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An Application Of The Factor Analytic Approach To The Construction Of An Overall Business Activity Index.

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AN APPLICATION OF THE FACTOR ANALYTIC APPROACH TO THE CONSTRUCTION OF AN OVERALL BUSINESS ACTIVITY INDEX

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THESIS

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ABSTRACT OF THESIS

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ABSTRACT

Business economists attempting to determine and to describe the changes in the business activity of metropolitan areas and other geographic sections are seriously limited in their work by the absence of a satisfactory Overall Business Activity Index (OBAI). Although there are several methods for constructing such a composite index, this thesis examines the application of factor analysis to the construction of an OBAI. The difficulty of applying this statistical technique has been in developing a set of weights for combining the extracted factors into an OBAI. Among the objectives of such an overall index are that it should preserve the uniqueness of the component factors and should retain the variance extracted by factor analysis. It was found that weights equal to the square root of the percent of common variance for each factor satisfy these objectives.

An overall index of business activity was constructed from eight constituent series employed by the University of New Mexico's Bureau of Business Research in their Index of Business Activity for New Mexico. The resulting OBAI was evaluated against the Bureau's Index and a verbal description of New Mexico's business activity. It was concluded that the index constructed by the factor analysis method was a satisfactory indicator of change in business activity. In

constructing and evaluating such a composite index, the lack of a clear definition of what constitutes business activity and of an objective basis for selecting the component series seriously limits an investigator. With these limitations, factor analysis offers a definite improvement over existing methods of combining a heterogeneous set of local time series into a unique index of an area's business activity.

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CHAPTER I

INTRODUCTION

A. The Problem

The basis of this thesis is that business economists attempting to determine and to describe the changes in the business activity of metropolitan areas and other geographic sections are seriously limited in their work by the absence of a satisfactory Overall Business Activity Index (OBAI). In the place of such a composite statistic, it has been necessary to resort to verbal summarizing or some method of subjectively combining several local business activity indicators, such as business failures, building permits, bank debits and the like. However, few attempts have been made to objectively combine such time series into an OBAI. In most general terms, such an overall index would be a percentage representing changes in values, prices, or other market variables where

> each item is a single variable or a composite representation of more than one variable and is compared with the corresponding figure in a selected base [with] the change being measured. . . either over periods of time or current comparisons relating to some variables in certain geographical areas.[1]

The problem explored in this thesis examines the

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1 Ajmer Singh, "Local Business Activity Index: Its Construction and Uses," Journal of Regional Science, 7:75, Summer, 1967.

application of the factor analytic approach to the analysis of time series data. In the terms of this problem, the factor analytic technique of principal components analysis is used as a means of combining a heterogeneous set of local time series into an OBAI which will represent the business activity of a given geographic area.

B. Purpose of the Study

Although there are many existing state or regional overall business indices which generally fulfill the above need and description, the usefulness and validity of these is now being questioned by the many users of such indices within various business and governmental departments.[2,3] This discussion has come about because of the growing popularity of using an OBAI as a basis for describing or forecasting an area's economic growth for both government and business interests. As these composite indices become generally utilized in aiding administrators to make many important decisions in such areas as plant location, determining seasonal demand, and in other areas of business concern, the interpreter must have complete confidence in the

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[2] *Ibid.*, pp. 75-82.

[3] Willard T. Carleton and Leonall C. Andersen, "A Principal Components Test of Bank Debits as a Local Economic Indicator," *The Journal Of Business*, 38: 409-415, October, 1965.

OBAI for him to have any confidence in his derived results and subsequent decisions. At the present time, the main questioning has been concerned with two basic areas of composite business activity indices. The first concern is with trying to determine what is business activity and then developing series which are representative of this activity. However, there is not currently a satisfactory general definition, which means that the selection of the representative series is still left to the discretion of the designer, who is supposedly knowledgeable in the business activity of the area. The second area of concern and the main interest of this thesis is with the methodology of constructing the geographic area's OBAI.

The current OBAI's are usually constructed with methods based more on the designer's knowledge of the area than on an objective analysis and combination of the time series data. In this methodology, the designer is first concerned with the selection of the respective time series and then with determining the weights needed to combine the various series into one overall index. In selecting the series, the designer uses his knowledge and then usually correlation analysis to delete any weak or duplicate series. Although the selection is both an important and difficult process, the real difficulty lies in developing the combining weights. These are usually derived as some percentage of income or employment accounted for by the respective series in the area. Although this is a logical method for developing weights, it can result in one series having an exceedingly heavy weight, with the end product being that this series could conceivably dictate the direction and pattern of the OBAI. Because of this undue influence, the utility of such an OBAI is nebulous and users would probably not have enough confidence in it to base any studies or decisions upon it.

In order to overcome such inherent weaknesses, several methods have been proposed with which to construct an OBAI whose component series and weights are more compatable with one another. There are currently two methods that have found favor with business economists. The first of these is "a general approach [which employs] regression and variance analysis where variation in a set of selected key independent variables explains (statistically) the variation in business activity; [but] there is still the major problem of constucting a valid dependent variable [which requires] considerable mathematical manipulation to construct an OBAI."[4] This method is well covered in Singh's article. The second objective methodology is classified as

> factor analysis -- a common term for a number of statistical techniques for the resolution of a set of variables into a small number of hypothetical

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[4] Singh, _op_. _cit_., p. 76.

> variables or so-called factors. This resolution is accomplished by an analysis of the intercorrelations of the variables, and the resulting factor loadings may then be used to construct an OBAI. . .No dependent variable as such needs to be specified, and many relevant variables which would have been discarded through regression as statistically insignificant are retained and reflected in relatively few basic dimensions.[5]

This second general approach to constructing an OBAI will be the subject of this thesis.

Before going any further into this thesis, it must be pointed out that any OBAI, regardless of construction technique, cannot stand alone as being entirely representative of the present or future business activity in a given area. The reason is that a statistical measure, such as an OBAI, based on the past, may be used in the present and future only so far as the underlying series of past business activity are similar to those of the present and future. Thus, a conscientious user would combine the interpretation of the index with an analysis of the present and projected component series. This would be done to determine if the underlying series are still relevant when compared with the results of the business analysis and to the actual needs of the user. Finally, an OBAI is an <u>indicator</u> of business activity change, which provides a basis for further inquiry into the nature of the change, and should never be used as the final word on the business activity in an area.

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[5] Ibid.

C. Organization of the Thesis

The first chapter is an introduction to the problem and to the method which will be used to solve it. The second chapter will outline and analyze some of the prior research into the factor analytic approach to constructing a composite index. Included in the third chapter is a general discussion of the statistical tools, especially factor analysis, the strategy of construction, and a statement of the criteria which will be used to check the methodology of construction. The fourth chapter will have two basic parts, with the first one outlining the construction of the OBAI using the time series of the University of New Mexico's Bureau of Business Research Index of Business Activity and with the second part presenting an interpretation of the factors which underlie the time series. The final chapter will contain a presentation of the evaluation and conclusions of this research project.

CHAPTER II

PROBLEM ANALYSIS

A. Reviews of Prior Research

In the following discussions of various research studies, we will observe that each study provided a step to the construction of an OBAI, but none of them actually constructed one using more than one factor.

The landmark research into the area of using factor analysis to construct a composite index was performed and presented by Gerhard Tintner in his book Econometrics.[6] In this work, Professor Tintner is primarily concerned with the statistical technique of factor analysis known as principal components analysis, which reduces "a group of variables into a more fundamental set of independent, i.e. orthogonal, components called 'factors', [and] also leads to maximum likelihood estimates."[7] Although Professor Tintner discusses the extraction of factors beyond the first one, computational difficulties (his work was done prior to the common use of computers) limited him to extracting and discussing the principal component, which accounts for the greater part of the variance of the variables. The basic objective of his work was to

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[6] Gerhard Tintner, Econometrics (New York: John Wiley and Sons, Inc., 1952), pp. 102-114.

[7] Ibid., pp. 102-103.

define the following linear function.

$$U = k_1z_1 + k_2z_2 \; . \; . \; . \; . \; k_nz_n$$ [8]

He defined it by using factor analysis to extract the coefficients k_i which then would be multiplied by the values of z_i and summed to achieve the composite index U. Although such a function provides an excellent basis for a composite index based on one factor, Professor Tintner did not carry the analysis on further to include other factors, but left further development of his idea to others.

One of the first economists to carry on Professor Tintner's work was R.S.G. Rutherford[9] who used principal components analysis on six Australian price series. His primary objective was "to analyze the weighting that should be applied to the components of any composite index number."[10] This meant, as shown in his study, that he would use the extracted factors (he extracted three factors), not as weights or as components in a composite index; but, as a standard against which the weights derived by other means would be measured so as to eliminate any unusual weights which would allow one series to dominate the index. Although Mr. Rutherford does offer a plausible solution to one of the problems

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[8] _Ibid_., p. 106.

[9] R.S.G. Rutherford, "The 'Principal Factors' Approach to Index Number Theory," _Economic Record_, 30:200, November, 1954.

[10] _Ibid_., p. 205.

encountered in the current construction methodology, he does not show how the extracted factors can be used in this measuring process. However, the main contribution of his study is that he shows that a set of economic time series are underlied by more than one factor, and that all factors must be extracted before proceeding to the construction of a composite index.

A study which duplicates Professor Tintner's methods was performed by Frederick V. Waugh.[11] In this study, unlike the prior one, Mr. Waugh does construct an index using factor analysis: principal components analysis. He constructed a "level-of-living index based upon only three census items in each county [which were] the percentages of farms with telephones, with home freezers, and with automobiles."[12] Using the data on these items for his principal components analysis, he achieved a set of weights, one weight for each of the three items, by going through the same process as outlined and discussed in Professor Tintner's chapter. Thus, he used the following linear function as a basis for multiplying each series by the corresponding weight and then summed to arrive at one overall index.

$$I = 0.586z_1 + 0.545z_2 + 0.599z_3$$ [13]

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[11] Frederick V. Waugh, "Factor Analysis: Some Basic Principles and An Application," Agricultural Economics Research, 14: 77-80, July, 1962.

[12] Ibid., p. 78.

[13] Ibid., p. 80. Note the similarity of this formula and that of Tintner.

Although an overall index (as simple as it may seem) has finally been constructed, it must be pointed out that Mr. Waugh again only used the first factor, assuming any remaining factors to have a negligible effect on the final index.

Another study which flowed from Tintner's work, but used computers to perform the computational tasks, was done by Willard T. Carleton and Leonall C. Anderson using several economic and financial indicators for the St. Louis metropolitan area as a basis for constructing an OBAI.[14] The purpose of their study was to use principal components analysis as "a rational method for combining a heterogeneous set of local economic time series into a smaller set (ideally into just one series) hopefully to represent the time patterns of economic activity."[15] In their application of factor analysis to the various series, they arrived at three factors which they then identified as being: first and third factors -- real and financial activity and the second factor -- construction awards. In an attempt to construct an overall index, they calculated the required factor scores; but, because they could not determine how to combine the three factors, they were unable to construct a "unique index of all local economic activity."[16]

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[14] Carleton, loc. cit.

[15] Ibid., p. 410.

[16] Ibid.

B. Analysis of Prior Research

In analyzing these studies, we can see that each has followed a basically different approach, with Professor Tintner's work as a starting point. In his landmark work, Professor Tintner provided a theoretical basis for using factor analysis as a method for constructing a composite index; but, he developed only a simple index based on one factor. In the next study, Mr. Rutherford recognized that more than one factor can underlie several economic time series; but, he proposed to use the extracted factors as a basis for developing a set of compatable weights. This could have been a useful approach if he had provided more detail on his computational procedures. The one study which duplicated Professor Tintner's computational procedures was performed by Mr. Waugh, who constructed a simple, but workable, index. However, he followed Professor Tintner too closely by constructing the index from only one factor. The final study was performed by Mr. Carleton and Mr. Anderson, who used factor analysis to extract more than one factor, but were unable to combine them into an OBAI.

In summary, we are faced with the situation where the studies, excluding Mr. Rutherford's, have either followed the approach of constructing an overall index based on one factor only, or the approach of achieving a number of factors but then being unable to combine them into a unique index. The major weakness of the latter approach is obvious, but the major weakness of the former one is more subtle. The logic behind the first approach is "that although there are many factors in operation, a single one is dominant [where] the presence of any secondary factor may be safely ignored."[17] However, this logic falls apart if there are any wide discrepancies in the data, as would be expected in the case of using several series of various types over a long span of time in attempting to construct an OBAI.

Thus, we have a few prior research studies that make up the literature in this area; but, they do not provide us with much assistance in solving the problem of this thesis beyond that of providing a basic technique: factor analysis.

C. Statement of Criteria

In this part of most theses, there would be a statement of one or several hypotheses to be tested by the data. However, in this thesis, we are applying the method of factor analysis to a relatively untried area. The objective is to go beyond the work of others in solving the basic problems of combining the factors into a unique index. This

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[17] Walter Isard, Methods of Regional Analysis: An Introduction to Regional Sciences (New York: John Wiley and Sons, Inc., 1960), p. 32.

means that we will be concerned with checking the results of the construction methodology against a set of criteria to determine if we have satisfied the objective. Because of the technical nature of the objective and the criteria, a full explanation of these items is contained in Chapter III after the discussion of factor analysis.

CHAPTER III

RESEARCH DESIGN

The purpose of this chapter is to present in general terms the statistical tools -- especially factor analysis -- used in the construction of the OBAI.

A. Preparation of the Time Series

In constructing any composite index, it must be remembered that each of the underlying series "normally contain inherent effects, at any point in time, of the composite forces of trend (T), cycle (C), seasonal (S), and irregular factors (I)."[18] Each of these conditions has certain effects upon time series, which are as follows:

> 1. Trend: the regular increase or decrease, according to some principle, over the whole period under consideration. For most series it is a growth element, dependent upon population and the development of industry. There is a normal change year after year in a developing or altering industrial society. . .
> 2. Seasonal Variation: the movement of the items within the year, which we attribute to the round of the seasons. There is a seasonal change in various lines of business activity just as there is a seasonal change in temperature or rainfall. Although an iron-clad system is not to be expected, the movement of the items, to be seasonal, must be systematic year after year.
> 3. Cycles: the undulating curves, or numerical values, secured by removing from the actual items the secular trend and seasonal variation, and expressing

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[18] Singh, *op. cit.*, p. 77.

the results in terms of comparable units. The actual figures thus corrected and expressed measure the rhythmic movements of business, the ebb and flow corresponding to depression and prosperity.

4. Irregular: includes all sporadic development which affects individual series or widespread changes due to momentous occurences such as wars or national catastrophes, which affect the time series.[19]

Although each of these conditions is discussed separately, it must be noted that "any particular value in a series can be looked upon as the product of factors which can be attributed to the four components."[20] Thus, we must make use of certain statistical tools which can be used to isolate or eliminate certain conditions from the original time series. In this thesis, the primary concern is with the removal of the trend and seasonal variation which would then leave the cycle and irregular components as a measure of the ebb and flow of business.[21]

The most common method of removing the trend component is the statistical technique known as the method of least squares. This method generally consists of fitting a least squares line $Y = a + bx$ by determining the values of a (the central ordinate) and b (the increment rate), which then yields

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[19] Warren M. Persons, "A Non-Technical Explanation of the Index of General Business Conditions," The Review of Economic Statistics, 2:39, 1920.

[20] John E. Freund and Frank J. Williams, Elementary Business Statistics: The Modern Approach (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1964), p. 321.

[21] Person, loc. cit., p.39

the equation of the line of trend from which "the various ordinates of trend during the period can be derived."[22] The ordinate of trend for any date is "the value of Y for the point on the line of trend at that date: it is the size which the variable would have had at that date if there had been no other fluctuations except the trend."[23] At this time, it must be pointed out that there are many time series which cannot be fitted with a straight line but require a line calculated from a second or higher degree polynomial (rarely above the fourth degree). In trying to determine which line to use, there is no "sure-fire" method other than calculating the various lines and then graphing them with the actual values to observe which one gives the best fit.[24] Regardless of which line is chosen, the next step consists of eliminating the trend by dividing each actual item by the corresponding ordinate of trend and expressing the result as a percentage (percent relatives of actual to trend) which "exhibit all the fluctuations of the original series except that portion due to the estimated trend."[25]

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[22] William L. Crum, Alson C. Patton and Arthur R. Tebbutt, Introduction to Economic Statistics (New York: McGraw-Hill Book Company, Inc.,, 1938), p. 311.

[23] Ibid., pp. 311-312.

[24] Note: There are several package programs such as Polynomial Regression (POLREG) used later in this thesis which greatly simplify these calculations.

[25] Crum, op. cit., p. 316.

The next component which is generally removed is seasonal variation. Unlike the elimination of trend, there are several methods for the elimination of seasonal variation. They are moving averages, relative-to-ordinate, and Person's link relative. Because of the characteristics of the time series which are used later in this thesis, we elected to use Person's link relative method. The essence of this method is as follows:

1. The calculation of period to period link relatives by dividing one period by the prior period. One can use either actual or secularly adjusted data for this calculation.
2. The verification of the existence and estimate of the general nature of the seasonal movement by the use of a multiple frequency table for each period.
3. The selection of the typical link for each period from the table. This usually is the median or, in the case of excessive spread, the average of some group of links.
4. The calculation of the adjusted index of seasonal variation (so the average equals 100) by the use of logarithms. The adjustment comes about because other variations (especially irregular) must be eliminated so the averages of the various period indices will equal 100.
5. The elimination of seasonal variation by dividing the actual (or secularly adjusted) data for a period by its appropriate adjusted seasonal index.[26,27]

Thus, seasonal variation can be removed from a time series, or both trend and variation can be eliminated, by using trend adjusted data.

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[26] Helen D. Falker, "The Measurement of Seasonal Variation," Journal of the American Statistical Association, 19:33, June, 1924.

[27] Crum, op. cit., pp. 326-352.

After these calculations, one has a time series with only cycle and irregular components remaining. In this thesis, we will use the following forms of the time series.

1. Actual data (Actual)
2. Trend adjusted (Seasonal)
3. Trend and seasonal adjusted (Deseasonal)

These three forms were chosen because they are the most common forms of time series analysis. From these three forms of the same time series, we can study their underlying structure as represented by factors extracted by factor analysis, which is discussed in the next section.

B. Factor Analysis

In reviewing prior research, it was generally concluded that factor analysis was little used or understood by economists, although it would have great applicability in many empirical problems. Thus, this thesis follows the directions suggested by these writers in applying the factor analytic technique of principal components to the problem of constructing an OBAI.[28] The objective is to reduce and combine a heterogenous set of local economic time series into a smaller set which can then be used to construct the OBAI, which will represent the time patterns of economic activity in a given geographic area. The method employed in meeting this objective

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[28] Note: This thesis makes exclusive use of the factor analytic technique of principal components. Throughout this thesis, then, there will be an interchangeability of terms with the most reliance on the use of the term factor analysis.

is principal components analysis. "The essential feature of principal components analysis is that it makes a linear transformation of a set of correlated variables into a new set of uncorrelated or orthogonal variables."[29] This means that "a group of correlated economic time series may be transformed via principal components analysis into a new set of variables, and the new variables may be identified as representing various dimensions of economic activity."[30] This still leaves the basic problem of determining how to combine these various dimensions into one OBAI.

The above paragraph delineated the method of principal components analysis, a particular form of factor analysis. Any form of factor analysis is "a method for determining the number and nature of the underlying variables among large numbers of measures."[31] In other words, factor analysis is "a means by which the regularity and order in phenomena can be discerned."[32] The starting point for factor analysis is correlation analysis, because the principal components

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[29] Carleton, op. cit., p. 410.

[30] Ibid.

[31] Fred N. Kerlinger, Foundations of Behavioral Research (New York: Holt, Rinehart and Winston, Inc., 1964), p. 650.

[32] R.J. Rummel, "Understanding Factor Analysis," Journal of Conflict Resolution, XI:445, September, 1967.

technique is "applied to a matrix of correlation coefficients among all variables."[33] These coefficients of correlation express the degree of linear relationship between each pair of original series variables of the matrix. When the coefficient is close to zero, the relationship is less than when the coefficient is closer to one. A negative sign indicates that the variables are inversely related. In the terms of this thesis, the prime interest in correlation, besides its use in factor analysis, is that the square of the correlation coefficient multiplied by 100 equals the per-cent variation in common for the data of the two variables. This basically means that this measure explains "the amount of variance or the number of common elements that contribute to both scores"[34] (example: a correlation 0.6 means that 36% i.e. r^2 multiplied by 100, of the elements in B are in A). In other words, the term percent variation in common means that if one knows the values of one of the two variables, one can produce, explain, predict, or generate that percent of the variation on the other variable.[35] This section should be well understood, for it is an integral part in checking the derived OBAI. Thus, it can be concluded that "factor

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[33] Ibid., p. 640.

[34] Raymond B. Cattell, Factor Analysis (New York: Harper and Brothers, 1952), p. 25.

[35] Rummel, op. cit., p. 461.

analysis, carried out on the correlation coefficients, shows us how some variables can be grouped together because they behave in the same way."[36]

This regularity of behavior is expressed in the terms of a factor which is "a construct, a hypothetical entity that is assumed to underlie"[37] the variables. In more precise terms, each factor can be thought of as representing a substantively meaningful independent (uncorrelated) pattern of interrelationships among the variables.[38] In most instances, there is usually more than one factor pattern so "the first unrotated factor pattern delineates the largest pattern of relationships in the data; the second delineates the next largest pattern that is independent of (uncorrelated with) the first; the third pattern delineates the third largest pattern that is independent of the first and second and so on."[39] Besides determining the number of factors, factor analysis also calculates the factor loadings that "measure which variables are involved in which factor pattern and to what degree."[40] The square of the loadings multiplied

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[36] Cattell, op. cit., p. 14.

[37] Kerlinger, loc. cit.

[38] Rummel, op. cit., p. 463.

[39] Ibid.

[40] Ibid.

by 100 gives the percent variation that an original series has in common with an unrotated pattern.

This discussion has led us to another meaning of factor analysis, which is that it is "a method for extracting common factor variances from sets of measures."[41] In this thesis, we will be actually concerned with two variances; (1) the percent of total variance (PTV) and (2) the percent of common variance (PCV). In the ensuing discussion, Example 1 on the next page can be referred to to clarify any difficulties in visualizing the computations. Before discussing the two variances, it is necessary first to define and explain another important concept -- that of communality (h^2). This concept refers to the "proportion of a variable's total variation that is involved in the patterns."[42] Besides giving the percent of variation of a variable in common with all patterns, the complement of h^2 is a measure of uniqueness which indicates to what degree a variable is unrelated to the others -- to what degree the data on a variable cannot be derived from the data on the other variables.[43] The h^2 itself is calculated by summing the squared loadings (l_1^2) for each variable. If the h^2's are summed, divided by the

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[41] Kerlinger, loc. cit.

[42] Rummel, op. cit., p. 465.

[43] Ibid.

Example 1

Computation of h^2, Percent of Common Variance, and Percent of Total Variance

		FACTORS						
		1		2		3		
VARIABLES	1	l_1^2	+	l_2^2	+	l_3^2	=	h^2
	2	l_1^2	+	l_2^2	+	l_3^2	=	h^2
	3	l_1^2	+	l_2^2	+	l_3^2	=	h^2
	4	l_1^2	+	l_2^2	+	l_3^2	=	h^2
	.	.		.		.		.
	.	.		.		.		.
	n	l_1^2	+	l_2^2	+	l_3^2	=	h^2

TOTALS $(l_1^2) + (l_2^2) + (l_3^2) = (h^2)$

PERCENT OF TOTAL VARIANCE $(\Sigma (l_1^2)/n) \cdot 100 + (\Sigma (l_2^2)/n) \cdot 100 + (\Sigma (l_3^2)/n) \cdot 100 = (\Sigma (h^2)/n) \cdot 100$

PERCENT OF COMMON VARIANCE $(\Sigma (l_1^2)/ (h^2)) \cdot 100 + (\Sigma(l_2^2)/ (h^2)) \cdot 100 + (\Sigma(l_3^2)/ (h^2)) \cdot 100 = 100.00$

Note: See Appendix C - Part 1 for computer computation the number of variables (n), and multiplied by 100, we have achieved the percent of total variation in the patterned data. The significance of this is that we have measured the order, uniformity, or regularity in the data.[44] Thus, we are ready to define the percent of total variance explained by a factor. It is calculated by "summing the column of squared loadings for a factor, dividing by the number of variables and multiplying by 100."[45] The result measures "how much of the data variation is involved in a pattern . . .a pattern's comprehensiveness and strength."[46] In simpler terms, we know that patterns are laid out in descending order of variance explanation so the PTV for each factor measures how much of the total variation is actually explained by each pattern. The next concept of interest is the percent of common variance which is calculated by summing the column of squared loadings for a factor, dividing by the sum of the h^2 values and multiplying by 100. The result indicates "how whatever regularity exists in the data is divided among the factor patterns [or] how much of the variation accounted for by all the patterns is involved in each pattern."[47] These two variances simply

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[44] *Ibid.*

[45] *Ibid.*

[46] *Ibid.*

[47] *Ibid.*

mean that the PCV indicates how much of all patterns' variation is accounted for by each pattern while the PTV indicates how much of the total variation of the patterned data is accounted for by each pattern.

The final concept in factor analysis which is of interest to us is that of factor scores. The use of a factor matrix establishes the existence of a pattern for a series while the factor score matrix establishes a score for a series on a pattern. The calculation of the factor scores will vary from study to study because of the different techniques of weighting each loading so it will be proportional to its involvement in a pattern. In the absence of a set technique, the objective is to achieve some degree of standardization in the pattern weights (W). In this thesis, standardization is achieved by dividing each loading of a series by the standard deviation(s) of that series. Then, the data for each series is multiplied by the standardized pattern which is then summed for all the series to yield a factor score (FS) for a pattern in a given time period. For an outline of this calculation, see Example 2. In interpreting factor scores, it must be remembered that they are composite variables "which can be used in other analyses or as a means of comparing cases on the patterns."[48] It is this concept of factor scores which will be an integral part in the construction of the OBAI.

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[48] Ibid., p. 470.

Example 2

Computation of Factor Scores

$$FS_{jk} = \sum (a_{ki} \cdot w_{ji})$$

j = 1,2,3. . . . n of factors

i = 1,2,3. . . . n of series

k = 1,2,3. . . . n of observations

Where:

a_{ki} = data for the k^{th} observation of the i^{th} series

w_{ji} = factor loading for the j^{th} factor divided by standard deviation of the i^{th} series

FS_{jk} = factor score for j^{th} factor of the k^{th} observation

Note: See Appendix C - Part 2 for computer computation.

C. Strategy of Construction

The strategy of constructing the OBAI is the same regardless of which form of the time series (actual, trend adjusted, trend and seasonally adjusted) is used in the factor analysis. After the initial step of determining the factors and the loadings for each time series through factor analysis, the following procedure is used to achieve the OBAI.

1. Divide each factor loading by the standard deviation of the variable so as to achieve a standardized weight.
2. Multiply the data of each series period by its appropriate weight and then sum to achieve a factor score for each factor for each period under consideration.
3. Calculate the standard deviation for the factor scores and then divide each score by its respective standard deviation to achieve some degree of standardization.
4. Multiply each of these standardized factor scores by the respective weight to achieve an index for each factor.
5. Then sum these indices to achieve an OBAI for each period.

D. Statement of Criteria

This thesis, then, is concerned with presenting a methodology of constructing an OBAI. We will use the set of time series which compose the University of New Mexico's Bureau of Business Research Index of Business Activity. If factors cannot be extracted from this set, we will use another set of time series, such as those of Business Week, so that this methodology of construction can be demonstrated. This methodology basically consists of using principal components analysis to determine the minimum number of uncorrelated dimensions needed to account for the maximum amount of variance in the original set of series. Thus, the basic problem is to develop a set of weights which can be used to combine the factors into a unique index.

In developing the weights, we have the objective of preserving the uniqueness of the factors and retaining the maximum variance. This retention is important for one of the basic goals of construction is to achieve maximum variance so that the index can delineate the periods of growth, levelness, and decline. Since the extracted factors are uncorrelated, any set of reasonable weights will preserve their uniqueness. However, the retention of maximum variance is much more difficult.

The first idea would be to use the PTV's for each pattern since their total equals the maximum variance extracted by factor analysis. However, one of the basic rules for this method is that the weights, when squared, equal one. This then leads us to consider the square roots of the PCV's for each pattern as the set of weights. This is logical because the PCV's represent how much of the patterned variance is accounted for by each pattern, and can be derived from the PTV (the extracted maximum variance). Thus, we have chosen our set of weights.

The next step is to check whether our weights preserve the uniqueness of the factors and the maximum variance of the factor analysis. This check will be accomplished by using correlation analysis and the following criteria.

1. $r_i^2 \cdot 100 = PCV_i$

2. $s_I^2 = PCV_I$

The first criterion is used to determine if we have preserved the uniqueness of the factors, because the only correlation or percent variation in common between the uncorrelated factors and the OBAI should be equal to the extraneous variables, i.e. the weights. The second criterion is used to determine if we have retained the maximum variance, because the variance of the index should equal the maximum variance of the factor analysis as represented by the PCV. By satisfying these criteria, we can conclude that we have devised a rational method for combining a heterogeneous set of local time series into an OBAI, which will represent the business activity of a given geographic area.

After determining that we have a rational method of constructing a composite index, we must then determine whether we have constructed a reasonable indicator of change in business activity. In evaluating the OBAI, we are confronted with a complicated problem consisting of two basic conditions, which make the evaluative process very difficult. The first is a lack of existing objective criteria or tests which can be used in evaluation. The second condition, which compounds the difficulty of evaluation, is an absence of a generally accepted meaning of business activity, especially at the regional level. Thus, we have no consistent general base against which to judge the quality of the derived index. Because of this situation, we can only specifically evaluate the derived OBAI by comparing it against the Bureau's Index and a verbal description of the pattern of business activity in New Mexico. What we will be looking for in the evaluation process is how well (in a subjective manner) the OBAI picks up the pattern of business activity, and for any deviations of the OBAI from the Bureau's Index. Because this is a subjective and specific evaluation, each user of the construction method must make his own evaluation to determine if he has constructed a reasonable indicator of change in business activity. Again, our evaluation will be done solely to determine if we have constructed a reasonable OBAI using factor analysis.

CHAPTER IV

RESULTS

A. Construction of the OBAI

As has already been stated, we will be using the set of time series which compose the Bureau of Business Research Index of Business Activity. This set consists of the following eight series.

1. Building Permits, total 18 cities
2. Electric Power Production
3. Wage Workers in Manufacturing
4. Index: Metallics Production
5. Petroleum Production
6. Potash Production
7. Bank Debits, 33 banks
8. Life Insurance Sales

These were originally chosen to measure changes in major groups of businesses, or industries.[49] These major groups are

1. Trade, services and amusements
2. Construction
3. Transportation and utilities
4. Manufacturing
5. Mining
6. Finance, insurance, and real estate

Because the purpose of this thesis is to demonstrate a methodology, any set of series could have been used. It was decided to use these series because of

1. The availability of the data;

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[49] Alan D. Carey, "A New Measure of Business for the State," New Mexico Business, 7:3-9, January, 1954.

[50] Ibid.

2. An interest in the economy of New Mexico;
3. And because they have been used to construct a composite index of business activity which will be helpful in evaluating the derived OBAI.

Although these series are normally reported in monthly and annual forms, we used them in quarterly form to facilitate the handling of the data and to remove some of the seasonal and irregular variation. We used the series of the period 1958-67 (40 quarters); but in computing the factors and basic statistical techniques, we used the period of 1958-65 (32 quarters). This was done to give us a base period with enough observations for the factor analysis, but leaving us with a needed period over which we can extend the derived OBAI to determine if it has maintained its relevance as an indicator of local business activity.

In presenting this methodology of construction, we could have used just the original series; but we are also interested in the different factors that might appear in different forms of the series. Thus, we will use three forms of the series -- the data on these are contained in Tables VIII-XV in Appendix A, Pages 59-73. The three forms are 1) the series in actual form (actual): column 1; 2) the series with trend removed (seasonal): column 3; and 3) the series with trend and seasonal removed (deseasonal): column 5.

The actual series are simple indices with 1957-59=100 as their base period. In seven of the eight series, the trend was removed by using the method of least squares to fit a straight line to the actual series. Because the compactness of the actual data in the early quarters was followed by a sharp upswing from quarter 22:151.5 to quarter 23:233.5 (Table IX, Page 61) the electric power production series was fitted with a second degree polynomial line. Although there was not too much seasonal variation in the series because of the use of the quarter form and the initial characteristics of the series, the remaining seasonal variation was removed by the use of Person's link relative method. Thus, we have prepared the time series in three forms for the ensuing factor analyses.

In performing the factor analyses, the sample program FACTO from the IBM Scientific Subroutine Package -- Version III was used. This sample program performs a principal components analysis on the correlation coefficients of the series. The full results of this program are contained in Appendix B, Pages 84-96. Of prime interest in this thesis are the extracted factors. There are two factors for the actual series and three each for the seasonal and deseasonal series. The respective loadings are contained in Tables I-III, Pages 34-36 , with an asterisk denoting the major loading for that series. After achieving the loadings the next step is to calculate the percent of common variance and percent of total variance for each factor as outlined in Example 1. These are also contained in Tables I-III, Pages 34-36.

TABLE I

THE LOADINGS, SQUARED LOADINGS, COMMUNALITIES (h^2), PERCENT OF TOTAL VARIANCE, AND PERCENT OF COMMON VARIANCE
ACTUAL

SERIES		ACTUAL FACTORS 1	2	h^2
1	LOADINGS	0.05713	0.95860*	
	SQUARED	0.00226	0.91894	0.92218
2	LOADINGS	0.92082*	0.16646	
	SQUARED	0.84791	0.02771	0.87562
3	LOADINGS	0.64267*	0.22302	
	SQUARED	0.41302	0.04974	0.46276
4	LOADINGS	0.76981*	-0.33153	
	SQUARED	0.59261	0.10991	0.70252
5	LOADINGS	0.89677*	-0.25041	
	SQUARED	0.80419	0.06270	0.86690
6	LOADINGS	0.81091*	0.03939	
	SQUARED	0.65757	0.00155	0.65913
7	LOADINGS	0.96089*	0.02233	
	SQUARED	0.92331	0.00050	0.92381
8	LOADINGS	0.95435*	0.07860	
	SQUARED	0.91078	0.00618	0.91696
PERCENT OF TOTAL VARIANCE		64.4	14.7	79.1
PERCENT OF COMMON VARIANCE		81.4	18.6	100.0
SQUARES		5.15267	1.17720	6.32987

TABLE II

THE LOADINGS, SQUARED LOADINGS, COMMUNALITIES (h^2), PERCENT OF TOTAL VARIANCE, AND PERCENT OF COMMON VARIANCE
SEASONAL

SERIES		SEASONAL FACTORS 1	2	3	h^2
1	LOADINGS	0.12744	0.85300*	-0.08841	
	SQUARED	0.01624	0.72761	0.00716	0.75167
2	LOADINGS	0.73638*	-0.26992	0.05659	
	SQUARED	0.54225	0.07285	0.00320	0.61831
3	LOADINGS	0.71387*	0.01768	-0.44922	
	SQUARED	0.50961	0.00031	0.20180	0.71172
4	LOADINGS	-0.69529*	-0.28771	0.27897	
	SQUARED	0.48342	0.08278	0.07782	0.64403
5	LOADINGS	0.56492	-0.65074*	0.26018	
	SQUARED	0.31913	0.42346	0.06769	0.81029
6	LOADINGS	0.11893	0.26740	0.83564*	
	SQUARED	0.01414	0.07695	0.69829	0.78939
7	LOADINGS	0.84572*	0.01177	0.05876	
	SQUARED	0.71524	0.00014	0.00345	0.71883
8	LOADINGS	0.55527*	0.36605	0.33890	
	SQUARED	0.30832	0.13399	0.11485	0.55717
PERCENT OF TOTAL VARIANCE		36.3	19.0	14.7	70.0
PERCENT OF COMMON VARIANCE		51.9	27.1	21.0	100.0
	SQUARES	2.90838	1.51810	1.17493	5.60141

TABLE III

THE LOADINGS, SQUARED LOADINGS, COMMUNALITIES (h^2), PERCENT OF TOTAL VARIANCE, AND PERCENT OF COMMON VARIANCE DESEASONAL

SERIES		DESEASONAL FACTORS 1	2	3	h^2
1	LOADINGS	0.27732	0.81117*	0.14083	
	SQUARED	0.07691	0.65800	0.01983	0.75474
2	LOADINGS	0.80919*	-0.36522	0.14118	
	SQUARED	0.65479	0.13338	0.01993	0.80810
3	LOADINGS	0.66564*	0.06485	-0.41127	
	SQUARED	0.44308	0.00420	0.16914	0.61642
4	LOADINGS	-0.59206*	-0.34573	0.41162	
	SQUARED	0.35053	0.11953	0.16943	0.63949
5	LOADINGS	0.42078	-0.74945*	0.04433	
	SQUARED	0.17705	0.56167	0.00190	0.74070
6	LOADINGS	0.46892	0.00084	0.56951*	
	SQUARED	0.21988	0.00001	0.32434	0.54423
7	LOADINGS	0.80989*	0.00906	-0.29607	
	SQUARED	0.65592	0.00008	0.08766	0.74366
8	LOADINGS	0.54098	0.24093	0.58826*	
	SQUARED	0.29266	0.05805	0.34605	0.69676
PERCENT OF TOTAL VARIANCE		35.9	19.2	14.2	69.3
PERCENT OF COMMON VARIANCE		51.8	27.7	20.5	100.0
	SQUARES	2.87082	1.53492	1.13835	5.54409

TABLE IV

PCV'S AND WEIGHTS FOR EACH FACTOR

	PCV	WEIGHTS
ACTUAL		
1	81.4	9.03
2	18.6	4.32
SEASONAL		
1	51.9	7.21
2	27.1	5.21
3	21.0	4.58
DESEASONAL		
1	51.8	7.20
2	27.7	5.26
3	20.5	4.53

The next procedure is to develop the weights by using the square roots of the various PCV's for each factor. The weights are contained in Table IV, Page 37. After developing the weights, we are ready to construct the OBAI -- in the three forms -- by using the strategy outlined in Chapter III. Each of the forms was expressed in computed form as standardized scores and as percentages of the mean. The computer programs and the results are contained in Appendix C, Pages 97-134. After constructing the OBAI's we have to determine if each fulfills our objective of retaining the maximum variance and the uniqueness of the extracted factors. As outlined in Chapter III, this fulfillment is determined by using correlation analysis to check if the indices and component series, in computed form, meet our criteria of

1. $r_i^2 = PCV_i$
2. $s_I^2 = PCV_I$

The results of our correlation analysis are shown in Table V, Page 39, from which we can see that each index fulfills our criteria. Thus, the final step is to evaluate the indices to determine if they are representative of the business activity in New Mexico. This is done in Chapter V.

B. Interpretation of the Factors

Before interpreting the factors, it would be useful to look again at the concept of factor loadings. In Chapter

TABLE V

RESULTS OF THE CORRELATION ANALYSIS ON THE OBAI AND COMPONENT FACTORS

CRITERIA #1 $r_i^2 = PCV_i$

	r	weight	r^2	PCV (%)
ACTUAL				
1	.902	9.02	81.4 =	81.4
2	.431	4.31	18.6 =	18.6
SEASONAL				
1	.721	7.21	51.9 =	51.9
2	.520	5.20	27.1 =	27.1
3	.459	4.59	21.0 =	21.0
DESEASONAL				
1	.720	7.20	51.8 =	51.8
2	.526	5.26	27.7 =	27.7
3	.453	4.53	20.5 =	20.5

CRITERIA #1 IS FULFILLED

CRITERIA #2 $s_I^2 = PCV_I$

	s_I^2		PCV (%)
ACTUAL	100	=	81.4 + 18.6 = 100.0
SEASONAL	100	=	51.9 + 27.1 + 21.0 = 100.0
DESEASONAL	100	=	51.8 + 27.7 + 20.5 = 100.0

CRITERIA #2 IS FULFILLED

III, this concept was defined as a measure of the degree of involvement a pattern has in a factor pattern.[51] These loadings should be read like correlation coefficients. This means that a series has a greater degree of involvement in a pattern when its positive loading is closer to one. A negative loading means that a series follows the basic factor pattern, but in an inverse relationship, such as variable 4 in Table II, Page 35. In attempting to interpret the extracted factors, it is useful to assign a series to a specific pattern (as was done in Tables I-III, Pages 34-36)according to its highest loading regardless of the sign. The reason is that a researcher will use standardized factor scores as the true basis for interpreting the factors. In this thesis, then, factor loadings are used to calculate the factor scores, which are then used to construct the OBAI and to interpret the component factors.

The following part of the thesis is one of the most difficult because there are no objective criteria which we can use in interpreting the factors. However, some attempt at interpretation must be made to provide us with an idea as to what the underlying dimensions are which aid us in evaluating and using the OBAI. Thus, the basic interpretation consists of determining what dimensions of the series are represented by the factor by observing, in factor score form, its basic

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[51] Rummel, loc. cit.

behavior over time and by comparing it with the series that are predominant in it. The graphed factor scores, expressed as standardized scores, are contained in Appendix D, Pages

The actual set of series has two factors. As can be seen in Figure 5, Page 137 the first factor has a pronounced upward trend. At first notice, this factor could be interpreted as representing a growth dimension. However this does not mean too much, for there are also periods of decline and levelness. Thus, what we are really looking at is a factor that represents the dimension of direction. This means that this factor will determine which direction the OBAI will follow -- whether up, level, or down. The second factor is a little more obvious, for it contains a pronounced cyclical influence. This factor represents the cyclical dimension of the series and provides the OBAI with some degree of cycle.

In the three factors (Appendix D, Pages 135-149) for both seasonal and deseasonal set of series, it can be observed that the first two factors are the same as in the actual set. Here it can be definitely seen that factor 1 picks up the basic direction of the series and then determines the direction of the OBAI. The real question lies in interpreting the third factor. Although both factors 3 have some seasonal variation, the third quarter is always down except in 1960 and 1963. Thus, the real dimension to consider is that of irregularity. It can be seen that both factors fluctuate with no readily apparent pattern. Hence, we can say that the third factors pick up the irregular dimension of the series.

Thus, we have simply determined that our OBAI -- Actual is primarily composed of the basic dimensions of direction and cyclical while the other two OBAI's are made up of these two dimensions and another one referred to as irregularity.

CHAPTER V

EVALUATION AND CONCLUSIONS

A. Evaluation

As was the case in interpreting the factors, we are confronted with the difficult task of evaluating the derived OBAI without the aid of objective criteria. In evaluating its behavior as an indicator of change in the business activity of New Mexico, we must basically rely upon the Bureau's Index and a verbal description of the business activity of New Mexico during the involved period. Even using these items as guidelines, we will not actually arrive at a value judgement of the quality of the OBAI; but we will have an appraisal of its advantages and disadvantages as a conglomerate over-view of its underlying series.

Since the Bureau's Index is important in evaluating the OBAI, we must take a short look at its construction. The Bureau's Index is composed of eight series, with the weights calculated as the percentage of total non-agricultural employment accounted for by the respective series. The series and their weights are contained in Table VI, Page 44. As one can see, the bank debits series at 56% has the heaviest weight, being five times heavier than electric power production with a weight of 11%. An example of the domination of the bank debits series is shown in Figure 1, Page 45, using

TABLE VI

THE COMPONENT SERIES OF THE BUREAU'S INDEX WITH CORRESPONDING WEIGHTS

SERIES	WEIGHTS* (%)
1. Building Permits	9
2. Electric Power Production	11
3. Wage Workers in Manufacturing	10
4. Index: Metallics Production	2
5. Petroleum Production	4
6. Potash Production	2
7. Bank Debits	56
8. Life Insurance Sales	6

*Note: The weights are changed occasionally, but rarely more than one or two percentage points. These are the latest weights.

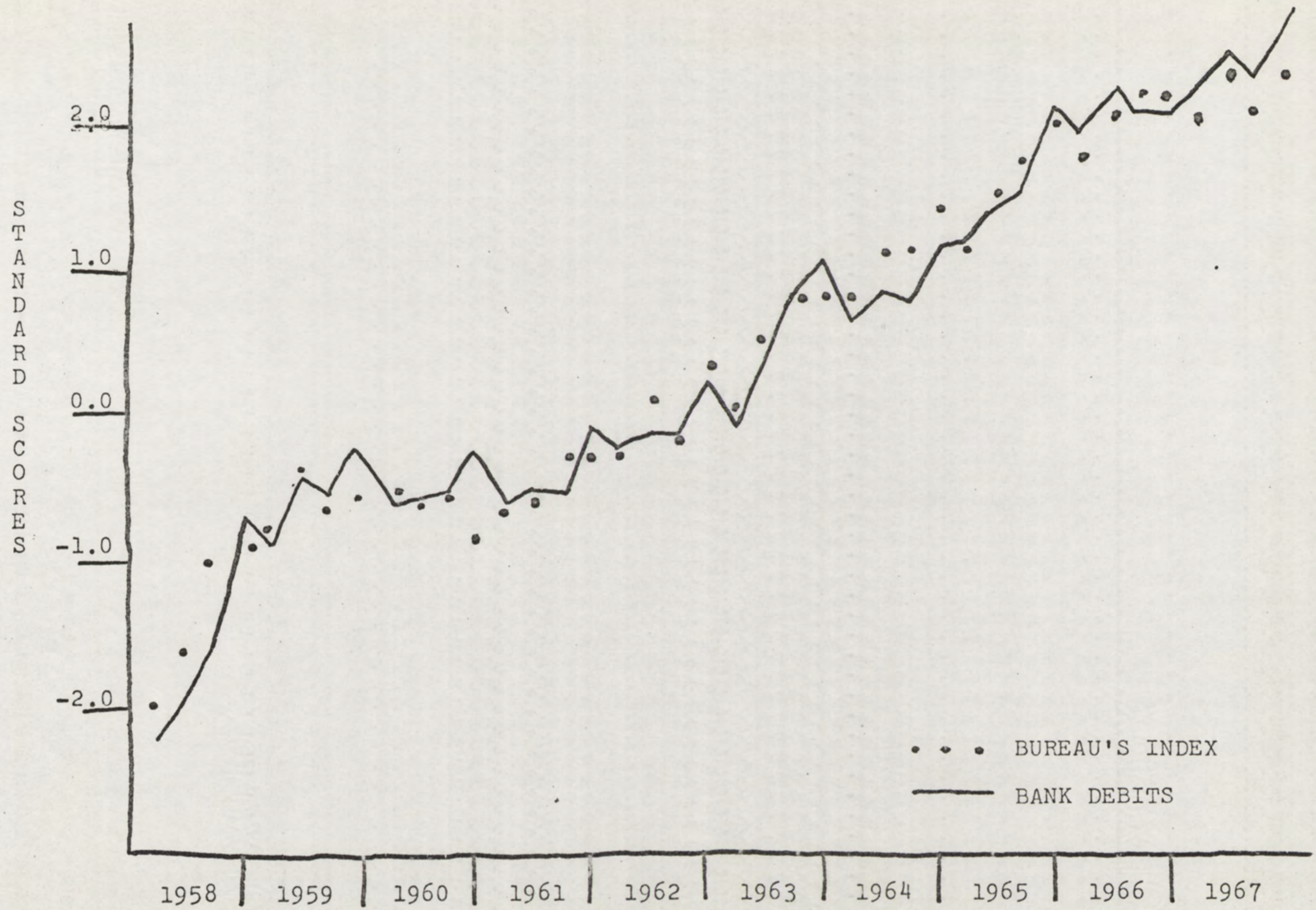

FIGURE 1 -- BANK DEBITS AND THE BUREAU'S INDEX - ACTUAL

the actual forms of both. This graph demonstrates that the bank debits series determines the basic direction of the Bureau's Index with the other seven series providing a patterning force by tempering the full directional force of the bank debits series. It should be pointed out that the Bureau's Index was initially designed to contain more series with equitable weights. However, the New Mexico Bureau of Revenue discontinued reporting several trade series which were to be an important part of the Index. Although the Bureau's Index is so dominated by one series, we will still use it as an evaluative aid. The reason for this use is that the Index has been a fairly good describer of the business activity, as outlined in the following paragraph, which means that our OBAI should not be fundamentally different from the Bureau's Index.

In trying to describe the business activity in New Mexico, we must rely upon the annual reports published by the Bureau. Having analyzed these reports, we have concluded that New Mexico entered the 1960's with a strong pattern of growth. However, for New Mexico, the sizzling '60's fizzled. Except in 1963, there has been no appreciable sign of growth, as had been the case in the late 1950's. In fact, the last few years (1964-67) have seen business activity remain basically stable with periods of growth being offset by periods of decline. Thus, we are looking for an index that has a pattern of growth in the late 1950's, with a decline in the early 1960's, followed by a spurt in 1963, concluding with a period of stability (growth countered by decline) from 1964 to 1967. As we can see in Figures 2-4, Pages 48-50, the Bureau's Index[52] has fairly well outlined this pattern of business activity in New Mexico.

We are now confronted with evaluating the OBAI to determine if it is a reasonable indicator of change in business activity in New Mexico. From Figures 2-4, Pages 48-50, we can observe that the OBAI has picked up the basic pattern of business activity outlined above. However, we can see that the fluctuations of the OBAI are much greater than those of the Bureau's Index. This was expected because the OBAI, being based on factor analysis, was designed to exhibit maximum variance, i.e. fluctuation. Although the OBAI was designed to exhibit maximum variance, it is conceivable that the Bureau's Index could have greater variation. In order to demonstrate that the OBAI has the greater variation, we have chosen to use the statistical method known as the Coefficient of Variation (C.V.). This is a useful technique for comparing two distributions where direct comparison would be misleading. It is calculated by dividing the standard deviation by the mean, which is then multiplied by 100 so that the coefficient can be expressed as a percentage. In interpreting the coefficient,

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[52] Note: Since the seasonal index equals 100, the seasonal and deseasonal Bureau's Index are identical.

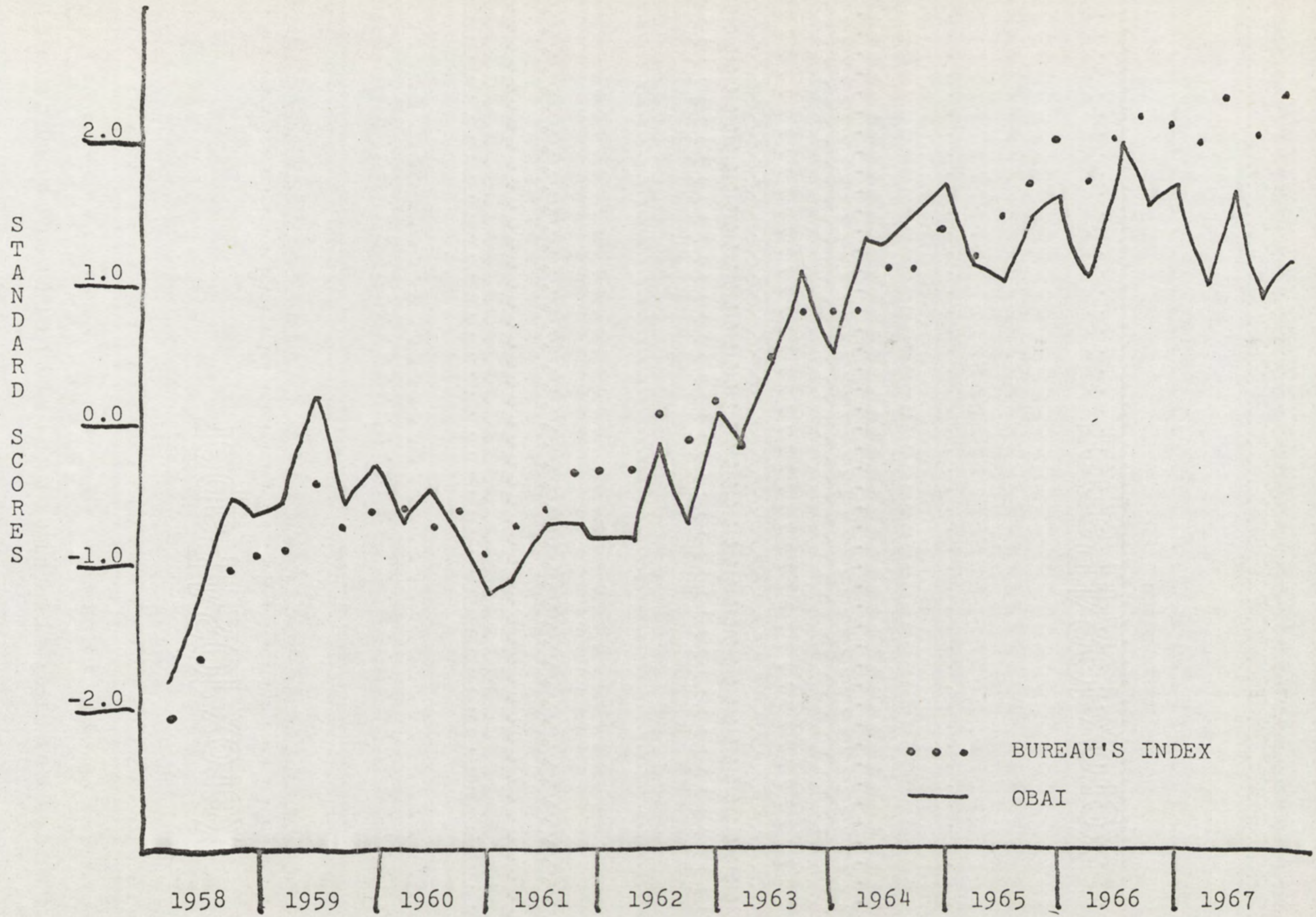

FIGURE 2 -- THE OBAI AND THE BUREAU'S INDEX - ACTUAL

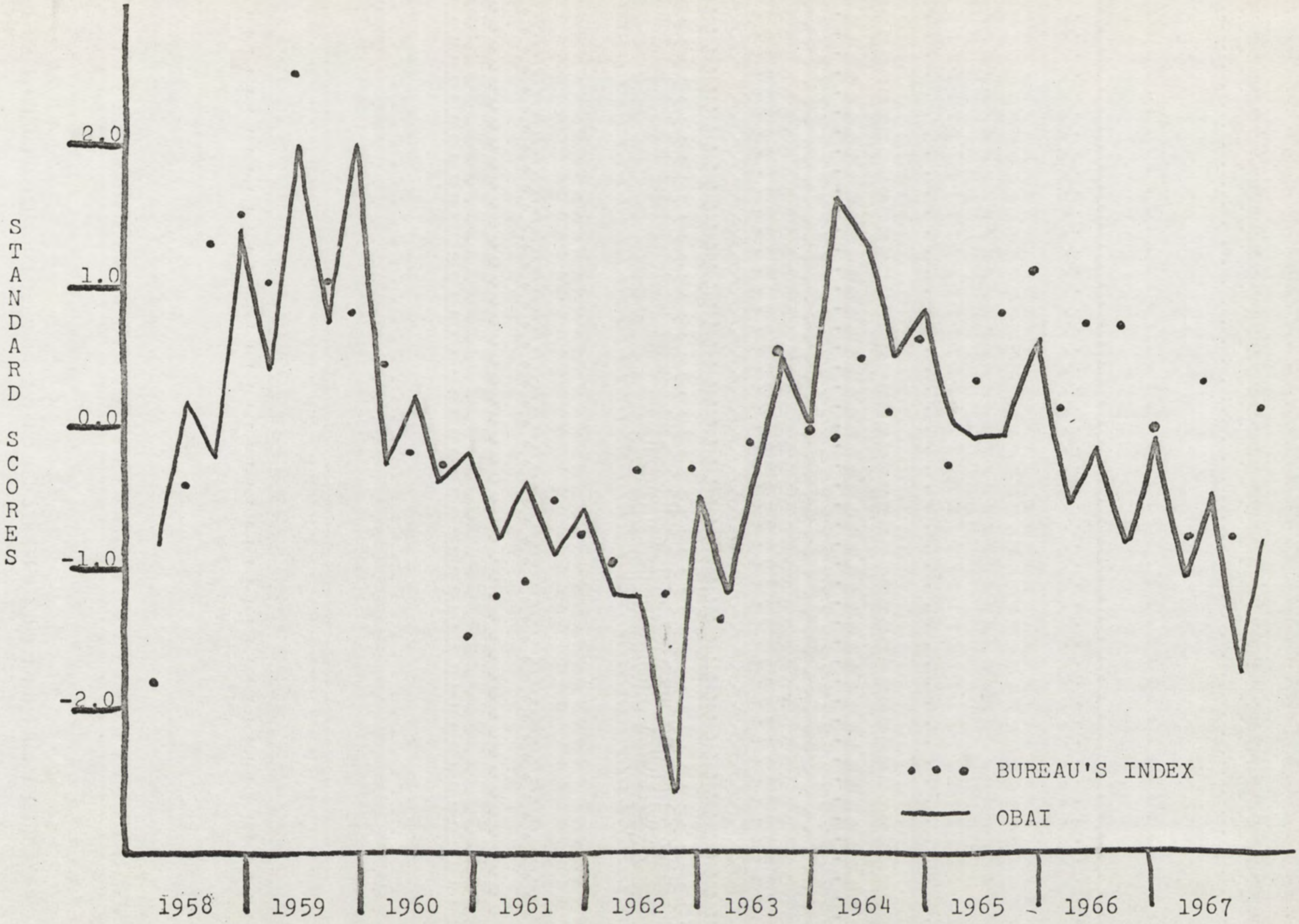

FIGURE 3 -- THE OBAI AND THE BUREAU'S INDEX - SEASONAL

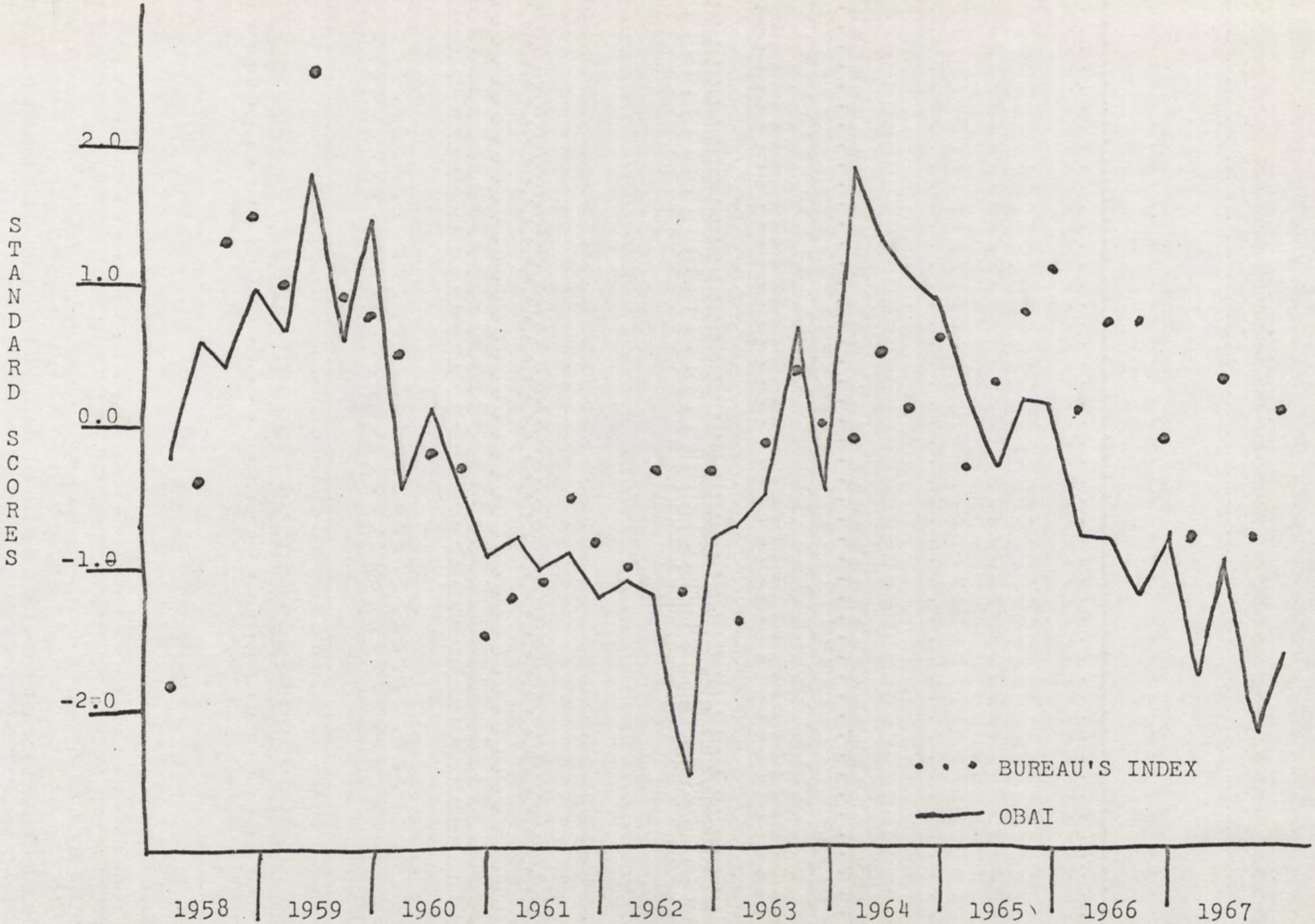

FIGURE 4 -- THE OBAI AND THE BUREAU'S INDEX - DESEASONAL

the index which has the greatest coefficient has the greatest variation. The results are in Table VII, Page 52 , from which we determine that the OBAI, in all three forms, has the greatest variation.

This characteristic of the OBAI can be looked upon as an advantage or disadvantage, depending upon the needs of the user. If the user is conscientious in his application of the OBAI, he would regard the exhibition of maximum variance as a definite asset, showing the sensitivity of the OBAI to the changes in business activity. However, if the user only takes the OBAI at face value to prove a specific point, he may feel that such large fluctuation is a definite disadvantage or a strength depending on how well the OBAI supports his contention. Thus, the first evaluation of the OBAI depends upon the user's point of view and conscience; but, the greater fluctuation demonstrates the OBAI's sensitivity to changes in the direction and pattern of business activity.

The foremost advantage of the OBAI is that it is not dominated by any one series. It is actually a conglomerate overview of all the movement of the underlying series. This simply means that the OBAI is more representative of the business activity delineated by the member series. Another advantage associated with this one is the ease of recalculating the index, should one want to delete or add new series. The OBAI, in all three forms, can be calculated in less than two

TABLE VII

COMPARISON OF THE OBAI
AND THE BUREAU'S INDEX AS
TO EXHIBITION OF VARIATION

	MEAN	STANDARD DEVIATION	C.V. (%)
ACTUAL			
BUREAU'S INDEX	118.4	12.7	10.7
OBAI	116.4	10.0	17.4
SEASONAL			
BUREAU'S INDEX	100.0	3.2	3.2
OBAI	171.8	10.0	5.1
DESEASONAL			
BUREAU'S INDEX	100.0	3.2	3.2
OBAI	115.1	10.0	17.5

minutes, with preparatory work at a minimum, by following the strategy of construction outlined in Chapter III and using already prepared programs.

Even though this evaluation was subjective due to the absence of any objective general basis for evaluation, it was observed that the derived OBAI did pick up the pattern of business activity in New Mexico during the period of investigation. Because the OBAI was shown to be a reasonable indicator of change in business activity, we can finally state in this instance that factor analysis is a rational method for combining a heterogeneous set of local time series into an OBAI which will represent the business activity of a given geographic area.

B. Conclusion

In this thesis, we have constructed an OBAI by using factor analysis and have evaluated it as a reasonable method for constructing a composite index. This evaluation was performed on a specific OBAI based on a certain pattern of business activity in a certain area and was not a general one with which one could determine the overall quality of any such derived OBAI. There are certain advantages in this method which allow it to prevail over other current methods of construction. They are as follows:

1. It cannot be dominated by one series, and is therefore more representative of the business

activity delineated by the component series.
2. The OBAI can be easily calculated and modified.
3. Because the OBAI is based on maximum variance, it is more sensitive to any changes in the direction and pattern of business activity.
4. It is a purely objective method of combining heterogeneous sets of time series in a unique index.

Because of these general advantages, it can be concluded that factor analysis is a rational method for combining a heterogeneous set of local time series into an OBAI which will represent the business activity of a given geographic area.

Even though these are fairly strong advantages, there are serious limitations to this method of construction. One limitation is that we do not really know what we are describing, measuring, representing or indicating, i.e. we do not really know what business activity is or even what series to use. Although such a limitation does not really affect the method of construction, it does seriously weaken any interpretation or analysis of the composite index. The reason is that, without a common denominator, an analyst cannot completely evaluate the index or its components unless he has developed his own concept of business activity. This further complicates any comparison between analyses of the same index by different analysts. Before an OBAI can become a complete and useful tool of analysis, there needs to be more work done on achieving some basic idea or concept of business activity. This is not to mean that we need a specific definition of business activity, for it can and will vary from area to area, but more likely a basic set of objective criteria which can be used to achieve a standard understanding of an area's business activity. This standard understanding plus the OBAI would place a powerful analytic technique in the hands of business economists.

Another basic limitation in the area of composite indices is the selection of the component series. Because there is no standard understanding of business activity, there is no basis for selecting the series except to rely on the designer's knowledge of a region. Although this thesis is not concerned with this area of composite indices, it does imply another method of selecting series. The method is to run a factor analysis on all the available series to determine which ones have the highest loadings and are representative of certain recognizable areas of business activity in a region. This method does not really standardize the meaning of business activity because there is no standard criteria for selecting the series from the factor matrix. However, it is a more rational and objective selection process than what is often used presently.

Because of these limitations, we have no true basis for evaluating the quality of an OBAI. Thus, we must rely upon the construction method to provide an OBAI that best represents the business activity reflected by the underlying series. With the limitations already discussed, factor analysis offers a definite improvement over existing methods of combining a heterogeneous set of local time series into a unique index of an area's business activity.

APPENDIX A

DATA TABLES

PART 1

WORKING TABLES

TABLE VIII

WORKING TABLE FOR
BUILDING PERMITS

Time	Actual Data (1)	Ordinate of Trend (2)	Relative, Actual to Trend (%) (3)	Seasonal Index (%) (4)	Adjusted Relative (5)
1958					
1	105.6	100.2	105.6	102	103.5
2	112.7	100.3	112.5	102	110.2
3	131.5	100.3	131.1	100	131.1
4	106.7	100.3	106.4	96	110.8
1959					
5	117.3	100.4	116.8	102	114.5
6	128.7	100.4	128.2	102	125.6
7	92.9	100.5	92.4	100	92.4
8	106.8	100.5	106.3	96	110.7
1960					
9	95.4	100.5	94.9	102	93.0
10	99.3	100.6	98.7	102	96.7
11	83.3	100.6	82.8	100	82.8
12	62.2	100.7	61.8	96	64.3
1961					
13	83.5	100.7	82.9	102	81.2
14	80.0	100.7	79.4	102	77.8
15	75.6	100.8	75.0	100	75.0
16	73.1	100.8	72.5	96	75.5
1962					
17	81.0	100.9	80.3	102	78.7
18	103.1	100.9	102.2	102	100.1
19	73.9	100.9	73.2	100	73.2
20	103.1	101.0	102.1	96	106.3
1963					
21	116.8	101.0	115.6	102	113.3
22	119.5	101.1	118.2	102	115.9
23	121.5	101.1	120.2	100	120.2
24	91.2	101.1	90.2	96	85.8
1964					
25	113.3	101.2	112.0	102	109.8
26	100.3	101.2	99.1	102	97.1
27	116.0	101.2	114.6	100	114.6
28	115.9	101.3	114.4	96	119.1

TABLE VIII (continued)

1965					
29	102.8	101.3	101.5	102	99.5
30	89.9	101.4	88.7	102	86.9
31	108.0	101.4	106.5	100	106.5
32	115.8	101.4	114.2	96	119.0
1966					
33	90.2	101.5	88.8	102	88.7
34	103.8	101.5	102.2	102	100.3
35	77.7	101.5	76.5	100	76.5
36	79.6	101.6	78.3	96	81.6
1967					
37	56.8	101.6	55.9	102	54.8
38	80.8	101.6	79.5	102	78.0
39	70.7	101.7	69.5	100	69.5
40	75.8	101.7	74.5	96	77.6

TABLE IX

WORKING TABLE FOR
ELECTRIC POWER PRODUCTION

Time	Actual Data (1)	Ordinate of Trend (2)	Relative, Actual to Trend (%) (3)	Seasonal Index (%) (4)	Adjusted Relative (5)
1958					
1	89.1	113.7	78.4	97	80.8
2	98.4	109.8	89.6	97	92.3
3	112.0	106.5	105.2	109	96.5
4	100.8	104.1	96.8	97	99.8
1959					
5	102.3	102.3	100.0	97	103.1
6	111.7	101.2	110.4	97	113.8
7	121.6	100.8	120.6	109	110.7
8	110.0	101.2	108.7	97	112.0
1960					
9	117.8	101.2	116.4	97	120.0
10	112.2	104.0	107.9	97	111.2
11	121.0	106.4	113.7	109	104.3
12	109.6	109.6	100.0	97	102.9
1961					
13	122.0	113.5	107.5	97	110.8
14	117.6	118.1	99.6	97	102.7
15	134.4	123.4	108.9	109	100.0
16	119.6	129.4	92.4	97	95.2
1962					
17	127.0	136.1	93.3	97	96.1
18	123.1	143.5	85.8	97	88.4
19	137.4	151.7	90.6	109	83.1
20	131.3	160.5	81.8	97	84.3
1963					
21	128.7	170.0	75.7	97	78.0
22	151.5	180.3	84.0	97	86.7
23	233.2	191.3	121.9	109	111.8
24	213.2	202.9	105.1	97	108.3
1964					
25	215.9	215.3	100.3	97	103.4
26	222.3	228.4	97.3	97	100.3
27	271.9	242.2	112.3	109	103.0
28	274.4	256.7	106.9	97	110.2

TABLE IX (continued)

1965					
29	284.0	271.9	104.5	97	107.7
30	285.4	287.8	99.2	97	102.2
31	333.7	304.5	109.6	109	100.6
32	278.2	321.8	86.5	97	98.1
1966					
33	247.6	338.4	73.2	97	75.4
34	271.1	354.9	76.4	97	78.8
35	327.8	370.9	88.4	109	81.1
36	287.8	386.9	74.2	97	76.5
1967					
37	308.9	403.8	76,5	97	78.9
38	321.2	418.6	76.7	97	79.1
39	339.9	434.4	78.2	109	71.8
40	300.9	450.0	66.9	97	68.9

TABLE X

WORKING TABLE FOR
WAGE WORKERS IN MANUFACTURING

Time	Actual Data (1)	Ordinate of Trend (2)	Relative, Actual to Trend (%) (3)	Seasonal Index (%) (4)	Adjusted Relative (5)
1958					
1	90.6	101.9	88.9	97	91.6
2	98.6	102.2	96.5	101	95.5
3	105.1	102.5	102.5	102	100.4
4	104.3	102.8	101.5	100	101.5
1959					
5	104.9	103.1	101.7	97	104.8
6	109.2	103.4	105.6	101	104.5
7	110.3	103.7	106.4	102	104.3
8	106.0	104.0	101.9	100	101.9
1960					
9	103.7	104.3	99.4	97	102.5
10	107.0	104.6	102.3	101	101.3
11	107.5	104.9	102.5	102	100.4
12	103.5	105.2	98.4	100	98.4
1961					
13	98.6	105.5	93.5	97	96.4
14	105.0	105.8	99.2	101	98.2
15	107.1	106.1	100.9	102	99.0
16	103.0	106.4	96.8	100	96.8
1962					
17	103,5	106.7	97.0	97	100.0
18	110.3	107.0	103.1	101	102.0
19	113.7	107.3	106.0	102	104.0
20	108.4	107.6	100.7	100	100.7
1963					
21	101.8	107.9	94.3	97	97.2
22	106.2	108.2	97.2	101	97.2
23	109.6	108,5	101.0	102	99.0
24	108.5	108.8	99.7	100	99.7
1964					
25	108.8	109.1	99.7	97	102.8
26	113.9	109.4	104.1	101	103.0
27	114.8	109.7	104.6	102	102.5
28	112.6	110.0	102.4	100	102.4

TABLE X (continued)

1965					
29	106.0	110.3	96.1	97	99.1
30	107.7	110.6	97.4	101	96.4
31	110.2	110.9	99.4	102	97.4
32	108.2	111.2	97.3	100	97.3
1966					
33	110.7	111.5	99.3	97	102.4
34	118.8	111.8	106.3	101	105.2
35	119.6	112.1	106.7	102	104.6
36	117.7	112.4	104.7	100	104.7
1967					
37	114.8	112.7	101.9	97	105.0
38	116.3	113.0	102.9	101	101.9
39	115.2	113.3	101.7	102	99.7
40	112.0	113.6	98.6	100	98.6

TABLE XI

WORKING TABLE FOR
INDEX: METALLICS PRODUCTION

Time	Actual Data (1)	Ordinate of Trend (2)	Relative, Actual to Trend (%) (3)	Seasonal Index (%) (4)	Adjusted Relative (5)
1958					
1	113.2	75.6	149.7	102	148.7
2	83.8	79.3	105.7	100	105.7
3	87.5	83.0	105.4	101	104.3
4	80.2	86.8	92.4	97	95.2
1959					
5	99.5	90.4	110.1	102	108.0
6	86.1	94.1	91.5	100	91.5
7	45.2	97.8	46.2	101	45.8
8	23.4	101.5	23.1	97	23.8
1960					
9	145.9	105.2	138.7	102	136.0
10	97.8	108.9	89.8	100	89.8
11	112.3	112.6	99.7	101	98.7
12	110.5	116.3	95.0	97	98.0
1961					
13	141.9	120.0	118.2	102	115.9
14	139.2	123.7	112.5	100	112.5
15	153.7	127.4	120.6	101	119.4
16	149.8	131.1	114.3	97	117.8
1962					
17	147.4	134.8	109.3	102	107.1
18	152.9	138.5	110.4	100	110.4
19	151.8	142.2	106.8	101	105.8
20	147.2	145.9	100.9	97	104.0
1963					
21	138.3	149.6	92.4	102	90.6
22	141.5	153.3	92.3	100	92.3
23	122.5	157.0	78.0	101	77.2
24	144.9	160.7	90.2	97	93.0
1964					
25	159.8	164.4	97.2	102	95.3
26	175.7	168.1	104.5	100	104.5
27	138.7	171.8	80.7	101	80.0
28	189.8	175.5	108.1	97	111.4

TABLE XI (continued)

1965					
29	204.1	179.2	113.9	102	111.6
30	214.7	182.9	117.4	100	117.4
31	176.1	186.6	94.4	101	94.2
32	178.9	190.3	94.0	97	96.9
1966					
33	198.5	195.0	101.8	102	99.8
34	196.2	199.7	89.2	100	98.2
35	197.4	204.4	96.6	101	95.6
36	197.4	209.1	94.4	97	97.3
1967					
37	175.6	213.8	82.1	102	80.5
38	183.7	218.5	84.1	100	84.1
39	96.3	223.2	43.1	101	42.7
40	92.8	227.9	40.7	97	42.0

TABLE XII

WORKING TABLE FOR
PETROLEUM PRODUCTION

Time	Actual Data (1)	Ordinate of Trend (2)	Relative, Actual to Trend (%) (3)	Seasonal Index (%) (4)	Adjusted Relative (5)
1958					
1	94.4	101.1	93.4	98	95.3
2	96.9	101.6	95.4	102	93.5
3	102.2	102.1	100.1	100	100.1
4	103.9	102.6	101.3	100	101.3
1959					
5	101.5	103.1	98.4	98	100.4
6	105.6	103.6	101.9	102	99.9
7	106.5	104.1	102.3	100	102.3
8	107.5	104.6	102.8	100	102.8
1960					
9	108.1	105.1	102.9	98	105.0
10	104.2	105.7	98.6	102	96.7
11	108.5	106.2	102.2	100	102.2
12	106.7	106.8	99.9	100	99.9
1961					
13	109.6	107.2	102.2	98	104.3
14	114.3	107.7	106.1	102	104.0
15	113.7	108.2	105.1	100	105.1
16	111.5	108.7	102.6	100	102.6
1962					
17	108.6	109.2	99.5	98	101.5
18	108.2	109.7	98.6	102	96.7
19	107.1	110.2	97.2	100	97.2
20	110.7	110.7	100.0	100	100.0
1963					
21	105.8	111.2	95.1	98	97.0
22	107.9	111.7	96.6	102	94.7
23	111.2	112.3	99.0	100	99.0
24	111.9	112.8	99.2	100	99.2
1964					
25	111.1	113.3	98.1	98	100.0
26	110.9	113.8	97.5	102	95.6
27	111.8	114.3	97.8	100	97.8
28	116.0	114.8	101.0	100	101.0

TABLE XII(continued)

1965					
29	118.0	115.3	102.3	98	104.4
30	117.4	115.8	101.4	102	99.4
31	115.8	116.3	99.6	100	99.6
32	119.1	116.8	102.0	100	102.0
1966					
33	119.3	117.3	101.7	98	103.8
34	121.6	117.8	103.2	102	101.2
35	121.2	118.3	102.4	100	102.5
36	125.8	118.8	105.9	100	105.9
1967					
37	123.9	119.3	103.8	98	106.0
38	121.2	119.8	101.2	102	99.2
39	124.9	120.3	103.8	100	103.8
40	124.6	120.8	103.1	100	103.1

TABLE XIII

WORKING TABLE FOR
POTASH PRODUCTION

Time	Actual Data (1)	Ordinate of Trend (2)	Relative, Actual to Trend (%) (3)	Seasonal Index (%) (4)	Adjusted Relative (5)
1958					
1	97.3	93.1	104.5	103	101.4
2	95.9	94.9	101.1	101	100.0
3	75.3	96.7	77.9	94	82.8
4	106.1	98.6	107.6	102	105.5
1959					
5	107.5	100.4	107.1	103	104.0
6	107.8	102.2	105.5	101	104.4
7	98.2	104.1	94.3	94	100.3
8	111.3	106.0	105.0	102	102.9
1960					
9	117.1	107.8	108.6	103	105.4
10	108.3	109.6	98.8	101	97.8
11	107.9	111.4	96.9	94	103.0
12	121.0	113.3	106.8	102	104.7
1961					
13	118.5	115.2	102.9	103	99.9
14	127.9	117.0	109.3	101	108.2
15	112.3	118.9	94.4	94	100.4
16	117.1	120.7	97.0	102	95.1
1962					
17	118.6	122.5	96.8	103	94.0
18	107.6	122.4	87.9	101	87.0
19	92.1	126.2	73.0	94	77.6
20	127.6	128.1	99.6	102	97.6
1963					
21	124.6	129.9	95.9	103	93.1
22	124.8	131.7	94.8	101	93.9
23	139.6	133.6	104.5	94	111.1
24	127.4	135.4	94.1	102	92.2
1964					
25	192.1	137.3	139.9	103	136.0
26	162.9	139.2	117.0	101	115.9
27	139.4	141.0	98.9	94	105.2
28	138.8	142.8	97.2	102	95.3

TABLE XIII (continued)

1965					
29	139.9	144.6	96.7	103	93.8
30	138.4	146.5	95.5	101	93.6
31	137.6	148.3	92.8	94	98.7
32	150.8	150.2	100.4	102	98.4
1966					
33	153.1	152.0	100.7	103	97.8
34	152.0	153.9	,98.8	101	97.8
35	149.5	155.7	96.0	94	102.1
36	160.0	157.6	101.5	102	99.5
1967					
37	152.7	159.4	95.8	103	93.0
38	153.1	161.3	94.9	101	94.0
39	123.0	163.1	75.4	94	80.2
40	137.2	165.0	84.1	102	81.5

TABLE XIV

WORKING TABLE FOR
BANK DEBTS

Time	Actual Data (1)	Ordinate of Trend (2)	Relative, Actual to Trend (%) (3)	Seasonal Index (%) (4)	Adjusted Relative (5)
1958					
1	90.7	99.6	91.1	98	92.9
2	93.3	101.0	92.4	100	92.4
3	99.0	102.4	96.7	100	96.7
4	111.6	103.8	107.5	102	105.4
1959					
5	108.4	105.3	102.9	98	105.0
6	115.5	106.7	108.2	100	108.2
7	114.5	108.1	105.9	100	105.9
8	118.6	109.6	108.2	102	106.0
1960					
9	112.9	111.0	101.7	98	103.8
10	113.5	112.4	101.0	100	101.0
11	114.0	113.8	100.2	100	100.2
12	118.8	115.3	103.0	102	100.9
1961					
13	112.8	116.7	96.7	98	98.6
14	114.4	118.2	96.8	100	96.8
15	115.1	119.6	96.2	100	96.2
16	121.0	121.0	100.0	102	98.0
1962					
17	119.3	122.5	98.4	98	99.4
18	122.9	123.9	99.2	100	99.2
19	126.0	126.7	99.4	102	97.4
20	120.8	125.3	96.4	100	96.4
1963					
21	120.4	128.2	93.9	98	95.8
22	126.4	129.6	97.5	100	97.5
23	134.5	131.0	102.7	100	102.7
24	136.9	132.5	103.3	102	101.3
1964					
25	130.8	133.9	97.7	98	99.7
26	134.2	135.3	99.2	100	99.2
27	133.5	136.8	97.6	100	97.6
28	138.7	138.2	100.4	102	98.4

TABLE XIV(continued)

1965					
29	138.7	139.6	99.4	98	101.4
30	142.8	141.1	101.2	100	101.2
31	144.2	142.5	101.2	100	101.2
32	151.6	143.9	105.4	102	103.3
1966					
33	150.0	145.4	103.2	98	105.3
34	154.8	146.8	105.4	100	105.4
35	151.7	148.3	102.3	100	102.3
36	152.2	149.7	101.7	102	99.7
1967					
37	154.1	151.2	101.9	98	104.0
38	158.2	152.6	103.7	100	103.7
39	154.5	154.1	100.2	100	100.3
40	161.8	155.4	104.1	102	102.1

TABLE XV

WORKING TABLE FOR
LIFE INSURANCE SALES

Time	Actual Data (1)	Ordinate of Trend (2)	Relative, Actual to Trend (%) (3)	Seasonal Index (%) (4)	Adjusted Relative (5)
1958					
1	88.3	90.1	98.0	95	103.1
2	101.4	92.5	109.6	103	106.4
3	101.1	94.9	106.5	98	108.7
4	109.3	97.3	112.3	104	108.0
1959					
5	95.7	99.8	95.9	95	100.9
6	116.6	102.2	114.1	103	110.7
7	107.3	104.7	102.5	98	104.6
8	122.2	107.1	114.1	104	109.7
1960					
9	97.0	109.5	88.6	95	93.2
10	114.9	111.9	102.7	103	99.7
11	111.7	114.4	97.6	98	99.6
12	115.0	116.8	98.5	104	94.7
1961					
13	109.3	119.2	91.7	95	96.5
14	116.2	121.7	95.5	103	92.7
15	124.6	124.1	100.4	98	102.4
16	130.0	126.5	102.8	104	98.8
1962					
17	117.8	128.9	91.4	95	96.2
18	119.9	131.4	91.2	103	88.5
19	111.3	133.8	83.2	98	84.9
20	127.6	136.2	93.7	104	90.9
1963					
21	119.2	138.7	85.9	95	90.4
22	129.6	141.1	91.8	103	89.1
23	129.0	143.5	89.9	98	91.7
24	149.7	145.9	102.6	104	98.6
1964					
25	148.3	148.4	99.9	95	105.1
26	171.5	150.8	113.7	103	110.4
27	158.6	153.2	103.5	98	105.6
28	178,6	155.7	114.7	104	110.3

TABLE XV (continued)

1965					
29	163.7	158.1	103.5	95	108.9
30	172.3	160.5	107.4	103	104.2
31	160.3	162.9	98.4	98	100.4
32	169.6	165.4	102.5	104	98.5
1966					
33	155.5	167.8	92.7	95	97.5
34	158.9	170.2	93.4	103	90.6
35	156.7	172.6	90.8	98	92.6
36	186.0	175.0	106.3	104	102.2
1967					
37	163.7	177.4	92.3	95	97.1
38	177.8	179.8	98.9	103	96.0
39	160.3	182.2	87.9	98	89.8
40	182.5	184.6	98.9	104	95.1

PART 2

BUREAU'S INDEX

TABLE XVI

WORKING TABLE FOR BUREAU'S INDEX

Time	Actual Data (1)	Ordinate of Trend (2)	Relative, Actual to Trend (%) (3)	Seasonal Index (%) (4)	Adjusted Relative (5)
1958					
1	92.6	98.3	94.2	100.0	94.2
2	98.3	99.6	98.7	100.0	98.7
3	105.2	100.9	104.3	100.0	104.3
4	107.3	102.2	105.0	100.0	105.0
1959					
5	107.0	103.5	103.4	100.0	103.4
6	113.4	104.8	108.2	100.0	108.2
7	109.3	106.1	103.0	100.0	103.0
8	110.3	107.4	102.7	100.0	102.7
1960					
9	110.5	108.7	101.7	100.0	101.7
10	109.3	110.0	99.4	100.0	99.4
11	110.3	111.3	99.1	100.0	99.1
12	107.1	112.6	95.1	100.0	95.1
1961					
13	109.5	113.9	96.1	100.1	96.1
14	111.1	115.2	96.4	100.0	96.4
15	114.6	116.5	98.4	100.0	98.4
16	115.0	117.8	97.6	100.0	97.6
1962					
17	114.9	119.0	96.6	100.0	96.6
18	119.2	120.3	99.1	100.0	99.1
19	116.9	121.6	96.1	100.0	96.1
20	121.6	122.9	98.9	100.0	98.9
1963					
21	118.7	124.2	95.6	100.0	95.6
22	125.0	125.5	99.8	100.0	99.8
23	129.1	126.8	101.8	100.0	101.8
24	128.4	128.1	100.2	100.0	100.2
1964					
25	128.9	129.4	99.6	100.0	99.6
26	132.9	130.7	101.7	100.0	101.7
27	132.5	132.0	100.4	100.0	100.4
28	136.0	133.3	102.0	100.0	102.0

TABLE XVI (continued)

1965					
29	133.2	134.6	99.0	100.0	99.0
30	137.1	135.9	100.9	100.0	100.9
31	140.6	137.2	102.5	100.0	102.5
32	143.4	138.4	103.6	100.0	103.6
1966					
33	140.3	139.7	100.4	100.0	100.4
34	144.4	141.0	102.3	100.0	102.3
35	145.8	142.3	102.4	100.0	102.4
36	143.1	143.6	99.7	100.0	99.7
1967					
37	141.0	144.9	97.3	100.0	97.3
38	147.8	146.2	101.1	100.0	101.1
39	143.6	147.5	97.3	100.0	997.3
40	147.4	146.8	100.4	100.0	100.4

THE BUREAU INDEX

ACTUAL

	DATA	PERCENTS OF MEAN	STANDARD SCORES
1	92.6	78.20125	-2.03929
2	98.3	83.01494	-1.58896
3	105.2	88.84203	-1.04383
4	107.3	90.61549	-0.87793
5	107.0	90.36215	-0.90163
6	113.4	95.76698	-0.39600
7	109.3	92.30450	-0.71992
8	110.3	93.14902	-0.64091
9	110.5	93.31792	-0.62511
10	109.3	92.30450	-0.71992
11	110.3	93.14902	-0.64091
12	107.1	90.44659	-0.89373
13	109.5	92.47342	-0.70412
14	111.1	93.82462	-0.57771
15	114.6	96.78040	-0.30120

16	115.0	97.11819	-0.26959
17	114.9	97.03374	-0.27749
18	119.2	100.66508	0.06222
19	116.9	98.72275	-0.11949
20	121.6	102.69193	0.25183
21	118.7	100.24280	0.02272
22	125.0	105.56325	0.52045
23	129.1	109.02567	0.84436
24	128.4	108.43457	0.78906
25	128.9	108.85677	0.82856
26	132.9	112.23477	1.14458
27	132.5	111.89699	1.11298
28	136.0	114.85280	1.38949
29	133.2	112.48817	1.16828
30	137.1	115.78178	1.47640
31	140.6	118.73750	1.75291
32	143.4	121.10214	1.97412
33	140.3	118.48412	1.72921

34	144.4	121.94661	2.05313
35	145.8	123.12898	2.16373
36	143.1	120.84874	1.95042
37	141.0	119.07529	1.78451
38	147.8	124.81793	2.32174
39	143.6	121.27103	1.98993
40	147.4	124.48015	2.29014

THE BUREAU INDEX

SEASONAL & DESEASONAL

	DATA	PERCENTS OF MEAN	STANDARD SCORES
1	94.2	94.16771	-1.82197
2	98.7	98.66615	-0.41668
3	104.3	104.26416	1.33212
4	105.0	104.96396	1.55072
5	103.4	103.36446	1.05106
6	108.2	108.16287	2.55004
7	103.0	102.96468	0.92615
8	102.7	102.66475	0.83246
9	101.7	101.66512	0.52018
10	99.4	99.36591	-0.19308
11	99.1	99.06601	-0.29177
12	95.1	95.06738	-1.54091
13	96.1	96.06705	-1.22863
14	96.4	96.36694	-1.13494
15	98.4	98.36626	-0.51037

16	97.6	97.56653	-0.76020
17	96.6	96.56688	-1.07248
18	99.1	99.06601	-0.29177
19	96.1	96.06705	-1.22863
20	98.9	98.86609	-0.35422
21	95.6	95.56721	-1.38477
22	99.8	99.76578	-0.07317
23	101.8	101.76506	0.55140
24	100.2	100.16565	0.05175
25	99.6	99.56584	-0.13562
26	101.7	101.66512	0.52018
27	100.4	100.36554	0.11421
28	102.0	101.96495	0.61387
29	99.0	98.96605	-0.32299
30	100.9	100.86536	0.27035
31	102.5	102.46486	0.77001
32	103.6	103.56445	1.11352
33	100.4	100.36554	0.11421

34	102.3	102.26488	0.70755
35	102.4	102.36482	0.73878
36	99.7	99.66582	-0.10439
37	97.3	97.26663	-0.85388
38	101.1	101.06525	0.33280
39	97.3	97.26663	-0.85388
40	100.4	100.36554	0.11421

APPENDIX B

FACTOR ANALYSIS RESULTS

PART 1

ACTUAL

THE MEANS AND STANDARD DEVIATIONS
FOR THE SERIES
ACTUAL

SERIES	MEANS	STANDARD DEVIATIONS
1. Building Permits	100.83	17.52
2. Electric Power Production	162.85	71.51
3. Wage Workers in Manufacturing	106.52	4.89
4. Index: Metallics Production	132.95	42.95
5. Petroleum Production	108.96	5.65
6. Potash Production	121.61	22.52
7. Bank Debits	121.74	14.25
8. Life Insurance Sales	127.74	25.32

CORRELATION COEFFICIENTS

ROW 1	1.00000	0.21856	0.10404	-0.15306	-0.17971	0.09937	0.05542	0.11977
ROW 2	0.21856	1.00000	0.52770	0.68359	0.75559	0.69491	0.87383	0.90673
ROW 3	0.10404	0.52770	1.00000	0.25083	0.55888	0.36814	0.65061	0.58573
ROW 4	-0.15306	0.68359	0.25083	1.00000	0.69795	0.60159	0.66627	0.69254
ROW 5	-0.17971	0.75559	0.55888	0.69795	1.00000	0.65042	0.87550	0.81042
ROW 6	0.09937	0.69491	0.36814	0.60159	0.65042	1.00000	0.74346	0.75922
ROW 7	0.05542	0.87383	0.65061	0.66627	0.87550	0.74346	1.00000	0.90477
ROW 8	0.11977	0.90673	0.58573	0.69254	0.81042	0.75922	0.90477	1.00000

EIGENVALUES

5.15270 1.17721

CUMULATIVE PERCENTAGE OF EIGENVALUES

0.64409 0.79124

FACTOR MATRIX (2 FACTORS)

VARIABLE 1	0.05713	0.95860
VARIABLE 2	0.92082	0.16646
VARIABLE 3	0.64267	0.22302
VARIABLE 4	0.76981	-0.33153
VARIABLE 5	0.89677	-0.25041
VARIABLE 6	0.81091	0.03939
VARIABLE 7	0.96089	0.02233
VARIABLE 8	0.95435	0.07860

PART 2

SEASONAL

THE MEANS AND STANDARD DEVIATIONS
FOR THE SERIES
SEASONAL

	SERIES	MEANS	STANDARD DEVIATIONS
1.	Building Permits	100.00	17.40
2.	Electric Power Production	100.34	11.98
3.	Wage Workers in Manufacturing	100.00	3.84
4.	Index: Metallics Production	100.11	22.92
5.	Petroleum Production	100.00	2.84
6.	Potash Production	100.05	11.27
7.	Bank Debits	100.01	4.24
8.	Life Insurance Sales	100.13	8.60

CORRELATION COEFFICIENTS

ROW 1	1.00000	-0.02682	0.10935	-0.20948	-0.36495	0.10764	0.09480	0.27455
ROW 2	-0.02682	1.00000	0.48390	-0.33179	0.51760	0.08808	0.46808	0.24105
ROW 3	0.10935	0.48390	1.00000	-0.48829	0.22430	-0.15272	0.48727	0.23761
ROW 4	-0.20948	-0.33179	-0.48829	1.00000	-0.10102	-0.01590	-0.57933	-0.28524
ROW 5	-0.36495	0.51760	0.22430	-0.10102	1.00000	0.02074	0.47241	0.20011
ROW 6	0.10764	0.08808	-0.15272	-0.01590	0.02074	1.00000	0.13561	0.21602
ROW 7	0.09480	0.46808	0.48727	-0.57933	0.47241	0.13561	1.00000	0.40260
ROW 8	0.27455	0.24105	0.23761	-0.28524	0.20011	0.21602	0.40260	1.00000

EIGENVALUES

2.90839	1.51267	1.17495

CUMULATIVE PERCENTAGE OF EIGENVALUES

0.36355	0.55263	0.69950

FACTOR MATRIX (3 FACTORS)

VARIABLE 1	0.12744	0.85300	-0.08841
VARIABLE 2	0.73638	-0.26992	0.05659
VARIABLE 3	0.71387	0.01768	-0.44922
VARIABLE 4	-0.69529	-0.28771	0.27897
VARIABLE 5	0.56492	-0.65074	0.26018
VARIABLE 6	0.11893	0.26740	0.83564
VARIABLE 7	0.84572	0.01177	0.05876
VARIABLE 8	0.55527	0.36605	0.33890

PART 3

DESEASONAL

THE MEANS AND STANDARD DEVIATIONS
FOR THE SERIES
DESEASONAL

	SERIES	MEANS	STANDARD DEVIATIONS
1.	Building Permits	99.72	17.45
2.	Electric Power Production	100.29	10.55
3.	Wage Workers in Manufacturing	99.94	3.06
4.	Index: Metallics Production	100.09	22.58
5.	Petroleum Production	100.01	3.09
6.	Potash Production	99.97	10.14
7.	Bank Debits	99.80	4.08
8.	Life Insurance Sales	100.11	7.36

CORRELATION COEFFICIENTS

ROW 1	1.00000	-0.03871	0.14788	-0.25928	-0.30997	0.11062	0.22644	0.35746
ROW 2	-0.03871	1.00000	0.41124	-0.26979	0.51927	0.37267	0.58552	0.41354
ROW 3	0.14788	0.41124	1.00000	-0.39507	0.15273	0.14276	0.52004	0.15762
ROW 4	-0.25928	-0.26979	-0.39507	1.00000	-0.00062	-0.12385	-0.49217	-0.18032
ROW 5	-0.30997	0.51927	0.15273	-0.00062	1.00000	0.10643	0.29610	0.11322
ROW 6	0.11062	0.37267	0.14276	-0.12385	0.10643	1.00000	0.20850	0.30142
ROW 7	0.22644	0.58552	0.52004	-0.49217	0.29610	0.20850	1.00000	0.21940
ROW 8	0.35746	0.41354	0.15762	-0.18032	0.11322	0.30142	0.21940	1.00000

EIGENVALUES

2.87086 1.53493 1.13836

CUMULATIVE PERCENTAGE OF EIGENVALUES

0.35886 0.55072 0.69302

FACTOR MATRIX (3 FACTORS)

VARIABLE 1	0.27732	0.81117	0.14083
VARIABLE 2	0.80919	-0.36522	0.14118
VARIABLE 3	0.66564	0.06485	-0.41127
VARIABLE 4	-0.59206	-0.34573	0.41162
VARIABLE 5	0.42078	-0.74945	0.04433
VARIABLE 6	0.46892	0.00084	0.56951
VARIABLE 7	0.80989	0.00906	-0.29607
VARIABLE 8	0.54098	0.24093	0.58826

APPENDIX C

COMPUTER PROGRAMS AND RESULTS

PART 1

EXAMPLE 1 - PROGRAM

```
C
C     THIS PROGRAM CALCULATES THE SQUARED LOADINGS,COMMUNALITIES(H**2),
C     PERCENT OF COMMON VATIANCE,PERCENT OF TOTAL VARIANCE
C
      DIMENSION F(8,3),SF(8,3),H2(8),PTV(3),PCV(3),SSF(3)
C     F=FACTOR LOADINGS
C     SF=SQUARED FACTOR LOADINGS
C     H2=COMMUNALITIES (H**2)
C     SSF=SUM OF SQUARED FACTOR LOADINGS
C     SHS=SUM OF COMMUNALITIES
C     PCV=PERCENT OF COMMON VARIANCE
C     PTV=PERCENT OF TOTAL VARIANCE
C     SPTV=SUM OF PERCENTS OF TOTAL VARIANCE
      SHS=0
  100 FORMAT(3F8.5)
  101 FORMAT(12X,'LOADINGS ',F8.5,5X,F8.5,5X,F8.5,/)
  102 FORMAT(7X,I2)
  103 FORMAT(12X,'SQUARED ',1X,F8.5,5X,F8.5,5X,F8.5,8X,F8.5,//)
  104 FORMAT(14X,'PTV ',3X,F6.3,8X,F6.3,8X,F6.3,8X,F8.5,//)
  105 FORMAT(14X,'PCV ',3X,F6.3,8X,F6.3,8X,F6.3,//)
  106 FORMAT(13X,'SUM OF ',/,12X,'SQUARES ',1X,F8.5,5X,F8.5,5X,F8.5,8X,F
     28.5,//)
  107 FORMAT(1H1,12X,'LOADINGS,SGUARED LOADINGS,COMMUNALITIES,PCV,AND,PT
     2V ',///)
  108 FORMAT(24X,'1 ',10X,'2 ',10X,'3 ',11X,'H**2 ',//)
      READ(5,100)((F(I,J),J=1,3),I=1,8)
      DO 120 J=1,3
      DO 120 I=1,8
      SF(I,J)=F(I,J)**2
      H2(I)=SF(I,J)+H2(I)
      SSF(J)=SSF(J)+SF(I,J)
  120 CONTINUE
      DO 121 M=1,8
      SHS=SHS+H2(M)
  121 CONTINUE
      SPTV=(SHS/8.)*100.
      DO 122 N=1,3
      PTV(N)=(SSF(N)/8.)*100.
      PCV(N)=(SSF(N)/SHS)*100.
  122 CONTINUE
      WRITE(6,107)
      WRITE(6,108)
      DO 123 K=1,8
      WRITE(6,101) F(K,1),F(K,2),F(K,3)
      WRITE(6,102)
      WRITE(6,103) SF(K,1),SF(K,2),SF(K,3),H2(K)
  123 CONTINUE
      WRITE(6,104) PTV(1),PTV(2),PTV(3),SPTV
      WRITE(6,105) PCV(1),PCV(2),PCV(3)
      WRITE(6,106) SSF(1),SSF(2),SSF(3),SHS
      CALL EXIT
      END
```

PART 2

OBAI - ACTUAL

```
C      THIS PROGRAM WILL CONSTRUCT AN OBAI FROM THE COMPONENT FACTORS
C      THAT ARE ALSO CALCULATED BY THIS PROGRAM
C
C      BASED ON ACTUAL DATA
C
       DIMENSION AINDEX(40),AF(40,2),CF(40,2)
       DIMENSION F(8,2),FS(40,2),PCV(2),D(2),A(8),S(2),AV(2),SU(2),SQ(2)
       DIMENSION SDS(8),SDF(2),ZF(40,2),FINDEX(40),ZINDEX(40)
C
C      F=FACTOR LOADINGS        FS=FACTOR SCORES
C      PCV=PERCENT OF COMMON VARIANCE          D=SQUARE ROOT OF PCV
C      S=SUM OF FACTOR SCORES FOR EACH PATTERN
C      AV=AVERAGE OF FACTOR SCORES FOR EACH PATTERN
C      SDS=STANDARD DEVIATION OF EACH SERIES
C      SDF=STANDARD DEVIATION OF FACTOR SCORES FOR EACH PATTERN
C      ZF=FACTOR SCORES EXPRESSED AS STANDARDIZED SCORES
C      AF=FACTOR SCORES EXPRESSED AS PERCENTAGES OF THE MEAN
C      FINDEX=THE OBAI EXPRESSED IN COMPUTED FORM
C      AINDEX=THE OBAI EXPRESSED AS PERCENTAGES OF THE MEAN
C      ZINDEX=THE OBAI EXPRESSED AS STANDARDIZED SCORES
C      CF=COMPONENT FACTOR
C
       KI=0
     1 FORMAT(2F8.5)
     2 FORMAT(8F7.4)
     3 FORMAT(2F6.3)
     4 FORMAT(8F6.1)
     5 FORMAT(9X,I3,5X,F10.5,8X,F10.5,10X,F10.5,//)
     6 FORMAT(10X,'THE OBAI EXPRESSED IN COMPUTED FORM ',///)
     7 FORMAT(1H1,9X,'THE OBAI EXPRESSED AS STANDARIZED SCORES ',///)
     8 FORMAT(1H1,9X,'THE OBAI EXPRESSED AS PERCENTAGES OF THE MEAN ',///
      2)
     9 FORMAT(1X,18X,'COMPONENT ',9X,'COMPONENT ',/,1X,20X,'FACTOR ',11X,
      2'FACTOR ',13X,'OBAI ',/,1X,23X,'1 ',17X,'2 ',///)
    11 FORMAT(1H1,////,27X,'OVERALL BUSINESS ACTIVITY INDEX-ACTUAL ',///)
       READ(5,1) ((F(I,J),J=1,2),I=1,8)
       READ(5,2) (SDS(I),I=1,8)
       READ(5,3) (PCV(I),I=1,2)
   100 KI=KI+1
       READ(5,4) (A(I),I=1,8)
       DO 20 K=1,2
       DO 20 L=1,8
       FS(KI,K)=FS(KI,K)&(A(L)*(F(L,K)/SDS(L)))
    20 CONTINUE
       IF(KI-40) 100,110,110
   110 DO 21 M=1,2
       DO 21 N=1,32
       S(M)=S(M)+FS(N,M)
    21 CONTINUE
       AV(1)=S(1)/32.
       AV(2)=S(2)/32.
```

```
      DO 22 MT=1,2
      DO 22 NT=1,32
      SU(MT)=SU(MT)+((FS(NT,MT)-AV(MT))**2)
      IF(NT-32) 22,23,23
   23 SQ(MT)=SU(MT)/32.
      SDF(MT)=SQRT(SQ(MT))
      D(MT)=SQRT(PCV(MT))
   22 CONTINUE
      DO 24 ML=1,2
      DO 24 NL=1,40
      CF(NL,ML)=D(ML)*(FS(NL,ML)/SDF(ML))
      FINDEX(NL)=CF(NL,ML)+FINDEX(NL)
      ZINDEX(NL)=(FINDEX(NL)-116.38676)/10.16011
      AINDEX(NL)=(FINDEX(NL)/116.38676)*100.
      ZF(NL,ML)=(FS(NL,ML)-AV(ML))/SDF(ML)
      AF(NL,ML)=FS(NL,ML)/AV(ML)
   24 CONTINUE
      WRITE(6,11)
      WRITE(6,6)
      WRITE(6,9)
      DO 25 JC=1,40
      WRITE(6,5) JC,CF(JC,1),CF(JC,2),FINDEX(JC)
   25 CONTINUE
      WRITE(6,7)
      WRITE(6,9)
      DO 26 JZ=1,40
      WRITE(6,5) JZ,ZF(JZ,1),ZF(JZ,2),ZINDEX(JZ)
   26 CONTINUE
      WRITE(6,8)
      WRITE(6,9)
      DO 27 JA=1,40
      WRITE(6,5) JA,AF(JA,1),AF(JA,2),AINDEX(JA)
   27 CONTINUE
      CALL EXIT
      END
```

OVERALL BUSINESS ACTIVITY INDEX-ACTUAL

THE OBAI EXPRESSED IN COMPUTED FORM

	COMPONENT FACTOR 1	COMPONENT FACTOR 2	OBAI
1	77.12839	21.01329	98.14168
2	80.11945	24.48973	104.60918
3	83.01775	28.45403	111.47177
4	86.71068	23.47089	110.18156
5	85.68053	25.41682	111.09735
6	89.96825	28.54419	118.51244
7	87.83257	22.38216	110.21472
8	88.55717	25.12595	113.68312
9	90.21558	18.56796	108.78354
10	88.95189	22.05516	111.00705
11	90.67433	17.79567	108.47000
12	90.42610	13.22202	103.64812
13	90.24797	15.33435	105.58232

14	94.12015	15.12350	109.24364
15	94.91266	14.41059	109.32324
16	94.23212	13.68034	107.91246
17	92.74344	15.84380	108.58723
18	94.30333	21.34500	115.64833
19	93.08965	16.10181	109.19145
20	96.73941	21.08278	117.82219
21	92.12164	23.64377	115.76541
22	95.81313	24.85611	120.66924
23	100.69435	26.68828	127.38263
24	101.61124	19.57259	121.18382
25	105.44121	24.21840	129.65961
26	107.24980	22.16579	129.41559
27	105.30417	26.55597	131.86014
28	109.59149	24.27696	133.86845
29	108.28490	19.66595	127.95085
30	109.78156	17.24747	127.02902
31	109.20406	23.01527	132.21933
32	110.88770	23.39479	134.28249

33	110.31596	17.58743	127.90340
34	114.13594	21.68227	135.81821
35	114.71649	16.96719	131.68369
36	117.34389	16.32948	133.67337
37	114.06702	12.03204	126.09904
38	115.79866	17.68062	133.47928
39	110.61569	17.08749	127.70319
40	112.08083	17.78642	129.86725

THE CEAI EXPRESSED AS STANDARIZED SCORES

	COMPONENT FACTOR 1	COMPONENT FACTOR 2	OBAI
1	-2.00039	-0.04591	-1.79576
2	-1.66888	0.76022	-1.15920
3	-1.34764	1.67946	-0.48375
4	-0.93833	0.52396	-0.61074
5	-1.05251	0.97519	-0.52061
6	-0.57727	1.70037	0.20922
7	-0.81398	0.27151	-0.60748
8	-0.73367	0.90774	-0.26610
9	-0.54986	-0.61294	-0.74834
10	-0.68992	0.19568	-0.52949
11	-0.49901	-0.79202	-0.77920
12	-0.52652	-1.85256	-1.25379
13	-0.54627	-1.36275	-1.06342
14	-0.11709	-1.41165	-0.70306
15	-0.02925	-1.57696	-0.69522
16	-0.10468	-1.74629	-0.83408

17	-0.26968	-1.24462	-0.76766
18	-0.09679	0.03101	-0.07268
19	-0.23131	-1.18479	-0.70819
20	0.17322	-0.02980	0.14128
21	-0.33860	0.56405	-0.06116
22	0.07055	0.84517	0.42150
23	0.61157	1.27002	1.08226
24	0.71320	-0.37998	0.47215
25	1.13770	0.69730	1.30637
26	1.33815	0.22134	1.28235
27	1.12251	1.23934	1.52295
28	1.59770	0.71088	1.72062
29	1.45288	-0.35833	1.13819
30	1.61876	-0.91913	1.04745
31	1.55476	0.41832	1.55831
32	1.74137	0.50632	1.76137
33	1.67800	-0.84030	1.13351
34	2.10139	0.10921	1.91252

35	2.16574	-0.98413	1.50559
36	2.45695	-1.13200	1.70142
37	2.09375	-2.12850	0.95592
38	2.28568	-0.81869	1.68232
39	1.71122	-0.95623	1.11381
40	1.87361	-0.79416	1.32681

THE OBAI EXPRESSED AS PERCENTAGES OF THE MEAN

	COMPONENT FACTOR 1	COMPONENT FACTOR 2	OBAI
1	0.81037	0.99067	84.32375
2	0.84180	1.15456	89.88065
3	0.87225	1.34146	95.77701
4	0.91105	1.10653	94.66846
5	0.90023	1.19827	95.45531
6	0.94528	1.34571	101.82639
7	0.92284	1.05520	94.69695
8	0.93045	1.18456	97.67702
9	0.94788	0.87538	93.46727
10	0.93460	1.03978	95.37772
11	0.95270	0.83897	93.19788
12	0.95009	0.62335	89.05490
13	0.94822	0.72293	90.71677
14	0.98890	0.71299	93.86259
15	0.99723	0.67938	93.93098
16	0.99008	0.64496	92.71884

17	0.97444	0.74695	93.29860
18	0.99082	1.00630	99.36552
19	0.97807	0.75912	93.81775
20	1.01642	0.99394	101.23332
21	0.96790	1.11468	99.46613
22	1.00669	1.17183	103.67952
23	1.05797	1.25821	109.44769
24	1.06761	0.92274	104.12164
25	1.10785	1.14177	111.40408
26	1.12685	1.04500	111.19441
27	1.10641	1.25197	113.29478
28	1.15145	1.14453	115.02034
29	1.13773	0.92715	109.93591
30	1.15345	0.81313	109.14388
31	1.14738	1.08505	113.60341
32	1.16507	1.10294	115.37608
33	1.15907	0.82915	109.89514
34	1.19920	1.02220	116.69557

35	1.20530	0.79991	113.14317
36	1.23291	0.76985	114.85272
37	1.19848	0.56725	108.34483
38	1.21667	0.83355	114.68596
39	1.16222	0.80559	109.72311
40	1.17761	0.83854	111.58249

PART 3

OBAI - SEASONAL

```
C
C     THIS PROGRAM WILL CONSTRUCT AN OBAI FROM THE COMPONENT FACTORS
C     THAT ARE ALSO CALCULATED BY THIS PROGRAM
C
C     BASED ON SEASONAL DATA
C
      DIMENSION F(8,3),FS(40,3),PCV(2),D(3),A(8),S(3),AV(3),SU(3),SQ(3)
      DIMENSION AINDEX(40),AF(40,3),CF(40,3)
      DIMENSION SDS(8),SDF(3),ZF(40,3),FINDEX(40),ZINDEX(40)
C
C     F=FACTOR LOADINGS        FS=FACTOR SCORES
C     PCV=PERCENT OF COMMON VARIANCE          D=SQUARE ROOT OF PCV
C     S=SUM OF FACTOR SCORES FOR EACH PATTERN
C     AV=AVERAGE OF FACTOR SCORES FOR EACH PATTERN
C     SDS=STANDARD DEVIATION OF EACH SERIES
C     SDF=STANDARD DEVIATION OF FACTOR SCORES FOR EACH PATTERN
C     ZF=FACTOR SCORES EXPRESSED AS STANDARDIZED SCORES
C     AF=FACTOR SCORES EXPRESSED AS PERCENTAGES OF THE MEAN
C     FINDEX=THE OBAI EXPRESSED IN COMPUTED FORM
C     AINDEX=THE OBAI EXPRESSED AS PERCENTAGES OF THE MEAN
C     ZINDEX=THE OBAI EXPRESSED AS STANDARDIZED SCORES
C     CF=COMPONENT FACTOR
C
      KI=0
    1 FORMAT(3F8.5)
    2 FORMAT(8F7.4)
    3 FORMAT(3F6.3)
    4 FORMAT(8F6.1)
    5 FORMAT(9X,I3,5X,F10.5,8X,F10.5,5X,F10.5,10X,F10.5,//)
    6 FORMAT(10X,'THE OBAI EXPRESSED IN COMPUTED FORM ',///)
    7 FORMAT(1H1,9X,'THE OBAI EXPRESSED AS STANDARIZED SCORES ',///)
    8 FORMAT(1H1,9X,'THE OBAI EXPRESSED AS PERCENTAGES OF THE MEAN ',///
     2)
   10 FORMAT(1X,18X,'COMPONENT ',8X,'COMPONENT ',5X,'COMPONENT ',/,1X,20
     2X,'FACTOR ',11X,'FACTOR ',7X,'FACTOR ',13X,'OBAI ',/,1X,23X,'1 ',1
     46X,'2 ',11X,'3 ',///)
   11 FORMAT(1H1,////,26X,'OVERALL BUSINESS ACTIVITY INDEX-SEASONAL ',//
     2/)
     2///)
      READ(5,1) ((F(I,J),J=1,3),I=1,8)
      READ(5,2) (SDS(I),I=1,8)
      READ(5,3) (PCV(I),I=1,3)
  100 KI=KI+1
      READ(5,4) (A(I),I=1,8)
      DO 20 K=1,3
      DO 20 L=1,8
      FS(KI,K)=FS(KI,K)&(A(L)*(F(L,K)/SDS(L)))
   20 CONTINUE
      IF(KI-40) 100,110,110
  110 DO 21 M=1,3
      DO 21 N=1,32
      S(M)=S(M)+FS(N,M)
```

```
21 CONTINUE
   AV(1)=S(1)/32.
   AV(2)=S(2)/32.
   AV(3)=S(3)/32.
   DO 22 MT=1,3
   DO 22 NT=1,32
   SU(MT)=SU(MT)+((FS(NT,MT)-AV(MT))**2)
   IF(NT-32) 22,23,23
23 SQ(MT)=SU(MT)/32.
   SDF(MT)=SQRT(SQ(MT))
   D(MT)=SQRT(PCV(MT))
22 CONTINUE
   DO 24 ML=1,3
   DO 24 NL=1,40
   CF(NL,ML)=D(ML)*(FS(NL,ML)/SDF(ML))
   FINDEX(NL)=CF(NL,ML)+FINDEX(NL)
   ZINDEX(NL)=(FINDEX(NL)-171.79041)/10.17660
   AINDEX(NL)=(FINDEX(NL)/171.79041)*100.
   ZF(NL,ML)=(FS(NL,ML)-AV(ML))/SDF(ML)
   AF(NL,ML)=FS(NL,ML)/AV(ML)
24 CONTINUE
   WRITE(6,11)
   WRITE(6,6)
   WRITE(6,10)
   DO 25 JC=1,40
   WRITE(6,5) JC,CF(JC,1),CF(JC,2),CF(JC,3),FINDEX(JC)
25 CONTINUE
   WRITE(6,7)
   WRITE(6,10)
   DO 26 JZ=1,40
   WRITE(6,5) JZ,ZF(JZ,1),ZF(JZ,2),ZF(JZ,3),ZINDEX(JZ)
26 CONTINUE
   WRITE(6,8)
   WRITE(6,10)
   DO 27 JA=1,40
   WRITE(6,5) JA,AF(JA,1),AF(JA,2),AF(JA,3),AINDEX(JA)
27 CONTINUE
   CALL EXIT
   END
```

OVERALL BUSINESS ACTIVITY INDEX-SEASONAL

THE OBAI EXPRESSED IN COMPUTED FORM

	COMPONENT FACTOR 1	COMPONENT FACTOR 2	COMPONENT FACTOR 3	OBAI
1	155.30432	-50.64607	50.61359	155.27184
2	167.52254	-48.47812	46.66859	165.71301
3	176.45422	-53.53125	38.49207	161.41504
4	183.06387	-53.24220	49.24741	179.06908
5	176.01233	-52.97377	45.87958	168.91814
6	188.38391	-51.34541	47.11208	184.15057
7	190.11244	-58.86342	40.25914	171.50816
8	191.71716	-52.21513	46.04245	185.54448
9	175.45686	-64.12462	49.86864	161.20088
10	178.82254	-55.33583	43.66356	167.15027
11	179.33578	-62.89452	44.33093	160.77220
12	175.99484	-61.71255	48.46976	162.75204
13	170.18486	-63.81754	49.93176	156.29909

14	174.80783	-65.48936	50.81801	160.13647
15	175.95703	-67.05670	46.65862	155.55894
16	173.04027	-62.95847	48.43022	158.51202
17	169.05458	-60.78212	44.87401	153.14647
18	171.18816	-56.76819	38.71518	153.13515
19	169.31526	-62.92886	31.47929	137.86569
20	171.68799	-55.74940	43.64548	159.58406
21	162.01237	-50.25386	41.47806	153.23657
22	168.66524	-50.90527	41.11641	158.87637
23	180.73645	-54.54068	43.51411	169.70988
24	178.32524	-57.42540	43.92667	164.82651
25	174.79210	-49.24492	56.13988	181.68706
26	177.72426	-50.62190	49.90091	177.00327
27	179.54359	-51.98570	41.65070	169.20859
28	180.36668	-54.00095	46.46252	172.82826
29	174.71469	-59.17068	48.35710	163.90111
30	175.06973	-59.61090	47.77229	163.23112
31	177.23685	-56.66971	43.07207	163.63921
32	177.00661	-54.19371	47.44240	170.25529

33	172.05632	-58.63121	45.39302	158.81813
34	178.23421	-57.88815	42.02325	162.36931
35	177.55229	-62.81651	40.72466	155.46043
36	178.73151	-61.28618	46.52672	163.97205
37	174.99167	-65.36942	43.03598	152.65823
38	176.35164	-58.55954	42.19931	159.99141
39	176.23773	-64.19487	34.27571	146.31857
40	176.89874	-59.25043	39.24501	156.89333

THE CEAI EXPRESSED AS STANDARIZED SCORES

	COMPONENT FACTOR 1	COMPONENT FACTOR 2	COMPONENT FACTOR 3	CEAI
1	-2.81836	1.13365	1.11632	-1.62319
2	-1.12274	1.55009	0.25496	-0.59719
3	0.11681	0.57944	-1.53033	-1.01953
4	1.03409	0.63496	0.81802	0.71524
5	0.05548	0.68653	0.08268	-0.28224
6	1.77240	0.99932	0.35179	1.21457
7	2.01228	-0.44480	-1.14450	-0.02773
8	2.23497	0.83225	0.11824	1.35154
9	-0.02162	-1.45541	0.95366	-1.04058
10	0.44547	0.23281	-0.40117	-0.45596
11	0.51671	-1.21913	-0.25545	-1.08270
12	0.05305	-0.99209	0.64823	-0.38815
13	-0.75326	-1.39643	0.96745	-1.52225
14	-0.11168	-1.71756	1.16095	-1.14517
15	0.04779	-2.01863	0.25278	-1.59498
16	-0.35698	-1.23141	0.63960	-1.30480

17	-0.91012	-0.81336	-0.13688	-1.83204
18	-0.61403	-0.04233	-1.48161	-1.83315
19	-0.87393	-1.22572	-3.06151	-3.33360
20	-0.54465	0.15336	-0.40512	-1.19945
21	-1.88742	1.20899	-0.87836	-1.82319
22	-0.96414	1.08386	-0.95732	-1.26899
23	0.71109	0.38554	-0.43380	-0.20444
24	0.37646	-0.16858	-0.34372	-0.68431
25	-0.11387	1.40279	2.32294	0.97249
26	0.29305	1.13829	0.96071	0.51224
27	0.54554	0.87632	-0.84066	-0.25370
28	0.65978	0.48922	0.20997	0.10198
29	-0.12461	-0.50382	0.62363	-0.77524
30	-0.07535	-0.58838	0.49594	-0.84108
31	0.22542	-0.02342	-0.53032	-0.80098
32	0.19345	0.45219	0.42391	-0.15085
33	-0.49353	-0.40020	-0.02355	-1.27472
34	0.36383	-0.25746	-0.75932	-0.92576

35	0.26919	-1.20414	-1.04286	-1.60466
36	0.43283	-0.91018	0.22398	-0.76827
37	-0.08617	-1.69452	-0.53820	-1.88002
38	0.10256	-0.38643	-0.72088	-1.15942
39	0.08676	-1.46891	-2.45094	-2.50298
40	0.17850	-0.51914	-1.36593	-1.46386

THE CEAI EXPRESSED AS PERCENTAGES OF THE MEAN

	COMPONENT FACTOR 1	COMPONENT FACTOR 2	COMPONENT FACTOR 3	CEAI
1	0.88436	0.89563	1.11236	90.38446
2	0.95393	0.85729	1.02566	96.46231
3	1.00479	0.94665	0.84596	93.96043
4	1.04243	0.94154	1.08234	104.23694
5	1.00228	0.93680	1.00832	98.32803
6	1.07272	0.90800	1.03541	107.19490
7	1.08257	1.04095	0.88480	99.83569
8	1.09170	0.92338	1.01190	108.00630
9	0.99911	1.13399	1.09599	93.83578
10	1.01828	0.97857	0.95962	97.29895
11	1.02120	1.11224	0.97429	93.58624
12	1.00218	1.09133	1.06525	94.73872
13	0.96909	1.12856	1.09738	90.98242
14	0.99542	1.15812	1.11686	93.21619
15	1.00196	1.18584	1.02544	90.55157
16	0.98535	1.11337	1.06438	92.27058

17	0.96266	1.07488	0.98622	89.14726
18	0.97481	1.00390	0.85087	89.14067
19	0.96414	1.11284	0.69184	80.25226
20	0.97765	0.98588	0.95922	92.89462
21	0.92256	0.88870	0.91159	89.19972
22	0.96044	0.90022	0.90364	92.48267
23	1.02918	0.96451	0.95634	98.78891
24	1.01545	1.01552	0.96540	95.94627
25	0.99533	0.87085	1.23382	105.76088
26	1.01202	0.89521	1.09670	103.03442
27	1.02238	0.91932	0.91538	98.49710
28	1.02707	0.95496	1.02113	100.60413
29	0.99489	1.04638	1.06277	95.40759
30	0.99691	1.05417	1.04992	95.01759
31	1.00925	1.00216	0.94662	95.25514
32	1.00794	0.95837	1.04267	99.10640
33	0.97975	1.03684	0.99763	92.44876
34	1.01493	1.02370	0.92357	94.51593

35	1.01104	1.11086	0.89503	90.49423
36	1.01776	1.08379	1.02254	95.44888
37	0.99646	1.15600	0.94583	88.86307
38	1.00421	1.03558	0.92744	93.13174
39	1.00356	1.13523	0.75330	85.17271
40	1.00732	1.04779	0.86251	91.32832

PART 4

OBAI - DESEASONAL

```
C
C     THIS PROGRAM WILL CONSTRUCT AN OBAI FROM THE COMPONENT FACTORS
C     THAT ARE ALSO CALCULATED BY THIS PROGRAM
C
C     BASED ON DESEASONAL DATA
C
      DIMENSION F(8,3),FS(40,3),PCV(2),D(3),A(8),S(3),AV(3),SU(3),SQ(3)
      DIMENSION AINDEX(40),AF(40,3),CF(40,3)
      DIMENSION SDS(8),SDF(3),ZF(40,3),FINDEX(40),ZINDEX(40)
C
C     F=FACTOR LOADINGS        FS=FACTOR SCORES
C     PCV=PERCENT OF COMMON VARIANCE          D=SQUARE ROOT OF PCV
C     S=SUM OF FACTOR SCORES FOR EACH PATTERN
C     AV=AVERAGE OF FACTOR SCORES FOR EACH PATTERN
C     SDS=STANDARD DEVIATION OF EACH SERIES
C     SDF=STANDARD DEVIATION OF FACTOR SCORES FOR EACH PATTERN
C     ZF=FACTOR SCORES EXPRESSED AS STANDARDIZED SCORES
C     AF=FACTOR SCORES EXPRESSED AS PERCENTAGES OF THE MEAN
C     FINDEX=THE OBAI EXPRESSED IN COMPUTED FORM
C     AINDEX=THE OBAI EXPRESSED AS PERCENTAGES OF THE MEAN
C     ZINDEX=THE OBAI EXPRESSED AS STANDARDIZED SCORES
C     CF=COMPONENT FACTOR
C
      KI=0
    1 FORMAT(3F8.5)
    2 FORMAT(8F7.4)
    3 FORMAT(3F6.3)
    4 FORMAT(8F6.1)
    5 FORMAT(9X,I3,5X,F10.5,8X,F10.5,5X,F10.5,10X,F10.5,//)
    6 FORMAT(10X,'THE OBAI EXPRESSED IN COMPUTED FORM ',///)
    7 FORMAT(1H1,9X,'THE OBAI EXPRESSED AS STANDARIZED SCORES ',///)
    8 FORMAT(1H1,9X,'THE OBAI EXPRESSED AS PERCENTAGES OF THE MEAN ',///
     2)
   10 FORMAT(1X,18X,'COMPONENT ',8X,'COMPONENT ',5X,'COMPONENT ',/,1X,20
     2X,'FACTOR ',11X,'FACTOR ',7X,'FACTOR ',13X,'OBAI ',/,1X,23X,'1 ',1
     46X,'2 ',11X,'3 ',///)
   11 FORMAT(1H1,////,25X,'OVERALL BUSINESS ACTIVITY INDEX-DESEASONAL ',
     2///)
      READ(5,1) ((F(I,J),J=1,3),I=1,8)
      READ(5,2) (SDS(I),I=1,8)
      READ(5,3) (PCV(I),I=1,3)
  100 KI=KI+1
      READ(5,4) (A(I),I=1,8)
      DO 20 K=1,3
      DO 20 L=1,8
      FS(KI,K)=FS(KI,K)&(A(L)*(F(L,K)/SDS(L)))
   20 CONTINUE
      IF(KI-40) 100,110,110
  110 DO 21 M=1,3
      DO 21 N=1,32
      S(M)=S(M)+FS(N,M)
   21 CONTINUE
```

```
      AV(1)=S(1)/32.
      AV(2)=S(2)/32.
      AV(3)=S(3)/32.
      DO 22 MT=1,3
      DO 22 NT=1,32
      SU(MT)=SU(MT)+((FS(NT,MT)-AV(MT))**2)
      IF(NT-32) 22,23,23
   23 SQ(MT)=SU(MT)/32.
      SDF(MT)=SQRT(SQ(MT))
      D(MT)=SQRT(PCV(MT))
   22 CONTINUE
      DO 24 ML=1,3
      DO 24 NL=1,40
      CF(NL,ML)=D(ML)*(FS(NL,ML)/SDF(ML))
      FINDEX(NL)=CF(NL,ML)+FINDEX(NL)
      ZINDEX(NL)=(FINDEX(NL)-115.06926)/10.15976
      AINDEX(NL)=(FINDEX(NL)/115.06926)*100.
      ZF(NL,ML)=(FS(NL,ML)-AV(ML))/SDF(ML)
      AF(NL,ML)=FS(NL,ML)/AV(ML)
   24 CONTINUE
      WRITE(6,11)
      WRITE(6,6)
      WRITE(6,10)
      DO 25 JC=1,40
      WRITE(6,5) JC,CF(JC,1),CF(JC,2),CF(JC,3),FINDEX(JC)
   25 CONTINUE
      WRITE(6,7)
      WRITE(6,10)
      DO 26 JZ=1,40
      WRITE(6,5) JZ,ZF(JZ,1),ZF(JZ,2),ZF(JZ,3),ZINDEX(JZ)
   26 CONTINUE
      WRITE(6,8)
      WRITE(6,10)
      DO 27 JA=1,40
      WRITE(6,5) JA,AF(JA,1),AF(JA,2),AF(JA,3),AINDEX(JA)
   27 CONTINUE
      CALL EXIT
      END
```

OVERALL BUSINESS ACTIVITY INDEX-DESEASONAL

THE CEAI EXPRESSED IN COMPUTED FORM

	COMPONENT FACTOR 1	COMPONENT FACTOR 2	COMPONENT FACTOR 3	OBAI
1	172.00549	-68.99829	3.08756	106.09476
2	179.11581	-64.71953	-0.61056	113.78572
3	186.35603	-67.36409	-6.62248	112.36946
4	194.90312	-71.25337	-5.82836	117.82138
5	194.62610	-71.65985	-8.97566	113.99059
6	201.38373	-68.82034	-6.84457	125.71881
7	200.61963	-73.63860	-13.29847	113.68256
8	203.13748	-69.88356	-10.79307	122.46085
9	193.75119	-83.85895	-6.89273	102.99951
10	190.59879	-71.40143	-9.30925	109.88811
11	189.77406	-78.10760	-7.21621	104.45024
12	186.63011	-79.27899	-8.31001	99.04109
13	186.58696	-82.75693	-4.57667	99.25336

14	185.35970	-82.08368	-5.17340	98.10262
15	182.65419	-82.34483	-1.95016	98.35919
16	182.39691	-79.85826	-5.92771	96.61093
17	184.88811	-77.95689	-9.89202	97.03918
18	180.96170	-70.46844	-14.86918	95.62407
19	177.38106	-74.23294	-19.78764	83.36047
20	182.01810	-71.46280	-10.77287	99.78242
21	177.49635	-66.50864	-10.89398	100.09373
22	179.08891	-65.41325	-11.09713	102.57852
23	192.82402	-70.52046	-8.23432	114.06923
24	188.70393	-75.32390	-10.23543	103.14461
25	196.00609	-70.98553	1.23878	126.25932
26	191.29076	-68.35861	-1.67638	121.25577
27	191.57613	-67.36482	-5.97399	118.23730
28	192.21573	-71.73360	-3.86218	116.61995
29	191.46533	-77.77277	-4.20994	109.48262
30	185.31369	-79.52533	-4.76044	105.02791
31	187.74570	-71.68333	-6.62073	109.44162
32	187.19449	-70.90749	-7.80463	108.48238

33	187.48557	-75.08669	-12.89729	99.50159
34	188.06477	-72.00429	-16.45087	99.60962
35	187.29913	-76.64732	-14.23965	96.41216
36	187.87801	-77.31398	-10.79388	99.77014
37	189.20409	-81.25632	-17.20421	90.74356
38	185.47214	-72.33028	-15.03011	98.11174
39	182.38066	-75.39049	-21.40642	85.58376
40	183.34659	-72.58325	-19.34697	91.41637

THE CEAI EXPRESSED AS STANDARIZED SCORES

	COMPONENT FACTOR 1	COMPONENT FACTOR 2	COMPONENT FACTOR 3	OBAI
1	-2.22297	0.79756	2.25855	-0.88334
2	-1.23488	1.61074	1.44242	-0.12634
3	-0.22872	1.10814	0.11568	-0.26573
4	0.95904	0.36898	0.29093	0.27088
5	0.92054	0.29173	-0.40363	-0.10617
6	1.85963	0.83138	0.06667	1.04821
7	1.75344	-0.08433	-1.35762	-0.13649
8	2.10334	0.62931	-0.80471	0.72754
9	0.79895	-2.02672	0.05604	-1.18799
10	0.36088	0.34084	-0.47725	-0.50997
11	0.24627	-0.93367	-0.01535	-1.04520
12	-0.19064	-1.15630	-0.25674	-1.57761
13	-0.19664	-1.81728	0.56716	-1.55672
14	-0.36718	-1.68933	0.43547	-1.66998
15	-0.74316	-1.73896	1.14679	-1.64473
16	-0.77891	-1.26639	0.26900	-1.81681

17	-0.43272	-0.90503	-0.60586	-1.77466
18	-0.97835	0.51816	-1.70425	-1.91394
19	-1.47595	-0.19729	-2.78968	-3.12102
20	-0.83155	0.32918	-0.80025	-1.50465
21	-1.45992	1.27072	-0.82698	-1.47400
22	-1.23861	1.47890	-0.87181	-1.22943
23	0.67011	0.50827	-0.24003	-0.09843
24	0.09756	-0.40463	-0.68165	-1.17371
25	1.11230	0.41988	1.85055	1.10141
26	0.45704	0.91913	1.20721	0.60892
27	0.49669	1.10800	0.25879	0.31182
28	0.58558	0.27771	0.72484	0.15263
29	0.48130	-0.87004	0.64809	-0.54988
30	-0.37358	-0.44291	0.52660	-0.98835
31	-0.03561	0.28726	0.11606	-0.55391
32	-0.11221	0.43472	-0.14520	-0.64833
33	-0.07176	-0.35955	-1.26908	-1.53229
34	0.00873	0.22627	-2.05331	-1.52165

35	-0.09767	-0.65614	-1.56532	-1.83637
36	-0.01722	-0.78285	-0.80489	-1.50585
37	0.16706	-1.53209	-2.21956	-2.39432
38	-0.35156	0.16431	-1.73976	-1.66909
39	-0.78117	-0.41728	-3.14692	-2.90218
40	-0.64695	0.11623	-2.69243	-2.32810

THE CBAI EXPRESSED AS PERCENTAGES OF THE MEAN

	COMPONENT FACTOR 1	COMPONENT FACTOR 2	COMPONENT FACTOR 3	CBAI
1	0.91491	0.94267	-0.43203	92.20078
2	0.95273	0.88421	0.08543	98.88454
3	0.99125	0.92034	0.92665	97.65375
4	1.03671	0.97348	0.81554	102.39169
5	1.03523	0.97903	1.25592	99.06258
6	1.07118	0.94023	0.95773	109.25490
7	1.06711	1.00606	1.86079	98.79489
8	1.08051	0.95476	1.51022	106.42358
9	1.03068	1.14569	0.96447	89.51088
10	1.01381	0.97550	1.30260	95.49736
11	1.00943	1.06712	1.00973	90.77162
12	0.99270	1.08312	1.16278	86.07085
13	0.99247	1.13064	0.64039	86.25531
14	0.98595	1.12144	0.72389	85.25526
15	0.97155	1.12501	0.27288	85.47824
16	0.97019	1.09104	0.82944	83.95894

17	0.98344	1.06506	1.38415	84.33110
18	0.96255	0.96275	2.08058	83.10130
19	0.94351	1.01418	2.76880	72.44373
20	0.96817	0.97634	1.50740	86.71509
21	0.94412	0.90865	1.52434	86.98564
22	0.95259	0.89369	1.55277	89.14502
23	1.02565	0.96346	1.15219	99.13092
24	1.00373	1.02909	1.43220	89.63698
25	1.04257	0.96982	-0.17334	109.72462
26	1.01749	0.93393	0.23457	105.37033
27	1.01901	0.92035	0.83591	102.75316
28	1.02241	0.98004	0.54042	101.34761
29	1.01842	1.06254	0.58908	95.14497
30	0.98570	1.03184	0.66611	91.27364
31	0.99864	0.97935	0.92641	95.10934
32	0.99570	0.96875	1.09207	94.27571
33	0.99725	1.02585	1.80466	86.47104
34	1.00033	0.98373	2.30190	86.56491

35	0.99626	1.04717	1.99249	83.78619
36	0.99934	1.05628	1.51034	86.70442
37	1.00639	1.11014	2.40731	78.85994
38	0.98654	0.98819	2.10310	85.26320
39	0.97010	1.03000	2.99530	74.37585
40	0.97524	0.99164	2.70714	79.44464

APPENDIX D

GRAPHS

PART 1

FACTOR SCORES AND OBAI - ACTUAL

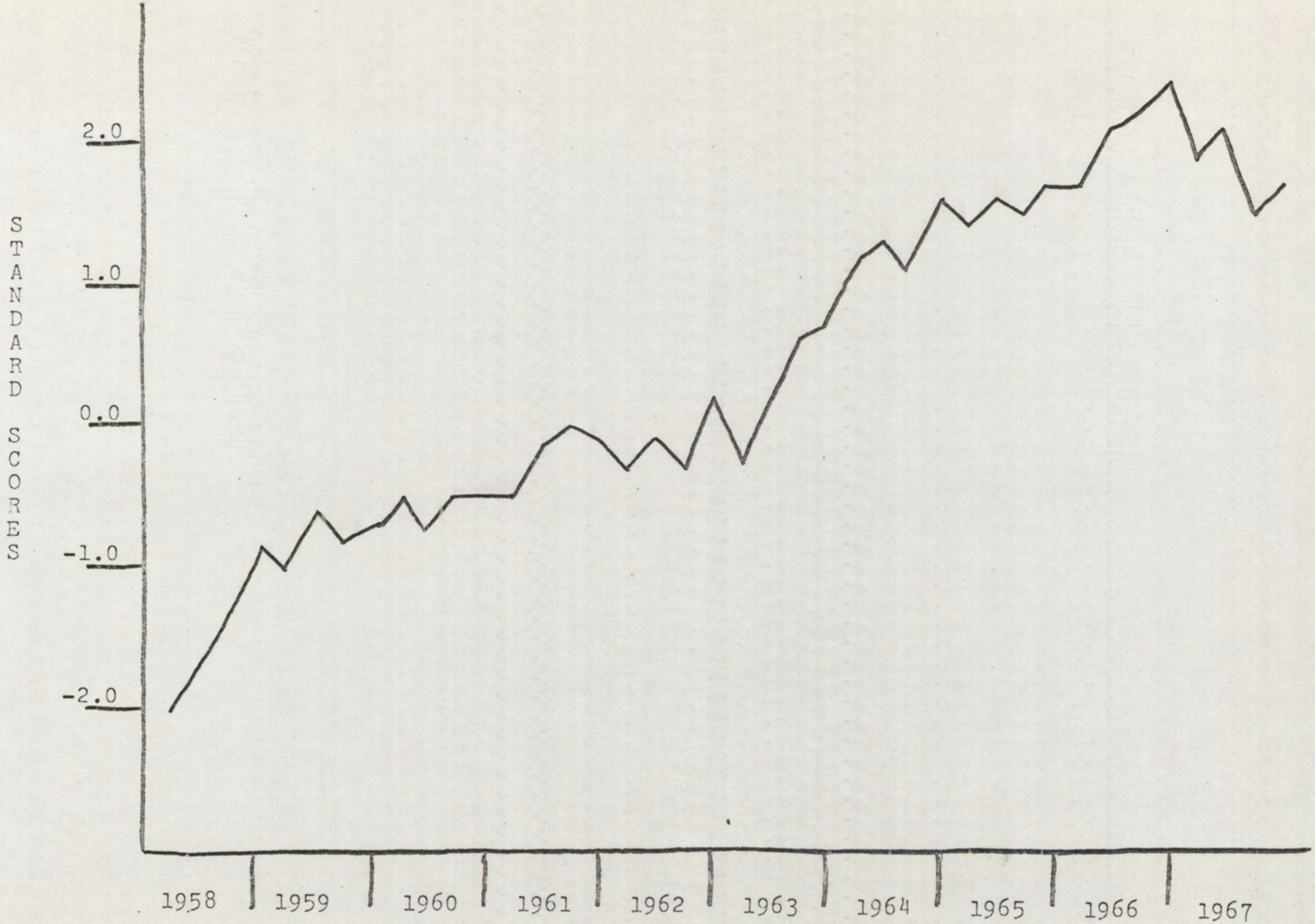

FIGURE 5 -- FACTOR SCORE #1 : ACTUAL

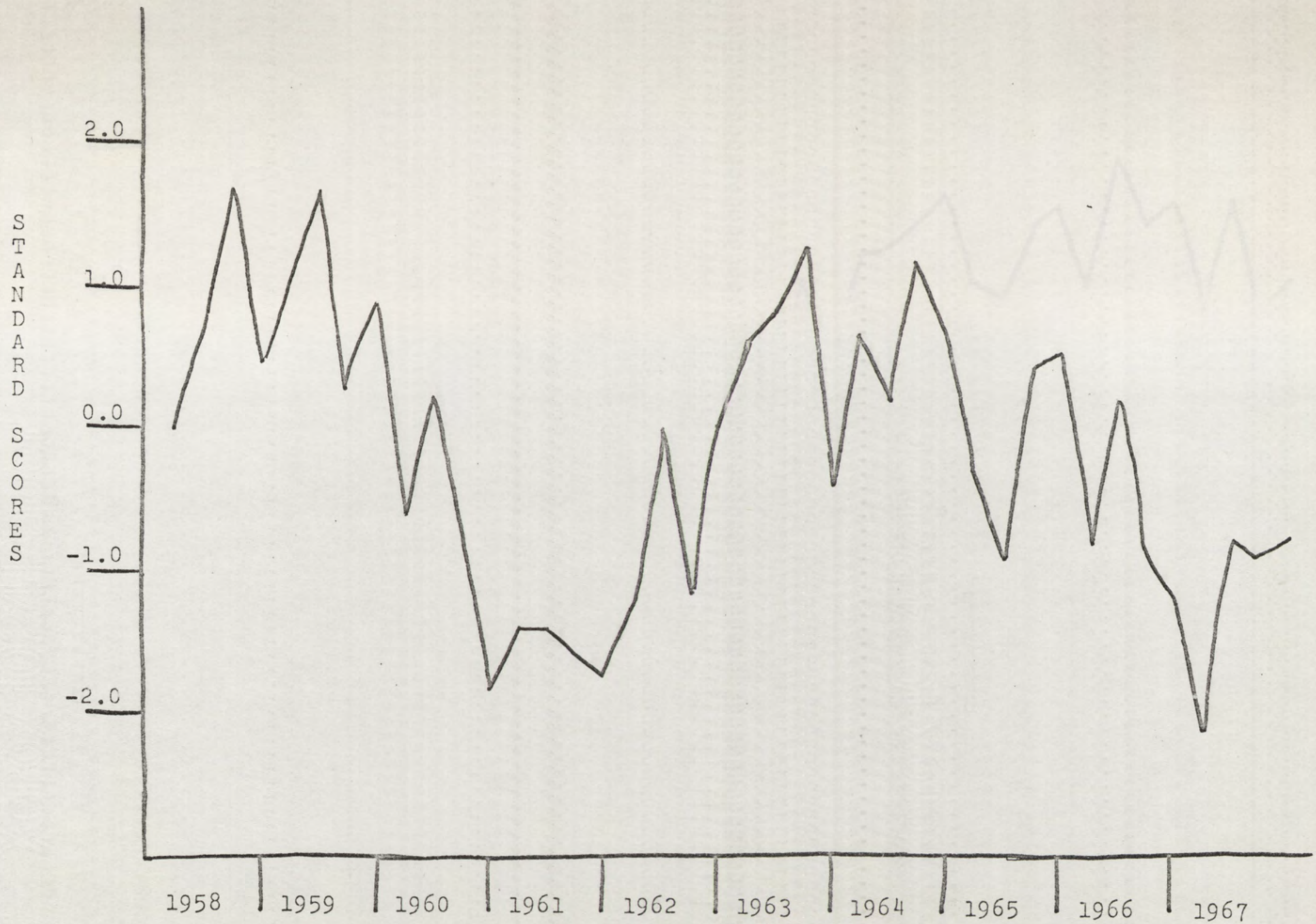

FIGURE 6 -- FACTOR SCORE #2 : ACTUAL

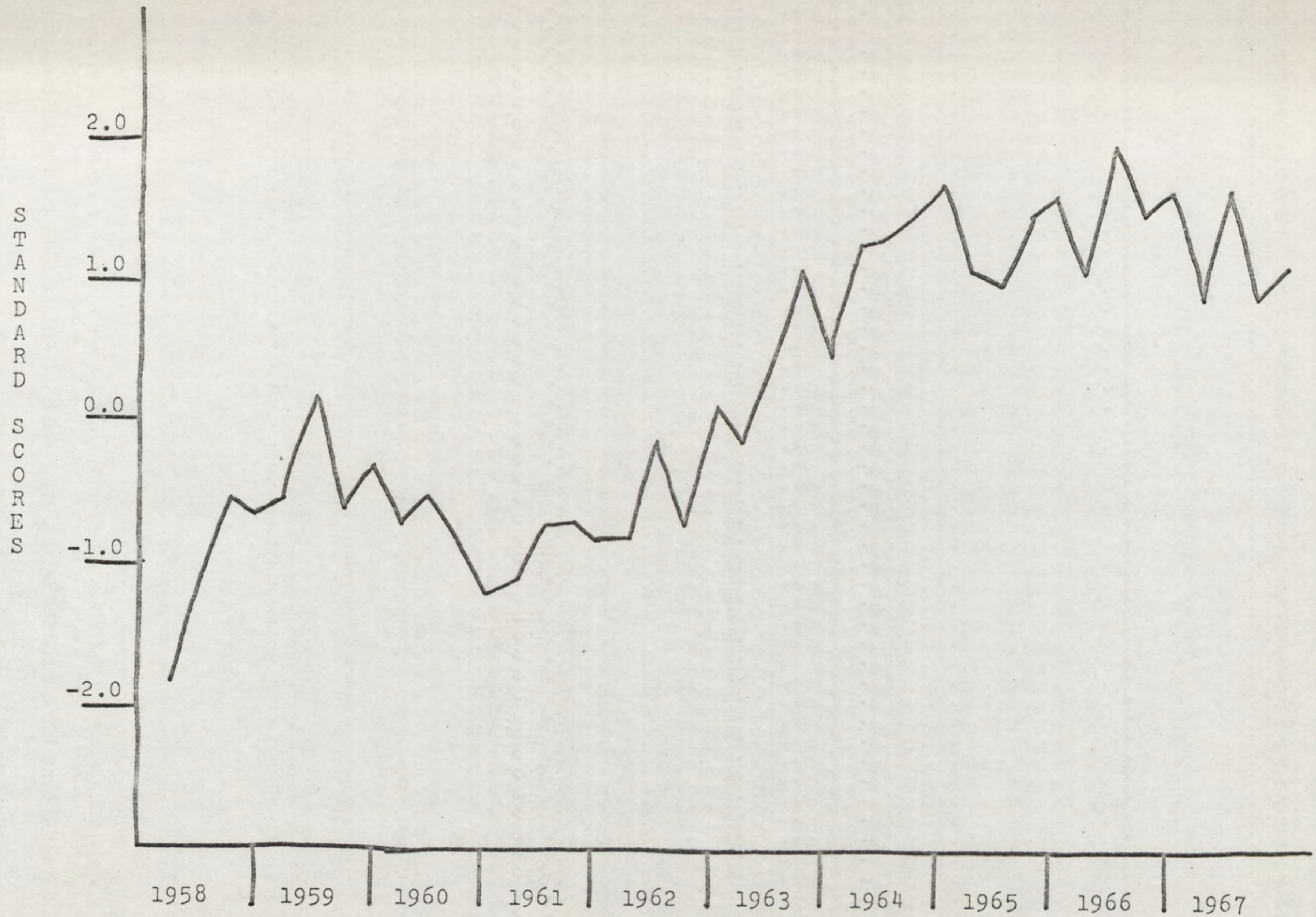

FIGURE 7 -- THE OBAI : ACTUAL

PART 2

FACTOR SCORES AND OBAI - SEASONAL

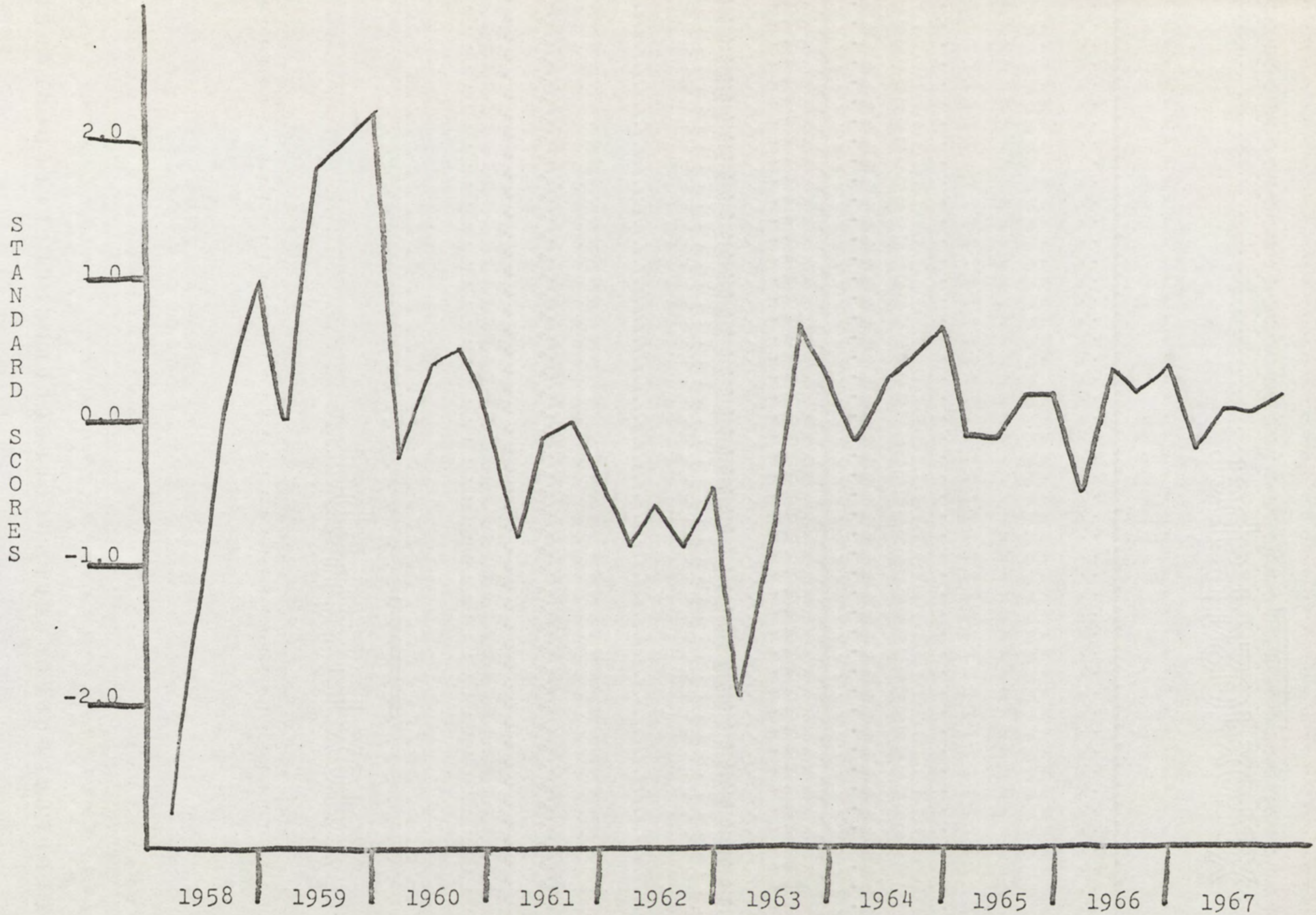

FIGURE 8 -- FACTOR SCORE #1 : SEASONAL

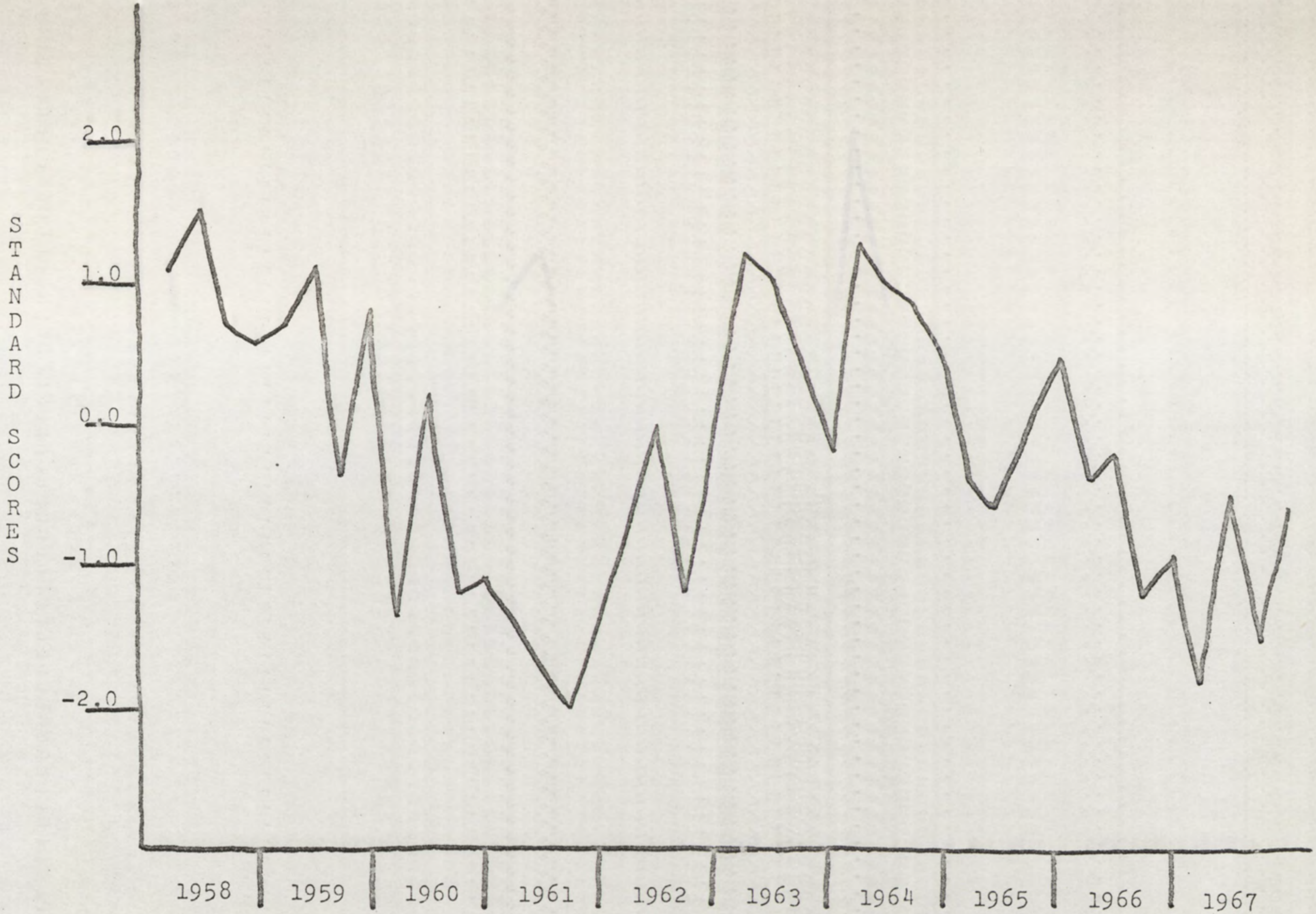

FIGURE 9 -- FACTOR SCORE #2 : SEASONAL

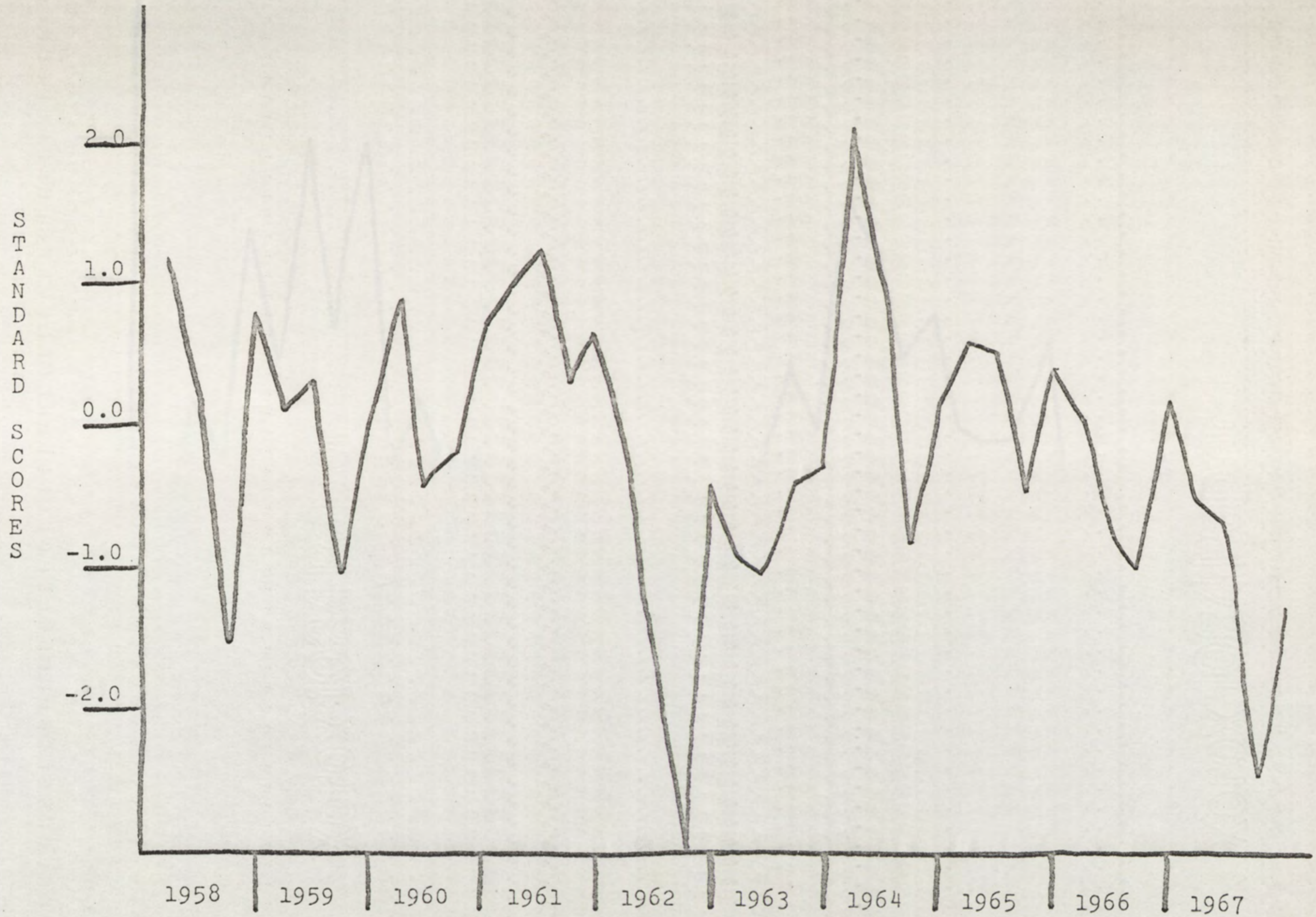

FIGURE 10 -- FACTOR SCORE #3 : SEASONAL

FIGURE 11 -- THE OBAI : SEASONAL

PART 3

FACTOR SCORES AND OBAI - DESEASONAL

FIGURE 12 -- FACTOR SCORE #1 : DESEASONAL

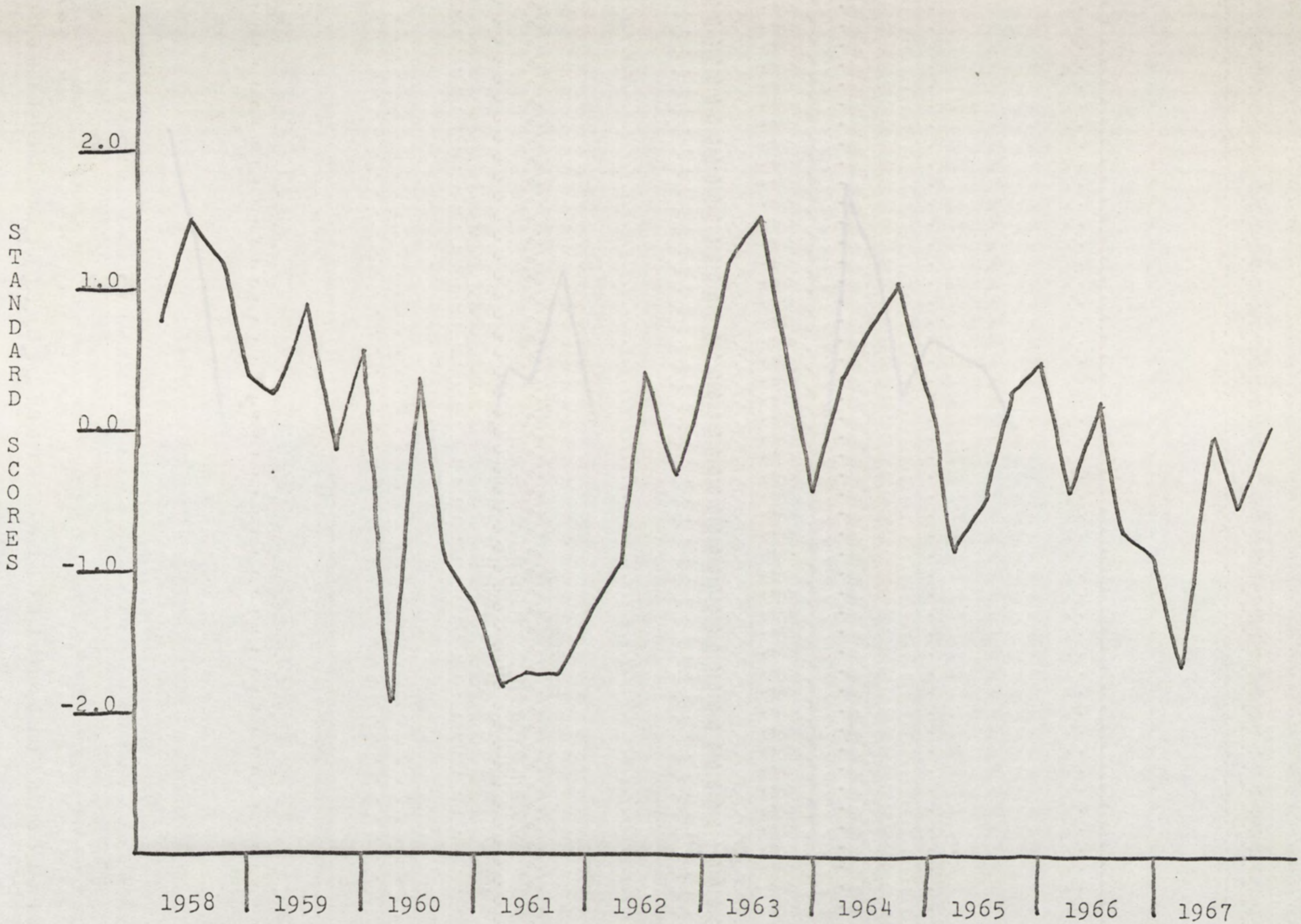

FIGURE 13 -- FACTOR SCORE #2 : DESEASONAL

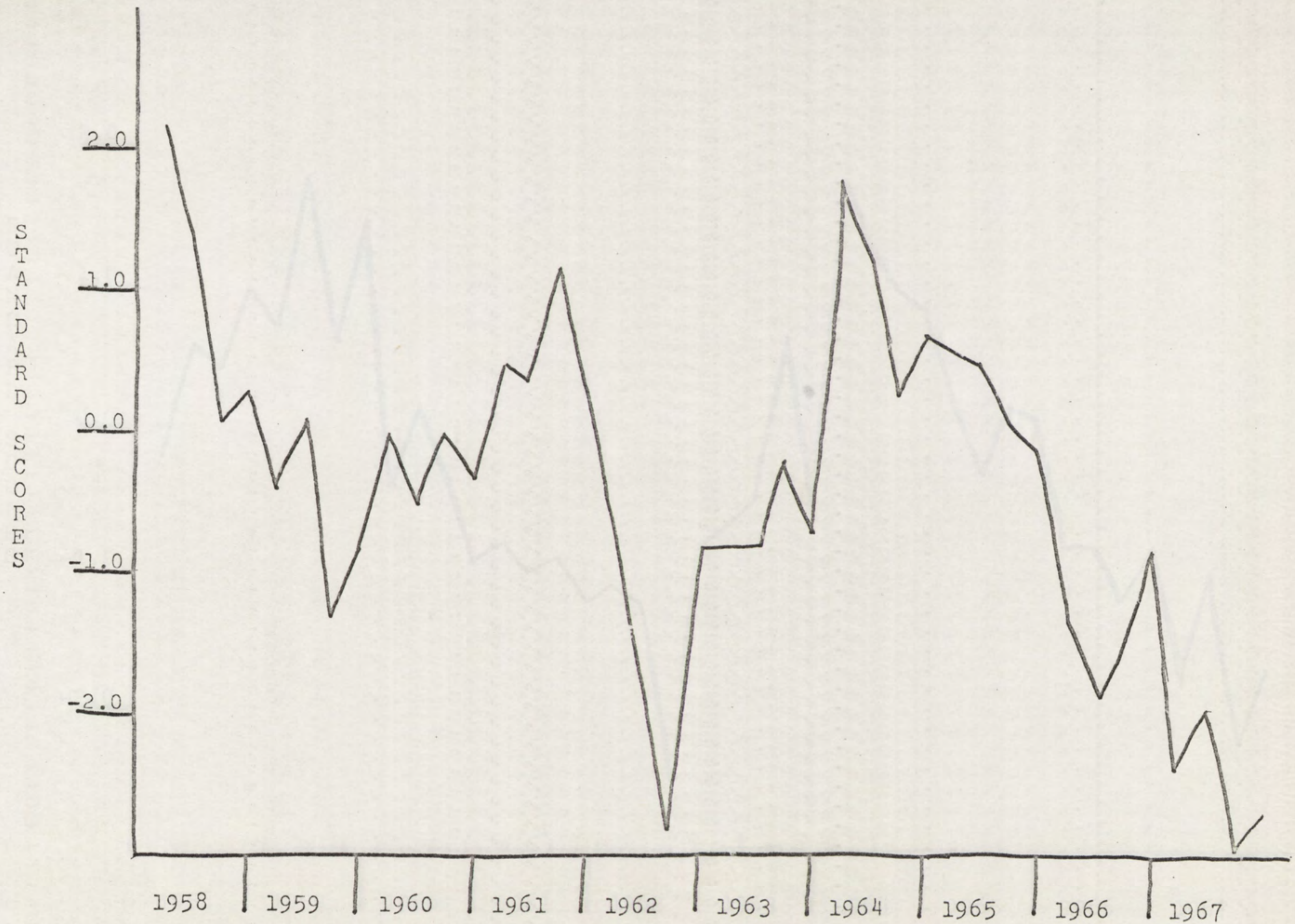

FIGURE 14 -- FACTOR SCORE #3 : DESEASONAL

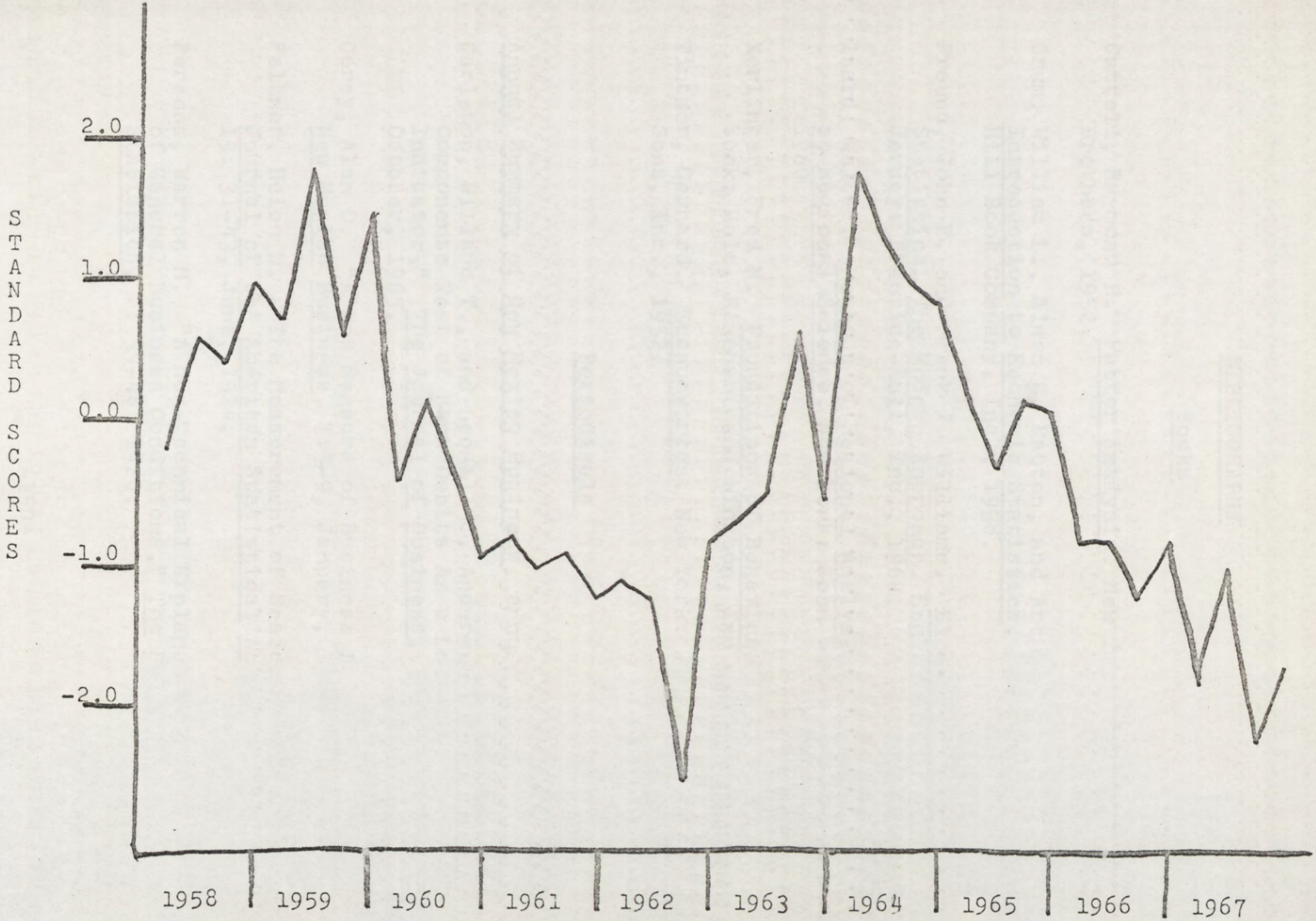

FIGURE 15 -- THE OBAI : DESEASONAL

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