to the existence of greater volatility and outliers yielding biased and leptokurtic distributions.

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9 It is important to state that the figures of the QISEA are estimated (backcasting) by INEGI from 1980.I to 2002.IV and measured afterwards (INEGI, 2019). In order to test the robustness of our results, we also considered these two subperiods. The results are similar in essence to those reported in this paper, and they are available upon request.

10 This regionalization is adopted for organization of the data only and it has no implications on the identification of the state business cycles. North: Baja California (BC), Sonora (SON), Chihuahua (CHIH), Coahuila (COAH), Nuevo Leon (NL) and Tamaulipas (TAM); North central: Aguascalientes (AGS), Baja California Sur (BCS), Colima (COL), Durango (DGO), Jalisco (JAL), Michoacan (MICH), Nayarit (NAY), San Luis Potosi (SLP), Sinaloa (SIN) y Zacatecas (ZAC); Center: Mexico City (CDMX), State of Mexico (EDOMEX), Guanajuato (GTO), Hidalgo (HGO), Morelos (MOR), Puebla (PUE), Queretaro (QRO) y Tlaxcala (TLAX); and South: Campeche (CAM), Chiapas (CHIA), Guerrero (GRO), Oaxaca (OAX), Quintana Roo (QROO), Tabasco (TAB), Veracruz (VER) y Yucatan (YUC).

11 As it is well known, a normal distribution has a skewness and a kurtosis of 0 and 3, respectively.

Table 1
Basic statistics of the annualized growth rates of the Quarterly Indicator of State Economic Activity of the Mexican States

	1995.III-2023.III								1995.III-2023.III							
States	Mean	Sd	Sk	Kur	Med	Min	Max	Nor	Mean	Sd	Sk	Kur	Med	Min	Max	Nor
Mexico	2.1	4.1	-0.5	3.5	2.7	-9.2	11.8	0.2	2.1	4.6	-0.9	11.0	2.4	-20.6	21.9	0.0
US	3.1	2.3	-0.2	3.8	3.3	-2.6	8.6	0.3	2.5	2.3	-0.7	9.2	2.4	-7.5	12.0	0.0
North	2.3	5.1	-0.5	3.1	3.2	-9.6	13.9	0.3	2.7	6.2	-0.5	6.0	2.9	-21.0	23.7	0.0
BC	2.1	6.4	-0.5	3.0	3.4	-12.0	16.1	0.2	2.3	6.8	-0.3	4.9	2.6	-21.6	26.2	0.0
CHIH	2.2	4.7	-0.4	3.2	2.9	-8.6	13.9	0.5	3.1	5.2	-0.9	5.0	3.6	-17.2	17.1	0.0
COAH	2.0	4.9	-0.5	3.2	2.6	-9.3	13.5	0.3	2.8	8.9	0.3	9.8	2.6	-32.0	45.0	0.0
NL	2.7	4.8	-0.4	3.3	3.9	-8.7	14.2	0.4	3.0	5.5	-1.0	8.5	3.5	-22.5	23.8	0.0
SON	2.5	5.4	-0.6	2.8	3.6	-9.7	13.3	0.2	2.5	5.5	-0.5	3.6	3.1	-16.6	16.8	0.1
TAM	2.2	4.5	-0.5	3.2	2.6	-9.2	12.3	0.3	2.2	5.1	-0.8	4.5	2.3	-15.9	13.1	0.0
Center-North	2.4	3.7	-0.4	3.7	2.9	-7.9	10.9	0.4	2.5	5.1	-0.6	6.6	2.9	-18.9	19.4	0.0
AGS	3.4	4.7	-0.5	3.1	4.5	-8.0	14.5	0.2	3.8	6.1	-0.8	10.1	4.4	-26.1	29.8	0.0
BCS	2.4	3.5	-0.1	2.6	2.6	-5.5	10.6	0.8	3.4	6.9	-0.6	8.9	4.2	-28.7	30.3	0.0
COL	2.3	3.1	-0.5	4.5	2.6	-7.7	9.9	0.0	2.1	4.8	-0.9	4.4	2.6	-13.0	10.8	0.0
DUR	1.8	3.6	-0.4	3.3	2.4	-6.9	10.8	0.4	2.0	4.0	-0.7	5.9	2.4	-15.3	13.6	0.0
JAL	1.9	4.0	-0.4	3.9	2.4	-9.8	12.2	0.2	2.3	4.5	-1.1	7.1	2.7	-18.3	16.2	0.0
MICH	2.3	2.8	-0.1	3.0	2.6	-4.8	8.8	1.0	2.3	4.0	-0.5	5.1	2.4	-13.1	14.1	0.0
NAY	2.2	4.2	-1.2	6.4	2.8	-15.1	10.5	0.0	1.7	6.1	0.0	5.0	2.0	-19.3	20.1	0.0
SLP	2.3	4.7	-0.7	3.6	3.2	-12.1	12.2	0.0	3.1	5.5	-1.0	8.9	3.8	-23.5	24.1	0.0
SIN	2.0	3.6	-0.2	3.4	2.3	-7.2	10.8	0.6	1.7	4.5	-0.5	5.0	2.0	-16.5	15.4	0.0
ZAC	3.0	2.3	0.0	2.9	3.1	-2.1	8.6	1.0	2.5	4.7	0.0	5.3	2.4	-15.7	19.3	0.0
Center	2.2	4.3	-0.6	4.0	3.0	-10.4	12.1	0.3	2.3	5.4	-0.6	8.1	2.5	-21.4	21.6	0.0
CDMX	2.0	4.3	0.0	3.0	2.7	-7.4	12.8	1.0	1.7	4.7	-0.7	10.1	1.9	-20.7	22.1	0.0
EDOMEX	1.8	3.9	-0.5	3.6	2.6	-9.6	11.0	0.2	2.4	5.1	-0.7	8.0	2.9	-21.2	22.5	0.0
GTO	2.3	4.0	-0.3	3.3	2.8	-6.9	12.4	0.6	3.0	5.2	-0.3	14.2	3.5	-23.3	29.8	0.0
HGO	2.1	4.8	-1.2	5.7	3.1	-16.5	11.8	0.0	1.8	6.0	-0.2	3.7	1.1	-15.6	14.3	0.2
PUE	2.1	4.0	-0.7	3.9	2.8	-10.4	11.1	0.0	2.8	6.2	-0.9	10.3	3.3	-28.6	28.5	0.0
MOR	1.9	3.8	-1.2	6.1	2.6	-13.3	10.0	0.0	1.7	5.3	-0.8	7.1	2.5	-21.6	20.4	0.0
QRO	2.9	6.1	-0.6	3.1	4.7	-11.6	16.4	0.1	3.2	5.8	-0.5	5.3	3.1	-21.3	18.8	0.0
TLAX	2.3	3.5	-0.5	3.6	3.0	-7.3	10.9	0.3	2.0	4.7	-0.6	5.9	1.9	-18.9	15.9	0.0
South	2.3	3.4	-0.5	3.9	2.8	-7.4	9.9	0.3	1.5	5.5	-0.3	7.0	1.6	-18.3	20.9	0.0
CAM	2.4	4.3	-0.5	3.2	3.3	-8.9	12.3	0.3	-1.2	5.6	0.4	2.3	-1.9	-11.0	11.3	0.1
CHIA	2.5	2.0	-0.3	2.9	2.7	-2.4	7.2	0.6	1.0	3.9	0.1	4.4	1.1	-12.6	15.1	0.0
GRO	1.4	2.5	-0.9	6.5	1.7	-8.6	7.2	0.0	1.1	4.6	-0.6	10.4	1.3	-21.1	21.1	0.0
OAX	2.1	4.1	-0.7	5.7	2.5	-13.5	10.9	0.0	1.2	5.9	-0.2	5.4	1.4	-17.2	22.8	0.0
QROO	2.9	4.0	-0.5	2.6	3.2	-6.1	11.2	0.3	4.0	8.7	-1.1	10.6	4.9	-36.3	37.7	0.0
TAB	2.4	3.6	-0.3	3.0	3.2	-6.5	11.0	0.6	2.3	6.6	0.7	4.4	1.9	-12.0	23.5	0.0
VER	2.3	2.9	-0.4	3.2	2.7	-4.9	9.0	0.5	0.9	4.0	-0.8	7.2	1.2	-17.2	13.9	0.0
YUC	2.5	3.5	-0.5	3.6	2.9	-8.3	10.5	0.2	2.8	4.5	-1.0	10.9	3.3	-19.4	21.7	0.0

Note: Sd = standard deviation, Sk= skewness, Kur= Kurtosis, Med= median, Min= minimum, Max= maximum, and Nor corresponds to the p-values of the Jarque-Bera's conventional test.
Source: Own elaboration with data from INEGI (2024).

More specifically, it is observed that states linked to manufacturing activities (Chihuahua, Coahuila, San Luis Potosi, State of Mexico and Guanajuato) and tourism (Baja California Sur and Quintana Roo) have higher average growth rates over the second period, but also some of them experienced higher volatility[12] (Coahuila and Quintana Roo). Furthermore, the range of the AGR also shows great variability, especially during the second subperiod: its lowest value lies between 22 and 23 percentage points (Campeche), while the largest one exceeds 77 points (Coahuila). In contrast, in the first subperiod, the smallest range varies between 9 and 10 percentage points (Chiapas), while the largest one does from 28 to 29 points (Hidalgo).

It is interesting to observe that these basic statistics provide preliminary information about the existence of asymmetric characteristics in the dynamics of the state output series, which supports the use of a classical business cycle approach instead of the growth cycle one. Mitchell (1927) and Keynes (1936) called the attention to these features of the data describing the business cycles long time ago. Their claims imply that economic downturns are brief and severe, whereas upturns are longer and more gradual. DeLong and Summers (1986), in turn, point out that this implies the existence of a significant skewness in a frequency distribution of the growth rates of output (that is, the distribution should have significantly fewer than half its observations below the mean) and the median should exceed the mean by an important amount. Also, they indicate that the frequency distribution would be leptokurtic due to the presence of outliers. These statistical properties can be evaluated on the basis of the information displayed in table 1.

Indeed, the figures of table 1 indicate the existence of asymmetries in the Mexican states output growth rates, especially over the second subperiod, which is consistent with the evidence provided for the GDP per capita of some Latin American countries by Mejía (1999) and for the manufacturing production of 17 Mexican states by Mejía (2007). These findings can be summarized in three central facts. First, although the largest annual downturns are more severe than the largest yearly upturns (the minimum annualized growth rate value is greater than the maximum annualized growth rate value in absolute terms), only in 12 out of 32 states, skewness

12 Volatility is measured through the standard deviation.

is negative in 29 cases. Second, the median is greater than the mean for the 32 states in the first subperiod and for 26 cases in the second one. And third, there is an excess of kurtosis in 31estates, suggesting that the distribution of the growth rates is leptokurtic in the second period of interest. These results are consistent with those corresponding to the national economy: skewness is negative, the median is greater than the mean and the distribution is leptokurtic.

Thus, the evidence does suggest the existence of generalized asymmetries in the dynamics of state production, at least of the kind suggested by DeLong and Summers. A more formal analysis is carried out in the rest of this paper to confirm these findings.

2. Classical business cycles: definitions

This section outlines the basic concepts of the classical business cycles approach and presents the methodology to date turning points and measure the synchronization of the resulting regimes.[13] As mentioned above, we use a modified version of the AKO methodology (Artis *et al*., 1997).[14]

The AKO methodology identifies the turning points that define the regimes of the business cycle in the level of economic activity, which afterwards allows us to capture the asymmetric characteristics of output performance.[15] Following Boldin (1994), the turning points are define as follows: a *peak* refers to the period immediately preceding a decline in real activity, or *recession*, while a *trough* refers to the period immediately preceding an upturn, or *expansion*. In turn, the *duration* of a cycle is the length of time required for the completion of a full cycle and can be measured by the time between two successive peaks or two successive troughs. Similarly, the duration of an expansion (recession) relates to the

[13] See Artis *et al*. (1997) and Mejía (2004) for further details.

[14] The main advantages of the AKO methodology are that it generates regimes for the US economy remarkably close to those identified by the National Bureau of Economic Research (NBER) and it is only based on a univariate analysis.

[15] An asymmetric cycle is one in which one regime (expansion) differs from the mirror image of the opposite one (recession), and vice versa. This fact challenges the traditional view of symmetric cycles and suggests that the economy responds nonlinearly to different types of shocks; ignoring these asymmetries can lead to misinterpretations of its dynamics (Sichel, 1993). In practical terms, the classical approach avoids the criticism regarding the possibility of generating spurious and symmetric fluctuations depending on the de-trending filter (Osborn, 1995; Canova, 1998). This approach contrasts with the alternative growth cycles approach that defines “expansions” and “contractions” as cyclical movements around a trend.

number of periods from a trough (peak) to a peak (trough). Finally, *the amplitude of a regime* refers to the magnitude of the variation of output between two successive turning points.

To date the turning points of the Mexican states business cycles, this paper introduces some modifications to the original proposal of Artis *et al*. (1997). In particular, their methodology is adapted to deal with quarterly data and, furthermore, it is adjusted to treat disaggregated data that usually exhibit greater volatility and have more outliers, which may distort the identification of the turning points. To be more specific, some state observations that coincide with identified national turning points seem to be outliers due to its magnitude. In such a case, they should be removed in the first step of the AKO methodology. Yet, in our proposal, the turning points are identified in the first steps and outliers are removed at the end when they do not coincide with any turning point.

Hence, our methodology can be summarized in the following steps. First, the values of the original (seasonally adjusted) series are smoothed by using a three-period centered moving average; turning points are tentatively identified in this smoothed series by identifying the highest (or lowest) points compared to the values of the four adjacent quarters[16] for each quarter, with the additional condition that peaks and troughs must alternate. Second, similar rules are applied to identify tentative turning points in the unsmoothed series, by imposing also the requirements that the amplitude of a regime to be at least one standard deviation of the quarterly difference of the natural logarithm of the series, and the duration of a cycle to be at least of five quarters. Third, the two sets of tentative turning points are compared to each other: if there is a close correspondence between the two sets of points (± 2 quarters), the existence of a turning point is confirmed and dated to the original series. Finally, it is verified whether outliers affect the identification of turning points: if the former correspond to a previously identified peak or trough, they are not replaced; otherwise, they are replaced by the average of their adjacent values.

On the other hand, to measure the synchronization between the regimes of the business cycle we also follow AKO and adopt a non-parametric procedure that ignores the magnitude of the change in the

[16] Since the original version of the AKO methodology uses monthly data, this document makes the corresponding adaptation to quarterly data.

level of the series and considers only the coincidence of the regimes of couples of states. Then, the classical business cycle chronologies are used to create a binary variable for each state, denoting periods of expansion by 0 and periods of recessions by 1. For a pair of states i and j, the 2 x 2 contingency table 2 shows the possible combinations of expansions and recessions.

TABLE 2
CONTINGENCY TABLE FOR BUSINESS CYCLE REGIMES

		State *j*		
		Expansion	Recession	Subtotal
	Expansion	n_{oo}	n_{01}	$n_{0.}$
State ***i***	Recession	n_{10}	n_{11}	$n_{1.}$
	Subtotal	$n_{.0}$	$n_{.1}$	N

Note: n_{ij} denotes the number of periods at which state i and state j are in regimes i, $j = \{0, 1\}$, and $n_{i.}$ and $n_{.j}$ stands for the total of periods of expansion and recession for state ***i*** and ***j***, respectively.

Then, the association between the classical cycle regimes of different pairs of states is measured by using a variant of the Pearson's contingency statistic (expressed as a percentage and ranging between 0 and 100). This corrected coefficient, CC_{corr} is defined as follows:[17]

$$CC_{corr} = \sqrt{\frac{\widehat{\chi^2}}{N + \widehat{\chi^2}} \frac{100}{\sqrt{0.5}}} \qquad (1)$$

where

$$\widehat{\chi^2} = \sum_{i=0}^{1} \sum_{j=0}^{1} \frac{[n_{ij} - n_{i.}n_{.j}/N]^2}{n_{i.}n_{.j}/N} \qquad (2)$$

The interpretation of the corrected contingency coefficient as a correlation measure is straightforward: if the two binary variables are independent (no contemporaneous relationship between expansion/recession) and $n_{ij} = n_{i.}n_{.j}$, then $CC_{corr} = 0$, while with complete dependence (complete correspondence between expansion/recession), that is with $n_{ij} = n_{i.} = n_{.j}, CC_{\text{corr}} = 100$ (see Artis *et al*., 1997 for further details).

[17] AKO argue that the Pearson's contingency coefficient is related to a conventional correlation coefficient for continuous data, but for a finite dimension contingency table it suffers from the disadvantage that the maximal attainable value is determined by the dimension of the table (Kendall and Stuart, 1973: 577). Since the maximum value for 2 x 2 table is 0.5 they use this corrected version.

3. Empirical results

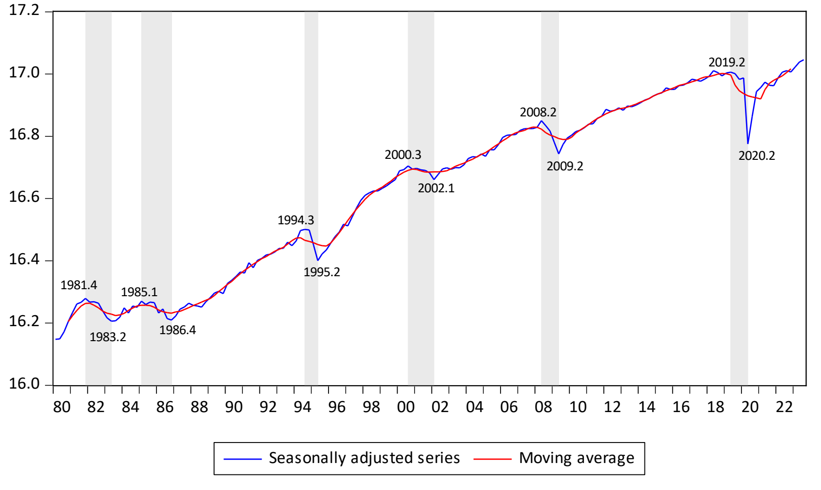
The methodology described above is applied to identify and characterize the business cycle regimes of the 32 Mexican states over the period 1980.I-2023.III. More specifically, this paper identifies and characterizes expansions and recessions in terms of mean, duration and volatility and measures their synchronization across the states and with those of the Mexican and the US economies. The analysis is based on the data of the QISEA for the Mexican states and the Gross Domestic Product (GDP) for Mexico and US. Panels (a) and (b) of Graph 1 show the logarithms and smoothed transformation as well as the turning points and business cycle regimes in the latter two cases; the shadowed areas represent recession periods, while the clear ones correspond to expansion phases.

Some facts appear apparent from the panels of graph 1. First, Mexico has experienced more recessions (6), especially in the eighties, than the US (5) (CFCEM, 2022; NBER, 2024). Second, the cycle regimes of these countries became more synchronized since the late nineties once the effects of the 1995 crisis were overcome and the integration of their economies became more consolidated (Mejía and Campos, 2011; Albarrán *et al*., 2022). Third, the Mexican recessions tend to be deeper and longer than the US ones (Mejía, 2007; Mejía *et al*., 2017). The full list of the identified turning points for the US, Mexico and the 32 Mexican states are reported in Table 3, while the characteristics of the business cycle regimes are shown in Table 4.

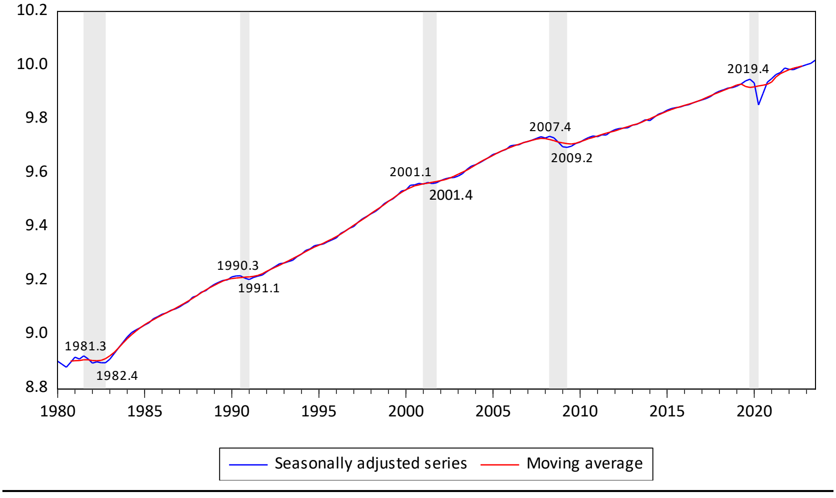
For illustrative purposes, panels of graph 2 show the business cycle regimes for selected states. To have a preliminary perspective of the synchronization of the business cycle regimes of the Mexican states with those of the Mexican and the US economy, the graphs also incorporate the corresponding turning point dates: the vertical solid lines indicate the turning point dates of the Mexican GDP identified with the AKO methodology, while the vertical black and gray dashed lines represent the turning point dates reported by the CFCEM (2022) and the NBER (2024) for the US, respectively.

Graph 1
Business cycle regimes of Mexico and US, 1980.I-2023.III
(Logs and three-quarter moving average of GDP)

a. México



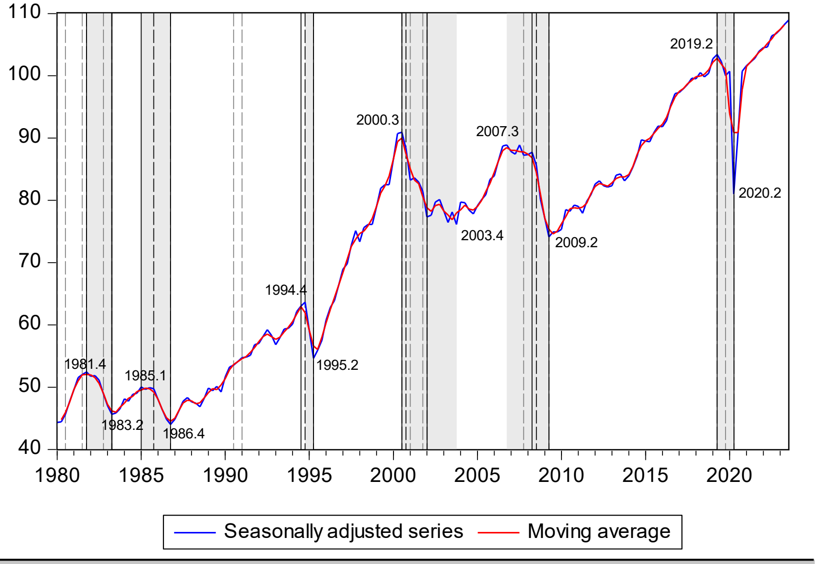
b. US



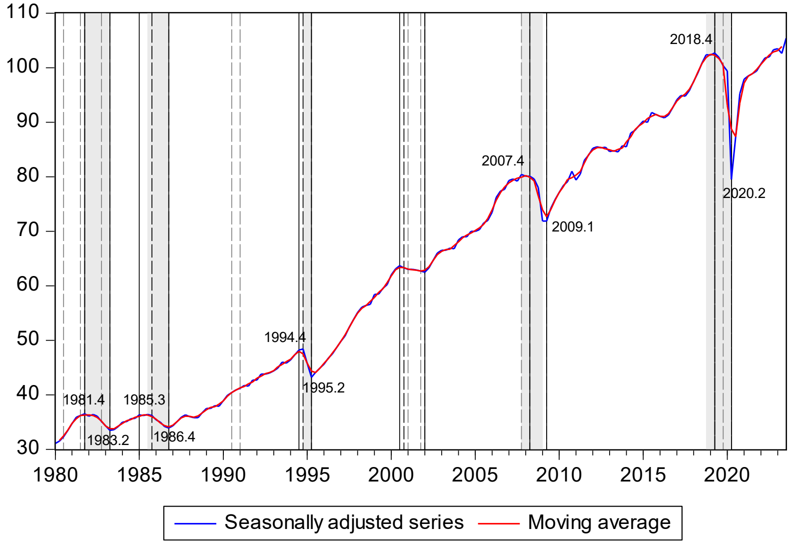
Note: Shadowed and clear areas represent recession and expansion periods, respectively.
Source: Own elaboration with data from INEGI (2024).

Graph 2
Turning Points of QISEA of selected Mexican states, 1980.I-2023.III
(Logs and three-quarter moving average)

a. Baja California



b. Nuevo Leon

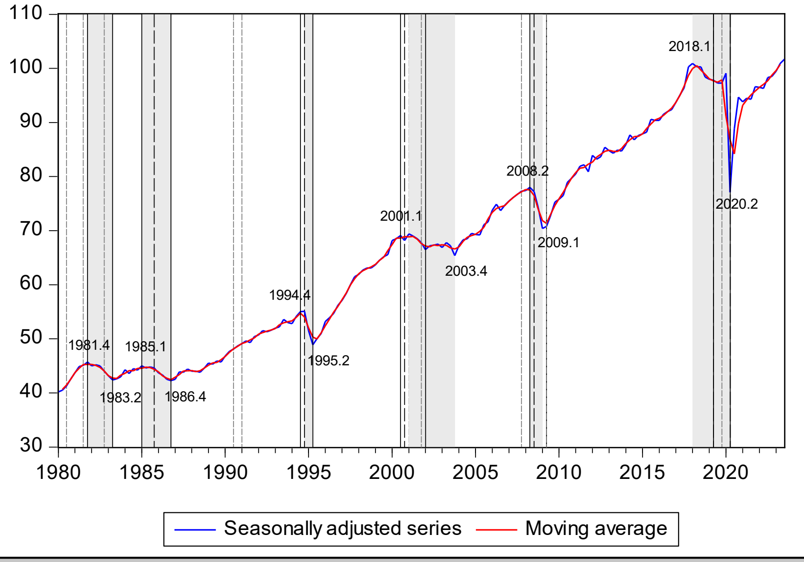


Graph 2

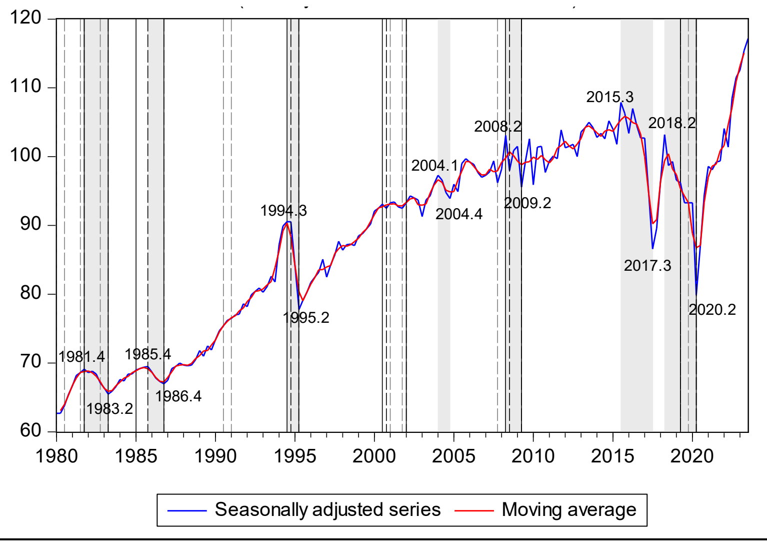
Turning Points of QISEA of selected Mexican states, 1980.I-2023.III

(Logs and three-quarter moving average) (continued)

c. State of Mexico



d. Oaxaca



Source: Own elaboration with data from INEGI (2024).

Additionally, Table 3 displays the dates of the turning points of the US and Mexican economies as wells as of the 32 Mexican states; the regionalization proposed by the Banco de México (2024) is used with the unique purpose of organizing the information of the Mexican states. Some general facts can be identified from these dates. First, national recessions coincide with similar regimes in most states, especially among those in the Northern, Central-North, and Central regions. Second, the alternation of expansion and recession has become more frequent after the Great Recession, especially in the Southern and Central states. Third, the mild 2000 US recession was transmitted to most states located in the Central and Central-North regiones, but only to few states of the Southern region. Fourth, in fact, the "recession of 2020" started in 2018 or 2019 and ended in the second quarter of 2020 in most states. Fifth, it seems that idiosyncratic shocks are important in Campeche, Tabasco and Coahuila since they were not fully affected by the pandemia or Zacatecas that has the fewest complete cycles (4) while Chiapas has the greatest number (9).

Table 4, in turn, displays the characteristics of the Mexican states cycle regimes in terms of magnitude, volatility and duration. This evidence suggests the existence of asymmetries according to the claims of Mitchell (1927) and Keynes (1936). Indeed, our results suggest the existence of asymmetries in duration: in all states, including the national economy, expansions last longer than recessions, although in Campeche the difference is only of one month. At state level, Zacatecas and Quintana Roo have the longest expansions in the average (30 and 32 quarters, respectively), while Campeche and Tabasco have experienced the longest recessions (11 and 12 quarters in the average, respectively).

To analyze the existence of asymmetries in magnitude, we compare two measures across regimes: the total (accumulated) percentage change (TCA) from one turning point to the following and the average quarterly growth rate (TCP) of each regime. For the former there is no evidence of asymmetries since the average increases of production during expansions are greater in absolute value than the average decreases in recessions both at state and national levels. However, for the latter there is evidence of asymmetry in magnitude for 30 states as well as for the national case since declines during recessions are greater in absolute value than increases during expansions. In contrast, in Chiapas and Tabasco, a couple of non-industrialized states specialized in primary activities, there is no evidence of asymmetry in magnitude.

TABLE 3
CLASSICAL BUSINESS CYCLES CHRONOLOGIES FOR THE MEXICAN STATES, 1980.I-2023.III

States	Peak	Trough	Peak	Trough	Peak	Trough	Peak	Trough	Peak	Trough	Peak	Trough
US	1981.III	**1982.I**			1990.III	1991.I						
NAC	1981.IV	1983.II	1985.I	1986.IV			1994.III	**1995.II**			2000.III	2002.I
North												
BC	1981.IV	1983.II	1985.I	1986.IV			1994.IV	**1995.II**			2000.III	2003.IV
CHIH	1981.IV	1983.II	1985.III	1986.IV			1994.IV	**1995.II**			**2000.II**	2002.I
COAH	1981.IV	1983.II	1985.III	1986.IV			1994.III	**1995.II**				
NL	1981.IV	1983.II	1985.III	1986.IV			1994.IV	**1995.II**				
SON	1981.IV	1983.II	1985.IV	1986.IV			1994.III	**1995.II**			2000.III	2003.I
TAM	1981.IV	1983.II	1985.IV	1986.IV			1994.IV	**1995.II**			2000.III	**2001.I**
Center North												
AGS	1981.IV	1983.II	1985.III	1986.IV			1994.IV	**1995.II**				
BCS	1981.IV	1983.II			1992.III	1993.IV	1994.III	**1995.II**			2001.II	2002.I
COL	1981.IV	1983.II	1985.IV	1986.IV			1994.IV	**1995.II**			2000.III	**2003.I**
DGO	1981.IV	1983.II	1985.IV	1986.IV			1994.IV	**1995.II**				
JAL	1981.IV	1983.II	1985.I	1986.IV			1994.IV	**1995.II**			2000.III	2003.I
MICH	1982.II	1983.II					1994.IV	**1995.II**			2000.III	2002.I
NAY	1981.IV	1983.II	1985.IV	1986.IV			1994.IV	**1995.II**			2001.II	**2003.I**
SLP	1981.IV	1983.II	1985.III	1986.IV			1994.IV	**1995.II**			2000.III	2002.I
SIN	1981.IV	1983.II	1985.IV	1986.IV			1994.III	**1995.II**			2000.III	2002.I
ZAC							**1995.I**	1996.II	1998.II	1999.II		
Center												
CDMX	1981.IV	1983.II	1985.I	1987.I			1994.III	**1995.II**			2000.III	2003.III
MEX	1981.IV	1983.II	1985.I	1986.IV			1994.IV	**1995.II**			2001.I	2003.IV
GTO	1981.IV	1983.II	1985.III	1986.IV			1994.IV	**1995.II**				
HGO	1981.IV	1983.II	1985.III	1986.IV			1994.IV	**1995.II**			2000.III	2003.I
MOR	1981.IV	1983.II	1985.III	1986.IV			1994.IV	**1995.II**			2001.II	2002.I
PUE	1981.IV	1983.II	1985.IV	1986.IV			1994.IV	**1995.II**			2001.I	2002.I
QRO	1981.IV	1983.II	1985.III	1986.IV			1994.IV	**1995.II**			2000.III	2003.II
TLAX	1981.IV	1983.II	1985.III	1986.IV			1994.IV	**1995.II**			2001.II	2003.II
South												
CAM	1982.II	1983.II	1985.IV	1986.IV	1992.III	1993.II	1995.I	1995.III	1998.II	1999.II		
CHIA	1981.IV	1983.II					1995.I	1996.II			2000.III	2002.I
GRO	1981.IV	1983.II	1985.IV	1986.IV			1994.IV	**1995.II**			2001.I	2003.I
OAX	1981.IV	1983.II	1985.IV	1986.IV			1994.III	**1995.II**				
QROO	1981.IV	1983.II					1994.IV	**1995.II**				
TAB	1981.IV	1983.II	1985.IV	1986.IV					1998.II			2002.I
VER	1981.IV	1983.II	1985.IV	1986.IV			1994.IV	**1995.II**	1998.II			2002.I
YUC	1981.IV	1983.II	1985.III	1986.IV			1994.IV	**1995.II**				

Note: Values in bold were identified as outliers, but since they correspond to a previously identified peak or trough, they are not replaced.
Source: Prepared with data from INEGI (2024).

Table 3.
Classical business cycles chronologies for the Mexican states, 1980.I-2023.III (continued)

States	Peak	Trough	Peak	Trough	Peak	Trough	Peak	Trough	Peak	Trough	Peak	Trough	Peak	Trough	Peak
US					2008.II	2009.II					2019.IV	**2020.II**			2023.III*
NAC					2008.II	**2009.II**					2018.II	**2020.II**			2023.III*
North															
BC			2006.IV			2009.II					2019.II	**2020.II**			2023.III*
CHIH					2008.II	**2009.II**					2019.I	**2020.II**			2023.III*
COAH					2007.IV	**2009.II**					2019.III	**2020.II**	2021.II	2021.IV	2023.III*
NL					2007.IV	**2009.I**					2018.IV	**2020.II**			2023.III*
SON					2008.II	**2009.I**					2019.III	**2020.II**			2023.III*
TAM					2008.I	**2009.I**					2019.III	**2020.II**			2023.III*
North central															
AGS					2007.III	**2009.I**					2019.III	**2020.II**			2023.III*
BCS					2008.II	2009.III	2012.II	**2013.I**			2018.IV	**2020.II**			2023.III*
COL					2008.III	2009.II	**2012.II**	2013.III	2015.IV	2016.III	2019.III	**2020.II**			2023.III*
DGO	2004.III	**2005.I**			2008.III	2009.III			2014.II	2015.III	**2018.III**	**2020.II**			2023.III*
JAL					2008.III	**2009.II**					2019.II	**2020.II**			2023.III*
MICH					2008.II	**2009.I**					2019.I	**2020.II**			2023.III*
NAY			2006.II	2007.II	2008.III	2009.III	2013.I	2013.IV			2019.I	**2020.II**			2023.III*
SLP					2008.III	**2009.II**					2018.II	**2020.II**			2023.III*
SIN					2008.II	2009.III	2010.II	2011.I			2019.I	**2020.II**			2023.III*
ZAC							2012.I	2013.II			2018.II	**2020.II**			2023.III*

TABLE 3.
CLASSICAL BUSINESS CYCLES CHRONOLOGIES FOR THE MEXICAN STATES, 1980.I-2023.III (CONTINUED)

States	Peak	Trough	Peak	Trough	Peak	Trough	Peak	Trough	Peak	Trough	Peak	Trough	Peak	Trough	Peak
Central															
CDMX					2008.III	**2009.I**					2018.IV	**2020.II**			2023.III*
MEX					2008.II	**2009.I**					2018.I	**2020.II**			2023.III*
GTO					2008.II	2009.II					2018.II	**2020.II**			2023.III*
HGO	2004.III	2006.I			2008.II	**2008.IV**			2016.I	2016.IV	2017.IV	**2020.II**			2023.III*
MOR			2005.III	2006.III	2007.III	**2009.II**					2017.I	**2020.II**			2023.III*
PUE					2007.IV	**2009.I**	2012.IV	2013.IV			2018.II	**2020.II**			2023.III*
QRO					2007.III	2009.II	2012.III	2013.IV			2018.I	**2020.II**			2023.III*
TLAX	2004.II	2005.III			2008.II	2009.III					2019.I	**2020.II**			2023.III*
South															
CAM	2004.III							2014.III	2015.I					2022.III	2023.III*
CHIA	2002.IV	2004.III	2006.III	2007.IV	2008.II	2009.II	2012.I	2013.I	2014.I	**2015.I**	2016.III	**2020.II**			2023.III*
GRO					2007.IV	**2009.II**			**2014.IV**			**2020.II**			2023.III*
OAX	2004.I	2004.IV			2008.II	2009.II			2015.III	**2017.III**	**2018.II**	**2020.II**			2023.III*
QROO					2008.II	**2009.II**					2020.I	**2020.II**			2023.III*
TAB							2013.IV					2019.I			2023.III*
VER					2007.IV	2009.II	2012.IV	2013.IV	2015.III	2017.IV	2020.I	**2020.II**			2023.III*
YUC					2008.I	2009.I					2019.I	**2020.II**			2023.III*

Note: Values in bold were identified as outliers, but since they correspond to a previously identified peak or trough, they are not replaced.
Source: Own elaboration with data from INEGI (2024).

Table 4
Classical Business Cycles Characteristics, 1980.I-2023.III

States	Expansions				Recessions				Cycles duration
	TCA	TCP	Standard desviation	Duration	TCA	TCP	Standard desviation	Duration	
US	31.8	0.8	0.9	33	-4.3	-1.9	1.6	3	36
NAC	24.6	1.3	1.4	21	-9.6	-2.4	3.0	5	26
North									
BC	32.8	1.7	2.0	19	-15.6	-3.4	3.2	7	26
CHIH	31.6	1.5	1.7	21	-11.0	-2.7	2.8	5	26
COAH	36.3	2.3	2.7	21	-15.8	-4.7	4.6	4	25
NL	38.3	1.5	1.5	25	-11.8	-2.9	3.0	5	30
SON	30.9	1.4	1.5	21	-12.4	-3.2	3.8	5	26
TAM	26.0	1.2	1.4	21	-10.5	-2.7	3.0	5	26
North central									
AGS	48.9	1.7	2.3	25	-12.7	-3.9	4.8	4	30
BCS	29.1	1.6	1.9	18	-9.3	-2.2	3.4	4	22
COL	18.4	1.1	1.7	15	-7.0	-2.2	2.0	5	20
DGO	19.0	1.0	1.3	19	-7.2	-2.4	1.1	4	22
JAL	24.5	1.2	1.2	20	-9.6	-2.7	1.8	6	26
MICH	26.1	1.1	1.6	25	-7.8	-1.9	2.6	5	30
NAY	19.8	1.4	1.8	15	-9.9	-2.8	2.0	4	20
SLP	32.3	1.5	1.7	21	-11.1	-2.8	2.0	5	26
SIN	18.7	1.2	1.6	18	-8.1	-1.9	2.2	5	22
ZAC	36.2	1.1	1.9	30	-8.6	-1.5	2.7	6	36
Center									
CDMX	22.9	1.2	1.5	19	-10.1	-2.6	3.2	7	26
MEX	26.6	1.3	1.6	19	-10.6	-2.5	2.2	6	26
GTO	36.2	1.4	1.8	25	-11.4	-2.5	2.7	5	30
HGO	17.3	1.2	1.7	14	-7.2	-2.5	1.8	6	20
MOR	22.0	1.2	1.5	17	-10.5	-2.4	2.0	6	22
PUE	26.7	1.4	1.7	18	-10.4	-2.5	2.8	5	22
QRO	30.4	1.7	1.7	16	-10.4	-2.2	2.3	6	23
TLAX	21.1	1.3	1.6	17	-8.2	-1.9	2.0	5	22
South									
CAM	15.6	1.3	1.2	12	-14.1	-1.9	1.0	11	23
CHIA	13.1	1.5	1.1	12	-5.6	-0.9	1.4	6	18
GRO	17.3	0.9	1.2	20	-8.7	-2.0	1.6	5	26
OAX	20.7	1.7	1.9	17	-10.9	-2.2	2.8	5	22

Table 4
Classical Business Cycles Characteristics, 1980.I-2023.III (CONTINUED)

States	Expansions				Recessions				Cycles duration
	TCA	TCP	Standard desviation	Duration	TCA	TCP	Standard desviation	Duration	
QROO	63.2	2.0	2.2	32	-17.3	-11.9	2.0	3	35
TAB	36.0	1.3	1.5	26	-12.2	-1.1	1.2	12	37
VER	13.5	0.9	1.1	14	-6.3	-3.1	2.8	6	20
YUC	32.4	1.3	1.3	25	-8.8	-2.5	2.4	4	30

Note: TCA: total percentage change from one turning point to the following, TCP: average quarterly growth rate.
Source: Own elaboration with data from INEGI (2024).

In turn, there is evidence of asymmetric volatility in 28 out of 32 states, and in the national case. In other words, growth rates show more heterogeneity during recessions than during expansions. However, it is important to highlight that in Colima, Nayarit, San Luis Potosi, Hidalgo, and Chiapas the growth rates volatility in recessions is remarkably close to that of expansion. Furthermore, the volatility in expansions is about two percentage points higher than in recessions in Durango, Campeche, Quintana Roo and Tabasco, states whose production concentrates in primary activities (agriculture and oil) or tourism. In turn, as in basic statistics, Coahuila shows the greatest volatility over both cycle regimes.

In summary, this evidence suggests that both national and state business cycles exhibit significant asymmetry in magnitude, duration, and volatility. In general, similar findings have been reported by Artis *et al*. (1997), Mejía (1999, 2004) and Stiblarová and Sinicáková (2019) for different groups of developed and developing countries, while Mejía *et al*. (2007), Gadea *et al*. (2012), Delajara (2013), Mondaca and Rojas (2017) and Colombo y Lazzari (2021) do so for the regiones or states of a set of developed and developing countries. A major implication of these results is that the severity and uncertainty provoked by recessions demand state-specific stabilization policies even if they are short-living.

Regarding the synchronization of the business cycle regimes, Tables 5 and 6 display the Pearson corrected contingency coefficient, defined in expressions (1) and (2), for the subperiods 1980.I-1995.II and 1995.III-2023.III. In order to classify the associations between the regimes, we define arbitrary ranges: there exists a strong association when the coefficient is greater than 60% and there exists a mild association when the coefficient lies between 40 and 60%.; otherwise, we say that there is a weak association between business cycle regimes.[18]

The full sample is split into two subperiods to gain some insight into the effects of the opening of the economy; the results show important differences.[19] In general, with the exception of Zacatecas, the synchronization of the business cycle regimes is strong both across the Mexican states and with respect to the national cycle over the first subperiod when the economy was rather closed.[20] Interestingly, the synchronization with the US regimes is very weak in all cases (see Table 5). These findings can be explained by the severity and diffusion of the recessions of this subperiod which were characterized by high levels of inflation, flights of capital and depreciation of the national currency, drops of production and employment as well as the adoption of contractionary stabilization policies that deepened the falls of production. Furthermore, even if the recessions of 1982-1983 and 1995 had international effects, especially on Latin America, their causes were mainly domestic which explains the low synchronization with the US cycle regimes and, consequently, the values of the Pearson contingency coefficient (Mejía and Erquizio, 2012; Moreno-Brid and Ros, 2009).

The synchronization between the business cycle regimes of the Mexican states decreases comparatively over the subperiod associated to the opening of The Mexican economy (1995.III-2023.III), but it increases with respect to the US cycles in several cases (Table 7). In general, the Northern states have cycles strongly correlated; whilst some Central-Northern and Central states have cycles moderately associated. Once again, the cycle regimes of the Southern states are much less correlated with those other states, and the national and international cycles, except for some special cases such as Quintana Roo and Yucatan. These findings could be explained by the heterogeneous adjustment of state economies to the change in the development model towards an open and market economy. Indeed, these transformations provoked substantial increases in international trade and foreign investment that were concentrated in some states located in the North, Centre-North and Center of Mexico. Similar findings are reported by Mejía and Campos (2011), Delajara (2013) and Mejía *et al*., 2018, 2019).

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[18] These ranges allow us to organize the synchronization in different categories to have a better understanding of this phenomenon, such as Artis *et al*. (1997), Mejía *et al*. (2018) and Albarrán *et al*. (2022) do.

[19] The computations for the full sample are available upon request.

[20] Actually, the opening of the Mexican economy stated around 1986 when it became a member of the General Agreement of Tariffs and Trade, which generated a production restructuration that eventually fostered its integration to the US economy (Moreno-Brid and Ros, 2009).

Moreover, at the same time, there is some evidence of interaction between the cycles of states belonging to different regions. For example, some states located in the Northern area (Baja California, Coahuila, Nuevo Leon, and Tamaulipas) as well as Guanajuato and some others of the Central-Northern region (Aguascalientes, Baja California Sur, Durango, San Luis Potosi, and Sinaloa) have cycles whose regimes are clearly correlated, which can be explained by the fact that most of these states adopted industrialization policies that expanded their exportation capacity as a means to take advantage of the expansion of the external demand. Hence, the Pearson correlation coefficients suggest the existence of a common business cycle for states that started their industrialization during the import substitution industrialization process, such as CDMX, the State of Mexico, Nuevo Leon, and Jalisco, or have recently implemented aggressive and successful strategies to incorporate their productive structures to global value chains such as Aguascalientes, Baja California, Sonora, San Luis Potosi, and Queretaro.

The correlation coefficients displayed in Table 7 imply a strong synchronization of the national and state business cycles in 23 cases, a moderate one in 5 cases, and a weak one in 4 states (Zacatecas, Campeche, Quintana Roo, and Tabasco). This evidence suggests a lower synchronization of the states with the national cycle due to differences in their adjustment to the change in the development model, which contrasts with the results for the former subperiod.

In summary, our findings suggest the existence of significant asymmetries between the business cycle regimes of the Mexican states as well as a substantial change in the synchronization of those regimes both across the states and with the national and international cycles. This heterogeneity may be explained by the importance of each state in the national production and, more important, by their capacity to upgrade their productive structures to get inserted in the global chains of value, especially those of the US.[21]

A major implication of these results is that state economies respond differently to policy and external shocks which calls for the need of local specific policies to stabilize them (Mejía *et al*., 2018, 2019). According to our results, industrialized states seem to be affected mainly by external shocks given the high integration to the US economy and they could respond similarly to common economic policies. On the contrary, the states located in the South and Southeast seem to respond highly to idiosyncratic shocks, which make more difficult to design common economic policies for these regions.

[21] Furthermore, these results are consistent with the hypothesis of divergence that has been reported in the analysis of economic growth of the Mexican states (Aroca *et al*., 2005; Rodríguez, 2005).

TABLE 5

CORRELATION AND PEARSON´S CORRECTED CONTINGENCY COEFFICIENTS FOR THE REDUCED SAMPLE: 1980.I-1995.II

		North						North central										Center								South									
		BC	CHIH	COAH	NL	SON	TAM	AGS	BCS	COL	DGO	JAL	MICH	NAY	SLP	SIN	ZAC	CDMX	MEX	GTO	HGO	MOR	PUE	QRO	TLAX	CAM	CHIA	GRO	OAX	QROO	TAB	VER	YUC	NAC	US
North	BC		**95.3**	**95.3**	**95.3**	**89.6**	**92.7**	**95.3**	*54.3*	**92.7**	**92.7**	**100.0**	**70.9**	**92.7**	**95.3**	**89.6**	31.3	**95.7**	**100.0**	**95.3**	**95.3**	**95.3**	**92.7**	**95.3**	**95.3**	**71.1**	**75.5**	**92.7**	**89.6**	**79.6**	**86.7**	**92.7**	**95.3**	**97.8**	0.7
	CHIH			**100.0**	**100.0**	**94.8**	**97.5**	**100.0**	**61.2**	**97.5**	**97.5**	**95.3**	**75.9**	**97.5**	**100.0**	**94.8**	34.1	**90.8**	**95.3**	**100.0**	**100.0**	**100.0**	**97.5**	**100.0**	**100.0**	**77.1**	**80.5**	**97.5**	**94.8**	**84.7**	**91.7**	**97.5**	**100.0**	**93.0**	3.7
	COAH				**100.0**	**94.8**	**97.5**	**100.0**	**61.2**	**97.5**	**97.5**	**95.3**	**75.9**	**97.5**	**100.0**	**94.8**	34.1	**90.8**	**95.3**	**100.0**	**100.0**	**100.0**	**97.5**	**100.0**	**100.0**	**77.1**	**80.5**	**97.5**	**94.8**	**84.7**	**91.7**	**97.5**	**100.0**	**93.0**	3.7
	NL					**94.8**	**97.5**	**100.0**	**61.2**	**97.5**	**97.5**	**95.3**	**75.9**	**97.5**	**100.0**	**94.8**	34.1	**90.8**	**95.3**	**100.0**	**100.0**	**100.0**	**97.5**	**100.0**	**100.0**	**77.1**	**80.5**	**97.5**	**94.8**	**84.7**	**91.7**	**97.5**	**100.0**	**93.0**	3.7
	SON						**97.5**	**94.8**	**70.5**	**97.5**	**97.5**	**89.6**	**75.9**	**97.5**	**94.8**	**100.0**	34.1	**90.8**	**89.6**	**94.8**	**94.8**	**94.8**	**97.5**	**94.8**	**94.8**	**77.1**	**80.5**	**97.5**	**100.0**	**84.7**	**91.7**	**97.5**	**94.8**	**93.0**	3.7
	TAM							**97.5**	**64.9**	**100.0**	**100.0**	**92.7**	**78.6**	**100.0**	**97.5**	**97.5**	35.8	**88.1**	**92.7**	**97.5**	**97.5**	**97.5**	**100.0**	**97.5**	**97.5**	**80.3**	**83.3**	**100.0**	**97.5**	**87.4**	**94.3**	**100.0**	**97.5**	**90.4**	5.3
North central	AGS								**61.2**	**97.5**	**97.5**	**95.3**	**75.9**	**97.5**	**100.0**	**94.8**	34.1	**90.8**	**95.3**	**100.0**	**100.0**	**100.0**	**97.5**	**100.0**	**100.0**	**77.1**	**80.5**	**97.5**	**94.8**	**84.7**	**91.7**	**97.5**	**100.0**	**93.0**	3.7
	BCS									**64.9**	**64.9**	*54.3*	**73.3**	**64.9**	**61.2**	**70.5**	32.6	*57.6*	*54.3*	**61.2**	**61.2**	**61.2**	**64.9**	**61.2**	**61.2**	**64.9**	**77.9**	**64.9**	**70.5**	**82.1**	*51.7*	**64.9**	**61.2**	**60.7**	2.1
	COL										**100.0**	**92.7**	**78.6**	**100.0**	**97.5**	**97.5**	35.8	**88.1**	**92.7**	**97.5**	**97.5**	**97.5**	**100.0**	**97.5**	**97.5**	**80.3**	**83.3**	**100.0**	**97.5**	**87.4**	**94.3**	**100.0**	**97.5**	**90.4**	5.3
	DGO											**92.7**	**78.6**	**100.0**	**97.5**	**97.5**	35.8	**88.1**	**92.7**	**97.5**	**97.5**	**97.5**	**100.0**	**97.5**	**97.5**	**80.3**	**83.3**	**100.0**	**97.5**	**87.4**	**94.3**	**100.0**	**97.5**	**90.4**	5.3
	JAL												**70.9**	**92.7**	**95.3**	**89.6**	31.3	**95.7**	**100.0**	**95.3**	**95.3**	**95.3**	**92.7**	**95.3**	**95.3**	**71.1**	**75.5**	**92.7**	**89.6**	**79.6**	**86.7**	**92.7**	**95.3**	**97.8**	0.7
	MICH													**78.6**	**75.9**	**75.9**	*51.5*	**66.5**	**70.9**	**75.9**	**75.9**	**75.9**	**78.6**	**75.9**	**75.9**	**66.2**	**84.5**	**78.6**	**75.9**	**91.6**	*58.0*	**78.6**	**75.9**	**68.6**	12.1
	NAY														**97.5**	**97.5**	35.8	**88.1**	**92.7**	**97.5**	**97.5**	**97.5**	**100.0**	**97.5**	**97.5**	**80.3**	**83.3**	**100.0**	**97.5**	**87.4**	**94.3**	**100.0**	**97.5**	**90.4**	5.3
	SLP															**94.8**	34.1	**90.8**	**95.3**	**100.0**	**100.0**	**100.0**	**97.5**	**100.0**	**100.0**	**77.1**	**80.5**	**97.5**	**94.8**	**84.7**	**91.7**	**97.5**	**100.0**	**93.0**	3.7
	SIN																34.1	**90.8**	**89.6**	**94.8**	**94.8**	**94.8**	**97.5**	**94.8**	**94.8**	**77.1**	**80.5**	**97.5**	**100.0**	**84.7**	**91.7**	**97.5**	**94.8**	**93.0**	3.7
	ZAC																	28.8	31.3	34.1	34.1	34.1	35.8	34.1	34.1	35.8	*47.8*	35.8	34.1	*44.6*	7.9	35.8	34.1	30.0	4.8
Center	CDMX																		**95.7**	**90.8**	**90.8**	**90.8**	**88.1**	**90.8**	**90.8**	**65.5**	**71.0**	**88.1**	**90.8**	**75.1**	**82.1**	**88.1**	**90.8**	**97.9**	2.0
	MEX																			**95.3**	**95.3**	**95.3**	**92.7**	**95.3**	**95.3**	**71.1**	**75.5**	**92.7**	**89.6**	**79.6**	**86.7**	**92.7**	**95.3**	0.7	0.7
	GTO																				**100.0**	**100.0**	**97.5**	**100.0**	**100.0**	**77.1**	**80.5**	**97.5**	**94.8**	**84.7**	**91.7**	**97.5**	**100.0**	**93.0**	3.7
	HGO																					**100.0**	**97.5**	**100.0**	**100.0**	**77.1**	**80.5**	**97.5**	**94.8**	**84.7**	**91.7**	**97.5**	**100.0**	**93.0**	3.7
	MOR																						**97.5**	**100.0**	**100.0**	**77.1**	**80.5**	**97.5**	**94.8**	**84.7**	**91.7**	**97.5**	**100.0**	**93.0**	3.7
	PUE																							5.3	**97.5**	**80.3**	**83.3**	**100.0**	**97.5**	**87.4**	**94.3**	**100.0**	**97.5**	**90.4**	5.3
	QRO																								**100.0**	**77.1**	**80.5**	**97.5**	**94.8**	**84.7**	**91.7**	**97.5**	**100.0**	**93.0**	3.7
	TLAX																									**77.1**	**80.5**	**97.5**	**94.8**	**84.7**	**91.7**	**97.5**	**100.0**	**93.0**	3.7
South	CAM																										**60.2**	**80.3**	**77.1**	*54.8*	**79.0**	**80.3**	**77.1**	**68.2**	18.0
	CHIA																											**83.3**	**80.5**	**96.1**	**79.1**	**83.3**	**80.5**	**73.2**	16.0
	GRO																												**97.5**	**87.4**	**94.3**	**100.0**	**97.5**	**90.4**	5.3
	OAX																													**84.7**	**91.7**	**97.5**	**94.8**	**93.0**	3.7
	QROO																														**74.2**	**87.4**	**84.7**	**77.3**	13.3
	TAB																															**94.3**	**91.7**	**84.4**	8.9
	VER																																**97.5**	**90.4**	5.3
	YUC																																	**93.0**	3.7
	NAC																																		0.7

Note: Bold is used to indicate strong correlation, italics for mild correlation, and normal for low correlation.
Source: Own elaboration with data from INEGI (2024).

Table 6

Correlation and Pearson's Corrected Contingency Coefficients for the reduced sample: 1995.III-2023.III

		North						North central										Center								South									
		BC	CHIH	COAH	NL	SON	TAM	AGS	BCS	COL	DGO	JAL	MICH	NAY	SLP	SIN	ZAC	CDMX	MEX	GTO	HGO	MOR	PUE	QRO	TLAX	CAM	CHIAP	GRO	OAX	QROO	TAB	VER	YUC	NAC	US
North	BC		**73.3**	*57.6*	*57.6*	**83.0**	**65.7**	**65.7**	*52.8*	**65.3**	21.4	**84.9**	**73.5**	**67.3**	**65.1**	**65.7**	7.7	**82.5**	**76.6**	*46.2*	*52.5*	*48.8*	*55.4*	**78.0**	**67.3**	24.0	*56.0*	*54.6*	18.1	9.9	16.3	28.8	*57.9*	**78.8**	*55.1*
	CHIH			*59.7*	**68.3**	**81.8**	**75.4**	*57.3*	**79.6**	**66.6**	*50.0*	**85.0**	**96.1**	**62.0**	**89.9**	**90.7**	18.5	**79.2**	**68.3**	**72.9**	**62.2**	**61.9**	**71.8**	**71.8**	**68.3**	12.3	*54.0*	*55.9*	*48.1*	27.6	14.6	*51.0*	**75.4**	**96.1**	**71.2**
	COAH				**80.9**	*50.3*	**79.1**	**87.4**	*57.6*	36.5	*46.3*	*48.2*	*54.8*	38.0	*48.2*	*53.8*	10.3	32.9	38.0	**69.6**	18.6	*57.6*	*58.8*	*51.4*	*47.1*	32.2	18.8	*47.0*	*47.1*	*59.7*	31.0	32.0	**79.1**	**64.3**	**82.7**
	NL					*50.3*	**79.1**	**87.4**	**73.9**	27.0	**64.2**	*48.2*	**72.9**	*47.1*	**66.2**	**62.3**	*41.1*	**60.5**	**63.4**	**85.5**	*44.7*	**71.5**	**80.1**	**65.5**	*55.6*	32.2	34.9	**61.2**	**63.4**	29.0	22.4	23.4	**94.4**	**64.3**	**71.7**
	SON						**75.4**	*57.3*	*60.0*	**82.6**	23.7	**94.3**	**86.4**	**68.3**	**73.7**	**75.5**	0.2	**89.0**	**79.3**	*47.2*	**73.1**	*41.6*	*58.9*	**76.8**	**74.0**	34.1	*41.9*	**61.7**	24.1	17.7	6.9	37.7	*57.3*	**86.4**	**60.1**
	TAM							**85.5**	*55.3*	*53.3*	*42.9*	**64.9**	**79.8**	35.2	**64.9**	**69.7**	15.7	*59.4*	*45.3*	**66.7**	*44.6*	*49.3*	*57.8*	*59.9*	*45.3*	10.0	36.9	39.4	*45.3*	35.0	8.6	*40.4*	**85.5**	**79.8**	**77.8**
North central	AGS								*55.3*	33.9	*42.9*	*44.7*	**61.7**	35.2	*44.7*	*51.6*	15.7	39.6	*45.3*	**66.7**	25.8	**65.7**	**66.4**	*59.9*	*45.3*	29.0	28.3	*47.9*	*45.3*	35.0	27.9	31.3	**85.5**	**61.7**	**77.8**
	BCS									**64.0**	**62.6**	**64.8**	**78.6**	**65.7**	**77.4**	**78.8**	*49.3*	**65.1**	**65.7**	**77.8**	*46.9*	**65.1**	**75.1**	**69.1**	**71.5**	19.9	*56.0*	*52.9*	*52.8*	25.6	10.6	27.7	**73.4**	**78.6**	**69.4**
	COL										18.1	**84.8**	**65.9**	**67.5**	**64.0**	*59.2*	19.8	**73.6**	*56.5*	33.3	*58.7*	23.1	*54.7*	**75.7**	*56.5*	12.4	33.5	*56.3*	30.5	5.3	8.9	*52.6*	33.9	**72.1**	*47.8*
	DGO											39.4	*46.7*	*43.2*	**62.6**	*51.0*	31.3	*41.3*	*43.2*	**75.8**	37.4	*43.5*	*46.9*	36.0	*57.0*	28.7	34.7	*49.9*	*57.0*	14.2	9.3	11.6	**63.0**	*46.7*	*56.5*
	JAL												**84.4**	**76.9**	**82.9**	**78.8**	7.6	**91.1**	**76.9**	*54.5*	**70.4**	*46.1*	*56.4*	**78.7**	**76.9**	31.0	*44.4*	**64.2**	30.1	15.9	4.4	34.7	*55.3*	**89.6**	*58.3*
	MICH													**60.9**	**89.6**	**90.7**	23.1	**84.2**	**73.7**	**69.8**	**68.3**	**61.4**	**77.0**	**72.6**	**67.6**	10.4	*55.8*	*56.4*	*46.0*	21.7	12.5	*44.2*	**79.8**	**95.7**	**64.2**
	NAY														*59.5*	**61.0**	13.7	**70.2**	**64.1**	*52.1*	*44.3*	*45.0*	**62.5**	**69.1**	**74.3**	4.8	30.8	*48.1*	25.2	6.6	28.3	19.2	*54.7*	**60.9**	*49.1*
	SLP															**83.9**	*41.6*	**82.1**	**76.9**	**84.0**	**70.4**	**70.7**	**80.3**	**78.7**	*59.5*	2.1	**61.3**	**64.2**	*59.5*	15.9	26.5	34.7	**64.9**	**89.6**	*58.3*
	SIN																12.6	**72.5**	**61.0**	**66.8**	*54.0*	*54.1*	**64.8**	**63.8**	**66.9**	2.8	*43.4*	*47.1*	*40.8*	21.9	0.4	35.8	**69.7**	**90.7**	**65.9**
	ZAC																	19.1	29.1	*55.4*	16.0	22.2	*47.5*	35.0	5.8	27.1	*42.7*	9.0	29.1	18.1	2.1	3.4	38.1	13.6	12.6
Center	CDMX																		**88.5**	*57.2*	**72.6**	*45.3*	**62.6**	**80.0**	**75.3**	35.4	*51.3*	**61.1**	31.2	1.6	4.4	19.7	*59.4*	**78.7**	*41.1*
	MEX																			**73.7**	**75.0**	**62.2**	**73.3**	**81.6**	**74.3**	21.2	*57.5*	**72.6**	*46.1*	6.6	4.5	5.9	**63.3**	**67.6**	*49.1*
	GTO																				*56.1*	**74.1**	**76.9**	**68.0**	*59.9*	33.7	*51.8*	**63.7**	**79.7**	37.1	7.2	11.2	**84.7**	**69.8**	**80.1**
	HGO																					*57.6*	*54.8*	**67.0**	**70.6**	2.5	35.9	**69.0**	*50.1*	11.1	24.5	14.5	*44.6*	**62.4**	28.8
	MOR																						**71.5**	**65.5**	*45.0*	36.5	*51.3*	**72.5**	*56.8*	9.9	15.0	28.8	**65.7**	**61.4**	*55.1*
	PUE																							**85.6**	*50.2*	20.6	*42.7*	**63.6**	*50.2*	9.5	2.1	*48.9*	**74.1**	**70.9**	*51.9*
	QRO																								**64.4**	1.4	*52.7*	**67.2**	36.6	3.7	1.2	*40.8*	*59.9*	**72.6**	*49.9*
	TLAX																									8.3	30.8	*53.5*	*46.1*	15.5	28.3	5.9	**63.3**	**67.6**	*60.0*
South	CAM																										8.1	17.5	36.5	25.3	5.1	4.4	29.0	10.4	23.5
	CHIAP																											*47.9*	*47.4*	14.0	23.5	9.9	36.9	*55.8*	36.9
	GRO																												**72.6**	0.7	*51.2*	*48.3*	*55.9*	*56.4*	*46.3*
	OAX																													15.5	24.1	38.0	**63.3**	*46.0*	*60.0*
	QROO																														37.8	0.3	35.0	32.0	**60.1**
	TAB																															**66.0**	27.9	12.5	22.6
	VER																																21.9	*51.1*	36.6
	YUC																																	**71.3**	**77.8**
	NAC																																		**75.4**

Note: Bold is used to indicate strong correlation, italics for mild correlation, and normal for low correlation.
Source: Own elaboration with data from INEGI (2024).

Conclusions

This paper introduces a modified version of the AKO methodology to characterize the quarterly business cycle regimes of the 32 Mexican states in terms of magnitude, duration and volatility as well as to measure their synchronization over a longer period than those used in previous studies, that goes from 1980 to 2023. Consistently with the existing international and national literature, our results suggest the existence of significant asymmetries between the business cycle regimes: in general, recessions are more volatile (growth rates are more heterogeneous) and last shorter than expansion in most cases. Furthermore, there is evidence of asymmetries in magnitude, suggesting that the average falls of production during recessions are greater than average rises over expansions in absolute terms. Hence, even if recessions are short living, the uncertainty associated to heir magnitude and duration demands for stabilization policies to mitigate their negative effects on production, income, investment, profits, consumption and wellbeing of families.

Regarding business cycle regimes synchronization, our results suggest that there exists important links between the business cycle regimes of states located in different regions of Mexico, especially among those of the Northern, Central-Northern and Central areas. Moreover, consistently with the evidence provided by previous studies, the cycles of the Southern and Southeastern states seem to respond mainly to idiosyncratic shocks linked to the specialization of their productive structure (agriculture, mining, tourism), which generates problems to have an effective common policy for these regions.

Furthermore, our results also suggest that the synchronization of the business cycles across the Mexican states and with the national cycle decreased significantly after the 1995 crisis while it rose with the US cycle. These patterns are consistent with the divergence hypothesis reported in the economic growth literature which suggests that the Mexican states have had different capacities to adapt to the development model based on an open and market economy. Hence, their reaction to policy and external shocks has become different, generating also heterogeneous fluctuations. In any case, these findings imply that common national economic policies can be ineffective in specific states or groups of them, and suggest the need of designing specific policies by the central government, but also the necessity of state governments to be able to apply their own policies.

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