Characterisation and Dating of the Tunisian Business Cycle – Using a Non-Parametric Approach

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Abstract

Aim: The study aimed to identify the characteristics of cyclical fluctuations in the Tunisian economy.

Methodology: To examine the main characteristics of cyclical fluctuations in the Tunisian economy, the author used the non-parametric method of Harding and Pagan (2003) for the quarterly series of real GDP and by sector over the period from January 2001 to December 2015.

Findings: The results of the analysis suggest that the Tunisian business cycle is divided into five recessionary phases, and that certain GDP cycles are marked as minor cycles with average durations ranging from 1.5 to 4 years. Nevertheless, the longest expansion phases were observed in the manufacturing, non-manufacturing and public administration services sectors, with duration of five quarters. The turning points in certain GDP sectors (market and non-market activities and financial services) demonstrate higher peaks and troughs throughout the study period in comparison to aggregate GDP**.**

Implications: The study provides a better understanding of the characteristics of the Tunisian economy by sector in light of the growing global economic crises.

Originality/value: This study is important in terms of predicting any slowdown in economic activity with the utmost accuracy in order to mitigate its effects or anticipate recovery periods regarding the recurring global crises. Identifying turning points in the cyclical fluctuations in the Tunisian economy is an essential element in diagnosing economic conditions. Cyclical analysis has become an important decision support tool for decision makers.

Keywords: sectoral business cycle, BBQ (Bry Boschan Quarterly) algorithm, turning points, historical dating, Tunisia

1. Introduction

In recent years, economists have resorted to using economic cycles in their analyses of both developed and developing economies, justified by the profound changes that the global economy is undergoing. As a result, due to the various crises that have occurred since the 1990s, developing countries, in particularly Tunisia, frequently experience economic crises and changes in their main macroeconomic indicators. Indeed, internal and external shocks have a significant impact on the Tunisian economy as a whole. However, global uncertainty, climate change, and political instability at the end of the 2000s have caused Tunisian economic growth to fluctuate, characterised by a predominance of cyclical variability. Given the vulnerability of the Tunisian economy, both globally and sectorally, to internal and external shocks, these factors have drawn the attention of researchers, analysts, and policymakers, placing the issue of the economic cycle in Tunisia at the centre of discussions. In this respect, the primary motivation was to study this new thinking in economics by providing as comprehensive an analysis as possible of the features specific to economic fluctuations. In this context, the study of the cyclical characteristics of economic cycles is of particular importance to researchers in this field, whilst Tunisia has rarely been the subject of economic analyses of this type (Baccouche et al. 1997; Medhioub, 2007; Elachhab, 2007, 2010; Medhioub & Mraïhi, 2011; Chebbi & Knani, 2013). In the context of the debates outlined above, we have set as the main objective of this article was to identify the character istics of the overall growth cycle and by sector in the Tunisian context, and to meet the research goal the author chose a nonlinear method based on the Bry and Boschan (1971) algorithm. To carry out this assessment, the study used quarterly GDP (overall and sectoral) figures, as this is the variable most frequently used to analyse economic cycles in the Tunisian economy.

Thus developing countries and Tunisia in particular, must undertake a comprehensive diagnosis of the business cycle in a manner analogous to that of developed countries. A comprehensive description of the characteristics of the business cycle is imperative, and must include the historical dating of the classical cycle (business cycle) and the growth cycle (deviation cycle) of GDP, both in general and in relation to specific sectors. In terms of defining business cycles in Tunisia, a literature review was carried out, focusing on the empirical work most frequently studied by economists in addressing the subject of business cycles in developed as well as developing countries. In the next stage of the research, the Bry Boschan method was employed a classic method that must be followed after the empirical examination. In accordance with extant literature on the subject, this characterization was based first, on its dating, followed by conducting an analysis of the central trends and indicators of variability, encompassing its entire length and breadth.

The structure of the work is as follows: the initial section is dedicated to the presentation of an overview of the extant empirical literature concerning the explanation of the main characteristics of business cycles. The next section describes the methods that were utilised, the third section comprises the main results and discussions, while the final section presents the conclusions.

2. The Main Characteristics of the Tunisian Economy

2.1. From Collectivisation to Privatisation of the Tunisian Economy

Since gaining independence, Tunisia's economy has been characterised by a dual-sector structure combining the public and private sectors. The main drivers of growth have been agriculture, industry (including textiles, chemicals and manufactured goods) and tourism. As Wilmots (2003) pointed out, phosphate production in the Gafsa region and olive oil production were the main sources of foreign income, defining the Tunisian economy. In the industrial sector, however, the chemical industries of Gabes were the only project serving as a hub for development in southern Tunisia prior to the rise of tourism. Tourism revenue was negligible at this time, with only 53,000 foreign visitors in 1962.

Since the 1970s, economic growth has been marked by increasing volatility, peaking at 17.7% in 1972 (see Figure 1). After this period, a decline was observed, reaching -0.7% in 1972. Amidst debt issues,

growing regional inequalities, and persistent unemployment, Tunisia underwent a socialist experiment affecting several sectors of the economy, including agriculture, services, and industry, in the 1960s. According to Ben Romdhane (2011), after the failure of this experiment and state control over the economy in the late 1960s, Tunisia modernised its agriculture by establishing cooperative production units and creating favourable conditions for accumulation in this sector. The country also promoted industrialisation by encouraging the private sector and establishing companies in industries requiring substantial investment. However, the nationalisation of foreign trade, state control of wholesale trade, and the authorities' development of the tourism sector gradually escaped state control and were progressively handed over to private Tunisian developers.

2.2. The Period from 1980 to 2000: From the "Great Crisis" in Tunisia to Opening up to the Global Economy

In the early 1980s, Tunisia's economy was marked by an economic crisis and significant debt due to its reliance on oil revenues. The situation worsened following a climate shock caused by a series of droughts that hit the country between 1985 and 1986. These events resulted in lower wages, decreased household consumption, and reduced investment by public enterprises. The decline in oil prices further strained the country's primary source of wealth and public finances. However, to protect the domestic market, the Tunisian government introduced taxes on imports. Primarily intended to offset the budget deficit and the decline in foreign exchange reserves (Morrisson & Talbi, 1996). In 1986, the Tunisian economy experienced its first year of negative growth, declining by 1.45% (see Figure 1). Rising unemployment and wage policy further exacerbated disparity in economic activity levels, resulting in an economic crisis, or the "great crisis," as described by Ben Romdhane (2011).

These warning signs all contributed to the collapse of the Tunisian economy. In June 1986, Tunisia sought help from the International Monetary Fund (IMF) by signing an agreement for an economic recovery programme known as a "structural adjustment programme" (SAP), which aimed to restore major structural balances in the economy. Implementing this national economic adjustment programme involved transferring certain public services to banks or private groups, either partially or completely.

After launching SAP in 1986, Tunisia adopted a new growth strategy in the early 1990s. This strategy was made possible by free trade agreements with the EU, which opened the country further to the market economy, and strengthened Tunisia's competitive advantage, making its economy more competitive, reducing its reliance on oil exports, and modernising industrial enterprises.

The results of the programme became apparent in 1990 when the Tunisian economy recovered from the crisis and experienced positive growth of nearly 8% in 1992 (see Figure 1). This reflects changes in the value added by various sectors, including agriculture, industry, and services. During this period, the agricultural sector's share of the GDP decreased, dropping from over 15% in the 1970s and 1980s. Due to climatic difficulties that affected the sector in the late 1980s. The decline contributed to a shift in the economy toward the manufacturing sector. Industrial value added then accounted for a significant portion of the country's wealth, surpassing 30% during the 1990s. Thanks to joint efforts by the government and private groups, the tourism sector expanded significantly during this period, and now contributes substantially to the national economy, particularly to agriculture, due to increased demand for food.

Since the 1995 signing of the association agreement, bilateral trade has more than doubled, and Tunisian exports to the EU have nearly tripled. From 1993 to 1999, exports accounted for 25.5% of the country's GDP. The industry secor is the most important in terms of exports and includes both manufacturing and non-manufacturing[1]. In 1998, this sector produced manufactured goods

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[1] The manufacturing sector includes food products, textiles, leather goods, construction materials, glass, plastics, machinery, electronics, chemicals, and wood products while the non-manufacturing sector includes mining, energy, and electricity.

accounting for 82% of total exports. The industrial sector's strong expansion has enabled Tunisia to develop its products' competitiveness, improve its comparative advantages, and increase exports while benefiting from freer access to international markets. Accooding to Zouari (2018), Tunisia is part of a free trade area and is moving toward establishing a specific relationship with the euro zone within the framework of the Deep and Comprehensive Free Trade Agreement (DCFTA), which extends beyond strictly commercial matters. Thus, Tunisia is a pre-accession country without actually becoming a member. As part of the liberalisation programme of the Deep and Comprehensive Free Trade Agreement (DCFTA) launched by the European Union, Tunisia committed to eliminating customs duties and quotas, liberalising trade in services, harmonising legislation and regulations, and reducing non-tariff barriers to trade and investment. This strategy reflects the breadth and depth of Tunisia's privileged partnership with the euro zone. This policy of openness has led to sustained, relatively rapid economic growth, reaching a rate of 3.5% in 1998, which placed Tunisia among the region's top performers (World Bank, 2014).

2.3. Evolution of the Growth Rate between 2000 and 2010

Since the 2000s, Tunisia has experienced relatively strong economic growth, averaging nearly 4% per year. Although Tunisia's growth was better than that of its neighbours, including Morocco and Algeria, it was lower than that of other middle-income countries in Asia and Latin America (World Bank, 2011).
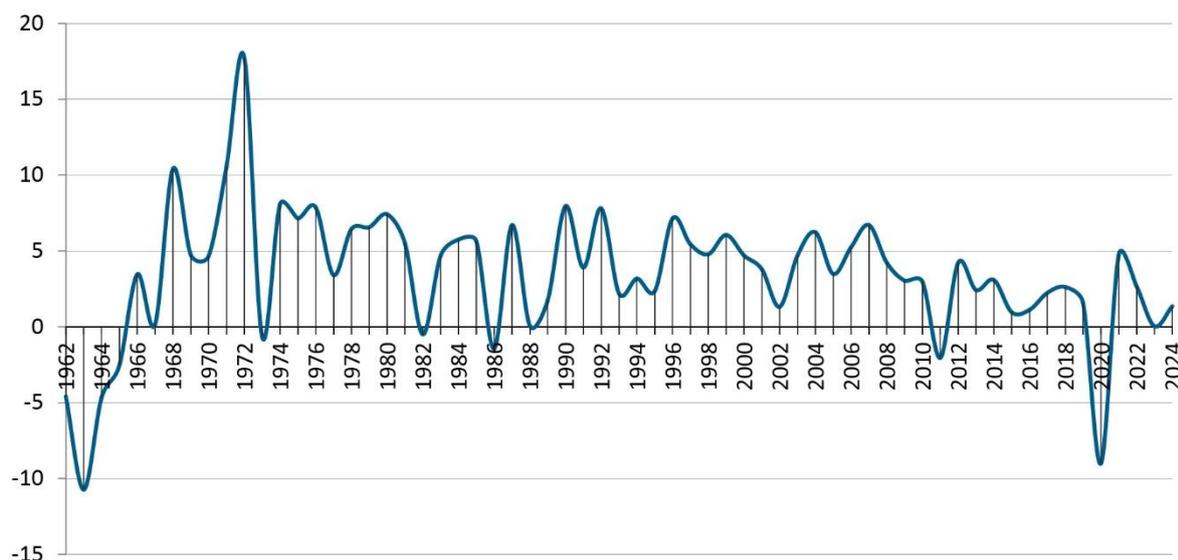

Fig. 1. Tunisian GDP growth (annual %)

Source: World Bank (BK).

Although significant economic growth was observed in the early 2000s, the Tunisian economy deteriorated due to several internal and external factors, including natural disasters, social unrest, and the financial crisis of 2009. A drought affected the agricultural sector in 2002, and terrorist attacks on the Ghriba Synagogue in Djerba on April 11 caused tourism revenues to plummet by 15%, significantly slowing down economic growth, which averaged 2.2% in 2002 (see Figure 1). Since 2008, there has also been a downward trend reflecting the structural weaknesses of the Tunisian economy (ITCEQ, 2019). The vulnerability of the Tunisian economy to international shocks, such as the 2009 financial crisis, explains this period of stagnation and decline in real economic activity. This deterioration of the Tunisian economy coincided with a series of crises and marked social unrest in the country. First, there was a revolt in the Gafsa mining basin against unemployment, corruption, and the nepotism of the Ben Ali clan, which lasted for six months in 2008. In 2010, the Tunisian Revolution erupted for the same reasons, and spreading throughout the country, led to the fall of the Ben Ali regime in early 2011.

2.4. The Period from 2011 to 2024: A Critical Period for the Economy

Since the overthrow of the ruling regime on January 14, 2011, Tunisia has experienced a challenging transition period marking a pivotal stage in its contemporary history. The state of the economy after the revolution showed disruption in all the sectors, including agriculture, industry, and services. Consequently, Tunisia has been undergoing a process of fundamental transformation to address the new challenges posed by the current economic and socio-political situation.

However, political and economic instability has weakened the country's macroeconomic stability. Social unrest, protests, and strikes have slowed production, investment, and consumption affecting the volume of savings, which recorded negative growth of 23% in 2011. The decline in domestic savings reflected the slowdown in gross national disposable income (GNI) growth, and led to worsening budget deficits and current account balances. Weak domestic demand, combined with sluggish external demand – in particularly the slow recovery of the Euro zone – has affected exports of goods and the number of tourists. Tunisia has become more vulnerable to terrorism due to its unfavourable economic situation and lack of security since the revolution, evidenced by the attacks that occurred in Sousse and Bardo. These attacks have also negatively impacted tourism, leading to a sharp decline in the number of foreign tourists, who are now discouraged from visiting Tunisia.

However, the tourism sector experienced spectacular growth before the 2011 revolution, becoming a pillar of the country's economy. Since then, there has been a sharp decline in domestic and foreign direct investment, as well as the closure of some foreign-owned factories. Meanwhile, the ongoing revolution in Libya, one of Tunisia's main trading partners, has led to a decline in demand for export goods and the return of many Tunisian workers. These events and their consequences caused GDP growth to fall by 1.9% in 2011 (see Figure 1). According to the African Development Bank (2013), the decline in production and the return of Tunisian workers from Libya pushed the unemployment rate to 18.9% (42% among young people).

Turmoil has affected the Tunisian economy since 2011, including the 2020 pandemic-related crisis and further weakened the country's already fragile economic growth. According to Ben Jelili (2024), the average annual growth rate of gross domestic product (GDP) declined from 4.2% between 2000 and 2010 to 1.8% between 2011 and 2019 due to the pandemic's devastating impact. The pandemic directly impacted supply and demand, resulting in significant changes in international trade.

The Tunisian economy has been in crisis since 2011, and weak growth was already characteristic of the economic situation when the COVID-19 pandemic hit. According to Ben Jelili (2024), the average annual growth rate of real gross domestic product (GDP) was 1.8% between 2011 and 2019, compared to 4.2% between 2000 and 2010. The pandemic further exacerbated Tunisia's socioeconomic vulnerabilities, leading to a 4.9% decline in overall investment, an 8% decline in household consumption, and a decline in production, next the unemployment rate rose to 21.6% in 2020. Certain sectors were hit especially hard, including non-manufacturing industries (-29% in turnover), tourism (-23%), transportation (-19.6%), and textiles (-17.7%). The lockdown directly impacted supply and demand, resulting in significant changes in international trade, (UNDP, 2020).

Tunisia's vulnerability to internal and external shocks underlines the importance of analysing its economic cycle, an issue at the centre of ongoing debates and reflections. This situation has important theoretical and empirical implications which reinforce the methodological choice.

3.   Literature Review

3.1. Theoretical Study of the Business Cycle

The conventional definition of the business cycle has a long historical provenance. The term was first coined by two American economists, A. Burns and W. Mitchell, who were pioneers in theoretical and methodological work on the business cycle. As posited by Burns and Mitchell (1946), *business cycles*

are characterized by recurrent succession. They have persisted through vast economic and social changes; they have overcome a multitude of experiments in industry, agriculture, banking, industrial relations and economic policy; they have confounded countless forecasters, belied the oft-prophesied arrival of a new era of prosperity, and survived the recurrent portents of chronic depression. It is also noteworthy that during the 19th and early 20th centuries, numerous economists placed significant emphasis on the subject of business cycles. This was due to the fact that the economy of that era was marked by a recurring pattern of expansions and slowdowns, interspersed with crises that occurred at regular intervals. Burns and Mitchell (1946) defined business cycles as *fairly regular fluctuations*, yet despite its precision, their definition offers no insight into the criteria that define an economic *expansion* and *recession*. The American NBER (*National Bureau of Economic Research*) provided the following definition of an economic recession as *a significant decline in economic activity lasting several months, reflected in output, employment and other important economic variables. (...) Periods of recession are often short and historically rare*. It is evident that the methodology employed by the NBER signifies that the economy is deemed to be in a state of recession solely in the event of a decline in economic activity. In accordance with the terminology established by Abraham-Frois (2002), the characterisation of the business cycle is based on the identification of the peaks and troughs that are indicative of turning points. This alternative explanation to that of the NBER considers that the reference cycle, also known as the *classical cycle*, is that which covers the period from one peak to the next or from one trough to the next.

It was not until the early 1970s that the first practical application of this cycle on an international scale was proposed by the NBER, prompted by P. Klein and G. Moore. The OECD's work subsequently led to the popularisation of the concept of the growth cycle through the dissemination of its Composite Leading Indicators. The present interest in this area was initiated by Mintz (1969), who defined the growth cycle as *the cyclical fluctuations of economic activity (GDP) around a long-period trend*. This phenomenon is referred to as a *growth cycle*. This definition is more useful when the long-term growth rate is high, with the result that periods of falling GDP levels are very infrequent. According to this definition, an economy is deemed to be in a state of recession when the rate of economic activity falls below its potential level for a period of several months. In practice, the definition of the growth cycle poses the problem of clearly distinguishing between the long-term trend and the cycle. This problem suggests that, when examining growth cycles, the primary consideration is the identification of turning points in business cycles. Regardless of the definition employed, these turning points delineate the two phases of the cycle: a recession defined as the period between a peak and a trough in economic activity and expansion i.e. the period between a trough and a peak. The length of the cycle is defined as the number of periods (*months, quarters, years, depending on the frequency of the data used*) between two peaks (or *two troughs*). Furthermore, Lucas' (1977) perspective on the growth cycle did not entail the assertion of a specific periodicity and amplitude for the phases of the cycle, but rather identified certain regularities in economic activity variations. In this regard, Lucas (1977) observed that *cyclical movements are characterized by variability in both amplitude and periodicity. The regularities observed pertain to the co-variations of different aggregate series*. The nature of the cycle depends decisively on the method used to identify the trend.

The theoretical literature offers a number of definitions of economic cycles. At an empirical level, understanding the economic cycle requires these theoretical foundations, which provide a framework for analysis and help to explain cyclical fluctuations in economic activity more effectively. To identify the characteristics of the economic cycle, sufficient empirical literature on the subject is essential, hence the study of economic cycles in developed countries, the subject of numerous publications (Damette & Rabah, 2010; Donadelli et al., 2017; Kaur, 2019; Pacella, 2021; Tüzen et al., 2022; Nafalana & Kartikasari, 2023).

3.2. Empirical Study of the Business Cycle

Most studies devoted to identifying features related to the economic cycle and using non-parametric methods concern developed countries (Gehringer & Mayer, 2021; Bavaria, 2022; Jeerawadee, 2025; Francisco-Xavier, 2025). Studies addressing the issue of the economic cycle using traditional methods are less common in developing countries, see e.g. those devoted to Cameroon (Diop, 2000; Yves & Ndongo, 2006), sub-Saharan African and advanced countries (Menounga & Akoa, 2023), and Tunisia (Baccouche et al., 1997; Medhioub, 2007; Elachhab, 2007, 2010; Medhioub & Mraïhi, 2011; Chebbi & Knani, 2013), Lebanon (Verne, 2011), and Morocco (ElAloui, 2015; Mossadak, 2025).

In their empirical study, Rand and Tarp (2002) examined the characteristics of the economic cycle in 15 different national economies, basing their analysis on a comprehensive set of stylised facts containing 19 macroeconomic variables. The study revealed significant differences between the economic cycles of developing and developed countries. Firstly, they identified variations in terms of duration and inflection points, and secondly, the data characterising Third World economies were different. The controversy surrounding the issue of the economic cycle provides a better understanding of the state of the Tunisian economy and improves the formulation of effective economic policies, particularly with regard to medium-term public finance management and monetary policy. In this context, Elachhab (2007) helped to revive interest in identifying and dating business cycles in Tunisia (classical and growth cycles) between 1970 and 2002, as well as comparing them with those in the United States and the euro zone. The results of this study identified three minor cycles (lasting an average of three years) and four major cycles (lasting an average of 5 years). Similarly, Bhoury and Mouha (2015) found, based on a study of the economic cycles in Tunisia between 1990 and 2014, that the Tunisian economic cycle was a minor cycle of 12.5 quarters, or 3.1 years. In a similar vein, Boughrine and Achouche (2017) underlined the pivotal juncture on this subject by employing the non-parametric Bry-Boschan approach in their analysis of business cycle characteristics spanning the period from 1992 to 2016. Indeed, the estimation result indicated that classical and growth cycles are analogous in explaining cyclical episodes in the Algerian economy.

Comparisons of studies on economic cycles between countries were also the subject of recent research which notably used the non-parametric approach of Bry and Boschan. Juliot and Landry (2018) focused on identifying economic cycles in ECCAS countries. The results showed that the nature of economic cycles has strengthened since 1986 in a sample of ten African countries, with the average duration of cycles varying from one country to another. Thus, the most pronounced troughs in CEMAC countries often occurred between 1990 and 1994. The recession period was particularly marked in Congo, Chad, Cameroon, Gabon, Burundi, and the Central African Republic.

Thus the studies that are of most interest to this research are those by Elguellab et al. (2014), dedicated to broadening the scope of research into business cycle characteristics in Morocco over a long period (1998-2012). The findings indicated that the features of the Moroccan cycle were consistent with and closely resembled those observed in both advanced and developing economies. Despite the cyclical profile of the Moroccan economy, the periodicity of the growth cycle was relatively short. This major change became evident specifically at the end of the 1990s with non-agricultural aggregates, rather than the overall aggregates generally used (*GDP per capita*). Another paper that proved particularly inspiring was that of Fanchy et al., (2024), involving an analysis of the Moroccan economic cycle during the period 1998 to 2023. Their employment of a range of filtering techniques (HP and CF) and the modified Bry Boschan method (BBQ) facilitated the realisation of the research goal of identifying the economic cycle and its turning points. The findings indicated that the Moroccan economy is characterised by thirteen peak-to-peak cycles and twelve trough-to-trough cycles, with recession phases that are longer and more volatile than expansion phases. Consequently, the results of this work underlined the need to define and adjust stabilisation policies clearly and effectively to meet the objectives set by Moroccan policy-makers.

4. Methodology

This study is concerned with the analysis of the characteristics of the economic cycle in Tunisia. To this end, the series of GDP, both overall and by sector (shares of value added), were considered[2]. The database encompassed quarterly periods commencing in January 2001 and concluding in December 2015, with a base year set at 100 (2010). The data were obtained from the National Institute of Statistics (NIS). The aforementioned variables were subject to seasonal adjustment and subsequently eliminated from trend effects by employing the filtering technique originally developed by Hodrick and Prescott (1997).[3]

To study the characteristics of the inter-sectoral cycle in Tunisia, the statistical method of the Hodrick–Prescott filter (1997) was adapted to extract the cyclical and trend components of sectoral variables. The long-term trend deviation of these variables was considered an estimate of their cyclical component.

Unlike other filtering techniques (Baxter & King, 1999; Christiano & Fitzgerald, 1999), the Hodrick-Prescott method allows the user to choose the value of λ according to the frequency of the series. The author employed this approach to decompose the variables, and opted for this approach for the Tunisian economic data series:

$$Y_t = g_t + c_t, \tag{1}$$

with t = 1, 2, ..., T. To perform this decomposition, one has to minimise the sum of the squares of the deviations of this series with respect to its tendency, while keeping a smooth trend:

$$\begin{cases} min_{gt} \sum_{t=1}^{T} c_t^2 \\ s.c\lambda \sum_{t=1}^{T}[(g_{t+1} - g_t)^2 - (g_t - g_{t-1})^2] \leq K. \end{cases} \tag{2}$$

After the resolution of this system, the cycle was thus obtained by the following formula:

$$c_t = \left(\frac{\lambda(1-L)^2(1-1/L)^2}{1+\lambda[(1-L)^2(1-1/L)^2]} \right) Y_t, \tag{3}$$

where λ represents a smoothing parameter that penalises the trend variance.

Once the data were broken down into cycles and trends, the author identified the characteristics of inter-sectors cycles using the method developed by Bry and Boschan (1971). Rand and Tarp (2002) indicated that this non-parametric approach remains the basis for all cycle-dating methods because it is linked to the National Bureau of Economic Research's (NBER) process for determining turning points. This algorithm has been applied to monthly series in various empirical studies, and these involving classical approaches included Anas & Ferrara, 2002; Mönch and Uhlig, 2005; Elachhab, 2007; ElAlaoui, 2015 and Kaur, 2019.

Moreover, Harding and Pagan (2003) adapted the procedures developed by Bry and Boschan to quarterly time series. Recent studies using this technique include those by (Juliot & Landry, 2018; Nafalana & Kartikasari, 2023; and Fanchy et al. 2024). The modified algorithm extension (contrary BBQ) retains a time range k[4] and identifies peaks and troughs by the local maxima and minima of the two preceding quarters. In line with Burns and Mitchell (1946) and Harding and Pagan (2003), a minimum duration of five quarters is required for the cycle and two quarters for one of its phases, namely expansion or contraction (Tüzen et al., 2022; Nafalana & Kartikasari, 2023).

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[2] The set of GDP sectors utilised here encompassed the following: agriculture and fisheries, manufacturing industry, non-manufacturing industry, public administration services, market and non-market sectors of activity, and financial services.

[3] The Hodrick and Prescott (1997) filter was used to isolate the 'smooth' trend from the cyclical component that engenders minimal fluctuations in the series around its trend.

[4] For k = 2 Quarter, for more details see Harding and Pagan (2003), p. 3.

This study used an approach based on the BBQ algorithm procedure developed by Harding and Pagan (2003) to identify the characteristics of the Tunisian economic cycle, which uses quarterly GDP series, both overall and by sector, see Tüzen et al. (2022). The approach involves the following steps:

for quarterly series, macroeconomic series Y_t shows a peak at date *t* if it verifies:

$\{Y_{t-2} < Y_t; Y_{t-1} < Y_t; Y_t > Y_{t+1}; Y_t > Y_{t+2}\}$ and a minimum (trough), if it verifies:

$$\{Y_{t-2} > Y_t; \ Y_{t-1} > Y_t; \ Y_t < Y_{t+1}; \ Y_t < Y_{t+2}\}. \tag{4}$$

Harding and Pagan (2003) posited that, following the identification of turning points, the analysis of the characteristics of the business cycle necessitates the determination of the duration and amplitude of the cycles, as well as the significance of the slopes of these phases.

The amplitude, or depth, of an expansion phase (*respectively, a recession phase*) is obtained by measuring the variation in the level of the series between two turning points. In summary, the amplitude of the recession or expansion is defined as the absolute value of the distance between a peak and a trough, and vice versa. The amplitude formula for a recession phase and an expansion phase is as follows:

$$\text{Amplitude} (A_i) = \begin{cases} (Y_P - Y_C)/Y_P \Rightarrow \ Recession\ phase \\ (Y_C - Y_P)/Y_C \Rightarrow Expansion\ phase, \end{cases} \tag{5}$$

where Y_P and Y_C represent, respectively, the values of the series at the peak and trough of the cycle under consideration.

Duration of the phase noted (D_i) is calculated as the number of quarters from peak to trough during contraction phases, and from trough to peak during expansion phases (the base of the triangle).

The severity noted (S_i) expresses a measure of the loss or gain suffered by the economy during each phase of the cycle. It is an indicator that summarises the information contained in duration and amplitude, written in the following form:

$$S_i = 0.5 * D_i * A_i. \tag{6}$$

5. Results and Discussion

5.1. Characterisation of the GDP Growth Cycle Overall and by Sector

5.1.1. Identifying Turning Points in the Overall Growth Cycle and by Sector in Tunisia

The results of identifying the turning points of the cyclical components of overall GDP and by sector (value-added shares) are presented in Tables 1 and 2. The quarterly series between 2000 and 2015 was analysed using the BBQ algorithm, as proposed by Harding and Pagan (2003), and a MATLAB program written by F. Arnaud (2006).

Examining the results of estimating the cyclical components of total GDP using the BBQ algorithm allowed to make some important observations. As shown in Table 1, the cyclical components of total GDP identified five peaks (2003Q3; 2005Q3; 2008Q3; 2010Q1, and 2012Q) and five troughs (2004Q3, 2007Q1; 2009Q2; 2011Q3, and 2013Q2). Hence five phases of recession have been documented (2003Q3-2004Q3; 2005Q3-2007Q1; 2008Q3-2009Q2; 2010Q1-2011Q3, and 2012Q3-2013Q2), with an average amplitude between phases of 3.46 quarters and an approximate loss of 8.36 quarters. It therefore appears that these huge declines between 1990 and 2015 in most sectors (agriculture and fishing, manufacturing and non-manufacturing industries, and market and non-market activities) were influenced by internal shocks such as political instability in Tunisia in 2008 and 2011, and external shocks (climate change, subprime crisis, and COVID-19 crisis). Consequently, the strong concentration on sectors that are particularly sensitive to shocks (agriculture, services, and manufacturing industries) increasingly amplifies booms and crises. Moreover, the Tunisian economy appeared to undergo six distinct expansion phases, with an average gain of 9.25 quarters, during the study period from 2001Q1

to 2015Q4. The expansion phases occurred during the following periods: 2002Q3 2003Q3, 2004Q3 2005Q3, 2007Q1 2008Q3, 2009Q2 2010Q1, 2011Q3 2012Q3, and 2013Q2 2014Q2. There were several factors that can explain periods of expansion in the Tunisian economy as a whole. First, macroeconomic stabilisation efforts were followed by restructuring measures at the production level. Second, a significant increase in exports to European countries with which Tunisia has trade agreements occurred due to the recovery of external demand, facilitating access to these markets.

Table 1. Characterisation of the global GDP growth cycle using Harding and Pagan's method (2003)

Variables	Peak	Recession Phase (Peak to Trough)			Trough	Expansion Phase (Trough to Peak)		
		Period and duration	Amplitude	Approximate Loss		Period and duration	Amplitude	Approximate Gain
GDP	2003Q3	2003Q3-2004Q3 (4Q)	2	4	2004Q3	2002Q3-2003Q3 (4Q)	3.9	7.8
	2005Q3	2005Q3-2007Q1 (6Q)	2.9	8.7	2007Q1	2004Q3-2005Q3 (4Q)	2.2	4.4
	2008Q3	2008Q3-2009Q2 (3Q)	1.2	1.8	2009Q2	2007Q1-2008Q3 (6Q)	2.9	15
	2010Q1	2010Q1-2011Q3 (6Q)	7	21	2011Q3	2009Q2-2010Q1 (3Q)	1.3	1.95
	2012Q3	2012Q3-2013Q2 (3Q)	4.2	6.3	2013Q2	2011Q3-2012Q3 (4Q)	9	18
						2013Q2-2014Q2 (4Q)	4.2	8.4
Average			**3.46**	**8.36**			**3.92**	**9.25**

Source: author's calculations.

However, observation of the results reported in Table 2 showed a divergence and a time lag. Indeed, the duration of recession phases averaged 28 quarters, or 5.75 years for the agriculture and fishing sectors. The average amplitude of recessions was 4.7 years. These episodes of slowdown in Tunisia's agricultural sector were the result of climate shocks, the most serious challenges facing humanity in the 21st century (Ben Romdhane & Bouaziz, 2021).

Moreover, the duration of recession phases for the non-manufacturing, market and non-market sectors averages five quarters, and six quarters for the manufacturing and public administration service sectors. In addition, three expansion phases were observed in the agricultural sector and four expansion phases for the market and non-market activity sectors and financial services over the period 2001Q1 to 2015Q4. The most protracted expansion phases were observed in the manufacturing, non-manufacturing and public administration service sectors, with a duration of five quarters.

Table 2. Characterisation of the GDP growth cycle by sector according to the Harding and Pagan method (2003)

Variables	Peak	Recession Phase (Peak to Trough)			Trough	Expansion Phase (Trough to Peak)		
		Period and duration	Amplitude	Approximate Loss		Period and duration	Amplitude	Approximate Gain
Agriculture and Fishing	2003Q1	2003Q1-2004Q4 (7Q)	9.7	33.95	2004Q4	2004Q4-2006Q1 (5Q)	2.1	5.25
	2006Q1	2006Q1-2006Q4 (3Q)	2.1	3.15	2006Q4	2006Q4-2007Q4 (4Q)	2.3	4.6
	2007Q4	2007Q4-2009Q2 (6Q)	2.5	7.5	2009Q2	2009Q2-2011Q1 (7Q)	4.7	16.45
	2011Q1	2011Q1-2012Q4 (7Q)	4.5	15.75	2012Q4			
Average			4.7	15.08			3.03	8.77
Manufacturing industries	2002Q4	2002Q4-2003Q2 (2Q)	0.2	0.2	2003Q2	2003Q2-2004Q1 (3Q)	1.1	1.65
	2004Q1	2004Q1-2005Q1 (4Q)	2.2	4.4	2005Q1	2005Q1-2005Q4 (3Q)	1.8	2.7
	2005Q4	2005Q4-2006Q2 (2Q)	1.7	1.7	2006Q2	2006Q2-2008Q1 (7Q)	4.7	16.45
	2008Q1	2008Q1-2009Q1 (4Q)	10.9	21.8	2009Q1	2009Q1-2010Q1 (4Q)	14.6	29.2
	2010Q1	2010Q1-2011Q1 (4Q)	12.3	24.6	2011Q1	2011Q1-2012Q1 (4Q)	8	16
	2012Q1	2012Q1-2013Q1 (4Q)	4	8	2013Q1			
Average			5.22	10.11			6.04	13.5
Non--manufacturing industries	2004T3	2004T3-2006Q2 (7Q)	9.4	32.9	2006Q2	2003Q1-2004Q3 (6Q)	6	18
	2007T2	2006T2-2007Q2 (4Q)	20.7	41.4	2008Q2	2007Q2- 2008Q2 (4Q)	18.2	36.4
	2009T1	2009T1-2009Q4 (3Q)	8.4	12.6	2009Q4	2008Q2-2009Q1 (3Q)	14.1	21.15
	2010T3	2010T3-2011Q3 (4Q)	12.2	24.4	2011Q3	2009Q4-2010Q3 (3Q)	9.8	14.7
	2012T4	2012T4-2013Q4 (4Q)	6.4	12.8	2013Q4	2011Q3-2012Q4 (5Q)	9.9	24.75
Average			11.42	24.82			11.6	23
Financial services	2004Q2	2004Q2 2005Q3 (5Q)	7.7	19.25	2005Q3	2002Q3 2004Q2 (7Q)	18.6	30.1
	2007Q4	2007Q4 2009Q2 (6Q)	6 .9	20.7	2009Q2	2005Q3 2007Q4 (9Q)	16.2	27.9
	2010Q2	2010Q2 2011Q2 (4Q)	5.5	11	2011Q2	2009Q2 2010Q2 (4Q)	17.1	14.2
	2013Q1	2013Q1 2014Q1 (4Q)	7.5	15	2014Q1	2011Q2 2013Q1 (7Q)	16.8	23.8
Average			6.9	16.48			17.17	24

Variables	Peak	Recession Phase (Peak to Trough)			Trough	Expansion Phase (Trough to Peak)		
		Period and duration	Amplitude	Approximate Loss		Period and duration	Amplitude	Approximate Gain
Market activities	2003Q3	2003Q3-2004Q3 (4Q)	1.5	3	2004Q3	2004Q3-2006Q3 (8Q)	0.8	3.2
	2006Q3	2006Q3-2008Q3 (8Q)	1.3	5.2	2008Q3	2008Q3-2009Q2 (3Q)	2.3	3.45
	2009Q2	2009Q2-2010Q3 (5Q)	3.2	8	2010Q3	2010Q3-2011Q4 (5Q)	3.3	8.25
	2011Q4	2011Q4-2012Q4 (4Q)	2.1	4.2	2012Q4	2012Q4-2013Q2 (2Q)	0.5	0.5
	2013Q2	2013Q2-2014Q1 (3Q)	0.4	0.6	2014Q1			
Average			1.7	4.2			1.72	3.85
Non-market activities	2003Q3	2003Q3-2004Q3 (4Q)	1.6	3.2	2004Q3	2004Q3-2006Q3 (8Q)	1.1	4.4
	2006Q3	2006Q3-2008Q3 (8Q)	1.7	6.8	2008Q3	2008Q3-2009Q2 (3Q)	2.7	4.05
	2009Q2	2009Q2-2010Q3 (5Q)	3.4	8.5	2010Q3	2010Q3-2011Q4 (5Q)	3.7	9.25
	2011Q4	2011Q4-2012Q4 (4Q)	2.6	5.2	2012Q4	2012Q4-2013Q2 (2Q)	0.7	0.7
	2013Q2	2013Q2-2014Q1 (3Q)	0.4	0.6	2014Q1			
Average			1.94	4.86			2.05	4.6
Public administration services	2003Q2	2003Q2-2004Q3 (5Q)	9.8	24.5	2004Q3	2004Q3-2005Q3 (4Q)	5.1	10.2
	2005Q3	2005Q3-2006Q1 (2Q)	1.3	0.325	2006Q1	2006Q1-2007Q3 (6Q)	1.7	5.1
	2007Q3	2007Q3-2008Q3 (4Q)	2.1	4.2	2008Q3	2008Q3-2009Q2 (3Q)	1.7	2.55
	2009Q2	2009Q2-2010Q3 (5Q)	2.2	5.5	2010Q3	2010Q3-2011Q3 (4Q)	4.1	8.2
	2011Q3	2011Q3-2012Q3 (4Q)	5.5	11	2012Q3	2012Q3-2013Q3 (4Q)	4.2	8.4
	2013Q3	2013Q3-2014Q2 (3Q)	2	3	2014Q2			
Average			**3.81**	**8.08**			**3.36**	**6.89**

Source: author's calculations.

Furthermore, as illustrated in Table 2, it is important to note that the downward phases of the cyclical components of GDP sectors, observable at the level of market and non-market activities and financial services, presented higher turning points than that of overall GDP throughout the period from 2001Q1 to 2015Q4. This finding is consistent with Lucas's (1977) theoretical model, according to which *cyclical movements are not uniform in terms of their amplitude or periodicity. The regularities observed concern the co-variations of different aggregate series*. It is clear that, despite the significance of certain periods of economic growth that are evident throughout the study period, they were nevertheless transient in nature. The phases of recession identified can be traced, subject to certain delays in action, to specific economic events in the history of the country (Elachhab, 2007), therefore the observed cyclical pattern corresponded with the emergence of significant social protests in the country i.e. the revolt in the Gafsa mining basin, driven by discontent regarding unemployment and corruption (specifically, the nepotism of Ben Ali clan), which persisted for six months in 2008. Secondly, political instability followed the outbreak of the Tunisian Revolution in 2010.

5.1.2. Dating the Overall Growth Cycle and by Sector in Tunisia

In relation to the dating of overall and sectoral GDP cycles in Tunisia, the results obtained by means of the non-parametric approach documented in Table 3 indicate that the cycles A (peaks to peaks) and B (troughs to troughs) were readily identifiable. The subsequent breakdown, as illustrated in the accompanying table, revealed the presence of four cycles A (troughs to troughs), particularly evident in the context of sectors (non-manufacturing industries, market and non-market activities), and four cycles B for overall GDP.

Table 3. Duration of GDP cycles overall and by sector in Tunisia

	Cycle A (Peak to Peak)	Cycle A Duration	Cycle B (Trough to Trough)	Cycle B Duration
GDP	2003Q3-2005Q3	8	2004Q3-2007Q1	10
	2005Q3-2008Q3	12	2007Q1-2009Q2	9
	2008Q3-2010Q1	6	2009Q2-2011Q3	9
	2010Q1-2012Q3	10	2011Q3-2013Q2	7
Agriculture and Fishing	2003Q1-2006Q1	12	2004Q4-2006Q4	8
	2006Q1-2007Q4	7	2006Q4-2009Q2	10
	2007Q4-2011Q1	13	2009Q2-2012Q4	14
Manufacturing industries	2002Q4 2004Q1	7	2003Q2-2005Q1	7
	2004Q1-2005Q4	7	2005Q1-2006Q2	5
	2005Q4-2008Q1	9	2006Q2-2009Q1	11
	2008Q1-2010Q1	8	2009Q1-2011Q1	8
	2010Q1-2012Q1	8	2011Q1-2013Q1	9

	Cycle A (Peak to Peak)	Cycle A Duration	Cycle B (Trough to Trough)	Cycle B Duration
Non-manufacturing industries	2004Q3-2007Q2	10	2006Q2-2008Q2	8
	2007Q2-2009Q1	7	2008Q2-2009Q4	6
	2009Q1-2010Q3	6	2009Q4-2011Q3	7
	2010Q3-2012Q4	11	2011Q3-2013Q4	9
Financial services	2004Q2-2007Q4	11	2005Q3-2009Q2	15
	2007Q4-2010Q2	10	2009Q2-2011Q2	8
	2010Q2-2013Q1	11	2011Q2-2014Q1	7
Market activities	2003Q3-2006Q3	12	2004Q3-2008Q3	16
	2006Q3-2009Q2	11	2008Q3-2010Q3	8
	2009Q2-2011Q4	10	2010Q3-2012Q4	9
	2011Q4-2013Q2	6	2012Q4-2014Q1	13
Non-market activities	2003Q3-2006Q3	8	2004Q3-2008Q3	16
	2006Q3-2009Q2	11	2008Q3-2010Q3	8
	2009Q2-2011Q4	10	2010Q3-2012Q4	9
	2011Q4-2013Q2	6	2012Q4-2014Q1	13
Public administration services	2003Q2-2005Q3	9	2004Q3-2006Q1	6
	2005Q3-2007Q3	8	2006Q1-2008Q3	10
	2007Q3-2009Q2	7	2008Q3-2010Q3	8
	2009Q2-2011Q3	9	2010Q3-2012Q3	8
	2011Q3-2013Q3	8	2012Q3-2014Q2	7

Source: author's calculations.

Additionally, three to five cycles were observed in the following sectors: agriculture and fisheries, manufacturing industries, financial services and public administration services. To elaborate further, it can be concluded that certain cycles were designated as minor cycles, with an average duration ranging from 1.5 to 4 years. These results are consistent with the conclusions of Elachhab's study (2007 and 2010), which revealed that the Tunisian economic cycle had three minor cycles with an average duration of three years, and four major cycles with an average duration of five years. This analysis also confirms Rouy's (1995) assertion that minor cycles generally last less than five years. However, this was not confirmed by other authors, e.g. Male (2011), who stated that the average duration of the Tunisian economic cycle was 7.6 years.

The findings presented in Table 3 are consistent with the results documented in Figures 2 and 3, enabling precise determination of the duration of phases and cycles for both the aggregate GDP and by sector of activity in Tunisia. As demonstrated in Figure 2, there is a clear correlation between the peaks and troughs in overall GDP. The graph is divided into segments by a red line, which delineates the peaks, troughs and phases. These lines serve as a practical tool for visualising the successive phases of the growth, recession and expansion cycle, which are successively shaded in grey and white.
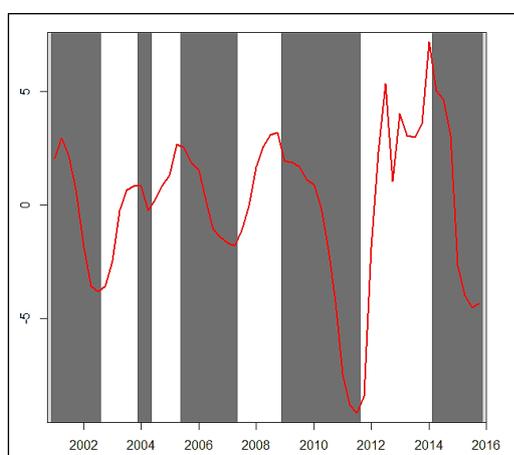

Fig. 2. Dating of GDP growth cycle

Source: author's elaboration.

As illustrated in Figures 2 and 3 below, the economic cycle in Tunisia is proposed to follow different chronologies. A thorough examination of the most recent data revealed that the Tunisian economy, in its totality and across its various sectors, has undergone four distinct recessions, which have been geographically confined during the period spanning January 2001 to December 2015. To elaborate further, in the context of the agriculture and fishing sector, it is feasible to identify four low points and four high points. Conversely, within the domains of market and non-market industries, along with financial services, five distinct recession phases were identified throughout the study period. Thus six recessionary phases were identified in the manufacturing and non-manufacturing sectors, suggesting significant fluctuations in this domain of activity.
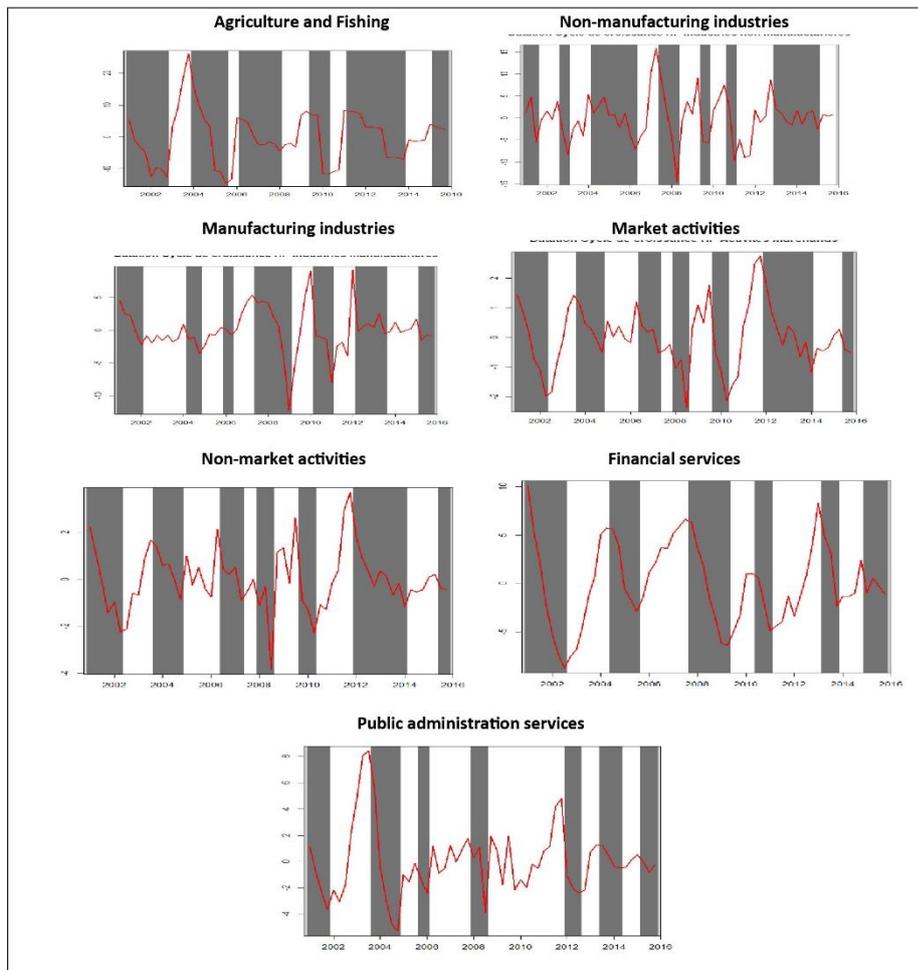

Fig. 3. Dating of growth cycle by sector

Source: author's elaboration.

As Ben Romdhane (2011) observed, the identification of the turning points of cyclical fluctuations in the national economy using a non-parametric approach constitutes a pivotal element in a business cycle diagnosis. Consequently, these analyses can influence public decision-makers to implement appropriate policies (monetary and budgetary) in the event of an economic slowdown or crisis, evident in the case of the financial crises between 2007 and 2009 and their harmful effects on the Tunisian economy. The second crisis occurred on 14 January 2011, when the current regime was deposed. From that date onwards, Tunisia experienced a period of considerable difficulty, characterised by a new phase that was both decisive and contemporary in nature. Indeed, the state of the economy following the revolution reflected disruption across all economic sectors (agriculture, industry and services). Consequently, the country is currently undergoing a period of fundamental transformation in order to

meet the new challenges dictated by the new economic and socio-political situation. However, following the January 2011 revolution, political and economic uncertainty caused a drop in macroeconomic stability. A decline in production, investment and consumption was observed, which was attributed to social unrest, protests and strikes.

This instability was subsequently reflected in the volume of savings, which reached a low level of growth in 2011. This decline in domestic savings was indicative of the slower pace of growth in gross disposable national income (GDI). Consequently, the budget deficit and current account balance are projected to deteriorate. The prevailing circumstances showed a confluence of factors, chief among them the anaemic domestic demand, further compounded by the slow recovery in the euro zone, exerting a deleterious effect on both goods exports and tourist arrivals. The unfavorable national economic situation, compounded by the absence of security following the revolution, has precipitated an escalation in the incidence of terrorism, as evidenced by the Sousse and Bardo attacks, among numerous others. The occurrence of terrorist acts has had a damaging effect on tourism, with a precipitous decline in the number of foreign visitors being discouraged from visiting Tunisia (see Ben Romdhane, 2011).

Due to the Tunisian economy's vulnerability to internal and external shocks, implementing a corrective strategy is essential for its protection. This strategy should focus on stabilising and developing key sectors, as well as providing domestic manufacturing and non-manufacturing industries with the means to improve production. This will establish these industries as pillars of economic and social stability. In light of the financial and climatic challenges the country is facing, countercyclical fiscal policies must be implemented, and small-scale farmers must be supported by offering them insurance against climate-related damage. Investment in water infrastructure is also necessary to help the country cope with climate change and drought. Official decision-makers should implement short and medium-term strategies in productive sectors, such as domestic manufacturing and non-manufacturing industries, by incorporating technology into production processes. They should also encourage investors to explore new growth sectors to diversify the economy and increase its profitability. Due to the deterioration of Tunisia's economic environment, policies of openness to the outside world have been adopted to leverage comparative advantages, boost exports, and gain freer access to international markets.

6. Conclusion

This research aimed to characterise and identify the inflection points of Tunisia's sectoral economic cycle between 2001Q1 and 2015Q4. As part of the methodological approach, the author employed the non-parametric method developed by Harding and Pagan (2003). Analysis of the results revealed that the economic cycles observed in Tunisia's overall and sectoral GDP were short-term. Four particularly pronounced cycles were identified, primarily in non-manufacturing industries and market and non-market activities. Three to Five cycles were observed in the agriculture and fisheries, manufacturing, financial services, and public administration sectors, however five recessions were also clearly identified between 2001Q1 and 2015Q4. In the agriculture and fisheries sector, it was important to distinguish between four phases of recession. Over the entire study period, six recessionary episodes were observed, primarily in market and non-market activities, as well as in financial services. Conversely, six phases of recession were recorded in manufacturing and non-manufacturing industries. It is important to note that the slowdowns that characterised the Tunisian economy as a whole, as well as each of its sectors, were the result of internal and external shocks.

Finally, other lines of research should be mentioned as well, such as the study of how exogenous shocks (e.g., climate change, wars, and geopolitical tensions) impact economic cycles in the MENA countries.

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