Article **Journal of Administration and Finance**
December 2023, Vol.10 No.27 18-28

Economic cycles of Mexico based on the global indicator of economic activity[1]

Ciclos económicos de México con base al indicador global de la actividad económica[1]

GALVÁN-CORRAL, Alberto†*, MURILLO-FÉLIX, Cecilia Aurora, QUIROZ-CAMPAS, Celia Yaneth and HINOJOSA-RODRÍGUEZ, Carlos Jesús

Instituto Tecnológico de Sonora, Unidad Navojoa. México.

ID 1st Autor: *Alberto, Galván-Corral* / **ORC ID:** 0000-0002-9625-0324, **CVU CONAHCYT ID:** 93702

ID 1st Co-author: *Cecilia Aurora, Murillo-Félix* / **ORC ID:** 0000-0002-2214-9880, **CVU CONAHCYT ID:** 971874

ID 2nd Co-author: *Celia Yaneth, Quiroz-Campas* / **ORC ID:** 0000-0002-6068-1552, **CVU CONAHCYT ID:** 281305

ID 3rd Co-author: *Carlos Jesús, Hinojosa-Rodríguez* / **ORC ID:** 0000-0002-7576-9338, **CVU CONAHCYT ID:** 237638

DOI: 10.35429/JAF.2023.27.10.18.28 Received July 25, 2023; Accepted December 30, 2023

Abstract

This study aimed to analyze the classic economic cycles of Mexico, based on the global indicator of economic activity (IGAE) and identify its main features or regularities; The quantitative paradigm was applied, with an econometric approach to classical economic cycles, using time series: global indicator of total economic activity and by sector of activity: primary, secondary and tertiary; The sample included from January 1993 to May 2023. The following were identified: chronology, duration, breadth or depth, volatility and comovement of the cycles, at a total level and by sector of economic activity. The results highlight that the economy has presented three complete cycles and one incomplete, currently the economy is in the recovery phase; The ascending phases last longer than the descending ones; the IGAE of primary, secondary and tertiary activities are procyclical to the total IGAE; The IGAE of secondary and tertiary activities can be considered coincident indicators of the total IGAE, while the IGAE of primary activities can be assumed as a six-month lagging indicator.

Cycles, Regularities, Chronology

Resumen

Este estudio tuvo por objetivo analizar los ciclos económicos clásicos de México, con base al indicador global de la actividad económica (IGAE) e identificar sus principales rasgos o regularidades; se aplicó el paradigma cuantitativo, con enfoque econométrico de los ciclos económicos clásicos, usando, para ello, las series de tiempo: indicador global de la actividad económica total y por sector de actividad: primarias, secundarias y terciarias; la muestra comprendió de enero de 1993 a mayo del 2023. Se identificaron: cronología, duración, amplitud o profundidad, volatilidad y comovimiento de los ciclos, a nivel total y por sector de la actividad económica. En los resultados sobresalen que la economía ha presentado tres ciclos completos y uno incompleto, actualmente la economía se halla en fase de recuperación; las fases ascendentes tienen mayor duración que las descendentes; el IGAE de las actividades primarias, secundarias y terciarias son procíclicas al IGAE total; el IGAE de las actividades secundarias y terciaras pueden considerarse indicadores coincidentes del IGAE total, mientras que el IGAE de las actividades primarias puede asumirse como indicador rezagado con seis meses.

Ciclos, Regularidades, Cronología

Citation: GALVÁN-CORRAL, Alberto, MURILLO-FÉLIX, Cecilia Aurora, QUIROZ-CAMPAS, Celia Yaneth and HINOJOSA-RODRÍGUEZ, Carlos Jesús. Economic cycles of Mexico based on the global indicator of economic activity. Journal of Administration and Finance. 2023. 10-27:18-28.

* Correspondence to Author (E-mail: ocameloa@uan.edu.mx)
† Researcher contributing first author.
[1] Publication financed with PROFAPI 2023 resources by the Instituto Tecnológico de Sonora.

Introduction

The analysis of the existence of increases and decreases in economic activity, known as economic cycles, dates back to the beginning of the last century, among them Kuznets (1926) pointed out the presence of similarities between economies during the economic cycle, while Mitchell (1927) noted the presence of stages or phases in the cycle, recoveries, expansions, recessions and contractions, while Mills (1936) revealed the existence of associations between quantities and prices in expansions and contractions of the economic cycle.

The modern theory of the business cycle determines that there are two basic purposes of its study, on the one hand, there is its systematic determination, which is identified as regularities or facts; while, on the other hand, there is the formulation of general equilibrium models, capable of replicating the regularities or facts of the cycle to evaluate the assumptions of the origin and means of diffusion of economic changes (Arango-Thomas and Castillo, 1999; Cuadra, 2008 and Orellana, 2011); the present analysis is located under the axis of the first purpose.

Kydland and Prescott (1990) were the ones who determined the empirical regularities of the US business cycle, from them, several authors have applied this methodology to identify them in multiple countries; in Chile there is the work of Restrepo and Soto (2006), in Colombia that of Alfonso, et. al (2013), while in Peru, Perea and Mendoza (2013) and Bustamante (2015), in Ecuador by Orellana (2011), specifically in the case of Mexico, the works of Torres (2000), Mejía-Reyes (2003), Mejía, et. al (2004), Erquizio Espinal (2007), Cuadra (2008), Almendra-Arao, et al (2008), González-Estrada and Hernández (2013), Mejía et al. (2013) Erquizio Espinal and Ramírez Rodríguez (2014), Erquizio Espinal and Gracida Romo (2017), Ramírez Rodríguez and Erquizio Espinal (2023), among others; these mentions are more enunciative than limiting; although there are multiple studies on economic cycles, the discussion cannot be considered closed or exhausted.

The purpose of this study was to analyse the classical business cycles in Mexico, based on the total IGAE and by sector of activity, and to identify their main features or regularities, with a sample from January 1993 to May 2023. This analysis is pertinent and relevant since the determination of the stylised facts (also known as empirical facts) or regularities of the business cycle is a matter of great interest, especially following the integration and implementation of the Committee for the Dating of Cycles of the Mexican Economy, This will make it possible, although it is not the central intention of the study, to determine whether the methodology used in this analysis produces the cycles and phases that the Committee itself, under its own criteria, determines.

Using the IGAE to determine Mexico's classic business cycles (total and by sector or type of activity) has advantages, since the National Institute of Statistics and Geography (INEGI) reports it as a monthly indicator, using the same conceptual and methodological reference framework as Mexico's national accounts, which means that the IGAE has a high correlation with the quarterly Gross Domestic Product (GDP), which is generally used to estimate business cycles, and can therefore be considered a magnificent indicator of the behaviour of the product (Heat, 2012).

This document is composed of four parts, the first one corresponds to the introduction, where arguments and general aspects about business cycles are presented, as well as the objective of the research; the second part comprises the methodology, where the type of research, variables, sample or period of analysis are described, as well as the description of the methodology and the procedure used; the third part presents the results and their discussion, as the fourth and last part, the conclusions of the research are presented.

Methodology

This section describes the most relevant methodological aspects employed. The study was quantitative, the data collected were examined by means of an econometric analysis of classical business cycles.

ISSN: 2410-342X

Classical business cycles were identified on the basis of the following variables: total EGAI; EGAI of primary activities (primary EGAI); EGAI of secondary activities (secondary EGAI) and EGAI of tertiary activities (tertiary EGAI); these variables have the following common features: they are seasonally adjusted time series (National Institute of Geography and Informatics, 2018), their periodicity is monthly, the unit of measurement is index (base 2018=100), the sample covered from January 1993 to May 2023. The variables are available for consultation and download at the Economic Information Bank of the National Institute of Statistics and Geography (INEGI).

The classical business cycles were determined based on the definition of Burns and Mitchell (1946), while the dating of the cycles or the identification of turning points was established based on the procedure of Bry and Boschan (1971).

In developing the present study, the following steps were followed: The classical business cycle method or approach was established as the approach to be applied in the present study. The variables with which the classical business cycles were identified (total IGAE and of primary, secondary and tertiary activities) were obtained. The classical business cycles were dated on the variables used, using the Bry-Boschan-Pagan-Harding dating algorithm, available as a complement to the Eviews v10 program. The cycle was determined from initial peak-valley-final peak (Pi-V-Pf), and the two phases of each cycle, descending (Pi-V) and ascending (V-Pf), were also identified. The business cycle dating was carried out following the criteria established by the Mexican Economic Cycle Dating Committee (2022), on the stages the most common style of identifying recession, contraction, recovery and expansion stages was followed. The regularities of Mexico's business cycles calculated were: timing, duration, breadth/depth, volatility and comovement (correlation). Finally, the results are discussed and conclusions of the study are derived.

The business cycle regularities were established following the procedure proposed by Kydland and Prescott (1990): depth or breadth, duration, volatility and correlation (of total IGAE vs. IGAE of primary, secondary and tertiary activities).

According to the chronology, the following features of business cycles by stage or phase are reported: chronology, times, average, minimum and maximum (Heat, 2011, 2012).

The most relevant regularities of the phases of the cycle (rising and falling) are, according to Erquizio Espinal (2007) and Erquizio Espinal, et al. (2020), the following:

- Chronology: the dating of the economic cycle is established, i.e. the date on which the initial peak, the valley and the final peak of each cycle occur, expressed in years, quarters or months.

- Duration: expressed in the number of years, quarters or months that elapse between the initial peak and the trough (downswing) and between the trough and the final peak (upswing).

- Amplitude/depth: is constituted by the difference between the values of the cycle indicator at the initial peak and trough (downswing) and between the final peak and trough (upswing).

- Volatility: determined by the standard deviation of the IGAE/average IGAE, multiplied by one hundred, for each identified cycle, i.e. the standard deviation of the growth rates of the cycle indicator in the downswing and the upswing.

- Based on the cycle chronology, the number of times the cycle occurs, average, minimum and maximum values are reported.

Results

In this section we describe and discuss the results of the classical business cycles in Mexico, first we present the cycles and stylised facts of the total IGAE, then those related to the primary, secondary and tertiary IGAE; the analysis of comovements between the total IGAE and by type of activity is presented at the end.

Next, the classical business cycles based on total GGEI are presented. Graph 1 shows the identification of the business cycles, three complete cycles and one incomplete cycle were determined, table 1 provides more detail on the dating of the cycles.

ISSN: 2410-342X

Graphic 1 Classical business cycles (CEC) of total IGAE, 1993M01-2023M05
Source: Own elaboration, the grey (shaded) part represents the downward phase of the cycle

Cycle	Home	End	Stage	Duration (months)	Cycle (Duration in months)
1	1994M12	1995M05	Recession	6	70
	1995M06	2000M09	Expansion	64	
2	2000M10	2002M01	Recession	16	94
	2002M02	2008M07	Expansion	78	
3	2008M08	2009M05	Recession	10	122
	2009M6	2018M09	Expansion	112	
4	2018M10	2020M05	Recession	20	
	2020M06		Expansion		

Table 1 Chronology of Mexico's CECs from total IGAE, 1993M01-2023M05
Source: Own elaboration

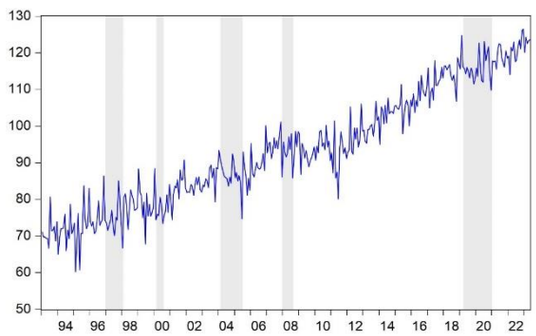
Graphic 1 and Table 1 present the general behaviour of Mexico's economy over the last three decades, identifying three business cycles between December 1994 and June 2020. There were four downswings (recession) and three upswings (expansion), all full cycles are considered atypical cycles, as they are composed of a recession and an expansion. The minimum duration of the full cycle was 70 months, while the maximum duration was 122 months; the shortest recession was 6 months, while the longest recession was 20 months. As for the duration of the expansion, the minimum was 64 months, while the maximum was 112 months. Currently, the economy is in an upswing, specifically an expansionary phase, however, it is not possible to determine or forecast its duration.

Table 2, contains the summary of the stylised facts of Mexico's CECs of the total IGAE, in the three cycles, the duration of the upswing is longer than the downswing, the first cycle had the highest volatility, followed by the third, the second cycle had the lowest volatility, it is also observed that two of the three cycles are above average in their volatility (the first and the third), while the second is below average; in terms of the breadth or depth of the cycles, the third cycle had the greatest depth, followed by the first and second, respectively; only the third cycle has a depth above the average. The descending phase with the greatest depth was that of cycle three, cycles 1 and 3 have a depth above average; with regard to the ascending phase, the greatest depth also corresponds to cycle three, plus cycles 1 and 2 have a depth below average.

Cycle	Chronology	Duration in months			Volatility	Amplitude (depth)		
		Total	Descent	Ascent		Cycle	Descent	Ascent
1	1994M12-2000M09	70	6	64	8.63	13.8	-6.3	20.2
2	2000M10-2008M07	94	16	78	5.82	12.3	-2.6	15.0
3	2008M08-2018M09	122	10	112	7.92	19.9	-7.2	27.2
			Average		7.46	15.3	-5.4	20.8

Table 2 Main facts of Mexico's CECs from total IGAE, 1993M01-2023M05
Source: Own elaboration

Having presented the results of the classical business cycles based on the total IGAE, it is appropriate to present those relating to the IGAE by sector or productive activity: primary, secondary and tertiary, respectively.



Graphic 2 IGAE CEC of primary activities, 1993M01-2023M05
Source: Own elaboration, the grey (shaded) part represents the downward phase of the cycle

Graphic 2 presents the classical business cycles based on the IGAE of primary activities, showing four complete cycles and one incomplete cycle, further details of the dating of these cycles are provided in table 3.

ISSN: 2410-342X

The behaviour of the Mexican economy over the last three decades based on the IGAE of primary activities is presented in graphic 2 and table 3; four complete and one incomplete business cycles were determined between December 1996 and January 2021. Five downswing and four upswing stages were identified, all cycles can be considered atypical, as they only present recession and expansion stages.

Cycle	Home	End	Stage	Duration (months)	Cycle (Duration in months)
1	1996M12	1998M01	Recession	14	38
	1998M02	2000M01	Expansion	24	
2	2000M02	2000M07	Recession	6	48
	2000M08	2004M01	Expansion	42	
3	2004M02	2005M06	Recession	17	46
	2005M07	2007M11	Expansion	29	
4	2007M12	2008M08	Recession	9	135
	2008M09	2019M02	Expansion	126	
5	2019M03	2020M12	Recession	22	
	2021M01		Expansion		

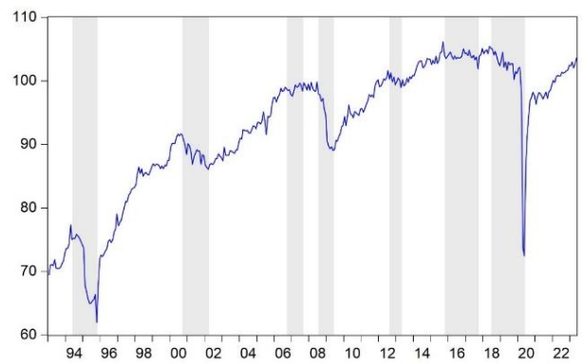
Table 3 Chronology of Mexico's IGAE CECs of primary activities, 1993M01-2023M05
Source: Own elaboration

The shortest full cycle had a duration of 38 months, while the longest was 135 months; in the downswing the minimum duration was 6 months and the maximum 22 months, while in the upswing the minimum duration was 24 months and the maximum 126 months. Assessing the most recent years, the economy is currently in an upswing, starting in January 2021, specifically in expansion, but it is not possible to specify the duration of the upswing.

		Duration in months				Amplitude (depth)		
Cycle	Chronology	Total	Descent	Ascent	Volatility	Cycle	Descent	Ascent
1	1996M12-2000M01	38	14	24	6.3	0.3	-7.5	7.8
2	2000M02-2004M01	48	6	42	5.4	16.6	-1.0	17.7
3	2004M02-2007M11	46	17	29	5.7	-7.8	-16.1	8.2
4	2007M12-2019M02	135	9	126	8.6	32.6	-0.2	32.8
			Average		6.5	10.4	-6.2	16.6

Table 4 Main facts of Mexico's CECs from the IGAE for primary activities, 1993M01-2023M05
Source: Own elaboration

Table 4, contains the summary of the stylised facts of the IGAE of primary activities, in all cycles the duration of the upward phase was longer than the downward phase, the last (fourth) cycle is the one with the highest volatility of all, the first three cycles present a volatility below the average, while only the fourth (last) cycle is above the average; regarding the depth of the cycles, cycles 2 and 4 are above average, while cycles 1 and 3 are below average, cycle 4 is the deepest and cycle 3 the shallowest, additionally, cycle 3 has a negative amplitude, which means that the fall of the IGAE in the downward phase was higher than the increase in the upward phase. The descent phase with the greatest depth corresponds to cycle three, cycles 1 and 3 present depth above the average, while cycles 2 and 4 have depth below the average; on the ascending phase it is observed that, the one with the greatest depth corresponds to cycle 4, above the average are cycles 2 and 4, while below cycles 1 and 3 are cycles 2 and 4 and cycles 4 and 4 are cycles 4 and 4.



Graphic 3 IGAE CEC of secondary activities, 1993M01-2023M05
Source: Own elaboration, the grey (shaded) part represents the downward phase of the cycle

Graphic 3 shows the classical business cycles based on the IGAE of secondary activities, showing six complete cycles and one incomplete cycle, a more detailed dating of the cycles is shown in table 5.

Graphic 3 and table 5 present the development of the Mexican economy over the last three decades based on the IGAE of secondary activities, six complete economic cycles were established between May 1994 and May 2020.

ISSN: 2410-342X

Seven stages of the downward phase and six of the upward phase were established, all of which are considered atypical cycles, given that they only present the recession and expansion stages. The longest complete cycle was the first, with a duration of 76 months, and the shortest was the third with 22 months; as for the downswing, the minimum duration was 9 months (cycle 5) and the maximum was 24 months (cycles 6 and 7); the minimum duration of the upswing was 8 months (cycle 6) and the maximum was 58 months (cycle 1); the minimum duration of the upswing was 8 months (cycle 6) and the maximum was 58 months (cycle 6); the minimum duration of the upswing was 8 months (cycle 6) and the maximum 58 months (cycle 6).

Cycle	Home	End	Stage	Duration (months)	Cycle (Duration in months)
1	1994M05	1995M10	Recession	18	76
	1995M11	2000M08	Expansion	58	
2	2000M09	2002M03	Recession	18	71
	2002M04	2006M08	Expansion	53	
3	2006M09	2007M08	Recession	12	22
	2007M09	2008M06	Expansion	10	
4	2008M07	2009M05	Recession	11	49
	2009M06	2012M07	Expansion	38	
5	2012M08	2013M04	Recession	9	38
	2013M05	2015M09	Expansion	29	
6	2015M10	2017M09	Recession	24	32
	2017M10	2018M05	Expansion	8	
7	2018M06	2020M05	Recession	24	
	2020M06		Expansion		

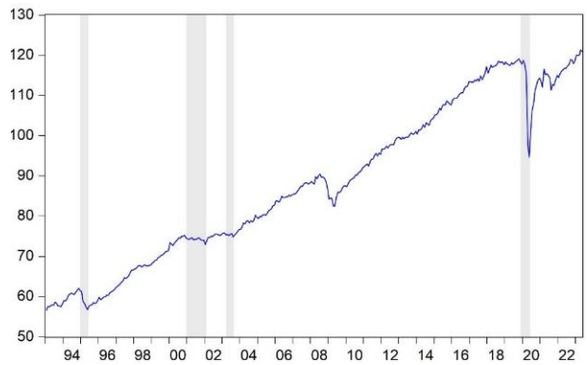
Table 5 Chronology of Mexico's CECs of IGAE secondary activities, 1993M01-2023M05
Source: Own elaboration

Based on the last incomplete cycle, the economy goes through the upward phase, specifically in the expansion stage, from June 2020 onwards, although it is not possible to estimate its duration. Table 6 contains the summary of the stylised facts of the GDP of secondary activities, it is observed that in most of the cycles the duration of the ascending phase is longer than the descending phase, only cycle 3 does not present this characteristic; the first cycle is the one that presented the highest volatility of all, while the third one the lowest, cycles 1, 2, and 4 present volatility above the average, while cycles 3, 5 and 6 their volatility is below the average; in terms of the breadth or depth of the cycles, the first cycle has the greatest depth, cycles 3 and 6 have a negative breadth, which implies that the fall of the IGAE in the downward phase was greater than its increase in the upward phase, cycles 1, 2, 4 and 5 have a depth above average, while cycles 3 and 6 have a depth below average.

The downward phase with the greatest depth was the first cycle, while the upward phase with the greatest depth also corresponds to the first cycle.

		Duration in months				Amplitude (depth)		
Cycle	Chronology	Total	Descent	Ascent	Volatilidad	Ciclo	Total	Descent
1	1994M05-2000M08	76	18	58	9.86	11.2	-13.0	24.3
2	2000M09-2006M08	71	18	53	3.89	6.6	-5.4	12.1
3	2006M09-2008M06	22	12	10	0.61	-0.2	-0.3	0.07
4	2008M07-2012M07	49	11	38	3.58	3.5	-8.8	12.4
5	2012M08-2015M09	38	9	29	1.72	4.6	-1.3	5.9
6	2015M10-2018M05	32	24	8	0.63	-0.4	-2.0	1.5
			Average		3.38	4.2	-5.2	9.4

Table 6 Mexico's CECs' main facts from the IGAE secondary activities, 1993M01-2023M05
Source: Own elaboration



Graphic 4 CEC of the IGAE of tertiary activities, 1993M01-2023M05
Source: Own elaboration, the grey (shaded) part represents the downward phase of the cycle

Graphic 4 and table 7 show the behaviour of the Mexican economy over the last three decades based on the IGAE of tertiary activities. Three complete and one incomplete business cycles were identified between December 1994 and June 2020. Four downswings and three upswings were identified, all cycles are considered atypical, as they only present two stages: recession and expansion.

Cycle	Home	End	Stage	Duration (months)	Cycle (Duration in months)
1	1994M12	1995M05	Recession	6	72
	1995M06	2000M11	Expansion	66	
2	2000M12	2002M01	Recession	14	27
	2002M02	2003M02	Expansion	13	
3	2003M03	2003M08	Recession	7	201
	2003M09	2019M10	Expansion	194	
4	2019M11	2020M05	Recession	7	
	2020M06		Expansion		

Table 7 Chronology of Mexico's CECs of the IGAE for tertiary activities, 1993M01-2023M05
Source: Own elaboration

ISSN: 2410-342X

The shortest complete cycle was the second with 27 months of duration, while the longest complete cycle was the third with 201 months; regarding the downward phase, the minimum duration was 6 months and the maximum 194 months, which corresponded to the first and third cycle respectively; the upward phase presented the minimum duration in the second cycle with 13 months and the maximum in the third cycle with 194 months. Based on the incomplete cycle, the economy is in an upward phase, specifically in an expansionary phase, starting in June 2020, but its duration cannot be anticipated.

Cycle	Chronology	Duration in months				Amplitude (depth)		
		Total	Descent	Ascent	Volatilidad	Ciclo	Total	Descent
1	1994M12-2000M11	72	6	66	8.27	13.0	-4.7	17.7
2	2000M12-2003M02	27	14	13	0.88	0.3	-1.5	1.8
3	2003M03-2019M10	201	7	194	13.80	43.2	-0.5	43.7
			Average		7.65	18.8	-2.2	21.1

Table 8 Main facts of Mexico's CECs from the IGAE of tertiary activities, 1993M01-2023M05
Source: Own elaboration

Table 8 shows the summary of the stylised facts of the IGAE of tertiary activities, it can be observed that in most of the cycles the duration of the upward phase is longer than the downward phase, only the second cycle, out of three, does not present this characteristic; cycle three is the one that presented the highest volatility of all, while cycle two presented the lowest volatility; in terms of the breadth or depth of the cycles, cycle three was the deepest and cycle two the shallowest; in terms of the downward phase, cycle one was the deepest and cycle three the shallowest; while the deepest upward phase was cycle three and cycle two the shallowest.

Indicator	Stages	Times	Average duration (months)
IGAE (total)	Recession	4	13.0
	Expansion	3	84.7
	Cycle	3	95.3
IGAE Primary Activities	Recession	5	13.6
	Expansion	4	55.3
	Cycle	4	66.8
IGAE Secondary Activities	Recession	7	16.6
	Expansion	6	32.7
	Cycle	6	48.0
IGAE Tertiary Activities	Recession	4	8.5
	Expansion	3	91.0
	Cycle	3	100.0

Table 9 Summary of Mexico's CECs, 1993M01-2023M05
Source: Own elaboration

Table 9 presents a summary of Mexico's classical business cycles according to the total IGAE and by sector of activity. In general terms, the duration of the cycles, based on the total IGAE is 95.3 months, comparing the duration of the cycles by type or sector of activity versus the total IGAE, primary activities present cycles with a shorter duration of approximately 29 months, which in terms of years represents a little more than 2 years in the reduction of the duration of the cycle, the cycle of secondary activities, lasts on average 47. 3 months less than the total IGAE cycle which represents a decrease of almost 4 years, the average cycle length of tertiary activities is the only one that is above the total cycle length by 4.7 months. As far as recessions are concerned, those of the total cycle last on average 13 months, in primary activities they last on average 13.6 months, which is practically equal to the total, while recessions in secondary activities last 3.6 months longer than those of the total cycle. Finally, the duration of expansions in the total cycle is 85 months, while by type or sector they last 55.3, 32.7 and 91 months on average, respectively.

Table 10 shows the cyclical behaviour of the total IGAE and its components by type of activity, under the period of analysis from January 1993 to May 2023, the cross-correlations of each variable with the total IGAE are reported. It is noticed that the IGAE of primary, secondary and tertiary activities are procyclical to the total IGAE, it is also noticed that the cycle of primary activities follows the cycle of total IGAE by six months, in other words, the cycle of primary activities lags the cycle of total IGAE by six months, while the cycles of secondary and tertiary activities are contemporaneous or coincidental to the cycle of total IGAE.

Variable X	Correlation of total IGAE with		
	IGAE of Activities Primary	IGAE of Activities Secondary Activities	IGAE of Activities Tertiary Activities
$X_{(t-6)}$	0.9320	0.8944	0.9761
$X_{(t-5)}$	0.9332	0.8958	0.9780
$X_{(t-4)}$	0.9321	0.8983	0.9803
$X_{(t-3)}$	0.9312	0.9012	0.9829
$X_{(t-2)}$	0.9311	0.9066	0.9865
$X_{(t-1)}$	0.9325	0.9146	0.9910
X	0.9368	**0.9185**	**0.9944**
$X_{(t+1)}$	0.9353	0.9079	0.9924
$X_{(t+2)}$	0.9334	0.8950	0.9889
$X_{(t+3)}$	0.9325	0.8857	0.9860
$X_{(t+4)}$	0.9341	0.8787	0.9839
$X_{(t+5)}$	0.9351	0.8727	0.9820
$X_{(t+6)}$	**0.9370**	0.8668	0.9806

Table 10 Cyclical behaviour of the total IGAE and by type of activity
Source: Own elaboration, correlation is significant at the 0.01 level (bilateral).

ISSN: 2410-342X

The determination of classical cycles according to the total IGAE and by type of activity made it possible to identify three complete cycles and one incomplete cycle for total and tertiary activities, one more complete cycle for primary activities, i.e. 4 complete cycles and one incomplete cycle, while for secondary activities 2 more cycles, i.e. six complete cycles and one incomplete cycle; according to the total cycles and by type of activity the economy goes through the upward phase or expansion stage, despite the differences in where the last recession phase ended and the last, and current, expansion phase started.

The results can be summarised as follows: Based on the total IGAE, three complete and one incomplete business cycles were identified; based on the current cycle, the economy is in an upward or expansion phase, due to the fact that the recession phase ended in May 2020, which coincides with the business cycles defined by the Mexican Economic Cycle Dating Committee (2022).

The duration of the upswings in the business cycle is longer than the duration of the downswings, both in the business cycles determined by the total IGAE and primary, secondary and tertiary activities, which is in line with Kydland and Prescott (1990), Heath (2012) and the Mexico Business Cycle Dating Committee (2022). The average business cycle volatility of the total IGAE is slightly higher than the average volatility of the IGAE cycles by primary and secondary activities, while the IGAE cycle of tertiary activities has the highest value, These results differ from those obtained by Cuadra (2008) as he found higher volatilities in the GDP cycle of manufacturing activities vs. the total GDP cycle, and also differ from those of González-Estrada and Hernández (2013) as they report a volatility of agricultural GDP of almost three times higher than the volatility of the GDP cycle.

Regarding the average amplitude of the cycle, the results are consistent with those corresponding to volatility, the amplitude of the total cycle is greater than that of the cycles of primary and secondary activities, but less than that of the cycle of tertiary activities, which also coincides with the amplitude of the upswing phase (expansion), as for the downswing phase, the greatest amplitude is observed in the cycle of primary activities, followed by the amplitude of the total cycle, followed by the amplitude of the cycle by secondary and tertiary activities, respectively.

From the above analysis it follows that business cycles are recurrent and non-periodic, which is consistent with Mitchell (1927) and Burns and Mitchell (1946). Finally, the comovements of the IGAE cycle by type of activity with respect to the total IGAE cycle, all variables, by primary, secondary and tertiary activity are procyclical to the total IGAE, while the IGAE of primary activities follows the total IGAE by six months, consequently it is considered a lagging indicator; the IGAE of secondary and tertiary activities are contemporaneous with the total IGAE, which partially coincides with the results of Cuadra (2008) who reports that the GDP of manufacturing activities is procyclical and contemporaneous with total GDP, and also partially coincides with the results of González-Estrada and Hernández (2013) since they report that agricultural GDP is procyclical with GDP and they differ in that they identify that agricultural GDP is a coincident indicator of GDP.

Acknowledgements

We are grateful for the support of the Instituto Tecnológico de Sonora for funding this research with resources from the Programa de Fomento y Apoyo a la Investigación (Profapi 2023) through the project Profapi 2023_058 AGC.

Conclusions

The objective of this research was met, as Mexico's economic cycles were analysed under the classical cycle approach, identifying their main features or regularities, taking as a reference period from January 1993 to May 2023.

ISSN: 2410-342X

Mexico's economy has presented three complete cycles, considering the last three decades. As of today, the economy is in its fourth cycle, specifically it is located in the ascending phase, in the expansion stage since June 2020. Based on the IGAE of primary, secondary and tertiary activities, four, six and three complete cycles and one incomplete cycle are determined, respectively, in all cycles there is coincidence in that the current stage is ascending, specifically, expansion, however the beginning varies depending on the sector of activity based on which the economic cycle is determined; based on primary activities the expansion began in January 2021, in June 2020 if the cycle is determined based on secondary or tertiary activities.

Mexico's business cycles are recurrent and non-periodic, the upward phases are longer or more prolonged than the downward phases. The total IGAE cycle is more volatile than the IGAE cycles by primary and secondary activity, but not by tertiary activities.

The depth of the total cycle is lower than that of the tertiary activity cycle and greater than those of the primary and secondary activity cycle, this is consistent for the upward phase, however, for the downward phase, the greatest depth is for the primary activity cycle, followed by the total, secondary and tertiary activity cycles, respectively.

The IGAE of primary, secondary and tertiary activities are pro-cyclical to the total IGAE; the IGAE of secondary and tertiary activities are coincident indicators, while the IGAE of primary activities is a lagging indicator (by six months) to the total IGAE.

The present study can be taken as a benchmark for extending analyses of this nature; the investigation of business cycles is a topic of interest that stimulates debate. Future analyses can be elaborated by including more variables, by using variables with quarterly periodicity, or by determining business cycles of either growth or acceleration, including under the approach of synchronisation of national or international business cycles.

References

Alfonso, V., Arango, L., Arias, F., Cangrejo, G., & Pulido, J. (2013). Ciclos de negocios en Colombia, 1975-2011. *Lecturas de Economía*, *78*, 115–149. https://doi.org/10.17533/udea.le.n78a14463

Almendra-Arao, G., González-Estrada, A., & Mora-Flores, J. S. (2008). Los ciclos económicos de México y sus regularidades empíricas. *Agrociencia*, *42*(3), 299–311. https://agrociencia-colpos.org/index.php/agrociencia/article/view/629

Arango-Thomas, L. E., & Castillo, M. (1999). *¿Son estilizadas las regularidades del ciclo económico? Una breve revisión de la literatura*. https://doi.org/10.32468/be.115

Bry, G. y Boschan, C. (1971) *Cyclical Analysis of Time Series: Selected Procedures and Computer Programs*, Technical Paper 20, NBER, New York. https://www.nber.org/books-and-chapters/cyclical-analysis-time-series-selected-procedures-and-computer-programs

Burns, A. y Mitchell, W. (1946) *Measuring Business Cycles*, NBER, New York. https://www.nber.org/books-and-chapters/measuring-business-cycles

Bustamante, R. (2015). Características estilizadas de los ciclos económicos de la economía peruana: 1980-2014. *Serie de Documentos de Trabajo Omega Beta Gamma*, *02–2015*, 1–16. https://economia.unmsm.edu.pe/data/doc_trab/02-2015-OBG.pdf

Comité de Fechado de Ciclos de la Economía de México. (2022). *Reporte de puntos de giro, recesiones y expansiones de 1980 a 2020*. https://comitefechadocicloseconomicos.mx/wp-content/uploads/2022/08/Reporte_CFCEM.pdf

Cuadra, G. (2008). *Hechos Estilizados del Ciclo Económico en México* (No. 2008–14; Documento de Investigación). https://www.banxico.org.mx/DIBM/web/documento/visor.html?clave=2008-14&locale=es_MX

ISSN: 2410-342X

Erquizio Espinal, A. (2007). Identificación de los Ciclos Económicos en México, 1949-2006. *Problemas Del Desarrollo : Revista Latinoamericana de Economía*, *38*(150). https://www.probdes.iiec.unam.mx/index.php/pde/article/view/7674

Erquizio Espinal, A., & Gracida Romo, J. J. (2017). Ciclos económicos clásicos en México el caso de Sinaloa y Sonora 1900-1926. *Paradigma Económico*, *9*(1), 27–58. https://paradigmaeconomico.uaemex.mx/article/download/4846/3251/

Erquizio Espinal, A., & Ramírez Rodríguez, R. (2014). La recesión de 2009 y la expansión 2010–2012 en las entidades federativas de México. *Estudios Fronterizos*, *15*(30), 181–213. https://doi.org/10.21670/ref.2014.30.a07

González-Estrada, A., & Hernández, A. L. E. (2013). Regularidades de las fluctuaciones cíclicas de la producción agropecuaria de México. *Revista Mexicana de Ciencias Agrícolas*, *4*(3), 367–380. https://cienciasagricolas.inifap.gob.mx/index.php/agricolas/article/view/1199

Heath, J. (2011). Identificación de los ciclos económicos en México; 30 años de evidencia. *Realidad, Datos y Espacio, Revista Internacional de Estadística y Geografía*, *2*(2), 19–31. https://rde.inegi.org.mx/index.php/2011/05/08/identificacion-de-los-ciclos-economicos-en-mexico-30-anos-de-evidencia/

Heath, Jonathan. (2012). *Lo que indican los indicadores : cómo utilizar la información estadística para entender la realidad económica de México* (INEGI, Ed.; Primera). Instituto Nacional de Estadística y Geografía. https://www.inegi.org.mx/contenido/productos/prod_serv/contenidos/espanol/bvinegi/productos/estudios/indican_indi/indica_v25iv12.pdf

Instituto Nacional de Estadística y Geografía. (2018). *Metodología del ajuste estacional 2017*. https://www.inegi.org.mx/contenidos/productos/prod_serv/contenidos/espanol/bvinegi/productos/nueva_estruc/702825099060.pdf

Kuznets, S. (1926). *Cyclical fluctuations, retail and wholesale trade*. New York. Adelphi.

Kydland, F. E., & Prescott, E. C. (1990). Business Cycles: Real Facts and a Monetary Myth. *Federal Reserve Bank of Minneapolis Quaterly Review*, *14*(2), 3–18. https://doi.org/10.21034/qr.1421

Mejía, P., Ochoa, S., & Díaz, M. Á. (2013). De la recesión a la recuperación: Producción y empleo en México y el Estado de México. *Problemas Del Desarrollo*, *44*(173), 133–162. https://doi.org/10.1016/S0301-7036(13)71878-9

Mejía, P. R., Martínez, J. A. G., & Rendón, W. L. B. (2004). *Ciclos económicos industriales clásicos en México*. http://polux.cmq.edu.mx/libreria/index.php?option=com_docman&view=download&alias=216-di0850323&category_slug=docum-investigacion&Itemid=189&accept_license=1

Mejía-Reyes, P. (2003). Regularidades empíricas en los ciclos económicos de México: producción, inversión, inflación y balanza comercial. *Economía Mexicana Nueva Época*, *XII*(2), 231–274. http://www.economiamexicana.cide.edu/num_anteriores/XII-2/Pablo_Mejia.pdf

Mills, F.C. (1936) Prices in recession and recovery: A survey of recent changes. New York. NBER. https://www.nber.org/books-and-chapters/prices-recession-and-recovery-survey-recent-changes

Mitchell, W.C. (1927) *Business cycles. The problem and its setting*. NBER, New York. https://www.nber.org/books-and-chapters/business-cycles-problem-and-its-setting

Orellana, M. (2011). Hechos estilizados del ciclo económico de Ecuador: 1990-2009. *Universitas*, *15*. https://doi.org/10.17163/uni.n15.2011.02

Perea, H., & Mendoza, I. (2017). Perú: ¿Cómo son sus ciclos económicos? In *Observatorio Económico Perú*. https://www.bbvaresearch.com/wp-content/uploads/2017/01/Observatorio-Ciclos-03-01-2017.pdf

ISSN: 2410-342X

Ramírez Rodríguez, R., & Erquizio Espinal, A. (2023). Ciclos económicos e indicadores del mercado de trabajo en la Frontera Norte de México. *Indiciales*, *1*(5), 22–35. https://doi.org/10.52906/ind.v1i5.48

Restrepo, J. E., & Soto, C. (2006). Regularidades empíricas de la Economía Chilena: 1986 - 2005. *Economía Chilena*, *9*(2), 15–40. https://repositoriodigital.bcentral.cl/xmlui/bitstream/handle/20.500.12580/3482/BCCh-rec-v09n2ago2006p015-040.pdf?sequence=4&isAllowed=y

Torres, G. A. (2000). Estabilidad en *Variables Nominales y el Ciclo Económico: El Caso de México* (No. 2000–03; Documento de Investigación). https://www.banxico.org.mx/publicaciones-y-prensa/documentos-de-investigacion-del-banco-de-mexico/%7BF7B17128-B05C-1672-21A9-6DB3BB8DF4B3%7D.pdf

ISSN: 2410-342X