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A SURVEY OF SEASONALITY IN THE CARIBBEAN MACROECONOMIC VARIABLES

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A survey of seasonality in the Caribbean macroeconomic variables

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If theis is an area of the econometric modelling which have known the greatest developments during this last decade, it is undoubtedly, that of time series econometrics. Initiated by Nelson and Plosser's works (1982), these developments were first dedicated to the study of the determinist and stochastic long run properties of economic variables.

In a context of univariate analysis, the main contributions consisted in putting forward some reliable methods for the tests of unit root, aiming at characterizing the nature of the series' trend (Dickey and Fuller (1981), Perron and Phillips (1988), Kwiatkowski, Phillips, Schmidt and Shin (1992)). Until the end of the 1980's, econometricians were principally interested in the non-seasonal series. If it's true that Hasza and Fuller suggested the extension of Dickey and Fuller's test to the seasonal series as early as 1984, the fact remains that seasonal time series did arouse attention only much later with the works of Osborn, Chui, Smith and Birchenhall (OCSB) (1988), Osborn (1990), and Hylleberg, Engle, Granger and Yoo (HEGY) (1990).
In a multivaried context, Frances' recent works (1994) also aim at modeling and studying seasonal variables. This latter relies on the formalization of Johansen (1988) and Johansen and Juseluis (1990) to formulate a test of seasonal integration based on the number of relations of cointegration existing between annual series, stemming from the initial quarterly or monthly series.

One could say that the application of the well known methods of deseasonalization would avoid resorting to the tests of seasonal integration. Just as one could say that those tests are not essential if the weight of the seasonal component is weak, in the decomposition of the studied series. But if ever this one turned out to have an unstable seasonal component, and that the latter presented large amplitudes, then it's the use itself of these methods of deseasonalization that could be recalled into question.

Concerning the necessity to use or not deseasonalized data, it's advisable to note that some economic variables are naturally seasonal and as a matter of fact their modeling implies the identification and the modeling of their seasonal component. On this point, Hyllerberg (1994) emphasizes moreover that the seasonal variations explain a large part of the fluctuations of some economic variables, and that the seasonal and non seasonal components are often dependent on one another.

This article offers a review of the literature on tests for unit roots in presence of seasonality, through numerous applications on caribbean data. If the econometric works on quarterly or monthly data, connected with the caribbean countries are nearly non existent

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at the present time, we should witness their development in the years to come. Even if there's a big deficiency of statistical data, it should be noted that long series do exist (currency, prices, etc) for some countries and that data bases are becoming richer. As for the need of analysis and that of the economic policy, the empirical verification of some questions gives more and more prominence to the interest of econometric work on periodical data. Just to give an example, there is today, a sort of emptiness around the quarterly models liable to be useful, for the analysis of the fluctuations in the caribbean countries (see Craigwell et al. (1995) for a discussion about the macroeconomic forecast in the English speaking Caribbean).

1. Definitions and characteristics of the seasonal series

When we refer to the traditional statistical methods connected with the analysis of time series, we usually describe the evolution of series distinguishing four types of movements that can combine with one another : the tendency, the cycle, the seasonal component, and the residual component.
The tendency represents the average evolution on a long run. The cycle follows a more or less periodical trajectory linked more often to the booming phase and the recession phase of the economy. The seasonal component comprises the variations which occur repeatedly in the course of time. The residual component, that is uncertain, is composed of many agents responsible for weak amplitudes which also come up in the evolution of the variable, but which can't be particularized.

Whether it's a matter of data relative to socioeconomic variables, or describing natural phenomena, the putting together of the components, each being under the influence of various factors (for example the annual holidays or the habits for the seasonal component), give rise to more or less complex evolutions, hard to describe straight away. In order to pass judgment on the basic evolution of background phenomena, it has become a standard procedure to separate the seasonal movements from any other component. Of course, prior to any mathematical transformation aiming at obtaining this decomposition, we always start with a visual analysis which can rely on different types of graphics.

As illustration examples, we will rely on two series, reproducing the respective evolutions of the index of Barbados' industrial production, and the number of tourist visiting this country. The first one is about quarterly data, from 1973 to 1994 whereas the second one gathers monthly data from January 1992 to April 1995.

figure 1. index of industrial production

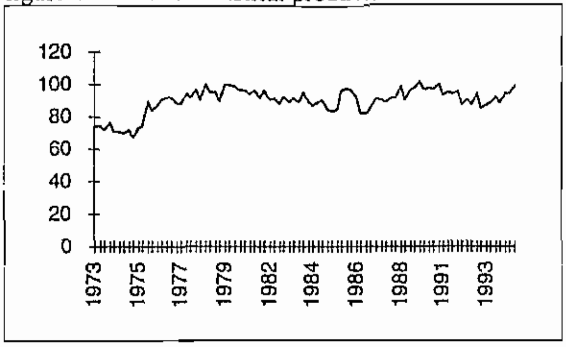
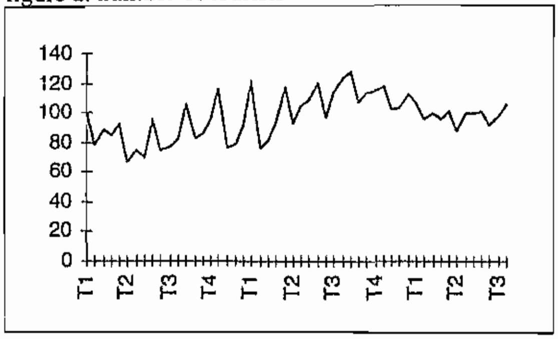


figure 2. number of tourists



The first diagram's observation shows two periods : the first on, relatively short, concerns the first two years and the first three quarters of year 75. We can notice some more or less constant values contained between 67 and 76. The second period also shows observations which values vary rather lightly around an average value. Still, the difference with the first period is the higher level of the value, contained between 82 and 101. on the whole, the evolution of the index of Barbados' industrial production can be summarized by saying that it doesn't seem to be affectd by any seasonal variation and that its observations rather tend to line up around an horizontal line.

Concerning the number of tourists' diagram, the second graph brings out clearly the presence of periodical movements more or less regular. On the given period, we can notice each year, the three following phases : the first one goes from January to June where we can see a more or less regular drop of the number of tourists. The second one goes from July to September where we can see a big increase in July followed by a first drop in August and then by a second one much bigger in September and eventually, on the third phase going from October to December, we can notice a rather regular increase. Those reports are really confirmed by the graph number 3 and the graph number 4 which superpose evolutions of different years. Concerning the graph about the number of tourists, the regularity of the seasonal movements is also confirmed by the graph number 5 of the monthly data.

figure 3. index of industrial production of Barbados

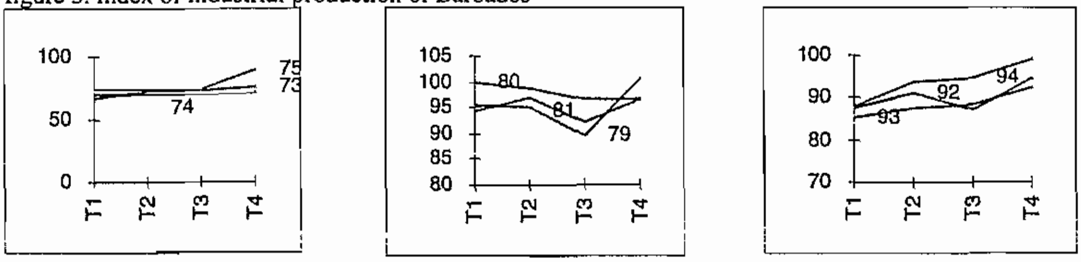


figure 4. number of tourists in quartely data

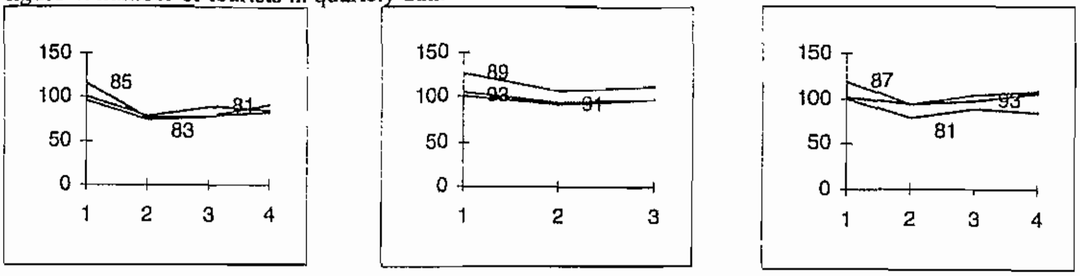


figure 5. number of tourists in monthly data

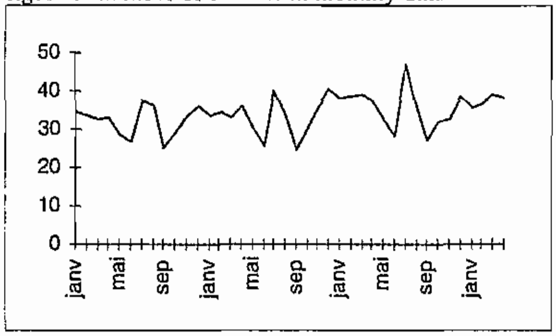
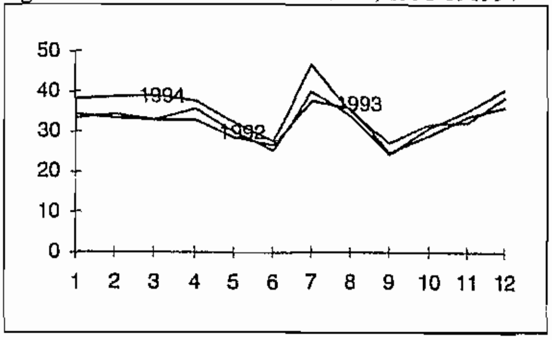


figure 6. number of tourists in 1992, 1993 et 1994



Although the graphs are a convenient approach to examine the profile of the tendency and of the seasonality of the series, they remain however insufficient to characterize their statistical properties.

Today, before any attempt to model economic variables can take place, it's from now on an established fact that the nature of the tendency and the origin of the seasonality of the series should be definite systematically. Indeed, as we already know, the application of econometric methods requires the use of the stationary series within the univaried context, and those of which the orders of integration are known, in the multivaried context.

Since Nelson's and plosser's study (1982), a significant number of work, both impirical and theoretical, has been achieved and has lead to practical procedures which permits to characterize the deterministic flavour, or the stochastic flavour that the tendency of the series may have. As far as seasonality is concerned, the working out of such procedures has taken much longer, even if the interest of the tests of unitary root in presence of seasonlity has been stressed by Hasza and Fuller as early as 1982.

Although the tendency's weight is widely dominating in the series' decomposition, the general speed of the tendency shows plainly, that a good acquaintance with the seasonality is often essential to explain some variables' evolution and fluctuactions.
So, following the example of the questions relative to the origin of the tendency of a given series X_t, it is important to know whether the shocks affecting X_t, will have a temporary effect only, on its seasonal component or, on the contrary, it will definitively influence its seasonal profile in the future. Consequently, these questions lead to questioning about the choice of the stationarization method of X_t. Should X_t's gross values be regressed on

variables indicative of seasonality (deterministic seasonality) or should they be differentiated to the seasonality's order (stochastic seasonality) ?

This is the definition of the notion of seasonal integration that we commonly apply : *a non stationary, stochastic process X_t is integrated in the order (d,D), we note I(d,D) if X_t is stationary after the application of D seasonal differences followed by the application of d first differences.*

Thus, a quarterly series is said *I(1,1)* if its stationarity requires only one transformation of the initial data X_t by the filter $X_t - X_{t-4}$ followed by a single first differentiation applied to the resulting series.

Compared to the case of the tendency, the econometric problems posed by the stationarization of seasonal series are more complicated. An obvious reason for that is the fact that the procedures of estimation and of test must take all the unit roots into account.

Furthermore, it is important to note that the seasonality is inherent in various economic series and that in this respect, instead of resorting to procedures which eliminate seasonal variations, some authors have stressed the importance of treating directly the unadjusted data and of working out some models which incorporate the modeling of their seasonality.

On the technical level, Wallis (1974) and Ghysels (1994) have shown that the use of adjusted series may favour the introduction of dodges in the econometric adjustments, which therefore, distorts the interpretation of the dynamics of the econometric models. For the cointegration, Hyllerberg (1994) have proved similar results.

On the theoretical level, as an other example of illustration, Osborn (1988) suggested a specification of England's function of consumption which incorporates an explicit formulation of seasonality. Using the hypothesis that consumption is often dictated by habits and that the couples buy, choosing goods according to seasons, Osborn suggested a function of consumption including parameters refering to these habits and preferences.

2. A review of the tests on seasonal unit roots

2.1. The univariate approaches

On considering series which gather quarterly gross data, the examination of their dynamic properties inevitably goes through the tests of seasonal unit roots. The interest of those tests has been brought to the fore by Hasza and Fuller (as early as 1984) who suggested a procedure achieving the extension of Dickey and Fuller's method. Testing the presence of unit root at the modulation zero in the model : $X_t = \alpha X_{t-s} + \varepsilon_t$, this procedure gave rise to many criticisms. Afterwards, Osborn, Chvi, Smith and Birchenhall (OCSB) (1988) advocated the parameterization (1) below, in order to test the null hypothesis *I(1,1)* against the alternatives *I(0,1)* and *I(1,0)*.

$$\Delta_1\Delta_4 X_t = \alpha_1 D_{1t} + \alpha_2 D_{2t} + \alpha_3 D_{3t} + \alpha_4 D_{4t}$$
$$+\beta_1\Delta_4 X_{t-1} + \beta_2\Delta_1 X_{t-4} + \sum_k \phi_k \Delta_1\Delta_4 X_{t-k} + \varepsilon_t \qquad (1)$$

where the D_i correspond to seasonary indicators.

We will note that the variable X is specified in first and fourth differences and not in level. Thus, the term $\Delta_4\ X_{t-1}$ enables or permits to test the non seasonal root 1 and $\Delta_1 X_{t-4}$ the seasonal root.

When $\beta_1 = 0$ with $\beta_2 < 0$ we concluded that X_t~*I(1,0)* whereas the property *I(0,1)* is verified when $\beta_2 = 0$ and $\beta_1 < 0$. In order to measure β_1 and β_2 significativity, Osborn (1990) suggested tables gathering the critical values of the asymptotic distributions of the statistics t_{β_1} and t_{β_2}.

Although this procedure is stronger than Hasza and Fuller's approach, it doesn't enable - permit to test all unitary roots' presence in a seasonary process.

Considering an autoregressive process

$$\phi(B)X_t = \varepsilon_t.$$

It's well known that its evolution is stationary if and only if all the roots of the polynomial $\phi(B)X_t = \varepsilon_t$ are situated outside the unity circle.
Consequently, it's clear that the reliability of the procedures of unit root's tests in presence of seasonality depends on their ability for testing all the seasonal frequencies.
It's in that perspective that Hylleberg, Engle Granger and Yoo (HEGY) (1990) used the decomposition.

$$(1-B^4) = (1-B)(1+B)(1-iB)(1+iB) = (1-B^2)(1+B^2)$$

In order to apply it to the model $X_t = \alpha X_{t-4} + \varepsilon$ for quaterly data.

Using the expedient of the transformation :

$$X_{1,t} = (1+B+B^2+B^3)X_t$$
$$X_{2,t} = -(1-B+B^2-B^3)X_t$$
$$X_{3,t} = -(1-B^2)X_t$$
$$X_{4,t} = (1-B^4)X_t$$

We obtain the model :

$$X_{4,t} = (1-B^4)X_t = \pi_1 X_{1,t-1} + \pi_2 X_{2,t-1} + \pi_3 X_{3,t-2} + \pi_4 X_{3,t-1} + \sum_k \phi_k X_{4,t-k} + \varepsilon_t \qquad (2)$$

which permits to test the presence of th e non-seasonal root 1 (at the frequency 0) and of the seasonal roots -1 (at the semiannual frequency $\frac{1}{2}$), i and -i (at the annual frequency $\frac{1}{4}$ and the frequency $\frac{3}{4}$).

Just as Perron underlined it, (1988), concerning the tests' power, a strategy aiming at assuring some reasonable properties of power to the tests, should begin with the most general model. Then, for the seasonal series, a suitable strategy should rely on regressions including seasonal indicators, a constant, and a tendency term as regressers. In this case, the equation of regression is the folowing :

$$X_{4,t} = \beta_0 + \beta_1 t + \alpha_1 D_{1t} + \alpha_2 D_{2t} + \alpha_3 D_{3t} + \alpha_4 D_{4t}$$
$$+ \pi_1 X_{1,t-1} + \pi_2 X_{2,t-1} + \pi_3 X_{3,t-2} + \pi_4 X_{3,t-1} + \sum_k \phi_k X_{4,t-k} + \varepsilon_t \quad (3)$$

In order to test the presence of the roots 1 and -1, the nullity of π_1 and π_2 must be evaluated by means of the t- statistics. Thus, we carry out the tests :

$$H_0 : \pi_1 = 0 \quad \text{against} \quad H_1 : \pi_1 < 0$$
$$H_0 : \pi_2 = 0 \quad \text{against} \quad H_1 : \pi_2 < 0$$

by using the critical values of Dickey and Fuller (1981).

Concerning the annual unit roots, HEGY suggested some tests based either upon the t-statistics or upon Fisher's united statistics.

For the t-statistics, we proceed in two stages : first, we carry out the bilateral test $\pi_4 = 0$ against $\pi_4 \neq$ using HEGY's critical values. Then, if $\pi_4 = 0$ so, the presence of the complex roots depends ont the test $\pi_3 = 0$ against $\pi_3 < 0$ by resorting this time to Dickey, Hasza and Fuller's critical values (1984).

As far as the united test of π_3 or π_4's nullity is concerned, even if it's simple and easy to bring the value of statistics F into play, once we know it, it's not useless to pall on it for a while, in order to give some precisions about how the value has been calculated.

Of course, F is estimated from the relations (2) or (3) by using the ratio of the regression sum of squared to the sum of squared residuals. If we designate by ê the vector of the residuals, by β the vector gathering the estimated coefficients and Z_t the matrix $(X_{1,t-1}, X_{2,t-1}, X_{3,t-2}, X_{3,t-1})'$, the F are defined as follows (Engle et al. (1993) and Ghysels et al. (1994) :

$$F_{34} = \frac{(R\hat{\beta})' \left[R(\sum Z_t Z_t')^{-1} R' \right]^{-1} (R\hat{\beta}) / 2}{\sum \hat{e}_t^2 / (T-4)} \quad \text{avec } R = \begin{pmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$F_{234} = \frac{(R\hat{\beta})'\left[R(\sum Z_t Z_t')^{-1} R'\right]^{-1}(R\hat{\beta})/3}{\sum \hat{e}_t^2 /(T-4)} \qquad \text{avec } R = \begin{pmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$F_{1234} = \frac{\hat{\beta}'\left[\sum Z_t Z_t'\right]\hat{\beta}/4}{\sum \hat{e}_t^2 /(T-4)}$$

By relying on the Brownian movements, we show that these statistics have got the same asymptotic distributions as the sum of the squared of the corresponding t-statistics. Their critical values, obtained by simulation have been established by Hegy for F_{34} and Ghysels and al (1994) for F_{234} and F_{1234}.

On the whole, the process X_t will have no unit root if all $\pi_{i's}$ are different from zero. Just as X_t will have no seasonal unit root if π_2 and π_3 or π_4 are different from zero.

Considering its robustness, this procedure is known today as a reference method (see Ghysels, Lee and Noh (1994)). Yet, we can note that its field of application remains limited to the test of the null hypothesis *I(0,1)* against the alternatives *I(1,0)* and *I(0,0)*.

For a more general test of the hypothesis *I(1,1)* against *I(2,0)* and *I(1,0)*, Osborn (1990) suggested a transformation of HEGY 's model (3). It's about the variant below :

$$\begin{aligned} \Delta_4\Delta_1 X_t &= \alpha_0 + \alpha_1(D_{1t} - D_{4t}) + \alpha_2(D_{2t} - D_{4t}) + \alpha_3(D_{3t} - D_{4t}) \\ &+ \pi_1 Z_{1,t-1} + \pi_2 Z_{2,t-1} + \pi_3 Z_{3,t-2} + \pi_4 Z_{3,t-1} + \sum_k \phi_k \Delta_4\Delta_1 X_{t-k} + \varepsilon_t \end{aligned} \qquad (4)$$

where the $Z_{i,t}$ are similar to the $X_{i,t}$ but defined in relation to $\Delta_1 X_t$:

$$\begin{aligned} Z_{1,t} &= (1 + B + B^2 + B^3)\Delta_1 X_t \\ Z_{2,t} &= -(1 - B + B^2 - B^3)\Delta_1 X_t \\ Z_{3,t} &= -(1 - B^2)\Delta_1 X_t \\ Z_{4,t} &= (1 - B^4)\Delta_1 X_t \end{aligned}$$

We concluded that X_t~*I(2,0)* and that there's no seasonal unit root when π_2 and π_3 or π_4 are revealingly different from zero and that $\pi_1 = 0\,\pi_1 = 0$. Inversely, we accept the hypothesis I (0,1) when $\pi_2 = \pi_3 = \pi_4 = 0$ and $\pi_1 < 0$. To achieve those tests, we use the critical values tabulated by Osborn (1990) for π_2, π_3 and π_4 and those of Dickey and Fuller (1981) for π_1.

The procedures which have just been exposed are valid for quarterly series. For the monthly data, it's also important to elaborate some tests of seasonal integration, since many economic variables, such as indexes, are measured at the end of each month. The procedure suggested by Baulieu and Miron (1993) comes within this perspective. It represents the homologue of HEGY's procedure and therefore works as follow :

We start from the factorization below of the filter $\Delta_{12} = 1 - B^{12}$

$$(1 - B^{12}) = (1 - B)(1 + B)(1 + B^2)(1 + B + B^2)(1 - B + B^2)(1 + \sqrt{3}B + B^2)(1 - \sqrt{3}B + B^2)$$

and they try to detect which ones among the roots of the polynomial $\Delta_{12} X_t$ have a significant influence in the fluctuation of the studied series. As in the case of quarterly data, the procedure of investigation is based on the linearization of Δ_{12} in the neighbourhood of the unit root 1 and the 11 seasonal roots which are respectively equal to :

$$-1;\pm i;-\frac{1}{2}(1\pm\sqrt{3}i);\frac{1}{2}(1\pm\sqrt{3}i);-\frac{1}{2}(\sqrt{3}\pm i);\frac{1}{2}(\sqrt{3}\pm i)$$

and are associated to the respective frequencies $\pi;\pm\frac{\pi}{2};\pm\frac{2\pi}{3};\pm\frac{\pi}{3};\pm\frac{5\pi}{6};\pm\frac{\pi}{6}$.

We therefore obtain the analogue of the model of regression (2) :

$$X_{13,t}=(1-B^{12})X_t=\sum_{k=1}^{12}\pi_k X_{k,t-1}+\sum_k \phi_k X_{13,t-k}+\varepsilon_t \tag{5}$$

where each $X_{i,t}$, $i=1,...,13$ corresponds to a function of the frequency associated to $X_{i,t}$ (see appendix 2).

Just as, we obtain the equivalent model to (3) by including a constant, a tendency and the seasonary indicators of the variables :

$$X_{13,t}=\beta_0+\beta_1 t+\sum_{k=1}^{12}\alpha_k D_{k,t}+\sum_{k=1}^{12}\pi_k X_{k,t-1}+\sum_k \phi_k X_{13,t-k}+\varepsilon_t \tag{6}$$

For the frequencies 0 and π, we test the respective null hypothesis $\pi_1=0$ and $\pi_2=0$ against the alternative hypotheses $\pi_1<0$ and $\pi_2<0$. In the case of other frequencies, we evaluate the significativity of the coefficients with the help of Student's and of Fisher's statistics for which Beaulieu and Miron have built tables gathering their critical values.

2.2 Frances' multivaried approach

Being based on Johansen and Juseluis (1990)' approach of cointegration, Frances (1994) suggested that we should test the presence of a stochastic seasonality by calculating the number of relations of cointegration between the four series of annual data stemming from the initial series, more precisely, these are the different stages that this procedure comprises:

(i) being given a seasonal series of period p, we make up the vector $X_t=(X_{1t}\ X_{2t}...X_{pt})$ where X_{it} is a series of annual data containing the observations of the season i :

(ii) Let the ECM model of order 1 :

$$\Delta X_t=\Pi X_{t-1}+\mu+\varepsilon_t$$

we estimate the matrix Π under the constraint $\Pi=\alpha\beta'$ by applying the method of the maximum of likelihood of Johansen and Juselius (1990).

(iii) We determine the number r of relations of cointegration between the X_{it} by using the test of the trace based on the statistics $Q_1(r) = -N \sum_{k=r+1}^{p} \log(1-\lambda_k)$ and the test of the maximum eigenvalue based on the statistics : $Q_2(r) = -N \log(1-\lambda_r)$ with, the λ_k designating the eigenvalues of β and $N = T / p$ the number of observations of the series X_{it}.

(iv) - If r=4, the initial series X_{it} is stationary, any differentiation is useless.

- If r=0, there isn't any relation of cointegration between the X_{it}, these last each being integrated, we concluded that the filter Δ_p (Δ_4 for a quarterly series and Δ_{12} for a monthly series) is suitable to make X_t stationary.

- when r is comprised between 1 and p, we test the presence of the seasonal roots -1, i and -i by imposing different constraints on the matrix Π.

3. Applications to the Caribbean macroeconomic variables

3.1. Unit roots tests of quarterly series

The basis of data that we consider for our econometric investigations is made of some series relative to Barbados, Jamaïca, Trinidad and Tobago, Guyana and the Republic of Dominica's real and nominal variables. It's about the total amount of money in circulation m_t, the index of the industrial production y_t, the consumption price index p_t. They gather unadjusted quarterly data of the seasonal variations which have been observed, for most of them, on the period going from 1960 to 1994 (see anne 1). As we said previously, the fact that we consider such data incorporating seasonal variations, permits to ignore any problem linked to distortions introduced by the adjustment procedures.

Before anlysing the nature of seasonality we first attempted to characterize the origin of the tendency. For that to happen, we relied on Jobert's sequential procedure (1992) (see appendix 3) for the ADF test. Then we carried out the tests of seasonary unit roots, making use of the different strategies previously expounded. Thus, for each of the variables, we performed the estimation of, model (1) for the OCSB's procedure, of the equations (2), (3) and (4) for HEGY's method and eventually of Frances model (8).

The estimations were made on the variables' logarithm. For each of them, the selection of the optimal delay has been made in comparision with the criterions AIC and BIC. For each country, the results are presented in three tables, respectively revolving around the ADF test, the OCSB test and HEGY's tests.

The results for the ADF tests

Let's take the example of the series m_t, in order to explain the strategy of HDF test. First, we start with the estimation of the equation (1). It shows that the hypothesis of the unit root must be accepted[2] $(1_t = -\ 0,59)$. Then, we test the term of tendency of the equation (4) by examining the statistics $t_t = -1,57$; thus the tendency is not significant, we evaluate once more the unit root in the equation (2). The value of τ_u value leads to the rejection of the hypothesis *I(1)*. But since the constant is significant in the equation (5) $(t_\alpha = 3,26)$, we eventually accept the hypothesis *I(0)*.

Thus, in Barbados' case, Dickey and Fuller's sequential tests lead to the rejection of the null hypothesis of unit roots for the series m_t , p_t and y_t (the latter is stationnary around a constant) and lead to it's acceptance for cr_t.

If we compare Trinidad and Tobago's results to those of Barbados, we can notice that the evolutions in time of m_t , p_t and y_t show the same behaviour. On the contrary, we must observe that the origins of these variables' behaviour are opposed to those of Jamaica and Guyana which stay stationary.

To give an economic interpretation, these results seem to indicate that any shock affecting the economies of Barbados and Trinidad and Tobago through the variables considered here will have transitory effects, whereas the effects of similar shocks for Jamaica and Guyana will remain persistant.

Table 1. Tests ADF I(1)/I(0)

	retard	$\tau_t(1)$	$t_t(4)$	$\tau_\mu(2)$	$t_\alpha(5)$	$\tau(3)$	Caract
Barbade							
m	4	-0,59	-1,57	-1,67	3,26		I(0)
cr	7	-2,56	-2,56				I(1)+T+T²
y	8	-0,89	-1,66	-4,98			I(0)+C
p	3	-0,84	-1,74	-1,89	2,18		I(0)
Trinidad et Tobago							
m	7	-1,94	0,16	-0,37	2,02		I(0)
y	0	-4,25					I(0)+T
p	4	-2,49	0,69	0,27	2,51		I(0)
Jamaïque							
m	4	-0,99	2,15				I(1)+T+T²
cr	8	-2,18	0,12	-0,27	2,39		I(1)+T
p	1	-1,21	2,59				I(1)+T+T²
Guyana							
m	8	-1,23	1,52	0,91	2,05		I(1)+T
cr	7	-2,02	0,72	0,35	2,55		I(1)+T
p	0	-2,21	3,70				I(1)+T+T²
République Dominicaine							
m	8	-1,58	1,48	0,79	2,05		I(0)
cr	8	-1,52	1,47	1,34	3,77		I(0)
p	7	-1,16	2,01				I(1)+T+T²

[2] The test statistics are respectively τ_t, τ_u and τ and their corresponding critical values - 3,45 ; -2,89 and -1,95 for a sample of 100 tall (Dickey and Fuller (1979)

The results of the OCSB tests

The results show very clearly that the null hypothesis *I(1,1)* at 5% is rejected for all the series[3]. More precisely, amoung the 16 examined series, 8 are *I(0,0)* (p_t for all the countries, y_t of Barbados and Trinidad et Tobago et m_t for Guyana) et the other 8 *I(1,0)*. For the latters, the rejection of the non stationary stochastic seasonality presence is confirmed by the statistics t_{β_2}. These series are *I(1,0)* because $\beta_1 = 0$ and $\beta_2 < 0$. Likewise, the others are *I(0,0)* because $\beta_1 \neq 0$ et $\beta_2 < 0$.

Table 2. Tests de OCSB I(1,1)/I(0,1) et I(1,0)

Séries	Retard	t_{β_1}	t_{β_2}	Conclusion
Barbade				
m	0	-1,24	-7,72	I(1,0)
cr	0	-1,24	-7,71	I(1,0)
y	0	-2,80	-7,48	I(0,0)
p	1	6,14	-9,65	I(0,0)
T. & T.				
m	7	1,28	-5,61	I(1,0)
y	0	-2,07	-5,81	I(0,0)
p	0	5,35	-9,46	I(0,0)
Jamaïque				
m	0	1,55	-8,77	I(1,0)
cr	1	1,84	-9,48	I(1,0)
p	2	5,92	-8,43	I(0,0)
Guyana				
m	5	2,05	-5,95	I(0,0)
cr	3	0,99	-8,93	I(1,0)
p	0	4,02	-9,26	I(0,0)
Rép. Dom.				
m	5	1,77	-6,50	I(1,0)
cr	5	-0,61	-7,16	I(1,0)
p	4	3,48	-5,90	I(0,0)

The results for HEGY's tests

here too, if we must bring a conclusion to the results of HEGY's tests, we won't fail to underline that the presence of unit roots to seasonal frequencies is rarely verified for the Caribbean periodical series. As a matter of fact, if we refer to the t-statistics of the test *I(0,1)/I(1,0)* and *I(0,0)*, on the 16 series studied here, the coefficients estimated for π_2 are very significant, such as those associated to π_3 and π_4. In the same way, the values F_{34} and F_{234} clearly reject the presence of unit roots to seasonal roots frequencies.

So, each serie has a stochastic trend, and none shows off a stochastic seasonality, which lets us think that their univariate representation is that of a stationary process in difference around a deterministic seasonal pattern represented by seasonal dummy variables.

[3] For a sample of 100, the critical values for t_{β_1} and t_{β_2} are respectively -1,94 and -1,93.

Table 3. Tests of HEGY I(0,1)/I(1,0) et I(0,0)

Séries	Test	k	t_{π_1}	t_{π_2}	t_{π_3}	t_{π_4}	F_{1234}	F_{234}	F_{34}	Concl.
Barbados										
m	Eq. (2)	1	3,10	-4,43	-3,63	-2,74	57,97	33,70	14,79	
	Eq. (3)	0	-0,29	-5,88	-5,50	-4,51	207,23	78,15	50,71	I(1,0)
cr	Eq. (2)	8	1,59	-3,19	4,19	-3,17	202,38	124,32	87,27	
	Eq. (3)	8	-0,74	-3,05	-4,13	-3,34	2166,76	141,01	104,71	I(1,0)
y	Eq. (2)	0	1,11	-2,54	-5,06	-5,57	31,43	39,99	44,05	
	Eq. (3)	0	-2,87	-3,86	-5,30	-5,11	8203,78	73,01	58,67	I(1,0)
p	Eq. (2)	0	1,59	-7,57	-5,41	-7,13	954,36	617,22	62,54	
	Eq. (3)	0	-0,87	-6,88	-5,48	-7,09	607,32	632,07	70,70	I(1,0)
T. & T.										
m	Eq. (2)	4	1,97	-2,00	-4,52	-1,82	64,91	48,47	47,36	
	Eq. (3)	1	-1,89	-4,62	-9,20	-1,33	2347,41	104,63	77,01	I(1,0)
y	Eq. (2)	3	2,12	-2,11	-4,07	-0,53	17,29	18,57	18,40	
	Eq. (3)	4	-2,14	-3,25	-4,58	-0,22	6923,88	49,12	42,03	I(1,0)
p	Eq. (2)	1	2,24	-4,25	-1,52	-8,15	956,05	292,26	55,86	
	Eq. (3)	1	-2,51	-4,28	-1,79	-8,36	262,84	344,89	65,63	I(1,0)
Jamaica										
m	Eq. (2)	8	3,21	-1,66	-1,02	-2,24	66,01	15,15	7,62	
	Eq. (3)	0	-0,49	-6,94	-5,53	-6,93	167,88	94,83	190,92	I(1,0)
cr	Eq. (2)	6	2,80	-2,48	-1,77	-1,57	60,78	25,05	8,89	
	Eq. (3)	8	-2,81	-5,21	-3,27	-1,43	13077,88	315,09	42,42	I(1,0)
p	Eq. (2)	0	3,52	-8,48	-0,70	-9,72	2077,12	742,08	48,00	
	Eq. (3)	0	-1,35	-7,62	-0,79	-10,55	1573,13	828,52	65,17	I(1,0)
Guyana										
m	Eq. (2)	5	2,12	-1,56	-1,59	-1,25	22,06	6,37	4,77	
	Eq. (3)	1	-1,18	-3,74	-4,78	-4,45	360,76	126,77	104,27	I(1,0)
cr	Eq. (2)	4	2,57	-5,27	-3,20	-3,62	246,66	108,62	43,51	
	Eq. (3)	4	-2,01	-5,22	-3,39	-3,56	2746,76	117,00	49,36	I(1,0)
p	Eq. (2)	2	2,49	-3,87	-5,86	-3,49	333,83	160,45	68,16	
	Eq. (3)	0	-2,00	-7,19	-7,73	-6,20	221,99	257,76	91,93	I(1,0)
Rep. Dom.										
m	Eq. (2)	5	2,12	-1,31	-2,54	-1,34	26,33	9,14	9,51	
	Eq. (3)	4	-1,50	-4,69	-5,26	-3,17	1050,63	170,55	115,62	I(1,0)
cr	Eq. (2)	6	4,93	-2,55	-3,38	-3,43	364,49	73,19	40,04	
	Eq. (3)	8	-1,76	-2,87	-4,47	-3,44	30446,04	205,74	122,96	I(1,0)
p	Eq. (2)	4	2,39	-5,44	-0,02	-5,05	743,16	416,17	22,89	
	Eq. (3)	5	-1,52	-4,49	0,12	-6,12	646,09	530,70	45,61	I(1,0)

Table 4. Tests of HEGY I(1,1)/I(2,0) et I(1,0)

Séries	k	t_{π_1}	t_{π_2}	t_{π_3}	t_{π_4}	F_{34}	Concl.
Barbados							
m	5	-5,18	-4,87	-6,15	0,69		I(1,0)
cr	8	-3,37	-3,19	-5,72	1,08		I(1,0)
y	0	-5,84	-3,75	-6,29	-0,78		I(1,0)
p	0	-2,85	-4,17	-7,15	-0,10		I(1,0)
T. & T.							
m	0	-3,27	-4,74	-6,85	4,37		I(1,0)
y	3	-3,12	-3,26	-3,38	2,98		I(1,0)
p	0	-2,90	-4,35	-6,60	-4,05		I(1,0)
Jamaica							
m	0	-4,35	-5,24	-6,65	-0,93		I(1,0)
cr	2	-3,78	-6,96	-4,19	-0,79		I(1,0)
p	0	-3,62	-6,62	-6,76	-5,63		I(1,0)
Guyana							
m	0	-3,09	-5,41	-7,53	0,88		I(1,0)
cr	3	-2,95	-5,27	-5,29	-0,28		I(1,0)
p	2	-2,78	-3,24	-6,35	-0,24		I(1,0)
Rep. Dom.							I(1,0)
m	3	-2,75	-4,91	-6,75	1,26		I(1,0)
cr	5	-4,92	-3,25	-6,31	-0,02		I(1,0)
p	4	-2,45	-4,51	-3,76	-4,29		I(1,0)

Conclusion

The results of the unit roots tests on the caribbean seasonal variables are interesting on several accounts.

Firstly, they are very much like the conclusions of the researches which tried to bring out the origin of trend and seasonality in industrialised countries (Nelson and Plosser (1982), Perron (1988), Osborn (1990), etc). Thus they point out that most of the caribbean economic variables have a unit root at the long run frequncy and haven't any at the seasonal frequencies.

Secondly, there is apparently no specificity about the proprieties of the processes generating observations of the economic variables in these smal open economies, although some caribbean series do not have the specific profile corresponding to the evolutions observed for similar series in industrialized countries.

Lastly, from a technical point of view, the results of the tests show that the differenciations $\Delta_1\Delta_4$ or $\Delta_1\Delta_{12}$ which were usually made according to the Box and Jenkins' methodology were often excessive. In a general way, this fact underlines how important it is to well examine the statistical properties of the caribbean macroeconomic series, to analyse the fundamental evolution connected with the economic tendencies in these countries. This is particularly true for the studies about economic fluctuations and short term forecasting which are becoming a more and more common practice, as more performant statistical measures are now available in those countries.

APPENDIX 1
The data

All the series relative to quarterly data are taken from the World Bank's data base.

Liste des variables dans l'ordre

Code	Pays	Période	Libellé
CRRD	Rep. Dom.	1960:1- 1994:4	domestic credit
MRD	Rep. Dom	1960:1 - 1994:4	money
PCRD	Rep. Dom.	1960:1 - 1994:4	index of consumer prices
CRB	Barbados	1967:1 - 1994:4	domestic credit
MB	Barbados	1967:1 - 1994:4	money
IPIB	Barbados	1973:1 - 1994:4	index of industrial production
PCB	Barbados	1966:1 - 1994:4	index of consumer prices
CRG	Guyana	1967:1 - 1994:4	domestic credit
MG	Guyana	1960:1 - 1994:4	money
PCG	Guyana	1960:1 - 1992:4	index of consumer prices
CRJ	Jamaica	1963:1 - 1994:4	domestic credit
MJ	Jamaica	1961:2 - 1994:4	money
PCJ	Jamaica	1960:1 - 1994:4	index of consumer prices
CRTT	Trin. & Tob.	1960:1 - 1994:4	domestic credit
MTT	Trin. & Tob.	1960:1 - 1994:4	money
IPITT	Trin. & Tob.	1978:1 - 1994:1	index of industrial production
PCPTT	Trin. & Tob.	1969:1 - 1994:4	index of consumer prices

APPENDIX 2
Décomposition of the polynom $(1-B^{12})X_t$ for the HEGY' test on monthly data

$$X_{1,t} = (1+B+B^2+B^3+B^4+B^5+B^6+B^7+B^8+B^9+B^{10}+B^{11})X_t$$

$$X_{2,t} = -(1-B+B^2-B^3+B^4-B^5+B^6-B^7+B^8-B^9+B^{10}-B^{11})X_t$$

$$X_{3,t} = -(B-B^3+B^5-B^7+B^9-B^{11})X_t$$

$$X_{4,t} = -(1-B^2+B^4-B^6+B^8-B^{10})X_t$$

$$X_{5,t} = -\frac{1}{2}(1+B-2B^2+B^3+B^4-2B^5+B^6+B^7-2B^8+B^9+B^{10}-2B^{11})X_t$$

$$X_{6,t} = \frac{\sqrt{3}}{2}(1-B+B^3-B^4+B^6-B^7+B^9-B^{10})X_t$$

$$X_{7,t} = \frac{1}{2}(1-B-2B^2-B^3+B^4+2B^5+B^6-B^7-2B^8-B^9+B^{10}+2B^{11})X_t$$

$$X_{8,t} = -\frac{\sqrt{3}}{2}(1+B-B^3+B^4+B^6+B^7-B^9-B^{10})X_t$$

$$X_{9,t} = -\frac{1}{2}(\sqrt{3}-B+B^3-\sqrt{3}B^4+2B^5-\sqrt{3}B^6+B^7-B^9+\sqrt{3}B^{10}-2B^{11})X_t$$

$$X_{10,t} = \frac{1}{2}(1-\sqrt{3}B+2B^2-\sqrt{3}B^3+B^4-B^6+\sqrt{3}B^7-2B^8+\sqrt{3}B^9-B^{10})X_t$$

$$X_{11,t} = \frac{1}{2}(\sqrt{3}+B-B^3-\sqrt{3}B^4-2B^5-\sqrt{3}B^6-B^7+B^9+\sqrt{3}B^{10}+2B^{11})X_t$$

$$X_{12,t} = -\frac{1}{2}(1+\sqrt{3}B+2B^2+\sqrt{3}B^3+B^4-B^6-\sqrt{3}B^7-2B^8-\sqrt{3}B^9-B^{10})X_t$$

APPENDIX 3
Henin and Jobert' strategy for the ADF test

We start from the five following equations:

$$(1)\qquad \Delta X_t = a + bt + \rho X_{t-1} + \sum_k \gamma_k \Delta X_{t-k} + \varepsilon_t$$

$$(2)\qquad \Delta X_t = a + \rho X_{t-1} + \sum_k \gamma_k \Delta X_{t-k} + \varepsilon_t$$

$$(3)\qquad \Delta X_t = \rho X_{t-1} + \sum_k \gamma_k \Delta X_{t-k} + \varepsilon_t$$

$$(4)\qquad \Delta X_t = a + bt + \sum_k \gamma_k \Delta X_{t-k} + \varepsilon_t$$

$$(5)\qquad \Delta X_t = a + \sum_k \gamma_k \Delta X_{t-k} + \varepsilon_t$$

We sort out the number of lags in the equation (1) with the help of the criterion BIC. Then we apply a downward sequentiel procedure which main stages are:

Stage I: We test $\rho = 0$ in the equation (1) by using the statistique τ_t. if τ_t is lower than the critical value, we go to stage II, if not we test the coefficient of the determinist trend with the standards t-Student. If $b = 0$ we go to the stage III, if not $X_t \sim I(0) + T + C$ or $X_t \sim I(0) + T$ depending on whether a is different from zero or not.

Stage II: We test $b = 0$ in the equation (4) according to the t-Student. If it's the case, we go to the stage III, if not, we concluded that $X_t \sim I(I) + T^2$.

Stage III: We consider the equation (2). We test the hypothesis of unit root from the statistic τ_u. If $\rho = 0$, we go to the stage IV, if not we test the nullity of a according to the t-Student. If $a = 0$ then $X_t \sim I(0)$, if not $X_t \sim I(0) + C$.

Stage IV: We test once again the nullity of a in the equation (5) according to the t of Student. if $a = 0$ then we go to stage V, if not $X_t \sim I(1) + T$.

Stage V: We test $\rho = 0$ in the equation (3) according to the statistic τ. If $\rho = 0$ then $X_t \sim I(1)$, if not $X_t \sim I(0)$.

APPENDIX 4
5% Critical values for the HEGY and OCSB' tests

modèle	n	t_{π_1}	t_{π_2}	t_{π_3}	t_{π_4}	F_{1234}	F_{234}	F_{34}
	48	-1,95	-1,95	-1,93	-1,76	2,62	2,80	3,26
Eq. (2)	100	-1,97	-1,92	-1,90	-1,68	2,55	2,76	3,12
	136	-1,93	-1,94	-1,92	-1,68	2,53	2,72	3,14
	48	-3,71	-3,08	-3,66	-1,91	6,53	6,09	6,55
Eq. (3)	100	-3,53	-2,94	-3,48	-1,94	6,47	5,99	6,60
	136	-3,52	-2,93	-3,44	-1,94	6,33	5,91	6,62

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