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Identifying and characterizing the business cycle: the case of Morocco

Aïcha El Alaoui

Abstract:

In this paper, I describe the key features of the Moroccan business cycles during the period 1980:q1-2012:q1. In particular, I identify the chronologies in classical and growth cycles (expansion phase, contraction phase and full cycles in real gross domestic product). Using the modified BB algorithm, I find eight business cycles and the ninth is not yet achieved. Then, I analyse the main features in these cycles by applying the method of Harding and Pagan (2001). Therefore, I show that the Moroccan economy characterized by the average cumulative gain is more important than the cumulative loss and by the domination of expansion phases.

Key words: Classical cycle, Growth cycle, HP filter, Morocco

JEL numbers: E23, E30, E32

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Introduction

In this last decade, economists have recourse to use the business cycles in their analyses either to developed or developing economies. This recourse has been justified by the profound changes, which the world economy knows. These changes are due to several factors such as the proliferation of the agreements of free exchange, the creation of regional economic groupings and so on. This process has led to an increasing of the sensibility of the national economies cycles and to the fluctuations of the international markets.

The Moroccan economy cannot be excluded from these world economic changes. Several agreements of free exchange have been signed by Morocco[1] such as the European Union's agreement in 1996[2], the United State's agreement in 2004[3], the Turkey's agreement in 2004[4], the Agadir's agreement signed in 2004[5], and so on. Moreover, the Moroccan economy depends on climatic changes. The value added in agriculture contributes between 15% and 20% in the Gross Domestic Product (GDP).

The growth of the Moroccan economy operates in a non-linear and a cyclic schema that combines alternative movements of expansion and recession with recurring variations during the last thirty years. These fluctuations are essentially the consequence of the cyclical factors. Several factors have an impact on the Moroccan economy. These factors are internal factors and external factors. The external factors are mainly the unfavourable climatic condition (long period of dryness) and the interaction between trade openness and the financial integration. The interior factor depends directly on the structural Moroccan economy, which essentially characterizes by the dominance of informal sectors and the competitors from foreign products and the lack of infrastructure and the non-diversification of foreign exchange. In addition, the financing of the balance of payments

[1]For more details see web site of the Ministry of Industry, Trade and New Technologies, Morocco, http://www.mce.gov.ma

[2]This agreement entered into effect on March 2000, which aims to establish a free exchange zone industrial to deepen the exchange liberalization in agricultural and fishery, to liberalize the exchange in services, and to strengthen the exchange integration.

[3] This agreement entered into effect on January 2006, which applies to all sectors of economic activity (the products' agricultural, industrial and textile, and the services).

[4] This agreement entered into effect on January 2006, which covers the exchange of the goods. A clause in the Agreement provides for the progressive liberalization of agricultural exchanges and the liberalization of the exchange of the services.

[5] This agreement signed between Morocco, Egypt, Tunisia and Jordan. It aims at the institution of a free exchange zone, the development of the industrial exchange, the promotion of the economic activity and the employment, the productivity improvement, the coordination of the global and the sectorial economy, and the harmonization of the legislation of member countries in the economic field.

greatly depends on the transfers of Moroccans living abroad and on tourism revenues, and so on.

These considerations justify the interest taken from this work in the questions of the relative irregularity in the time of the business cycle of the Moroccan economy. While there is a little work, which deals with the business cycle fluctuations that, the Moroccan economy has confronted during the past thirty years. This is regrettable since business cycle fluctuations are one of the central concepts in macroeconomics.

This study is a contribution and a comparison with other studies. Indeed, there are several studies using the business cycle to describe the fluctuations of the economy. Fathi (2007) describes some of the key features of the Tunisian business cycle (classical and growth cycles) during the period 1970-2002 and compare the Tunisian business cycle with the US and the Euro-zone business cycles. Urasawa (2007) has established the robust stylized facts for recent Japanese business cycle fluctuations, by examining the cyclical component of macroeconomic time series based on the frequency domain analysis. Fournier (1999) constructed the band-pass filter applied to French GDP. Then, this filter has applied to the main French economic time series (household consumption, investment, imports and exports) and foreign GDP series. Fournier found out a synchronization of cyclical components of European GDP and a persistent lead of Anglo-Saxon economies, and others studies applied in developed and developing economies.

The objective of this paper is to determine the dating turning point in real GDP and to analyze of its cyclical characteristics. Another aim of this study is to determinate the main features in cycle of real GDP by using the method of Harding and Pagan (2001).

The plan of this paper is as follows. In the next section, I provide an overview of theories on classical and growth cycles. In the third section, I present main business cycle dating methods as Bry-Boschan algorithm, Hodrick-Prescott (HP) filter, band-pass filter and Christiano-Fitzgerald filter. In the fourth section, I describe the sequence of economic fluctuations and to proceed with the algorithm of Bry-Boschan, the dating of turning points (peaks and troughs), and I compare business and growth cycles. In the fifth section, I analyze the specific characteristics of these cycles by evaluating the amplitude and the severity of the various cyclic phases since the early 80s. In the sixth section, I evaluate the degree of synchronization of the economy cycle with some macroeconomic variables to determine whether this co-movement is procyclical, acyclical or countercyclical. Thus, I check if the macroeconomic indicators coincide, retard or advance the cycle of real GDP. The last section will be devoted to conclusions and remarks.

1. Literature review

Business cycles are more or less regular patterns in fluctuations of macroeconomic variables, such as output, unemployment, consumption, investment, prices or interest rates. National Bureau of Economic Research (NBER) gives a more sophisticated definition:

> ″Business cycles are a type of fluctuations found in the aggregate economic activity of nations that organize their work mainly in business enterprises: a cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle; this sequence of changes is recurrent but not periodic; in duration business cycles vary from more than one year to ten or to twelve years; they are not divisible into shorter cycles of similar character with amplitudes approximating their own." (Burns and Mitchell 1946, p. 3).

The Burns and Mitchell's definition gives "more than one year" as the lower limit of duration of business cycles and "to ten or to twelve years" as the upper limit. This definition provides also, an accurate description of the manner of growth cycles and repeated.

Lucas (1977) was the first to introduce the definition of growth cycles. The growth cycles are "movements about trend in gross national product (GNP) in any country can be well described by a stochastically described differences equation of very lowered" (Lucas 1977, p. 9). In this approach, the time series of output growth are generally detrended to obtain the "growth cycles", which can be defined as the deviation of output from its long-term trend. Obviously, business cycles are variations around the trend although these variations are likely not to be permanent. These variations have also characterized by their periodicity, where the period is the approximate time interval between two peaks or two troughs in GDP growth and in different aggregate time series.

2. Methodology

In this section, I discuss four methods of business cycle. The first method adopts the definition of classical cycle. It is the algorithm of the Bry-Boschan. The other three methods look for turning points after detrending the series. These are the Hodrick-Prescott (HP) filter, the Baxter-King filter or band-pass (BP) filter and finally the Christiano-

Fitzgerald (CF) filter. Obviously, there are many other methods to use[6], but I have to make a selection.

2.1. The algorithm of Bry-Boschan

This approach is related to the process of turning point determination practiced by the NBER. It "roughly parallels the traditional sequence of first identifying major cyclical wings (movements), then delineating the neighbourhoods of their maxima and minima, and finally narrowing the search for turning points to specific calendar dates" (Bry-Boschan 1971, p. 16). In contrast to the NBER dates, this procedure relies on individual series, because a comprehensive analysis with the use of different statistical tools can lead to a loss of consistency over time (Christoffersen 1990, p. 6).

Table 1 shows the successive steps of the Bry-Boschan algorithm in a schematic way. The general idea of this algorithm is to perform different degrees of smoothing of the data in order to locate neighbourhoods of potential peaks and troughs, which are then, finalized using the original series[7].

Table 1: Bry-boschan procedure for programmed determination of turning points

1 Determination of extremes and substitution of values.
2 Determination of cycles in 12-month moving average (extremes replaced). A. Identification of higher (or lower) than 5 months on either side. B. Enforcement of alteration of turns by selecting highest of multiple peaks (or lowest of multiple troughs).
3 Determination of corresponding turns in Spencer curves (extremes replaced). A. Identification of highest (or lowest) value within +/- 5 months of selected turn in 12-month moving average. B. Enforcement of minimum cycle duration of 15 months by eliminating lower peaks and higher troughs of shorter cycles.
4 Determination of corresponding turns in short-term moving average of 3 to 6 months, depending on MCD (months of cyclical dominance). A. Identification of highest (or lowest) value within +/- 5 months of selected turn in Spencer curve.
5 Determination of turning points in unsmoothed series. A. Identification of highest (or lowest) value within +/- 4 months, or MCD term, whichever is larger, of selected turn in short-term moving average. B. Elimination of turns within 6 months of beginning and end of series. C. Elimination of peaks (or troughs) at both ends of series which are lower (or higher) than values closer to end. D. Elimination of cycles whose duration is less than 15 months. E. Elimination of phases whose duration is less than 5 months.
6 Statement of final turning points.

Source: Bry and Boschan 1971, p. 21.

[6] See Bonenkamp and al., 2001, for presentation and comparison of different methods of business cycle dating both on theoretical and practical grounds.

[7] For a detailed overview of the Bry-Boschan procedure, see Bry-Boschan, 1971, pp.7-63 .

The algorithm of Bry-Boschan is applied initially to monthly data, in level, to identify turning points in the classic reference cycle, see step 2 in above table. The general rule of identification retains a time range, *k*, of five months, which imposes on cycle a minimal duration of fifteen months and in one of its phases (contraction, expansion) a minimal duration of six months. Harding and Pagan (2003) have modified this algorithm and have adapted it for the quarterly time series (Fathi 2007, p. 31-61). This modified algorithm (noted BBQ) retains a time range, k, of two quarters and identifies peaks and troughs by the maxima and minima locals of the two preceding quarters or according to observation. In agreement with Burns and Mitchell (1946), Harding and Pagan required on the cycle a minimal duration of five quarters and in one of its phases, expansion or contraction, a duration of two quarters at the least (Fathi 2007, p. 31-61).

2.2. The filter of Hodrick-Prescott (HP)

The filter of Hodrick-Prescott applied frequently by proponents of real business cycle theory. The economists in this domain of research treat trend and cyclical components in one theoretical framework. They believe that business cycle movements are the result of unexpected changes in technological progress or individual preferences.

This filter is a smoothing technique that decomposes time series y_t in two components: a trend component g_t and a cyclical component c_t. Thus, $y_t = g_t + c_t$, for $t=1,2,\ldots,T$. To make this decomposition, it is necessary to solve the following minimization problem:

$$\underset{C_t, g_t}{Min} \sum_{t=1}^{T} C_t^2 + \lambda \sum_{t=1}^{T} \left[\left(g_{t+1} - g_t \right) - \left(g_t - g_{t-1} \right) \right]^2$$

$$\textit{Subject to} \qquad y_t = g_t + c_t \qquad (1)$$

The variance between the trend component g_t and the cyclical component c_t is reflected by the parameter λ. This parameter is very important. It determines the penalty for adjusting the trend. In other words, the parameter λ controls the smoothness of the trend. The decomposition of time series y_t depends on the value of λ, where $\lambda \in (0, \infty)$. Two considerations are balanced by this parameter:

- If $\lambda=0$, there is no penalty for adjusting the trend. The objective function (1) becomes:

$$\underset{C_t, g_t}{Min} \sum_{t=1}^{T} C_t^2$$

$$\textit{Subject to} \qquad y_t = g_t + c_t \qquad (2)$$

The solution is $g_t=y_t$, and $c_t=0$. Therefore, the trend is equal to the actual data and the business cycle components are zero.

- If λ is big, I want to make:

$$\sum_{t=1}^{T}\left[\left(g_{t+1}-g_t\right)-\left(g_t-g_{t-1}\right)\right]^2 \qquad (3)$$

The change in the growth rate of the trend component is small. Therefore, high λ makes it optimal to have a trend component with fairly constant slope.

In the extreme case as λ goes to infinity, it is optimal to set the term of equation (3) to *0* for all period, that is: $\left[\left(g_{t+1}-g_t\right)-\left(g_t-g_{t-1}\right)\right]$, which is a constant linear trend. The parameter λ is very important to resolve the equation (1). The value of this parameter depends crucially on the frequency of the data. Generally, λ is equal to 14400 for monthly data, it is equal to 1600 for quarterly data, and it is equal to 100 for annual data.

2.3. The filter of Baxter-King

Baxter and King (1999) have proposed the band-pass (BP) filter. They adopted the definition of "business cycles suggested by the procedures and findings of NBER researchers like Burns and Mitchell". They considered the band-pass filter "more flexible and easier to implement than other filters and produces a better approximation to the ideal filter" (Baxter and King 1999, p. 590).

The BP-filter pays explicit attention to the duration of business cycles. This filter is a linear filter, two-sided moving average "that passes through components of the time series with periodic fluctuations between six and 32 quarters, while removing components of higher and lower frequencies" (Baxter and King 1999, p. 575). In this respect, the BP-filter deviates from the other distinguished methods[8].

Baxter and King (1999) proposed to decompose the time series y_t in a trend component t_t, a cyclical component c_t and an irregular component ir_t. Thus, y_t is written by:

$$y_t= t_t+ c_t+ir_t \qquad (4)$$

The ideal filter preserves all business cycle fluctuations c_t but eliminates all other fluctuations, both the high frequency fluctuations ir_t, with periods less than six quarters, and the low frequency fluctuations t_t with periods exceeding 32 quarters (eight years). The BP-filter is the best approximate of the ideal filter according to Stock and Watson (2000). The first-difference filter eliminates the trend (low frequencies fluctuations), but it exacerbates the high frequency fluctuations. The HP-filter, however, attenuates less of the

[8]For the detail of construction of approximate band-pass filters, see section II, Baxter and King (1999).

cyclical component and it does not amplify high frequencies. This filter still passes much of the high-frequency noise outside the business cycle frequency band.

2.4. The filter of Christiano-Fitzgerald

Christiano-Fitzgerald (1999) proposed to study optimal linear approximations. The optimal criterion is the minimization of the mean square error criterion. They approximate y_t, denote the data generated by applying the ideal band pass filter to the raw data, x_t, by $\hat{y}_t$ a linear function, or filter, of the observed sample x_t's. They "select the filter weights to make $\hat{y}_t$ as close as possible to the object of interest" (Christiano-Fitzgerald 1999, p. 1). This description is equivalent a sense of minimizing the mean square error criterion:

$$E\left[\left(y_t - \hat{y}_t\right) \middle/ x\right], x \equiv \left[x_1, ..., x_T\right] \qquad (5)$$

Martin (2006) has shown that the filter of Baxter-King and the filter of Christiano-Fitzgerald "are based on the same ideal band-pass filter. Hence, the differences between the two filters are merely due to the type of approximation of the ideal band-pass filter". The approximations by Baxter-King (1999) and by Christiano-Fitzgerald (2003) differ in two assumptions. The first assumption concerns the spectral density of the variables. Baxter and King assume that the variables are independent and identically distributed; Christiano and Fitzgerald presume the distribution of a random walk. The second assumption regards the symmetry of the weights of the filter. Baxter and King assume symmetric weights where as Christiano and Fitzgerald omit this assumption, (Martin 2006, p. 16-17).

The decision about the choice of filter depends essentially on (i) short or long business cycles have been analyzed, (ii) the characteristics of the cycles and (iii) the trend of the original data series can remove trouble-free. In this paper, I use the Bry-Boschan algorithm.

3. Results and discussion

The data used in this study is the quarterly real Gross Domestic Product of the Moroccan economy, noted *Mor_RGDP*. Then, I have used the algorithm of Bry-Boschan modified by Harding and Pagan (2003) denoted BBQ[9]. The criteria used is related to a five quarters of minimum period for a full cycle and two quarters minimum period for phases

[9]I am very grateful to Everts Martin and Robert Inkaar for their helps for providing me the program MATLAB.

of expansion as well as phases of recession. In addition, I have tried to detect the turning point in classical and growth cycles.

3.1. Classical cycle of *Mor_RGDP*

The BBQ is used to sketch the dating of turning points in the business cycle of *Mor_RGDP* during the period 1980:q1-2012:q1. The below chart presents the results.

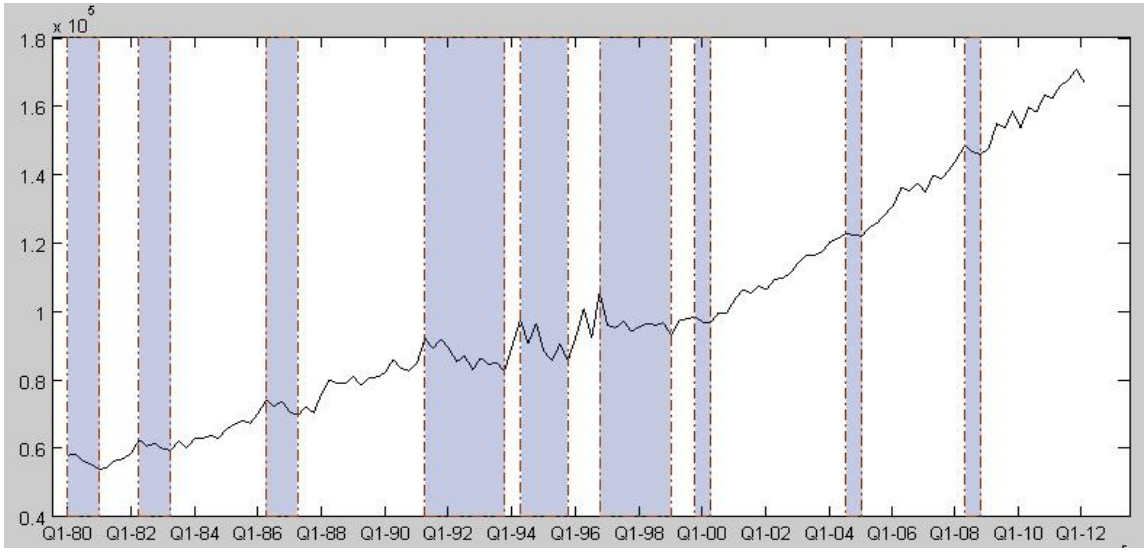


Figure 1: Dating business cycle of *MOR_RGDP*, 1980:q1-2012:q1

The results show that the Moroccan economy has recognized eight full cycles (trough-to-trough). The ninth cycle is still not accomplished. It began in 2009:q1 (recession phase unachieved). Table 2 demonstrates in detail these results.

Table 2: Duration of classical business cycles of *MOR_RGDP*

CBC Reference dates		Duration in Quarter			
Trough (T)	**Peak (P)**	**Contraction**	**Expansion**	**Cycle**	
		P to T	**T to P**	**P to P**	**T to T**
1981:q1	**1982:q2**		5	---	---
1983:q2	**1986:q2**	4	12	16	9
1987:q2	**1991:q2**	4	16	20	16
1993:q4	**1994:q2**	10	2	12	26
1995:q4	**1996:q4**	6	4	10	8
1999:q1	**1999:q4**	9	3	12	13
2000:q2	**2004:q3**	2	17	19	5
2005:q1	**2008:q2**	2	13	15	19
2008:q4	**---**	2	---	Cycle unachieved	15
	Mean	4.88	9.00	14.86	14.38
	Median	4.00	8.50	15.00	14.50
	Standard Deviation	3.50	6.14	3.76	8.28

Source: My estimation

The above table shows, also, the reference dates of peaks and troughs, and the duration in quarter of contraction and expansion. The minimum cycle length is five

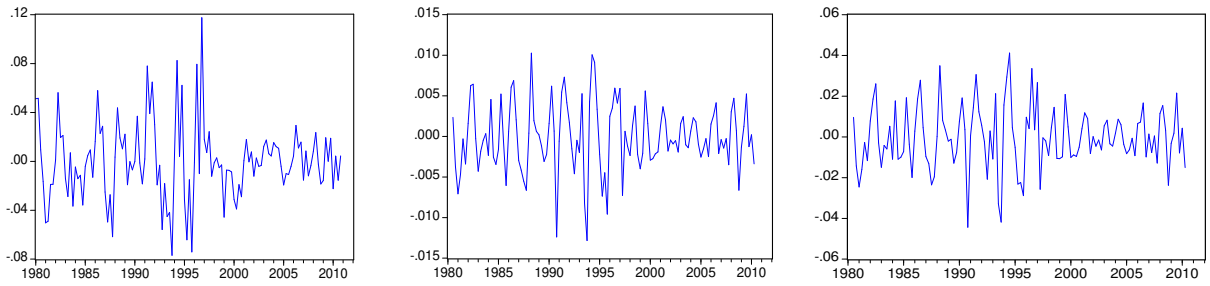
quarters and the maximum cycle length is twenty-six quarters. The long duration of contraction (peak-to-trough) is 1991:q2-1993:q4, it records ten quarters. The short durations of contraction are 1999:q4-2000:q2, 2004:q3-2005:q1 and 2008:q2-2008:q4, its record just two quarters. The maximum duration of expansion (trough-to-peak) records seventeen quarters, during the period 2000:q2-2004:q3. The short duration of expansion records, also, two quarters, during the period 1993:q4-1994:q2.

The average duration of expansion (9) is more important than the average duration of contraction (≈5). Therefore, the Moroccan economy records the long duration of expansion comparatively by the duration of contraction. This analysis of classical business cycles illustrates the domination of cycle (peak-peak). The average duration of full cycle P-P (14.86) is slightly important than the average duration of full cycle T-T (14.38).

These findings are the same as those concluded by Department of studies and Economic Forecast, Ministry of Finance, Morocco (2009). This study was been realized during the period 1980:q1-2008:q2. The main conclusion is the duration of cycle, which varies from six to sixteen quarters. The phases of expansion are considerably longer than the phases of recession with average duration of 6.25 quarters and 3.38 quarters, respectively. The Moroccan economy has recognized eight full cycles and the ninth cycle has not been achieved yet.

3.2. Growth cycle of *Mor_RGDP*

In order to detect the turning point of Growth cycle, I have applied three methods, which were explained in the previous section (HP filter, BP filter and CF filter). To decompose the series of *Mor_RGDP* in cyclical component and irregular component, the following chart displays the results of each filter during the period 1980:q1-2012:q1.



(a) HB (1600) filter **(b) BP (6,32) filter** **(c) CF filter**

- **Each filter applies in log of RGDP (Mor_LRGDP).**
- **Results are obtained by using Eviews 5**

Figure 2: Growth cycles of *Mor_RGDP*

From this figure, I have observed that the deviations from the trend obtained by these three methods are nearly similar. Except for a few small differences recorded at the

amplitudes. Three cyclical components redraw the same path and have the same chronic cyclical episodes. In this work, I have used the HP filter because it is more robust estimate compared to other filters, and it is used by many economists.

Table 3: Duration of growth cycles of *Mor_RGDP*

Growth BC Reference dates		Duration in Quarter			
Trough (T)	Peak (P)	Contraction P to T	Expansion T to P	Cycle P to P	Cycle T to T
1981:q1	1982:q2		5	---	---
1983:q4	1986:q2	6	10	16	11
1987:q4	1988:q2	6	2	8	16
1989:q2	1991:q2	4	8	12	6
1993:q4	1994:q2	10	2	12	18
1995:q4	1996:q4	6	4	10	8
1997:q4	1998:q2	4	2	6	8
1999:q1	2001:q2	3	9	12	5
2002:q1	2003:q2	3	5	8	12
2005:q1	2006:q2	7	5	12	12
2007:q1	2008:q2	3	5	8	8
2010:q1	---	7	---	Cycle unachieved	12
	Mean	5.36	5.18	10.40	10.55
	Median	6.00	5.00	11.00	11.00
	Standard Deviation	2.20	2.79	2.95	4.03

Source: My estimation

The length of minimum cycle is five quarters. The length of maximum cycle is eighteen quarters. The durations of contraction fluctuate between three quarters to ten quarters, but the durations of expansion fluctuate between two quarters to ten quarters. The average of the contraction phase is roughly equal to the expansion phase. Thus, the duration of full cycle peak-to-peak is similar to the cycle trough-to-trough. These cycles can bound to specific events of the Moroccan economy, for example: the application of the structural adjustment program, the modernization of the financial sector, the liberalization of foreign trade, the signature of several free trade agreements, the rise of world prices of oil, wheat....

3.3. Growth cycle vs. Classical cycle

The comparison of the reference dates and durations in quarter for growth and classical cycles are represented in the following table.

Table 4: Growth cycle and business cycle, 1980:q1-2012:q1

Reference dates and duration in quarter of cycle

Growth Cycle			Cycle	Business Cycle			Cycle
T	**P**	**T**	**T-T**	**T**	**P**	**T**	**T-T**
1981:q1	1982:q2	1983:q4	11	1981:q1	1982:q2	1983:q2	9
				1983:q2	1986:q2	1987:q2	16
1983:q4	1986:q2	1987:q4	16				
				1987:q2	1991:q2	1993:q4	26
1987:q4	1988:q2	1989:q2	6				
1989:q2	1991:q2	1993:q4	18				
1993:q4	1994:q2	1995:q4	8	1993:q4	1994:q2	1995:q4	8
1995:q4	1996:q4	1997:q4	8	1995:q4	1996:q4	1999:q1	13
1997:q4	1998:q2	1999:q1	5				
1999:q1	2001:q2	2002:q1	12	1999:q1	1999:q4	2000:q2	5
				2000:q2	2004:q3	2005:q1	19
2002:q1	2003:q2	2005:q1	12				
2005:q1	2006:q2	2007:q1	8	2005:q1	2008:q2	2008:q4	19
2007:q1	2008:q2	2010:q1	12				
				2008:q4	Cycle unachieved		
2010:q2	CU						

Source: My estimation

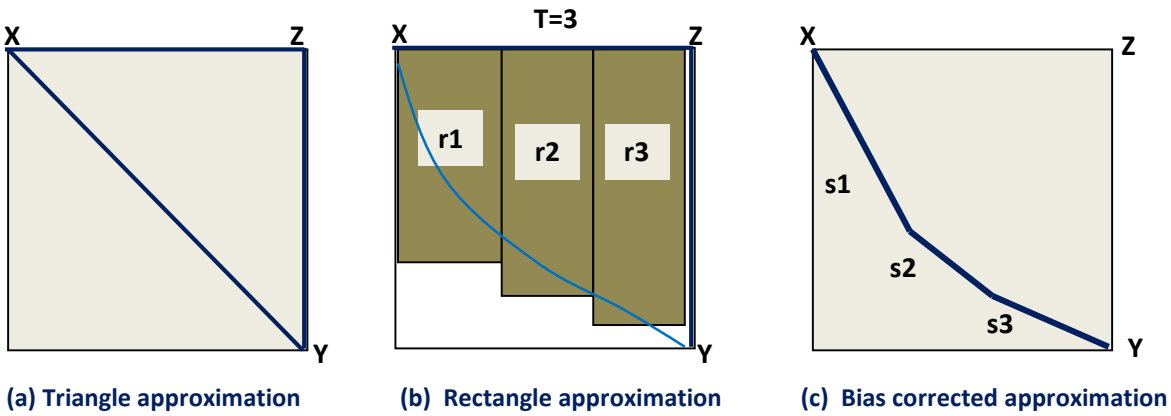
There are many peaks and troughs in growth cycle than in that of classical cycle. Thus, the Moroccan economy has recognized eleven cycles (trough-to-trough). The twelfth cycle is still not accomplished. It began in 2010:q1 (recession phase unachieved). The comparison of the reference dates between classical cycle and growth cycle illustrates that the dates of expansion phases and the dates of contraction phases are nearly similar.

I have observed in growth cycle that the dates of expansion phase have started at the second quarter and the dates of contraction phase have stared at the first quarter or the fourth quarter. The growth cycles are numerous and symmetrical compared to the classical cycles, and tend to anticipate the latter.

3.4. Analysis of main characteristics of classical and growth cycles

It is necessary to analyze the principal characteristics of business cycle to appreciate the cyclical fluctuations. Thus, I have focused on four characteristics of the duration, the amplitude, the cumulative loss or gain and the excess. Pagan (1997) and Harding and Pagan (2001) have identified these four characteristics[10]. They have presented the recessionary phase by a triangle XYZ, see figure 3.

[10]See Athanapoulos, Anderson and Vahis (2001) for more explication.



Source: Athanapoulos, Anderson and Vahid 2001.

Figure 3: calculation of cumulative loss and excess

The first characteristic is presented by the base of triangle *XYZ*. This base shows the duration, noted *D*, which measures how long it takes in quarters for the phase to be completed. The second characteristic is presented by the height of triangle *XYZ*. It shows the amplitude, noted *A*, which is given by the total change in output as the economy moves from its peak to its trough. From point *X* to point *Y*, the economy moves from its peak to its trough. The area of the triangle *XYZ* presents a crude measure. It is given by:

$$CT = \tfrac{1}{2} DA \qquad (6)$$

Harding and Pagan have called it the "triangle approximation" to cumulative losses, which is illustrated in figure 3.a. Nevertheless, the authors have demonstrated that the "rectangle approximation" is the best approximation of the cumulated losses in output comparatively to the "triangle approximation" (figure 3.b). This "rectangle approximation", noted C_R, is given by the sum of the areas of the *T* small rectangles *r*, and each rectangle relates to a single quarter during the phase, thus:

$$C_R = \sum_{t=1}^{T} r_t, \; for \quad t = 1,...,T \; where \quad T = D \qquad (7)$$

The figure 3.c shows the small corner triangles, noted s_t, which measure the change in amplitude during each corresponding quarter *t*. The total area in these small triangles is given by:

$$S = \frac{1}{2}\sum_{t=1}^{T} S_t = \frac{1}{2} A \qquad (8)$$

The "bias corrected" measure of cumulated output loss, noted C_{bc}, is then given by:

$$C_{bc} = C_R - \frac{1}{2} A \qquad (9)$$

This formulation gives the third characteristic, the measure of cumulated output loss. The fourth business cycle characteristic (Excess) is given by the difference between the "bias corrected" cumulated output loss and the "triangle approximation" of this loss. According to this measure, Harding and Pagan (2001) formulated the "excess index", noted I_E, as following:

$$I_E = \frac{1}{D}\left(\frac{1}{2}DA + \frac{1}{2}A - C_R\right) \qquad (10)$$

This "index describes the shape of the actual business cycle relative to the triangle approximation, it provides a measure of the shape of the cycle", (Anthanapoulos 2001, p.8).

It is useful to separate between recessionary phase (peak-to-trough) and expansionary phase (trough-to-peak) of the business cycle. The characteristics of the classical cycle and the growth cycle are represented in appendix table 5.

The results of classical cycle show existence of the asymmetric in evolution of real GDP. The average duration of contraction phase is shorter than that of the expansion phase. Therefore, the length of expansion is nine quarters as long as the length of contraction (five quarters). The average amplitude shows that the average decline in *Mor_RGDP* during contractions phases (≈4.5%) is considerably smaller than the average rise during expansion phases (14.3%). This characteristic explains the overall ascendant trend in *Mor_RGDP*. The average quarterly amplitude of *Mor_RGDP* rises in expansion (≈2 percent a quarter) is slightly faster than the average quarterly amplitude of *Mor_RGDP* declines in contraction (-0.84 percent a quarter).

The average cumulative loss during contraction phase is less important than that of the expansion phase. Consequently, the loss recorded during the contraction phase is compensated in expansion phase (12.3 percent). The excess index is negative (-2.4) in contraction phase, i.e. the cumulative loss is considerably higher than that the triangle approximation. Contrary, this index is positive (≈5) in expansion phase, i.e. the cumulative gain is considerably weaker than that of the triangle approximation.

In contrast to the classical cycle, the growth cycle is symmetric. The average duration in contraction phase (5.36 quarters) is roughly equivalent to that of expansion phase (5.18 quarters), with the average amplitude of this phase (≈9%) is higher than that of contraction phase (about 1%). The average quarterly amplitude of *Mor_RGDP* rises in expansions phases (2.11 percent a quarter) is slightly faster than the average quarterly amplitude of *Mor_RGDP* declines in contraction phases (-0.15 percent a quarter).

The same as the classical cycle, the average cumulative loss during contraction phase is less important than that in expansion phase. Therefore, the loss recorded during the contraction phase is compensated in expansion phase (8 percent). The cumulative gain is less important during the expansion phase than the triangle approximation, excess index records 1.57.

In comparing phases of classical and growth cycles, the average duration of contraction of the classical cycle is almost equivalent as long as the average duration of contraction of the growth cycle. The average amplitude of contraction classical cycle is higher than the growth cycle. In contrast, the average duration of expansion classical cycle is twice as long as the average duration expansion of growth cycle. The expansion phases tend to be longer-lived than contraction phases.

4. Cycle co-movement with other macroeconomic variables

In this section, I have analyzed the co-movement between the macroeconomic variables and the growth cycle. I have used the quarterly macroeconomic time series. Each series covers the period from 1998:q1 to 2012:q4. These series denoted Y_t are: final consumption of households *FCH*, government expenditures *G*, investment (Invest equals gross fixed capital formation plus variations of stocks), importation *M*, exportation *X*, employment *Emp* and deflator *Def*.

In the first step, I have used the HP filter to decompose each series into a growth component and a cyclical component. In the second step, I have studied six orders of cross-correlation denoted ρ of the cyclical component of each series with the cyclical component of real gross domestic product (Mor_RGDP_{t+k}), with the k quarter of lead or lag. In the last step, I have commented each correlation. The variable Y_t is procyclical if $\rho>0$ i.e. the variable usually increases in expansion or decreases in recession. The variable Y_t is acyclical if $\rho=0$, i.e. the variable shows no systematic relationship to the business cycle. The variable Y_t is countercyclical if $\rho<0$, i.e. the variable usually decreases in expansion and increases in recession. The following table summarizes the results:

Table 6: Cross-correlation of *Mor_RGDP* with Y_t

Variable		*Y*	*FCH*	*G*	*INV*	*M*	*X*	*EMP*	*Def*
***k*=**	**-6**		0.228	**-0.231**	-0.034	0.082	0.040	-0.051	0.035
	-5		-0.062	0.026	-0.045	0.086	0.013	0.063	0.027
	-4		0.167	-0.194	-0.032	-0.077	-0.176	-0.057	0.021
	-3		-0.010	0.089	-0.148	-0.118	-0.046	-0.240	0.055
	-2		**0.238**	-0.168	-0.150	-0.101	-0.126	**0.260**	0.111
	-1		-0.028	0.042	-0.134	-0.010	-0.078	0.301	0.037
	0		-0.046	0.057	**0.391**	-0.020	**-0.189**	0.250	-0.013
	1		0.113	-0.044	0.026	0.012	-0.040	-0.058	0.047
	2		0.047	0.000	0.191	-0.035	0.123	0.213	0.076
	3		0.005	0.008	0.057	0.004	0.166	0.123	0.144
	4		-0.054	-0.090	-0.034	0.013	-0.013	-0.072	**0.156**
	5		-0.224	0.203	0.014	0.119	0.078	-0.210	0.136
	6		0.080	-0.118	0.114	**0.165**	0.201	-0.048	0.096

Source: My calculation

The analysis of cross-correlations between *Mor_RGDP* and variables Y_t shows that investment is procyclical and coincident, employment is procyclical and lagging with two quarters. The exports are countercyclical and coincident. Nevertheless, the imports are procyclical and leading with six quarters. The finale consumption of households is procyclical and lagging with two quarters. However, the government expenditure is countercyclical and leading with six quarters. The deflator is procyclical and leading with four quarters.

5. Conclusion

In this paper, I have analyzed the dating of classical cycle and growth cycle. The empirical findings indicate that the Moroccan economy has recognized eight cycles (T-T) and the ninth cycle is still not achieved since 2008:q4. Moreover, I have remarked that the Moroccan economy has been moderately dominated by the expansion phases.

Comparing business cycle with growth cycle, I have found that the reference dates are roughly similar but the dates of growth cycle are numerous and symmetrical compared to the classical business cycle. The analysis of the characteristics of classical cycle and growth cycle has shown the existence of the asymmetric in evolution of *Mor_RGDP*.

The results of the finding of this paper are consistent with other research. The study of "Department of Studies and Economic Forecast, Ministry of Finance, Morocco" shows that "Morocco has witnessed since the beginning of the eighties complete business cycles and a ninth one not yet finished. This latter started at the fourth quarter of 2000 and

registered since then a record of an expansion phase of 31 quarters". The results of this department have shown, also, that the duration and scale of expansion phases were substantially longer than those of recession and that cumulative loss were largely compensated by the cumulative gain.

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Appendix

Table 5: Characteristics of classical cycle and growth cycle, 1980:q1-2012:q1

1.Classical Cycle

Contraction phase

Periods P	Periods T	Duration	Amplitude	Quarterly amplitude	Cumulative- loss	Excess index
1982:q2	**1983:q2**	4	-4.23	-1.06	-0.34	-2.03
1986:q2	**1987:q2**	4	-4.69	-1.17	1.42	-2.70
1991:q2	**1993:q4**	10	-7.63	-0.76	2.94	-4.11
1994:q2	**1995:q4**	6	-7.34	-1.22	1.30	-3.89
1996:q4	**1999:q1**	9	-8.37	-0.93	-1.28	-4.04
1999:q4	**2000:q2**	2	-1.54	-0.77	1.56	-1.55
2004:q3	**2005:q1**	2	-0.25	-0.13	0.02	-0.14
2008:q2	**2008:q4**	2	-1.43	-0.72	-0.21	-0.61
Mean		**4.88**	**-4.44**	**-0.84**	**0.67**	**-2.38**

Expansion phase

Periods T	Periods P	Duration	Amplitude	Quarterly amplitude	Cumulative- gain	Excess index
1981:q1	**1982:q2**	5	8.71	1.74	5.87	3.18
1983:q2	**1986:q2**	12	18.05	1.50	15.87	7.70
1987:q2	**1991:q2**	16	21.72	1.36	15.21	9.91
1993:q4	**1994:q2**	2	8.99	4.50	22.18	-6.59
1995:q4	**1996:q4**	4	8.03	2.01	2.87	3.30
1999:q1	**1999:q4**	3	5.11	1.70	-0.18	2.61
2000:q2	**2004:q3**	17	25.21	1.48	21.18	11.36
2005:q1	**2008:q2**	13	18.62	1.43	15.11	8.15
Mean		**9**	**14.30**	**1.97**	**12.26**	**4.95**

2. Growth Cycle

Contraction phase

Periods P	Periods T	Duration	Amplitude	Quarterly amplitude	Cumulative loss	Excess index
1982:q2	**1983:q4**	6	-0.30	-0.05	-0.17	-0.12
1986:q2	**1987:q4**	6	-2.70	-0.45	0.03	-1.36
1988:q2	**1989:q2**	4	1.04	0.26	-2.17	1.06
1991:q2	**1993:q4**	10	-7.63	-0.76	2.94	-4.11
1994:q2	**1995:q4**	6	-7.34	-1.22	1.30	-3.89
1996:q4	**1997:q4**	4	-7.82	-1.95	-8.61	-1.76
1998:q2	**1999:q1**	3	0.33	0.11	-0.04	0.18
2001:q2	**2002:q1**	3	1.06	0.35	0.82	0.26
2003:q2	**2005:q1**	7	5.27	0.75	2.57	2.27
2006:q2	**2007:q1**	3	1.03	0.34	1.15	0.13
2008:q2	**2010:q1**	7	6.52	0.93	5.32	2.50
Mean		**5.36**	**-0.96**	**-0.15**	**0.28**	**-0.44**

Expansion phase						
Periods				Quarterly amplitude	Cumulative gain	Excess index
T	P	Duration	Amplitude			
1981:q1	**1982:q2**	5	8.71	1.74	5.87	3.18
1983:q4	**1986:q2**	10	16.66	1.67	12.38	7.09
1987:q4	**1988:q2**	2	7.94	3.97	18.60	-5.33
1989:q2	**1991:q2**	8	8.21	1.03	1.07	3.97
1993:q4	**1994:q2**	2	8.99	4.50	22.18	-6.59
1995:q4	**1996:q4**	4	8.03	2.01	2.87	3.30
1997:q4	**1998:q2**	2	1.53	0.76	-2.04	1.79
1999:q1	**2001:q2**	9	11.07	1.23	3.13	5.19
2002:q1	**2003:q2**	5	7.29	1.46	5.43	2.56
2005:q1	**2006:q2**	5	7.51	1.50	6.75	2.40
2007:q1	**2008:q2**	5	7.26	1.45	3.94	2.84
Mean		**5.18**	**8.89**	**2.11**	**8.00**	**1.57**

Source: My estimation

Notes: for each of the two cycles (classical and growth), and for each of two phases (expansion and contraction), five results are presented. First, the duration of each peak-to-trough or trough-to-peak. Second, the amplitude that presents (in percentage) the total change in output as the economy moves from its peak (trough) to its trough (peak). Third, the quarterly amplitude is given by amplitude divided by duration. Fourth, the cumulative loss/gain presents, in percentage, the cumulated loss or gain in output during each phase. The last column presents the excess index, which measures the shape of the cycle.