PLANTATIONS, STAPLE EXPORTS AND THE SEASONALITY OF BIRTHS IN JAMAICA: 1880-1938[1]

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INTRODUCTION

Historical demography has traditionally focused on the levels of fertility, mortality and migration, and on variation in these with respect to time and place. Interest has recently been shown in the seasonality of vital events in an effort to place demographic performance within a broader framework of society and economy. [Nurge 20, Thompson and Robbins 29, Spencer, Hum and Deprez 26, Spencer and Hum 27].

Within the Caribbean, Jamaica has been the subject of considerable historical demographic research. [See, for example, Braithwaite 4, Comitas 6, Smith 28]. On the whole, these studies have had a three-fold thrust: (i) to describe demographic performance at particular points in time, (ii) to describe patterns of demographic change over relatively long time periods, and (iii) to describe demographic performance and patterns of demographic change among particular regions, with special attention to urban-rural variation. Thus far the literature on Jamaica has been relatively unconcerned with seasonality in demographic events.

The present study attempts to assess the seasonality of births as registered in the rural parishes of Jamaica during the late 19th and early 20th centuries. In the first place, we are interested in determining the extent to which such seasonality actually existed within the several administrative parishes of Jamaica. Secondly and more important, we wish to examine the possibility that variation in the degree of seasonality of births among individual parishes was systematically related to differences in the nature of parish social and economic structure.

Determination of the existence of seasonality of births may be approached in a straightforward, although generally unfamiliar, statistical manner. The second objective of this study requires a prior discussion of the determinants and meaning of parish social and economic structure, as well as an explanation of the relationships between that structure and the seasonality of births. Part one of this paper is given over to the latter discussion. In part two we describe the data and empirical classification of individual rural parishes which allow a statistical assessment of the propositions. Parts three and four contain a brief discussion of the method of analysis and interprets the results of that analysis. Implications of the findings are then discussed in a concluding section.

PARISH SOCIO-ECONOMIC STRUCTURE

The concept of parish socio-economic structure is best viewed as an extension of two general approaches to the study of Jamaican economic history: the staple export theories of growth and the plantation thesis of economic underdevelopment. It is useful, therefore, to review briefly the principal features of each general approach.

Based on the early work of Harold Innis [13] and Douglas North [19] and subsequently modified along the lines suggested by Melville Watkins [30], Jonathan Levin [15], Dudley Seers [25] and others, staple export theories stress the differential impact of export and domestically consumed production on such aggregate measures of economic performance as national income, employment, investment and the rates of change of these variables over time. It is argued that a dynamic and expanding staple export sector will raise the level of such aggregate measures of economic performance far above what may be expected under the circumstances of domestically consumed agricultural production. Indeed some authors appear to hold that the staple export sector provides the most important, if not the only, means by which economically underdeveloped regions may hope to generate the surplus required to achieve self-sustaining growth. [Lewis 16, Rostow 24].

The apparent failure of certain staple exporting regions to achieve such growth has encouraged the examination of institutional barriers to rapid economic growth. Particular emphasis has been laid on the organizational form of agricultural production. Reflected in the work of Robert Baldwin [1], Lloyd Best [3], George Beckford [2] and others, this approach has stressed the differential development impact of plantation as opposed to peasant forms of agricultural organization. Special attention is paid to the ways these organizational forms of production affect the distribution of income between and among factors of production, the propensities to save and to invest, the predilection towards technological innovation, and the nature of social, cultural and political relationships within the region under study.

It is clear that these two general approaches to the study of Jamaican economic history are highly complementary. Depending upon the specific problem under examination one approach may be given added emphasis, but any comprehensive understanding of Jamaican economic change requires that attention be given to both these approaches simultaneously [Lobdell 17].

Against this background it may be expected that Jamaican administrative parishes which differed with respect to the nature of crops cultivated and/or the organizational forms of agricultural production also differed in socio-economic characteristics. Let us assume that each agricultural parish produced either staple exports or domestically consumed crops exclusively, and that production was organized exclusively either by plantations or small settlers ('peasants'). With these assumptions it is possible to distinguish four ideal-type rural parishes:

Class I – Parishes in which staple exports were produced by plantations.

Class II – Parishes in which staple exports were produced by peasants.

Class III – Parishes in which domestically consumed crops were produced by plantations.

Class IV – Parishes in which domestically consumed crops were produced by peasants.

The socio-economic structure of these ideal-type parishes may be expected to differ in a number of important respects.[2] Here we concentrate on only two: (i) the general stability of parish economic activity over time, and (ii) the nature of parish social organization. It will be argued that both features may be expected to influence the extent to which seasonality of births occurred within the several parishes.

The stability of parish economic activity over time was influenced by two different types of temporal variation. Firstly, there were short period cycles in the rhythm of economic activity that arose out of the nature of the crops actually produced within a parish. The cultivation and harvesting of many staple export crops (e.g., sugar cane, coffee, cocoa and various spices) are highly seasonal. Thus periods of feverish activity alternate with periods of 'dead season' and tend to generate marked cycles in employment and household incomes. Conversely, the cultivation and harvesting of most domestic crops (e.g., yams, cocoes, fruits, vegetables and the grazing of small livestock) are more evenly spaced throughout the year.

The second type of temporal variation in parish economic activity results from what may be termed exogenously induced fluctuations in the composition of parish output. For example, a deterioration in staple export prices due to changed international market conditions may have induced a shift in the nature of the crops cultivated in a particular parish, and hence resulted in a change in the short period cycles of economic activity. Similarly, the appearance of crop-specific disease may have induced a change in the composition of parish output and thus altered the seasonal patterns of parish economic activity. However, these are not the consequence of seasonal or other regularly recurring variations and as a result need not directly concern the present study.

It is likely that seasonality in parish economic activity contributed significantly to cyclical patterns in social behaviour. Certainly, there is evidence to suggest that temporary migration was very sensitive to seasonal cropping patterns, and that this ebb and flow within parishes given over to the production of staple exports was a source both of social vitality and of social crisis.[3] Elsewhere it has been argued that cyclical patterns in the number of births in agricultural regions are related to cyclical patterns in work load and employment. [Nurge 20, Thompson and Robbins 29, Spencer, Hum, Deprez, 26, 27]. Although some uncertainty attaches to the precise nature of this relationship, it appears that seasonality in economic activity and seasonality in births are related. Similarly, it has been shown that the seasonality of births is considerably less marked in regions where economic activity was less seasonal in nature.[4] Hence, it may be supposed that Jamaican parishes given over to the cultivation of staple exports would tend to exhibit more seasonality in births than would parishes in which agricultural production was concentrated on domestically consumed crops.

The second feature of parish socio-economic structure to be considered here is the nature of parish social organization. It is generally held that the nature of social organization within Caribbean territories depends to a large extent on the manner in which economic activity is organized.[5] In particular, it is common to distinguish 'plantation society' from 'peasant society' when discussing general types of Caribbean social organization.

These two general types of social organization differ in many important respects: the customs and traditions governing the use and ownership of land; the perceived and actual opportunities for social and economic mobility on the part of individuals; the ability to influence the social and economic policies of government; the nature of social institutions through which individuals are integrated into some larger community. In so far as social behaviour depends upon the nature of social organization, it is to be expected that variation in such behaviour will be evident between parishes in which production was organized by plantations and those in which peasant production predominated.

Demographic performance is an important component of social behaviour and hence may be expected to vary between different types of parish social organization. Available data indicate that general demographic performance did in fact vary considerably from parish to parish during the late 19th and early 20th centuries [Roberts 23]. More specifically, the level of fertility appears to have been lower, and the level of mortality higher, in parishes wherein production was organized by plantations rather than by small settlers [Lobdell 17]. That is, population growth through natural increase appears to have been at least partly related to the nature of parish social organization.

These relationships notwithstanding, it is difficult to forsee that the nature of parish social organization would have a noticeable impact on the seasonality of births. Unlike the seasonality in economic activity which is inherent in the production of particular crops, the previously described characteristics of parish social organization *per se* are not obviously subject to any seasonal variation.

Of course it is possible that seasonality in births was not solely dependent on seasonal patterns in parish economic activity. If differing parish social structures embodied peculiar mores which somehow impinged upon the timing of births, then there may have been a degree of seasonality in births among plantation as opposed to peasant parishes. One such possibility lies in the differences that existed with respect to marriage and mating behaviour. It is known that the proportion of females never married and the proportion of females living in very informal visiting arrangements with males were both significantly greater in plantation than in peasant communities [Clarke 5, Appendices 2, 9, Cumper 7, table 6 p. 94]. Quite apart from the obvious implications on the comparative levels of fertility, this differential mating pattern may, in complex and largely unforseen ways, have induced greater seasonality of births in plantation as opposed to peasant communities.

Given that the organizational form of agricultural production has been a principal interest in the study of Jamaican economic history, it is useful to investigate empirically the possibility that seasonality of births was more marked in plantation parishes. Even though the exact causal mechanism is vague and imprecise, such an investigation may prove helpful to an understanding of the non-economic causes of seasonality and to a further elaboration of the broader consequences of organizational forms of production.

It is now possible to offer some tentative propositions which relate the nature of ideal-type socio-economic structures to observed patterns of seasonality of births. Those parishes in which production was dominated by the cultivation of staple exports (Class I and Class II) may be expected to have experienced greater variability of births than those parishes in which production was dominated by the cultivation of domestically produced crops (Classes III and IV). To a less marked extent, those parishes in which plantations organized production (Classes I and III) may be expected to have experienced greater variability than those parishes in which production was organized by peasants (Classes II and IV).

When considered simultaneously, the nature of crops actually produced and the organizational form of production may be expected to re-inforce or mitigate the tendency towards seasonality of births within individual agricultural parishes. Thus, parishes in which staple exports were produced on plantations (Class I) may be expected to have experienced a greater degree of variability of births than did those parishes in which domestic crops were produced by peasants (Class IV). On the other hand, parishes in which domestic crops were produced by plantations (Class III), or in which staple exports were produced by peasants (Class II), may be expected to show either great or little seasonality in births depending on the relative impact of the crops produced and the organizational form of production.

These propositions must be seen as first attempts to describe the complex relationship between parish socio-economic structure and a specific type of demographic event, namely seasonality of births. The causal mechanisms of such relationships are obviously not comprehensively elaborated and at best are only imperfectly understood. In short, these propositions are not testable hypotheses in the strict sense, but rather are intended to indicate one direction in which future research into these relationships may proceed.

TOWARDS AN EMPIRICAL TEST OF THE PROPOSITION

The Data

In order to examine cyclical patterns in the number of registered births for each parish, it is necessary to obtain registration of births by month or quarter in each year. Fortunately, the *Annual Reports of the Registrar-General for Jamaica*[6] tabulate the number of births by quarter of registration in each of the fourteen parishes for the period 1880-1938. On the whole these data appear to be reasonably complete and consistent with the various population censuses beginning in 1881 [Roberts 23, pp. 16-28].

There are two minor difficulties associated with the use of these data on births. First there is no way to determine whether births were actually registered during the same quarter as they occurred. It is likely that some lag occurred between actual date of birth and the date of registration. If this time lag were relatively short, then the accuracy of the published data will not be seriously impaired except in the case of births at the end of one quarter which were subsequently registered in the following quarter. Since there is no obvious method by which possible lags may be incorporated in the published data, we assume that all births registered in a given quarter actually occurred in that quarter.

A second possible difficulty arises because births were recorded on the basis of the parish of registration rather than the mother's parish of normal residence. Only in the cases of Kingston and St. Andrew parishes does this appear to have been a significant problem. Especially after 1920, women normally resident in suburban St. Andrew frequently gave birth in hospitals sited in the urban parish of Kingston. Thus, it is customary to aggregate the parishes of Kingston and St. Andrew when examining demographic data [Roberts 23, p. 280]. In all other cases, we have assumed that the parish of registration and the mother's parish of normal residence coincided.

There are two types of historical data which are useful in the classification of parishes on the basis of socio-economic structure. First, annual data on acreage under specific crop are readily available in the published *Handbook of Jamaica* [10]. Although collected for the purpose of taxation and thus open to imprecision as a result of tax evasion, these data provide a reasonable index of the nature of crops actually cultivated in each parish. The proportion of cultivated acreage under staple export crops is a particularly useful index of the degree to which a given parish was dominated by the production of staple exports as opposed to domestic crops. Apart from the problem of tax avoidance, it is evident that these data do not adequately deal with land simultaneously cultivated in more than one crop. In the absence of any method by which such double counting may be eliminated, it has been necessary to assume the essential accuracy of the published data.

The *Handbooks* also provide information which affords an estimate of the degree to which the organization of agricultural production was undertaken by plantations. Detailed annual figures are available concerning the acreage under the control of banana, sugar and coffee plantations, although it must be noted that these plantations often produced a variety of crops. Using this information, it is possible to estimate the proportion of cultivated acreage under the control of plantations within a given parish during any chosen time period.

The resulting plantation index is very crude for two reasons. In the first place, the data do not include other plantations which may have existed within a particular parish. To the extent that these other plantations were small, they may be safely ignored. But if they were sizeable in terms of acreage – as, for example, the so-called 'cattle pens' of St. Ann and Manchester – then the plantation index will understate the prominence of plantations in the organization of parish production.

Secondly, the index tends to overstate the significance of plantations in so far as

the numerator includes all acreage under plantation control whether actually cultivated or not. One might suppose that this overstatement was more or less constant over time and between parishes, in which case the significance of the error is greatly diminished. If such an assumption is rejected, then one must admit to a possibly substantial and irreducible error in the plantation index.

Empirical Definitions

Our empirical definition of the number of registered births in any given quarter for any particular parish is simply the data as published by the Registrar-General. Since the problem under investigation centres on the seasonality of births and not on the levels of fertility, it is not necessary to adjust birth registrations for the size or composition of parish populations.

An empirical definition of an agricultural parish's socio-economic structure is less straightforward. The ideal-type parish socio-economic structures are not directly useful for empirical investigation, since both the data and contemporary observers agree that each agricultural parish accommodated plantations as well as peasants, and that output consisted of staple exports as well as domestically consumed crops [Olivier 21 pp. 269-289]. Hence, some rather arbitrary definitions of parish socio-economic structure are required. Fortunately, the resulting empirical classification of parishes appears to be relatively unaffected by fairly wide changes in the criteria established.[7]

We define a parish as "dominated by plantation organization of production" if at least one-quarter of acreage under cultivation was controlled by plantations during the time period under study. Those parishes in which less than one-quarter of acreage under cultivation was controlled by plantations during the period under study, we define as "dominated by peasant organization of production".

In a similar vein, we define a parish as "dominated by staple export production" if at least one-fifth of acreage under cultivation was given over to the production of staple export crops during the time period under study. Those parishes in which less than one-fifth of cultivated acreage was given over to the production of staple export crops during the time period under study we define as "dominated by domestic crop production".

Empirical Classification of Parishes According to Socio-Economic Structures

In an attempt to assess the empirical validity of the previously discussed propositions, we have selected for study the period 1880-1938. Two principal considerations led us to conclude that these years form an appropriate time period. In the first place, the statistical method of analysis requires as long a time series as possible with respect to registered births by quarter and by individual parish. The registration of all vital events appears to have been reasonably comprehensive by 1880 and were reported annually by the Registrar-General until 1938 after which there is a break in the series. Hence the years 1880-1938 represent the longest period for which comparable quarterly data on registered births are conveniently available.

Secondly and more important, the period 1880-1938 appears to have been an era of considerable homogeneity with respect to the empirical classification of individual parish socio-economic structure. This is not to say that each parish was characterized over time by an immutable proportion of cultivated acreage under staple export production and by an inflexible proportion of acreage under the control of plantations. On the contrary, many parishes over time exhibited irregular fluctuations in the use to which land was put, and most parishes experienced diminution in the relative importance of plantation organization. However, with the exception of only a few parishes, these variations were not sufficiently large over time to shift a given parish from one empirical classification to another.

Whether the years 1880-1938 are taken together, or subdivided into various shorter time periods, the application of our empirical definitions yields essentially the same classification of parishes with respect to socio-economic structure. Consequently, in order to facilitate the technical requirements of the statistical analysis, we have chosen to apply the empirical definitions to the whole period 1880-1938. The results of this classification are summarized in Figure 1.

FIGURE 1

AN EMPIRICAL CLASSIFICATION OF PARISHES BY SOCIO-ECONOMIC STRUCTURE, JAMAICA, 1880-1938

Organization of Production

Nature of Crop Produced		Plantation Dominated	Small Settler Dominated
Staple Export Dominated		Class I St. Thomas St. Catherine	Class II Portland St. Mary
Domestic Crop Dominated		Class III Trelawny Clarendon St. James Westmoreland	Class IV Manchester St. Ann St. Elizabeth Hanover

METHODOLOGY

Two basic approaches were employed since we wish to investigate both variations that occur across parishes in Jamaica (cross-sectional analysis) as well as fluctuations throughout time (time-series analysis). As one of the major concerns of our enquiry is to detect whether or not seasonal patterns of births are significantly influenced by such socio-economic characteristics as the nature of the crop cultivated and the organizational form of production, we utilize methods designed for the analysis of multiple classification of data. These 'classical' techniques of variance analysis are reasonably familiar and need not be described here.[8] Very briefly, since the variability of a variable may be the result of several factors of interest, analysis of variance techniques enable us to divide the variance of the measured variable (e.g., the number of recorded births) into portions caused by the several factors of interest (e.g., nature of the crop, mode of production), and a portion caused by experimental error.

While techniques of the analysis of variance have advanced to a considerable degree of sophistication, two considerations led us to view this approach as incomplete for the problem at hand. The first consideration is purely practical. Because of the small number of parishes for which independent vital statistics series are available, we cannot expect very satisfactory seasonal cross-sectional variation to be revealed even when the series are detrended, so that the coefficient of variation reflects mainly the seasonal component. In addition, it is possible that results recorded may be somewhat misleading, as in the case for residents of St. Andrew who had their 'births' registered in Kingston. Finally, because our information is in the form of historical time series data, this feature should be exploited.

The second consideration is of theoretical significance. An important class of questions has to do with the nature of fluctuations through time: for example, does the seasonality of crop production influence birth timing? An adequate response to that question depends upon an accurate characterization of the time-related variation of births rather than variation across parishes; in short, time series analysis is required.

Recently developed statistical techniques known as spectral methods have been used with considerable success in applications requiring the characterizations of time-varying phenomenon [Nold 18]. In somewhat oversimplified terms, spectral analysis is based on the fundamental idea that a series generated by a stochastic process can be usefully decomposed into an infinite number of component cycles, each of which is associated with a specific period or frequency.[9] Time series have commonly been analyzed in terms of such notations as 'trend', 'cycles', 'seasonal', 'error' components as well as visualizing movements through time as 'long run', 'short run' or 'medium run'. Unlike simply comparing peaks and troughs of time series data, spectral methods are based upon rigorous foundations and can accommodate more detailed description. Theorems exist stating that if a series is stationary (essentially trend free), then it can be uniquely decomposed into many uncorrelated components each of which is associated with a period or frequency. 'Frequency' indicates the number of cycles completed per unit time period, and 'period' describes the length of time required for one complete cycle. For example, a frequency centred at 0.25 cycles per quarter year

corresponds to a period of 12 months. The term 'frequency' is simply the inverse of the intuitive concept of 'period'. For technical reasons it is more convenient to represent or characterize a data series with reference to its component frequencies of cycles than to work with time periods of differing lengths.

Having decomposed a data series, one may then speak of the amplitude or relative importance of various cyclical components. The measure of importance adopted is the amount contributed to the overall variance by the component we are considering: thus, for a variable containing a cycle of specific period (or frequency) the importance of the cycle is the reduction in variance affected when this component is removed. Spectral techniques are therefore appropriate for detecting regular periodicities in data ranging from short term seasonal fluctuations to longer term cycles extending perhaps over periods of several years.

The application of spectral methods is not without its many practical considerations, the first of which is whether or not a series of given length provides sufficient observations to estimate the spectrum. The data required depend partly on the length of the cycle of interest. For instance, if the cycle is of length 4 years, each 4 years is in effect one observation. However, there is no agreed upon minimum number of observations below which the tool becomes inappropriate. A second consideration is the choice of the number of estimated components. This choice involves a compromise between the number of frequency intervals at which the spectral density is estimated and the accuracy of each point estimated. Again there exist only general guides resulting from varied experience. It is clear however that decomposing a data series of given length has its advantages in terms of description. Oscillations with periods comparable in length with the length of the data series available are grouped with 'trend' and cycles whose period are shorter than the time-interval between successive observations cannot be extracted. In short, interpretation of such terms as 'long run' and 'rapid oscillations' depends upon the length of the available data series and the time-interval between consecutive observations.

A fundamental problem for the practical application of spectral methods is the issue of non-stationary. The theory and technique is developed under the requirement of 'stationarity', essentially an assumption that the same 'rules' have been in operation throughout the sample. This is likely to be strictly valid in few cases, hence some modification of the data, such as removal of trend, may be necessary before estimates of spectra can be derived. While it is true that the study of non-stationary series is still in its early stages, techniques and methods do exist that minimize undesirable effects due to time-changing spectra under certain circumstances. [Granger and Hatanaka 9].

To summarize, spectral analysis is highly complementary to traditional variance component analysis since, used in combination, it is possible to characterize the nature of the variability both through time as well as across regions.

RESULTS

The majority of our findings are summarized in Tables 1 and 2. Table 1 presents the mean, standard deviation, coefficient of variation (standard deviation divided by

TABLE 1

PARISH	CLASS	MEAN	STANDARD DEVIATION	COEF. OF VARIATION %	SPECTRUM VALUE AT .25 cycles /qtr.	SPECTRUM SHAPE
St. Thomas	I	358.54	69.96	19.51	14,911.63	Single Peak
St. Catherine	I	781.49	149.19	19.09	43,240.24	Single Peak
Portland	II	400.52	77.78	19.42	17,226.35	Single Peak
St. Mary	II	566.92	109.85	19.38	29,680.51	Single Peak
Trelawny	III	329.33	43.37	13.17	3,598.99	Single Peak
Clarendon	III	721.84	87.66	12.14	18,431.42	Single Peak
St. James	III	371.89	55.25	14.86	5,085.21	Single Peak
Westmoreland	III	606.09	70.49	11.63	11,972.60	Single Peak
Manchester	IV	616.95	75.62	12.26	3,185.30	No Peak
St. Ann	IV	655.32	73.21	11.17	4,802.05	No Peak
St. Elizabeth	IV	754.67	87.85	11.64	7,019.23	Double Peak
Hanover	IV	361.44	50.13	13.87	7,068.51	Single Peak
St. Andrew		440.45	85.75	19.46	25,527.98	Single Peak
Kingston		510.49	78.88	15.45	6,821.66	Single Peak

TABLE 2

CLASS (ES)	DESCRIPTION	VARIANCE	COEF. OF VARIATION %	SPECTRUM VALUE AT .25 cycles /qtr.	SPECTRUM SHAPE
I	Plantation – Staple	38,238.77	17.15	96,899.50	Single Peak
II	Peasant – Staple	32,571.91	18.65	89,743.38	Single Peak
III	Plantation – Domestic	42,737.84	10.19	108,652.13	Single Peak
IV	Plantation – Domestic	49,346.99	9.30	30,298.08	No Peak
I & II	Staples	123,297.19	16.66	363,062.56	Single Peak
I & III	Plantation	134,439.19	11.57	403,264.50	Single Peak
II & IV	Peasant	127,161.19	10.63	214,045.13	Single Peak
III & IV	Domestic	155,613.13	8.93	244,313.75	Single Peak
Kingston & St. Andrew	Urban	19,697.43	14.76	55,194.41	Single Peak

mean) as well as the height of the estimated spectrum at .25 cycles per quarter, corresponding to one cycle per year. Table 2 presents similar information for each of the classes of parish socio-economic structure as well as various combinations. Both tables include calculations for the urban parishes of St. Andrew and Kingston, as well as a brief remark characterizing the shape of the estimated spectrum.

Because the parishes are of unequal population size, the coefficient of variation was judged to be a better summary measure of variability than either variance or standard deviation. A chi-square test on the twelve rural parishes before classification did not reveal any significant difference in the coefficients of variation at the 5 per cent level. It cannot be inferred, however, that socio-economic structure is unimportant. On the contrary, when cross-classified by type of crop and nature of organization, an inspection of the coefficients of variation, whether by individual parishes or by classes, does indicate that higher variability is associated with staple crop production. For instance, it is clear from Table Two that the coefficient of variation for Classes I plus II (Staples) is greater than that for Classes III plus IV (Domestic), 16.7 per cent compared to 8.9 per cent. In addition, from Table 1, it is evident that individual parishes dominated by staple production display greater variability than parishes dominated by domestic crop production, about 19 per cent compared to 11-15 per cent. As may be seen in Table 2, among parishes in which production was organized by plantations, those producing staple exports exhibit more variability than those producing domestically consumed crops. Similarly, among parishes in which production was organized by peasants, greater variability is associated with the production of staple exports than with the cultivation of domestically consumed crops. Rough inspection would also seem to indicate that the coefficients of variation for parishes in which production was organized by plantations are little different than for parishes in which peasant organized production predominated.

Employing the coefficients of variation for the individual parishes, an analysis of variance for multiple-classified data with unequal numbers of observations and no interaction [10] was performed. The mean value of the coefficient of variation observed for parishes dominated by staple crops, whether produced by plantations or peasants, was significantly different at the 1 per cent level from that observed for parishes dominated by staple crops, whether produced by plantations or peasants, was significantly different at the 1 per cent level from that observed for parishes dominated by domestic cultivation, whether organised by plantation or peasant. On the other hand, a similar test reveals no statistically significant difference between parishes in which production was organized by plantations and parishes in which production was organized by peasants, regardless of the specific crops cultivated. This confirms our impression gained by inspection of Tables One and Two. In addition, regression analysis [11] showed a positive and significant relationship between the percentage of land under staple cultivation and the coefficient of variation. The percentage of cultivated land under plantation organization was not a significant variable.

The question now arises as to the proportion of the total variability that can be accounted for by purely seasonal fluctuations. This requires the

application of spectral methods. The spectrum for each of the individual parishes, individual Classes and combinations of Classes was estimated using detrended [12] data for the period 1880-1938. With few exceptions, the only peak occurred at .25 cycles per quarter (c.p.q.) corresponding to one cycle per year. The height of the peaks for each parish and classification are set out in Tables 1 and 2. Although the spectrum value at .25 c.p.q. cannot be interpreted in isolation from the size of the total variance, it is clear that seasonal fluctuations constitute the only significant contribution to overall variability that can be attributable to cyclical behaviour, thereby confirming that much of the measured variability is due to annual fluctuations. Typical spectrums for Classes I and IV are shown in figures 2 and 3.

We have already seen that higher coefficients of variation are associated with staple production. On the suggestion that the seasonal work pattern is greater for staples than for domestic crops, Classes I and II should show a higher level of seasonal fluctuation by spectral analysis than Classes III and IV. For comparison, the spectrum value has to be corrected by the standard deviation: the greater the standard deviation, the more the spectrum value has to be reduced. In comparing Classes I and III, Clarendon in Class III (s.d. 87.66, spectrum height 18,431) would seem to be the only parish in the same range as a parish from Class I, St. Thomas (s.d. 69.96 spectrum height 14,911). In fact, it was a marginal decision to place Clarendon in Class III rather than Class I. From the appendix Clarendon can be seen to have the highest percentage of land in staple exports of the parishes classified as domestic. Otherwise Classes I and II clearly embody more seasonality than Classes III and IV respectively. Since we find that whether a parish was 'plantation or peasant' seemed to make no difference, we may also compare Class I with IV and Class II with III. Again Clarendon in Class III is the only parish that does not appear to fit the degree of seasonality implied by its classification. Overall it is apparent that parishes dominated by staple crops reveal markedly higher seasonal fluctuations than parishes devoted to the production of domestic crops.[13]

Although we have argued that a considerable degree of homogeneity existed throughout the period examined, an attempt was made to ascertain whether our statistical results are peculiar to the time period chosen for study. To that end we distinguish two sub-periods: 1880-1911, during which the principal staple export was bananas, and 1912-1938, during which the export of sugar products re-emerged as an important undertaking. [Hart 11, Eisner 8].

Spectra estimated for individual parishes in the two periods 1880-1911 and 1912-1938 are remarkably similar. Moreover there are only four parishes for which the Class characterization in 1912-1938 differs from that in 1880-1911. In three cases (Hanover, Westmoreland and St. Elizabeth) the classification shifted from Class III to Class IV: that is, from plantation to peasant organized production of domestic crops. Such reclassifications are only of minor consequence in so far as the mode of production is apparently not associated with any significant differences in the variability of registered births. However the fourth reclassification, St. Catherine from Class III (Domestic Crops) to Class I (Staple Exports) does involve an increase in variability. The coefficient of variation increases from 15.6 per cent in 1880-1911 to 23.1 per cent in 1912-1938 as would be expected by this shift in classification.

FIGURE 2

CLASS IV PARISHES

DOMESTIC CROPS CULTIVATED BY PEASANTS

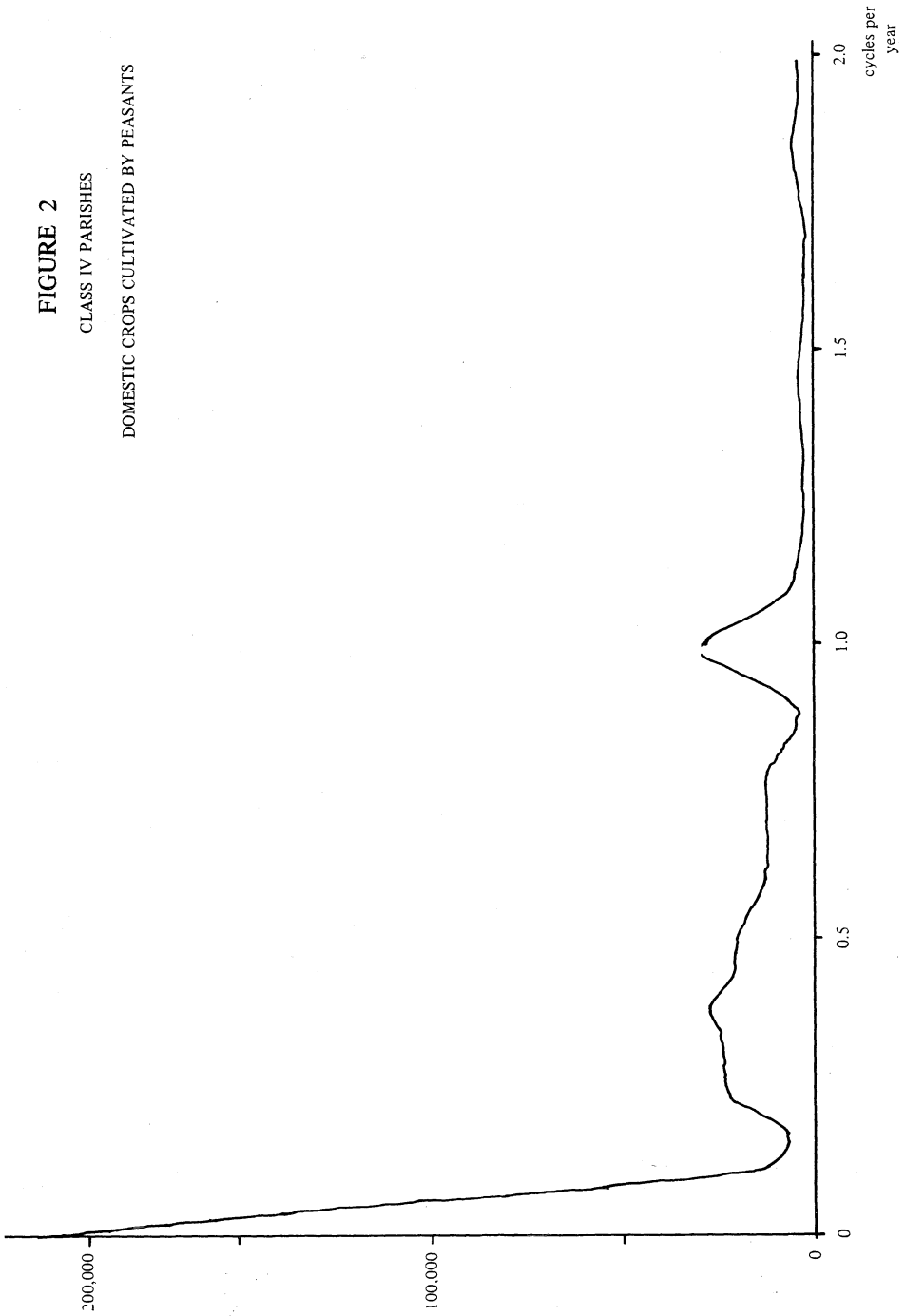
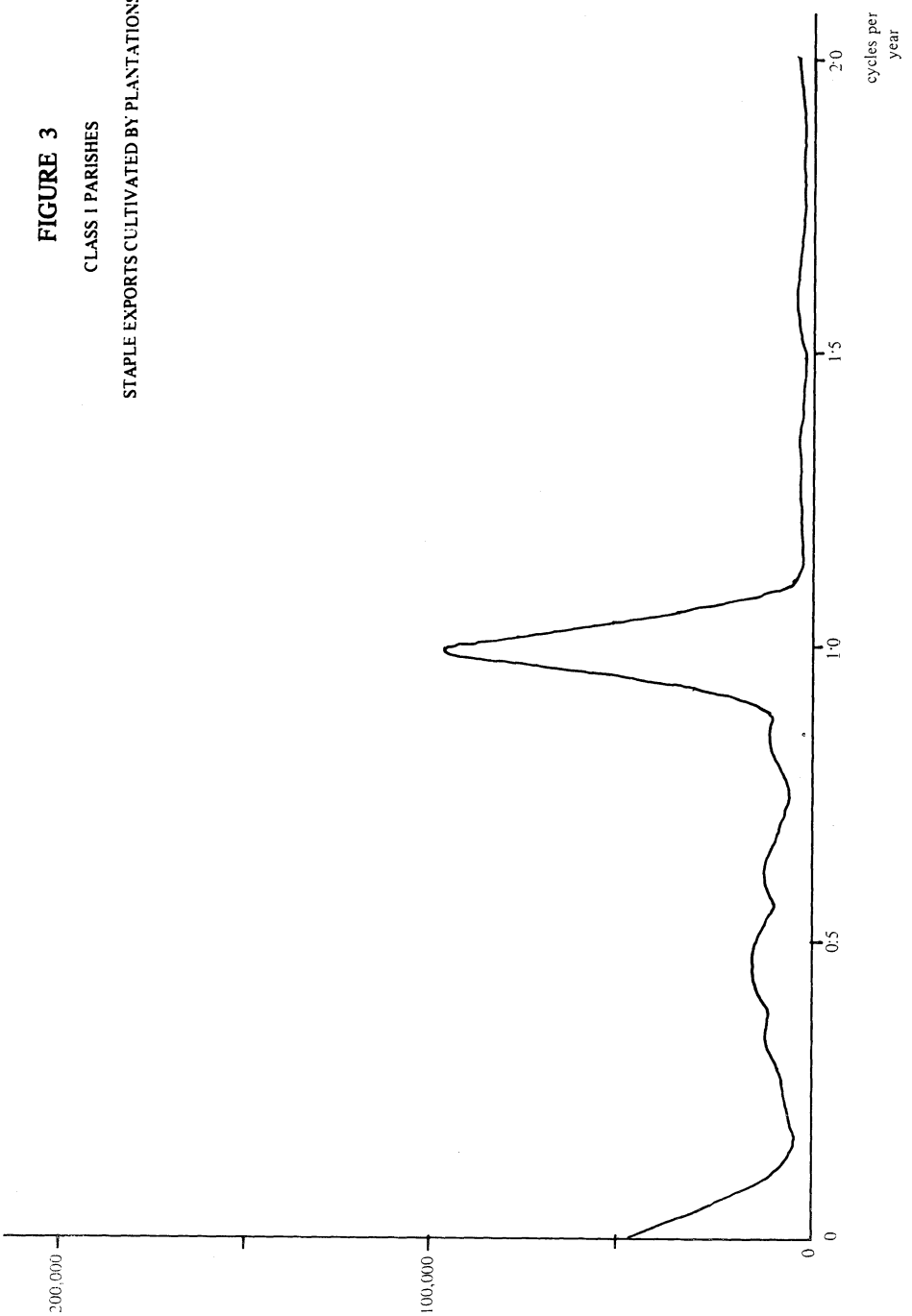


FIGURE 3

CLASS I PARISHES

STAPLE EXPORTS CULTIVATED BY PLANTATIONS



It was not possible to explore for Jamaica the usual distinction between rural and urban areas. This is partly due to the complication that births for St. Andrew cannot be disentangled from those of Kingston, and also because Kingston constitutes the sole parish capable of being considered urban. Considered together, St. Andrew and Kingston had a coefficient of variation of 14.7 per cent (see Table 1 and 2) which is about midway in the range observed for the rural parishes.

SUMMARY AND IMPLICATIONS

Historical demography has traditionally been interested in the complex relationships between demographic performance and socio-economic variables. One fairly new approach to this problem has involved the study of cyclical patterns in recorded levels of vital events. Recent research along this line suggests that seasonal variation in the number of births differs significantly between well-defined sub-national regions, and that such variation may be systematically related to the nature of regional economic structure.

The present paper examines two aspects of seasonality of births within individual rural parishes of Jamaica during the years 1880-1938. In the first place, we were interested in determining the extent to which individual parishes did experience seasonal variation in the number of births. Employing quarterly data on the number of registered births in each parish during these years, the application of spectral analysis provided evidence of considerable variation in the extent to which births were seasonal from parish to parish.

The second task of this paper was to determine whether seasonality of births was systematically related to the socio-economic structure of individual parishes. The classification of parishes by socio-economic structure proceeded on the basis of the predominant organizational form of agricultural production (plantation *vs.* peasant) and on the basis of the nature of the crops actually cultivated (staple exports *vs.* domestic crops). Statistical analysis suggests that parishes given over to the cultivation of staple exports exhibited significantly greater seasonality of births than did parishes in which production was devoted to domestically consumed crops. At the same time, there appears to have been no significant difference in seasonality of births between those parishes in which production was organized by plantations and those in which peasant organized production prevailed. Thus, our findings indicate that seasonality of registered births in the rural parishes of Jamaica depended primarily on the nature of agricultural output rather than the mode of production.

Apart from these specific findings, we believe the present study will be of more general interest in three respects. While some previous research has been directed to the study of fertility differentials across the parishes, the present study represents the first attempt to describe and analyse seasonal patterns in registered births. There is much scope for the further study of seasonal variation in deaths and migration, and indeed for the study of seasonality or cyclical patterns in other types of social behaviour. Secondly, the present study suggests that enquiry into economic-demographic relationships may be usefully pursued at the regional as opposed to the national level

of aggregation. This in turn lends support to the argument that less aggregative studies of Jamaican history are highly desirable. Finally and perhaps most important, the present study sheds light on the social implications of economic structure in Jamaica, and thus encourages further efforts to develop and elaborate the existing models of plantation society and staple export economy.

FOOTNOTES

[1]This is a revised version of a paper presented at the Western Economic Association Annual Meeting held in San Diego, June 1975. The authors are grateful to Earl McArthur for assistance with the data calculations.

[2]Other features of parish socio-economic structure include the level of real aggregate parish income and the distribution of such income between and within factor classes. See Lobdell [17].

[3]See Clarke [5] pp. 14-25, 93-94, 189-190; Olivier [21] pp. 290-310; Orde-Browne [22] pp. 17-20, 84-86.

[4]See Spencer, Hum, Deprez [26]. In this study it was found using spectral analysis that the urban centre of Liege during the 17th Century experienced much less seasonality in births than did surrounding rural areas. Also in Spencer and Hum [27] it was shown that in Buddu, Uganda, the fairly even pattern of agricultural activity was associated with an even pattern of births.

[5]See for example Beckford [2], especially chapter 1, pp. 3-29; Wolf [31]; Horowitz [12] pp. 179-189.

[6]These Annual Reports may be seen at the Public Record Office in London under C.O. 140.

[7]See the classification in the Appendix.

[8]For a complete description of the technique involved see Kempthorne [14], Ch. 6.

[9]Spectral analysis constitutes representing a time series in the "frequency domain". Let $x(t)$ be a time series with zero mean. Define $x(t)$ to be a stationary process if $\mathrm{Cov}\{x(t), x(t+\theta)\} = E\{x(t), x(t+\theta)\} = g(\theta)$; that is the autocovariance, $g(\theta)$, is a function of the "lag", θ, alone. Then a fundamental theorem states that there exist a function $F(\lambda)$ such that:

$$g(\theta) = \int_{-\pi}^{\pi} e^{i\theta} \, dF(\lambda)$$

The function $F(\lambda)$ is the spectral distribution function and its derivative, f, is the spectral density of the process. In brief, $g(\theta)$ of the time series $x(t)$ can be defined as the (independent) weighted 'sum' of sinusoids of period $2\pi/\lambda$ and the variation of $F(\lambda)$ at λ determines the importance which its corresponding period will have in the spectral representation. The variation of $x(t)$ can be depicted as:

$$\mathrm{var}\, x(t) = \int_{-\pi}^{\pi} f(\lambda)\, d\lambda$$

This last representation shows that spectral analysis can also be regarded as a decomposition of the variance of $x(t)$ into independent components attributable to various frequencies, each frequency corresponding to a period of given length. The plot of the estimated amplitude of $f(\lambda)$ against frequency is one of the basic analytic tools of spectral methods. Peaks in the estimated spectrum at certain frequencies suggest important cycles of particular periods. For further details, see Granger and Hatanaka [9].

[10] The coefficient of rank correlation between the plantation-index and the staples-index for 1880-1938 was 0.1325.

[11] The independent variables used were the average percentage of land under plantation and the average percentage of land producing staple exports by parish over the period 1880-1938 as in the table in the appendix. Table 1 contains the figures for the coefficient of variation for the same period. There were 12 observations, one for each parish. There was a positive and significant relationship (at the 1 per cent level) between the percentage of land producing staple exports and the coefficient of variation, both when the percentage of land under plantations was included and just by itself. The percentage of land under plantation was not significant even at the 10 per cent level in any of the regressions.

[12] There was virtually no difference in the spectra estimates using detrended or unadjusted data.

[13] This is illustrated by Figures 2 and 3 and Tables 1 and 2. The scales of Figures 2 and 3 have been drawn so as to be comparable.

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APPENDIX

PARISH	CLASS	AVG. % OF LAND UNDER PLANTATION	AVG.% LAND IN STAPLE EXPORTS
St. Thomas	I	60.63	35.20
St. Catherine	I	34.51	22.11
Portland	II	11.92	31.15
St. Mary	II	20.67	38.69
Trelawny	III	59.06	13.80
Clarendon	III	68.29	17.70
St. James	III	45.77	15.97
Westmoreland	III	39.92	10.06
Manchester	IV	7.55	7.58
St. Ann	IV	6.83	5.82
St. Elizabeth	IV	20.68	2.36
Hanover	IV	19.97	10.94

(a) **ACREAGE UNDER PLANTATION AS PER CENT OF TOTAL ACREAGE UNDER CULTIVATION:**

Acreage under the control of plantations is taken to be the sum of acreage under banana, sugar and coffee plantations, and is reported annually in the *Handbooks of Jamaica*. Total acreage under cultivation for each parish is also reported annually in the *Handbooks*. The data reported in this table are the *numerical average* of the nine five-year averages.

That is,

$$P_i = \frac{1}{9} \sum_{t=1}^{9} \frac{P_i t}{C_i t} \times 100$$

Where P_i = Average % Cultivated Land Under Plantation Control in the $i - th$ parish;

$P_i t$ = Sum of acreage under the control of sugar, banana and coffee plantations in the $i - th$ parish during the $t - th$ period;

$C_i t$ = Acreage under cultivation in the $i - th$ parish during the $t - th$ period;

t = 1891-1895, 1896-1900, . . . , 1931-1935.

(b) Acreage under staple export crops is the sum of acreage under cultivation in sugar cane, bananas, coffee, cocoa, citrus, and coconuts. These data are reported in the *Handbooks of Jamaica*. The data reported in this table are the *numerical average* of nine five-year averages. Thus,

$$X_i = \frac{1}{9} \sum_{t=1}^{9} \frac{X_i t}{C_i t} \times 100$$

Where X_i = Average % Cultivated Land under staple exports in the $i - th$ parish;

$X_i t$ = Sum of acreage under all staple exports in the $i - th$ parish; during the $t - th$ period;

$C_i t$ = Acreage under cultivation in the $i - th$ parish during the $t - th$ period;