Volume Title: Seasonal Analysis of Economic Time Series

Volume Author/Editor: Arnold Zellner

Volume Publisher: NBER

Volume URL: http://www.nber.org/books/zell78-1

Publication Date: 1978

Chapter Title: An Overview of the Objectives and Framework of Seasonal Adjustment

Chapter Author: Shirley Kallek

Chapter URL: http://www.nber.org/chapters/c4320

Chapter pages in book: (p. 3 - 32)

AN OVERVIEW OF THE OBJECTIVES AND FRAMEWORK OF SEASONAL ADJUSTMENT

Shirley Kallek
Bureau of the Census

INTRODUCTION

The Bureau of the Census has been involved extensively in the seasonal adjustment of economic time series for the past 25 years—both in the development of basic methodology and in the practical application of seasonal adjustment techniques to tens of thousands of series. Much of the credit for the advances in this field must go to Julius Shiskin, presently Commissioner of the Bureau of Labor Statistics, and at one time Chief Economic Statistician at the Bureau of the Census. It was through his efforts in developing a large-scale computer program to decompose time series in the early 1950's that seasonal adjustment of innumerable time series with relative ease and accuracy could be accomplished. This achievement has resulted in great advances in business cycle analysis.

Continued widespread use of seasonal adjustment techniques and the dominant use of the X–11 program over these past 20 years brings us to a point where further assessment is appropriate. It is a credit to the adaptability and reliability of the X–11 program that more than 100,000 different economic and demographic series have been adjusted by this program. This is probably more than 100 times the number that were adjusted by clerical means previously.

This paper discusses the development of seasonal adjustment techniques over the past 50 years and points out a number of problems which are still prevalent in the current methodology as noted in specific series published by the Census Bureau. In concluding, the objectives of seasonal adjustment techniques relative to the broader concerns of seasonal analysis are examined, pointing up the fact that perhaps it is now time to move to the latter concept in an effort to improve our seasonal adjustment techniques.

DEVELOPMENT OF SEASONAL ADJUSTMENT TECHNIQUES

Although the development of computerized techniques initiated a new era in seasonal adjustment and time series analysis, work in deseasonalizing data series had been going on for over 50 years. The early manipulations were laborious and could only be done in a superficial manner. W. M. Persons first delineated the basic components of a time series to be comprised of seasonal fluctuation, secular trend, cyclical movement, and a residual designated as the irregular component. In the 1920's and early 1930's the Federal Reserve Board and the National Bureau of Economic Research were heavily involved in the smoothing of economic time series. Early methods of smoothing series by sight inspection were, in turn, replaced by developing a series of arithmetic operations. The best known seasonal adjustment methods developed during that period were differences from moving average and the ratio-to-moving average. There was also a fair amount of discussion of the use of monthly means, but as pointed out by Helen D. Falkner, "The chief advantage of the mean is the extreme ease of computation, but this is offset by the failure to make adequate allowance for the effect of the three other types of fluctuation. The arithmetic average is particularly subject to extreme items, and it is for that reason that a monthly seasonal index obtained by this method may be governed more by an exceptional deviation than by the systematic seasonal movement" [2]. In that earlier period, simplicity of calculation was a necessity of any seasonal adjustment technique. In a May 1930 publication, Howard G. Brunsman noted, "Curve fitting seasonal indexes and correlation computations in comparison of time series involve laborious computation. It is important, therefore, to devise short cuts and economize in labor in these statistical computations" [1]. Computer technology has changed that situation and has permitted the use of complex computational models in defining and analyzing economic fluctuations.

In some ways it is difficult to believe that the Census Bureau has just celebrated the 25th anniversary of the

I am grateful to Tyler R. Sturdevant, Fred Mayes, William Menth, and Peter Ohs for their valuable suggestions and computational assistance.

introduction of its first computer, Univac I, and that this computer system was the first to be used outside the military establishment. The tabulation and processing of basic unadjusted economic time series such as the monthly manufacturers' shipments, inventories, and orders, retail sales, housing starts, etc., were only converted to computer processing in the 1960's. In 1954, Shiskin developed and introduced at the Bureau of the Census an electronic computer program known as Method I for decomposing time series. The first Census program approximated the hand methods which were generally used up to that time, and was basically a refinement of the ratio-to-moving average method developed by Frederick R. Macaulay at the National Bureau of Economic Research. It is particularly appropriate, therefore, that this seasonal adjustment conference has been cosponsored by the National Bureau.

Method I was replaced a year later with an improved program designated as Method II. Variants of Method II followed; X–3, the first variant made available to the public was released in 1960. The latest variant, X–11, was introduced in 1965, but numerous changes, particularly the ability to select from various options, have been incorporated into the program over the past 10 years. Earlier versions of X–11 had few of the options such as adjustment for trading days, strikes, etc., which are available today. One of the major advantages of the present version is that the user may select optional features which best suit the pecularities of the time series being adjusted. Equally important are the various analytical measures used in business cycle analysis. This, however, may also create problems because, unless care is taken, the large volume of analytical material and tests automatically printed out can lull the analyst to a mechanistic acceptance of the default options without complete understanding of the nuances of the various alternatives.

As noted, the electronic computer technique for decomposing time series gained acceptance very rapidly and was in general use by 1960. Most major countries used the program extensively in adjusting their national time series or experimented with other forms of computerized techniques. The first major conference to assess this breakthrough was held in November 1960 in Paris, sponsored by the Organization for European Economic Cooperation in collaboration with the Conference of European Statisticians. It is interesting to note that the view expressed at the conference was that, "many users are not yet sufficiently familiar with deseasonalized data and that publication involves risks of faulty interpretation and unsound policy decisions" [6, p. 18]. To overcome these difficulties, it was suggested that adjusted data should always appear in conjunction with the original data and revisions should be avoided, whenever possible, in order to prevent any distrust of the figures. Even as late as 1969, it was difficult for many, particularly in the business community, to accept the idea of seasonally adjusted data. Charles Reeder of E. I. duPont pointed out that management still viewed seasonal adjustment with skepticism, noting that, "seasonally adjusting company data borders on tampering with official company figures and such a practice makes management uneasy, to say the least." Reeder offered a counter suggestion, "When adjusting for seasonality, never show both the unadjusted and seasonally adjusted monthly figures on the same table or chart, even as index numbers. It is not only confusing but it serves no analytical purpose" [4].

THE CENSUS BUREAU'S APPROACH

The Census Bureau's prime interest in adjustment techniques reflects its policy of publishing seasonally adjusted data for its economic time series. The Bureau publishes over 100 monthly and quarterly major series, each of which presents data for its detailed components so that in total more than 1,000 series require individual adjustment. The Bureau's policy in this respect recognizes that the availability of seasonally adjusted data is essential for the data user, particularly for short term economic analysis. We present such data in spite of the fact that seasonally adjusted series may have a greater error than the corresponding unadjusted series since, in addition to the errors of the unadjusted series, errors arising from the process of seasonal adjustment are inherent in the series.

The Bureau has, in its use of the X–11 seasonal program, made a number of empirical assumptions in adjusting its many data series for seasonality. Some of the assumptions, I am afraid, are rather simplistic due to the need to process large numbers of series on a timely basis. There is no doubt that more research must be accomplished before we can better understand the behavior of the various series and be assured that an optimum approach is being used.

Parametric methods have been studied and tested in great detail at the Bureau, particularly by H. Rosenblatt [5], using spectral techniques. The results have not been very fruitful in isolating the seasonal factors when applied to actual economic time series. Nor has adjustment through the use of regression techniques proved to give the exactness of fit, the flexibility, or the variety of tests needed for any general purpose seasonality program. Work done in this area by, for example, Stephenson and Farr in the early 70's utilizing a flexible regression method and allowing for changing trend and seasonality, yielded results that are not, in the overall, superior to those of the X–11 program [8]. Although we have attempted to study weather or climatic conditions as a cause of seasonality we have not met with much success. A study made some years ago attempted to isolate the impact of weather conditions on the irregular factor of retail sales but the geographic dispersion was too great and no practical application was possible [7].

The Bureau has generally used a rather restricted definition of seasonality reflecting the regularly periodic fluctuations which recur every year with about the same timing and with the same intensity. Adjustments are made for selected reasons such as calendar-month variation and trading-day variation, model changeover, etc. With rare exceptions, adjustment of Census series assumes a multiplicative model where the original series (O) is expressed as

$$O = S \times C \times TD \times I \tag{1}$$

where S, C, TD, and I are, respectively, the seasonal, trend-cycle, trading-day and irregular components of O. The trading-day adjustment is considered as a separate component, since it consists of variations attributable to the composition of the calendar and can be measured.

The adjustment process works best when the seasonal component S_t (although at one period rarely identical to the seasonal for the same period 1 year late, i.e. $S_t + 12$), changes gradually and with a significant degree of correlation in the monthly factors from year to year. Limited studies of our economic time series have indicated that an additive seasonality model for the observed data which assumes that the seasonal is a constant amount and independent of the level is not appropriate.

Since our basic goal is to produce an adjusted series which will most clearly show the trend cycle, selected modifications are made to the basic data which result from nonrandom behavior of the irregular component. The application of these modifications is optional and the effect of each option is reflected by a prior adjustment factor. Prior modifications are made for trading-day and calendar-month variation, holidays, and strikes.

While all phases of the adjustment process provide opportunities for modifying extreme values, the modification for strikes is unique since it alone directly modifies seasonally adjusted data. It should be emphasized, however, that the effect of all such modifications are noted in specified output tables and, like other prior modifications, are totaled as a separate component of the combined seasonal factor. In this way, as much irregularity as possible is removed before computing the trend-cycle estimate.

The Census Bureau, as a data producer, must also establish factors ahead of time for use in adjusting data for current periods. The method which produces the best seasonally adjusted historical series may not produce the most appropriate projected year ahead factors. For example, can a series which evidences moving seasonality be measured with enough accuracy to make reliable estimates of future adjustment factors?

We should also point out that there is no consistent treatment in the use of these options or to the overall approaches for handling these problems by various economic divisions of the Bureau. This, I think, stems from the many options presented in the X–11 program which are subject to the selectivity of the analyst. Analysts set up their own multivalued decision criteria based on knowledge of the data series and select different items to be evaluated and apply different weights to the results. It would be more reassuring to be able to assign more rigorous statistical criteria to the decision process.

Returning to the 1960 OECD conference, the basic discussions revolved about an exchange of ideas concerning various computer techniques and the problems involved. I mention here a list of research projects which were either underway or planned because, to a large extent, they still represent many of the problems underlying the framework of seasonal adjustment and for which we still do not have satisfactory solutions [6, pp. 22–56].

- Extrapolation of seasonal factors; empirical comparison of factors projected by different methods of adjustment, particularly at turning points.
- Replacement of the 12-month moving average by another curve to avoid distortion in the second iteration.
- The nature of irregular factors; the distribution of and the development of significance tests using this knowledge.
- Improvement of the technique of identification and replacement of extreme values.
- Working-day and other prior adjustment for calendar variation.
- Testing for the dominance of trend or time-conditioned seasonality; development of criteria of the type of adjustment applicable to a given series; incorporation of a selection device in the case of machine treatment.
- The moving-amplitude adjustment.
- Provision for time-conditioned seasonality in the regression method.
- The further decomposition of the trend component into a trend and cyclical component.
- Combination of the months for cyclical dominance (MCD) and seasonal band concepts.
- The underlying causes of the changes in seasonal patterns.

I should now like to turn to specific problems included in the list of OECD projects which are still of concern to Census Bureau staff. Although these problems have been pervasive, the solutions do not appear to be either easy or forthcoming in the very near future. One of our expectations is that this seasonal conference will generate new ideas and approaches and identify new avenues of research to be pursued, and give impetus to further study by the academic community. The data collector continues to be greatly concerned when an unusual occurrence in a current figure is explained away or justified as, just a quirk in the seasonal adjustment process.

The Aggregation Problem

The Bureau publishes, for all of its major current economic time series, seasonally adjusted results at both the aggregate level and the detailed level of the component series comprising the total. Thus the analyst must face the question whether to adjust the series total directly for seasonality or to adjust each of the components and derive the seasonally adjusted total by addition. It would appear that until now relatively little theoretical progress has been made in this area.

With the exception of two major series, imports and exports, and weekly retail sales, the detailed components of the Bureau series are seasonally adjusted and the seasonally adjusted total for the series is the sum of the adjusted components. This approach makes available many more detailed adjusted series as well as having the advantage of defining the aggregates in terms of their components. Also, from a pragmatic point of view, one avoids embarrassing questions regarding inconsistencies between the sum of the components and the series total.

The determination of the level of detail at which components are to be seasonally adjusted brings forth another set of problems. The finer the detail, the more sensitive the series will be to the seasonal fluctuations and the more likely the irregular component will be greater. Also, since there is less chance for offsets, the homogeneity of the component series assumes greater importance. To a large extent, the basic component series are determined by the interests expressed by data users and our ability to provide statistically sound unbiased estimates of the unadjusted series.

There are circumstances, where differing seasonal patterns dictate the composition of the components of the original unadjusted estimates. For example, in the monthly manufacturers' survey, it was originally planned to estimate automobile assemblies and automotive parts as a single cell but the seasonal patterns of the two series were so different that a separation was needed for reliable estimation. The adjustment procedure applied to some types of series can result in odd situations. Thus, independently adjusting the figure for multifamily housing starts in permit issuing areas can produce a larger total than the comparable figure for all multifamily homes.

How does one test whether the difference between the directly adjusted total and the aggregate obtained from the sum of components is significant? Totals obtained from direct measurement versus the sum of the components for two monthly series, housing starts and manufacturers' shipments, are examined in table 1. There is a tendency for the sum of the detailed components to have a greater seasonality and a greater irregular component as seen in the following summary measures for manufacturers' shipments:

	Total	Sum of components
$\bar{I}$ Average month-to-month percent change, without regard to sign for irregular component	0.99	3.95
$\overline{CI}$ Average month-to-month percent change, without regard to sign for seasonal adjusted series	1.36	4.69

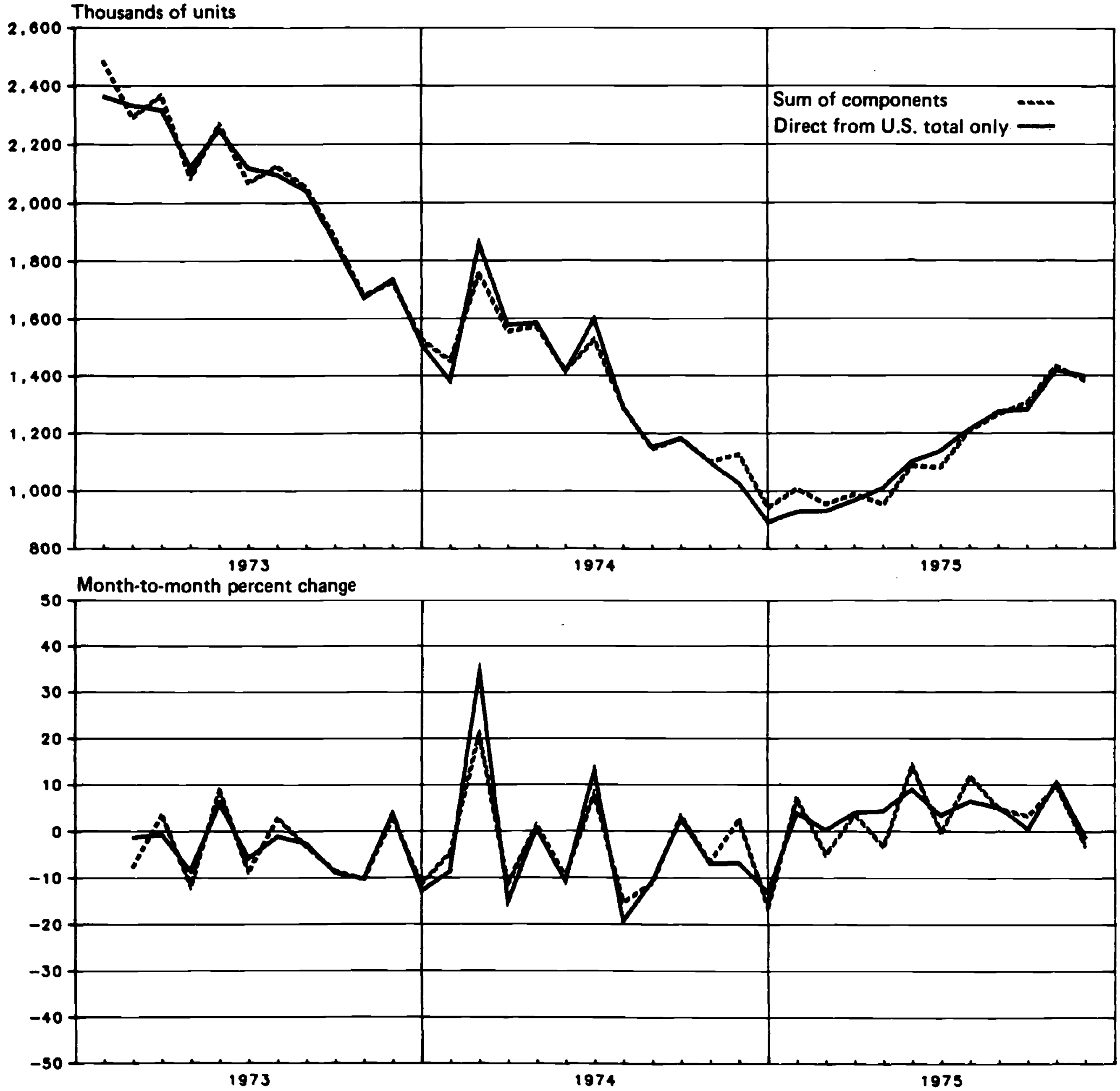
Figure 1 shows housing starts seasonally adjusted using both the sum of components and the direct U.S. total. In comparing the month-to-month percent change between the two series, one can readily see that the estimates derived from the direct total produces a much smoother month-to-month series.

Data in the foreign trade area are treated differently in that the direct totals of imports and exports are seasonally adjusted independently from their component series. Again, as can be seen in table 2, the differences between the total obtained by direct adjustment of the unadjusted total and that obtained from the aggregation of adjusted commodity groups are significant for certain months. Furthermore, the individual commodity series are also seasonally adjusted independently by country. For want of a better approach, the Bureau assumes that in this area it is more satisfactory to adjust total imports and exports directly and note that the seasonally adjusted component series do not add to the total. These differences, however, assume critical significance whenever the seasonally adjusted merchandise trade balance (which is obtained by the subtraction of exports from imports) exhibits different movements or different magnitudes of change when computed by both methods.

It would appear that for most months in most series, changes in the composition of the individual series have relatively little impact on overall seasonal patterns for the total and that either method is satisfactory. The fact that there is little difference between the aggregate and the sum of the components is used as a positive check of the validity of the data. The major problem to be resolved is how to adjust when the differences are irregularly distributed among the months.

Figure 1. **HOUSING STARTS, SEASONALLY ADJUSTED ANNUAL RATES**

(With trading-day adjustment)



Source: U.S. Department of Commerce, Bureau of the Census; *Housing Starts,* Construction Reports, series C20, No. 12, December 1975.

Table 1. COMPARISON OF ALTERNATE METHODS OF SEASONAL ADJUSTMENT OF AGGREGATES FOR HOUSING STARTS AND MANUFACTURERS' SHIPMENTS

Series	Method	Description	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
			1975											
HOUSING STARTS (ANNUAL RATES) (IN THOUSANDS OF UNITS)......	TOTAL.....	SEASONALLY ADJ. DATA.......	928	931	968	1,011	1,102	1,140	1,214	1,276	1,293	1,419	1,399	(NA)
	COMPONENT.	SEASONALLY ADJ. DATA.......	1,005	953	986	982	1,085	1,080	1,207	1,264	1,304	1,431	1,381	(NA)
	TOTAL.....	MONTH-TO-MONTH CHANGE......	35	3	37	43	91	38	74	62	17	126	-20	(NA)
	COMPONENT.	MONTH-TO-MONTH CHANGE......	65	-52	33	-4	103	-5	127	57	40	127	-50	(NA)
	TOTAL.....	MONTH-TO-MONTH PERCENT CHG.	3.9	0.3	3.9	4.4	9.0	3.4	6.5	5.1	1.3	9.7	-1.4	(NA)
	COMPONENT.	MONTH-TO-MONTH PERCENT CHG.	6.9	-5.2	3.5	-0.4	10.5	-0.5	11.8	4.7	3.2	9.7	-3.4	(NA)
MANUFACTURERS' SHIPMENTS (MONTHLY) (IN MILLIONS OF DOLLARS)....	TOTAL.....	SEASONALLY ADJ. DATA.......	79,951	79,970	77,718	80,697	79,882	81,350	82,608	85,224	85,292	86,653	84,953	88,253
	COMPONENT.	SEASONALLY ADJ. DATA.......	79,292	79,354	77,635	80,703	79,734	81,039	83,029	85,210	86,200	87,403	86,515	87,616
	TOTAL.....	MONTH-TO-MONTH CHANGE......	-546	19	-2,252	2,979	-815	1,468	1,258	2,616	68	1,361	-1,700	3,300
	COMPONENT.	MONTH-TO-MONTH CHANGE......	-462	62	-1,719	3,068	-969	1,305	1,990	2,181	990	1,203	-888	1,101
	TOTAL.....	MONTH-TO-MONTH PERCENT CHG.	-0.7	-	-2.8	3.8	-1.0	1.8	1.5	3.2	0.1	1.6	-2.0	3.9
	COMPONENT.	MONTH-TO-MONTH PERCENT CHG.	-0.6	0.1	-2.2	4.0	-1.2	1.6	2.5	2.6	1.2	1.4	-1.0	1.3

- Entry represents zero. NA Not available.

Table 2. COMPARISON OF ALTERNATE METHODS OF SEASONAL ADJUSTMENT OF AGGREGATES FOR IMPORTS AND EXPORTS

Series	Method	Description	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
			1975											
IMPORTS (MONTHLY) (IN MILLIONS OF DOLLARS).....	TOTAL.....	SEASONALLY ADJ. DATA.......	9,636	7,928	7,467	7,959	7,266	7,104	7,824	7,877	8,205	8,170	8,204	8,526
	COMPONENT.	SEASONALLY ADJ. DATA.......	9,371	7,823	7,293	8,129	7,325	7,044	7,876	7,860	8,304	8,273	8,339	8,495
	TOTAL.....	MONTH-TO-MONTH CHANGE......	386	-1,708	-461	492	-693	-162	720	53	328	-35	34	322
	COMPONENT.	MONTH-TO-MONTH CHANGE......	170	-1,548	-530	836	-804	-281	832	-16	444	-31	66	156
	TOTAL.....	MONTH-TO-MONTH PERCENT CHG.	4.2	-17.7	-5.8	6.6	-8.7	-2.2	10.1	0.7	4.2	-0.4	0.4	3.9
	COMPONENT.	MONTH-TO-MONTH PERCENT CHG.	1.8	-16.5	-6.8	11.5	-9.9	-3.8	11.8	-0.2	5.6	-0.4	0.8	1.9
EXPORTS (MONTHLY) (IN MILLIONS OF DOLLARS).....	TOTAL.....	SEASONALLY ADJ. DATA.......	9,373	8,755	8,685	8,648	8,222	8,716	8,894	8,979	9,146	9,225	9,409	9,250
	COMPONENT.	SEASONALLY ADJ. DATA.......	9,265	8,692	8,542	8,569	8,269	8,591	8,844	8,940	8,918	9,244	9,355	9,152
	TOTAL.....	MONTH-TO-MONTH CHANGE......	511	-618	-70	-37	-426	494	178	85	167	79	184	-159
	COMPONENT.	MONTH-TO-MONTH CHANGE......	496	-573	-150	27	-300	322	253	96	-22	326	111	-203
	TOTAL.....	MONTH-TO-MONTH PERCENT CHG.	5.8	-6.6	-0.8	-0.4	-4.9	6.0	2.0	1.0	1.8	0.9	2.0	-1.7
	COMPONENT.	MONTH-TO-MONTH PERCENT CHG.	5.6	-6.2	-1.7	0.3	-3.5	3.9	2.9	1.1	-0.2	3.6	1.2	-2.2

A somewhat similar problem exists in the treatment of derived data items such as the merchandise trade balance or manufacturers' new orders. The current Bureau practice is to obtain the seasonally adjusted figures by derivation in the same manner that the unadjusted data are obtained. A review of the problems associated with manufacturers' new orders may clarify the problem.

Manufacturers' new orders are not estimated directly but are derived by adding the change in the backlog of unfilled orders to the shipments for the current month. Under this scheme, cancellations and revisions in contract prices are reflected more accurately in the new orders figures. Seasonally adjusted new orders are derived in the same way. This may be expressed symbolically as—

B_i = Backlog of unfilled orders at the end of month i

S_i = Shipments during the month i

O_i = New orders received during the month i

BSF_i = Seasonal adjustment factor for backlog at the end of month i

SSF_i = Seasonal adjustment factor for shipments during month i

SO_i = Seasonal adjusted new orders

Unadjusted new orders

$$O_i = S_i + (B_i - B_{i-1}) \qquad (2)$$

Seasonally adjusted new orders

$$SO_i = \frac{S_i}{SSF_i} + \frac{B_i}{BSF_i} - \frac{B_{i-1}}{BSF_{i-1}} \qquad (3)$$

This procedure for seasonally adjusting new orders has a clear advantage in terms of avoiding inconsistencies in publication. The problem arises in the relative precision of a figure which is computed indirectly using three seasonal factors compared to a figure seasonally adjusted directly.

It has been noted that, for most series, the seasonal pattern of the industry is sufficiently stable and the magnitude of month-to-month changes is sufficiently small that either method produces about the same result. Data for the metal working machinery and general industrial machinery, shown in table 3, illustrate this point. Unfortunately, seasonal patterns and the magnitude of month-to-month movement are less stable in some of the larger industries such as aircraft, and steam engines and turbines. It is these industries which frequently dictate the pattern of month-to-month movement in the overall total for new orders as reflected in table 3. The month-to-month movements as well as differences in the direct and implied seasonal factors are disturbingly different.

Trading-Day Factors

Existing trading-day adjustment procedures pose a difficult choice between reasonable empirical daily weights and fitted weights computed by trading-day regression [9]. The trading-day adjustment option of the X–11 program provides weights for each of the 7 days of the week by regressing the irregular series upon the number of times each day occurs in a particular month. This option can more than occasionally include negative weekday values and extraordinarily high weekend day values. It is easy to see how unusual daily weights can result from the regression. All Mondays, for example, are given equal weight in the regression, without consideration in manufacturing, for example, of the seasonal patterns of capacity utilization, overtime practices or usage of reduced work weeks during recessions. An accidental concentration of Mondays during a month of heavy overtime, for example, could result in an exaggerated weight for Monday. For retail sales, these weights are interpreted as an indication of the historical relationship of sales among the various days of the week. More commonly, results can be misleading even if not absurd. This can follow from uneven distribution of sales within portions of months and from changes overtime in trading patterns.

Changes in blue laws in parts of the country have resulted in increased proportion of sales on Sundays. However, because of the regression approach, it takes a considerable period before any change in Sunday trading-day factors can be reflected, and even then, only partially. Again, this can result in distortions of weekly and monthly estimates by not reflecting current trading-day patterns.

To indicate potential complexity of the difficulties encountered in trading-day adjustment, the automotive trade area will be considered. While the Bureau produces monthly estimates of passenger car sales, industry figures are based upon 10-day sales reports. The sum of industry's 10-day sales reports should be closely in line with our monthly estimates. However, several of the Bureau's monthly trends differed seriously from the industry 10-day sales reports.

From the outset we suspected that the method used to compute trading-day factors was erroneous. The method used assumes that each day of the week has an equal effect, regardless of when the day occurs in the month. To test this assumption, we applied the weekly seasonal adjustment to the automotive group. The reason for doing so was because the weekly seasonal adjustment program computes a seasonal factor for each of the 366 possible week-ending days of the year. This permitted us to determine whether a pattern of intramonth variation existed, which, in effect, would nullify our assumption concerning trading days.

The results of our study showed that there is a marked intramonth seasonal pattern in the automotive

Table 3. SEASONALLY ADJUSTED NEW ORDERS AND SEASONAL FACTORS: 1970

(Millions of dollars)

Series	Method	Description	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
METAL/WORKING MACHINERY......	DIRECT	SEASONALLY ADJ. NEW ORDERS.	256	251	223	241	245	260	239	253	273	259	259	279
	DERIVED	SEASONALLY ADJ. NEW ORDERS.	270	250	213	242	247	253	244	255	273	249	254	281
	DIRECT	MONTH TO MONTH CHANGE......	-40	-6	-28	18	4	15	-21	15	20	-14	-	19
	DERIVED	MONTH TO MONTH CHANGE......	-31	-20	-37	29	5	6	-9	11	18	-24	5	27
	DIRECT	SEASONAL FACTOR............	94.8	102.9	105.9	104.0	102.1	109.3	93.0	92.0	106.2	95.3	89.8	103.0
	DERIVED	IMPLIED SEASONAL FACTOR....	90.0	103.2	110.8	103.7	101.2	112.3	91.0	91.4	106.2	99.2	91.7	102.1
GENERAL INDUSTRIAL MACHINERY.	DIRECT	SEASONALLY ADJ. NEW ORDERS.	373	397	371	378	385	381	386	369	372	359	386	430
	DERIVED	SEASONALLY ADJ. NEW ORDERS.	372	395	367	377	391	379	390	361	390	362	383	422
	DIRECT	MONTH TO MONTH CHANGE......	-38	24	-27	7	8	-4	5	-17	3	-14	27	44
	DERIVED	MONTH TO MONTH CHANGE......	-30	23	-28	10	14	-12	11	-29	29	-28	21	39
	DIRECT	SEASONAL FACTOR............	92.4	107.2	103.9	102.7	99.1	106.0	90.2	102.5	102.9	98.7	94.9	101.5
	DERIVED	IMPLIED SEASONAL FACTOR....	92.7	107.8	104.9	102.9	97.7	106.6	89.2	104.7	98.2	97.8	95.6	103.3
STEAM ENGINES AND TURBINES...	DIRECT	SEASONALLY ADJ. NEW ORDERS.	272	306	190	195	232	132	259	192	186	189	230	150
	DERIVED	SEASONALLY ADJ. NEW ORDERS.	229	278	183	179	227	136	263	199	166	190	234	176
	DIRECT	MONTH TO MONTH CHANGE......	110	34	-117	5	38	-101	128	-67	-6	3	41	-80
	DERIVED	MONTH TO MONTH CHANGE......	31	49	-95	-4	48	-91	127	-64	-33	24	44	-58
	DIRECT	SEASONAL FACTOR............	78.2	85.5	108.6	84.8	91.2	131.5	90.3	97.9	103.5	83.5	100.0	150.3
	DERIVED	IMPLIED SEASONAL FACTOR....	93.0	94.2	112.6	92.2	93.4	127.2	89.0	94.5	116.3	83.2	98.3	127.8
COMPLETE AIRCRAFT............	DIRECT	SEASONALLY ADJ. NEW ORDERS.	516	1,234	1,161	935	1,153	1,126	1,095	1,104	1,150	913	886	1,122
	DERIVED	SEASONALLY ADJ. NEW ORDERS.	494	1,063	1,184	1,069	1,158	1,093	1,055	1,153	1,047	1,000	908	1,163
	DIRECT	MONTH TO MONTH CHANGE......	-302	718	-73	-226	217	-27	-31	9	45	-237	-27	236
	DERIVED	MONTH TO MONTH CHANGE......	-334	569	121	-115	89	-65	-38	98	-106	-47	-92	255
	DIRECT	SEASONAL FACTOR............	92.2	94.4	118.3	88.0	85.2	92.2	136.7	94.1	97.6	98.7	93.1	108.4
	DERIVED	IMPLIED SEASONAL FACTOR....	96.4	109.6	116.0	77.0	84.8	95.0	141.9	90.1	107.2	90.1	90.9	104.6

- Entry represents zero.
X Not applicable.

series. Sales rise sharply as the end of the month approaches, then decline at the beginning of the next month. Given that Friday and Saturday have quite heavy trading-day weights, one can easily envision the error which would result should a month begin on Friday. No doubt this problem occurs in other trade areas. Since transfer payments are disbursed around the first of the month, such immediate demand areas such as food and drug categories of retail store sales could have a similar problem. The length and detail, I believe, of the foregoing discussion are justified by realizing the complex interrelationships which exist between the many components of an economic time series.

Terminal Periods and Projected Factors

Another important problem which still remains vexing is the determination of the seasonal adjustment factors to be applied to current periods in a data series. The first published estimate is the data item most carefully scrutinized, particularly with regard to the change from the preceding period. This, unfortunately, is usually the least reliable in the series of estimates both statistically and because of the changing nature of the seasonal.

Theoretical guidance would be especially welcome in refining the current empirical definition of the components of the time series models used in seasonal adjustment. To what extent should the estimated seasonal factors for a particular month be permitted to have trends? This question takes on particular importance when "smoothing the series" (i.e., minimizing the MCD) is seen as conflicting with establishing stable seasonal factors. Clearly a smoother seasonally adjusted series and shorter MCD's may be achieved by ascribing some of the irregular variation to the seasonal component by means of moving seasonals. Unfortunately, a concomitant result of this procedure are seasonal factors that are susceptible to revision. Conversely, rigidly defined seasonal factors leave much more residual variation in the seasonally adjusted series and complicate analysis. A general purpose seasonal adjustment procedure must come to grips with balancing these alternatives and, at present, there are no theoretical guidelines for making the compromise.

The Bureau normally applies the projected seasonal factors from the X–11 program to its current estimates. The practice of updating the seasonals varies by program area, as previously noted, but under any circumstances the projected factors are the least reliable (and the most cautious) since they are obtained by applying half of the change of the moving seasonal of the last 2 years.

An examination of several manufacturers' shipments series indicates the magnitude of the problem. Tables 4a and 4b show how the seasonal adjustment factors for a particular year can vary as additional data for subsequent years become available. The mean and standard deviation of these differences are shown in table 5. Although one would expect some stabilization after one or two years, in many cases, the mean of the difference appears to be greater in the third or subsequent years. For example, in table 4a the seasonal factors for farm machinery and equipment for February 1973 range from 111.4 as the projected factor with 1972 as the latest data available to 106.9 when 1973 information is available to 103.5 when computed with information through 1975. Similar differences for December 1973 can be seen with a range from 77.4 to 80.7 to 80.0 when data through 1975 are available. The mean difference between the projected and actual was 1.73 with a standard deviation of 1.34 when computed with actual 1973 data, but this increased to a mean of 2.30 with a standard deviation of 2.23 when an additional year's data for 1974 was added.

To a large extent this is due to the treatment of extreme values which may or may not be removed from the calculations. If the 13-term moving average is used, then 6 months on either side of the month for which the trend estimate is to be made are needed. Beyond the month for which data are available, the information must be assumed. Further revisions come about since the weighted means of the ratio give about half the weight to the last 5 years. Probably the most difficult decision to make is whether an identified extreme is actually an irregular or is a change in the seasonal. It should be pointed out that revisions could be greatly reduced by using stable seasonal factors. Revisions could also be reduced if fewer or no extremes were modified. Since flexibility, extremes, residual seasonality, revisions, and many other areas are interrelated, the problem of revisions cannot be approached without taking into account the possibility of creating offsetting problems in other parts of the adjustment.

This, then raises the question of how often seasonal factors should be updated. The Australian Statistical Office believes that, for maximum accuracy, new seasonal factors should be obtained monthly so that the maximum amount of actual information can be included in the calculations. Others, including Lovell [3], have made the same suggestion. While, from a theoretical point of view, this approach may have some advantages, the practical problems would preclude its use by a large-scale data producing group such as the Census Bureau or the Bureau of Labor Statistics. One cannot ignore policy considerations and the possible misperceptions about the use of changing seasonal factors. Operationally, the inordinate amount of staff and computer resources needed to adjust the thousands of series monthly as well as constantly publish revised data preclude such an approach.

Table 4a. **SEASONAL FACTORS FOR SALES OF FARM MACHINERY AND EQUIPMENT (MANUFACTURERS' SHIPMENTS)**

(Computations based on data from different years)

Year of data	Year of factors	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1966	1967	95.0	110.9	120.7	124.9	113.0	110.7	92.2	86.5	96.9	93.9	72.9	82.3
1967	1967	95.0	110.7	122.1	123.7	112.2	109.8	88.7	87.0	95.4	95.2	75.0	85.8
1968	1967	94.7	111.2	122.1	122.6	110.1	107.8	87.7	86.1	96.9	97.1	77.0	87.9
1969	1967	95.1	111.1	121.8	122.1	108.9	107.3	86.8	86.6	98.6	98.6	78.1	87.2
1970	1967	94.7	110.8	121.0	121.1	108.1	106.9	86.2	85.8	97.6	106.6	76.3	86.7
1967	1968	95.1	110.7	122.0	123.3	112.2	109.9	88.4	87.0	95.2	95.3	75.1	86.1
1968	1968	94.3	111.0	122.3	122.4	109.6	107.4	87.1	86.0	97.1	97.6	77.4	88.3
1969	1968	94.8	110.7	121.9	121.6	107.6	106.6	85.9	86.7	99.4	99.6	78.8	87.6
1970	1968	94.6	110.7	120.9	120.3	106.6	106.5	85.2	86.1	98.6	108.6	76.5	86.8
1971	1968	95.0	111.5	121.6	120.8	106.9	107.5	86.3	87.9	100.0	104.6	76.1	82.2
1968	1969	94.2	111.0	122.4	122.3	109.3	107.2	86.8	86.0	97.1	97.8	77.6	88.6
1969	1969	94.5	110.4	122.1	121.3	107.0	106.2	85.5	86.7	99.9	99.9	79.2	87.7
1970	1969	94.5	110.9	120.7	119.5	105.4	106.2	84.9	86.4	99.3	109.8	76.5	86.5
1971	1969	95.1	112.1	121.7	119.8	105.3	107.5	86.0	88.4	101.3	106.4	76.0	80.9
1972	1969	94.1	111.0	120.7	118.8	104.8	107.4	85.6	88.3	101.8	110.9	76.8	80.2
1969	1970	94.3	110.2	122.2	121.2	106.7	106.0	85.3	86.8	100.1	100.0	79.4	87.7
1970	1970	94.6	111.0	120.4	119.1	104.9	106.1	85.0	86.5	99.7	110.2	76.4	85.9
1971	1970	95.0	112.4	121.4	119.2	104.2	107.9	86.0	88.7	102.1	107.6	75.6	79.7
1972	1970	93.9	111.1	120.3	117.8	103.8	108.1	85.9	89.0	103.5	111.2	76.6	79.0
1973	1970	93.5	109.6	119.5	117.0	103.7	107.9	85.3	89.8	104.6	112.7	76.5	81.0
1970	1971	94.6	111.0	120.3	118.9	104.7	106.0	85.1	86.5	99.9	110.4	76.3	85.7
1971	1971	95.1	112.5	121.3	118.9	103.9	108.3	86.0	88.7	102.6	108.1	75.2	79.1
1972	1971	93.6	111.2	120.0	116.9	103.3	108.8	86.2	89.4	104.7	111.2	76.5	78.0
1973	1971	93.1	108.6	118.8	115.8	103.4	108.7	85.5	90.6	106.7	113.1	76.4	81.0
1974	1971	93.3	106.9	118.9	115.9	103.5	108.9	86.5	89.9	106.2	112.9	79.1	79.7
1971	1972	95.2	112.6	121.2	118.8	103.7	108.5	86.0	88.7	102.8	108.4	75.0	78.8
1972	1972	93.5	111.3	119.9	116.6	103.2	109.3	86.0	89.8	105.1	110.9	76.3	77.6
1973	1972	92.3	107.4	118.2	115.0	103.4	109.3	85.6	91.3	108.0	113.0	76.4	81.0
1974	1972	92.7	104.8	118.5	115.2	103.7	109.8	86.6	90.4	107.4	113.0	80.2	79.6
1975	1972	92.3	105.3	118.7	115.7	104.0	109.9	85.6	89.8	106.9	112.7	80.4	79.8
1972	1973	93.4	111.4	119.8	116.5	103.1	109.6	85.9	90.0	105.3	110.8	76.3	77.4
1973	1973	91.8	106.9	118.0	114.6	103.3	109.4	85.8	91.5	108.5	113.1	76.5	80.7
1974	1973	92.4	102.8	118.3	114.6	103.9	110.2	87.0	90.3	107.7	113.2	81.2	79.5
1975	1973	91.9	103.5	118.7	115.7	104.6	110.5	85.7	89.1	107.1	112.8	81.9	80.0
1973	1974	91.6	106.7	118.0	114.3	103.2	109.5	85.8	91.6	108.7	113.1	76.6	80.6
1974	1974	92.1	101.6	118.2	114.4	104.2	110.3	87.2	90.0	107.9	113.2	81.6	79.5
1975	1974	91.6	102.2	118.3	116.0	105.2	111.0	85.4	88.2	107.0	112.8	82.9	80.1
1974	1975	92.0	101.0	118.2	114.3	104.3	110.4	87.3	89.8	108.0	113.2	81.8	79.4
1975	1975	91.5	101.6	118.0	116.0	105.7	111.2	85.3	87.9	106.7	112.6	83.2	80.2

Table 4b. **SEASONAL FACTORS FOR INTERNAL COMBUSTION ENGINES**

(Computations based on data from different years)

Year of data	Year of factors	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1966	1967	93.0	104.7	117.4	112.8	109.4	113.9	84.1	87.1	102.8	87.7	90.3	96.2
1967	1967	92.9	105.5	115.9	110.8	108.0	111.8	85.4	88.0	101.7	89.4	92.8	97.7
1968	1967	92.5	105.8	114.4	112.7	107.7	111.4	82.1	89.6	101.3	91.3	94.2	97.5
1969	1967	92.6	106.6	114.0	111.0	108.0	109.9	84.6	90.0	101.6	90.9	94.4	97.6
1970	1967	92.4	106.6	114.5	111.0	107.3	109.9	84.6	89.9	102.1	90.9	93.2	98.1
1967	1968	92.9	105.5	115.8	110.8	108.0	111.7	85.5	88.1	101.4	89.4	93.0	97.7
1968	1968	92.6	106.0	113.9	112.6	107.5	111.1	81.9	90.0	100.9	91.8	94.6	97.4
1969	1968	92.3	107.3	112.9	110.4	107.8	109.2	84.9	90.7	101.4	91.3	94.9	97.4
1970	1968	92.0	107.5	114.1	110.6	106.7	108.9	85.1	90.4	102.5	91.4	93.2	98.4
1971	1968	92.4	107.5	114.8	110.9	106.8	108.8	84.8	90.0	102.3	90.4	92.3	98.8
1968	1969	92.6	106.0	113.6	112.5	107.5	110.9	81.7	90.2	100.7	92.0	94.7	97.3
1969	1969	92.1	107.6	112.5	109.9	107.8	108.7	85.0	91.1	101.4	91.6	95.0	97.2
1970	1969	91.4	107.7	114.2	110.6	106.5	108.1	85.3	90.6	102.8	91.4	93.0	98.8
1971	1969	92.2	107.9	115.6	111.1	106.3	107.9	84.9	90.1	102.6	90.1	91.7	99.7
1972	1969	92.5	108.1	115.2	111.0	106.2	108.3	84.2	90.1	103.3	90.3	91.7	98.6
1969	1970	92.0	107.8	112.3	109.7	107.8	108.5	85.1	91.3	101.3	91.7	95.0	97.1
1970	1970	91.0	107.9	114.1	110.9	106.3	107.6	85.4	90.6	103.1	91.3	92.8	98.7
1971	1970	92.2	108.0	116.1	111.2	105.6	107.6	85.1	89.9	103.1	89.5	91.1	100.3
1972	1970	92.8	108.6	115.9	110.9	105.2	108.4	83.9	89.7	104.4	90.0	91.1	99.0
1973	1970	94.0	109.4	116.9	111.3	105.6	108.0	83.5	89.4	103.6	89.6	90.2	96.6
1970	1971	90.8	108.1	114.1	111.0	106.3	107.4	85.5	90.6	103.2	91.2	92.7	98.7
1971	1971	92.3	108.1	116.5	111.4	105.4	107.6	85.1	89.7	103.2	89.1	90.7	100.8
1972	1971	93.1	108.6	116.6	111.0	104.4	108.6	83.3	89.2	105.1	89.7	90.7	99.3
1973	1971	95.0	110.2	118.1	111.7	105.3	108.0	82.6	88.6	103.9	89.7	89.8	95.9
1974	1971	94.9	110.8	118.0	111.6	104.2	108.2	83.0	88.3	103.6	89.9	90.1	95.8
1971	1972	92.3	108.2	116.7	111.5	105.3	107.6	85.1	89.5	103.3	89.0	90.6	101.1
1972	1972	93.4	108.6	117.2	110.8	104.0	108.8	83.3	89.0	105.5	89.6	90.5	99.4
1973	1972	95.9	110.8	118.9	111.7	105.1	108.0	81.9	88.1	103.9	90.0	89.6	95.3
1974	1972	95.8	111.9	118.9	111.5	103.3	108.7	82.6	87.6	103.3	90.6	90.2	95.1
1975	1972	95.1	110.8	117.6	110.9	104.3	107.5	82.0	87.9	104.0	91.6	91.6	97.3
1972	1973	93.5	108.6	117.5	110.7	103.7	108.9	83.2	88.8	105.6	89.5	90.4	99.5
1973	1973	96.4	111.1	119.4	111.9	105.0	107.9	81.4	88.0	103.9	90.1	89.4	94.9
1974	1973	96.2	112.8	119.1	111.6	102.6	109.0	82.2	87.1	103.0	91.3	90.4	94.1
1975	1973	95.5	111.1	116.9	110.7	103.8	107.0	81.5	87.6	104.0	92.8	92.8	97.4
1973	1974	96.7	111.2	119.6	112.0	105.0	107.9	81.2	88.0	103.8	90.2	89.3	94.7
1974	1974	96.5	113.5	119.0	111.5	102.5	109.2	81.9	86.8	103.0	91.7	90.4	93.5
1975	1974	95.6	111.1	115.7	110.6	103.8	106.4	81.2	87.6	103.8	93.8	93.7	97.5
1974	1975	96.7	113.9	118.9	111.5	102.4	109.3	81.8	86.7	102.9	91.9	90.4	93.2
1975	1975	95.3	111.1	115.2	110.5	103.8	106.1	81.2	87.3	103.5	94.3	94.4	97.5

Table 5. **MEANS AND STANDARD DEVIATIONS OF DIFFERENCE BETWEEN YEAR-AHEAD AND ACTUAL SEASONALS**

(Computations based on 1, 2, 3, 4, and 5 years ahead)

Year-ahead date	Sales of farm machinery and equipment									
	1 year		2 years		3 years		4 years		5 years	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
1967	1.40	1.09	2.32	1.77	2.81	2.00	3.43	3.43	2.70	2.34
1968	1.53	.83	2.23	1.71	3.06	3.46	2.79	2.56	3.51	3.66
1969	1.25	.76	2.47	3.07	2.89	2.64	3.36	3.76	3.59	3.84
1970	1.90	2.65	2.84	2.37	3.38	3.15	3.59	3.26	3.59	3.30
1971	1.83	1.64	2.09	2.13	2.61	1.81	3.03	1.66	2.86	1.65
1972	1.37	.71	2.70	1.69	2.95	2.19	2.81	2.07	(X)	(X)
1973	1.73	1.34	2.30	2.23	2.24	2.15	(X)	(X)	(X)	(X)
1974	1.48	1.66	1.88	1.85	(X)	(X)	(X)	(X)	(X)	(X)
1975	1.09	.58	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)

Year-ahead date	Internal combustion engines									
	1 year		2 years		3 years		4 years		5 years	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
1967	1.42	.62	1.97	1.11	2.17	1.23	2.11	1.07	1.96	1.04
1968	1.31	1.00	1.31	1.00	1.27	.83	1.17	.73	1.17	.72
1969	1.16	.99	1.60	.92	1.86	.94	1.70	.88	1.74	1.03
1970	1.13	.62	1.76	1.29	1.87	1.15	2.12	1.26	2.11	1.25
1971	1.07	.85	1.49	.76	2.13	1.22	2.17	1.16	1.77	1.09
1972	1.01	.61	1.85	1.62	2.09	1.64	1.76	1.13	(X)	(X)
1973	1.76	1.06	1.94	1.51	1.63	.95	(X)	(X)	(X)	(X)
1974	1.17	.66	1.71	1.51	(X)	(X)	(X)	(X)	(X)	(X)
1975	2.16	1.34	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)

The Bureau of Labor Statistics has a fixed policy of announcing the seasonal factors for each of its series a year ahead of time. Although the Census Bureau publishes in advance the seasonal factors to be used there is, unfortunately, no overall policy for either the frequency of update or for the number of back years for which revised data should be shown. In the manufacturing area, new seasonal factors are computed each time the series are rebenchmarked. However, this procedure which is scheduled annually, has not been followed rigidly and there has been a regrettable use of outdated factors. New factors in the construction statistics area, i.e., housing starts, value put in place, etc., are computed each spring and the series revised back three years. Data for retail trade are seasonally adjusted semiannually and revised factors as well as revised seasonally adjusted data are published whenever the revisions are deemed to be significant (which is itself a somewhat arbitrary procedure).

Other Problems

Adjustment for strikes presents another problem. Cyclical variations which extend three or more quarters are easily identified by the moving-average technique of the X-11 program and strikes which affect one or at the most two months, are properly identified as irregular movements and treated accordingly. However, some series, such as the steel industry, historically have had periods of prestrike increased buying followed by either a strike or heavily reduced demand, both with the same statistical result. These movements span several months and may extend for an entire year. Existing mechanical procedures cannot deal with these conditions accurately. Not only is this a problem in historical identification of seasonality, but it also presents a problem in the presentation of seasonally adjusted data during the build-up period when normal seasonal patterns fail to operate.

The upcoming change in the fiscal year of the Federal Government poses still another problem. A three to ten point difference between the June and July seasonal factors is quite common. In addition to Federal fiscal cycle, this is due to the automotive model changeover phenomenon, the fiscal behavior of non-government organizations, the vacation cycles in industry and the underlying pattern of consumers. But some part of this will change with the new fiscal year and existing adjustment procedures will not reliably identify the change for at least 2 and perhaps as long as 5 years.

Another class of problems may be grouped together as difficulties in the presentation of seasonally adjusted data. In addition to presenting seasonally adjusted data, what additional information would users need to evaluate the precision of the adjustment or the underlying nature of variations in the series? How much confusion or benefit would result from an annual (or more frequent) revision of the historical seasonally adjusted series and the factors used for the months ahead? What additional measures of the behavior of the series would users like to see whether in benchmark publications released when seasonal factors are updated, or in the current monthly releases? These questions cannot be adequately answered without comment from the data using community.

OBJECTIVES OF SEASONAL ADJUSTMENT AND SEASONAL ANALYSIS

The removal of seasonality from economic time series has become so commonplace that the rationale and objectives of the exercise are sometimes forgotten. Seasonally adjusted numbers are accepted by almost everyone without question until the results become controversial, are difficult to explain in terms of other economic phenomena or distort the econometrician's model.

As stated before, in its simplest form, seasonality refers to regular periodic fluctuations which recur every year with about the same timing and with the same intensity and which, most importantly, can be measured and removed from the time series under review. Added to this are those portions of the irregular component which can be measured and also removed. In other words, one attempts to remove as much of the fluctuation which obscures the trend-cycle component of the series. To date this is what most seasonal adjustment techniques attempt to do and what we, at the Bureau, have been attempting to accomplish in publishing seasonally adjusted data. The objectives that are desirable and necessary in providing seasonally adjusted data include, among others–

- The development of techniques which permit an accurate measurement of the seasonal component or, as a minimum, permit the measurement of the amount of over-or-under adjustment of a series.
- The establishment of statistically objective models to determine which of the many alternative approaches should be used rather than by selection based on intuitive judgment.
- The establishment of statistically measurable criteria for determining the goodness of fit of the selected model.
- The establishment of techniques which will adjust terminal observations with more reliability and not necessarily from the utilization of one model and thus minimize revisions.
- The development of techniques which will permit the publication of sampling errors for seasonally adjusted as well as unadjusted numbers.

- The development of techniques which will assume sum preservation to the maximum extent possible.
- And, as a related objective, the measurement of the systematic effects which otherwise would be confounded with the irregular component, such as trading-day and calendar-month variation, to preserve the properties of the trend-cycle components to the maximum extent possible.

There is, however, another aspect to the problems of seasonal adjustment, relating to the broader question of seasonal analysis. Should not seasonality itself be studied? If one is forecasting a monthly time series, for example, one attempts to include the seasonal component in the estimate. What is the impact of seasonality on various econometric models? How can seasonality be specified or should seasonally adjusted data be used?

To date, our seasonally adjusted series reflect the methodology related to seasonal adjustment techniques. Perhaps some of our problems will be solved if we broaden the seasonal adjustment area to encompass the analysis of seasonality. This, of course, poses even more difficult problems than the ones associated with seasonal adjustment. Taking the latter approach, one must be concerned with the casual factors of seasonality for a particular series as well as the interrelationships which exist among various related time series. For example, should the series on manufacturers' sales and unfilled orders be adjusted independently without consideration of the interdependence of the two time series? Economic concepts and subject matter knowledge must be brought to bear on the problem.

Ideally, one would want to build a model for each time series which could explain its seasonal component historically as well as permit accurate projections for the future. The ideal, however, may not be very practical due to the pragmatic need to seasonally adjust thousands of time series.

This, then, is the theme of the conference for the next 2 days. The early sessions will discuss seasonal adjustment procedures currently in use, special problems relating to this technique, and suggestions for improvement. Later sessions are concerned with seasonality as related to econometric modeling and time-series analysis. These discussions will, I hope, provide some practical improvements in present methodology as well as serve as a stimulus for further research. Perhaps, our most important objective is the removal of uncertainty in our seasonally adjusted numbers.

REFERENCES

1. Brunsman, H. G. *Simplified Procedure in Statistical Analysis of Time Series.* Columbus: The Ohio State University Press, 1930.
2. Falkner, H. D. "The Measurement of Seasonal Variation." *Journal of the American Statistical Association* 19 (June 1924) : 167–179.
3. Lovell, M. C. "Seasonal Adjustment of Economic Time Series and Multiple Regression Analysis." *Journal of the American Statistical Association* 58 (December 1963) : 993–1010.
4. Reeder, C. B. "The Seasonal Adjustment Program: Problems and Application From the Users' Point of View," *Business Economics,* September 1969.
5. Shor, M. "Exploratory Work in Measurement of the Effect of Weather Factors in Retail Sales." Paper presented at the 1963 Annual Meeting of the American Statistical Association.
6. Stephenson, J. A., and Farr, H. T. "Seasonal Adjustment of Economic Data Applications of the General Linear Statistical Model. *Journal of the American Statistical Association* 67 (March 1972) : 37–45.
7. U.S. Department of Commerce, Bureau of the Census. *Estimating Trading-Day Variation in Monthly Economic Time Series,* by A. Young. Technical Paper 12. Washington, D.C.: Government Printing Office, 1965.
8. ———. *The Spectral Analysis of Economic Time Series,* by H. Rosenblatt. Working Paper 14. Washington, D.C.: Government Printing Office, 1963.
9. ———. *Spectral Analysis and Parametric Methods for Seasonal Adjustment of Economic Time Series,* by H. Rosenblatt. Working Paper 23. Washington, D.C.: Government Printing Office, 1965.
10. U.S. Department of State, Office of European Community and Atlantic Political-Economic Affairs (OECD). *Seasonal Adjustment on Electronic Computers.* Washington, D.C.: Government Printing Office, 1962.

APPENDIX

A BRIEF DESCRIPTION OF THE CENSUS METHOD II SEASONAL ADJUSTMENT PROCEDURE

The adjustment procedure known as the X–11 Variant of the Census Method II [1] uses a ratio-to-moving average approach to decompose the original time series O_i in the following manner:

$$O_i = C_i S_i TD_i H_i I_i, \text{ where} \tag{1}$$

C_i = the trend-cycle or long-term underlying value of the series

S_i = the pure seasonal factor including the length-of-month adjustment

TD_i = the trading-day adjustment factor

H_i = the holiday adjustment factor

I_i = the irregular or unexplained component

The X–11 procedure is iterative. As each factor of O_i is isolated and removed from O_i, the remaining factors are recomputed. This procedure continues until each factor is isolated. Such a refinement process sharpens the seasonal estimates considerably.

In compact form, the steps are as follows:

1. Compute H_i.

   Thus $\dfrac{O_i}{H_i} = C_i S_i TD_i I_i$

2. Compute TD_i.

   Thus $\dfrac{O_i}{TD_i H_i} = C_i S_i I_i$

3. Compute S_i.

   Thus $\dfrac{O_i}{TD_i H_i S_i} = C_i I_i$

This is referred to as seasonally adjusted data.

The first estimate of C_i, the trend-cycle, is computed using a 2-term average of a 12-term moving average (chronologically) of O_i. This removes the primary long-term trend

$$\frac{O_i}{C_i} = S_i TD_i H_i I_i \tag{2}$$

[1] For a complete description of the Census Bureau's seasonal adjustment procedure, see *Technical Paper 15* (rev.), U.S. Department of Commerce, Bureau of the Census. "The X–11 Variant of the Census Method II Seasonal Adjustment Program," by J. Shiskin, A. H. Young, and J. C. Musgrave (1967).

Of the four components on the right hand of step (2), only one, S_i, can be immediately isolated. This is accomplished by taking a moving average of the values in (2) separately for each month. We then obtain a series

$$\frac{O_i}{C_i S_i} = TD_i H_i I_i \tag{3}$$

As we currently cannot discern the three components, we refer to them as I'_i, the variation currently unexplained. The first table of the printout, labeled "D-13 Final Irregular Series," is a table of I'_i values. It should be noted that the U.S. total retail sales series shown in the accompanying tables, 1966–1975, is a shortened series for purposes of illustration. Actual series used for adjustment purposes includes data from a longer historical period.

Using the I'_i, H_i is then computed. This factor is for holidays which affect more than 1 month. For retail sales, they are: Easter, Labor Day, and Thanksgiving-Christmas. These factors are shown in table A-2, following the original series shown in A-1.

The O_i are then modified by the H_i. To this series a preliminary trading day adjustment is made. The prior trading-day factors are shown in table A-4. Normally, the prior trading-day factors are computed from daily weights last calculated as being statistically significant when compared to previous suppositions. The resulting data set is in table B-1—the prior adjusted original series.

After computing the C_i from the B-1 series, we can compute

$$\frac{O_i}{C_i H_i TD'_i} = S_i I_i \tag{4}$$

where TD'_i is the assumed trading-day factor.

Next, these SI ratios are used to compute an estimate of I_i. This measure of unexplained variation is used to detect outlies and a modification of approximate extreme SI ratios occurs. Finally, an estimate of S_i is made from the modified SI ratios. A seasonally adjusted series follows, with a new C_i derived therefrom.

Since the seasonally adjusted series may be written as

$$\frac{O_t}{S_t H_t TD'_t} = C_t I_t \qquad (5)$$

there is no need to remove seasonality from the data used to compute the trend estimate. A weighted moving average of the series in (5) is therefore used, with the moving average length determined by various statistics which measure the stability of the series. The three option lengths are 9, 13, and 23 term. The trend estimates are modified for the outlier effects previously noted. Unmodified *SI* ratios (table D-8) and modified areas (D-9) are computed as a result.

The sudden jump from the B to D table series indicates that three iterations of the same procedures occur. An exception is the computation of final trading-day factors, which is done at step C-15. Using the most recent estimates of I_t, we use the technique of linear multiple regression analysis. A test determines if residual trading-day variation exists (recall that the assumed trading-day variation was removed previously). In retail trade, new TD_t are used only if the residual trading-day variation is significant. To avoid spurious correlation influencing computations, certain extreme irregular values are excluded from the computation of residual trading-day variation (see C-14). If new TD_t are used, they are shown in table C-18.

A moving average of table D-9 *SI* ratios is used to compute final seasonal factors (D-10). Next, a combined adjustment factor, CAF_t, is computed, where

$$CAF_t = S_t TD_t H_t \qquad (6)$$

so that the final seasonally adjusted series (D-11) is

$$\frac{O_t}{CAF_t} = C_t I_t \qquad (7)$$

Computations shown in the tables are not consistent due to rounding performed for printing purposes.

The final trend-cycle estimates are obtained from (7) as they were from (5). A final irregular series (D-13) indicates the unexplained variation I_t after all adjustments to the series are made.

The remaining tables are analytical tools for the components of the series. Table E-5 shows the month/month percent change in the original series, while table E-6 shows these changes in the final seasonally adjusted series (D-11). Table F-2 is the so-called summary measures table, giving various measures of adjustment quality. The single most important statistic in F-2 is the months for cyclical dominance (MCD), located about three-fourths of the way down the table. The MCD indicates the minimum period over which the average absolute change can be attributed to cyclical change rather than unexplained fluctuations.

A few other details peculiar to the adjustment of retail trade series are in order. First, the length of moving average of *SI* ratios used to compute final seasonal factors is varied by month. This is done to detect moving seasonality present in some months. This selection is made on the basis of table D-9A moving seasonality ratios. Page 16 of *Technical Paper 15* gives more details as to the selection of seasonal moving average curves.

Sigma limits used to determine outliers are modified occasionally in order to prevent moving seasonality from being discarded as an outlier.

Table A-1—THE X-11 SEASONAL ADJUSTMENT PROGRAM OF THE BUREAU OF THE CENSUS

THE X-11 PROGRAM IS DIVIDED INTO SEVEN MAJOR PARTS-

PART	DESCRIPTION
A.	PRIOR ADJUSTMENTS, IF ANY
B.	PRELIMINARY ESTIMATES OF IRREGULAR COMPONENT WEIGHTS AND REGRESSION TRADING DAY FACTORS
C.	FINAL ESTIMATES OF ABOVE
D.	FINAL ESTIMATES OF SEASONAL, TREND-CYCLE AND IRREGULAR COMPONENTS
E.	ANALYTICAL TABLES
F.	SUMMARY MEASURES
G.	CHARTS

TABLES ARE IDENTIFIED BY THEIR PART LETTER AND SEQUENCE WITHIN THE PART. A GIVEN TABLE HAS THE SAME IDENTIFICATION IN THE STANDARD, LONG AND FULL PRINTOUTS. THE SAME NUMBER IS GIVEN TO CORRESPONDING TABLES IN PARTS B, C AND D. THUS, TABLES B10., C10. AND D10. ARE ALL TABLES OF SEASONAL FACTORS. WHERE NO CORRESPONDING TABLE EXISTS THE SEQUENCE NO. IS NOT USED IN THE PART. THUS, B8. AND D8. ARE TABLES OF UNMODIFIED SI RATIOS BUT THERE IS NO C8.

THIS SERIES RUN
SERIES TITLE- RETAIL SALES   U.S. TOTAL, ALL STORES
PERIOD COVERED- 1/66 TO 12/75

TYPE OF RUN - MULTIPLICATIVE SEASONAL ADJUSTMENT
STANDARD PRINTOUT.   NO CHARTS.
PRIOR TRADING DAY ADJUSTMENT WITH   LENGTH OF MONTH ADJUSTMENT.
TRADING DAY REGRESSION COMPUTED STARTING 1973 EXCLUDING IRREGULAR VALUES OUTSIDE 2.5-SIGMA LIMITS.
TRADING DAY REGRESSION ESTIMATES APPLIED STARTING 1966 IF SIGNIFICANT.
SIGMA LIMITS FOR GRADUATING EXTREME VALUES ARE 1.5 AND 2.5
MOVING AVERAGES FOR SEASONAL FACTOR CURVES- J F M A M J J A S O N D
3X3

OADIDO 1/66 - 12/75 MULTIPLICATIVE SEASONAL ADJUSTMENT STANDARD PRINTOUT

	COMBINED WEIGHT	PRIOR WEIGHT	REGRESSION COEFF.	ST.ERROR (COMB.WT.)	T (1)	T (PRIOR WT.)
MONDAY	.989	.914	.075	.044	-.244	1.728
TUESDAY	1.007	1.048	-.042	.042	.155	-.981
WEDNESDAY	.941	.963	-.022	.046	-1.271	-.474
THURSDAY	1.078	1.054	.023	.048	1.616	.487
FRIDAY	1.479	1.347	.132	.044	10.871*	2.990**
SATURDAY	1.043	1.294	-.251	.046	.927	-5.405**
SUNDAY	.463	.379	.084	.047	-11.479*	1.801

* COMBINED WT. SIGNIFICANTLY DIFFERENT FROM 1 AT 1 PER CENT LEVEL
** COMBINED WT. SIGNIFICANTLY DIFFERENT FROM PRIOR WEIGHT AT 1 PER CENT LEVEL

SOURCE OF VARIANCE	SUM OF SQUARES	DGRS.OF FREEDOM	MEAN SQUARE	F
REGRESSION	.584	6.	.097	5.752***
ERROR	.998	59.	.017	
TOTAL	1.582	65.		

*** RESIDUAL TRADING DAY VARIATION PRESENT AT THE 1 PER CENT LEVEL

STANDARD ERRORS OF TRADING DAY ADJUSTMENT FACTORS DERIVED FROM REGRESSION COEFFICIENTS

31-DAY MONTHS-	.14
30-DAY MONTHS-	.13
29-DAY MONTHS-	.14
28-DAY MONTHS-	.00

STABLE SEASONALITY TEST

	SUM OF SQUARES	DGRS.OF FREEDOM	MEAN SQUARE	F
BETWEEN MONTHS	5891.984	11	535.635	522.187**
RESIDUAL	110.781	108	1.026	
TOTAL	6002.766	119		

**STABLE SEASONALITY PRESENT AT THE 1 PER CENT LEVEL

RETAIL SALES   U.S. TOTAL, ALL STORES

D13. FINAL IRREGULAR SERIES

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	S.D.
1966	100.2	99.5	100.6	101.3	97.9	99.8	100.0	100.2	99.1	100.6	99.9	100.4	.8
1967	99.7	98.6	100.1	99.9	99.8	100.4	100.2	99.3	100.8	98.1	99.8	100.6	.8
1968	99.7	100.0	100.1	100.3	99.6	100.2	99.9	100.3	98.6	99.9	100.3	99.3	.5
1969	100.2	100.4	99.7	99.9	100.4	99.8	98.8	100.0	100.1	99.9	100.0	100.3	.4
1970	100.0	100.0	100.0	99.6	100.3	100.1	99.8	100.3	100.2	99.5	97.4	100.4	.8
1971	100.1	99.9	99.8	100.8	99.7	100.2	98.5	99.2	100.6	99.8	100.8	100.1	.6
1972	99.7	98.8	101.8	99.8	100.5	99.9	100.0	100.2	99.4	100.6	99.7	99.9	.7
1973	100.1	100.0	100.3	100.1	99.8	99.8	100.1	99.6	100.4	100.0	100.0	100.4	.2
1974	99.8	99.4	100.2	100.4	99.7	100.0	100.2	102.9	100.1	100.0	98.2	99.4	1.0
1975	100.1	100.6	99.6	97.0	100.4	99.7	100.2	101.0	99.5	99.8	100.2	102.5	1.2
S.D.	.2	.7	.6	1.1	.7	.2	.6	1.1	.7	.7	1.0	.9	

TABLE TOTAL- 11993.4   MEAN- 99.9   STD. DEVIATION- .8

S.E. 2.515
120
A 99.762 B .039 W 19. X 90.000 XSQ 622.000 Y 1895.801 KY 7983.064
S.E. 2.280
106
A 100.453 B -.131 W 19. X 68.000 XSQ 518.000 Y 1901.342 KY 6797.245

Table A-1—THE X-11 SEASONAL ADJUSTMENT PROGRAM OF THE BUREAU OF THE CENSUS—Continued

RETAIL SALES U.S. TOTAL, ALL STORES

A 1. ORIGINAL SERIES

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1966	22014.	21195.	24736.	25526.	24800.	26011.	25322.	25399.	24918.	26012.	26339.	32237.	304510.
1967	22519.	21504.	25733.	25134.	26630.	27710.	26020.	26271.	26314.	26268.	27362.	32953.	314518.
1968	24087.	24253.	27132.	27708.	29431.	29358.	28746.	29651.	27257.	29701.	30414.	34448.	341891.
1969	26523.	25168.	28325.	29220.	31322.	30155.	29585.	30000.	29168.	31282.	30460.	36675.	357888.
1970	27559.	26109.	29466.	30462.	32217.	32356.	32133.	31376.	30856.	32898.	31193.	38724.	375447.
1971	28865.	27932.	32105.	33965.	34199.	35033.	34560.	33840.	34102.	35659.	36018.	42572.	408850.
1972	30504.	30987.	36220.	35389.	38166.	38730.	36961.	37994.	37522.	39014.	39790.	47004.	448379.
1973	35768.	34977.	41310.	40586.	43178.	43585.	41665.	43135.	40917.	43721.	44544.	49824.	503311.
1974	37923.	36668.	42709.	44200.	47033.	45609.	46034.	48444.	43800.	46758.	46351.	52253.	537782.
1975	41315.	39802.	44937.	45896.	51236.	49052.	50026.	50663.	48275.	52046.	50526.	60681.	584423.
AVGE	29728.	28873.	33268.	33819.	35818.	35730.	35135.	35677.	34313.	36336.	36300.	42737.	

TABLE TOTAL- 4176999. MEAN- 34808. STD. DEVIATION- 8453.

RETAIL SALES U.S. TOTAL, ALL STORES

A 2. PRIOR MONTHLY ADJUSTMENT FACTORS

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVGE
1966	100.000	100.000	100.025	99.975	100.000	100.000	100.000	99.927	100.073	100.000	99.768	100.232	100.000
1967	100.000	100.000	100.042	99.958	100.000	100.000	100.000	100.028	99.972	100.000	99.760	100.240	100.000
1968	100.000	100.000	99.989	100.011	100.000	100.000	100.000	100.231	99.769	100.000	99.803	100.197	100.000
1969	100.000	100.000	100.350	99.650	100.000	100.000	100.000	100.332	99.668	100.000	99.795	100.205	100.000
1970	100.000	100.000	100.042	99.958	100.000	100.000	100.000	99.724	100.276	100.000	99.786	100.214	100.000
1971	100.000	100.000	99.944	100.056	100.000	100.000	100.000	99.825	100.175	100.000	99.777	100.223	100.000
1972	100.000	100.000	100.140	99.860	100.000	100.000	100.000	100.028	99.972	100.000	99.760	100.240	100.000
1973	100.000	100.000	100.115	99.885	100.000	100.000	100.000	100.129	99.871	100.000	99.751	100.249	100.000
1974	100.000	100.000	99.989	100.011	100.000	100.000	100.000	100.231	99.769	100.000	99.803	100.197	100.000
1975	100.000	100.000	100.042	99.958	100.000	100.000	100.000	100.332	99.668	100.000	99.795	100.205	100.000
AVGE	100.000	100.000	100.068	99.932	100.000	100.000	100.000	100.079	99.921	100.000	99.780	100.220	

TABLE TOTAL- 11999.998 MEAN- 100.000 STD. DEVIATION- .143

A2A. PRIOR FACTORS, ONE YEAR AHEAD

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVGE
1976	100.000	100.000	100.115	99.885	100.000	100.000	100.000	99.825	100.175	100.000	99.777	100.223	100.000

RETAIL SALES U.S. TOTAL, ALL STORES

A 4. PRIOR TRADING DAY ADJUSTMENT FACTORS

A4A. PRIOR DAILY WEIGHTS

MON	TUE	WED	THUR	FRI	SAT	SUN
.914	1.048	.963	1.056	1.347	1.294	.379

A4B. PRIOR TRADING DAY ADJUSTMENT FACTORS WITH LENGTH OF MONTH ADJUSTMENT

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVGE
1966	100.5	92.0	102.1	100.7	99.7	98.6	101.9	101.6	99.9	100.5	98.6	104.1	100.0
1967	99.7	92.0	103.0	97.5	101.6	99.9	100.5	102.1	100.7	99.7	98.6	101.9	99.8
1968	101.6	95.5	101.9	98.4	103.0	97.5	101.6	104.1	96.2	102.1	100.7	99.7	100.2
1969	103.0	92.0	100.5	98.6	104.1	96.2	102.1	101.9	98.4	103.0	97.5	101.6	99.9
1970	104.1	92.0	99.7	98.6	101.9	98.4	103.0	100.5	98.6	104.1	96.2	102.1	99.9
1971	101.9	92.0	101.6	99.9	100.5	98.6	104.1	99.7	98.6	101.9	98.4	103.0	100.0
1972	100.5	95.4	103.0	97.5	101.6	99.9	100.5	102.1	100.7	99.7	98.6	101.9	100.1
1973	101.6	92.0	104.1	96.2	102.1	100.7	99.7	103.0	97.5	101.6	99.9	100.5	99.9
1974	102.1	92.0	101.9	98.4	103.0	97.5	101.6	104.1	96.2	102.1	100.7	99.7	99.9
1975	103.0	92.0	100.5	98.6	104.1	96.2	102.1	101.9	98.4	103.0	97.5	101.6	99.9
AVGE	101.8	92.7	101.8	98.4	102.2	98.4	101.7	102.1	98.5	101.8	98.7	101.6	

TABLE TOTAL- 11997.0

A4C. PRIOR TRADING DAY ADJUSTMENT FACTORS, ONE YEAR AHEAD

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVGE
1976	104.1	93.2	101.6	99.9	100.5	98.6	104.1	99.7	98.6	101.9	98.4	103.0	100.3

RETAIL SALES U.S. TOTAL, ALL STORES

B 1. PRIOR ADJUSTED ORIGINAL SERIES

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1966	21906.	23041.	24230.	25363.	24879.	26375.	24846.	25017.	24929.	25885.	26775.	30886.	304131.
1967	22590.	23485.	24962.	25792.	26210.	27743.	25593.	25733.	26146.	26351.	27812.	32256.	314973.
1968	23707.	25413.	26625.	28144.	28561.	29806.	28292.	28409.	28387.	29101.	30271.	34489.	341206.
1969	25739.	27359.	28091.	29739.	30079.	31334.	28988.	29339.	29729.	30357.	31309.	36022.	358086.
1970	26561.	28382.	29547.	30901.	31612.	32867.	31183.	31309.	31208.	31592.	32481.	37860.	375504.
1971	28323.	30364.	31616.	33986.	34031.	35531.	33188.	34007.	34519.	34989.	36671.	41222.	408446.
1972	30454.	32469.	35101.	36351.	37562.	38775.	36780.	37216.	37283.	39138.	40444.	46010.	447583.
1973	35204.	38022.	39625.	42324.	42335.	43295.	41797.	41806.	42025.	43031.	44708.	49457.	503600.
1974	37156.	39863.	41911.	44896.	45643.	46784.	45308.	46414.	45616.	45813.	46133.	52316.	537850.
1975	40394.	43267.	44698.	46567.	49172.	50968.	49015.	49547.	49204.	50508.	51934.	59601.	584574.
AVGE	29173.	31165.	32641.	34406.	35005.	36348.	34529.	34879.	34905.	35676.	36854.	42012.	

TABLE TOTAL- 4175953. MEAN- 34803. STD. DEVIATION- 8312.

Table A-1—THE X-11 SEASONAL ADJUSTMENT PROGRAM OF THE BUREAU OF THE CENSUS—Continued

RETAIL SALES U.S. TOTAL, ALL STORES

C16. EXTREME IRREGULAR VALUES EXCLUDED FROM TRADING DAY REGRESSION
(OUTSIDE 2.5-SIGMA LIMIT)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVGE
1970	*******	*******	*******	*******	*******	*******	*******	*******	*******	*******	98.2	*******	********
1971	*******	*******	*******	*******	*******	*******	98.3	*******	*******	*******	*******	*******	********
1972	*******	*******	102.2	*******	*******	*******	*******	*******	*******	*******	*******	*******	********
1973	*******	*******	*******	*******	*******	*******	*******	*******	*******	*******	*******	*******	********
1974	*******	*******	*******	*******	*******	*******	*******	102.4	*******	*******	98.0	*******	********
1975	*******	*******	*******	97.1	*******	*******	*******	*******	*******	*******	*******	102.1	********

RETAIL SALES U.S. TOTAL, ALL STORES

C15. FINAL TRADING DAY REGRESSION

	COMBINED WEIGHT	PRIOR WEIGHT	REGRESSION COEFF.	ST.ERROR (COMB.WT.)	T (1)	T (PRIOR WT.)
MONDAY	1.002	.914	.388	.041	.052	2.144
TUESDAY	1.006	1.048	-.342	.040	.150	-1.055
WEDNESDAY	.930	.963	-.033	.044	-1.599	-.754
THURSDAY	1.083	1.054	.029	.045	1.827	.630
FRIDAY	1.469	1.367	.122	.042	11.289*	2.933**
SATURDAY	1.043	1.294	-.251	.044	.978	-5.737**
SUNDAY	.467	.379	.388	.044	-12.086*	1.995

* COMBINED WT. SIGNIFICANTLY DIFFERENT FROM 1 AT 1 PER CENT LEVEL
** COMBINED WT. SIGNIFICANTLY DIFFERENT FROM PRIOR WEIGHT AT 1 PER CENT LEVEL

SOURCE OF VARIANCE	SUM OF SQUARES	DGRS.OF FREEDOM	MEAN SQUARE	F
REGRESSION	.594	6.	.099	6.580***
ERROR	.888	59.	.015	
TOTAL	1.482	65.		

*** RESIDUAL TRADING DAY VARIATION PRESENT AT THE 1 PER CENT LEVEL

STANDARD ERRORS OF TRADING DAY ADJUSTMENT FACTORS DERIVED FROM REGRESSION COEFFICIENTS

31-DAY MONTHS-	.13
30-DAY MONTHS-	.12
29-DAY MONTHS-	.13
28-DAY MONTHS-	.00

RETAIL SALES U.S. TOTAL, ALL STORES

C18. TRADING-DAY ADJUSTMENT FACTORS FROM COMBINED DAILY WEIGHTS

C18A. COMBINED DAILY WEIGHTS

MON	TUE	WED	THUR	FRI	SAT	SUN
1.002	1.006	.930	1.083	1.469	1.043	.467

C18B. COMBINED TRADING-DAY ADJUSTMENT FACTORS WITH LENGTH OF MONTH ADJUSTMENT

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVGE
1966	100.2	92.0	101.9	100.2	100.1	98.6	101.8	101.6	100.4	100.2	98.4	103.8	99.9
1967	100.1	92.0	103.4	97.0	101.6	100.4	100.2	101.9	100.2	100.1	98.6	101.8	99.8
1968	101.6	95.5	101.8	98.6	103.4	97.0	101.6	103.8	96.8	101.9	100.2	100.1	100.2
1969	103.4	92.0	100.2	98.4	103.8	96.8	101.9	101.8	98.6	103.4	97.0	101.6	99.9
1970	103.8	92.0	100.1	98.6	101.8	98.6	103.4	100.2	98.4	103.8	96.8	101.9	100.0
1971	101.8	92.0	101.6	100.4	100.2	98.6	103.8	100.1	98.6	101.8	98.6	103.4	100.1
1972	100.2	95.3	103.4	97.0	101.6	100.4	100.2	101.9	100.2	100.1	98.6	101.8	100.1
1973	101.6	92.0	103.8	96.8	101.9	100.2	100.1	103.4	97.0	101.6	100.4	100.2	99.9
1974	101.9	92.0	101.8	98.6	103.4	97.0	101.6	103.8	96.8	101.9	100.2	100.1	99.9
1975	103.4	92.0	100.2	98.4	103.8	96.8	101.9	101.8	98.6	103.4	97.0	101.6	99.9

TABLE TOTAL- 11996.5

C18C. COMBINED TRADING-DAY ADJUSTMENT FACTORS, ONE YEAR AHEAD

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVGE
1976	103.8	93.5	101.6	100.4	100.2	98.4	103.8	100.1	98.6	101.8	98.6	103.4	100.4

RETAIL SALES U.S. TOTAL, ALL STORES

C19. ADJUSTED* ORIGINAL SERIES
*ADJUSTED BY...PRIOR MONTHLY ADJUSTMENT FACTORS
*ADJUSTED BY...TRADING-DAY ADJUSTMENT FACTORS FROM COMBINED DAILY WEIGHTS

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1966	21960.	23041.	24266.	25470.	24769.	26379.	24879.	25006.	24807.	25948.	26842.	30985.	304354.
1967	22491.	23485.	24869.	25935.	26199.	27605.	25956.	25771.	26257.	26236.	27816.	32299.	314921.
1968	23697.	23383.	26661.	28101.	28455.	29971.	28281.	28499.	28218.	29144.	30400.	34338.	341153.
1969	25643.	27359.	28160.	29814.	30175.	31147.	29031.	29378.	29684.	30244.	31482.	36007.	358125.
1970	26646.	28382.	29417.	30906.	31654.	32817.	31067.	31386.	31286.	31693.	32287.	37917.	375458.
1971	28361.	30364.	31603.	33819.	34115.	35623.	33294.	33857.	34524.	35036.	36615.	41068.	408276.
1972	30529.	32515.	34970.	36552.	37546.	38585.	36871.	37271.	37441.	38966.	40450.	46372.	447770.
1973	35189.	38322.	39751.	42071.	42369.	43483.	41613.	41650.	42258.	43013.	44488.	49579.	503483.
1974	37212.	39563.	41967.	44527.	45473.	47045.	45289.	46563.	45344.	45882.	46329.	52086.	537874.
1975	39964.	43267.	44808.	46684.	49329.	53664.	49088.	49613.	49129.	50319.	52221.	59576.	584643.
AVGE	29167.	31163.	32647.	34418.	35009.	36331.	34537.	34900.	[illegible]	35648.	36893.	41993.	

TABLE TOTAL- 4176055. MEAN- 34800. STD. DEVIATION- 8310.

Table A-1—THE X-11 SEASONAL ADJUSTMENT PROGRAM OF THE BUREAU OF THE CENSUS--Continued

RETAIL SALES U.S. TOTAL, ALL STORES

D11. FINAL SEASONALLY ADJUSTED SERIES

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1966	25253.	25043.	25280.	25456.	24579.	25075.	25227.	25450.	25229.	25557.	25822.	26016.	304288.
1967	25528.	25697.	25913.	25871.	25977.	26235.	26310.	26193.	26723.	26137.	26773.	27205.	316663.
1968	27219.	27553.	27824.	28014.	28156.	28503.	28566.	28904.	28624.	29031.	29272.	29082.	340843.
1969	29484.	29637.	29439.	29681.	29785.	29641.	29417.	29759.	30072.	30163.	30315.	30606.	358002.
1970	30528.	30583.	30778.	30723.	31149.	31281.	31456.	31781.	31619.	31599.	31161.	32383.	375217.
1971	32629.	32523.	33035.	33562.	33527.	33972.	33631.	34242.	34875.	34889.	35339.	35262.	407769.
1972	35188.	35152.	36552.	36173.	36863.	36879.	37185.	37614.	37798.	38781.	39084.	39546.	447113.
1973	40605.	41101.	41495.	41580.	41501.	41586.	41533.	41956.	42578.	42733.	42932.	43169.	503070.
1974	43024.	43135.	43798.	44267.	44464.	44995.	45491.	44797.	45718.	43522.	44782.	45461.	537435.
1975	46192.	46321.	46794.	46063.	48223.	48533.	49261.	49852.	49520.	49985.	50431.	52053.	583712.
AVGE	33605.	33744.	34091.	34135.	34422.	34671.	34545.	35255.	35276.	35470.	35589.	36109.	

TABLE TOTAL- 4172111. MEAN- 34768. STD. DEVIATION- 7736.

RETAIL SALES U.S. TOTAL, ALL STORES

D12. FINAL TREND CYCLE - HENDERSON CURVE

9-TERM MOVING AVERAGE SELECTED. I/C RATIO IS .76

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1966	25194.	25173.	25149.	25117.	25102.	25129.	25215.	25374.	25561.	25742.	25863.	25908.	304531.
1967	25595.	25557.	25853.	25927.	26033.	26142.	26255.	26356.	26480.	26650.	26858.	27074.	315383.
1968	27304.	27542.	27771.	27998.	28240.	28460.	28548.	28807.	28922.	29013.	29135.	29273.	341114.
1969	29399.	29507.	29604.	29661.	29673.	29591.	29735.	29824.	29989.	30189.	30375.	30530.	358176.
1970	30626.	30685.	30753.	30871.	31064.	31297.	31492.	31591.	31644.	31755.	31967.	32260.	376006.
1971	32589.	32575.	33130.	33397.	33653.	33893.	34136.	34408.	34706.	34953.	35122.	35226.	408087.
1972	35336.	35555.	35886.	36270.	36634.	36925.	37210.	37568.	37990.	38555.	39202.	39893.	447006.
1973	40554.	41073.	41407.	41537.	41565.	41631.	41809.	42099.	42439.	42741.	42922.	43004.	302789.
1974	43111.	43343.	43697.	44149.	44617.	45034.	45365.	45582.	45613.	45535.	45552.	45752.	537351.
1975	46093.	46525.	46984.	47464.	48037.	48659.	49174.	49513.	49781.	50076.	50429.	50810.	583546.
AVGE	33610.	33816.	34024.	34239.	34462.	34655.	34904.	35110.	35313.	35521.	35762.	35973.	

TABLE TOTAL- 4173989. MEAN- 34783. STD. DEVIATION- 7705.

RETAIL SALES U.S. TOTAL, ALL STORES

F 2. SUMMARY MEASURES

AVERAGE PER CENT CHANGE WITHOUT REGARD TO SIGN OVER INDICATED SPAN

SPAN IN MONTHS	A1 O	D11 CI	D13 I	D12 C	D10 S	A2 P	C18 TD*	F1 MCD	E1 MOD.O	E2 MOD.CI	E3 MOD.I
1	7.37	1.05	.83	.63	5.51	.16	4.20	.76	7.15	.80	.51
2	9.49	1.52	.80	1.21	7.97	.14	3.19	1.42	9.50	1.31	.48
3	10.57	2.08	.70	1.82	9.24	.14	3.15	1.99	10.56	1.88	.37
4	10.37	2.62	.72	2.43	8.86	.14	3.62	2.56	10.32	2.47	.46
5	9.44	3.17	.68	3.35	7.63	.13	2.64	3.11	9.23	3.09	.41
6	10.03	3.76	.68	3.73	6.07	.16	4.10	3.73	9.81	3.71	.41
7	11.03	4.37	.71	4.34	7.55	.14	3.02	4.37	10.96	4.34	.43
9	12.55	5.63	.67	5.61	9.64	.14	2.96	5.62	12.55	5.63	.44
11	10.73	6.91	.63	6.89	6.49	.16	4.14	6.89	10.54	6.90	.37
12	7.63	7.55	.78	7.53	.13	.06	1.32	7.54	7.56	7.54	.48

RELATIVE CONTRIBUTIONS OF COMPONENTS TO VARIANCE IN ORIGINAL SERIES

SPAN IN MONTHS	D13 I	D12 C	D10 S	A2 P	C18 TD*	TOTAL	RATIO (X100)
1	1.29	.74	61.93	.35	36.01	100.00	90.36
2	.84	1.94	83.81	.33	13.35	100.00	84.18
3	.49	3.34	86.16	.32	9.99	100.00	88.75
4	.54	6.05	80.04	.02	13.35	100.00	91.08
5	.61	12.35	77.80	.32	9.21	100.00	85.12
6	.53	20.16	54.34	.04	24.73	100.00	67.77
7	.53	21.95	66.78	.02	10.67	100.00	69.82
9	.34	23.58	69.52	.01	6.55	100.00	84.70
11	.37	44.29	39.30	.02	16.02	100.00	92.94
12	1.05	95.99	.03	.01	2.94	100.00	102.25

AVERAGE DURATION OF RUN

CI	I	C	MCD
2.59	1.53	19.85	4.72

I/C RATIO FOR MONTHS SPAN

1	2	3	4	5	6	7	8	9	10	11	12
1.32	.66	.38	.33	.22	.18	.16	.14	.12	.11	.09	.10

MONTHS FOR CYCLICAL DOMINANCE 2

AVERAGE PER CENT CHANGE WITH REGARD TO SIGN AND STANDARD DEVIATION OVER INDICATED SPAN

SPAN	A1		D13		D12		D10		D11		F1	
IN	O		I		C		S		CI		MCD	
MONTHS	AVGE	S.D.	AVGE	S.D.	AVGE	S.D.	AVGE	S.D.	AVGE	S.D.	AVGE	S.D.
1	1.43	10.45	.02	1.09	.59	.39	.65	8.63	.62	1.21	.61	.72
2	2.39	12.12	.03	1.13	1.19	.75	.87	10.08	1.22	1.45	1.21	1.18
3	3.38	12.96	.02	1.09	1.80	1.38	.98	10.95	1.83	1.71	1.82	1.46
4	3.53	12.71	.01	1.02	2.42	1.37	.90	10.47	2.43	1.91	2.44	1.67
5	4.16	11.69	.03	.93	3.06	1.51	.85	10.06	3.09	2.04	3.09	1.85
6	4.77	11.41	.03	.99	3.70	1.82	.61	7.68	3.73	2.22	3.73	2.03
7	5.45	11.61	.03	1.02	4.34	2.01	.84	9.53	4.37	2.40	4.37	2.24
9	7.33	13.83	.02	.94	5.61	2.38	1.08	11.45	5.63	2.67	5.62	2.52
11	7.35	13.50	.02	.93	6.89	2.74	.85	11.36	6.91	3.02	6.89	2.89
12	7.57	3.81	.02	1.07	7.53	2.90	.01	.18	7.55	3.25	7.54	3.07

Table A-1—THE X-11 SEASONAL ADJUSTMENT PROGRAM OF THE BUREAU OF THE CENSUS—Continued

RETAIL SALES U.S. TOTAL, ALL STORES

D13. FINAL IRREGULAR SERIES

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	S.D.
1966	100.2	99.5	100.5	101.3	97.9	99.8	100.0	100.3	98.7	100.4	99.8	100.4	.9
1967	99.7	98.6	100.2	99.8	99.8	100.4	100.2	99.4	100.9	98.1	99.7	100.5	.8
1968	99.7	100.0	100.2	100.1	99.7	100.1	100.1	100.3	99.0	100.1	100.5	99.3	.4
1969	100.3	100.4	99.4	100.1	100.4	99.8	98.9	99.8	100.3	99.9	99.8	100.3	.4
1970	100.0	100.0	100.1	99.5	100.3	99.9	99.9	100.6	99.9	99.5	97.4	100.4	.8
1971	100.1	99.8	99.7	100.4	99.6	100.2	98.5	99.5	100.5	99.8	100.6	100.1	.5
1972	99.6	98.9	101.9	99.7	100.6	99.9	99.9	100.2	99.5	100.6	99.7	99.9	.7
1973	100.1	100.1	100.2	100.1	99.8	99.9	100.1	99.7	100.3	100.0	100.0	100.4	.2
1974	99.8	99.5	100.2	100.2	99.7	99.9	100.5	102.7	100.2	100.0	98.3	99.4	1.0
1975	100.2	100.6	99.6	97.0	100.4	99.8	100.1	100.7	99.5	99.8	100.0	102.4	1.2
S.D.	.2	.7	.7	1.1	.7	.2	.6	.9	.7	.7	1.0	.9	

TABLE TOTAL- 11992.6 MEAN- 99.9 STD. DEVIATION- .7

1966	100.1	100.1
1967	100.0	100.0
1968	100.3	100.3
1969	100.0	100.0
1970	100.1	100.1
1971	100.3	100.3
1972	100.3	100.3
1973	100.0	100.0
1974	100.1	100.1
1975	100.1	100.1

RETAIL SALES U.S. TOTAL, ALL STORES

E 5. MONTH-TO-MONTH CHANGES IN ORIGINAL SERIES

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVGE
1966	********	-3.7	16.7	3.2	-2.8	4.9	-2.6	.3	-1.9	4.4	1.3	22.4	3.8
1967	-30.1	-4.1	19.1	-2.3	6.0	4.1	-6.1	1.0	.2	-.2	4.2	20.4	1.0
1968	-26.9	.7	11.8	2.1	6.2	-1.3	-1.1	3.1	-8.1	9.0	2.4	13.3	.9
1969	-23.0	-5.1	12.6	3.1	7.2	-3.7	-1.9	1.4	-2.8	7.2	-2.6	20.4	1.1
1970	-24.6	-5.6	12.9	3.4	5.8	.4	-.7	-2.4	-1.7	6.6	-5.2	24.1	1.1
1971	-25.5	-3.2	14.9	5.8	.7	2.4	-1.4	-2.1	.8	4.6	1.0	18.2	1.4
1972	-28.1	1.3	16.9	-2.3	7.8	1.5	-4.6	2.8	-1.2	4.0	2.0	18.1	1.5
1973	-23.9	-2.2	18.1	-1.5	6.1	.9	-4.4	3.5	-5.1	6.9	1.9	11.9	1.0
1974	-23.9	-3.3	16.5	3.5	6.4	-3.0	.9	5.2	-9.6	6.8	-.9	12.7	.9
1975	-20.9	-3.7	12.9	2.1	11.6	-4.2	2.0	1.3	-4.7	7.8	-2.9	20.1	1.8
AVGE	-25.2	-2.9	15.2	1.7	5.5	.2	-2.0	1.4	-3.4	5.7	.1	18.2	

TABLE TOTAL- 170.6

RETAIL SALES U.S. TOTAL, ALL STORES

E 6. MONTH-TO-MONTH CHANGES IN FINAL SEASONALLY ADJUSTED SERIES (D11.)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVGE
1966	********	-.8	.9	.7	-3.4	2.0	.6	.9	-.9	2.5	-.1	.8	.3
1967	-.7	-1.3	1.6	-.2	.4	1.0	.3	-.4	2.0	-2.2	2.4	1.6	.4
1968	.0	1.2	1.0	.7	.5	1.2	.6	.8	-1.0	1.4	.8	-.6	.6
1969	1.4	.5	-.7	.8	.4	-.5	-.8	1.2	1.1	.3	.5	1.0	.4
1970	.1	.2	.3	-.2	1.4	.4	.6	1.0	-.5	-.1	-1.4	4.0	.5
1971	.8	.6	.7	1.5	-.0	1.3	-1.0	1.8	1.8	.0	1.3	-.2	.7
1972	-.2	-.1	4.0	-1.0	1.9	.0	.8	1.2	.5	2.6	.8	1.9	1.0
1973	1.0	1.2	1.0	.2	-.2	.2	.6	.3	1.5	.4	.5	.6	.7
1974	-.3	.3	1.5	1.0	.5	1.2	1.1	2.9	-2.3	-.4	-1.6	1.5	.4
1975	1.6	1.4	-.1	-1.6	4.7	.7	1.4	1.2	-.7	.9	.9	3.2	1.1
AVGE	.5	.3	1.0	.2	.6	.8	.4	1.1	.2	.5	.4	1.4	

TABLE TOTAL- 73.4

RETAIL SALES U.S. TOTAL, ALL STORES

D20. FINAL COMBINED FACTORS
(SEASONALS COMBINED WITH FINAL TRADING-DAY AND/OR PRIOR HOLIDAY FACTORS) 311

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVGE
1966	87.2	84.6	97.8	100.3	100.9	105.7	100.4	99.8	98.8	100.6	102.0	123.9	100.0
1967	87.2	84.7	99.3	97.2	102.5	105.6	98.9	100.3	98.5	100.5	102.2	121.1	99.8
1968	88.5	85.1	97.5	98.9	104.5	101.9	100.3	102.6	95.2	102.3	103.9	118.5	100.2
1969	90.0	84.9	96.2	98.4	105.1	101.7	100.6	100.8	97.0	103.7	100.5	119.8	99.9
1970	90.3	85.1	95.7	99.1	103.4	103.4	102.2	98.7	97.6	104.1	100.2	119.6	100.0
1971	88.5	85.1	97.2	101.3	102.0	103.1	102.8	95.8	97.8	102.2	101.9	120.7	100.1
1972	87.0	88.2	99.1	97.8	103.5	105.0	99.4	101.0	99.3	100.6	101.8	118.0	100.1
1973	88.1	85.1	99.6	97.8	104.0	104.8	99.6	102.8	96.1	102.3	103.8	115.4	100.0
1974	88.1	85.0	97.5	99.9	105.8	101.4	101.2	103.5	95.8	102.7	103.5	114.9	99.9
1975	89.4	85.0	96.0	99.6	106.2	101.1	101.6	101.6	97.5	104.1	100.2	116.6	99.9

TABLE TOTAL- 11998.3 MEAN- 100.0 STD. DEVIATION- 8.0

D20A. COMBINED FACTORS, ONE YEAR AHEAD

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVGE
1976	89.8	86.4	97.4	101.6	102.5	102.7	103.5	99.4	98.0	102.5	101.7	118.6	100.3

Table A-1—THE X-11 SEASONAL ADJUSTMENT PROGRAM OF THE BUREAU OF THE CENSUS—Continued

RETAIL SALES   U.S. TOTAL, ALL STORES

D 8. FINAL UNMODIFIED SI RATIOS

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVGE
1966	87.2	91.5	96.5	101.4	99.7	104.9	98.6	98.4	97.0	100.9	103.9	119.7	99.9
1967	86.9	90.8	96.1	100.0	100.6	105.5	98.5	97.7	99.1	98.5	103.7	119.4	99.8
1968	86.8	92.2	95.9	100.3	100.7	105.3	98.7	98.9	97.5	100.4	104.4	117.4	99.9
1969	87.3	92.8	95.2	100.5	101.7	104.9	97.6	98.5	99.0	100.2	103.7	118.0	99.9
1970	87.0	92.5	95.6	100.1	101.9	104.9	98.7	99.3	98.8	99.7	101.0	117.6	99.8
1971	87.1	92.5	95.5	101.3	101.4	105.0	97.4	98.3	99.4	100.2	104.3	116.6	99.9
1972	86.4	91.5	97.5	100.9	102.5	104.4	99.0	99.1	98.5	101.0	103.2	115.5	100.0
1973	86.8	92.7	96.1	101.4	101.9	104.4	99.4	98.9	99.6	100.7	103.6	115.2	100.1
1974	86.2	91.9	96.0	101.6	102.0	104.6	99.9	102.3	99.5	100.8	101.6	113.6	100.0
1975	86.4	92.8	95.3	99.4	102.9	104.3	100.0	100.3	98.8	100.5	103.5	117.2	100.0
AVGE	86.8	92.1	96.0	100.6	101.4	104.8	98.8	99.2	98.7	100.3	103.3	117.0	

TABLE TOTAL- 11990.3

STABLE SEASONALITY TEST

	SUM OF SQUARES	DGRS.OF FREEDOM	MEAN SQUARE	F
BETWEEN MONTHS	5823.156	11	529.378	528.384**
RESIDUAL	108.203	108	1.002	
TOTAL	5931.359	119		

**STABLE SEASONALITY PRESENT AT THE 1 PER CENT LEVEL

RETAIL SALES   U.S. TOTAL, ALL STORES

D 9. FINAL REPLACEMENT VALUES FOR EXTREME SI RATIOS

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVGE
1966	*******	*******	*******	100.0	100.8	*******	*******	*******	97.8	*******	*******	*******	********
1967	*******	91.9	*******	*******	*******	*******	*******	97.8	98.7	100.3	*******	*******	********
1968	*******	*******	*******	*******	*******	*******	*******	*******	98.0	*******	*******	*******	********
1969	*******	*******	*******	*******	*******	*******	98.6	*******	*******	*******	*******	*******	********
1970	*******	*******	*******	*******	*******	*******	*******	*******	*******	*******	103.4	*******	********
1971	*******	*******	*******	*******	*******	*******	98.8	99.3	*******	*******	103.9	*******	********
1972	*******	92.5	95.8	*******	*******	*******	*******	*******	98.5	*******	*******	*******	********
1973	*******	*******	*******	*******	*******	*******	*******	*******	*******	*******	*******	*******	********
1974	*******	*******	*******	*******	*******	*******	*******	99.6	*******	*******	103.3	113.8	********
1975	*******	*******	*******	101.1	102.9	*******	*******	100.2	*******	*******	*******	114.8	********

D 9A. YEAR TO YEAR CHANGE IN IRREGULAR AND SEASONAL COMPONENTS AND MOVING SEASONALITY RATIO

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
I	.425	.406	.380	.370	.446	.262	.149	.759	.731	.362	.425	.611
S	.076	.072	.065	.126	.161	.082	.113	.128	.104	.067	.056	.383
RATIO	5.62	5.57	5.89	2.93	2.77	3.19	1.31	5.92	7.03	5.43	7.56	1.59

RETAIL SALES   U.S. TOTAL, ALL STORES

D10. FINAL SEASONAL FACTORS

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVGE
1966	87.0	92.0	96.0	100.1	100.8	105.2	98.5	98.3	98.3	100.4	103.9	119.1	100.0
1967	87.1	92.1	96.0	100.2	100.9	105.2	98.7	98.4	98.3	100.4	103.9	118.7	100.0
1968	87.1	92.2	95.8	100.3	101.1	105.1	98.7	98.6	98.6	100.4	103.9	118.1	100.0
1969	87.0	92.3	95.7	100.4	101.3	105.1	98.7	98.7	98.7	100.3	103.8	117.7	100.0
1970	87.0	92.5	95.6	100.6	101.6	104.9	98.8	98.8	98.9	100.3	103.7	117.1	100.0
1971	86.9	92.5	95.7	100.8	101.8	104.8	99.0	98.9	99.0	100.4	103.6	116.5	100.0
1972	86.8	92.5	95.7	101.0	101.9	104.6	99.2	99.1	99.1	100.5	103.5	115.6	100.0
1973	86.7	92.5	95.8	101.2	102.1	104.6	99.5	99.3	99.2	100.7	103.6	114.9	100.0
1974	86.5	92.6	95.8	101.3	102.3	104.5	99.6	99.5	99.2	100.8	103.5	114.6	100.0
1975	86.5	92.6	95.8	101.3	102.3	104.4	99.7	99.5	99.2	100.7	103.5	114.5	100.0

TABLE TOTAL- 11997.8   MEAN- 100.0   STD. DEVIATION- 6.9

D10A. SEASONAL FACTORS, ONE YEAR AHEAD

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVGE
1976	86.5	92.6	95.8	101.3	102.3	104.4	99.7	99.5	99.2	100.7	103.4	114.4	100.0

COMMENTS ON "AN OVERVIEW OF THE OBJECTIVES AND FRAMEWORK OF SEASONAL ADJUSTMENT" BY SHIRLEY KALLEK

Gary Fromm
National Bureau of Economic Research
and
Stanford Research Institute

INTRODUCTION

The paper by Shirley Kallek provides an informative and useful, though abbreviated, summary of the history of seasonal adjustment at the Bureau of the Census and some of the problems encountered in application of its techniques. The use of the Census X–11 program in the United States has mushroomed, until today it is utilized for virtually all seasonally adjusted series published by the Federal government and also is widely applied in the private sector. As such, its procedures deserve careful scrutiny to determine whether they are the best available or whether improvements are in order in light of new developments in statistical theory and methodology, in the structure and functioning of the processes generating the data being adjusted and analyzed, and in difficulties experienced when the standard tools are applied. Certainly, recent events with seasonally adjusted unemployment statistics, as well as past observations of negative serial correlation in initial reports of these figures, gives little reason to be complacent with X–11 and leads to the suspicion that at least certain aspects of this routine require fundamental modification.

Before turning to the specific problems raised in Kallek's paper, some general considerations should be borne in mind. To begin with, it should be emphasized that the total variation in a series is of interest and not just that part which remains after removal of so-called seasonality. The wife of a construction worker who goes to the supermarket in the winter when food prices seasonally are high does not have the option of paying a seasonally adjusted lower price with a seasonally adjusted higher income. Her behavior and purchases largely will be conditioned by the prices she actually confronts and by the money in her purse and relatively much less by actual last or next summer's expected prices and income. By the same token, it does not help workers seeking jobs to tell them that seasonally adjusted they are employed.

Clearly, expectations about possible future events influence behavior and decisions of economic agents to make purchases, extend credit, undertake production, and so forth. Those expectations to a degree depend on extensions of past regularities of seasonal fluctuations. But, uncertainty about the seasonal often may be as great, if not greater, than uncertainty about the trend, cycle, or other systematic influences and can have substantial impacts on the actions of the agents. This should be taken into account in analyzing observed events and data.

It should be remembered that the separation of the total variation of a time series into seasonal and other components is done to permit identification of underlying patterns and causal relationships and to lower the possibility of being misled by spurious correlations resulting from systematic and independent seasonal influences. Seasonal components, however, cannot be observed directly and their removal is, to a large extent, arbitrary. One can remove too much or too little, thereby creating additional observation noise or error. This can lead to biased and inconsistent estimates of parameters of equations and models, and to incorrect prescriptions for business and government policies.

An alternative procedure is to allow for interactions between seasonal and other components by specifying models that simultaneously account for the total variation of sets of series. As part of this process, seasonal patterns would be allowed for by a combination of systematic deterministic and stochastic factors. Weather, trading days, holidays, model-year introduction dates, standard shutdown periods, and other institutional constraints on within-year activity patterns would be included among the deterministic elements. While the explanatory power of the latter may be low, it is better to account for them explicitly rather than by mechanical smoothing of unadjusted data, as is the case where ARIMA methods solely are used.

In X–11, first, outlier due to strikes or other (sometimes unknown) causes are replaced in the nonadjusted data by smoothing across the periods of discontinuity (these may include periods of build-up and catch-up). A preliminary trend cycle next is computed (via a 2-term average of a 12-term moving average in the case of monthly data) and removed from the strike-adjusted original data. Thus, initial seasonal factors are calculated and applied to the trend-cycle adjusted data. The newly computed series is used to compute holiday-adjustment factors. These are then applied to the original outlier-adjusted series and another modified series is calculated. This modified series is adjusted for trading days to obtain a prior adjusted original series. The trend cycle is calculated once again and removed from the latter, leaving a series of seasonal-irregular (SI) ratios. These are utilized to obtain an estimate of the irregular or unexplained variation, which is employed to detect outliers and modify a-proximate extreme SI ratios. Finally, an estimate of seasonal factors is made from the modified SI ratios. These are combined with the trading-day and holiday factors to obtain final adjustment factors; these then are applied to the original data (including observations affected by strikes) to obtain the final adjusted series.

It is clear that the X–11 procedure is both complex and arbitrary. Analysts applying the routine have many options for smoothing the data at each stage and easily may make inappropriate choices. When not overridden, standard values for options are preset. These default conditions, which often are used routinely, may be valid for many series, but not for others. Another troublesome aspect of X–11 is the iterative sequential nature of the procedure. Too much or too little variance may be removed at each stage of the adjustment process. The prefilter steps with the goal "as much irregularity is removed before computing the trend-cycle estimate" may be particularly egregious. Step-wise variance reduction which ignores covariances may be as fallacious in X–11 as it is in regression procedures wherein variables are selected and parameters are estimated seriatim.

Another weakness of X–11 is that seasonal adjustment assumes that underlying data are generated either by a multiplicative or an additive process. That is, using Kallek's notation–

$O = S \times C \times TD \times I$ Multiplicative

or

$O = S + C + TD + I$ Additive

where

O = original series

S = seasonal component

C = trend-cycle component

TD = trading-day component

I = irregular and other (holiday, strikes, etc.) components

In theory, there is little reason why the true generating process should take either of these forms. It could just as well be a combination of linear and additive or be of a more complex nonlinear type. The Census Bureau has found that the multicaptive model seems to be superior to the additive model when judged by variances of seasonal and irregular components. However, even with only this criterion, it is likely that a combined linear-additive model would yield superior results.

AGGREGATION

Turning now to particular problems, that of aggregation has a number of different aspects. A question often raised is whether it is better to adjust aggregates of series directly for seasonality or to adjust each of the components and derive the seasonally adjusted total by addition (weighted as appropriate in the case of price and other indexes). With a nonlinear seasonal adjustment procedure such as X–11, only by happenstance will direct seasonal adjustment of total series yield the same answer as unconstrained combination of seasonally adjusted components. From the standpoint of interpretation and to limit public misunderstanding of seasonally adjusted data. combinations of components and aggregates should be constrained to be consistent.

There are two aspects here. First, there are technical aggregation conditions. These pertain to series with unrelated, independent components. For instance, seasonally adjusted housing starts by region should sum to aggregate U.S. total starts. While there may be some interaction in starts activity between regions, in the short run (within one year) these largely are independent and the imposition of a sum preservation constraint is unlikely to cause appreciable distortion in within-year and interregional patterns of seasonally adjusted data. The problem can be stated as—seasonally adjust each of a set of series x_i and their sum, $y = \Sigma x_i$ such that the sum of the seasonally adjusted components equals the seasonally adjusted sum $y^s = \Sigma x^s_i$. The current Census procedure is to either sum the seasonally adjusted components and treat this as the seasonally adjusted aggregate or separately to seasonally adjust components and the unadjusted aggregate. The latter method easily may yield positive or negative residuals between the sum of adjusted components and the adjusted aggregate. Joint estimation constraining these residuals to zero would seem preferable. The effect of imposing this constraint would be to produce summary measures of irregulars and seasonally adjusted data with variances that lie between those of totals directly adjusted and those obtained from summing adjusted components.

In some quarters, including the Census Bureau, great store appears to be placed on minimizing average month-to-month changes in seasonal adjustment factors and in estimated irregular components of the data. However, there appears to be little basis in theory why this criterion should yield seasonally adjusted data which correspond more nearly to true values of such data than criteria which, in essence, do not entail variance minimization. The analogy of ordinary least squares (OLS) and simultaneous equation estimation here is applicable. While an OLS estimator may have minimum variance, in many cases it may be biased and inconsistent.

Emphasis on the part of users of X–11 in lowering month-to-month variances perhaps is understandable in light of the characteristic of that routine to produce monthly seasonal factors which exhibit negative serial correlation properties. The desire to reduce such correlation is reasonable in light of inertial and adjustment lags which underlie most economic processes. Such lags, in the absence of institutional characteristics such as holidays, vacation shutdowns, model changeovers, and so forth, generally would cause seasonal factors to change smoothly from period to period rather than in zig-zag patterns. However, X–11 users who seek to reduce this difficulty in the selection of aggregation alternatives may be causing other problems in their seasonal adjustment of data.

Similar considerations pertain to the second aspect of aggregation, that of casual interactions and identities which relate sets of economic time series. Kallek cites the case of shipments, new orders, and unfilled orders in which the Census Bureau obtains seasonally adjusted new orders as the sum of seasonally adjusted shipments and the difference in the stocks of seasonally adjusted unfilled orders. Again, as above, all three series can be adjusted simultaneously subject to the constraint that an identity be satisfied exactly. Another data set which could be so treated is that for shipments, production, and inventories. Because shipments appear in both sets of data, different seasonal adjustment factors could be obtained if they were calculated separately. Therefore, all five series probably should be adjusted simultaneously, subject to both identities.

It is true that there is a danger that with use of this procedure that distortions could be caused in the seasonally adjusted data leading to biases and inconsistency in estimated behavioral characteristics and other relationships utilizing these data. Nevertheless, this risk may be less than that of applying the assumption now inbedded in X–11 that seasonals are stochastically and deterministically independent in economic time series that otherwise are interrelated.

TRADING-DAY FACTORS

Blind adherence to independence assumptions can cause spurious and erroneous adjustments in a variety of other areas. Kallek gives a few examples in the case of trading-day factors, which in X–11 are assumed to be independent of when a day occurs in a month. To the extent that there is knowledge of intramonth or quarter patterns of activity, such information should be used in making trading-day adjustments. These adjustments also might be varied by taking account of patterns of within-year movement. Again, it should be clear that there may be significant advantages to procedures which simultaneously, rather than sequentially, adjust for trading-day and seasonal variation. In so doing, allowances should be made for discontinuities in coefficients, as would occur when there are substantial shifts in institutional characteristics such as relaxation or elimination of legally prescribed nontrading days. Bayesian approaches to this problem may be helpful.

TERMINAL PERIODS AND PROJECTED FACTORS

Another area where application of more advanced techniques could be highly beneficial is that of obtaining seasonal factors for terminal periods and for periods beyond those for which actual observations are available. The X–11 routine uses centered moving averages of data in the allocation of variances to different components of original series. Thus, at endpoints, extrapolations of data are needed to carry the moving averages to the limit of actual observations. Currently, X–11 uses naive projections of the initial and last few years of data at the terminal dates for this purpose. Thus, estimates of seasonal factors in the last few years beyond the initial observation and prior to the final observation of a series are subject to extreme variability arising from undue weight accorded the data in that same interval. Tables of X–11 seasonal factors for farm machinery and internal combustion engines presented by Kallek amply illustrate the instability in seasonals arising from use of this naive method. To some degree this is due to the treatment of extreme values which may or may not be removed from the calculations. But, the patterns revealed in Kallek's tables are too consistent to assign primary responsibility for the instability to this source. For instance, in the case of farm machinery, January-April seasonal factors calculated with data five years beyond dates during 1966–71, with the exception of data for one month, all are lower and for some other months all are higher than those initially estimated.

The answer to reducing the severity of endpoint problems probably lies in more systematic and longer-term extrapolation of observed data using ARIMA techniques. ARIMA projections for 5 years beyond the sample period could be prepared annually and used in the calculation not only of past seasonal factors, but of seasonal factors for a year ahead. This would obviate the need for direct projection of seasonal factors, or use of factors from the preceding year or an average of the past 2 years, as the basis for seasonal adjustment of current data.

Nevertheless, while use of ARIMA methods may be beneficial, it is no panacea. ARIMA coefficients and extrapolations can be highly sensitive to extreme and endpoint values, to the degrees of assumed polynomials, and to the length of time period over which the estimates are made. Experimentation is necessary to determine the variability of endpoint and extrapolated seasonal factors as the ARIMA equations change when their parameters are altered (as a consequence of shifts in time periods and degrees of polynomials).

STRIKES AND EXTREME OBSERVATION PROBLEMS

Adjustments for strikes and other extreme observations are troublesome because the number of data points available to prepare statistically reliable estimates are few or nonexistant. A number of alternatives could be employed either to modify or replace the extremes. Classical methods for replacing missing observations are one possibility.

Another is to infer normal values for the observations by use of behavioral or ARIMA models. These could be used in the calculation of seasonal factors and to obtain normal values of seasonally adjusted observations during and immediately before and after the observed extremes. The normal values could then be deseasonalized and subtracted from the observed values. The difference, when added to the normal observation would then yield an estimate of the seasonally adjusted observation including an allowance for strikes, other extremes, and irregular elements.

CONCLUDING COMMENTS

In closing her paper, Kallek correctly emphasizes the need to reexamine the rationale and objectives of seasonal adjustment. She states that "one attempts to remove as much of the fluctuation (of seasonal and irregular components) which obscures the trend-cycle component of a series." Also, it is the objective "to preserve the properties of the trend-cycle components to the maximum extent possible." I believe these objectives, when followed, would tend to yield estimates of seasonally adjusted data that both mislead the public and policymakers and cause difficulties for modelbuilders in constructing systems of equations that are unbiased and consistent. If an unobserved seasonal component of a series is to be removed, it should be the minimum due to systematic calendar (natural and institutional) influences and not the maximum which best displays a moving-average trend cycle. The primary objective of seasonal adjustment should not be to uncover an unobserved trend cycle, but, rather, to facilitate the estimation of structural and behavioral models and to enhance the likelihood of improved public and private decisionmaking. Seasonal adjustment and analysis should be viewed as an integral, and not prior, step in these processes. This may not be easy to attain in the short-run, but continuing efforts should be devoted to those goals. Notwithstanding, my demurrer on this point, I found Kallek's paper provocative, and she is to be thanked for a valuable contribution to this conference.

COMMENTS ON "AN OVERVIEW OF THE OBJECTIVES AND FRAMEWORK OF SEASONAL ADJUSTMENT" BY SHIRLEY KALLEK

Lawrence R. Klein
University of Pennsylvania

SOME CONCEPTUAL PROBLEMS

In an economy with seasonal movements that are as large relative to other movements as they are in the United States, it is important to do as well as possible in isolating seasonal factors. Shirley Kallek's paper, indeed this whole conference, makes a significant contribution to our understanding of the issues.

Let us begin by taking up the statement of concepts and goals. Kallek says, ". . . seasonality refers to regular periodic fluctuations which recur every year with about the same timing and with the same intensity and which, most importantly, can be measured and removed from the time series under review."

This is an acceptable statement, as far as I am concerned, but she continues by stating, "added to this are those portions of the irregular component which can be measured and also removed. In other words, one attempts to remove as much of the fluctuation which obscures the trend-cycle component of the series." The same idea is expressed more directly, where she states, "our basic goal is to produce an adjusted series which will most clearly show the trend cycle. . ."

A related point of view can be found in Julius Shiskin's statement in *IESS*, "The objective of economic time series analysis is to separate underlying systematic movements in such series from irregular fluctuations."

I take seasonal movements to be one of those systematic movements, but I think that official statisticians should stick very closely to the objective of measuring seasonals—not to try to isolate trend cycles. It is important to eliminate the standard seasonal component from published time series, and that is what the official statistician should try to do. We are having trouble with our seasonals because they are doing more—either inadvertently or by intent.

I would go along with adjustments for Easter, trading days, and similar calendar effects. I would strongly oppose any adjustments to raw data for strikes, natural disasters, or general nonrepetitive events.

I find it hard to determine precisely what Kallek's view is about the treatment of strikes, but the following comments in her paper seem to me to go beyond seasonal measurement and adjustment:

"Prior modifications are made for trading-day and calendar-month variations, holidays, and strikes.

"While all phases of the adjustment process provide opportunities for modifying extreme values, the modification for strikes is unique since it alone directly modifies seasonally adjusted data."

"However, some series, such as the steel industry historically have had periods of prestrike increase buying followed by either a strike or heavily reduced demand, both with the same statistical result. . . . Not only is this a problem in historical identification of seasonality, but it also presents a problem in the presentation of seasonally adjusted data during the build-up period when normal seasonal patterns fail to operate."

Strikes or natural disturbances are things that confound the economic analysis of time series, but they are not seasonally related and should not be touched when the data are being adjusted for seasonal variations. Perhaps if the seasonals were not viewed as always changing such disturbances would not pose a seasonal identification problem. Strikes like trends and cycles are part of the economic process and should not be isolated unless we want strike-adjusted data. It is my view that we are concerned primarily with seasonally adjusted and not strike-adjusted data; therefore, I believe that the present problem is being approached from the wrong viewpoint.

Trend adjustments, like seasonal adjustment, would be appropriate by official statisticians provided they were made by generally approved methods and done on a uniform basis across series, but the concepts of the cycle and the random component are so much under debate, requiring such sophisticated measurement techniques that I think that it is highly inappropriate for official data preparation agencies to try to release regular statistical series that reflect particular points of view about the way the economy is structured. It is entirely appropriate for research institutes and academic centers to try to distill the trend cycle or to measure cycles and random components of economic time series, but such measures should not be permitted to cloud the regular publication of official statistics. That is not to say that government statisticians and economists should refrain from making special studies to investigate the various components of economic time series, but the regularly published economic series should be adjusted only for seasonal variation, strictly conceived.

SOME PROBLEMS OF MEASUREMENT

There are three particular problems that are either explicit or implicit in Kallek's paper.

1. The iterative application of X–11–.
2. Changing seasonals.
3. Treatment of identities.

The main content of X–11 is to use the time-honored "ratio-to-moving-average" method of computing seasonal adjustment factors. This is an attractive method because of its simplicity and intuitive appeal. The objectionable feature is the provision for iteration. After the ratios by months (weeks, quarters) are averaged across years, with proper allowance for extremes and drift, there is a provision for repeating the operations and iterating. The series that are iterated undoubtedly contain some error components. The iteration of moving averages of error is well known to be a method of generating cyclical movements; thus, there is a danger of cyclical movements being introduced by the repeated application of steps in X–11.

Series should be adjusted for trading days, moving averages computed, ratios-to-moving-average formed, and averages of ratios obtained. The procedure should then cease. Further manipulation of data can be dangerous and introduce spurious movements.

There is every reason to believe that seasonal patterns change over time and that the change is gradual. These ideas would seem to be entirely compatible with Kallek's and the prevailing view. But I do not think that seasonal factors should be successively reevaluated every week, month, quarter, or year. Are seasonal factors simply economic variables, or are they parameters? I take the latter view. Parameters do undergo structural change; so I would not want to see them estimated and fixed forever, but I deplore the all too frequent changing of seasonal patterns. We do not rebase index numbers every year; we do it every five, ten, or twenty years, and the same attitude should be applied to seasonals.

In pure time series analysis of many of our main statistical series, we have long observation periods over many past seasons. We should have good statistical estimates of the relevant seasonal factors, and there is no need to argue that every new observation gives us an opportunity to improve our seasonal estimate.

Shiskin wrote in *IESS* about the economic situation in spring, 1961, "The question was whether the recent improvements were larger or smaller than normal seasonal changes. In forecasting the pattern in the months ahead, it was crucial to know whether the economy had entered a new cyclical phase. . ." Consider now, the spring of 1975, where we had exactly the same kind of problem, and business-cycle students were all watching carefully the monthly unemployment statistics for a clue about a new cyclical phase in a much worse business situation than prevailed in 1961.

After seasonal adjustment, it was announced that the unemployment rate fell from 9.2 percent (May) to 8.6 percent (June)—an unusually large drop in this important statistic, signalling, in part, a new cyclical phase. Now, any close student of the economy knew that the announced figure was wrong. Unemployment could not have fallen by that amount. It was totally counter-intuitive among professional observers. After the year's end, seasonals were recalculated, and the new data showed, after seasonal adjustment, a drop of only 0.2 percentage points. Given the fineness of detail that is needed to monitor the U.S. economy and recommend serious policy action, we cannot tolerate such wide swings in judgment about seasonal factors.

The prescription is simple: Estimate seasonal factors without iteration and keep them for 5 years or more. From time to time, reevaluate seasonal factors and make changes where there is clear indication that patterns have altered. Include only the pure seasonal element in the seasonal factors.

Identities (or adding-up conditions) hold for pure, raw, unadjusted data. Should they hold for seasonally adjusted data? I do not have a clear opinion on this matter. It would be nice if both adjusted and unadjusted data satisfied the same identities, but that may be asking too much. Consider, for example, unemployment (U), labor force (L), and employment (E). The identity is–

$$L = E + U$$

There is no mathematical reason for the adjusted data to satisfy this identity if all three series are independently adjusted for seasonal variation. I do not find it satisfying to adjust an arbitrary pair and derive the third, adjusted, from the identity. That is one possible approach. I would prefer an honest recognition of the problem and the publication of three separate adjusted series that do not satisfy the identity. I realize that linear additive seasonals can be made to satisfy a linear identity, but all seasonals are not of that type and all identities are not linear.

In Kallek's paper, the identity for seasonally adjusted new orders is derived as a residual. I would much prefer the procedure of first deriving the new orders series from the pure, raw, unadjusted data. The new orders series are of great cyclical importance and deserve a separate, careful seasonal adjustment. The problem is made somewhat worse by the varying, from period-to-period, of the unfilled orders seasonal factors. If they were left alone for a few years, as argued in the previous section, there would be only one seasonal correction for the change in unfilled orders. This would not solve the problem but might possibly make the nonsatisfaction of the adjusted identity somewhat less serious.

Finally, let me refer to Kallek's call for more accurate measurement of the seasonal component. I, too, want to see this objective met, but I must ask how is it possible to determine accuracy when the true seasonal component is not observable?