A sectoral analysis of Barbados' GDP business cycle

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Abstract

This paper has two main objectives. Firstly, to establish and characterise a reference cycle (based on real output) for Barbados over the quarterly period 1974-2003 using the Bry and Boschan algorithm. Secondly, to link this aggregate output cycle to the cycles of the individual sectors that comprises real output. The overriding conclusions are that the cycles of tourism and wholesale and retail closely resembles that of the aggregate business cycle, while the non-sugar agriculture and fishing cycle is acyclical.

1. Introduction

For many years, heads of governments in small, insular, developing countries, and particularly in the Caribbean, have been concentrating their attention on typical problems pertaining to the long term tendencies and repercussions of national production, that is, the standard of living, health and life expectancy, macroeconomic stability, and so on. In return, relatively little consideration has been given to short term concerns. The issue of cyclical fluctuations in economic activity, their characteristics and origins has therefore been more or less overlooked in the documents of macroeconomic policies implemented in Caribbean nations. Unlike developed countries, where specialised institutes like the National Bureau of Economic Research (NBER) in the United States and the Organisation of Economic Cooperation and Development (OECD) in Europe have had many years of practice, in the Caribbean, to date, there has been no such tradition of officially monitoring economic cycles.

Quarterly economic publications released by different central banks within the Caribbean may be regarded as works of cyclical analysis. However, they naturally tend to focus on monetary matters, rather than on the dating of business cycle phases, the evaluation of their characteristics and their specific role and relationship with economic variables. Moreover, the diagnoses set out in these central banks' publications are not usually developed within a framework consistent with the elaboration of short-term government policies. Indeed, monitoring a business cycle, which comprises alternating periods of economic upturns and declines, and which is primarily measured by gross domestic product (GDP) fluctuations and characterised by variations in other variables, plays an extremely important role in determining today's economic policies. Furthermore, this constant observation of the business cycle is particularly valuable when choosing between economic and structural measures. Since economic imbalances such as unemployment and budgetary deficits can be either transitory or persistent in nature, the ability to determine the exact state of an economy's situation at a given moment in time is therefore an advantage, when it comes to planning counteractive actions.

In a small developing country like Barbados, it is normal that periods of economic fluctuations are more frequent and pronounced than the developed economies (Craigwell and Maurin, 2005). This

is due to the fact that production is subject to natural constraints such as limited size as well as natural disasters, which in turn affect economic activity. The high level of dependence experienced by such states, with regard to bigger countries, represents yet another form of restriction (market access regulations, and so on).

In order to explain these cyclical variations in production, many publications tend to highlight three types of mechanisms. The first deals with domestic channels. Idiosyncratic shocks, provoked, for example, by growth inducing budgetary policies or new fiscal policies, can lead to relatively substantial variations in GDP. The second involves shocks that affect all economies, such as oil shocks or wars, as was the case with the recent Gulf war. Finally, economic interdependence explains how shocks are transmitted from one economy to another. Thus, various studies have recently examined how economic shocks in the United States have impacted other countries (see Rand and Tarp, 2002).

This study continues the documentation of Barbados' cycle initiated in articles written by Craigwell and Maurin (2002, 2004, 2005). More specifically, it focuses attention on sector-based production cycles, in order to explore the idiosyncratic components of the Barbadian economic cycle. After the introduction, a description and definition of the Barbadian business cycle is given. Next, an overview of the methodological principles is presented. Results concerning the aggregate business cycle are next in line, and then the relationship between GDP and the production sectors are assessed. The final part is the conclusion.

2. Descriptions and Definition of the Barbadian Business Cycle

The Data

The sectoral real GDP data used in this paper are estimated seasonally adjusted quarterly series spanning the period 1974 to 2003, with base year equal to 1974. They are based on available indices of real output and sectoral employment when sectoral production is unavailable. The first publication of these series was in 1997 (Lewis, 1997) but have been upgraded and updated based on some methodological changes instituted by the Barbados Statistical Service and the Central

Bank of Barbados. The fact that Lewis (1997) work is relatively recent illustrates the difficulties encountered by some countries, especially developing countries, in presenting quarterly national accounts data. However, the existence of this type of high-frequency data is a pre-requisite for economic policymaking and financial programming. Bloem, Dippelsman and Maehle (2001) give a telling example: "The recent financial crises taught us that availability of timely key high-frequency data is critical for detecting sources of vulnerability and implementing corrective measures in time".

Fluctuations in Aggregate Economic Activity

Despite its small size of 431 square kilometres, a population of less than 270,000 inhabitants and a meagre endowment of natural resources, Barbados' development experience has been a true success story. It has diversified from a monoculture based on the production and export of raw sugar, to an economy driven by tourism and financial services. Barbados remains among the most developed countries in Latin America and the Caribbean, with levels of health, education, communication and social services comparable to those of industrialised countries. In fact, in 2004, Barbados was ranked 29th among 177 countries in the United Nations Development Programme's Human Development Index.

Figure 1. The Logarithm of Real GDP of Barbados

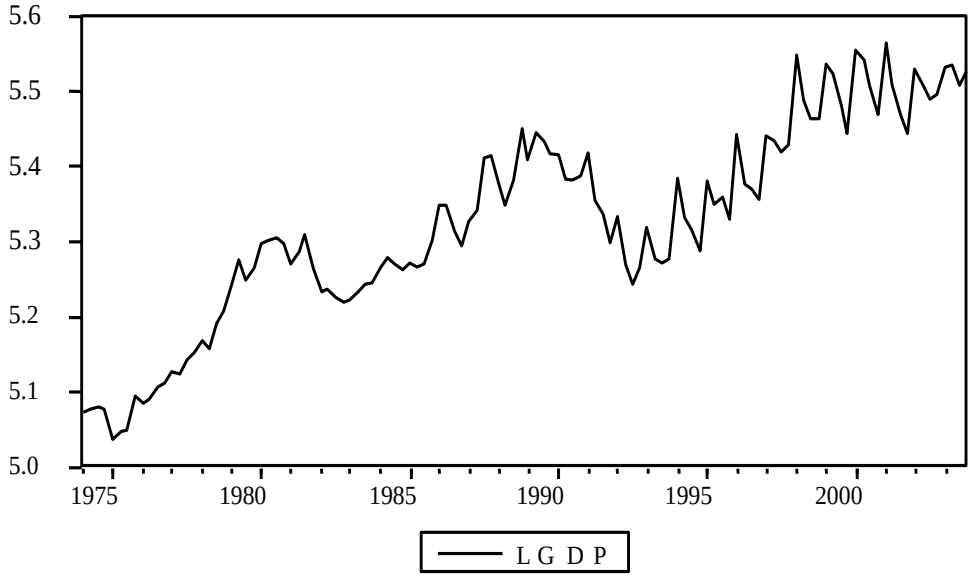


Figure 1 depicts the growth experience of Barbados, which can be summarised in terms of the following sub-periods:

- The diversification and growth phase of the 1974-1980 period, when tourism and manufacturing were taking over from sugar as the dominant earners of revenue and generators of employment. In the first half of this decade, in the midst of a global recession with high inflation, stagnation in the principal markets for goods and services and increasing transportation costs, there was declining sugar production and moderate growth in the industrial and tourism sectors, leading to a drop in real output between 1974 and 1975. However, by 1976 the Barbadian economy rebounded.

- The slower growth phase of the 1980-1990 period, associated with two oil shocks that had very negative effects on Barbados' trading relations. The second shock in 1979/1980 triggered a long and deep recession, as shown in a fall in production between 1981 and 1982, which was accompanied by an abnormally high inflation rate. From 1983 to 1986, there was increased optimism about economic prospects, thanks to international tourism. Nevertheless, the economy showed signs of slowing and the dynamism, which had long been a positive feature of the economy, disappeared. Investment declined sharply, manufacturing output shrank, agriculture –mainly sugar – continued its downward trend and tourism suffered a decrease in arrivals from regional sources. Consequently, the Barbadian economy recorded contractions in real GDP of 3.1% in 1990, then 4.1% in 1991 and 6.2% in 1992. This real sector crisis was accompanied by a balance of payments crisis, which led to capital flight and debt accumulation.

- The recovery phase between 1993 and 2000, primarily occasioned by the application of austerity measures from the International Monetary Fund structural adjustment programme. In this period, Barbados resumed a positive growth path, with real GDP rising for eight consecutive years, boosted mainly by tourism and financial services.

- The period 2000 to 2001. A world recession and the September 11 terrorist attacks put a damper on real value added of major sectors like tourism and manufacturing. Government had to increase expenditure to keep its main engines of growth going.

- The post September 11 period. With government counter cyclical spending, tourism recovered and real output started to grow.

Sectoral Structure of GDP

Figure 2 and Table 1 indicate that the various productive sectors in the Barbadian economy have not evolved in an identical manner over the last three decades. Generally, the sectors can be divided into three different categories according to their evolution: those with a large degree of fluctuation (sugar, non-sugar agriculture and fishing, manufactured goods and tourism, as well as mining and quarrying); those which have remained relatively stable (electricity, gas and water, government, transport, storage and communication and business and other services), and; those which fall somewhere in-between the first two (construction and wholesale and retail trade).

Wholesale and retail trade has the heaviest weighting in total production at nearly 20%, a figure that has remained more or less constant since the beginning of the 1970s. The second-largest sector is business and other services, whose share of GDP has diminished slightly, moving from 19.2% in 1974 to 17.6% in 1994 and then to 16.6% in 2003. The third-largest productive sector is tourism, the importance of which has grown steadily since the beginning of the 1970s, with its percentage of GDP moving from 10.1% in 1974 to 12.0% in 1982 to remain at above 15% since the 1990s.

Having occupied third place up to the middle of the 1980s, today, government is in fourth position, with its share of total output remaining steady at around 13%. Next in line are the construction, transport, storage and communications and manufacturing sectors, with weights falling between 8% and 10% since the middle of the 1990s.

The sugar industry was the seventh–most productive sector in Barbados in 1974, with a percentage of 7.3% of total GDP. Today, it is in tenth place, with a corresponding weight of 1.6%

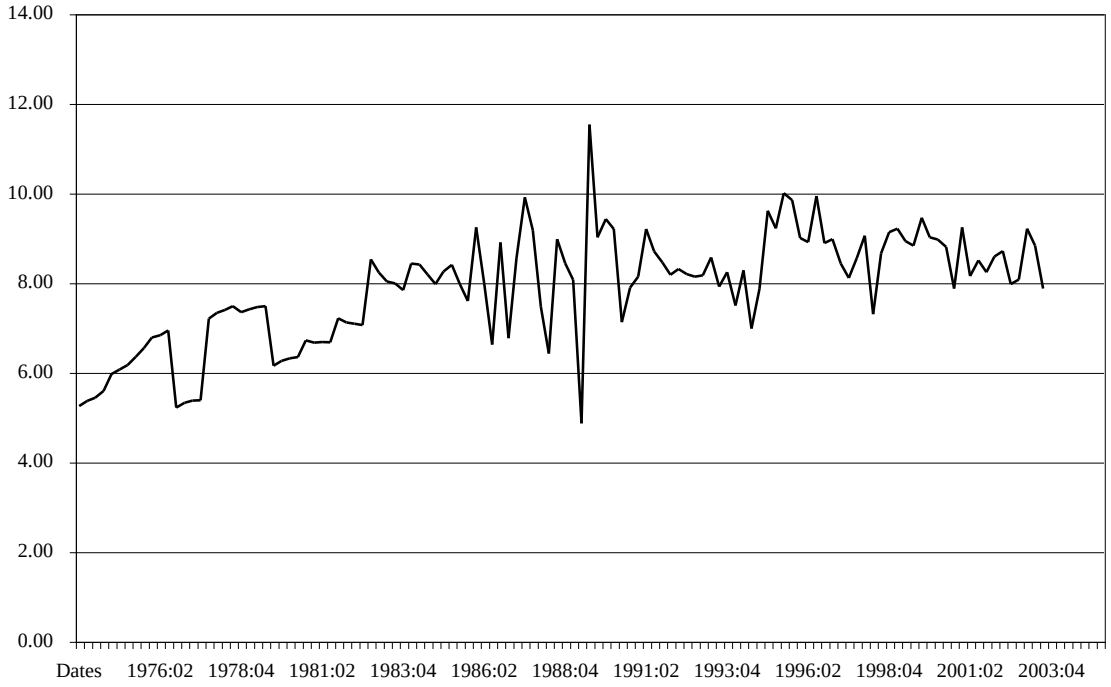
of GDP. With non-sugar agriculture and fishing also on the decline, the importance of the primary sector as a whole in Barbados' aggregate production has steadily diminished over time.

These differences in the way that the various sectors have evolved translate clearly into a sectoral redistribution of aggregate output over the last three decades that reflects the creation of new businesses and industries in some branches of the economy and the simultaneous demise of businesses and industries in other branches. However, they also bear testimony to the inter-linkages between the different sectors, as well as their roles in the growth of the Barbadian economy. This observation gives credence to the philosophy of the NBER, which conceptualises the business cycle as a function of the different evolutions of all the various sectors that make up total output (see Burns and Mitchell, 1946).

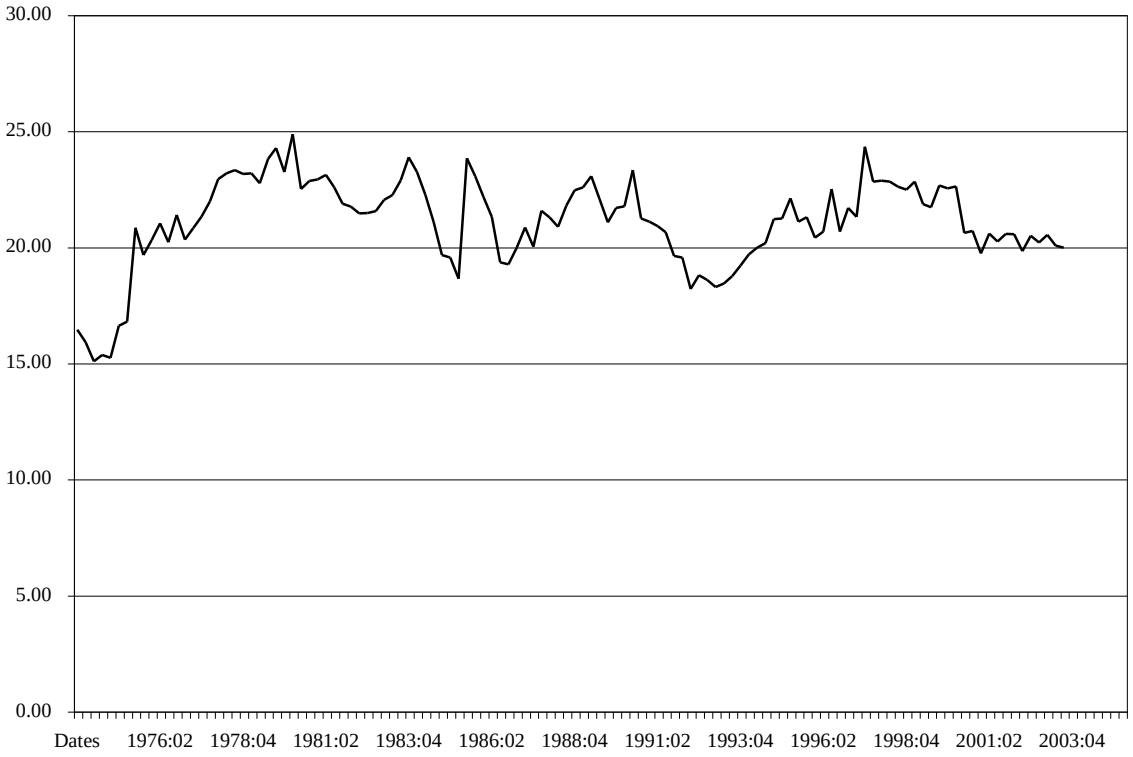
Figure 2. The Quarterly Sectoral Production

Sugar

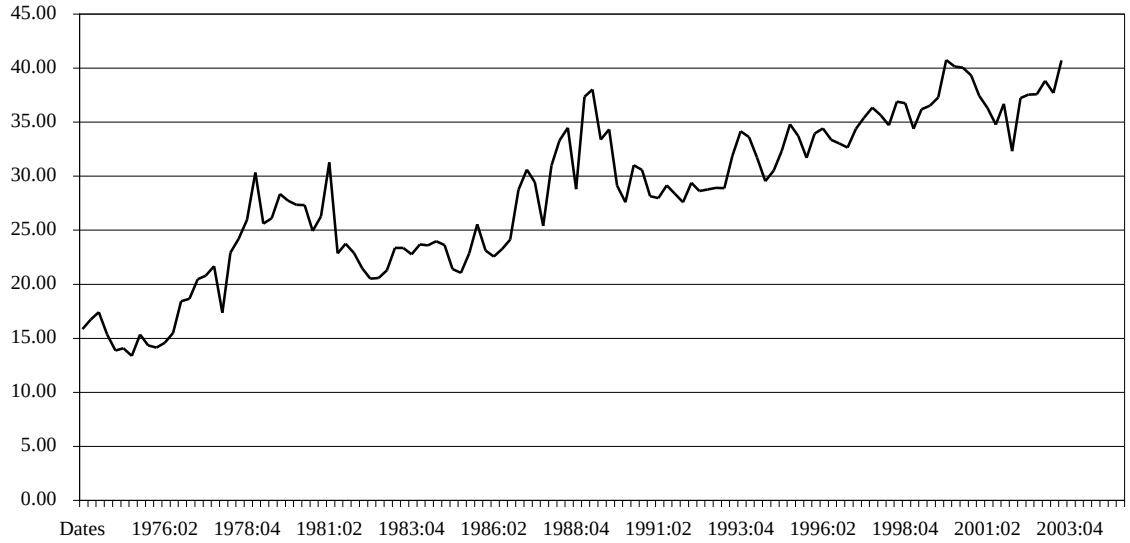
Non-Sugar Agricultural and Fishing



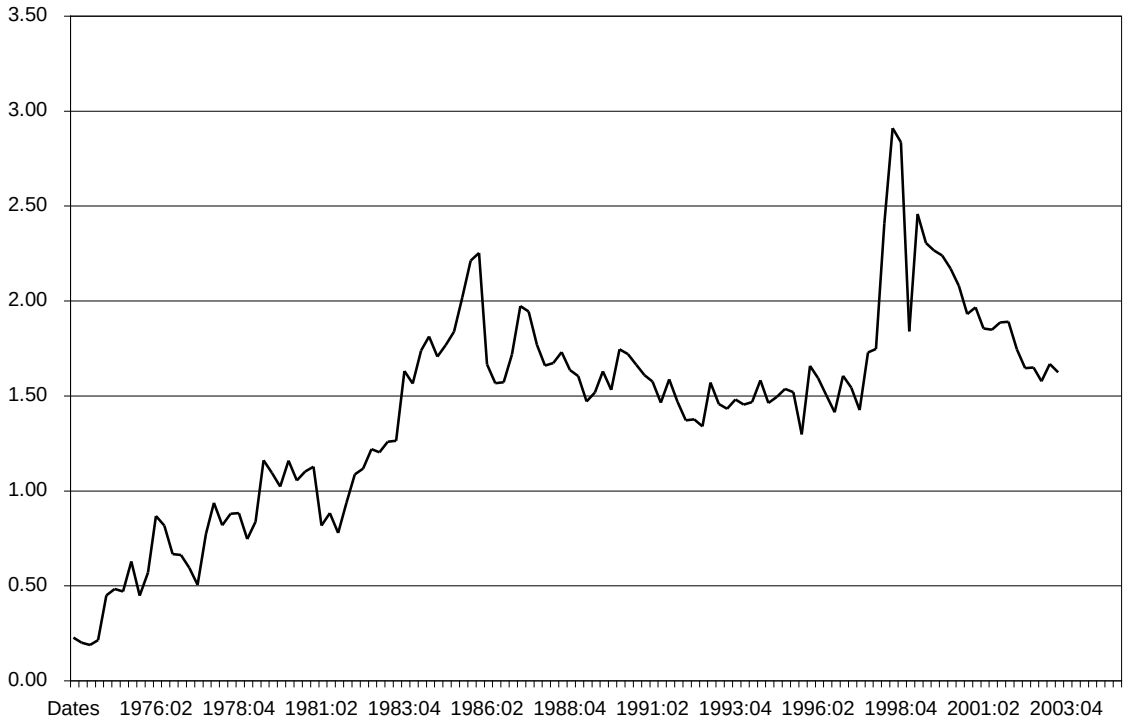
Manufacturing



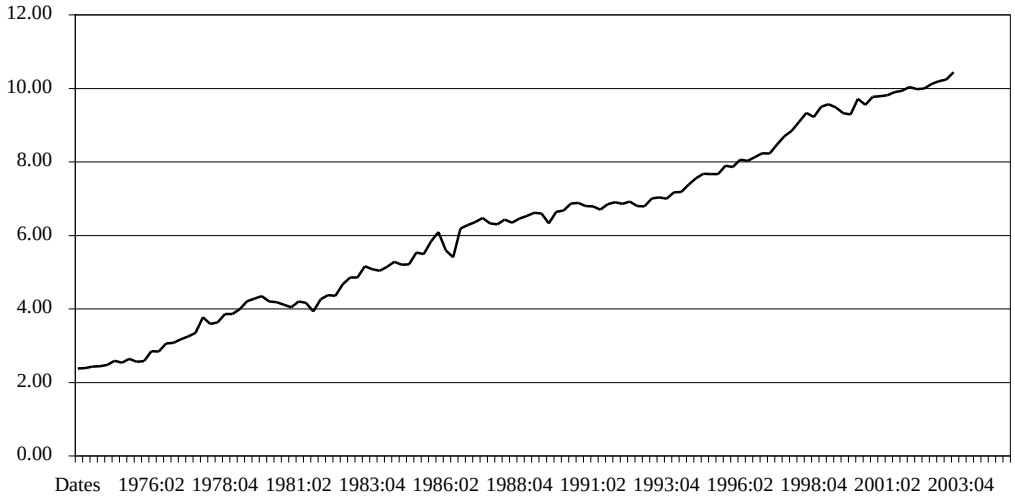
Tourism



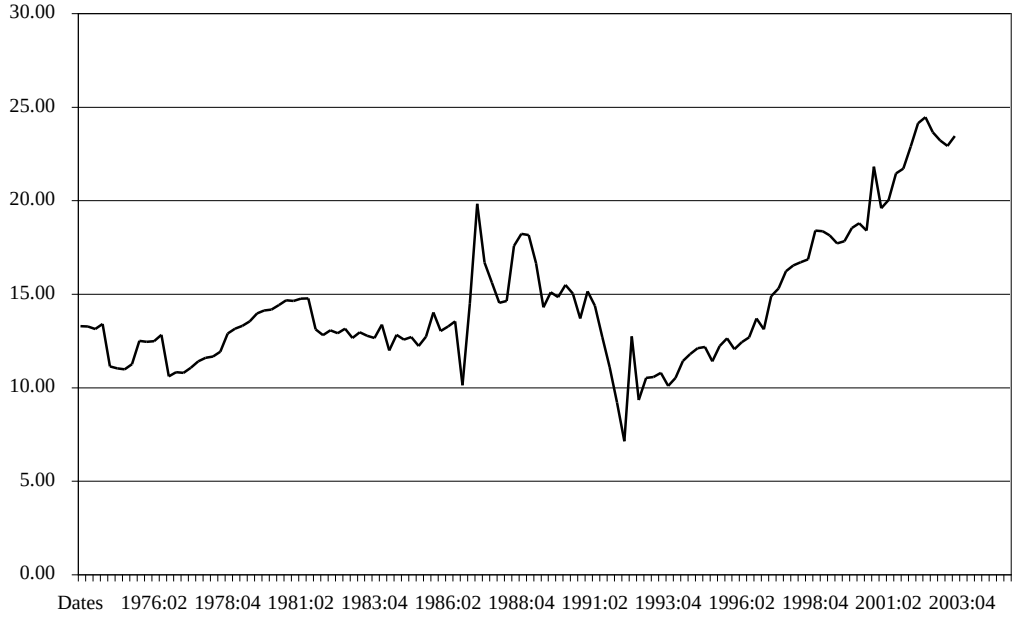
Mining and Quarrying



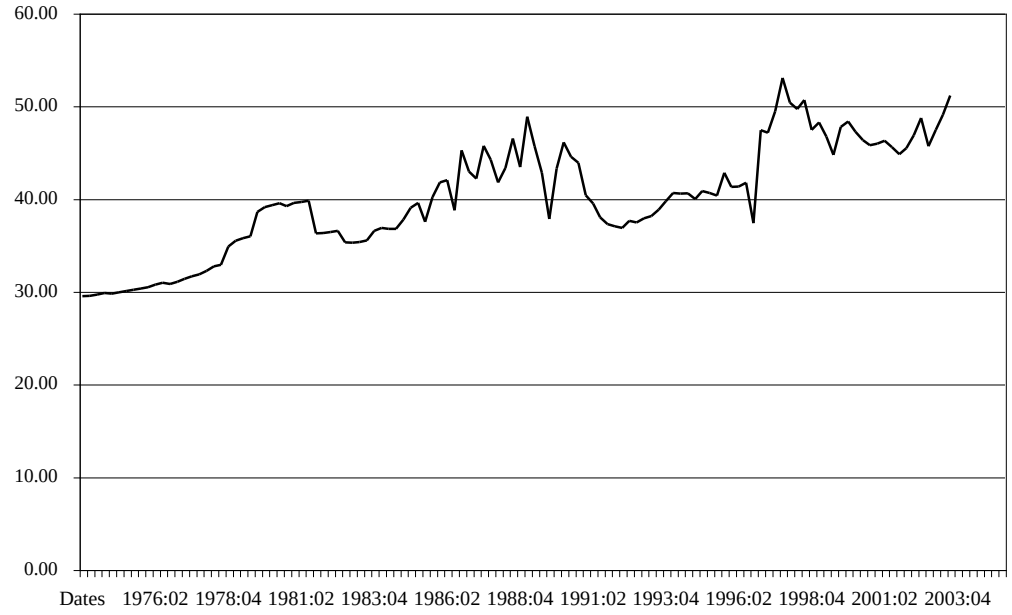
Electricity, Gas and Water



Construction



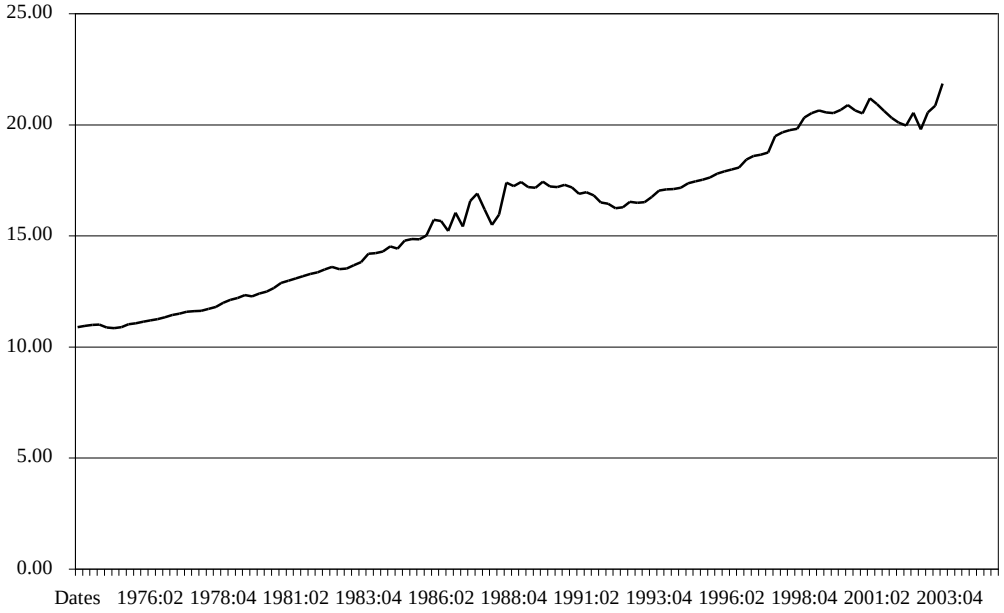
Wholesale and Retail



Government


40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Dates
1976:02
1978:04
1981:02
1983:04
1986:02
1988:04
1991:02
1993:04
1996:02
1998:04
2001:02
2003:04

Transportation, Storage and Communications



Business and other service

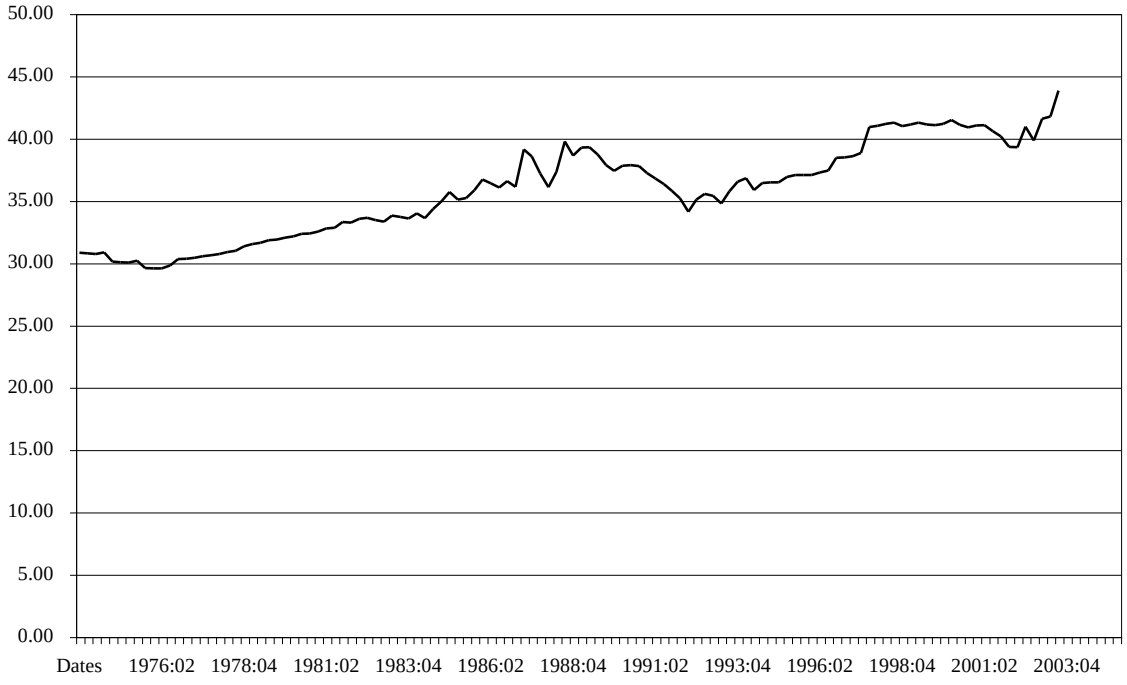


Table 1. Evolution of the Sectoral Decomposition of the Barbadian GDP

Sector name	1974		1984		1994		2003	
	value	%	value	%	value	%	value	%
Traded sector								
Sugar	46.97	7.33	42.28	5.44	22.30	2.70	15.61	1.55
Non-sugar Agricultural and Fishing	21.60	3.37	32.93	4,24	31.13	3.77	34.51	3.44
Manufacturing	62.65	9.77	90.33	11.62	78.92	9.55	80.68	8.04
Tourism	64.79	10.10	93.32	12.01	128.97	15.60	154.31	15.37
Non-traded sector								
Mining and quarrying	0.80	0.13	6.72	0.86	5.96	0.72	6.50	0.65
Electricity, Gas and Water	9.50	1.48	20.40	2.62	28.60	3.46	40.85	4.07
Construction	52.83	8.24	50.60	6.51	43.20	5.22	93.21	9.28
Wholesale and retail	118.31	18.45	146.74	18.88	161.14	19.49	193.33	19.26
Government	97.11	15.15	101.58	13.07	113.11	13.68	135.45	13.49
Transportation, Storage and Communications	43.61	6.80	57.00	7.33	68.13	8.24	82.80	8.25
Business and other services	123.01	19.19	135.35	17.41	145.34	17.58	166.71	16.60
Total GDP	641.17	100.00	777.24	100.00	826.80	100.00	1003.97	100.00

Definition of The Barbadian Business Cycle

One important lesson to be learnt from the observations in the previous sections is that economic fluctuations in Barbados provide some evidence of cyclical movements. Craigwell and Maurin (2005) argued and showed empirically that these fluctuations reflect Barbados' export-oriented profile and extreme dependence on its ties with the industrialised countries. Its growth experience over the last four decades has therefore been very much linked, on the one hand, to the potential to export implied by preferential agreements for access to large markets and, on the other hand, to increases in public expenditure funded through its institutional relationships with Europe and North America. Hence, the Barbadian economy is particularly vulnerable to shocks, especially exogenous shocks such as changes in the rules of engagement for accessing European and North American markets, fluctuations in global demand for its exports and varying levels of access to external financing.

The above factors determine the economic fortunes of Caribbean countries like Barbados, resulting in alternating phases of prosperity and recession of irregular duration. Therefore, the use of the classical definition by Burns and Mitchell (1946) may be appropriate in characterising the Barbadian business cycle. However, from a purely practical point of view, several difficulties arise when attempting to formalise Burns and Mitchell's theoretical description and measure the cycle derived from it. From their description, the idea clearly emerges that the cycle encompasses several expansionary phases, which occur very close together across various spheres of economic activity. Should the cycle therefore be captured using a single composite indicator such as GDP or using several variables to represent economic activity? A second problem also arises from their definition, namely, how to identify and measure the cycle, its duration or even its amplitude. With this new trend, a number of issues have arisen regarding the methods and results of such cyclical analysis. Harding and Pagan (2004) clearly detailed the nature of these problems and proposed a number of possible solutions.

Despite the drawbacks of employing GDP, especially its tendency to underestimate economic activity due to its failure to account correctly for phenomena such as the environment or informal economic activity, it remains the best overall indicator of essential economic information for a given period. No doubt it is for this reason that the premier institutions, for example, the NBER and the OECD, charged with measuring economic activity around the world have adopted GDP as a measure of quarterly or annual economic activity and as the indicator of choice for the measurement of cycles. For all the above reasons, real GDP is utilised in this paper as the reference cycle for the Barbadian economy. Indeed, the advantages of using a single indicator are made clear by Bodart, Kholodilin and Shadman-Mehta (2003) who states that "the use of a single GDP series has an important advantage: it avoids the uncertainty about the precise dates of the business cycle turns when multiple reference series are utilised".

With regard to the practical calculation aspects of the description and measurement of the cycle, the econometric literature provides several analytical techniques that are not always complementary and may even yield contradictory results if not correctly applied. This comes about because analysts may apply these methods in three different ways. They may operate either directly on the raw GDP series y_t, or on the series z_{1t}, which represents the difference between

y_t and its permanent component, or alternatively on the growth rate of y_t, represented by z_{2t}. As pointed out by Harding and Pagan (2004), these three alternatives have led to some confusion about the correct terminology to use in relation to the cycle. Cyclical analysis using the series y_t is referred to as the classical cycle, also known as the business cycle. Studies utilising z_{1t} make reference to the growth cycle, while those employing z_{2t} speak to growth rate cycles, which are different from cycles in economic activity. This confusion has also been fermented by certain econometric studies that incorrectly combined cycle dating algorithms and time series decomposition techniques. In this regard, Harding and Pagan (2004) have justifiably declared that, "it is surprising to see academics quoting NBER cycle statistics and, at the same time, either removing a stochastic trend from series such as GDP through use of filters such as Hodrick-Prescott".

In light of the above clarifications, this paper examines the Barbadian business cycle using the series y_t and the Bry and Boschan (1971) algorithm, which is the tool of reference for determining the turning points in economic activity.

3. Non-parametric Approach to Determining Phase Durations

Dating the turning points of a cycle is a crucial step in the study of economic cycles. Firstly, it influences the content of the information disseminated describing the characteristics of economic cycles, that is, the frequency of turning points, the distinctions between major and minor cycles, the duration of peaks and troughs, the symmetry or asymmetry of these phases, their average duration and their variability. Secondly, it is important in order to correctly undertake comparisons of the cyclical profiles of different countries, especially where the intention is to characterise periods of recession and expansion and their degree of synchronisation at the international level. Finally, anticipating turning points in the economy would allow policy makers to be proactive in their policymaking, as they would have a better understanding of the dynamics of the economy, not only at the aggregate GDP level, but also at the sectoral level.

Whereas analyses of this specific dating issue have traditionally been confined to a select few economic research institutions such as the NBER in the United States, since the beginning of the 1990s there has been an explosion of research from institutions all over the world, most notably the OECD on countries in the European Union (see Allard (1994) for France, Bodart, Kholodilin and Shadrnan–Mehta (2003) for Belgium, Bruno and Otrando (2003) for Italy). Today, the various methods utilised in dating and documenting economic cycles can be classified according to two broad categories: parametric and non-parametric methods. Nonparametric models have been criticised for using ad hoc dating rules while parametric models like the Hamilton (1994) switching regime method have the inconvenience that all the business cycle analysis depends on the underlying statistical model chosen. In this study, the Bry and Boschan (1971) approach is utilised primarily because of its popularity and because in a paper on Barbados by these authors (Craigwell and Maurin, 2005) it gave similar underlying results to the Hamilton (1994) method.

The Bry and Boschan Dating Procedure

The Bry and Boschan (1971) procedure is the most popular method for the selection of turning points. It consists of the *ad hoc* encoding of filters under rules devised by Burns and Mitchell (1946) and was developed in such a way as to reproduce the results of applying the NBER's dating criteria. It operates on the original data and isolates local minima and maxima in a time series, subject to constraints on both the length and amplitude of expansions and contractions. These constraints concern principally the alternation of peaks and troughs and the persistence of downturns and upturns expressed as cycles, phases and depth restrictions. It is differences in these constraints that have given rise to alternative refinements of the Bry-Boschan seminal dating algorithm, see for example, Artis, Kontelemis and Osborn (2002) and Artis, Marcellino and Proietti (2004).

In practice, the Bry and Boschan procedure consists of six phases of successive application of moving average filters and the treatment of extreme values (see the Box below).

Outline of the Bry and Boschan Procedure

Step 1: Identification and replacement of extreme values.

Step 2: Determination of cycles using the standard deviation of the moving average filter. For this and subsequent steps, there are constraints on the alternation of peaks and troughs by selecting the highest of the multiple peaks and the deepest of the multiple troughs.

Step 3: Application of a Spencer Curve on the series resulting from Step 2 and updating of the turning points. Elimination of the cycles with the shortest duration.

Stage 4: Determination of the turning points in the series resulting from Step 3 by way of a new moving average filter, the order of which must be calculated. Elimination of the cycles with durations that are too short.

Stage 5: Determination of the turning points in the original series, taking into consideration the information garnered from Step 4. Elimination of the cycles and phases with durations that are too short.

Stage 6: Final selection of turning points.

In essence, this algorithm selects the peaks and troughs that are candidates for turning points and then applies a series of operations in order to eliminate the points that do not satisfy the criteria characterising cycles.

Bruno and Otranto (2003) highlight the need to generalise the Bry and Boschan procedure within a multivariate framework. They therefore review several solutions proposed in the literature, classifying them into two groups: the indirect approaches, which aggregate the turning points identified using several different series, and the direct approaches, which construct a composite indicator based on different economic variables and which apply the Bry and Boschan procedure to identify the turning points in economic activity. The latter is the approach taken in the present study.

4. The Barbadian Reference Cycle

While the Bry and Boschan algorithm was initially created for monthly series, with specific parameters imposing the sequence of peaks and troughs, as well as the duration and amplitude of the different phases of the cycle, it has subsequently been adapted for use with quarterly data.

This paper employs a slightly modified version of the RATS programme written by Bruno and Otranto[1], which itself is a translation of the GAUSS code written by Harding and Pagan (2001). The set of parameters K=L=2 commonly adopted for quarterly data, as well as the Spencer moving average (order 4) were utilised, replacing the parameters K=L=6 and the Spencer moving average of order 15. Therefore, a turning point y_t corresponds to a local maximum or minimum of more or less two quarters: y_t is a trough if and only if $(\Delta_2 y_t, \Delta y_t) < 0$ and $(\Delta y_{t+1}, \Delta_2 y_{t+1}) > 0$; y_t is a peak if and only if $(\Delta_2 y_t, \Delta y_t) > 0$ and $(\Delta y_{t+1}, \Delta_2 y_{t+1}) < 0$, with $\Delta_2 y_t = y_t - y_{t-2}$ and $\Delta y_t = y_t - y_{t-1}$.

The turning points identified are shown in Figure 3. Over the thirty-year period, it should be noted that Barbados' real GDP registered only four troughs – 1975:1, 1982:3, 1992:3 and 2002:1 – and, therefore, a similarly small number of peaks, in 1981:3, 1988:4 and 2000:2.

Tables 2 and 3 reproduce the durations of the different phases of the cycles: the complete cycles from trough to trough and peak to peak, the expansionary phases between trough and peak and the recessionary phases covering the periods from peak to trough. A notable feature of these measurements is the strong asymmetry between phases, with the expansionary phases generally being much longer in duration than the recessionary phases. The expansionary phases consist of between 24 and 30 quarters, whereas the recessionary phases, which are much more variable, lasted between 3 and 14 quarters.

Table 2. Durations of the Phases of the Barbadian real GDP Cycle (quarterly)

Expansions		Contractions		Total
Period	Duration in Trimesters	Period	Duration in Trimesters	Duration in Trimesters
1975:1-1981:3	26	1981:4-1982:3	3	29
1982:4-1988:4	24	1989:1-1992:3	14	38
1992:4-2000:2	30	2000:3-2002:1	6	36

[1] Many thanks to G. Bruno and E. Otranto for allowing use of their RATS programme.

Table 3. Descriptive Characteristics of the Phases of the Barbadian BBQ Cycle

	Expansion	Contraction	Total
Average duration	26.7	7.7	34.4
Median duration	26	6	38
Max duration	30	14	40
Min duration	24	3	31
Proportion of time	74.16%	25.84%	
Ratio expansion/contraction			2.87
Average amplitude	28.49%	-12.18%	
Steepness	0.96	-1.18	

This chronology reveals that the three periods of expansion each lasted at least six years and occurred in the 1970s, 1980s and 1990s, respectively, consistent with the information in Figure 1 of Section 2. In effect, with respect to the phases in real GDP, growth fluctuated significantly, however, the contractionary phases were not sufficiently significant to be considered real recessionary phases. It is also important to highlight the fact that the characteristics of the Barbadian cycle are somewhat different from those of other developing countries. Considering, for example, a varied group of countries in Africa (Côte d'Ivoire, Malawi, Nigeria, South Africa and Zimbabwe), South America (Chile, Colombia, Mexico, Peru and Uruguay), as well as Asia and North Africa (India, South Korea, Malaysia, Morocco and Pakistan), Rand and Tarp (2003), using the Bry and Boschan procedure, showed that the average duration of their cycles was between 7 and 18 quarters. Conversely, the characteristics of the Barbadian cycle appear to be more similar to those of developed countries, like Australia (see Harding and Pagan, 2002a,b) and France and Spain (see Harding and Pagan, 2001). In fact, the main difference that appears between the Barbados cycle and the business cycle of developed countries relates to the characteristics of the contraction phase where Barbados stands out as having longer contractions with more pronounced amplitude. This finding is in accordance with Barbados high dependency on the developed countries for trade of goods and services.

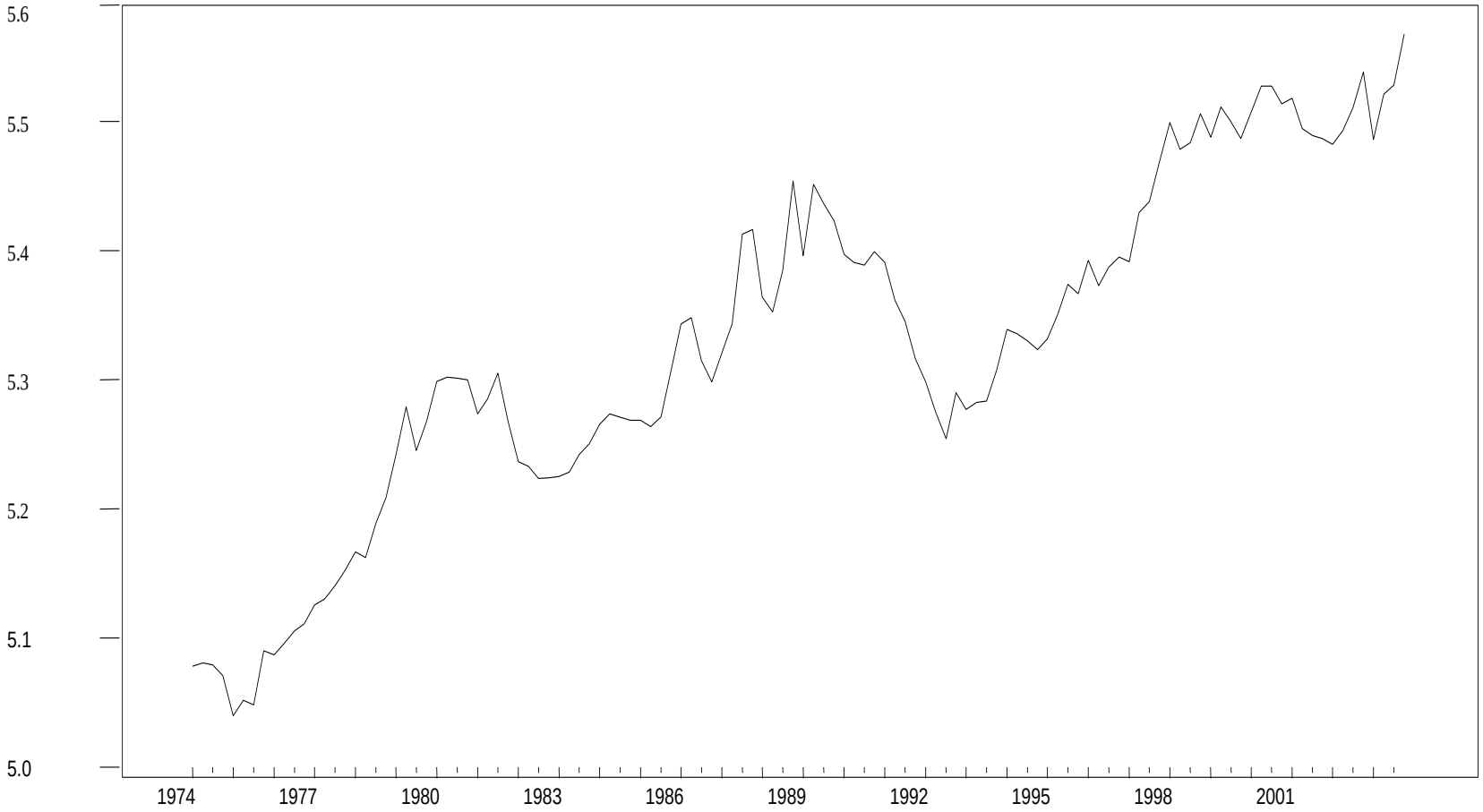
5. Relationships Between Total GDP and the Production Sectors

In line with the Burns and Mitchell (1946)'s definition of the business cycle, which suggests that the cycle may be better detected by forecasting the various sectors of the economy, the Barbadian economic fluctuations are examined via the individual behaviour of each sector. In order to do this, the techniques of univariate analysis of time series and dynamic factor models that are relevant to the multivariate methods are adopted, using the BUSY software developed within the context of a project financed by the European Commission (see Fiorentini and Planas, 2003). Designed and implemented to serve as the official tool of analysis and information on the economic cycles of the European Community, this software has a number of functions that allow the identification of a cycle for the entire community as well as the description, estimation and prediction of cycles of other variables (from each country) in relation to the reference cycle.

Analysis of the Turning Points

The reference series here, y_t, is quarterly GDP and $x_{i,t}, i = 1,...11$ refers to the sectoral production series. All in all, it is a question of repeating the cyclical classification exercise on the different couples $(y_t, x_{i,t}), i = 1...11$. Precisely, this classification relies on the examination of the time lags between the occurrences of turning points of the two series in order to identify leading, coincident or lagged situations of the series $x_{i,t}$ with respect to the series x_t. These three cases are found when the two series possess a certain degree of common dynamic cycle; they can be schematised by Figure 4 below (Abad, Cristobal and Quilis, 2000). Conversely, if the cyclical trajectories of the two series are very different, one can say there is an absence of a cyclical relationship between them, that is, the two series are acyclical.

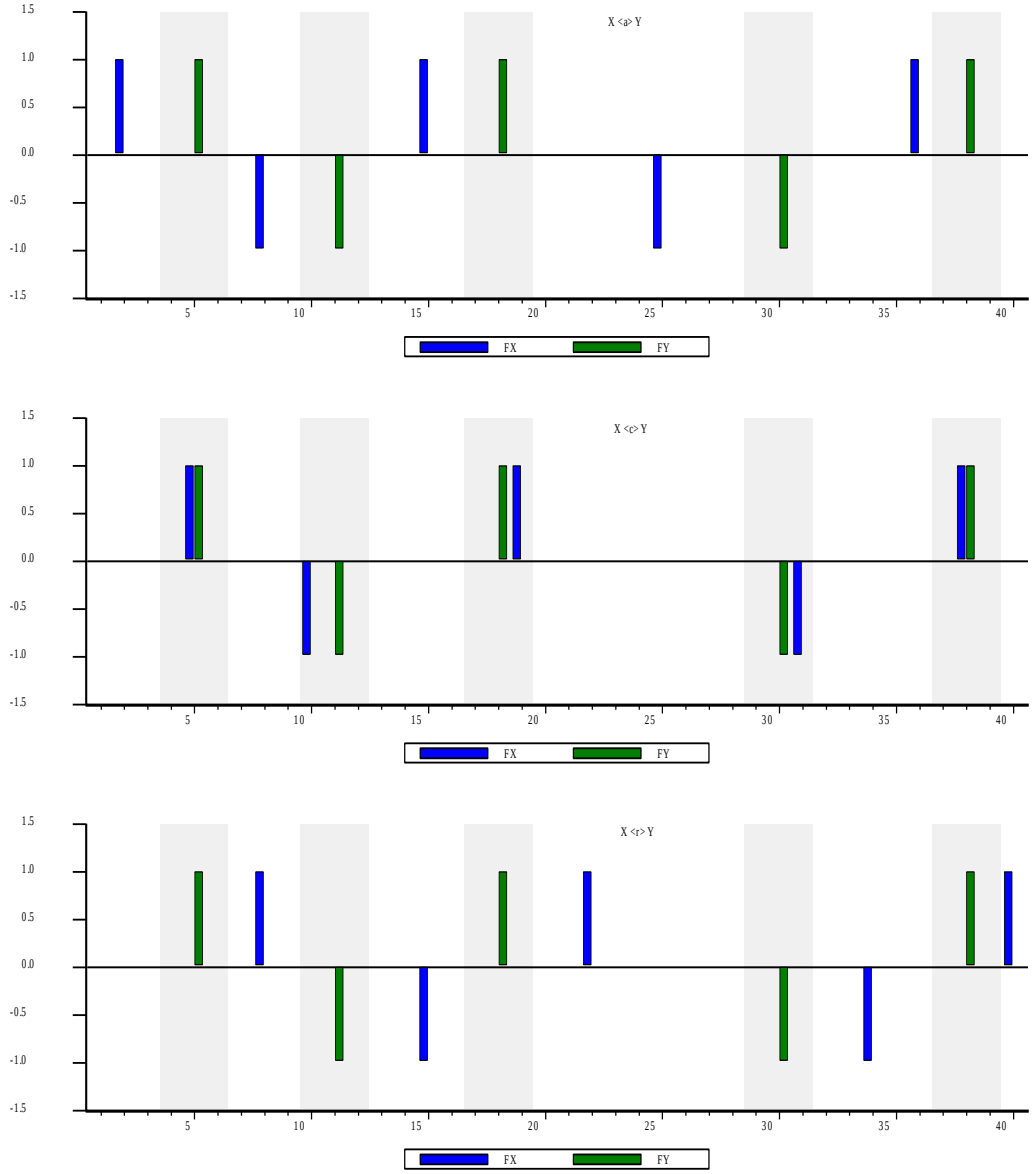
Figure 3. Barbadian real GDP (logarithms), Bry-Boschan reference cycle dates



The Bry and Boschan procedure is applied to the deseasonalised data of each of the eleven sectoral production series. Table 4 confirms the timetable of the GDP cycle shown in Section 4 above. For each sector, it provides the details on the time gaps of occurrence of the turning points in relation to the reference cycle. A negative (positive) value means that the turning point in question of the series under consideration is leading (lagging) in relation to that of the GDP series. On examination of the signs and values of Table 4, one can opt for the following classification:

- The sectors whose cyclical fluctuations are leading those of the GDP are Electricity, Gas and Water (elect), Manufacturing (manu), Non-sugar Agriculture and Fishing (nagrf) and Sugar (sug);
- The Tourism and Wholesale and Retail sectors (tour and retail, respectively) present a behaviour with GDP that is ambiguous;
- The sectors whose cyclical fluctuations lag behind those of GDP are Government (gov), Transportation, Storage and Communications (transcom) and Construction (construc);
- The remaining sectors, which have an acyclical profile, are Mining (mining) and Business and Other Services (other).

Figure 4. Leading, coincident and lagged indicators



Source : Abad, Cristobal and Quilis(2000).

Table 4. Turning point analysis: leads and lags with respect to the GDP reference series

Reference Series	Trough 1975 Q1	Peak 1981 Q3	Trough 1982 Q3	Peak 1988 Q4	Trough 1992 Q3	Peak 2000 Q2	Trough 2002 Q1	# of extra cycles
construc	-	+1	+8	+1	0	-	-	-1
elect	-	-5	-2	-	-	-	-	-2
gov	+7	-2	+4	+8	+4	+7	-	0
manu	-2	-4	0	+3	0	-10	-	1
mining	-2	-7	-2	+7	+2	-6	+5	2
nagrf	-	-11	-10	-4	+9	-1	+3	2
other	+6	-27	-	0	0	+1	+2	0
retail	-	+1	+3	+2	0	-9	0	0
sug	-	-3	+5	-8	0	-13	0	1
tour	+2	-9	+1	+3	-1	0	+1	1
transcom	0	-	-	+5	0	+4	+4	-1

Note: *+ (-) denotes a lag (lead) with respect to the reference series*

Tables 5 and 6 summarise the characteristic measurements of the sectoral cycles. In particular, those in Table 5 give the average time lags in relation to the peaks and troughs. Their values reflect fairly well the classification established above. The figures in Table 6 show that the tour and retail series are those that present the cyclical profiles nearest to that of the reference series.

Table 5. Analysis of turning point sequences with respect to the GDP reference series

	Average Lag at			Median Lag at		
Reference Series	**Peaks**	**Troughs**	**All**	**Peaks**	**Troughs**	**All**
construc	1.00	4.00	2.50	1.00	4.00	1.00
elect	-5.00	-2.00	-3.50	-5.00	-2.00	-3.50
gov	4.33	5.00	4.67	2.50	4.00	5.50
manu	-3.67	-0.67	-2.17	-7.00	-1.00	-1.00
mining	-2.00	0.75	-0.43	-6.50	0.00	-2.00
nagrf	-5.33	0.67	-2.33	-7.50	-3.50	-2.50
other	-8.67	2.67	-3.00	-13.50	1.00	0.50
retail	-2.00	1.00	-0.50	-4.00	0.00	0.50
sug	-8.00	1.67	-3.17	-10.50	0.00	-1.50
tour	-2.00	0.75	-0.43	-4.50	1.00	0.50
transcom	4.50	1.33	2.60	4.50	0.00	2.00

Note : *+ (-) denotes a lag (lead) with respect to the reference series*

Table 6. Analysis of cycles with respect to the GDP reference series

Phases and cycles average duration				
	P to T	**P to P**	**T to P**	**T to T**
Reference Series	8.67	37.00	27.33	35.33
construc	12.50	29.00	18.00	32.00
elect	7.0	-	-	-
gov	10.50	41.50	26.67	33.00
manu	10.67	22.33	15.25	23.33
mining	11.00	21.50	12.00	22.20
nagrf	13.00	20.50	7.75	22.00
other	10.00	51.00	40.50	51.50
retail	11.67	32.00	23.00	37.00
sug	15.25	21.00	8.00	23.67
tour	9.25	33.67	24.67	35.00
transcom	8.50	45.00	47.50	55.50

Analysis of the Cross Correlations and Spectral Coherence

The Cross Correlations

The cross correlations constitute one of the more common approaches adapted to estimating the relationships between the cycles of two economic variables. For the couple (y_t, x_t), they estimate the degree to which the movements of the two variables are in sync. In this way, they allow one to verify whether the movements of variable x_t tend to be produced at the same time as the changes of the variable y_t. They are calculated as follows:

$$\rho_{y,x}^{(k)} = \frac{\sum_t (y_t - \mu_y)(x_{t+k} - \mu_x)}{\sum_t (y_t - \mu_y)^2 \sum_t (x_t - \mu_x)^2} \quad k = 0, \pm 1, \pm 2, \ldots$$

where μ_y and μ_x are the respective means of y and x. When $k = 0$, a measure of the degree of simultaneous evolution of the two variables is derived.

On the basis of this play of coefficients, one can define a simple procedure for characterising the behaviour of the series x in relation to the series y:

- Define a maximum limit for k noted L (normally $L = 1$ in the case of quarterly series);

- Retain as a value for k the lag time which maximises the absolute value of the correlation calculated between the two series: $k^* = \arg\max(|\rho_{y,x}(k)|)$;
- Apply the decision rule:

$$x_t \text{ is an } \begin{Bmatrix} leading \\ coincident \\ lagged \end{Bmatrix} \text{ indicator of } y_t \text{ if } k^* \in \begin{Bmatrix} (-\infty, -L) \\ [-L, L] \\ (L, \infty) \end{Bmatrix}$$

The examination of the correlations between the cyclical component of GDP and that of the eleven series of production shows that the configuration of the economic fluctuations varies significantly from one sector to another. The series representing the Construction, Tourism, Wholesale and Retail as well as Business and Other Services sectors are strongly coincident with the total GDP cycle.

The Spectral Coherence

Spectral analysis lends itself equally well to this exercise of comparing cycles of different production series. It is based on the Fourier transformation of the series in order to represent them within the frequency domain instead of the time space. It calculates synthetic magnitudes *(densities)* with the aim of characterising the relationship between the evolution of each of the sectoral productions and that of total production. It is principally a question of the following statistics: the coherence and the average waiting period. The coherence measures the proportion of the variance explained by the sectoral indicator to the frequencies given by the reference series. Here the frequencies of the cycle ranged between 1.5 to 8 years. A high value means that the sectoral indicator contains information, which is strongly linked to the cyclical behaviour of the reference series. The average waiting period is useful in measuring the degree of lead or lag of the sectoral indicator in relation to the reference series.

Tables 7 and 8 show the results from the BUSY software. They have been computed not on the initial series but on their cyclical components obtained using the Hodrick-Prescott (HP) and Baxter-King (BK) filters since the spectral analysis requires the data to be stationary. Using either filter, Tables 7 and 8 make clear that the retail (Wholesale and Retail), other (Business and Other Services), tour (Tourism) and construc (Construction) series are those which present the strongest coherence with the GDP series on the frequency intervals relative to the movement of the cycle, that is, those allowing a period comprising between 2 and 8

years or 6 and 32 quarters. Conversely, the movements of the cyclical components of the sug (Sugar), nagrf (Non-sugar Agriculture and Fishing), mining (Mining and Quarrying) and elect (Electricity, Gas and Water) do not appear to be closely linked to those of the GDP cycle.

Table 7. Bivariate statistics with the Reference Series GDP and the HP filter

Series	Coherence	Average Spectrum	Mean Delay	Cross-correlation		
	2 Y-8 Y	2 Y-8 Y	2 Y-8 Y	r_0	r_{max}	t_{max} (1)
construc	0.61	0.28	-0.16	0.65	0.65	0
elect	0.26	0.31	0.43	0.43	0.43	1
gov	0.43	0.24	0.08	0.47	0.48	1
manu	0.32	0.30	0.18	0.51	0.51	0
mining	0.01	0.29	1,75	0.03	0.10	1
nagrf	0.01	0.18	7.04	-0.04	-0.20	-3
other	0.58	0.32	-0.15	0.72	0.72	0
retail	0.64	0.32	0.02	0.72	0.72	0
sug	0.07	0.18	-0.32	0.25	0.25	0
tour	0.59	0.31	0.10	0.71	0.71	0
transcom	0.49	0.30	-0,34	0.64	0.64	0

(1) *The + (-) sign refers to a lead (lag) with respect to the reference series*

Table 8. Bivariate statistics with the Reference Series GDP and the BK filter

Series	Coherence	Average Spectrum	Mean Delay	Cross-correlation		
	2 Y-8 Y	2 Y-8 Y	2 Y-8 Y	r_0	r_{max}	t_{max} (1)
construc	0.48	0.36	0.06	0.68	0.68	0
elect	0.10	0.39	0.42	0.30	0.32	1
gov	0.23	0.35	0.53	0.47	0.50	1
manu	0.32	0.35	0.23	0.56	0.56	0
mining	0.03	0.36	0.45	0.14	0.16	1
nagrf	0.03	0.36	6.17	-0.12	-0.22	-3
other	0.34	0.38	-0.31	0.55	0.55	0
retail	0.53	0.38	0.14	0.70	0.70	0
sug	0.04	0.37	-0.72	0.15	0.24	-1
tour	0.45	0.38	-0.20	0.66	0.66	0
transcom	0.33	0.38	-0.60	0.53	0.59	-1

(1) *The + (-) sign refers to a lead (lag) with respect to the reference series*

Contributions of the sectoral cycles to the standard deviation of the GDP cycle

This section is based on the work of Grégroir and Laroque (1992) and Fournier (2000). Given that overall GDP is obtained by aggregating the value-added of the various sectors, it is possible to calculate the contribution of the cyclical component of each sector to the variance in the cyclical component of total GDP. Let z_c to be the cyclical component of sector z, filtered in levels, then the contribution of the cycle of this series to the variance of the GDP cycle is equal to the ratio:

$$\frac{\text{cov}(GDP\_c, z\_c)}{\text{var}(GDP\_c)}$$

This contribution can also be decomposed into the product of the correlation between the two cyclical components and the ratio of their standard deviations using the following identity:

$$contribution(z) = \frac{\text{cov}(GDP\_c, z\_c)}{\text{var}(GDP\_c)} = correlation(GDP\_c, z\_c) \times \frac{\sigma(z\_c)}{\sigma(GDP\_c)}$$

Thus, the contribution of the cycle of an element of the GDP cycle to the variance of the GDP cycle is greater than the degree of correlation between the cyclical components (this element fluctuates in the same direction as GDP) and greater than the cycle of this element. It can be shown that the summation of the different contributions is equal to 1. In effect, if $GDP = z_1 + z_2 + ... + z_k$, with, in the case of Barbados, $z_1, z_2, ..., z_k$ representing the 11 productive sectors, respectively, then $GDP\_c = z_1\_c + z_2\_c + ... + z_k\_c$, where GDP_c represents the cyclical component of GDP, z_1_c, that of sector z_1. Therefore,

$$\text{var}(GDP\_c) = \text{cov}(GDP\_c, z_1\_c) + \text{cov}(GDP\_c, z_2\_c) + ... + \text{cov}(GDP\_c, z_k\_c).$$

It should be noted that these relationships do not make sense unless the series are filtered in levels. The cyclical components are expressed in the same units as their parent series. The values calculated for these different correlations and contributions to the GDP cycle appear to be in keeping with the dynamics of the Barbadian economy over the last three decades described in Section 2 above. Firstly, *Tourism* and *Wholesale and Retail* contribute the most to the cycle in the amounts of 28.17% and 25.04%, respectively. These contributions are relatively large because they are significantly correlated with the GDP cycles and also because the cycle itself is very large. *Construction*, *Business and Other Services* as well as *Manufacturing* contribute modestly, whereas *Sugar*, *Mining and Quarrying*, *Electricity, Gas and Water* and *Transportation, Storage and Communications* make a very modest contribution to the cycle (less than 6%). All of these sectors have positive correlations. In fact,

only the *Non-Sugar Agriculture and Fishing* sector contributes negatively to the variance in the GDP cycle and therefore appears to be moving counter-cyclically.

Table 9. Contributions of the sectoral cycles to the standard deviation of the GDP cycle (Hodrick-Prescott with λ=1600)

Sector name	Correlation with GDP Cycle	Ratio of Standard devial of GDP	Contribution
Traded sector			
Sugar	0.28	0.19	5.37
Non-sugar agricultural and fishing	-0.01	0.12	-0.12
Manufacturing	0.54	0.7	9.03
Tourism	0.73	0.38	28.17
Non-traded sector			
Mining and quarrying	0.18	0.03	0.56
Electricity, Gas and Water	0.18	0.03	1.19
Construction	0.45	0.20	13.06
Wholesale and retail	0.64	0.34	25.04
Government	0.74	0.12	5.29
Transportation, storage and communications	0.63	0.05	3.39
Business and other services	0.73	0.12	9.02

Conclusions

The paper provides a timetable of dates of turning points of Barbados' economic fluctuations over the last three decades as well as establishes some measures of the characteristics of the Barbadian business cycle. In addition, the features of the aggregate cycles are mapped to individual sectors, allowing identification of the sources of the fluctuations and the contributions of the sectoral cycles to the Barbadian cycle. The overriding conclusion is that the tourism and wholesale and retail cycles are closely and positively linked to that of total GDP, whatever statistical measure is employed. In addition, the non-sugar agriculture and fishing sector is acyclical to the total GDP series.

Several implications can be derived from this study. One, since it establishes a timetable for the turning points of Barbados' business cycles, comparisons with other regional and

international countries can be done. Two, the results of this paper adds to the information on the business climate in Barbados, information that is much awaited and needed by the various economic policy makers. Three, the information on the turning points can be utilised to determine coincident and leading indicators for economic analysis and forecasting. Finally, within the context of the pursuit of the regional integration process, studies on the business cycles in the Caribbean will be of great use for the conduct of economic and monetary policy making at the supranational level such as that proposed for the Caribbean Community, CARICOM.

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