Revue Internationale Multidisciplinaire
D'Economie et de Gestion
ISSN: 2724-7260
Volume 2: Numéro 2

Datation et synchronisation des cycles de croissance: cas de la Tunisie et de ses principaux partenaires européens

Dating and synchronization of growth cycles: case of Tunisia and its main European partners

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Date de soumission : 02/08/2022
Date d'acceptation : 17/11/2022
Citation: Trabelsi, R (2022). Dating and synchronization of growth cycles: case of Tunisia and its main European partners. Revue Internationale Multidisciplinaire D'Economie et de Gestion d'Economie et de Gestion. Volume 2 : Numéro 2.

Abstract

This paper analyzes the dating and synchronization of the Tunisian growth cycle with its main European partners over the period 1993–2014. Using several cycle extraction techniques, and notably retaining the Baxter-King filter, tests for cyclical phase asymmetry, and the Bry-Boschan dating algorithm, we identify turning points and examine the stylized facts of the cycle. Synchronization with Italy, France, and Germany is assessed using correlation coefficients and complemented by the calculation of a concordance index, which measures the degree of phase coincidence between Tunisia and its partners. The results show that Tunisian cycles are relatively short and regular, with eight complete cycles over the study period, and that only certain macroeconomic aggregates, such as imports, exports, prices, and the real exchange rate, fully confirm the empirical regularities observed in developing countries. The evolution of synchronization and the concordance index highlights a transition from lagged synchronization (1993–2000) to relative independence (2001–2008), and finally to strong and nearly contemporaneous synchronization after the global financial crisis. These findings underscore the major role of external shocks in cyclical co-movements and provide valuable insights for economic policy.

Keywords: Growth cycle, Baxter-King filter, Asymmetry, Stylized facts, Bry-Boschan algorithm, Synchronization, Concordance index.

1. Introduction

The analysis of business cycles has been a major concern for over a century, both for business cycle researchers and for economic analysts. This topic has gained even greater importance with the succession of major recessionary episodes that have affected both the national and the global economy since the late 1990s. Among the most significant examples are the U.S. recession of 2001, the severe slowdown in the euro area, the global financial crisis of 2008, and the political revolutions in some Arab countries, in particularly the Tunisian Jasmine Revolution, which occurred at the beginning of 2011, resulted in substantial economic and social impacts. In this context, attention to the national economic situation has intensified due to the increasing sensitivity of national economic cycles to fluctuations in international markets.

The identification of economic cycles, whether it involves detecting periods of expansion and recession or pinpointing turning points, as well as the analysis of co-movements and cycle synchronization among partner economies, plays a crucial role in guiding public decision-makers and informing the implementation of appropriate economic policies. Thus, the study of business cycles remains an essential tool for economic management. In this framework, issues related to the definition of cycles, their identification methods, their synchronization across countries or economic regions, and the methodological approaches used to highlight stylized facts have regained interest.

However, analyzing business cycles remains a complex task, as it requires addressing four fundamental questions. First, which series should be used to represent aggregate economic activity? Second, what definition of the business cycle should be adopted? Third, which filtering method for the business cycle? Fourth, which approach to dating and synchronization should be selected to ensure it is the most appropriate?

Existing literature focuses almost exclusively on developed countries, while similar analyses are less common in developing economies. Nevertheless, several studies have examined business cycles in African countries. For instance, research has been conducted in Cameroon (Diop, 2000; Ndongo, 2006, 2007), Côte d'Ivoire (Doko and Sanou, 2004), Algeria (Boughidene and Achouche, 2017), and Morocco (Elguellab, Rifi, and Zafri, 2014).

In Tunisia, several authors have examined economic cycles, addressing a variety of research questions using diverse statistical and econometric techniques. Key contributions include studies by Baccouche et al. (1997), Elachhab (2007a, 2007b, 2009, 2010), Knani and Fredj (2010), Garfa (2013), Belhedi et al. (2015), Catin and Sabta (2018), Chebbi and Knani (2013), Bhoury and Mouha (2015), as well as Medhioub (2007) and Medhioub and Mraihi (2011). Collectively, these works provide a comprehensive overview of the characteristics and dynamics of Tunisian business cycles.

Tunisia is characterized by a fragile institutional framework and persistent political and economic instability, exacerbated by climatic conditions that are unfavorable to growth, which heavily depends on agriculture. Its GDP exhibits significant irregularities. Furthermore, the Tunisian economy remains highly exposed to international markets, whether in financial flows, trade in goods and services, or commodity markets, which increases its vulnerability to global price fluctuations and the emergence of crises. In this context, it is essential to examine the characteristics of the Tunisian business cycle and assess its synchronization with the cycles of European partners. Thus, analyzing cyclical fluctuations provides a better

understanding of the determinants of economic dynamics and serves as a valuable tool for guiding the design and implementation of economic policies.

Moreover, analyzing the stylized facts of the business cycle is crucial, regardless of the intended purpose. In developing countries, and particularly in Tunisia, these facts differ from those observed in advanced economies, which has important implications for economic policymaking and macroeconomic modeling.

The objective of this paper is threefold. First, in the absence of an official dating of the Tunisian business cycle, we aim to establish a chronology of economic fluctuations and characterize the cyclical properties of the national economy. For this purpose, we employ the non-parametric dating techniques developed by Bry and Boschan (1971) . Second, we provide an illustration of certain stylized facts of the Tunisian business cycle. Third, we assess the degree of synchronization of the Tunisian business cycle with those of its main trading partners such as, France, Italy, and Germany. This synchronization is measured using two approaches: the first involves estimating cross-correlations between different cyclical components, while the second is based on calculating a concordance index following the method of Harding and Pagan (2002).

The paper is organized as follows. Section 2 defines the concept of the business cycle adopted in this study. It provides a brief overview of economic cycles, reviews the main methods for estimating business cycles, and discusses the measurement of growth cycles. Section 3 presents the statistical properties of the economic cycle, including descriptive statistics and correlations of cycle measures. Section 4 detailing the dating of growth cycle phases and highlighting the main stylized facts. Section 5 examines the synchronization between Tunisia and its main trading partners, presenting maximum correlations and concordance index results. Finally, the paper concludes with a summary of findings and policy implications.

2. Defining and measuring business cycle

2.1 Brief overview of economic cycles

In the economic literature, three main approaches have been proposed to interpret cycles.

The first, introduced by Burns and Mitchell (1946) at the NBER (National Bureau of Economic Research), corresponds to the classical cycle or business cycle. According to this approach, the cycle consists of successive phases of expansion and contraction, which recur repeatedly but not in a strictly regular pattern, within series reflecting the overall evolution of economic activity. These phases are identified through turning points, representing the local maxima and minima of the observed series. Thus, a peak signals the end of a growth phase and the onset of a recession, while a trough indicates the recovery of the economy and the return to positive expansion (Ferrara, 2009; Harding and Pagan, 2002; Majetti, 2012). The typical duration of this business cycle ranges between two and ten years, and its detection primarily relies on identifying these key points.

The second approach, known as the modern cycle or growth cycle, was proposed by Mintz (1969). It defines the cycle as the deviation of the series from its long-term trajectory. The trough, corresponding to the low point of the cycle, occurs when the growth rate falls below its potential level, whereas the peak, representing the high point, arises when growth exceeds its structural trend. To date this type of cycle, it is necessary to use decomposition

techniques that allow the separation of long-term movements, represented by the trend, from short-term fluctuations that reflect the growth cycle.

The third conception, adopted by the work of Anas and Ferrara (2007), as well as by Ferrara (2009) and Majetti (2012), is the most recent in the study of economic cycles and corresponds to the acceleration cycle, also referred to as the growth rate cycle. This cycle is characterized by periods of rapid expansion or acceleration and periods of slowdown **or** deceleration in the pace of economic growth. The peak**,** corresponding to the highest point of the growth rate, signals the end of an acceleration phase in economic evolution and the transition to a deceleration phase, while the trough, representing the local minimum, marks the end of deceleration and the beginning of a new phase of accelerated recovery**.**

In this perspective, it is advisable to specify the type of cycles under consideration in order to guide the selection of appropriate tools for their measurement, as well as the methods used to characterize them. In this article, we adopt the growth cycle framework while retaining certain features of the classical cycle, such as its periodicity and the duration of its various phases.

Since the economic cycle is unobservable, it is necessary to rely on statistical methods to identify it. Numerous trend–cycle extraction techniques are available in the empirical literature, all aiming primarily to isolate the short-term component of a time series from its long-term component. However, each method has its own specific properties, which can influence the shape of the resulting cycle. Consequently, the main challenge lies in selecting the decomposition technique that is most suitable for our data, in order to estimate the growth cycle accurately and reliably.

2.2 Methods of estimating the business cycle

Given that the business cycle cannot be directly observed, it is necessary to formulate hypotheses about its features to allow its estimation. Various statistical techniques are available to remove the short-term component, often referred to as the "cycle as well as the trend", within the observed data.

To extract the cyclical component, we consider both parametric approaches, such as the three classical filters; Christiano-Fitzgerald (CF), Hodrick-Prescott (HP) and Baxter-King (BK), and non-parametric approaches, based on econometric modeling, namely the Beveridge-Nelson (BN) decomposition and Harvey's unobserved components models (UC).

We highlight the points of convergence and divergence between these different methods by presenting a summary of the estimated cycles for the industrial production index in Tunisia. The objective is to examine whether these methods provide a comparable assessment of the variations in the output gap, defined as the difference between the observed production and its estimated long-term trend, or whether, on the contrary, they lead to significantly different interpretations of the evolution of the economic cycle over time.

In this study, we use the monthly series of the industrial production index in Tunisia as well as those of its main European partners. The analysis covers the period from January 1993 to April 2014. and the data were extracted from the IFS database of DataStream.

2.3 Measuring Growth Cycles

We begin the descriptive analysis with a summary of the different measures of the GDP cycle. Figure 1 illustrates the time series of the cycles estimated using the various decomposition techniques. Note that, in all detrending methods, the output gap, representing the cycle, is calculated as the difference between the observed values and the corresponding filtered values. Note that, in all detrending methods, the output gap, representing the cycle, is calculated as the difference between the observed values and the corresponding filtered values. For the empirical implementation, all models were carried out using WinRATS 10, except for the UC specification, which was estimated with STAMP.

The HP filter is distinguished by its conceptual simplicity and ease of implementation, relying on the smoothing parameter λ set at 14,400 for monthly data. Its application to the industrial production index produces relatively large short-term fluctuations. This pronounced volatility of the cyclical components results from the choice of a very high smoothing parameter (leakage effect), because a portion of the variance attributable to the trend is incorrectly assigned to the cyclical component, thus leading to a distorted cycle.

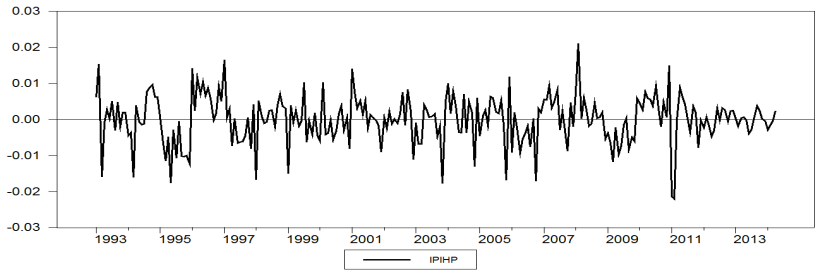
The graph clearly illustrates the recurrent, though non-periodic, sequence of upward and downward phases of the cycle obtained with the BK filter, which appears smoother, broader, and less volatile than the cycle produced by the HP filter. Unlike the output gap estimated with the HP filter, the peaks and troughs are more clearly identifiable throughout the series. These turning points are particularly pronounced over the period 1997–2009, reflecting more significant reversals in Tunisian industrial activity. The magnitude of the upward and downward phases is greater at the beginning of the period (1993–1997) and gradually decreases over time.

The growth cycle extracted using the CF filter exhibits a shape close to a sine wave, characterized by a regular alternation of upward and downward phases. Moreover, the number of peaks and troughs identified by this method appears less clearly distinguished. The cyclical components obtained from the CF and BK filters display very similar dynamics, and a strong concordance between their phases can be observed.

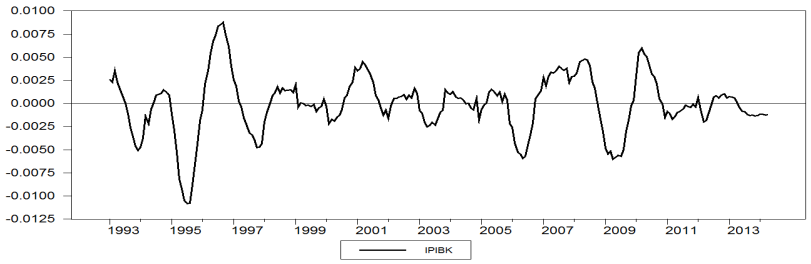
The BN model produces a cycle similar to that obtained with the HP filter, characterized by a very small amplitude and a rapid succession of fluctuations. However, it does not exhibit the properties required to be considered a true cycle in the sense of the NBER. It does not display periodic movements or clearly identifiable recurrent patterns. In this respect, the "cycle" essentially captures only the unforeseen variations of the series. Given these limitations, this approach is excluded from our study.

The cycle generated by the UC approach exhibits a structured alternation between periods of expansion and contraction, with amplitudes more pronounced at the beginning and end of the period, and more moderate in the middle. Compared to other decomposition methods, the generated cycle closely resembles that obtained with the BK filter, with expansion and contraction phases following a coherent pattern and the peaks and troughs of the industrial production index occurring at roughly the same points in time.

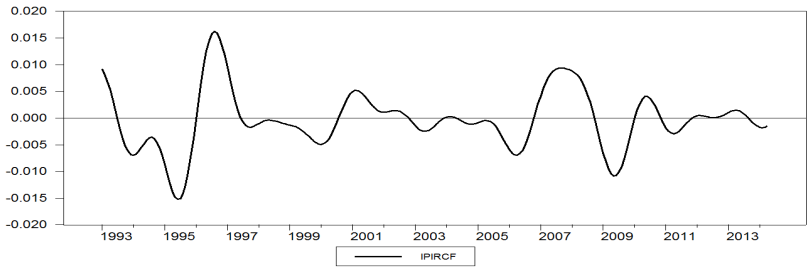
Fig 1. Cyclical components. HP, BK, CF, BN and UC



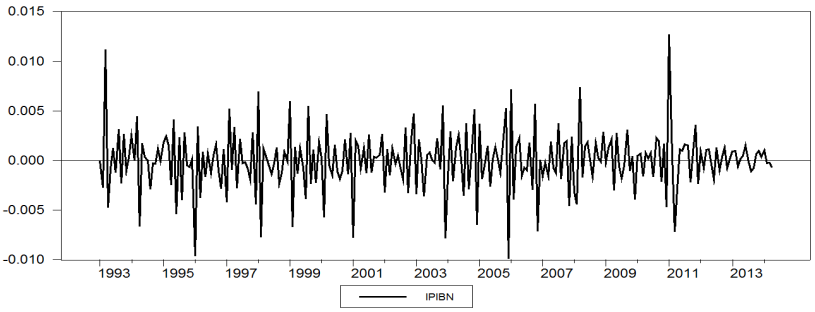
BK



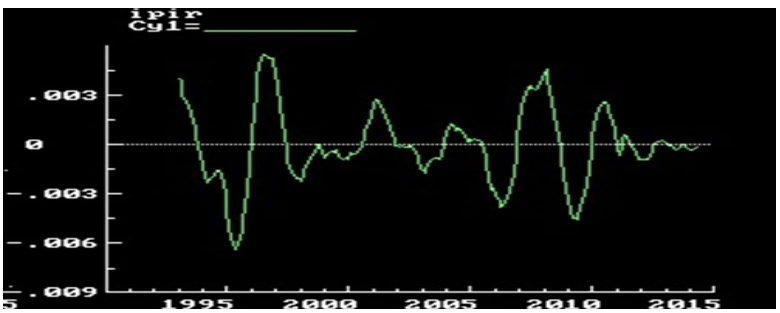
CF



BN



UC



Overall, both detrending techniques produce largely similar characteristics, with the notable exception of the BN decomposition. Nevertheless, the results highlight differences in both the amplitude and volatility of the various cyclical components of the IPI series. This analysis further corroborates the well-established finding that the characterization of the business cycle is highly sensitive to the estimation methods employed (Canova, 1998; Chagny and Dopke, 2001).

In this context, we will select the technique that is best able to reproduce the main economic events in Tunisia over the period under study. The chosen method will be the one that best satisfies the required statistical properties.

3. Statistical properties of the economic cycle

Using the descriptive statistics of each cyclical component, we assess whether the cycles obtained by different methods reflect the key empirical properties of economic cycles namely, stationarity and phase asymmetry (see Hamilton, (1998)) and align with the findings and expectations of business cycle researchers.

Table 1. Descriptive statistics

	HP	***CF***	***BK***	***BN***	***MCI***
Standard deviation	0.74	0.49	0.18	0.29	0.72
Ttiples Asymmetry (Proc Triples)	-0.10 (0.18)	**0.30** (0.01)	**-0.35** (0.002)	0.04 (0.38)	-0.12 (0.47)
Deepness (transversal asymmetry)	-0.20 (0.48)	**0.28** (0.02)	**-0.26** (0.01)	0.05 (0.40)	-0.15 (0.50)
Steepness (longitudinal asymmetry)	-0.12 (0.15)	**0.20** (0.03)	**-0.30** (0.006)	0.09 (0.62)	-0.10 (0.48)
ADF stationarity test	-5.223***	-3.603**	-3.3211**	-5.127***	-3,1252**

P-values in parentheses. **,*** denote the statistical significance of stationarity at the 5% and 1% levels, respectively. Bold font indicates statistically significant asymmetry.

Table 1 presents the results of the deepness, steepness, and triple asymmetry tests, as well as the Peron unit root test. As shown in this table, all series are clearly stationary at the 5% significance level.

To test asymmetry, we rely on Sichel's tests (deepness and steepness) as well as the Triples test, which allow us to assess whether recession and expansion phases differ in terms of depth and slope. Based on the p-value, the results show that only the CF and BK cycles exhibit statistically significant asymmetry. The CF cycle is characterized by deep troughs and rapid expansions, while the BK cycle displays recessions that are deeper and more abrupt than expansions. Regarding the other component cycles, they exhibit non-significant asymmetry.

Table 1. also reveals contrasting volatilities among the different cyclical components: the HP (0.74) and MCI (0.72) series are the most volatile, CF (0.49) and BN (0.29) are moderate, while the BK cycle (0.18) exhibits very low volatility, reflecting a

smoother dynamic that is less responsive to cyclical shocks.

According to the correlation coefficients presented in Table 2, most component cycles exhibit formally similar patterns, except for BN, which shows a weak correlation with the rest.

Table 2. Correlations of cycle measures

Correlation	HP	BK	CF	BN	UC
HP	1.00				
BK	0.49	1.00			
CF	0.54	0.74	1.00		
BN	-0.57	0.09	-0.00	1.00	
UC	0.21	0.72	0.39	-0.05	1.00
Probability	**HP**	**BK**	**CF**	**BN**	**UC**
HP	-				
BK	0.01	-			
CF	0.00	0.00	-		
BN	0.00	0.79	0.96	-	
UC	0.04	0.00	0.03	0.85	-

The p-values test whether each correlation coefficient equals zero.

The divergences between the extracted cycles can be explained by the assumptions underlying each method, which makes comparing their relative merits irrelevant. For the next steps, a choice is required: we retain the cycle obtained using the Baxter-King filter. On the one hand, it clearly captures the short-term fluctuations of Tunisian industrial activity and highlights more pronounced turning points; on the other hand, the extracted component exhibits a statistically significant asymmetry, reinforcing the economic relevance of the cycle. Based on this, we will rely on the BK cycle to derive the stylized facts and then proceed with the dating and synchronization of Tunisian cycles.

4. Turning points chronology and stylized facts

4.1. Dating growth cycle phases

The description of economic cycles, as well as the identification of turning points in activity, constitutes essential information for an accurate cyclical analysis. Furthermore, the detection and forecasting of changes in economic phases enable public authorities to be alerted and to implement appropriate measures in the event of a slowdown or crisis (Damette et Rabah, (2009)).

In this paper, following Elachhab (2007a, 2007b) and Medhioub (2007), we apply the Bry-Boschan algorithm to identify peaks and troughs, as well as the recession and expansion phases of the Tunisian growth cycle.

Table 3 presents the results obtained using the non-parametric BBA procedure. These findings reveal eight complete cycles, defined from peak to peak or from trough to trough, over the period 1993–2014. The longest cycle spans 37 months, approximately two years.

Table 3. Growth Cycle Turning Points Chronology

Turning Points for Series IPIBK						
Peaks		Peak-to-Peak	Trough-to-Peak	Troughs	Trough-to-Trough	Peak-to-Trough
				1993:12	cycle 1	
1994:07			7	1995:08	20	13
1996:09	cycle 1	26	13	1997:10	cycle 2	26	13
1999:01	cycle 2	28	15	2000:02	cycle 3	28	13
2001:03	cycle 3	26	13	2003:04	cycle 4	38	25
2003:11	cycle 4	32	7	2004:12	cycle 5	20	13
2005:05	cycle 5	18	5	2006:05	cycle 6	17	12
2008:06	cycle 6	37	25	2009:04	cycle 7	35	10
2010:03	cycle 7	21	11	2011:03	cycle 8	23	12
2012:11	cycle 8	32	20				

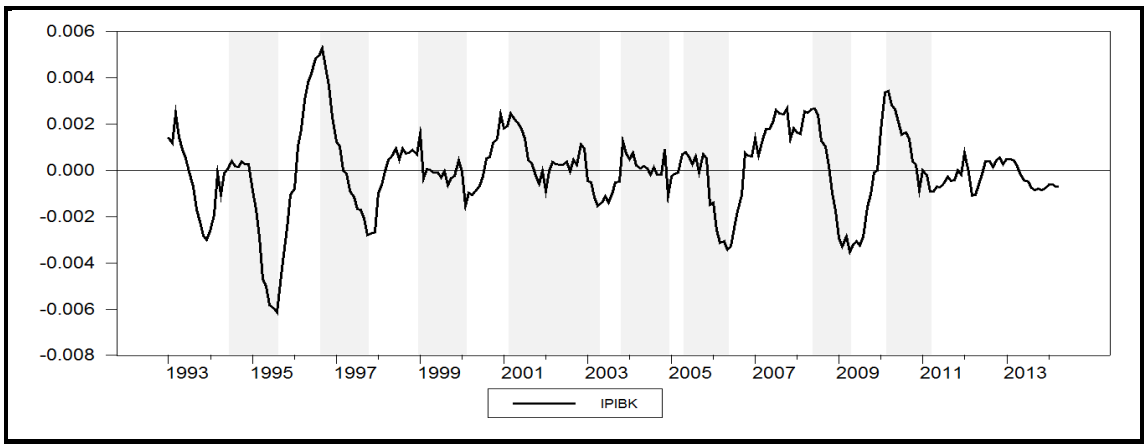
Source. Winrats 10 estimation.

Among these cycles, some recessions stand out due to their intensity and economic impact. The 1995 recession can be attributed to a cyclical slowdown caused by internal economic adjustments and the gradual liberalization of certain sectors, which temporarily reduced industrial growth. The 2001 recession occurred in the context of a global slowdown linked to the Internet bubble crisis and regional tensions, notably affecting Tunisian exports and the industrial sector. Finally, the 2008–2009 recession corresponds to the global financial crisis, which severely disrupted external demand and the financing of Tunisian firms, resulting in deeper troughs than in other cycles.

The eight phases of recession are clearly visible in the figure 2. The shaded areas indicate recessions, while the white areas correspond to expansion phases, reflecting pronounced economic slowdowns. Regarding fig 2, recessions appear more abrupt, while expansions are more gradual, which is consistent with the asymmetry tests previously mentioned.

The mean duration of recessions is slightly longer than that of expansions, at 13.5 months versus 12.5 months. These cycles are relatively short and regular, consistent with the characteristics of an industrial cycle in an emerging economy such as Tunisia. The fluctuations exhibit moderate amplitudes, reflecting only small deviations from the long-term trend of industrial production.

Fig 2. Recession and Expansion states



4.2. Stylized facts of the Tunisian growth cycle

Based on the cycle chronology we established for the period 1993–2014, we present a few examples of stylised facts of the Tunisian business cycle. This is done through an examination of the cyclical behavior of key macroeconomic aggregates, as well as the volatility and persistence of output.

Table 4. Cyclical correlations between key macroeconomic variables

	cycleIPI	*cycleIMP*	*cycleEXP*	*cycleIPC*	*cycleM2*	*cycleTCHR*	*cycleIPIeuro*
cycleIPI	1						
cycleIMP	0.21	1 (10.55)					
cycleEXP	0.36	0.80	1 (10.44)				
cycleIPC	-0.13	0.29	0.10	1 (1.05)			
cycleM2	-0.16	0.28	0.31	**0.01**	1 (0.27)		
cycleTCHR	-0.11	**0.04**	-0.10	0.52	**0.01**	1 (1.72)	
cycleIPIeuro	0.27	0.73	0.78	0.31	0.18	**0.01**	1 (2.33)

Not: Values in parentheses indicate volatility, calculated as the ratio of the standard deviation of the cycles to that of the IPI cycle. Coefficients that are not statistically significant are shown in bold

Table 5 reports the correlation coefficients between the cycles of the different series and reveals strong correlations between the components of the trade balance and the reference cycle, indicating that exports and imports are procyclical. In contrast, the Consumer Price Index (CPI), the monetary aggregate M2, and The real effective exchange rate (REER) exhibits a weak correlation with the IPI, suggesting that it behaves acyclically with respect to the business cycle

We revisit the major empirical regularities of business cycles in developing economies, as reported in the research of Agénor et al. (2000), as well as Rand and Tarp (2002), and compare them with the empirical findings from our study:

- *Industrial production* is generally more volatile in developing economies than in industrialized countries; however, this stylized fact is not confirmed in the case of Tunisia. Indeed, the volatility of the European industrial production index (IPI_euro) is approximately twice that of Tunisian industrial activity (IPI), despite the latter experiencing recurrent crises and marked fluctuations in its main macroeconomic aggregates.
- The monetary aggregate (M2) is generally reported as procyclical in the literature: Contrary to the widely held view that the monetary aggregate (M2) follows the business cycle, in Tunisia it moves in the opposite direction to industrial production. This pattern likely reflects the actions of monetary authorities, who inject liquidity during periods of slowdown to support the economy. Furthermore, specific features of the country, such as financial system constraints, weak credit transmission to the real sector, and the allocation of liquidity toward non-productive or precautionary

uses may alter or even reverse the conventional relationship between money supply and industrial activity.

- ***Consumer Price Index (CPI):*** Consistent with stylized facts, the Tunisian CPI appears countercyclical, with a negative correlation coefficient relative to the IPI.
- ***Real effective exchange rate*:** The REER is acyclical, as it shows no significant co-movement with the industrial production cycle, with a weak correlation coefficient of -0.12.
- ***Exports and imports*:** These variables are procyclical and strongly correlated with Tunisia's industrial activity as well as that of its main European partners, with coefficients exceeding 0.70. They also represent the most volatile series in the country.

These findings allow a comparison of the Tunisian case with the empirical regularities established by Trap and Rand (2002) in developing countries, confirming some trends while highlighting specific divergences in the Tunisian context.

One of the most notable findings concerns the heightened volatility of exports and imports, which are particularly sensitive to external demand. This vulnerability reflects their strong dependence on fluctuations in both domestic and foreign demand, as well as on economic shocks and changes in international goods prices.

The pronounced volatility of trade flows, closely linked to fluctuations in domestic and external demand, warrants a deeper analysis of the synchronization between Tunisian industrial activity and that of its main European partners, in order to better understand the interactions between domestic and international business cycles.

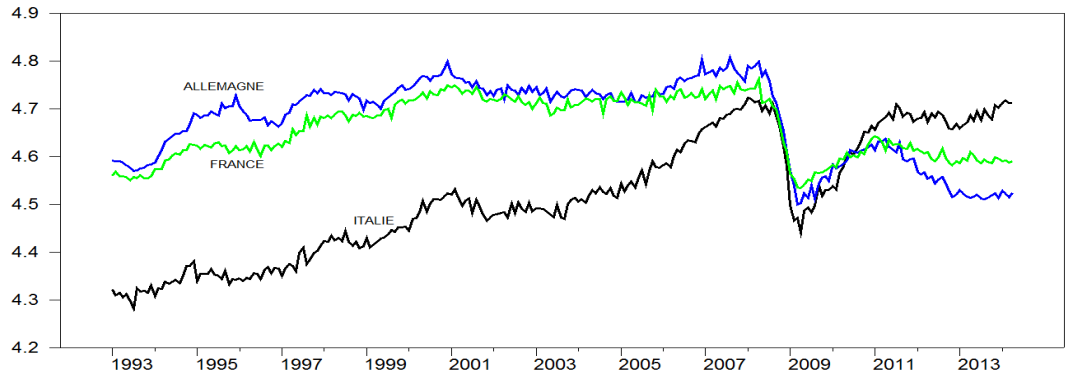
5. Synchronization between Tunisia and its main trading partners

Now, we examine the degree of coordination between the evolution of national economic activity and that of its main trading partners, which account for the most significant trade flows for Tunisia. These notably include continental economies such as France, Italy, and Germany. The analysis is based on the study of cross-correlations as well as the comparison of cyclical phases.

In a first step, it is essential to explore each country's individual dynamics and to identify the turning points in their activity.

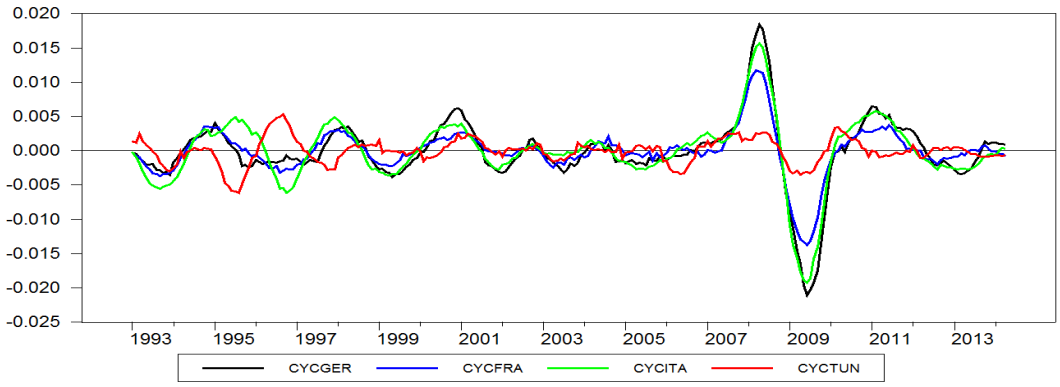
The evolution of industrial production indices for Tunisia's three main partner countries (in Figure. 3) shows convergent trends, with close and similar trajectories, and a steady growth aligned with their long-term growth paths. In 2007, all three series experienced a deep trough due to the subprime crisis, followed by a prolonged decline until 2009, reflecting a sustained recession. Subsequently, they entered a recovery phase and drew closer together, before diverging again from 2011 onwards.

Fig 3. Industrial Production for main European partners



To preliminarily assess whether there is any cyclic concordance or phase shift among the different cycles, we have plotted the four series in the same graph (Figure 4).

Fig 4. Tunisian Cycle vs. French, German, and Italian Cycles



The European cycles were also extracted using the BK filter, as was the Tunisian cycle.

Figure 4 presents a comparison of the cyclical components of Tunisian GDP with those of France, Germany, and Italy.

At the beginning of the studied period, European cycles exhibit higher amplitudes and partial synchronization with the Tunisian cycle, which is less pronounced and more irregular, reflecting an incomplete transmission of external shocks. In addition, the growth cycles of France, Germany, and Italy are largely coincident and synchronized, generally leading the Tunisian cycle, which seems to mirror the cyclical fluctuations observed in these countries.

The following phase, covering the early 2000s up to 2006, is characterized by low volatility and attenuated cycles, with limited synchronization, reflecting a stable international environment and an increased capacity for Tunisia to absorb external disturbances.

During the global financial crisis, cycles experienced a sharp and simultaneous amplification, with European economies recording a strong synchronized decline. The Tunisian cycle also suffered a negative impact, but less pronounced. In this context, Tunisia's economy is not completely sheltered from European recessive phases. However,

the recessions experienced in Tunisia have been generally moderate and mild (Elachhab, 2007a).

In the recovery period after 2010, European economies began a gradual rebound, while the Tunisian cycle remained less synchronized, reflecting the combined effect of internal constraints and external factors on the national economic recovery.

Subsequently, the analysis of cross-correlations and the calculation of concordance indices complement the graphical analysis in order to assess the position of the national economic cycle relative to its main European partners.

In order to more precisely analyze the effects of trade liberalization between Tunisia and Europe, the strengthening of financial links after the 1990s, as well as the repercussions of the economic turbulences experienced by Europe during the 2000s and 2009, we divided our sample into three periods. For each of these periods, we calculate the correlations between two economic cycles for different temporal lags k and retain the highest coefficient obtained. Therefore, the maximum correlation allows us to identify the moments when the two cycles are most closely linked and whether one cycle leads or lags the other, serving as an indicator of synchronization and the intensity of co-movement between economic cycles (Beine and Coulombe 2003). Table 5 reports the values of the correlation coefficients.

Table 5. Maximum correlations between economic cycles

	$\rho_{cycITALY,\ cycTUNISIA}$	$\rho_{cycFRANCE,\ cycTUNISIA}$	$\rho_{cycGERMANY,cycTUNISIA}$
1993-2000	*K=16* ***(0.57)***	*K=21* ***(0.61)***	*K=20* ***(0.58)***
2001-2008	*K=-5* ***(0.49)***	*K=-3* ***(0.43)***	*K=-2* ***(0.53)***
2009-2014	*K=1* ***(0.77)***	*K=1* ***(0.75)***	*K=2* ***(0.72)***

Correlation coefficients are presented in parentheses (significance tested against $T^{(-1/2)}$). K denotes the number of temporal lags: a positive K indicates that one cycle leads another, a negative K signifies a lag, and K=0 corresponds to contemporaneous correlations, meaning the cycles are considered coincident.

We analyse the synchronisation of the Tunisian business cycle with major European economies over three distinct periods.

Firstly, during the period 1993 to 1999, correlations between the Tunisian cycle and those of Italy, France, and Germany range from 0.57 to 0.61, reflecting a moderately high and positive co-movement. However, the large positive lags, ranging from 16 to 21 months, indicate that European cycles clearly lead the Tunisian cycle. This pattern suggests a slow transmission of cyclical fluctuations, consistent with the relatively low level of trade and financial integration at that time. Transmission occurred mainly through indirect channels such as tourism, remittances, and export demand, while structural and institutional rigidities in Tunisia delayed adjustment. Overall, cyclical synchronisation was present but delayed rather than contemporaneous. This result aligns with the arguments of Frankel and Rose (1998), as well as Baxter and Kouparitsas (2005), who emphasize that trade and financial interdependencies are key drivers of business cycle alignment, highlighting that

low integration at this stage limited the immediate impact on Tunisian cycles.

Secondly, in the period from 2000 to 2006, the degree of synchronisation weakens as correlations drop to values between 0.43 and 0.53. Interestingly, the Tunisian cycle slightly precedes European cycles, as indicated by the negative lags. This reversal in the lead–lag relationship, combined with lower correlations, reflects a phase of relative cyclical autonomy for Tunisia. This period coincides with macroeconomic stability and attenuated cycles, as well as a diversification of economic partners and a reduced sensitivity to European demand fluctuations. Despite some trade integration, the effect on cyclical synchronisation remained limited, likely because global economic conditions were relatively stable and shocks were small, illustrating that integration alone is not sufficient to generate strong co-movements in the absence of significant external disturbances.

Thirdly, in the post-crisis period from 2007 to 2014, synchronisation strengthens markedly. Correlations reach 0.77 with Italy, 0.75 with France, and 0.72 with Germany, while very small lags of one to two months indicate that cycles are almost contemporaneous. This sharp increase reflects the dominant influence of the global financial crisis and its aftermath. The crisis generated large common shocks that were transmitted rapidly across economies. In this context, trade and financial linkages acted as efficient channels for the propagation of these shocks, and Tunisia became more closely synchronized with European economic conditions.

Finally, these results highlight that trade and financial integration alone do not guarantee strong cyclical synchronisation. Before 2008, integration contributed to delayed or weak co-movements, whereas after the crisis, large external shocks played a decisive role in aligning cycles. Concordance appears to be state-dependent, strengthening significantly during periods of substantial global shocks when trade and financial linkages accelerate the transmission of disturbances.

To further quantify the degree of synchronization between the Tunisian industrial cycle and those of its main European partners, we compute the concordance indices using the Harding and Pagan (2002) approach.

Denoted $CI_{x,y}$, the concordance index between two variables X and Y represents the average proportion of periods in which the two series are concurrently in the same phase, and is given by:

$$CI_{x,y} = \frac{1}{T}\left\{\sum_{1}^{T} S_{x,t}.S_{y,t} + (1-S_{i,t})(1-S_{j,t})\right\}$$

$$S_{X,t} = \begin{cases} 1 \;\; if \;\; X \; is \; an \; \text{expansion} \\ 0 \;\; otherwise \end{cases}$$

In this study, the concordance index is calculated based on the recession phases previously identified by the Bry-Boschan algorithm. A value of 0.5 indicates that the two series are not systematically synchronized.

Table 6 lists the concordance index between the Tunisian growth cycle and those of its three main Europeans trading partners.

Tableau 6. Results of the Concordance Indexes

	France	*Germany*	*Italy*	*Tunisia*
France	1			
Germany	0.83	1		
Italy	0.82	0.88	1	
Tunisia	0.58	0.56	0.48	1

Table 6 highlights that, the growth cycles of partner countries are highly synchronized, being in the same phase more than 80% of the time, which reflects their economic closeness, the intensity of trade, and the integration of their financial and sectoral channels. Thus, these economies evolve very similarly and often respond to the same external shocks.

The concordance indexes between the Tunisian cycle and those of France (0.58), Germany (0.56), and Italy (0.48) indicate varying levels of synchronization.

Indeed, the value of 0.58 with France reflects a moderate concordance, suggesting that the two economies are in the same phase of the cycle slightly more than half of the time. Similarly, the index of 0.56 with Germany indicates a positive but limited co-movement, reflecting a partial synchronization of cyclical phases. In contrast, the lower index of 0.48 with Italy points to a lack of marked synchronization, with the cycles often occurring in different phases.

Overall, these results suggest that the Tunisian economic cycle is more closely aligned with those of France and Germany than with Italy, while still exhibiting an overall incomplete synchronization with its European partners. These results can be explained by the fact that Tunisia maintains more intensive trade and financial links with France and Germany, facilitating a more direct transmission of cyclical shocks. In contrast, structural differences in the Tunisian economy and the more irregular pace of its cycle reduce overall synchronization with its European partners, particularly with Italy.

6. Conclusion

In this paper, we aim to analyze the Tunisian growth cycle and its synchronization with the main European partners, while highlighting the implications of these results for the conduct of economic policy. This study addresses the issue of the business cycle from several complementary perspectives, ranging from the extraction of cyclical components to the analysis of phase asymmetry, stylized facts, turning point dating, and international synchronization.

For the extraction of cycle, we chose the Baxter and King method after comparing several techniques. The differences observed between the methods are mainly due to the shape of the trend and the assumptions underlying each filter. The BK filter produces

cyclical components consistent with the classical conception of business cycles, reflecting an alternating pattern of peaks and troughs. This choice is also justified by the statistical properties of the cycles, particularly the phase asymmetry tested using the Sichel (1993) and Triples methods, for which the BK filter exhibits statistically significant asymmetry.

Building on this, we conducted a detailed analysis of the turning points and stylized facts of the Tunisian cycle. The application of the Bry and Boschan algorithm allowed us to identify eight complete cycles, the longest spanning approximately two years. These cycles are fairly brief and stable, consistent with the patterns observed in the industrial cycles of emerging economies. In examining the stylized facts of the Tunisian cycle, we compared our results with those for Agénor et al. (2000) and the findings of Rand and Tarp (2002) for developing countries, only imports, exports, prices, and the real exchange rate fully confirm the empirical regularities observed for these economies, while the results for other aggregates appear less conclusive.

Finally, the analysis of concordance and synchronization, conducted using correlation coefficients and the Harding and Pagan concordance index, shows an evolution of maximum correlations from lagged synchronization (1993–2000), to relative independence (2001–2008), and finally to strong and nearly contemporaneous synchronization after the crisis. These results highlight the role of external shocks in cyclical co-movements and suggest that increasing trade integration may heighten Tunisia's vulnerability to foreign business cycles, particularly during global downturns. The concordance index indicates a moderate degree of phase coincidence for France (0.58) and Germany (0.56), whereas cycles with Italy appear desynchronized, a result also confirmed by Lachhab (2010).

Therefore, this study provides a comprehensive view of the Tunisian economic cycle, employing various analytical techniques and offering valuable insights for policymakers to better anticipate and manage the effects of external shocks and cyclical fluctuations on the national economy.

However, future research could extend the analysis of the Tunisian business cycle and its synchronization with partner economies in several directions. First, broadening the sample to include other Mediterranean countries or African countries, could provide a more comprehensive view of regional cyclical dynamics. Further investigation of transmission channels, including sectoral trade flows and foreign direct investment, would help clarify the mechanisms underlying cycle synchronization. Additionally, examining asymmetries between expansion and recession phases and applying nonlinear models could shed light on state-dependent or nonlinear relationships.

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ISSN: 2724-7260
Volume 2: Numéro 2