Volume Title: Seasonal Adjustments by Electronic Computer Methods

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Volume Publisher: NBER

Volume ISBN: 0-87014-418-9

Volume URL: http://www.nber.org/books/shis58-1

Publication Date: 1958

Chapter Title: Faults of Method I and their Improvement in Method II

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Chapter URL: http://www.nber.org/chapters/c2601

Chapter pages in book: (p. 5 - 22)

correction factors must, however, be available, for punching or taping, along with the original observations; there is no technique built into the electronic computer program for estimating such factors. The working day correction is accomplished by the modification of the original observations, in the electronic computer routine, before they are started through the seasonal adjustment process.

The faults in Method I and the methods for overcoming them which have been adopted in Method II are described below and comparisons of the seasonal adjustments made by Methods I and II are shown and analyzed for several economic series. A detailed description of each of the steps in these seasonal methods can be obtained by writing to the authors.

III. FAULTS OF METHOD I AND THEIR IMPROVEMENT IN METHOD II

1. *Improvements in the Trend-Cycle Curves*

(a) *Smoothing the trend-cycle curves:* The five-month moving average of the preliminary seasonally-adjusted series, which has been used in Method I as the underlying trend-cycle curve, occasionally yields a somewhat irregular curve, although for most series it produces better results than earlier methods based on a 12-month moving average of the original series. Nevertheless, for series with large irregular components, the 5-month moving average does not result in a smooth delineation of the trend-cycle components of the series. (See, for example, Chart 1.)

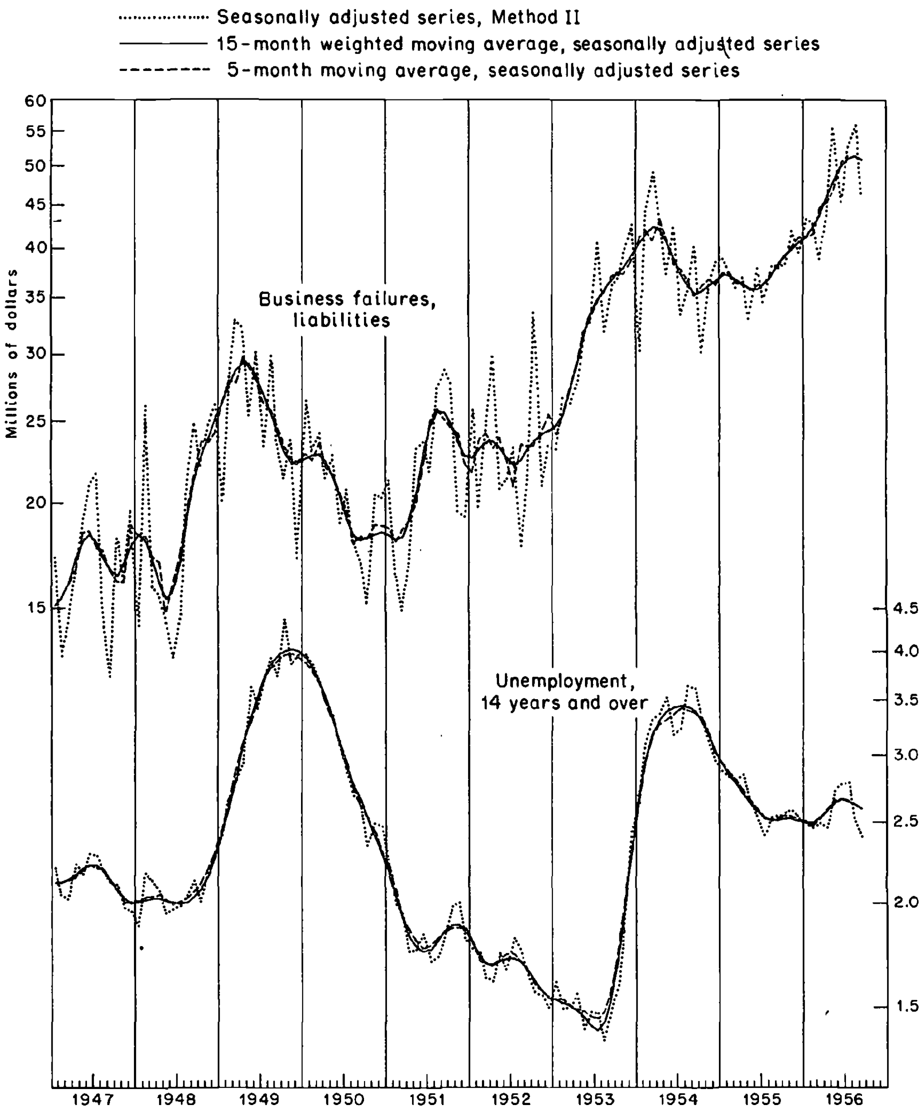
With the burden of computations no longer a factor, the writers were able to turn to the large array of complex graduation formulas previously developed by others to select a curve which is as flexible as, yet smoother than the five-month moving average.

It seems fairly clear to students of this problem that there is no single graduation formula which best delineates the underlying cyclical movements of all economic series.[4] Perhaps it may be possible eventually to develop criteria for selecting a particular graduation formula for each series according to the types of cyclical and irregular fluctuations characteristic of that series. Then with electronic computer programs for a large number of different graduation formulas available, the computer would calculate measures of the cyclical and irregular components in each series, and on the basis of these select the smoothing formula most suited to each particular series. The writers have tried to make such a start; however, its development is for the future. For the present, because of the time that will be required to develop a conceptual basis for this idea and to prepare the electronic computer programs, the writers have selected a single graduation formula to measure the trend-cycle factors.

Graduation formulas are available which provide smooth and flexible curves and also eliminate seasonal fluctuations; for example, Macaulay's 43-term formula. But such formulas involve the loss of a relatively large number of points at the beginnings and ends of series. Graduation formulas which provide similarly smooth and flexible curves and involve the loss of relatively few points do not also eliminate seasonal variations. The computation for a preliminary seasonally adjusted series is now easy mechanically; on the other hand, the

[4] See, for example, Arthur F. Burns and Wesley C. Mitchell, *op. cit.* Chapter 8, esp. p. 320.

CHART 1. Comparison of Spencer 15-month weighted moving average and simple 5-month moving average.



replacement of missing points is difficult conceptually. We, therefore, chose one of the formulas which requires a preliminary seasonally adjusted series, but also minimizes the loss of points—the Spencer fifteen-month weighted moving average.

The Spencer formula appears well suited for the purpose at hand: For most series it gives a smooth representation of the trend-cycle components, and fits the data as closely as a simple five-month moving average. The weights of the Spencer graduation are as follows: -3, -6, -5, 3, 21, 46, 67, 74, 67, 46, 21, 3, -5, -6, -3. This weighting scheme is equivalent to taking a five-month moving average of a five-month moving average of a four-month average of a four-month moving average of the data, with weights of $-3, 3, 4, 3, -3$ applied to either of the two five-month moving averages.[5] This graduation formula also has the property of fitting a third degree polynomial exactly. The marked improvement in smoothing that can result from the use of the Spencer formula in place of the simple five-month moving average is illustrated in Chart 1. The greater the amplitude of the irregular movements in a series in proportion to its cyclical movements the more advantageous will be the use of the Spencer formula in place of the simpler moving average. This improvement in smoothing is reflected in the resulting seasonal-irregular ratios and in all the subsequent computations.

Although the Spencer weighted fifteen-month moving average appears to yield a better estimate of the trend-cycle component (as we imagine it) than the five-month moving average, there is still the fundamental question of the suitability of either for this purpose. As we have said, different types of smooth curves will almost certainly be more appropriate for some series. We expect to investigate the subject of smoothing the preliminary seasonally adjusted series more intensively at a later stage (see Appendix A).

(b) *Extending the trend-cycle curves:* The five month moving average of the preliminary seasonally adjusted series used in Method I also is defective in that it entails the loss of two observations at the beginning and at the end of each series. Since the last two months of the series are usually of considerable importance, Method I fills in these months by extrapolating the seasonal adjustment factors to cover the missing data. (The beginning of the series is similarly completed by symmetry.) This method works well in most series, but, as with the extrapolation in Method I of the five-term moving average (described in subsection 2, below), it is not optimum when there is a trend in the seasonal factors (i.e., a moving seasonal) at the end or beginning of the data.

Method II attempts to improve upon this extrapolation procedure. Instead of extending the seasonal factors, we use an average of the last four months of the preliminary seasonally adjusted series as an estimate of the value of each of the seven months following the last month of this series. These estimates are then used in computing the seven missing values at the end of the Spencer graduation. The beginning of the Spencer graduation is supplied in similar manner. The Spencer graduations in Chart 1 have been extended to the ends of the series. The fit in these series, as in most of the series we have tested, appears quite good.

2. *Improvements in Seasonal Adjustment Factor Curves*

Moving positional means of five terms are fitted to the seasonal-irregular ratios for each month in Method I: The largest and the smallest ratios in each set of five terms are dropped from each computation before the remaining three are averaged. These positional means have not always provided smooth curves, and occasionally are not even good fits, particularly at the beginnings and ends of series. These defects arise partly from the method used for eliminating ex-

[5] For more information on the Spencer graduation, and on smoothing formulas, generally, see Frederick R. Macaulay's *The Smoothing of Time Series* (National Bureau of Economic Research, New York, 1931), esp. pp. 55, 121–140, and M. G. Kendall, *Advanced Theory of Statistics* (London, 1946), Vol. II, Chapter 29. The fifteen-month graduation formula used above was first described by J. Spencer in his article "On the Graduation of the Rates of Sickness and Mortality," *Journal of the Institute of Actuaries*, Vol. 38 (1904), p. 334.

CHART 2. Comparison of seasonal adjustment factors computed by methods I and II, sample months of sample series.

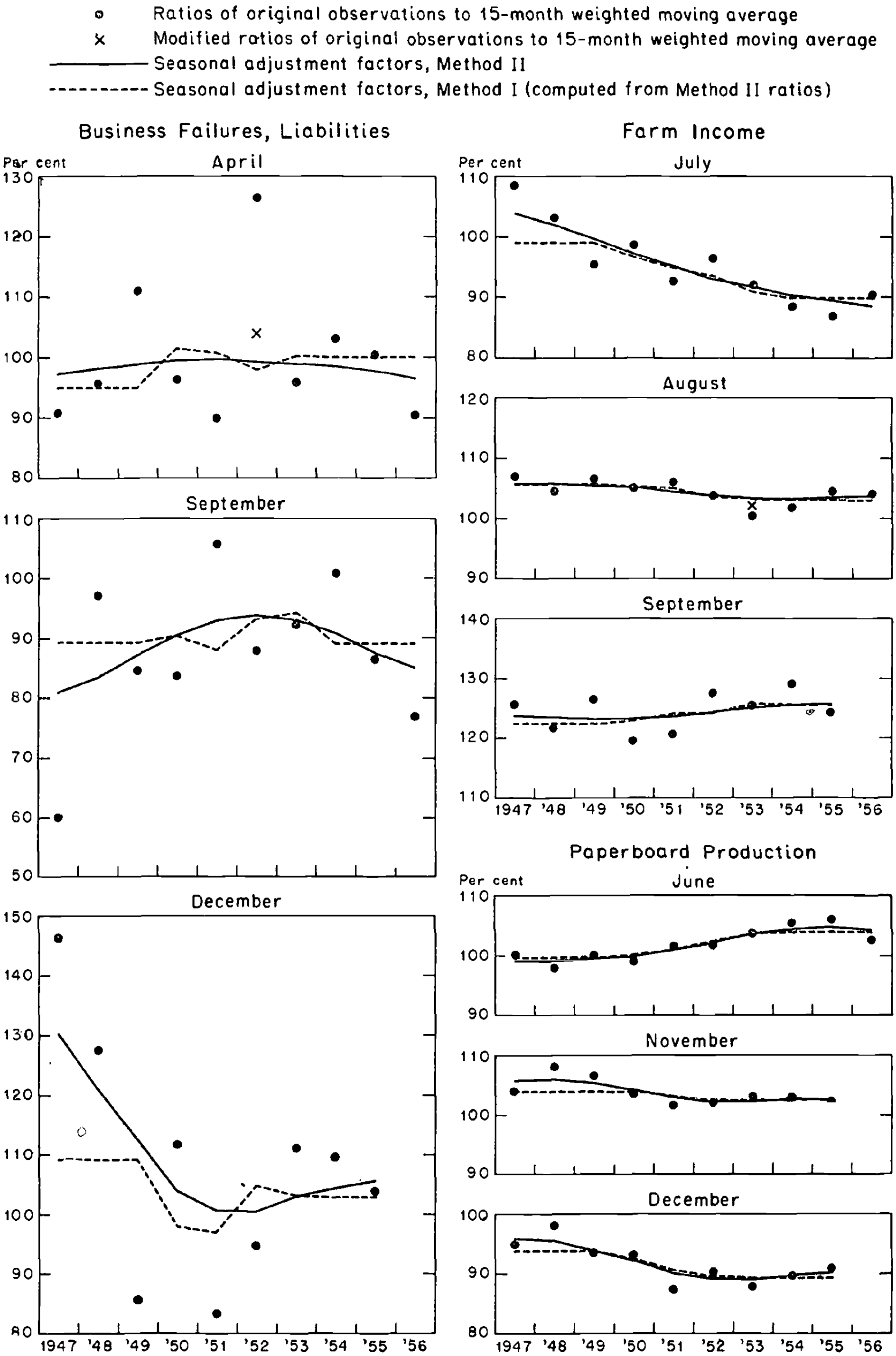
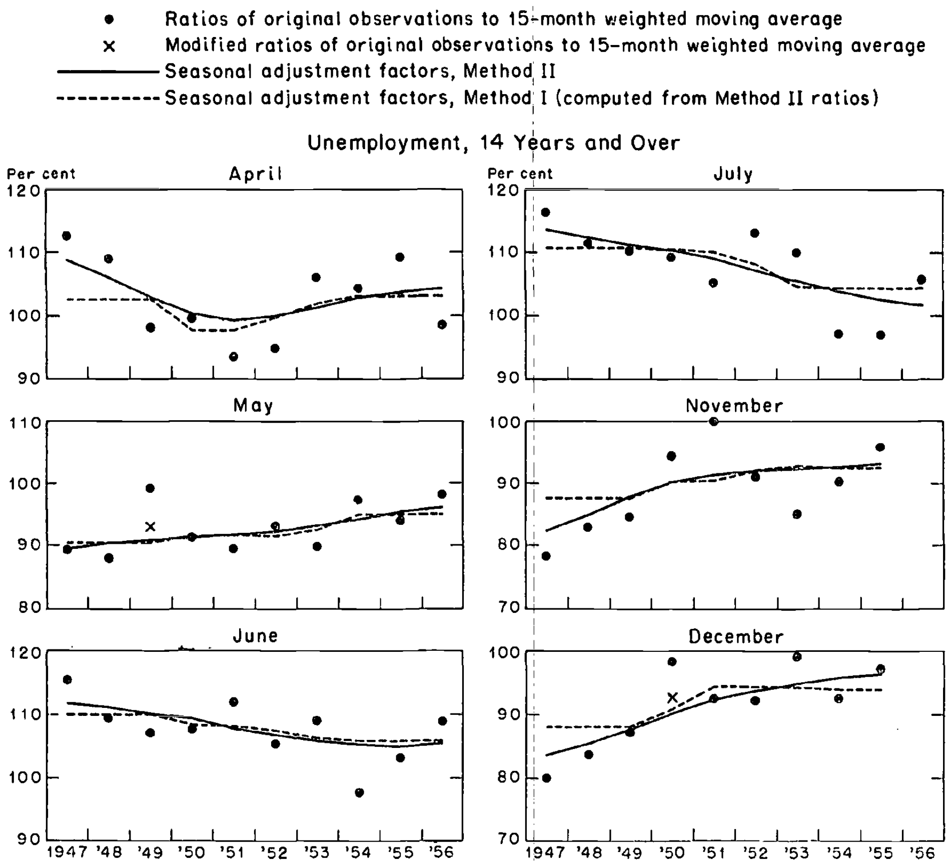


CHART 2. (*concl.*) Comparison of seasonal adjustment factors computed by methods I and II, sample months of sample series.



treme ratios—a method which sometimes eliminates ratios which are probably not extreme, or retains ratios which had best be omitted, and thus distorts the estimate of the seasonal factor—and partly from the limitations of a simple five-term moving average of the seasonal-irregular ratios.

(a) *Isolating extreme ratios:* To improve the identification of extreme ratios, a control chart procedure has been adopted in Method II. For each month, control limits of two "standard errors" are determined above and below the five-term moving average of the ratios. (The square of the standard error is here defined as the average of the squared deviations of the ratios from their corresponding five-term moving average values.) Any ratio falling outside the limits is designated as "extreme" and is replaced by the average of the "extreme" ratio and the ratios immediately preceding and following. If the extreme ratio is the first ratio for the month, it is replaced by the average of the first three ratios for the month; if it is the last ratio, it is replaced by the average of the last three ratios for the month. In effect, the weight accorded the extreme ratio in subsequent smoothing operations is reduced by two-thirds, while the weights of the adjacent ratios are each increased by one-third. This procedure is applied separately to the ratios of each month, from January to December.

The results of the new procedure as compared with the method of positional means are illustrated in Chart 2. The effects of centering (in both methods) and smoothing (in Method II), which are discussed below, mask the differences due to the different treatment of extremes. Nevertheless, it is clear that small dips or crests in the lines of smoothed ratios due to the treatment of extremes in Method I have now been eliminated (see especially Chart 2, Business Failures, April 1952 and September 1951).

It should be borne in mind that the determination of "extremeness" for any ratio depends on the deviations of all the ratios in the series for that particular month from their moving average values. The standard error varies from month to month within series and between series. At present the data for all the years in the series for each month are used as one period for the purpose of calculating the standard error. Future experience may prove that two or more periods are preferable. Furthermore, our selection of *two* standard errors as the control limits is arbitrary. Tests of these limits now planned may lead to a change, probably to a smaller figure, say $1\frac{1}{2}$ standard errors, so that more items are identified as extremes (see Appendix A). This procedure would involve more smoothing of the seasonal-irregular ratios, which would in turn yield smoother seasonal-adjustment factor curves.

A limitation of the new procedure may be mentioned here; since the five-term moving average, which serves as the base for the computation of the standard error, does not reach to the ends of the series, it must be extrapolated if any extremes in the first or last two years are to be identified and properly modified. Now, what weight shall be given to the ending (or beginning) years in this extrapolation? If the ratios for these years receive large weights, they will hardly ever be identified as extreme ratios; if the weights are small, a trend in the ratios may be confused with extreme items and the ratio curves may not be given their proper slope in the beginning and ending years. This problem is difficult to solve. In Method II the following procedure has been adopted: The average of the last two ratios for a given month is used as the estimated value of the ratio for each of the two years following the last year available; these estimated values are then used in calculating the moving average values for the last two years. The beginning years are treated similarly.

(b) *Smoothing the fitted curves:* Even after adjusting extreme ratios properly, the five-term moving average of the ratios for each month sometimes is too erratic in its changes from year to year to fit our model of time series analysis, which assumes gradual seasonal change from year to year. The five-term moving average in Method I is therefore replaced in Method II by a three-term moving average of a three-term moving average. This is equivalent to a five-term moving average with the weights 1, 2, 3, 2, 1. This smoothing formula appears to be superior to the simple five-term moving average in eliminating erratic year-to-year changes in direction, while at the same time retaining the smooth short-term movements of the ratios. Furthermore, the ratios are smoothed *after* they are centered (i.e., adjusted so that their sum will be 1200.0 for each calendar year), rather than *before* centering, as in Method I, to avoid any distortions in the smoothed series due to centering. (It can easily be shown that distortions of the centered values will not occur in this case; that is, that smoothing based on linear formulas—of which the unweighted moving average is the simplest example—will not change annual totals.) Thus, Method II now produces seasonal adjustment factors that are centered and change only gradually from year to year. Moreover, an important innovation has now been introduced: The three-term of the three-term moving average is replaced by the three-term of the five-term moving average, whenever irregular movements are pronounced.[6] Thus, a more powerful smoothing process is used for series having large irregular movements (see Appendix A).

The effects of the revised smoothing formulas for seasonal-irregular ratios used in Method II compared with those used in Method I are shown in Chart 2. The fit of the smoothed lines to the ratios, with smoothing and centering accomplished in a mechanical manner, will, of course, differ from any smoothing done manually by the usual trial and error process. However, the differences in terms of the seasonally adjusted data will probably not be large or significant. In general, the fit of Method II is closer to the ratios and is smoother than that of Method I.

(c) *Extending the fitted curves:* Method I does not take into account obvious changing trends and new seasonal factors in obtaining seasonal factors for the first and the last few years of each series. In Method I the first seasonal factor that can be computed for each month relates to the *third* year, but is also used for the first two years; and the last seasonal factor computed, which relates to the third year from the end of the series, is extrapolated to the last two years.

This procedure—of bringing seasonal adjustment factors up to date by leveling off the curves so that their slopes are zero for the recent years—has been followed quite generally. It is, however, at variance with a basic assumption of our method, that the seasonal factors may vary gradually from year to year. Where the seasonal is truly constant—that is, where the slope of a seasonal adjustment factor curve is zero for several years—all the methods that we have considered for bringing the factors up to date give about the same results. For cases where the slopes may be significantly different from zero, level curves at the beginnings and ends will not measure the full seasonal factors; and consequently, the seasonally adjusted series will contain not only the trend, cycle, and irregular, but also some seasonal components.

For this reason, a more sensitive extrapolation procedure has been introduced in Method II. The seasonal adjustment factor curve is not extrapolated directly to the end of the series; instead, the average of the last two seasonal-irregular ratios for a given month is taken as the estimated value of each of the following two ratios; and these estimates are used in computing the two seasonal factors that would otherwise be missing at the end of the series. (A similar procedure is used for the initial years.) The average of the last two available ratios, rather than the value of the last ratio alone, is used as the estimate in order to avoid any distortion that might result from a highly irregular terminal ratio.

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[6] To make this decision, measures of the average amplitude of the month-to-month movements in the trend-cycle, seasonal, and irregular components of series have been developed and are used automatically in the computer program. For a description of these measures, see Julius Shiskin, "New Measures of Economic Fluctuations," *Improving the Quality of Statistical Surveys, Papers Contributed as a Memorial to Samuel Weiss*, American Statistical Association, Washington, D.C., 1956.

This procedure has the advantage of flexibility in the types of curves used at the ends of series. On the one hand, where there are strong forces making for a constant seasonal pattern, the method will yield level curves at the ends of series. On the other hand, where there are strong forces making for a changing seasonal pattern, it will permit changes at the ends of series. The leveling off of the ratios for years following the last year of actual data will, however, exercise a constraint on the extent to which the slopes can change. While this procedure makes full use of the available data, it is neutral with respect to the question of future turns in seasonal behavior. It does not assume that trends will continue up or down or that they will reverse themselves but, instead, assumes only that the seasonal-irregular ratios continue at current levels. In the cases where this assumption proves to be wrong, it will not give as bad results as would follow from one of the alternative assumptions.

The difference in our methods of fitting curves to the first and last years of the seasonal-irregular ratios may be clarified in the following algebraic terms. If X_n is the last ratio available, then it is implicit in Method I that $X_{n+1}=X_{n-4}$ and $X_{n+2}=X_{n-3}$, while in Method II we explicitly make $X_{n+1}=X_{n+2}=\frac{1}{2}(X_n+X_{n-1})$.

It seems reasonable to assume that better estimates of the missing ratios will usually be provided by ratios for more current than for less current years.

Inspection of this approach for our test series indicates that it generally gives reasonable results. The results of employing these different methods routinely to obtain seasonal adjustment factors for the beginnings and ends of series are illustrated in Chart 2. It is clear from the chart that a trend in the ratios will now be reflected at the ends of the series and that the resultant curves for the terminals of series will be similar to those for the middles.

It is important to note, however, that this method of adjusting the ends is not always satisfactory. Unsatisfactory adjustments will appear more frequently in series with large irregular components, when the last two ratios are both relatively extreme, and particularly when they fall on the same side of the seasonal adjustment factor curve.

The changes in the treatment of the initial and terminal years in Method II, as compared to Method I, appear to account for most of the differences that have been observed in series adjusted by both methods. Future experience with Method II is expected to lead to modifications of this procedure by introducing more complex extrapolation methods.

The technique of using extrapolated average values at the ends of series to extend moving averages to cover the full period of the data is employed three times in Method II: (1) to extend the weighted Spencer 15-month moving average fitted to the preliminary seasonally-adjusted series (Section III, 1, b); (2) to extend the five-term moving average used as a basis for calculating control limits needed to isolate extreme ratios (Section III, 2, a); and (3) to extend the seasonal adjustment factor curve fitted to the seasonal-irregular ratios. A good deal obviously depends upon this technique. It seems reasonably safe and is certainly preferable to the alternative assumption that the cyclical or seasonal curves level off at the beginnings and ends of series. We recognize, however, that we are dealing here with the basic problem of economic forecasting, and that this technique may sometimes lead us astray.

3. *Extending the Electronic Computer Program to Cover 30-Year Monthly Series*

Method I is limited to monthly series of a maximum duration of fifteen years. For most of our users, concerned primarily with postwar data, this has been satisfactory; but for groups concerned with longer series, we were only able to make this service available in a rather clumsy way by splitting the data into segments with very long overlaps.

The memory capacity of the electronic computing machines for which the Method II program has been prepared does not permit an indefinite expansion of the period that can be used. A substantial increase in the number of years to be covered would require the use of relatively inefficient techniques and would slow down operations. Fortunately, a simple expedient permitted the doubling of the maximum number of years included. (Instead of using one computer memory position for each monthly figure as in the earlier method, Method II puts *two* months' data into each position. While this limits the maximum number of digits for each month to six, it is, for most economic series, a satisfactory upper limit.) Thus, the new method can now be routinely applied to any time series from six to thirty years long. For longer series division into several overlapping segments is necessary for the present.

4. *Additional Tests*

In the analysis of current economic conditions, a great deal of interest attaches to monthly changes. For this reason a reasonable argument can be made that month-to-month *changes* rather than monthly *levels* should be adjusted for seasonality. Indeed, the well-known link relative method developed by Warren M. Persons follows this idea.[7] The link relative method, however, lacks the flexibility or the simplicity of the ratio-to-moving-average method for computing moving seasonal adjustment factors.

To determine whether Method II makes a good seasonal adjustment of month-to-month changes as well as monthly levels, link relatives of seasonal-irregular ratios were compared with the link relatives of the seasonal adjustment factors implicitly fitted to these link relatives by Method II. The results indicate that the implicit curves fitted to the link relatives of the seasonal-irregular ratios are similar in smoothness, closeness of fit and general sweep to the curves fitted to the ratios to moving average. Consequently, Method II seems to yield a seasonal adjustment of the month-to-month changes of about the same quality as the seasonal adjustment of the absolute observations. Chart 3 illustrates this point.

What is the effect of our method of seasonal adjustment upon series that have no seasonal component—does our method introduce spurious fluctuations in series? To answer this question partially Method II was applied to stock prices, which are not considered to have any seasonal fluctuations, and to unemployment after adjustment for seasonal variations by Method II. As can be seen from Chart 4, the effect of a Method II adjustment upon such series is trivial.

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[7] See Warren M. Persons, "Indices of Business Conditions," *Review of Economic Statistics*, January 1919.

CHART 3. Comparison of link relatives of seasonal-irregular ratios and seasonal adjustment link relative factors implicitly fitted to these link relatives by method II, sample months of two sample series.

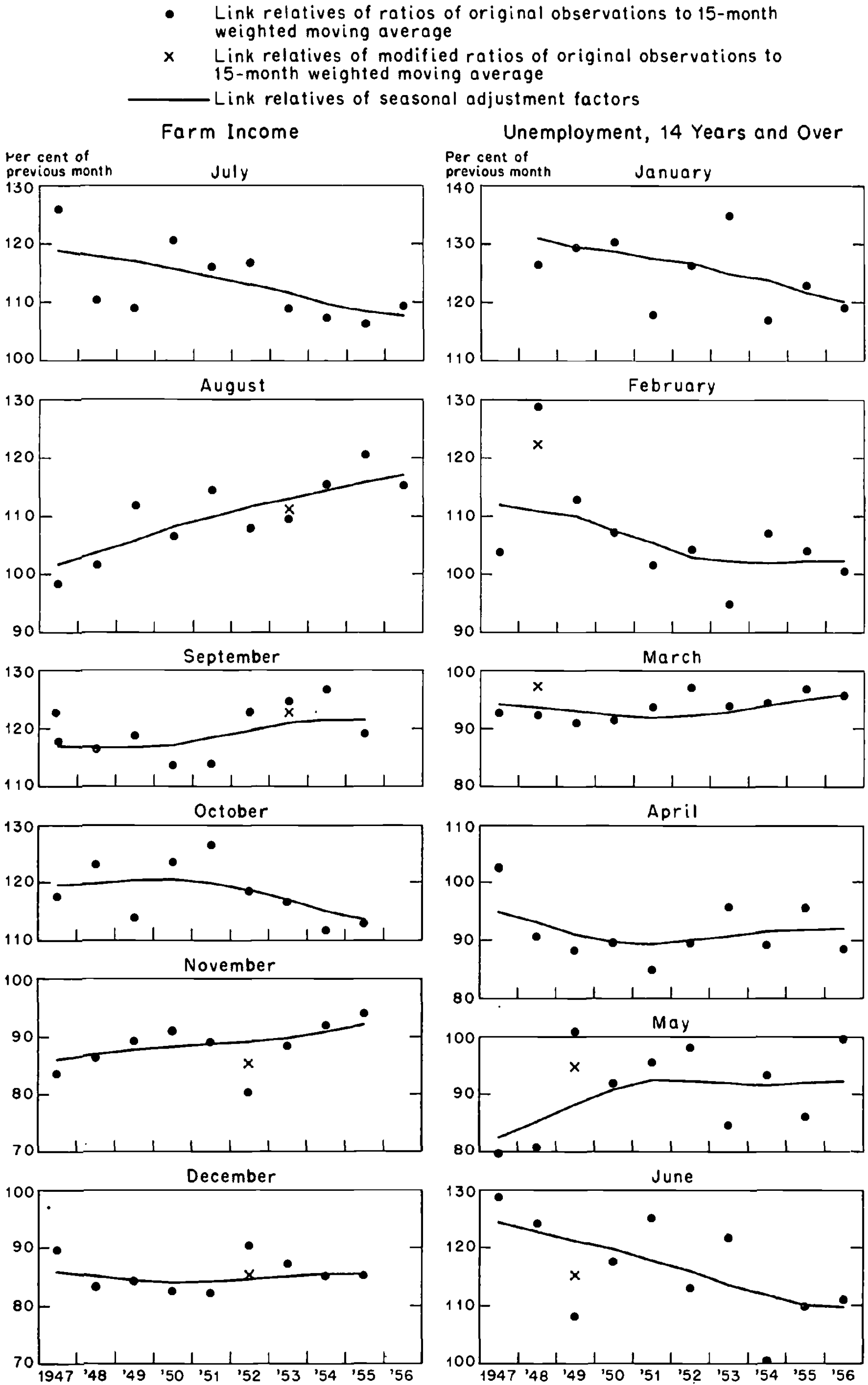
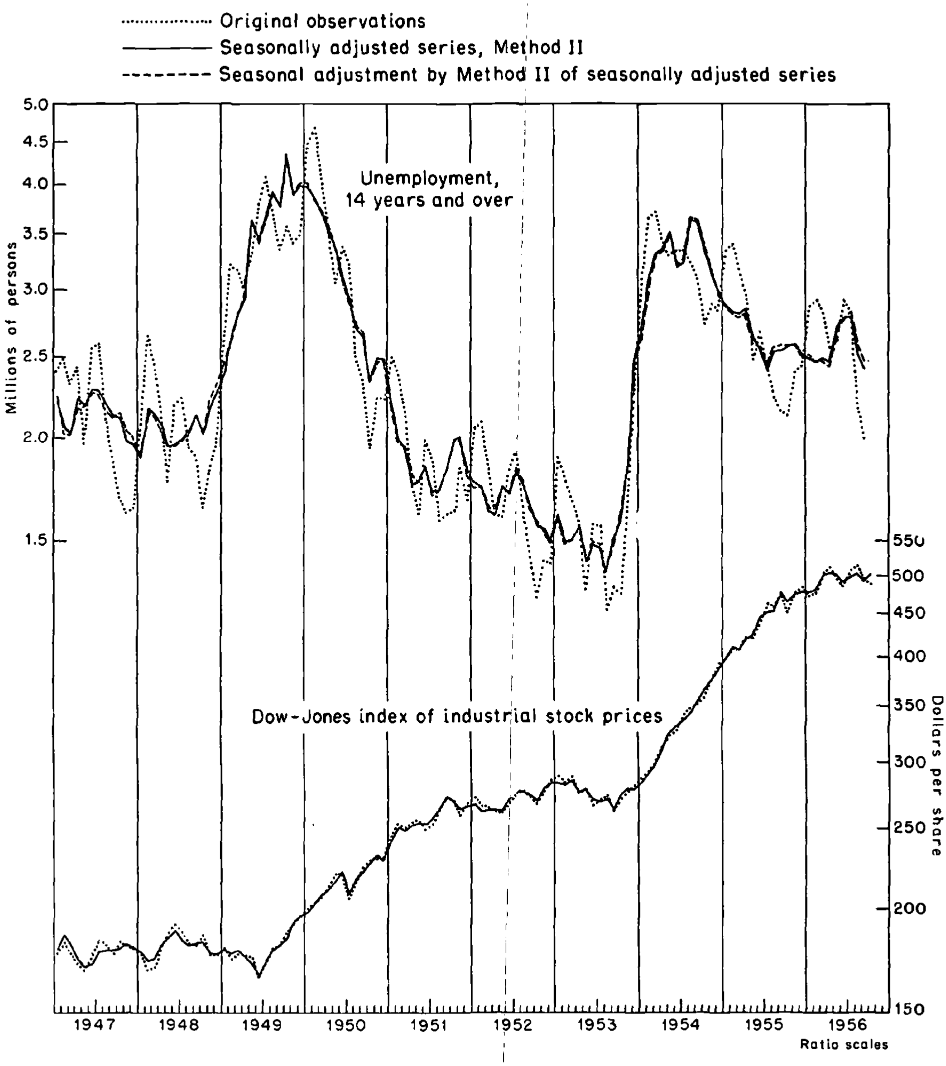


CHART 4. Effect of seasonal adjustment by method II on series without seasonal components.



5. *Conclusions Regarding Method II*

It is difficult to measure objectively the quality of a seasonal adjustment. There is widespread agreement, however, that a good adjustment is one that minimizes repetitive intra-year movements. While moving average curves satisfy this criterion such curves have in the past had limited use for business-cycle analysis because they distort or bias the dates of turning points, the amplitudes, and the patterns of business cycles, and because there is no satisfactory way of bringing them up to date. While it is conceivable that a moving average curve that overcomes these limitations can eventually be developed, for the present, conventional seasonally adjusted series appear preferable.

Inspection of the results yielded by Methods I and II for a sample of series indicates that in terms of this criterion, i.e., the minimization of repetitive intra-year movements, Method II is the better. The techniques for estimating the trend-cycle component, for isolating extreme items, and for smoothing the seasonal-irregular ratios for each month are certainly better than the corresponding techniques used in Method I. The technique for extending the different moving average curves to the beginnings and ends of series also seems better. Comparisons of the net results of all these factors are made in Chart 5, which shows the original observations and the data seasonally adjusted by Methods I and II for some of our test series. The theoretical advantages of Method II have little impact on these series, except at the beginnings and ends. However, where the differences do occur, the advantages appear to be in favor of the newer method.

CHART 5. Comparison of seasonal adjustments by methods I and II.

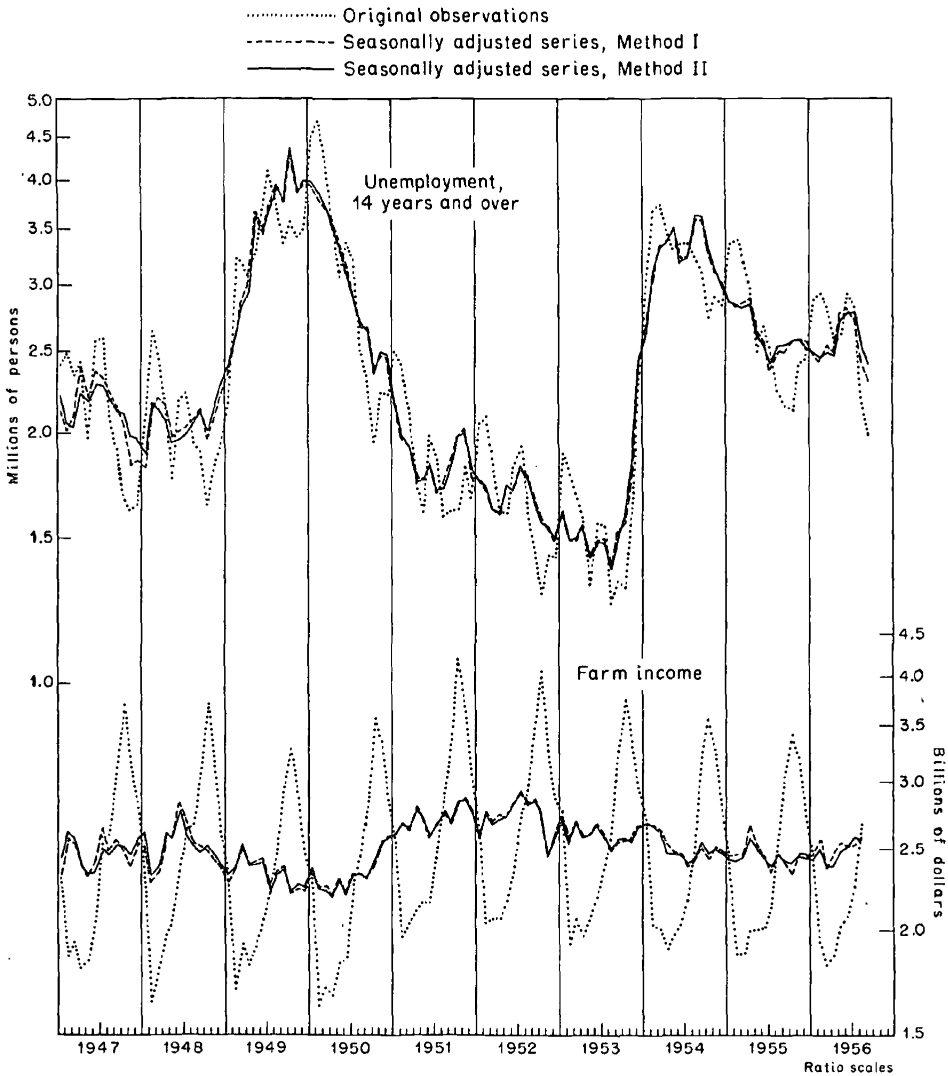
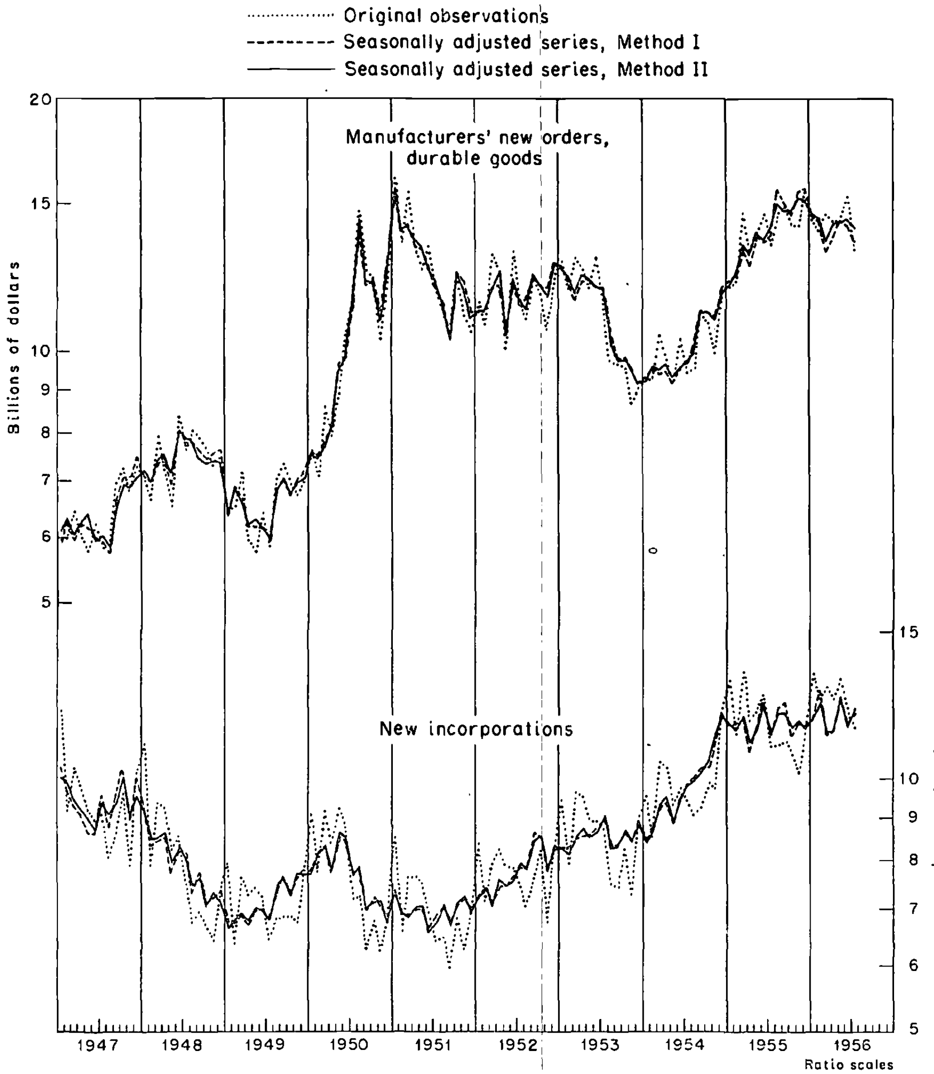


CHART 5. (*concl.*) Comparison of seasonal adjustments by methods I and II.



A comparison has also been made of seasonal adjustments prepared manually at the National Bureau of Economic Research, the Office of Business Economics of the Department of Commerce, and the Department of Agriculture, and the Method II adjustments for the same series. The NBER adjustments, shown in Chart 6, employ stable seasonal factors, with two short periods selected for each series; the OBE and Department of Agriculture employ moving adjustments for the series selected. The differences in the results are small. Where differences do appear, Method II usually yields the smoother seasonally adjusted series. It seems plain from these comparisons that Method II can be counted upon to yield an adjustment of the same order of quality as the best manual methods. Furthermore, this method appears to be of such generality that it can make stable and moving adjustments about equally well.

CHART 6. Comparison of manual and electronic computer seasonal adjustments.

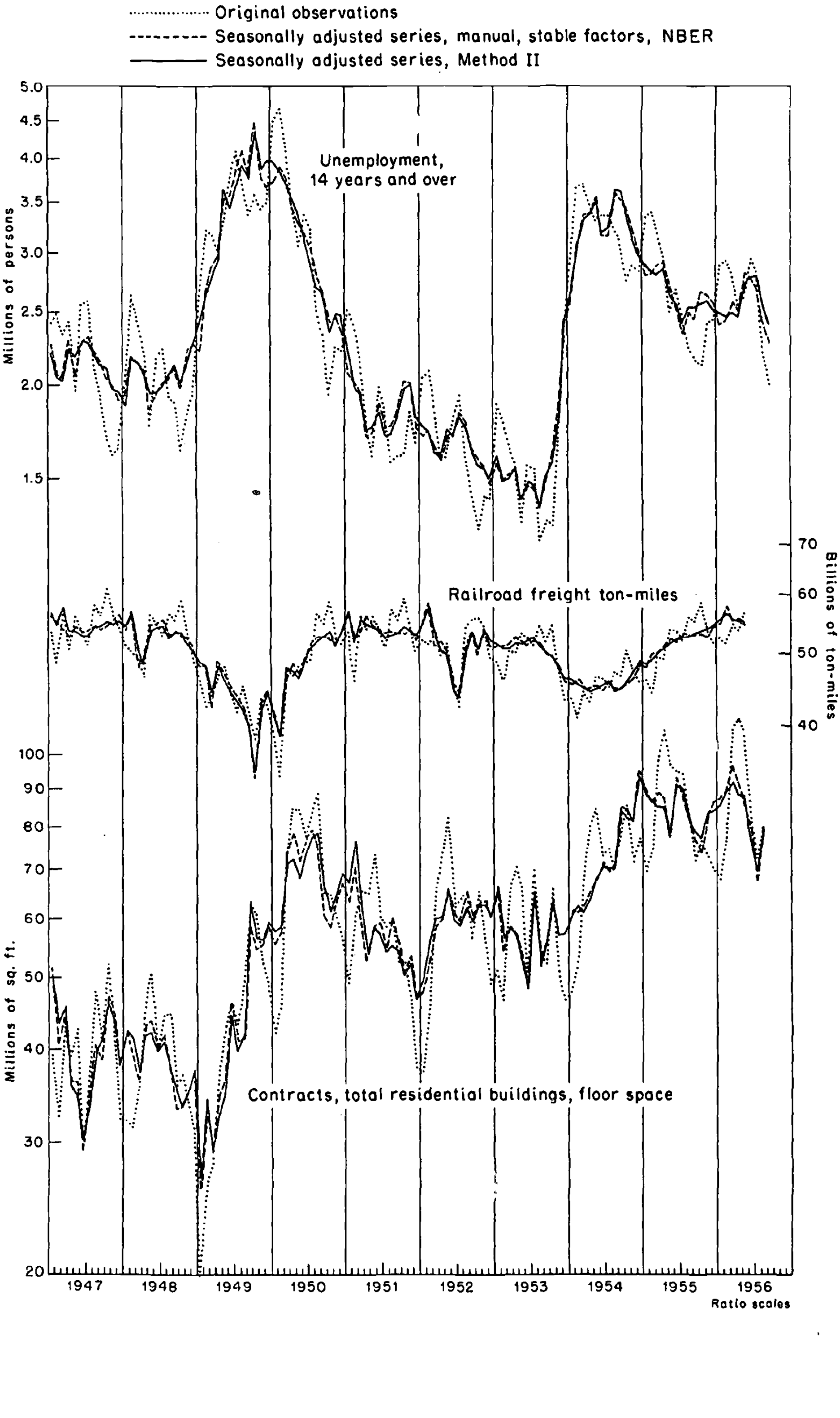
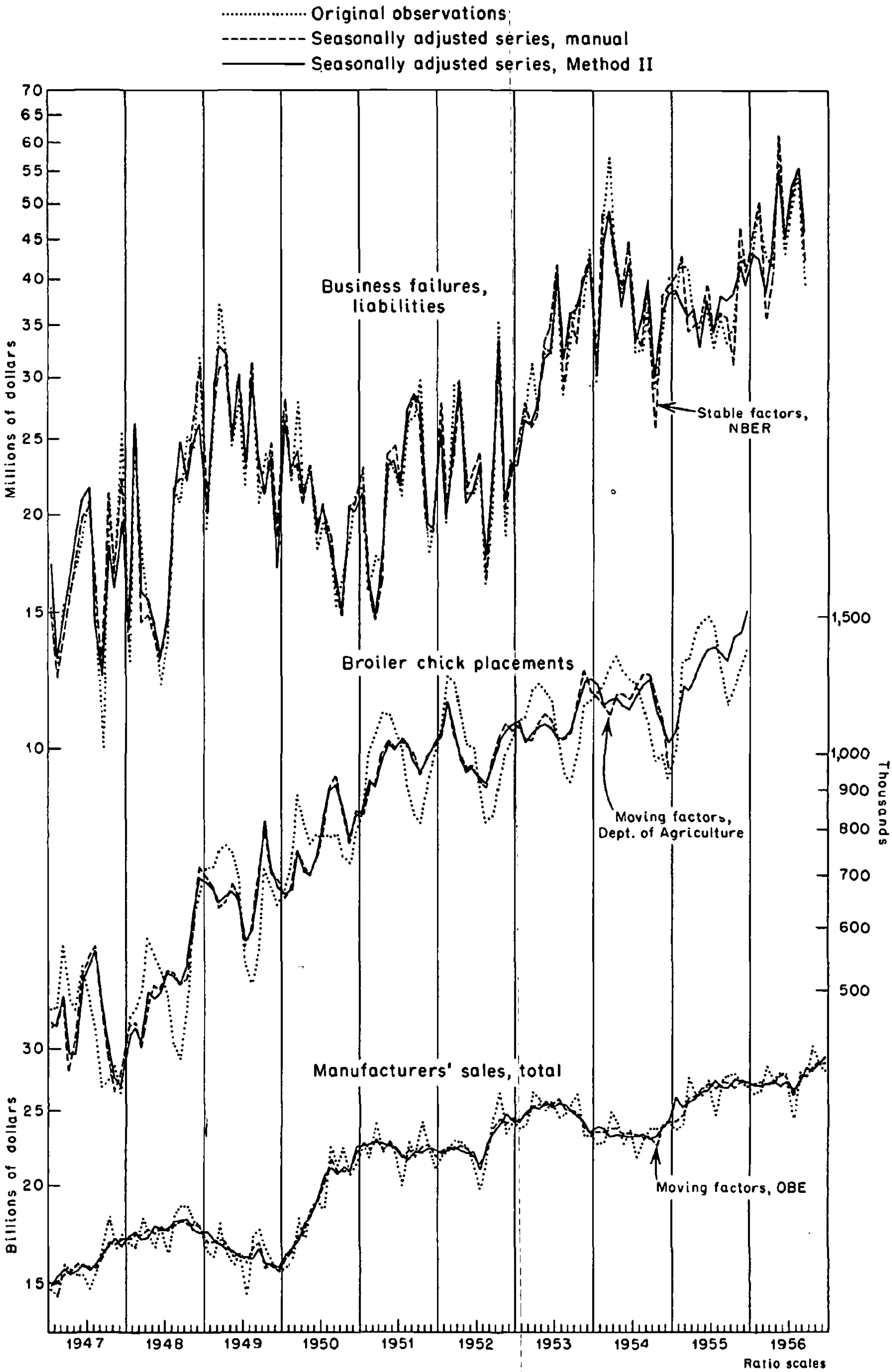


CHART 6. (*concl.*) Comparison of manual and electronic computer seasonal adjustments.



A professional review of each Method II adjustment is, however, still necessary. As in the case of all methods of seasonal adjustment, this method implicitly makes certain assumptions regarding the nature of the forces affecting each series. These assumptions are probably applicable to most series, but not to all. For example, it assumes that the relations between seasonal and cyclical forces are multiplicative rather than additive. For the comparatively few series for which these relations are not primarily multiplicative, poor seasonal adjustments may result. In the light of current figures that became available after some of the adjustments were made, it is also clear that the adjustments at the ends of series are sometimes unsatisfactory. There may be other deficiencies of which we are not yet aware. Constant vigilance is therefore required.

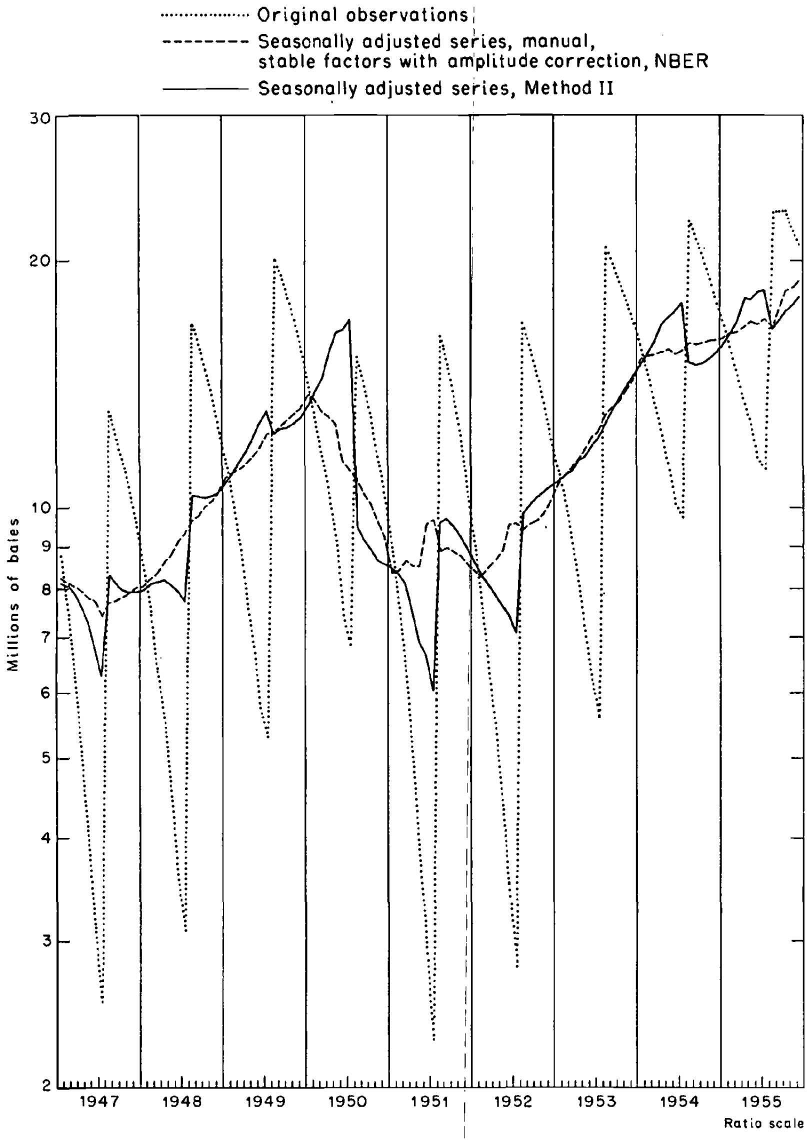
That Method II does not always yield good adjustments can be seen from the series shown in Chart 7. The Method II adjustment for cotton stocks does not smooth out the annual patterns fully, leaving positive or inverted patterns of the same shape but smaller amplitude than that of the seasonal factors. As can be seen from the chart, a much more satisfactory adjustment was obtained by using a stable seasonal index with an amplitude correction. This illustration suggests difficulties where the monthly figures for the year (calendar or fiscal) are tied together by a single common event (e.g., in agricultural crop series).

Another type of series for which Method II will not produce a uniformly good adjustment is one in which there is an abrupt change in the seasonal pattern. The technique adopted for fitting moving averages to seasonal-irregular ratios will always yield smooth seasonal factor curves, in accordance with our assumption of slow, gradual changes in the seasonal factors from year to year. Sudden year-to-year shifts can, however, occur for various reasons, for example, as a result of administrative decisions by business associations or government agencies. Thus abrupt seasonal changes no doubt occurred in some parts of the economy when the automobile industry changed the dates for introducing new models from the spring to the fall, and when the government deferred the date for submitting income tax returns from March 15 to April 15.

It is also clear from our studies that the isolation of the seasonal factor is suspect in the case of series with very large irregular factors. For this reason the Univac program routinely adds constant seasonal adjustment factors and corresponding seasonally adjusted series when the average month-to-month amplitude of the irregular factor is four per cent or more.

Experience gained with the results of Method II has led to a program of testing some alternative procedures with a view to introducing further improvements. Thus the present method of obtaining seasonal-irregular ratios at the ends of series does not give good results when the last two ratios, whose average is used as the estimate for the years following the last one for which a figure is available, are both relatively extreme, and particularly when they fall on the same side of the seasonal adjustment factor curve. Experiments are being made with various alternatives, including averaging more ratios when the irregular component is large. A moving average curve, of a period that varies with the magnitude of the irregular fluctuations of the series, is planned instead of the fifteen-month weighted moving average alone. At present the program provides

CHART 7. Sample of unsatisfactory method II seasonal adjustment: Total cotton stocks.



no precise test of the existence of seasonality in a series though some computations are made to guide the user in making such a judgment. A test which involves correlating the irregular and seasonal components, year by year, may be feasible, and statements could be printed with the computations explaining whether a seasonal adjustment is necessary and whether the results are satisfactory according to this test.[8]

[8] These possible revisions are described more fully in Appendix A.

This brief description of changes contemplated is intended to underline the fact that while we consider the results of Method II satisfactory for most purposes, we do not by any means consider them the best attainable within this framework. Improvements will continue to be introduced as the need for them becomes clear and techniques for making them are developed.

The direction of these changes will be toward including within the general approach a large variety of alternative techniques. Measures of the relations among the systematic economic forces characteristic of each series and of the relations between these forces and chance forces are now computed. In addition the electronic computer program will provide for a larger array of smoothing and curve fitting formulas. The appropriate technique for each series will then be selected automatically among the alternatives on the basis of the measures of the characteristics of each series. There are prospects that different techniques can even be used automatically for different time periods of the same series. As we stated earlier, the present program contains a start toward this goal, in that there is no fixed formula for computing the seasonal adjustment factors for all series, and that one of three formulas is now selected according to the magnitude of the average absolute amplitude of the irregular component of the series.

The Census seasonal electronic computer program appears, however, already to have brought us fairly close to a mechanical method of providing on a mass basis seasonal adjustments of the quality previously obtained for a small number of series by a combination of laborious hand methods and professional judgments.[9]

The computations of Method II take about two and one-half times as long on Univac as those of Method I—2.3 minutes for a ten-year monthly series as compared to one minute. While the relative increase in cost for Method II as compared to Method I may appear large, the cost of doing the calculations involved in either Method I or II on an electronic computer is small compared to the cost of simpler methods by conventional means, and a great many series can be adjusted rapidly. The necessary computing and printing for 3,000 ten-year series could be completed on a Univac system in one week. A large volume of data can thus be made ready for further analysis on short notice and large-scale seasonal computations that become necessary because of revisions in original data can be completed quickly.

IV. FINAL REMARKS

(1) The present electronic computer program has been prepared for monthly series only. However, experiments conducted at the National Bureau of Economic Research and the Dominion Bureau of Statistics of Canada indicate that it can also be applied to quarterly data. Good results can be obtained by the following procedure: convert the quarterly series to a monthly one by interpolating monthly values in the series, apply the computer program to the converted series, then convert the monthly adjusted series back to quarterly form. The interpolation can be accomplished very easily by repeating the quar-

[9] Several other methods of seasonal adjustment already have been or are being programmed for electronic computers. So far, however, they have been applied only on a small scale and, therefore, cannot be appraised. Appendix B gives a summary description of them.