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An Analysis of the Jamaican Business Cycle

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Abstract

The analysis of coincident and leading indicators can provide useful information to policy makers when assessing the direction of current as well as future economic activity. Owing to the lack of reliable historical data, very little research has been done on the business cycle in developing economies. It is in this context that this paper seeks to provide a detailed analysis of the Jamaican business cycle and attempts to provide leading forecasts of the country's cycles. Further, the study examines the relationship between the U.S. and the Jamaican business cycles. The paper finds that the Jamaican economy experienced two business cycles. The expansionary phases are notably longer than the contractionary phases and lasts between 10 to 45 quarters. The contraction phases last between 2 to 11 quarters. The chronology of the real GDP series show that the cycles of the Jamaican economy last between 21 and 49 quarters. In this context, Jamaica's business cycles are found to be more comparable with that of developed countries. The coincident index is found to be useful in capturing the peaks and troughs, while the leading index is useful for predicting future evolution of the economy. There is no synchronization between business cycles in Jamaica and the US, however, there is a high level of similarities between the two cycles.

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1.0 Introduction

The formulation of macroeconomic policy depends to a great extent on a clear understanding of current and future trends in economic activity. It is in this context, that a thorough knowledge of business cycles is critical for policy makers when designing stabilization and adjustment programmes. In the event of an unforeseen contraction in output, policy makers may need to relax macroeconomic policy to prevent a prolonged

reduction in economic activity. On the other hand, an improvement in economic performance, especially, subsequent to a recession, would validate a removal of policy-induced incentives. Further, dating the turning points of a cycle is important as it provides critical information to policy makers as it relates to the cycles' frequency, distinction between major and minor cycles and the duration of peaks and troughs. Cycle dating is important as it facilitates comparisons of the cyclical profiles of different countries. Over the years, more interest has been expressed in analyzing the business cycle of developing countries on account of their openness to international trade and other foreign activities.²

A number of procedures have been designed to analyze business cycles. Chief among them are Bry and Boschan, Hamilton Parametric Dating procedures and univariate filters. Additionally, coincident and leading indexes were developed to respond to policymakers' needs for a dependable estimate of economic activity in lieu of the release of the official statistical data. A coincident indicator is defined as a variable that is correlated with the current level of economic activity (i.e., real GDP), while a leading indicator is correlated with future economic activity. These indicators are currently widely used in advanced economies to determine the stage of business cycle activity.³ Their availability in emerging markets is, however, limited attributed in part to the lack of sufficient historical data to determine the reliability of the indicators.

The aim of this paper is two-fold, first to define the Jamaican business cycle, followed by an estimation of coincident and leading indexes. The paper is also meant to provide a channel for improving the Bank's forecast of economic growth. The methodology utilized is based on the

² Other foreign activities includes: movement in oil prices, foreign investments, wars and movement in the foreign interest rates, among others.

³ Pioneered by Burns and Mitchell (1946).

technique employed by Stock and Watson (1989). The paper begins with a review of the literature on business cycles, with a focus on developing countries. Following this, the stylized facts of the Jamaican economy between 1981 and 2007 is presented. The proceeding section then discusses the methodology that is employed, while the penultimate section gives the findings of the study. The final section presents the conclusion.

2.0 Literature Review

Business cycles are typically perceived to be the distance between two troughs or two peaks. A working definition was first established by Burns and Mitchell (1946)⁴, which is as follows:

“Business cycles are a type of fluctuation 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 twelve years; they are not divisible into shorter cycles of similar character with amplitudes approximating their own.”

Although a wide literature on business cycles is available for developed countries, the research for the developing countries, more so the Caribbean has been fairly scant. Some possible explanations offered for this limited literature for the Caribbean and other developing countries are: (i) the business cycle in developing countries are likely to be more dependent on weather patterns than cyclical fluctuations, as a result of the dominance of agriculture in GDP (Mall, 1999); (ii) the quality and

⁴ Leaders of the research team at National Bureau of Economic Research.

frequency of the data and; (iii) there exist difficulties in discerning any type of cycle or economic regularity because of crises and market gyrations typical of developing countries (Agenor, McDermott and Prasad, 2000).

Studies of the Jamaican business cycle include work done by Murray (2007) who determined the main drivers of the Jamaican Business cycle. Murray (2007) developed a structural vector autoregressive model of the Jamaican Economy. The purpose of the model was to identify and disaggregate the main factors that drive the Jamaican business cycle. The model also provided an additional mechanism for the examination of the transmission of monetary policy to effect changes to prices in Jamaica. The paper finds that domestic factors and international variables were the main drivers of the Jamaican business cycle. However, the international variables were found to be relatively less important than the other factors. The author also found that fiscal policy has a more direct impact on the business cycle than monetary policy conducted through interest rates. Other prominent work for the Caribbean includes Craigwell and Maurin (2005) who defined the sequence of the peaks and troughs, as well as the phases of the Barbadian business cycle. Analyzing data from 1974 to 2003, Craigwell and Maurin (2005) found that the Barbadian economy had three expansionary phases which consisted of 24 to 30 quarters, while the recessionary phases lasted between 3 to 14 quarters. They also found that the cycles of tourism, wholesale and retail closely resembled and were positively correlated with the aggregate business cycle. Craigwell and Maurin (2005) revealed also that the non-sugar agriculture & fishing cycle was counter cyclical to GDP.

In an extension of their work, Craigwell and Maurin (2005b) did a comparative analysis of the Barbados and the United States business

cycle, using non-parametric and parametric methods. The main findings of the study were that the Barbadian business cycle is closely linked to the U.S. business cycle and that the U.S. recessions precede those observed in Barbados. Also, while the expansions and contractions in the U.S lasted for 27 and 2 quarters, respectively, those in Barbados lasted for 29.7 and 10.3 quarters, respectively. In addition, the paper revealed the synchronization of the US and Barbadian business cycles, in that over the period, 83 per cent of the time both cycles were in the same state.

Cotrie (2005) analyzed the business cycles in Barbados using coincident and leading indicators.⁵ The framework utilized for estimating the coincident index was the state space model (SSM). The models developed were based on the Stock and Watson (1989) methodology. The coincident index was estimated from the SSM, while the vector auto-regression methodology was used to derive the leading index. The author found that the coincident index was useful in the dating of the peaks and troughs, while the leading index was useful for predicting future evolution of the economy.

Research outside the Caribbean, includes among others, work done by Mongardini and Saadi-Sedek (2003) and Dua and Banerji (1999, 2001) for the Jordanian and Indian economy, respectively. Mongardini and Saadi-Sedek (2003) used a simplified version of the Stock and Watson (1989) method. The paper presented an econometric approach to derive composite indexes of coincident and leading indicators for Jordan. The results showed that it was possible to establish meaningful economic and statistically significant relations between indicators from

⁵ These indices were created using the Burns and Mitchell (1946) 's definition of the business cycle

different sectors of the economy. Also these indexes can be used to estimate present and future direction of economic activity.

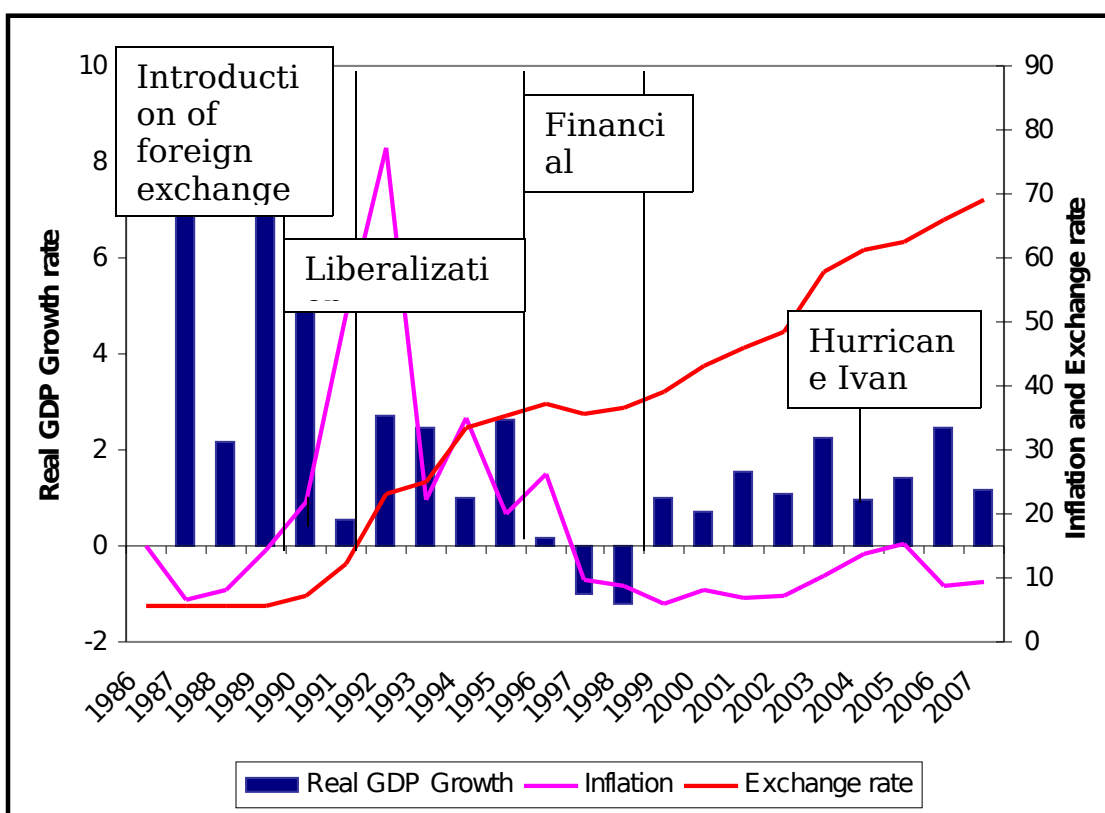
3.0 Economic Performance of the Jamaican Economy (1981-2007)

Jamaica is a lower to middle income, oil-importing country, with a vast array of natural resources. It is 11,453 square kilometers in size and has a population of 2,780,132.⁶ During 1981 to 2007, Jamaica recorded average growth of 1.4 per cent (see Figure 1). In the 1980's Jamaica's economy was characterized by sporadic and unsustainable growth, with significant expansion in 1987 and 1989, attributed to foreign direct investment and a boom in the financial sector. The annual average inflation rate had risen to a high of 27.4 per cent in that decade partly because of the rapid depreciation of the exchange rate. This was due to the change in the exchange rate regime and the introduction of the foreign exchange auction mechanism in 1984. The poor performance of the Jamaican economy continued during the 1990s, as indicated by the trends in most macroeconomic indicators. The period was characterized by very low and negative rates of economic growth as well as high levels of unemployment. Between 1991 and 1999, the Island recorded average annual growth of 0.9 per cent. The economy grew by 5.5 per cent in 1990; however, there were negative rates of growth in 1997 and 1998. This period of contraction, was influenced primarily by the financial sector crisis which occurred during that time. The unemployment rate remained at over 15 per cent of the labour force during the period 1990 to 2000. There was a gradual reduction in the unemployment rate thereafter reaching 10.1 per cent in 2007. The reduction in unemployment was partly attributed to significant foreign and domestic investment in the tourism, construction and transportation & communication industries as well as increased development in the financial sector. During the early

⁶ Population figure for 2007.

1990's the country experienced periods of hyperinflation. Annual average inflation peaked in 1992 at 77.3 per cent. This period was characterized by the liberalization of the foreign exchange rate regime. Single digit inflation was achieved during 1997 to 2002 following relatively tight monetary policies adopted by the authorities to contain inflation. Double digit inflation returned between 2003 and 2005. Double digit inflation returned between 2003 and 2005.

Figure 1: Economic Performance 1981-2007



Jamaica's growth rate over the review period was affected by several factors. Serju (2006) highlighted factors such as quality of labour inputs, adverse shocks, capital efficiency, low capacity utilization and debt. Approximately 86.0 per cent of the Jamaican labour force is literate, which is significantly low when compared to some of our Caribbean

counterparts⁷. With respect to adverse shocks, over the sample period the economy was subjected to adverse domestic and external shocks (e.g. financial sector crisis, hurricanes, oil prices, terrorist attack on the United States etc). The financial sector crisis in the mid 1990's imposed a cost of approximately 40 per cent of GDP on the economy and was one of the major factors that inhibited growth in the late 1990's. The decline in this sector accounted for 58.0 per cent of the decline in GDP over the period 1997 to 1998. Given the series of shocks, periods of high investment in production capacity were at times followed by periods of extremely low capacity utilization. In this regard, investments that were made during the economic and building boom of the 1990's were underutilized. The country's high debt level has also served to limit economic growth. Over the review period the country's debt on average stood at 124.6 per cent of GDP, which placed Jamaica among the most indebted countries in the world. The high debt led to low productivity levels via heightened macroeconomic uncertainty and crowding out credit to productive sectors. This high debt placed an upward pressure on interest rates. The average interest rate throughout the review period was approximately 21.7 per cent.⁸

Economic activity during the period was erratic, dominated by the financial crisis of the late 1990s, and the liberalization in 1991. The rest of the period was characterized by somewhat uneven growth due to external and domestic factors. The pattern of regular booms and troughs typical of advanced economies is not evident. However, periods of higher and slower growth seem to indicate some pattern of business cycle activity. This is in keeping with evidence from other emerging markets (Agenor, McDermott, and Prasad, 2000), where the business cycle is dominated by

⁷ Barbados and Trinidad & Tobago.

⁸ Interest rate refers treasury bill rate

sudden macroeconomic crises, oftentimes making it difficult to discern any type of cycle or economic regularity.

4.0 The Jamaican Business Cycle

GDP has longed been used by the National Bureau of Economic Research (NBER) and the Organization of Economic Cooperation and Development (OECD) as a measure of economic activity and thus a measure of business cycle. In this regard, the real GDP will be employed in this study as the reference series for the Jamaican economy. Based on the literature review, the Bry and Boschan algorithm is employed in this paper to determine the sequence of the peaks and troughs, as well as the phases of the Jamaican business cycle. To ascertain the robustness of the Bry and Boschan procedure, univariate filters are constructed. Further, the coincident and leading indexes as postulated by Stock and Watson (1989) will be employed to aid in the analysis and forecast of the Jamaican business cycle. The GDP series is seasonally adjusted. The source of the data is the Bank of Jamaica's database. The sample period is from 1981 to 2007.

4.1 The Bry and Boschan Non-Parametric Dating Procedure

The Bry and Boschan procedure is a popular method used for the selection of turning points. Non-parametric model uses mathematical procedures and makes no assumptions about the probability distribution of the variables being assessed. Non-parametric models, however, differ from parametric models in that the model structure is not specified a priori but is instead determined from the data.⁹ It

⁹ Generally, a parametric model is a set of related mathematical equations in which alternative scenarios are defined by changing the assumed values of a set of fixed coefficients (parameters). These models use mathematical procedures with the assumption that the distributions of the variables being assessed belong to known parameterized families of probability distributions. Non-parametric models are accepted to be more robust than parametric models as they have greater power efficiency (i.e. they have greater power relative to the sample size) and they provide

consists of using the ad hoc encoding of filters under rules devised by Burns and Mitchell (1946). The procedure operates on the original data and isolates the local maxima and minima in a time series subject to constraints on both the length and amplitude of contractions and expansions. These constraints involve the alternation of peaks and troughs as well as the persistence of downturns and upturns. The Bry and Boschan procedure uses six steps in discerning the turning points of the cycle. These are:

- ❖ Identification and replacement of extreme values.
- ❖ 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 peaks and the deepest troughs.
- ❖ 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.
- ❖ 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.
- ❖ Determination of the turning points in the original series, taking into account the information garnered from step 4. Elimination of the cycles and phases with durations that are too short.
- ❖ Final selection of turning points.

Essentially, what the Bry and Boschan procedure does is to select the peaks and troughs that are candidates for the turning points and then apply a series of operations to eliminate the points that do not satisfy the criteria for a cycle. The Bry and Boschan procedure was originally created for monthly series with specific parameters but was later

unique information (e.g., the interaction in a factorial design).

adopted for use with quarterly data. A modified version of the RATS programme written by Bruno and Otranto (2003) for the Bry and Boschan procedure is utilized in this paper.¹⁰ The modification include using the set of parameters $K=L=2$, which is commonly used for quarterly data, as well as the Spencer moving average curve of order 4, instead of the parameters $K=L=6$ and the Spencer moving average of order 15, which are typically used for monthly data. In this context, a turning point Y_t corresponds to a local maximum or minimum of more or less two quarters: i.e. 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 $\Delta y_t = y_t - y_{t-1}$.

4.2 The Hodrick Prescott and Baxter King Filters

The Hodrick-Prescott filter (HP) is a mathematical tool used to obtain a smoothed non-linear representation of a time series, one that is more sensitive to long-term rather than to short-term fluctuations. The adjustment of the sensitivity of the trend to short-term fluctuations is achieved by modifying a multiplier denoted by λ . The method minimizes the variance of the time series around the trend according to the following minimization problem:

$$\text{Min} \sum_{t=1}^T (y_t - \tau_t)^2 + \lambda \sum_{t=2}^{T-1} [(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1})]^2.$$

The series Y_t is made up of a trend component, denoted by τ and a cyclical component, denoted by C such that $Y_t = \tau + C$. The first term is

¹⁰ We would like to thank R. Craigwell and A. Maurin for the use of this programme, as obtained from G. Bruno and E. Otranto

a measure of the fitness of the time series equation, it is the sum of the squared deviations $d_t = y_t - \tau_t$ which penalizes the cyclical component. The second term is a measure of the smoothness, a multiplier (λ) of the sum of the squares of the trend component's second differences. Given an adequately chosen, positive value of λ , there is a trend component that will minimize the formula. Hodrick and Prescott (1980) established a value of $\lambda = 1600$ for quarterly data.

The band-pass (BP) filter of Baxter and King (1995)¹¹ uses moving averages that isolate the periodic components of an economic time series that lie in a specific band of frequencies. Baxter and King's (1995) business cycle filter, referred to as a linear filter, eliminates very slow moving (trend) components and very high frequency (irregular) components while retaining intermediate (business cycle) components. This method does not require judgments about trend breaks; however, it requires analysts to make assumptions about how the filters are structured, including the values of one or more parameters. The filters are two-sided symmetric linear filters that apply a set of weights $a_i, i = 0, \pm 1, \pm 2, \dots$ to a time series y_t .

4.3 The Hamilton Parametric Dating Procedure

The Hamilton Parametric Dating procedure assumes a statistical model and uses it to deduce the chronology from the turning points and the characteristics of the cycle. A Markov chain is used to represent the economic evolution of the economy given that the business cycle consists of a finite number of possible outturns. These outturns are the expansionary and recessionary phases. In recent years, the Hamilton Parametric Dating procedure has been considered comparable and sometimes preferable to the Bry and Boschan Procedure because; (a)

¹¹ See Baxter and King (1995) for a detailed working of the BP filters.

growth rates changes from state to state in the Hamilton model, while it remains constant in the Bry and Boschan procedure, (b) in regard to the mathematical proofs for the identification of turning points, the Hamilton procedure is more precise, and (c) the Markovian approach facilitates the forecasting of turning points as well as allows for statistical inference to be made due to its use of econometric estimation. Hamilton (1994) proposes that the evolution of the variable Δy_t (GDP) be represented as an autoregressive model that includes a two-stage Markov chain. This is done as the successive stages describing an economic situation are essentially positioned on either the ascending or descending path. The objective of this regime switching model is to provide a description and probabilistic valuation of the transitional phase from one stage to another. The model is estimated as follow:

$$\begin{aligned}\Delta y_t &= \mu_{st} + \sum_{i=1}^r \delta_i \Delta y_{t-1} + \varepsilon_i \\ \mu_{st} &= \mu_0(1 - S_t) + \mu_1 S_t \\ \Pr[S_t = 1 | S_{t-1} = 1] &= p_{11} \text{ and } \Pr[S_t = 0 | S_{t-1} = 0] = p_{00}\end{aligned}$$

The first two equations describe the path of Δy_t , by introducing regime changes in the model through both the levels and the variance of Δy_t . $\varepsilon_t \sim \text{i.i.d.} N(0, \sigma^2)$ and S_t is a stage variable defined by $S_t = \{0, 1\}$. Given that S_t is not observable, the estimation of the model is not possible as the stochastic process that generates the values of S_t is restricted.

5.0 Results: Business Cycles for the Jamaican Economy

5.1 Bry and Boschan Procedure

A business cycle is typically defined as the distance between two troughs, or two peaks. An expansion phase in the cycle is represented by the distance between a peak and the preceding trough, while a contraction is the distance between a peak and the subsequent trough. Figure 2 depicts the turning points of the Jamaican business cycle from the Bry and Boschan procedure. The shaded regions are indicative of a contraction in the cycle, while the areas not shaded signal an expansion. During 1981 to 2007, the Bry and Boschan procedure shows that the country experienced two business cycles.

Figure2

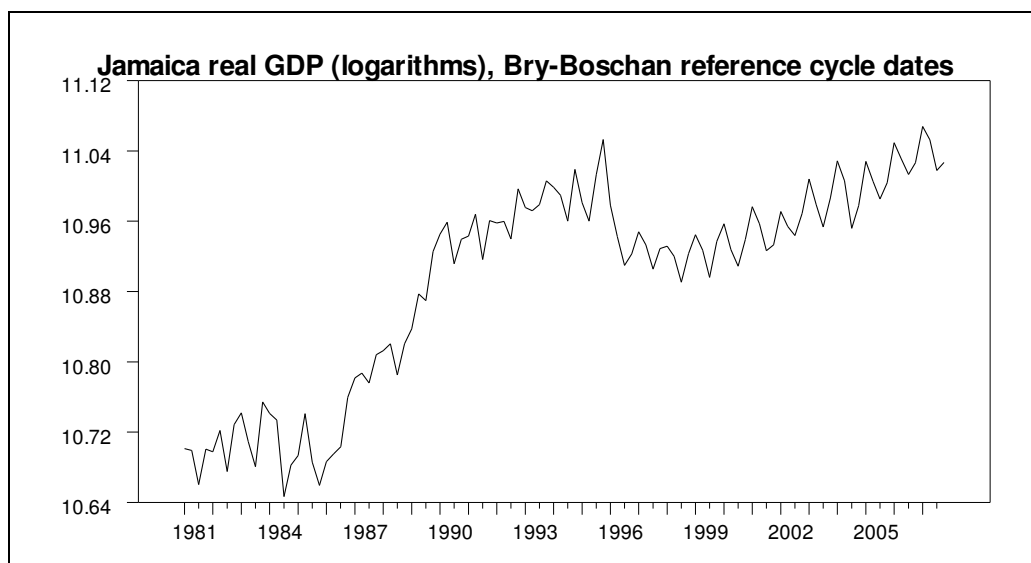


Table1: Chronology of the Jamaican Business Cycle

Contractions		Expansions		Total Cycle
Periods	Duration in Quarters	Periods	Duration in Quarters	Duration in Quarters
1983:4 - 1984:3		1984:4 - 1995:4		
1996:1 - 1998:3	4	1998:4 - 2001:1	45	49
2001:2 - 2001:3	11		10	21
	2			

Table 2: Descriptive Characteristics of the Phases of the Jamaican BBQ¹ Cycle

	Expansion	Contraction	Total
Average Duration	27.5	5.7	24
Median Duration	28	4	21
Min Duration	10	2	2
Max duration	45	11	49
Proportion of time	76.39%	23.61%	100

1 Bry and Boschan Quarterly

Tables 1 and 2 show the duration of expansions and contractions of the Jamaican economy and gives a description of the phases of the Jamaican business cycles, respectively. Table 1 reveals that the Jamaican economy recorded three peaks, in 1983:04, 1995:04 and 2001:01. It also recorded a similar number of troughs, in 1984:03, 1998:03 and 2001:03. The peak and trough are the turning points of the business cycle and act as an indication of the economic activity that occurred for the respective periods.¹² Accordingly there are two periods of expansion and three periods of contraction. The expansionary phases are notably longer than the contractionary phases and lasts between 10 to 45 quarters. The contraction phases last between 2 to 11 quarters. The expansions occurred between the mid 1980's and the mid 1990's and between the late 1990's and early 2000's. The chronology of the real GDP series show that the cycles of the Jamaican economy last between 21 and 49 quarters.

Rand and Tarp (2002) examination of business cycles duration in developing countries showed that developing countries usually record

¹²Peaks and troughs help in the determination of expansions and contractions in the economy.

cycles between 7 and 18 quarters.¹³ Craigwell and Maurin (2005) showed that the Barbadian business cycle lasted between 29 and 38 quarters and were more comparable to those of developed countries. Further, the authors noted that the main difference between Barbados cycle and that of developed countries was the longer contraction phase experienced in Barbados. Barbados contraction phases lasted between 3 and 14 quarters. From the above, it indicates that Jamaica's business cycles are more comparable with that of developed countries, based on its long cycles, extended periods of expansions and relative short periods of contractions.

5.2 The Hodrick Prescott & Baxter King Filters

Figure 3 shows the cycles derived from the HP and BP filters. The peaks and troughs of the cycle are used to discern Jamaica's business cycle.

Figure 3: Comparison of the Hodrick Prescott Filter and the Baxter - King Frequency Filter

¹³ Studied a wide cross section of developing countries from Africa, South America and Asia.



Table 3: Chronology of the Jamaican Business Cycle

Contractions		Expansions		Total Cycle
Periods	Duration in Quarters	Periods	Duration in Quarters	Duration in Quarters
1983:4 -1985:2 1996:1 - 1997:4 2001:3 - 2002:1		1985:4 - 1995:3 1998:1 - 2001:1		
	7 8 3		40 13	47 21

The filters generate similar results in regard to the cycles of the Jamaican economy. However, the cycle generated by the Baxter-King filter is smoother than that deduced by the Hodrick Prescott filter. Table 3 gives the results of the chronology of the Jamaican business cycle according to the filters. Similar to the Bry and Boschan procedure the filters indicate that there are two business cycles in the Jamaican economy for the sample period 1981 to 2007. The cycles occurred from: 1983:4 to 1995:4, and 1996:1 to 2001:2. The duration of the cycles according to the filters is between 21 and 47 quarters. Similar to the Bry and Boschan procedure there are also three periods of contraction and two periods of expansion in the economy. The only dissimilarity between the filters and Bry and Boschan procedure, which is fairly marginal, is in the exact starting and ending dates of the peaks and the troughs. The main advantage of the Bry and Boschan procedure over the filters is that different de-trending methods could extract different types of business cycle information from the original series, resulting in significant qualitative and quantitative differences. Also, the Hodrick Prescott filter can generate business cycle dynamics even if none is present in the original data. However, the Bry and Boschan procedure is a robust non-parametric methodology. Thus, given the reliability of non-parametric models the results of the Bry and Boschan procedure will be used as the formal results of the cyclical chronology of the Jamaican business cycle.

5.3 Results of the Hamilton Procedure

To determine the probability of remaining at each stage of economic activity, the Hamilton parametric dating procedure is applied to the growth rate of the real GDP series. The results obtained after 36 iterations are presented in table 4. The results show that most of the parameters are statistically significant and that the average values of GDP growth rate during expansionary and contractionary phases are -5.0 per cent and 0.6 per cent, respectively. Further, the results indicate that the probability of staying in an expansion ' ρ_{22} ' is very high at 0.957, while the probability of staying in a recession ' ρ_{11} ' is very low at 0.189. The Hamilton procedure also indicates that the average duration of being in a contraction ($1/(1-p_{11})$) is 1.23 quarters, while the average duration of being in an expansion ($1/1-p_{22}$) is 23.3 quarters. This is less than the average durations obtained from the Bry and Boschan procedure which estimated the average duration of contractions and expansions to be 5.7 and 27.5 quarters respectively.

Given the above results, and the fact that the last turning point in Jamaica occurred in 2001:03, a trough, it is reasonable to opine that Jamaica is in an expansionary phase and is expected to reach a peak by end 2007 or early 2008.

Table 4: Maximum Likelihood Estimates of the Hamilton Model

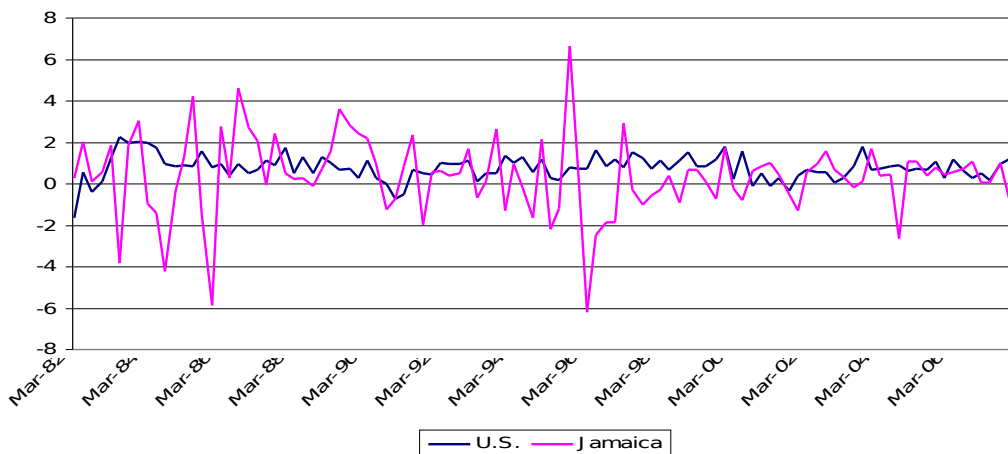
Parameters	Estimates
μ_1	-5.008 (-7.233)
μ_2	0.629 (4.619)
\emptyset_1	0.0875 (0.8419)
\emptyset_2	-0.164 (-1.721)
\emptyset_3	0.307 (3.090)
\emptyset_4	-0.259 (-2.563)

P11	0.189 (1.152)
P22	0.957 (43.768)
σ	1.366 (13.471)
Log-likelihood	-197.018

6.0 Comparing the Jamaican and U.S. Business Cycles

Due to its size and limited productive capacity attributed to the relative scarcity of factors of production, Jamaica is very dependent on industrialized developed countries. Jamaica's main trading partner is the United States of America (US). With the onset of globalization, Jamaica has become even more vulnerable to shocks to the economy of its major trading partners. It is in this context, that the relationship between the US and the Jamaican business cycles is analyzed. Figure 4 shows the relationship between the growth in the US economy and that in Jamaica. A negative correlation of 0.005 exists between the countries growth rates.

Figure 4: Jamaican and U.S Real GDP Growth Rates



The chronology of the US business cycle published by the NBER, as shown in table 5, identifies the dates of peaks and troughs that frame economic recession or expansion in the U.S. The NBER definition of a recession is less restrictive than the Bry and Boschan procedure because it considers the most recursive events, while the Bry and Boschan procedure only uses negative growths as periods of recession.

Table 5: Comparison of the Jamaican and U.S. Business Cycles

Contraction				Expansions			
Jamaica		US		Jamaica		US	
Periods	Durati on in Quart ers	Periods	Durati on in Quarte rs	Periods	Durati on in quarte rs	Periods	Duratio ns in Quarter s
1983:4- 1984:3	4	1981:3- 1982:4	5	1984:4 -1995:4	45	1983:1- 1990:3	31
1996:1 -1998:3	11	1990:4- 1991:1	2	1998:4 - 2001:1	10	1991:2 - 2001:1	40
2001:2 - 2001:3	2	2001:2- 2001:4	3				

	Cycle1 Trough to Trough	Cycle2 Trough to Trough	Average
US	33	43	38
Jamaica	49	21	35

The features of the Jamaican business cycle are fairly similar to those of the US. Both countries have relatively long periods of expansions and short periods of contractions¹⁴. Jamaica and the US experienced two business cycles over the review period as well as three periods of

¹⁴ This is a salient feature of business cycles in developed countries.

recession and two periods of expansion. However, for the majority of the time that Jamaica experiences a contraction, the US was in an expansionary phase. With the exception of the recessionary phase in the US, triggered by the September 11 terrorist attack, the contraction phase in the US coincides with an expansion in the Jamaican cycle. This occurrence was supported by a crude estimate of the synchronization between the two countries cycle. It is estimated that 20.0 per cent of the time that the US is in a recession, Jamaica is in the same state. Likewise, 46.5 per cent of the time that the US is in an expansionary phase, Jamaica is expanding.

Although most of the contractions and expansions experienced by the U.S. and Jamaica did not occur at the same time, some were triggered by the same factors. The contraction that was recorded for both Jamaica and the U.S. in the 1980's was triggered by the oil crisis which occurred in the late 1970's. Similarly the contraction of the 1990's recorded for the U.S. was triggered by Iraq's invasion of Kuwait which caused a jump in oil prices. This turn of events caused a drop in consumer confidence which had a devastating effect on the financial sector (the saving and loan crisis) which forced the U.S. into a recession. Alternatively, the contraction in the Jamaican economy in the 1990's was caused by a financial crisis which occurred because of a lack of efficient supervision. Conversely, the contraction that occurred in 2001 for both countries did so as a result of the terrorist attack on the United States as well as the global economic slowdown. The first period of expansion recorded for Jamaica and the U.S occurred as a result of an increase in capital flow and the recovery of the construction industry respectively. The second period of expansion occurred because of an improvement in the international financial market.

In an attempt to formally determine the degree of business cycle synchronization between the US and Jamaica, a cross correlation analysis of the cyclical components is conducted. The results generated from the cross correlation of the US and Jamaican cycles indicates that there is no lag or lead relationship between the two cycles (see Table 6). This signifies that there is no pronounced relationship between business cycles in the US and Jamaica.

Table 6: Cross correlations of cyclical components of the Jamaican and US GDPs

Delay	-8	-7	-6	-5	-4	-3	-2	-1	0
Corr	-0.138	-0.153	-0.172	-0.170	-0.176	-0.160	-0.160	-0.179	-0.189
Delay	1	2	3	4	5	6	7	8	
Corr	-0.216	-0.163	-0.099	-0.044	0.0407	0.0838	0.1024	0.1564	

To verify if there is an asymmetric relationship between business cycles in the US and Jamaica, the test for asymmetry formulated by Calderon, Chong and Stein (2002) is used. The test is conducted using the following formula:

$$asymmetry(Y_{US}, Y_{Jam}) = \sigma \left(\frac{Y_{US_t} - Y_{US_{t-1}}}{Y_{Jam_t} - Y_{Jam_{t-1}}} \right)$$

In the formula above, σ (.) represents the standard deviation computed over τ periods and Y represents the log of output. It is important to note that the cycles are similar when asymmetry $(Y_{US}, Y_{Jam}) = 0$. The asymmetry of the U.S and Jamaican business cycle has a value of 0.0015 suggestive of high similarity in the cycles of the countries.

7.0 Coincident and Leading Indicators

During the formulation of macroeconomic policies, a timely understanding of the direction of economic activity is important. However, in many instances, the statistics that are required to assess the direction of economic activity are only available with a significant lag, rendering an inadequate policy response. It is in this context, that composite indexes of coincident and leading indicators were created to satisfy policy makers need for a dependable signal of the direction of economic activity in lieu of the release of the official data. A coincident indicator is defined as a variable that is correlated with the current level of economic activity while a leading indicator is one that is correlated with future economic activity. These indexes are used extensively to determine the stage of business cycle activity. Their uses in developing countries are, however, limited due to the lack of sufficient historical data to determine the dependability of the indicators.

The construction of coincident and leading indexes was first conducted by the NBER in the 1930's. The study was pioneered by Burns and Mitchell (1946), who lead a team of researchers to study sets of economic variables in an attempt to identify whether those variables persistently lead, coincided, or lagged turning points in the U.S. business cycle. The study on coincident and leading indicators was further enhanced by Moore and Shiskin (1967) in the 1950's and 1960's. These researchers combined economic series into a composite of leading, coincident and lagging economic indicators. This was done by applying a formal weighting scheme that scored the variables in terms of their economic significance, statistical adequacy, cyclical timing and business cycle conformity.

The Burns and Mitchell (1946) methodology was criticized in two aspects by Koopmans (1947) and others. Firstly, in determining the relationship

between the indicators and economic activity little or no reliance was placed on economic theory. Secondly, the method was not considered scientific as it relied on subjective analysis instead of an econometric approach.

It is with these shortcomings in mind that Stock and Watson (1989) developed an econometric model to formulate coincident and leading indicators. The authors defined the composite index of coincident indicators as a single unobserved variable, “the state of the economy.” The index was estimated using dynamic factor analysis, where the parameters of the index were determined by maximum likelihood estimation. The composite index of leading indicators was formulated by constructing a forecast of the index of coincident indicators using a vector autoregressive model.

8.0 The Stock and Watson Theoretical Approach: Coincident and Leading Indicators

The Stock and Watson (1992) composite coincident index is based on an econometric model in which the ‘state of the economy’ is an unobservable variable that share similar characteristics with many macroeconomic variables. It is the fluctuations in these variables, which share a common element that is estimated. Given that the derived coincident index should reflect the state of the economy, it stands that a fair forecast of the coincident index should give an appropriate leading index. The approach is founded on the notion that the co-movements in many macro economic variables have a common element that can be captured by a single underlying, unobserved scalar time series, referred to as C_t .

The model is structured as follows:

$$Z_t = \beta + \gamma C_t + u_t \quad (1)$$

$$\Psi (L) C_t = \delta + \eta_t \quad (2)$$

$$D (L) u_t = \epsilon_t \quad (3)$$

Z_t represents an $n \times 1$ vector of macroeconomic time series variables that are assumed to move contemporaneously with overall economic conditions. Z_t consist of two components, the unobserved scalar component and the error. Also, C_t is assumed to enter each of the variables contemporaneously, while β is the mean of Z_t . $\Psi (L)$ and $D (L)$ are scalar lag polynomial and a polynomial matrix respectively. Additionally, Z_t is a vector of the logarithms of time series variables. The lag polynomials $\Psi (L)$ and $D (L)$ are autoregressive processes that are assumed to have finite orders of p and k respectively. The stochastic component of C_t is represented by $\Psi (L) C_t = \delta + \eta_t$; where, as previously mentioned $\Psi (L)$ is an autoregressive operator of order p , and δ is the mean of C_t .

Many macroeconomic time series are characterized as having stochastic trends, which enter through C_t , therefore each element of Z_t would contain a stochastic trend that would be common to each element. In this regard, Z_t would be cointegrated of order $k-1$.

Consequently, the system is re-specified as:

$$\Delta Z_t = \beta + \gamma \Delta C_t + u_t \quad (4)$$

$$\Psi (L) \Delta C_t = \delta + \eta_t \quad (5)$$

$$D (L) u_t = \epsilon_t \quad (6)$$

The estimated value of ΔC_t is the coincident index, which is a linear combination of past and present values of ΔZ_t . $\Delta C_{t/t} = W(L) \Delta Z_t$, and $W(L)$ is a weighting vector. To estimate the model, equation (4) – (6) are transformed in state-space form and the unobserved state of the economy estimated using the Kalman Filter. The Kalman Filter estimation consists of two parts, the state equation and the measurement equation. The state equation describes the evolution of the unobserved state vector, which consists of ΔC_t , U_t and their lags. The measurement equation relates the observed variables to the elements of the state vector.

To estimate the leading indicator, Stock and Watson (1992) used the Vector Autoregressive (VAR) methodology. This can be represented as:

$$\Delta C_t = \mu_c + \lambda_{cc}(L) \Delta C_{t-1} + \lambda_{cy}(L) Y_{t-1} + V_{ct} \quad (7)$$

$$Y_t = \mu_y + \lambda_{yc}(L) \Delta C_{t-1} + \lambda_{yy}(L) Y_{t-1} + V_{yt}$$

(8)

In the formula above, Y_t is a vector of stationary leading indicators and V_{ct} and V_{yt} are serially uncorrelated error terms. ΔC_t is the coincident index, which is correlated with current economic activity, while the leading index is correlated with future economic activity.

8.1 Result: Coincident Indicator

Estimating the coincident index contains a sequence of steps; firstly, a reference series is chosen for the Jamaican economy, real GDP. Secondly, variables of coincident indicator are chosen based on their level of correlation with real GDP, their contribution to GDP and the closeness of their evolution with that of GDP. The variables of choice are the industrial production index, tourism value added, and distributive trade value added.¹⁵ Table 7 shows the correlation of the

¹⁵ The industrial production index was constructed from production in the electricity, manufacturing, mining and agriculture industries. A number of variables were initially considered, however, only three were chosen as coincident indicators.

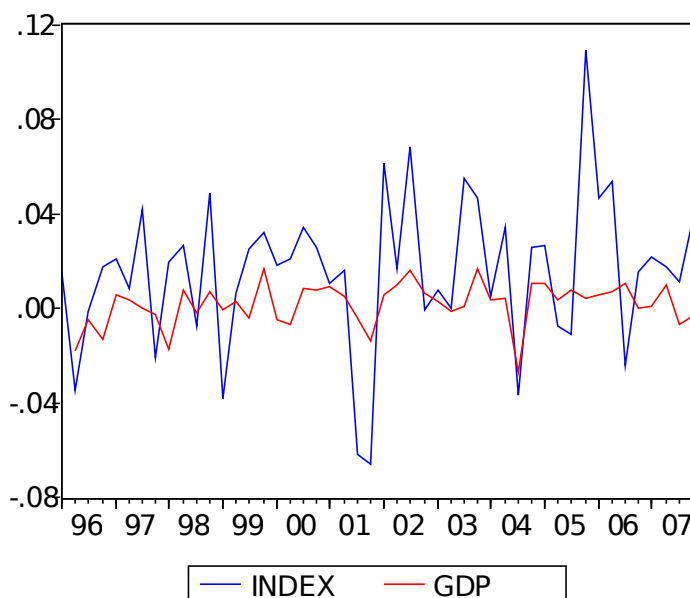
variables with GDP. Thirdly, the series are logged and tested for unit roots; the augmented Dickey Fuller test reveals that all the variables have to be differenced once to become stationary (see table 1 in Appendix B). The series are then seasonally adjusted using the census X12 procedure.¹⁶ The evolutions of the series are presented in figure 1 in appendix B. The Johansen cointegration test reveals that the variables are not cointegrated at the 5% level of significance (see table 2 in appendix B). The variables used in the paper are normalized by subtracting the mean and dividing by the standard deviation of its difference. This is done to standardize the amplitude of the series.

Table 7: Correlation of GDP with the Coincident Indicators

	RGDP	TOUR	IPI	DIST
RGDP	1.000000	0.875085	0.709299	0.753734
TOUR	0.875085	1.000000	0.693091	0.512096
IPI	0.709299	0.693091	1.000000	0.427689
DIST	0.753734	0.512096	0.427689	1.000000

The Kalman filter applied to equations 4-6 recursively constructs minimum mean square error (MMSE) estimates of the unobserved state vector,

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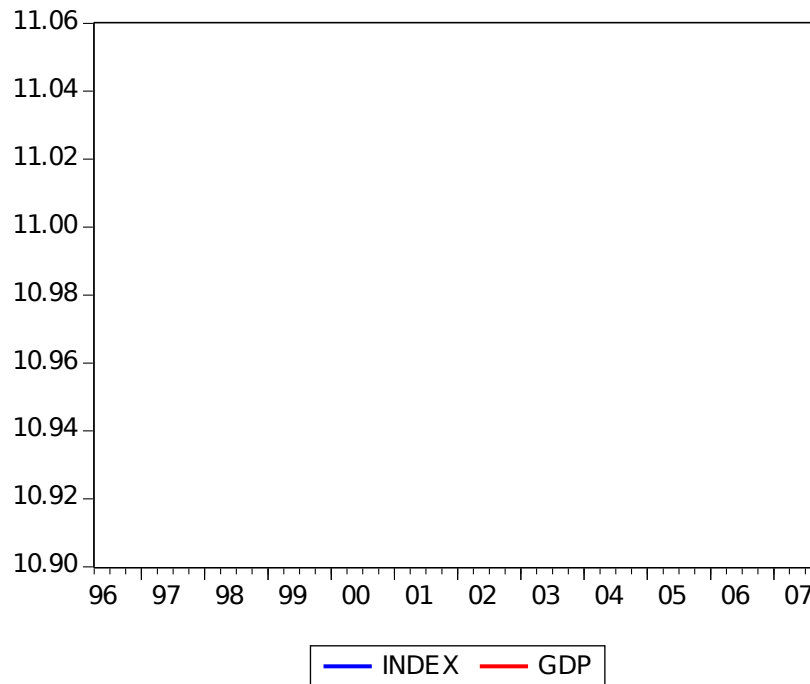
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Figure 4 shows that movements in the coincident index pick up most of the turning points in real GDP growth. The coincident index growth is, however, more volatile than GDP growth. Of note, the coincident index growth is used to obtain a general direction of economic activity or the stage of business cycle activity and not necessary the magnitude of that activity. The next step is to derive the coincident index from the coincident index growth rates. A simple procedure is used to derive this index. The initial value of the coincident index is set equal to the equivalent observation of the log of real GDP. Subsequent observations are then derived by multiplying the previous observation by the fitted quarterly growth rate of the coincident index. The coincident index is graphed with log real GDP in figure 5.

Figure 5: Comparison of Coincident Index and Log of Real GDP



As mentioned before, the coincident index picks up most of the turning points in the cyclical behaviour of real GDP. However, in some parts of the sample the coincident index tends to understate the cyclical fluctuations in the real GDP series. This can be attributed to the preponderance of weather changes in determining the business cycle of emerging economies as well as sudden shocks to the economy.

8.2 Result: Leading Indicator

The procedure for estimating the leading index is similar to that for the coincident index. Variables of leading indicator are chosen from different sectors of the economy based on their level of correlation with real GDP. The variables chosen for the construction of the leading index are net foreign assets of commercial banks, consumer goods imports, M2, and CPI. Next, the series are logged and tested for unit roots. The augmented Dickey Fuller test reveals that the variables are integrated of order one. The series are seasonally adjusted using the

census X12 procedure. Table (8) shows the correlation of the variables, while figure 1 in appendix C shows the evolution of the series.

Table 8: Correlation of Real GDP and the Leading Indicators

	LRGDPSA	LCONGDSS A	LCPIISA	LM2SA	LCFASA
LRGDPSA	1.000000	0.707874	0.877842	0.784754	0.840592
LCONGDSS A	0.707874	1.000000	0.908182	0.942672	0.852214
LCPIISA	0.877842	0.908182	1.000000	0.970212	0.931297
LM2SA	0.784754	0.942672	0.970212	1.000000	0.940522
LCFASA	0.840592	0.852214	0.931297	0.940522	1.000000

The Johansen cointegration test reveals that the variables are not cointegrated at the 5 per cent level of significance, suggesting that the use of the VAR methodology is suitable. To construct the leading index, the VAR is applied to equations 7 and 8. The series are differenced and a VAR in first differences is estimated. The leading horizon used for this paper is two quarters; this is in line with the NBER- CB and the OECD methodologies. This time period is expected to provide policy makers with sufficient time for policy formulation. After estimating the VAR equation 1 in Appendix C is obtained:

Figure 6 shows a lagged relationship of two quarters between the growth rate of the leading index and that of real GDP. The root mean square error of this estimate is 0.009. To derive the leading index, the fitted growth rates of the index are used in the same manner as in the construction of the coincident index. The initial value of the index is set equal to the equivalent observation of the log of real GDP. Subsequent observations are then derived by multiplying the previous observation by the fitted quarterly derived growth rate of the leading index. Figure 7 graphs the index.

The leading index forecasts most, but not all of the peaks and troughs in the economy. Of note, the leading index performs reasonably as an indicator of contractions and expansions in the economy. Most of the recessions and contractions forecasted by the leading index did materialize; however, it failed to predict the significant level of contraction in 2004, attributed primarily to weather related causes, Hurricane Ivan. Typically, composite indicators have the downfall of not capturing weather changes or man made disasters.

Figure 6: Comparison leading Index and Real GDP Growth Rates

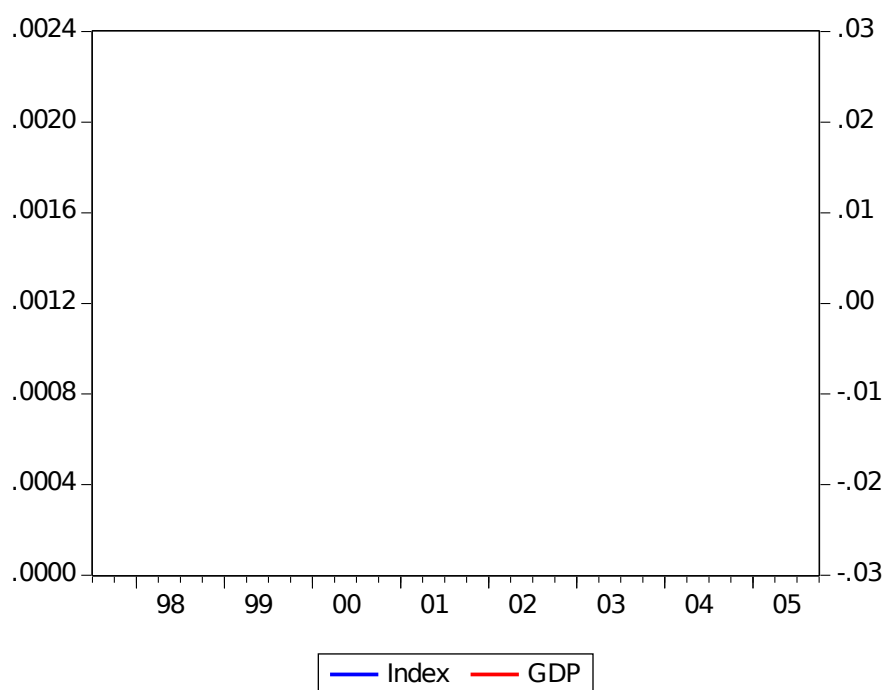
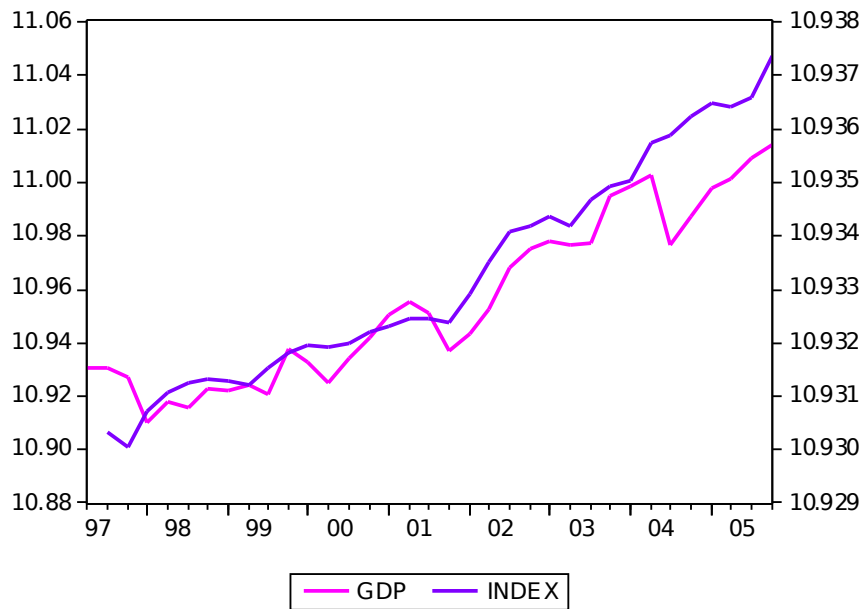


Figure 7: Comparison of the Leading Index and the Log of Real GDP



In an attempt to enhance business cycle analysis and equip policy makers with real time estimates, a forecast of the leading index is conducted. This forecast is expected to provide information on the direction of the economy.

Figure 8: Forecast of the Leading Indicator

The projections in figure 8, indicate that the quarterly forecast of the direction of economic activity made by the leading index between 2006 and 2007 were reasonably accurate. The leading index, therefore could serve as a reference point for policy makers in the Jamaican economy. The performance of the index could be made better with the availability of more highly correlated indicators.

Conclusion

This paper has provided a detailed analysis of the Jamaican business cycle and has attempted to provide leading forecasts of the county’s cycles. In addition, the study examined the relationship between the U.S. and the Jamaican business cycles.

The paper finds that the Jamaican economy experienced two business cycles, from 1983:04 to 1995:04 and 1996:1 to 2001:01. The expansionary phases are notably longer than the contractionary phases and lasts between 10 to 45 quarters. The contraction phases last between 2 to 11 quarters. The chronology of the real GDP series show that the cycles of the Jamaican economy last between 21 and 49 quarters. In this context, Jamaica's business cycles are found to be more comparable with that of developed countries, based on its long cycles, extended periods of expansions and relative short periods of contractions. The Hamilton Parametric Dating procedure revealed that the probability of staying in a recession is 0.189 while the probability of staying in an expansion is 0.957. It also estimated the average duration of an expansion to be 23.25 quarters and the average duration of a contraction to be 1.23 quarters.

Given that the last turning point in Jamaica occurred in 2001:03, a trough, it is reasonable to opine that Jamaica is in an expansionary phase and is expected to reach a peak by end 2007 or early 2008. Further the coincident index is found to be useful in capturing the peaks and troughs, while the leading index is useful for predicting future evolution of the economy.

A comparison of the Jamaican and U.S business cycles revealed that business cycles in Jamaica are fairly similar to that of the US. Jamaica and the US experienced two cycles over the review period as well as three periods of recession and two periods of expansion. The results generated from the cross correlation of the US and Jamaican cycles signifies that there is no synchronization between business cycles in the countries. However, there is a high level of asymmetry between the two cycles as depicted by a formal test.

Given that the Jamaican GDP data is available with a lag, the coincident index provides an alternative to policy makers to the general direction of economic activity. Further, the leading index helps policy makers as it provides valuable information about the future path of the economy.

Possible extensions to the paper include the use of more highly correlated indicators to improve the construction of the indexes. Further, a sectoral analysis of Jamaica's business cycle could be researched.

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APPENDICES

Appendix A: Definition of Variables and movement of Trade between Jamaica and the US.

Table 1: Definition of Variables

Name	Definition
Tour	Tourism (Hotels, Restaurants and Clubs)
IPI	Industrial Production Index
DIST	Distributive Sales

CFA	Net Foreign assets of Commercial Banks
CPI	Consumer Price Index
M2	M2
CONGD S	Consumer Goods Imported

Appendix B: Results of the Coincident Index

Table 1: Unit Roots

Variables	Level	First Difference
IPI	-2.912 (0.0514)	-9.2113 (0.000)
Tour	-2.994 (0.1447)	-7.073 (0.000)
DIST	-2.303 (0.4241)	-5.592 (0.000)
CFA	-1.800 (0.6885)	-7.382 (0.000)
CONGDS	-2.429 (0.3605)	-9.318 (0.000)
M2	-3.122 (0.1134)	-5.343 (0.000)
CPI	-0.780488 (0.9602)	-4.927 (0.001)

Figure 1: Series Evolution

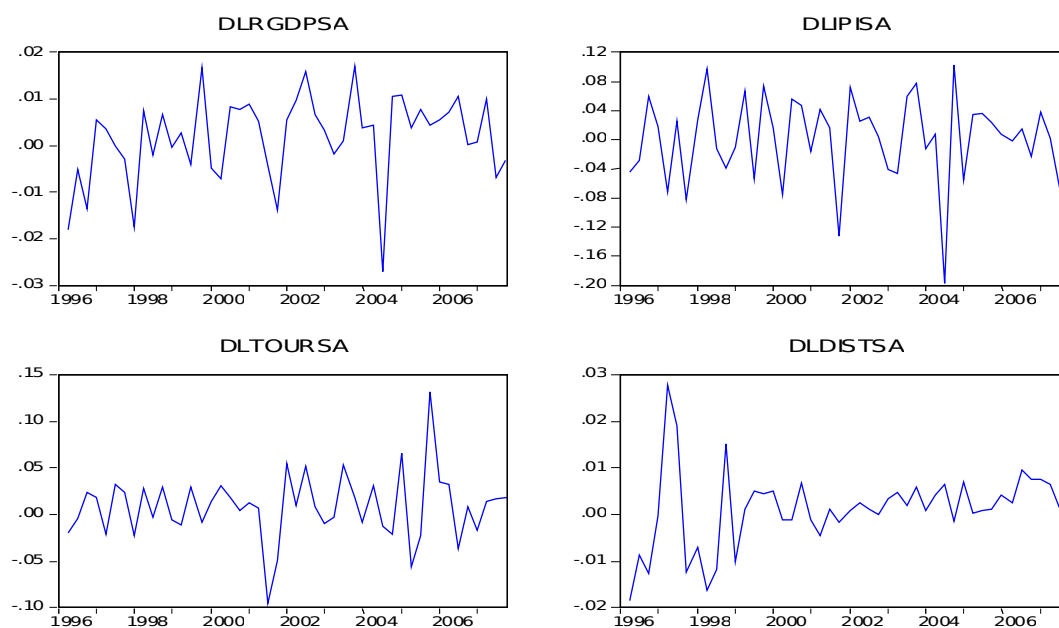


Table 2: Results of Cointegration Test

Date: 07/14/08 Time: 10:03
 Sample (adjusted): 1996Q3 2007Q4
 Included observations: 46 after adjustments
 Trend assumption: Linear deterministic trend
 Series: LDISTSA LIPISA LTOURSA
 Lags interval (in first differences): 1 to 1
 Unrestricted Cointegration Rank Test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.298454	26.58958	29.79707	0.1121
At most 1	0.200163	10.28403	15.49471	0.2595
At most 2	0.000218	0.010044	3.841466	0.9199

Trace test indicates no cointegration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.298454	16.30556	21.13162	0.2075
At most 1	0.200163	10.27398	14.26460	0.1946
At most 2	0.000218	0.010044	3.841466	0.9199

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Measurement Equations

$$\Delta LIPISA = 0.00147 - 2.894 \Delta Ct + Ut$$

$$\Delta LTOURSA = 0.00445 - 12.281 \Delta Ct + Ut$$

(0.9763) (0.995)

$$\Delta LDISTSA = 0.0334 - 13.84 \Delta Ct + Ut$$

(0.8354) (0.9998)

State Equations

$$Ut^{IPI} = -0.354U_{t-1}^{IPI} - 0.264U_{t-2}^{IPI} + \varepsilon_t^{IPI}; \sigma = -0.862$$

$$\begin{aligned}
U_t^{\text{Tour}} &= -0.8084U_{t-1}^{\text{Tour}} - 0.8545U_{t-2}^{\text{Tour}} + \varepsilon_t^{\text{Tour}}; \sigma = 0.204 \\
&\quad (0.3615) \quad (0.6642) \quad (0.9214) \\
&\quad (0.0081) \quad (0.754) \quad (0.4522) \\
U_t^{\text{DIST}} &= 1.154*U_{t-1}^{\text{Dist}} - 0.8625U_{t-1}^{\text{Dist}} + \varepsilon_t^{\text{Dist}}; \sigma = 0.297 \\
&\quad (0.000) \quad (0.000) \quad (0.0758)
\end{aligned}$$

$$\begin{aligned}
\Delta C_t^{\text{IPI}} &= -0.623 + \eta_t \\
&\quad (0.9185)
\end{aligned}$$

$$\begin{aligned}
\Delta C_t^{\text{Tour}} &= 0.0246 + \eta_t \\
&\quad (0.9091)
\end{aligned}$$

$$\begin{aligned}
\Delta C_t^{\text{Dist}} &= 0.0786 + \eta_t \\
&\quad (0.8237)
\end{aligned}$$

Appendix C: Results of the Leading Indicator

Equation 1

$ \begin{aligned} Dlead_{t+2} &= 0.3147*dcoindpt (-1) + 0.0574*dcoindpt (-2) - 0.4609*dcoindpt (-3) - \\ &0.4958*dcoindpt (-4) + 0.0199*dlcfasa (-1) + 0.0028*dlcfasa (-2) + 0.0124*dlcfasa \\ &(-3) + 0.0029*dlcfasa (-4) - 0.0099*dlcongdsaa (-1) - 0.0022*dlcongdsaa (-2) - \\ &0.0027*dlcongdsaa (-3) + 0.0045*dlcongdsaa (-4) - 0.0585*dln2sa (-1) + \\ &0.0448*dln2sa (-2) - 0.0480*dln2sa (-3) + 0.0109*dln2sa (-4) + 0.0545*dlcpisa \\ &(-1) + 0.0109*dlcpisa (-2) + 0.0010*dlcpisa (-3) + 0.2045*dlcpisa (-4) - 0.0028 \end{aligned} $

Figure 6: Leading Indicators Series Evolution

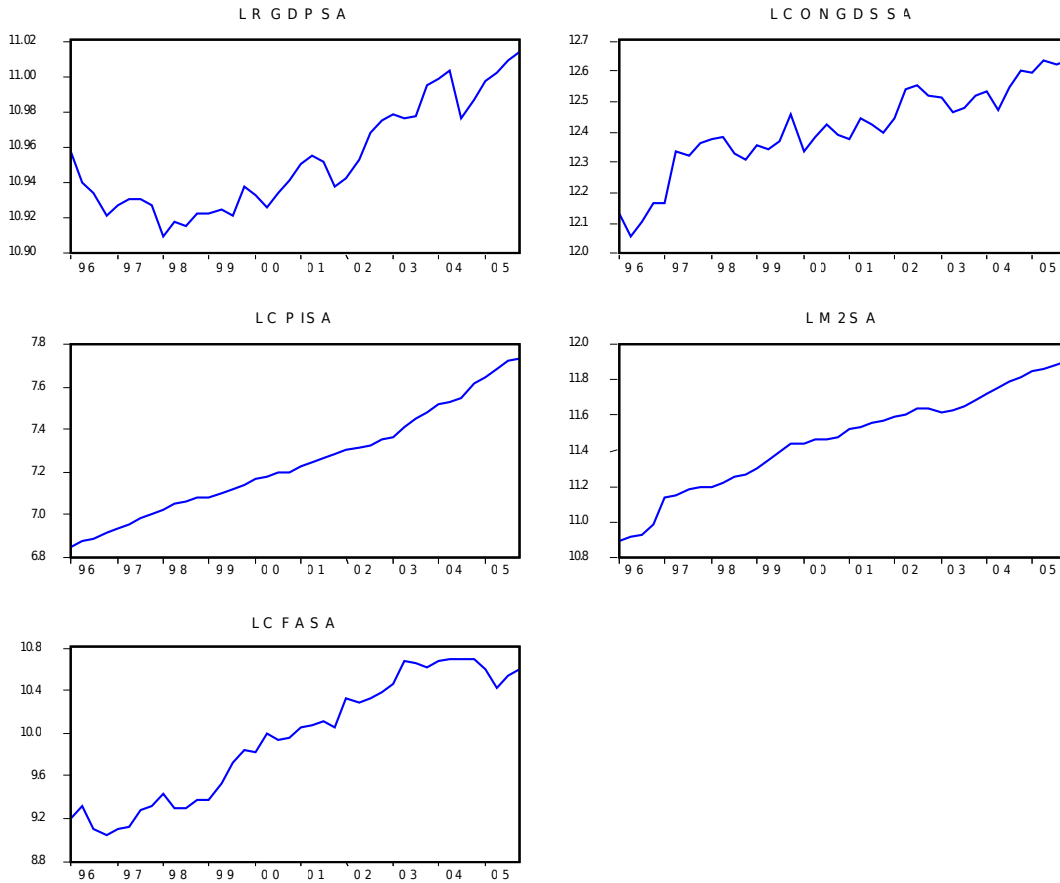


Table 1: Results of Cointegration test

Date: 07/11/08 Time: 10:09
 Sample (adjusted): 1996Q4 2007Q4
 Included observations: 45 after adjustments
 Trend assumption: Linear deterministic trend
 Series: COINDPT LCFASA LCONGDSSA LM2SA LCPISA
 Lags interval (in first differences): 1 to 1
 Unrestricted Cointegration Rank Test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**

None	0.406004	62.04294	69.81889	0.1780
At most 1	0.366717	38.60325	47.85613	0.2764
At most 2	0.252575	18.04554	29.79707	0.5627
At most 3	0.100965	4.945109	15.49471	0.8146
At most 4	0.003452	0.155621	3.841466	0.6932

Trace test indicates no cointegration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.406004	23.43969	33.87687	0.4971
At most 1	0.366717	20.55770	27.58434	0.3038
At most 2	0.252575	13.10044	21.13162	0.4430
At most 3	0.100965	4.789488	14.26460	0.7681
At most 4	0.003452	0.155621	3.841466	0.6932

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values