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AN EVALUATION OF CONCURRENT ADJUSTMENT ON CENSUS BUREAU TIME SERIES

by

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Summary: The procedure of using the most recent month's datum to produce the seasonal factor from which the seasonally adjusted estimate for that month is derived is commonly referred to as concurrent adjustment. The alternative of concurrently adjusting with Census X-11 is shown to be an improvement over the present practice of using twelve projected seasonal factors for seasonal adjustment. The improvement is on the order of 12% reduction in the root mean square error and a 20% reduction in the average absolute difference of month-to-month percentage changes. The use of the X-11 final adjustment as the definition of the target seasonal adjustment in the evaluation statistics is investigated and found to be a reasonable choice. The investigation of other-than-default X-11 options is found to be warranted in conjunction with the use of concurrent adjustment for some series.

AN EVALUATION OF CONCURRENT ADJUSTMENT ON CENSUS BUREAU TIME SERIES

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Bureau of the Census

Introduction

The development of the Census Method II X-11 seasonal adjustment in the late 1960's signified a major breakthrough in seasonal adjustment. The use of computers for seasonal adjustment made practical the seasonal adjustment of large numbers of series. Census X-11 gained widespread acceptance as a seasonal adjustment method, and is now in use throughout the world in both government and private industry.

In the intervening years since the introduction of Census X-11, a collection of improvements in seasonal adjustment procedures and possible alternatives to Census X-11 have gradually been amassed. Some of these alternatives are modifications to the usual Census X-11 procedure, and some use an entirely different approach. The purpose of this paper is to address a modification to Census X-11 that has been suggested over the years, but has only become feasible in recent years as the cost of computing has declined.

The usual practice with Census X-11 is to apply the seasonal adjustment procedure once a year to data ending in December of that year (year n). The projected seasonal factors[1/] produced by the method for the upcoming year (year n+1) are then used to seasonally adjust the data as they become available.

1/ The term "seasonal factors" will be used in its broadest sense throughout the paper, to include not only the seasonal factor alone, but the combined factor including the seasonal, trading-day and holiday effects.

This use of projected factors was initially necessary due to the operational constraints involved in seasonally adjusting many series each month, but as more computing power has become available this constraint has diminished. The use of twelve projected factors has the further advantage of promoting public confidence in the sensitive seasonally adjusted economic indicators, since the projected factors are determined ahead of the actual time they are applied. However, the production of projected seasonal factors does not take into account the most recent history of the series, as would be the case if X-11 were rerun every month as the latest datum becomes available. Then no projection would be involved; the seasonally adjusted estimate would be the result of applying the Census X-11 filters to the entire data set, including the current month. This procedure, of using the most recent month's datum to produce the seasonal factor from which the seasonally adjusted estimate for that month is derived, is commonly referred to as "concurrent adjustment"2/ . This paper examines the possible gains offered by concurrent adjustment with Census X-11 on a selected set of Census Bureau time series. The relative improvement of concurrent adjustment over the usual mode of seasonally adjusting once a year with projected factors is computed and evaluated, along with two alternative modes.

The next section presents a review of the research history which laid the foundations for this study. Following that review, the twenty-three Census time series used in the study are described in section 2. Two measures were selected to evaluate the alternative modes of using X-11, the root mean square error and a month-to-month percentage change statistic. These measures are described in section 3. The results discussed in section 4 for eighteen of the

2/ "Concurrent adjustment" is the term in use in the U.S. and Canada; "current updating" is the equivalent term in use in the U.K.

series indicate quite strongly that improvements in producing seasonally adjusted estimates are achievable with concurrent adjustment in most series. The five construction series are discussed separately in section 5. Some questions remain to be addressed in contemplating the operational implementation of concurrent adjustment with X-11, and these are discussed in the concluding section.

1. Review of Research on Concurrent Adjustment

A number of researchers and government statisticians have pursued the concept of concurrent adjustment as an improvement over the current practice of seasonally adjusting with X-11 once a year. Professor Wayne Fuller, in consultations with Census Bureau staff, expressed his belief in the mid-1960's and again in an informal report in 1978, that "the biggest potential gain in seasonal adjustment [is] in the inclusion of the current observation in the construction of the seasonal factor for that observation." [3] Fuller elaborated in the 1978 report on the statistical reasoning behind this conclusion. He considered two models based on the use of five observations; a fixed-weights seasonal model (based on Young's linear approximation to X-11 [9]), and an autoregressive prediction method of seasonal adjustment. The reduction in root mean square error of the estimated from the historical seasonal factor was at least 15%. In the situations where the postulated model is not true (i.e., in the situations most difficult to predict), Fuller suggests the gains from using the current observation are even larger. Fuller contrasted the theoretical variance of the adjusted series produced using only past data in estimation of the seasonal with that from the adjusted series produced using current data, and found the series obtained with current data had a smaller variance. Fuller's evaluation of two Bureau economic series substantiated the theoretical results, with a reduction of over half in the mean square differences between estimated and historical seasonal factors, and with a reduction of one-third in one series and over one-half in the other series in the mean square error of the month-to-month change.

Several other empirical studies have led to recommendations in favor of concurrent adjustment. Empirical work at Statistics Canada in the early 1970's led to concurrent adjustment of several series with the X-11 program. In his 1978 study of sixteen Census Bureau series, Professor John Geweke also found evidence supporting the value of concurrent adjustment [4]. Two forecasting methods, a spectral method and an autoregressive method, were used to augment the series submitted to X-11 for seasonal adjustment. With the current month's datum used in producing the current month's seasonal adjustment, there was substantial improvement over the year-ahead mode of using X-11 and X-11 augmented by the two forecasting methods. Geweke found substantial gains from concurrent X-11 augmented procedures in series with only minor problems with revisions as well as in more troublesome series. Geweke showed definitive evidence that to really improve the reliability of month-to-month changes in the current seasonally adjusted data, the most recent month's data must be utilized.

Probably the most extensive empirical study so far was conducted by Professor James Durbin, of the London School of Economics, and Peter Kenny of the Central Statistical Office, United Kingdom [5]. Their study gives substantive evidence in favor of concurrent adjustment. Kenny and Durbin studied twenty-three economic time series from the UK and found an overall reduction in root mean square error (of the initial estimate of the seasonally adjusted series from the "final", historical estimate) of around 15% when X-11 is used in a concurrent fashion. This contrasts sharply with the 6% improvement they found with the best of various forecasting procedures used in conjunction with X-11. The greatest gain seems to come from using the most current data in producing the seasonally adjusted estimate for the current month.

Further theoretical evidence of the advantages offered by concurrent adjustment is given in a 1981 paper by Dr. Estela Dagum [2]. Dagum considered the mean absolute difference between the transfer functions associated with the theoretical filters for the concurrent adjustment with X-11 versus the theoretical filter for the "final", historical adjustment. By the standards of this measure, she found the concurrent adjustment filter closer to the central, "final" filter than any of the twelve monthly forecasting filters, which suggests that more accurate estimates are achieved with concurrent adjustment than with the standard year-ahead seasonal factor adjustment. This was exactly what was observed empirically by Kenny and Durbin.

In addition to the results reported in this paper for concurrent adjustment, other statistical agencies have also been pursuing the concept of concurrent adjustment. The recommendations to the Federal Reserve Board from its Committee of Experts on Seasonal Adjustment Techniques [7, p. 2] includes a recommendation to seriously consider performing seasonal adjustment on a concurrent basis. As part of the task force effort to pursue this recommendation, a recent study by Amanda Bayer and David Wilcox [1], of two monetary series provided a favorable assessment of concurrent adjustment with X-11 for those two series. Also, the Bureau of Labor Statistics publishes each month, as one of the alternative, unofficial estimates of unemployment, the estimate based on concurrent adjustment [6, p. 223].

Other countries which follow a practice of concurrently adjusting all or some of their series include Australia, New Zealand, Canada, Portugal, and the Netherlands.

2. Description of the Data and Design of the Study

The data used in this study come from four different economic areas. Six series are from the (business) retail and wholesale trade area (BUS), six series are from the manufacturers' shipments, orders and inventories survey in industry (IND), six series are from the export statistics compiled by the foreign trade area (FTD), and five series are from the Construction Statistics Division (CSD). These series are plotted and their characteristics summarized in Appendix A.

The BUS, FTD, and IND series span the time period January, 1967 through July, 1980. The value-put-in-place series from construction runs from January 1967 through December 1979. The other four construction series were augmented by earlier data (since the longer 3x9 moving averages used require five years subsequent data for a final adjustment and the time period 1967-1979 would then have produced only twelve observations with which to evaluate the alternative modes of adjustment). These series begin in January 1960 (for permit series) or January 1964 (for housing starts series), and end in December, 1979.

The series were selected for the study by the economic statistics divisions at the U.S. Bureau of the Census. The particular series included were chosen because they were consistent in definition over the time period of study, and because they provided a variety of types of series. All but one of the series show significant seasonality, by X-11's standards, for seasonal adjustment. The exception, FTDXUJAPAN, exports of the U.S. to Japan, was included because of special concerns with the series that this study might illuminate.

The design of the study consisted of starting with a seven-year base-period of data, usually 1967-1973. Then, as each suceeding month of data was added a seasonal adjustment with Census X-11 was calculated. This simulated the effect of adjusting in concurrent mode.[3/]

In addition to the concurrent mode of adjustment, two other alternatives to the usual twelve-months-ahead projection were evaluated in this study. Six-months-ahead adjustment refers to the running of X-11 semiannually, and using the first six projected factors from X-11 to adjust the next six months of data.[4/] One-month-ahead adjustment refers to the monthly event of running X-11 at time t, but using the first projected factor from X-11 (for month t+1) to adjust the next month's datum.

For each series, the X-11 seasonal adjustment options presently in use at the Bureau were used throughout the historical period of the study. (While the use of a seven-term filter, called the "3x5 moving average"[5/], is the default in

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3/ The important caveat to mention is the use of final figures for the unadjusted data in the twenty-three series used in this study. When the actual monthly statistics are released, time delays in survey response and processing require the release of "advance" or "preliminary" unadjusted data, which is then subject to revision in the following month's release, as more respondent data is available. These preliminary unadjusted figures are seasonally adjusted by the twelve-months-ahead projected factors (the usual application of Census X-11). The results of this study are thought to be transferable to the actual seasonal adjustment situation with preliminary data, though in the latter case, the effect of revisions in the unadjusted numbers themselves will confound the single effect of whether better seasonal estimates are produced. (See section 6).

4/ A procedure very similar to the six-months-ahead mode of adjustment simulated in this study is followed in the actual seasonal adjustment of the five retail trade series in this study.

5/ A "3xn" moving average is a three-term average of an n-term average; the overall impact is of an (n+2)-term weighted average applied to the data (see [8] for details of the seasonal moving averages).

Census X-11, series can be adjusted with different lengths of seasonal moving averages. In BUS and IND series, these filter lengths are determined by the analysts for individual months. In the FTD series and four of the CSD series, the 11-term, 3x9 seasonal filter is used for all months.)

3. Comparison Statistics for Evaluating Alterations

To evaluate the relative improvement of concurrent adjustment (or any alternative mode) over the operational, twelve-months-ahead adjustment, comparisons between a first published figure and a target, or definition of truth, are needed. The definition of the true seasonal adjustment used in this study and also in the study by Kenny and Durbin, is the "final" seasonal adjustment produced by X-11 on all the data. (For instance, the seasonal adjustment produced in July, 1980 is taken to be the final adjustment for the relevant experimental periods, Jan. 1974 - July 1977, in BUS series.) A final adjustment is achieved with X-11 when sufficient data is available to use a symmetric filter for the adjustment of the center term. Allan Young noted [9] that while the true central-term adjustment requires 145 terms (seven years on each side of the point being adjusted), an approximately final adjustment (for default X-11 options) is achievable with a nearly symmetric filter obtained with only 73 terms (three years of data on each side of the point being adjusted). Thus, for the purposes of this study, the final adjustment obtained with the nearly symmetric filter of length at least 73 is taken to be the true seasonal adjustment. For series where longer seasonal moving averages are specified (FTD, CSD), the nearly symmetric filter requires more than three years of data subsequent to the month being adjusted (five years in the case of 3x9 moving averages).

The two measures used to summarize the relative improvement of alternatives to the operational, twelve-months-ahead adjustment are the root mean square error and month-to-month percentage change (defined below).

Letting x_t be the first-published seasonally adjusted estimate from any one of the modes of adjustment, X_t the final seasonally adjusted estimate, and n the number of observations, the root mean square error is defined as

$$[(1/n) \ \Sigma \ (x_t - X_t)^2]^{1/2} \ .$$

The root mean square error addresses the accuracy of estimates with regard to the level of the series. In addition, the accuracy of month-to-month movements is important. The release of important economic statistics to the public and news media is usually accompanied by a statement of month-to-month change. A relevant measure of month-to-month change is the average absolute difference of month-to-month percentage change:

$$[1/(n-1)] \ \Sigma \left| (x_{t+1} - x_t)/x_t - (X_{t+1} - X_t)/ X_t \right| .$$

It is important to assess the accuracy of estimates with regard to both the level and the month-to-month change. In this study, we are therefore interested in measuring how closely each alternative mode of adjustment reflects the final seasonally adjusted figures in terms of these two measures.

4. Results

The two measures, root mean square error (RMSE) and the average absolute difference of the month-to-month percentage change (AADM), were computed for concurrent adjustment, one-month-ahead adjustment, six-months-ahead adjustment, and the operational, twelve-months-ahead adjustment. The statistics calculated for the alternative modes of adjustment were then individually compared to the corresponding statistic for twelve-months-ahead adjustment by forming the ratio of the statistic for the alternative mode divided by that statistic for twelve-months-ahead adjustment. A ratio value less than 1.00 thus indicates that the alternative mode produces seasonally adjusted values that differ from the final to a lesser extent than the seasonally adjusted values from twelve-months-ahead adjustment. In this case, the alternative mode is an improvement over the usual practice of twelve-months-ahead adjustment. Conversely, a ratio value greater than 1.00 indicates the alternative mode does not offer improvement over the twelve-months-ahead adjustment.

The RMSE results for the eighteen BUS, FTD and IND series are summarized in Table 1. (The construction series presented particular problems and are discussed separately in section 5). The value of the ratio [RMSE (alternative mode) ÷ RMSE (twelve-months-ahead)] is given in parentheses in Table 1 for each series for alternative modes. For each series, the relative RMSE ratios were also ranked from smallest (i.e., most reduction in RMSE) to largest.

The average reduction in RMSE with concurrent adjustment over these eighteen series is 16%[6/]. The one-month-ahead and six-months-ahead adjustments provide reductions of 2% and 1% respectively.

Almost all series show a substantial reduction in RMSE with concurrent adjustment. The series RGROC does not show much difference among the four alternative modes of adjustment. The series FTDXUJAPAN shows up clearly as different from the rest of the series; the results are due to the aforementioned problem of lack of enough seasonality to warrant adjustment with X-11. With the exception of FTDXUJAPAN and FTDXU2, concurrent adjustment consistently offers the most reduction in RMSE from the usual twelve-months-ahead procedure.

The BUS series taken by themselves in Table 1 show an average reduction of 18% with concurrent adjustment, which is similar in magnitude to the 21% reduction shown with concurrent adjustment in the FTD series taken as a group. The IND series average a 13% reduction in RMSE with concurrent adjustment. The results for FTDXUJAPAN and FTDXULAR are different in magnitude from the other FTD series, with good reason. As Appendix A shows, these series have seasonality that either is insignificant or borders on being insignificant for the purposes of adjusting with Census X-11.

6/ Because these numbers are ratios, a weighted geometric mean was used to compute the average, where the weights (exponents) are w_i = (number of observations in the specific series) ÷ (total number of observations in all series).

Table 1: ROOT MEAN SQUARE ERROR OF ALTERNATIVE MODES, RELATIVE TO 12-MONTHS-AHEAD ADJUSTMENT

(Values in the table are the ratios of the RMSE statistic for the mode indicated, divided by that for 12-months-ahead; * denotes rank of mode currently in use)

Economic Area (Period of Observations)	Series	Rank and Ratio for Alternative Modes: Concurrent		1-Month-Ahead		6-Months-Ahead		12-Months-Ahead
Business--Retail and Wholesale Trade (Jan. 1974- July, 1977)	RAUTODLRS	1	(.8317)	2	(.9640)	3*	(.9789)	4
	RFURNDLRS	1	(.7248)	2	(.9452)	3*	(.9723)	4
	RGROC	1	(.9700)	4	(1.0194)	3*	(1.0069)	2
	1/ RHARDWARE	1	(.7395)	2	(.9738)	3*	(.9780)	4
	RTAUTO	1	(.8418)	2	(.9685)	3*	(.9838)	4
	WFURN	1	(.8163)	4	(1.0411)	3	(1.0152)	2*
Business Average 2/			.8169		.9848		.9891	
Foreign Trade (Jan., 1974 - July, 1975)	FTDXUCAN	1	(.7188)	2	(.9478)	4	(1.0102)	3*
	1/FTDUCARSC	1	(.6545)	4	(1.0079)	2	(.9959)	3*
	FTDXUJAPAN	2	(1.0258)	4	(1.3034)	3	(1.0721)	1*
	FTDXULAR	1	(.9072)	4	(1.0918)	3	(1.0737)	2*
	FTDXUWH	1	(.6768)	4	(1.0161)	2	(.9777)	3*
	FTDXU2	3	(.8364)	1	(.7737)	2	(.8297)	4*
Foreign Trade Average 2/			.7925		1.0111		.9896	
Industry--Shipments, Orders, Inventories (Jan. 1974 - July, 1977)	1/INS21VS	1	(.8858)	2	(.9992)	4	(1.0030)	3*
	1/INS36VS	1	(.8433)	2	(.9498)	3	(.9942)	4*
	INS46VS	1	(.8461)	3	(.9996)	2	(.9976)	4*
	1/INS63TI	1	(.9566)	2	(.9402)	3	(.9583)	4*
	INS8ØUO	1	(.8641)	3	(.9460)	2	(.9351)	4*
	INS86VS	1	(.8554)	4	(1.0139)	2	(.9940)	3*
Industry Average 2/			.8744		.9743		.9800	
OVERALL AVERAGE 3/			.8353		.9812		.9854	

1/ Adjusted multiplicatively as in practice, but needs a non-logarithmic transformation.
2/ Unweighted geometric mean.
3/ Weighted geometric mean, w_i = (number of observations in specific series) ÷ (total number of observations in all series).

The reduction in RMSE for one-month-ahead and six-months-ahead adjustment over all three groups of series is only 1-2%, not nearly as large as for concurrent adjustment (an actual increase in RMSE is noted for one-month-ahead in FTD series). On the basis of RMSE, which assesses the accuracy of the estimate of the level, the most promising of the alternatives is clearly concurrent adjustment.

The quality of month-to-month movements in the alternative modes versus that of twelve-months-ahead adjustment is summarized in Table 2. Again, the values shown in the table are the ratios [AADM (alternative mode) ÷ AADM (twelve-months-ahead)], and are ranked from most reduction to least. The overall average reduction for the AADM statistic for these eighteen series is 20% for concurrent adjustment, as opposed to no reduction for the one-month-ahead and six-months-ahead alternatives. The series RGROC again shows very little difference among all four modes. It is a series with a very stable seasonal pattern (most due to trading-day variation) and is not problematic for seasonal adjustment. With the exception of that one series, concurrent adjustment always offers the most reduction from the usual X-11 procedure, with regard to the average-absolute-difference of month-to-month percentage change. The evidence again favors concurrent adjustment as the best alternative.

For the five retail series, a fair assessment of the improvement over current practice involves similar calculations of ratios where the denominator is taken to be the value for six-months-ahead adjustment, which is

Table 2: AVERAGE ABSOLUTE DIFFERENCE OF MONTH-TO-MONTH PERCENTAGE CHANGE OF ALTERNATIVE MODES, RELATIVE TO 12-MONTHS-AHEAD ADJUSTMENT

(Values in the table are the ratios of the AADM statistic for the mode indicated, divided by that for 12-months-ahead; * denotes rank of mode currently in use.)

Economic Area (Period of Observations)	Series	Rank and Ratio for Alternative Modes: Concurrent	1-Month-Ahead	6-Months-Ahead	12-Months-Ahead
Business-Retail and Wholesale Trade (Jan., 1974 - July, 1977)	RAUTODLRS	1 (.8570)	4 (1.0609)	3* (1.0355)	2
	RFURNDLRS	1 (. 6824)	2 (.9663)	4* (1.0098)	3
	RGROC	3 (.9857)	1 (.9589)	2* (.9821)	4
	1/RHARDWARE	1 (.7634)	3 (.9492)	2* (.9477)	4
	RTAUTO	1 (.9052)	4 (1.0947)	3* (1.0394)	2
	WFURN	1 (.7683)	3 (1.0229)	4 (1.0346)	2*
Business Average 2/		.8209	1.0073	1.0076	
Foreign Trade (Jan., 1974 - July, 1975)	FTDXUCAN	1 (.4505)	2 (.8802)	3 (.9818)	4*
	1/FTDXUCARSC	1 (.6200)	2 (.9904)	3 (.9938)	4*
	FTDXUJAPAN	1 (.8646)	4 (1.1342)	3 (1.0482)	2*
	FTDXULAR	1 (.8553)	4 (1.0468)	3 (1.0283)	2*
	FTDXUWH	1 (.6003)	3 (.9765)	2 (.9720)	4*
	FTDXU2	1 (.7631)	3 (.8394)	2 (.7697)	4*
Foreign Trade Average 2/		.6750	.9730	.9608	
Manufacturer's Shipments, Orders and Inventories (Jan. 1974 - July, 1977)	1/INS21VS	1 (.9384)	2 (.9916)	4 (1.0038)	3*
	1/INS36VS	1 (.8143)	2 (.9852)	4 (1.0183)	3*
	INS46VS	1 (.8755)	3 (1.0084)	4 (1.0232)	2*
	1/INS63TI	1 (.8818)	2 (.9312)	3 (.9313)	4*
	INS8ØUO	1 (.8502)	3 (.9534)	2 (.9393)	4*
	INS86VS	1 (.7247)	4 (1.1439)	3 (1.0901)	2*
Industry Average 2/		.8448	1.0001	.9996	
OVERALL AVERAGE 3/		.8017	.9980	.9957	

1/ Adjusted multiplicatively as in practice, but needs a non-logarithmic transformation.
2/ Unweighted geometric mean.
3/ Weighted geometric mean, w_i = (number of observations in specific series) ÷ (total number of observations in all Construction series).

the present adjustment practice for retail sales series. The results in Table 3A (RMSE) and Table 3B (AADM) are similar to Tables 1 and 2. A 17% reduction in RMSE is obtained on the average, and a 17% reduction in AADM. Essentially no improvement is offered by one-month-ahead adjustment.

5. Construction Series

This section discusses the analysis of the five Construction series. Three series, CON-PRAOTH, CON-BPNE1, and CON-HSNC5, demonstrate improvement with concurrent adjustment, similar to the previous eighteen series. As section 5.1 discusses in detail, for these three series, concurrent adjustment is recommended with the presently-used options. The results for the housing starts and building permits series were not quite what was expected, based on the experience with the eighteen previous series, which led to further investigations.

First, the choice of the standard as the X-11 final adjustment as the true seasonal adjustment was evaluated with a simulated series whose characteristics were similar to that of the housing starts and building permits construction series. As discussed in section 5.2, no evidence was found to indicate that the choice of the true seasonal adjustment in these series was deficient. Secondly, section 5.3 discusses the investigation of the use of shorter moving averages with concurrent adjustment for these series, which produces an improvement in the evaluation statistics for one series, CON-HSNCI.

Table 3A: ROOT MEAN SQUARE ERROR OF ALTERNATIVE MODES, RELATIVE TO 6-MONTHS-AHEAD ADJUSTMENT

(Values in the table are ratio of the RMSE statistic for the mode indicated, divided by that for 6-months-ahead.)

Economic Area (Period of Observations)	Series	Rank and Ratio for Alternative Modes: Concurrent	1-Month-Ahead	6-Months Ahead
Retail Sales (Jan., 1974 - July, 1977)	RAUTODLRS	1 (.8497)	2 (.9847)	3
	RFURNDLRS	1 (.7455)	2 (.9722)	3
	RGROC	1 (.9634)	3 (1.0124)	2
	RHARDWARE	1 (.7561)	2 (.9956)	3
	RTAUTO	1 (.8557)	2 (.9845)	3
	Average 1/	.8304	.9898	

1/ Unweighted geometric mean

Table 3B: AVERAGE ABSOLUTE DIFFERENCE OF MONTH-TO-MONTH RATIOS OF ALTERNATIVE MODES, RELATIVE TO 6-MONTHS-AHEAD ADJUSTMENT

(Values in the table are ratio of the AADM statistic for the mode indicated, divided by that for 6-months-ahead.)

Economic Area (Period of Observations)	Series	Rank and Ratio for Alternative Modes: Concurrent	1-Month-Ahead	6-Months-Ahead
Retail Sales (Jan., 1974 - July, 1977)	RAUTODLRS	1 (.8277)	3 (1.0245)	2
	RFURNDLRS	1 (.6758)	2 (.9569)	3
	RGROC	3 (1.0037)	1 (.9763)	2
	RHARDWARE	1 (.8054)	3 (1.0015)	2
	Average 1/	.8296	1.0019	

1/ Unweighted geometric mean

5.1: Results with presently-used options

The value put-in-place series, CON-PRAOTH, was very regular and is adjusted with the default 3x5 moving averages. The evaluation statistics for CON-PRAOTH are presented in Tables 4A and 4B, which show improvement with concurrent adjustment over the twelve-months-ahead adjustment, similar to that exhibited by the previous eighteen series.

The remaining four series are presently adjusted with the optional 3x9 seasonal moving averages, requiring five years of data subsequent to the experimental observation to allow for computation of the X-11 final adjustment used as the standard for comparison. These four series are characterized by a large irregular, rapidly changing trend and changing amplitude of the seasonal (even under variance-stabilizing transformations). The large irregular can be attributed to the fact that these series are not highly aggregated (being data cross-classified by region and type of structure), and the series CON-HSNC5 has high sampling variability. The evaluation results for these four series are presented in Tables 5A and 5B, where two series, CON-BPNE1 and CON-HSNC5, show improvement with concurrent adjustment. A more detailed, year-by-year analysis is displayed in Table 6.

For the series CON-BPNC1, only one year, 1968, offered improvement in RMSE with concurrent adjustment; three years (1967, 1968, 1973) offered improvement in AADM. However, the overall average indicates concurrent adjustment is not an improvement over the twelve-months-ahead adjustment for this series. For the series CON-BPNE1, with the presently-used 3x9 moving

Table 4A: ROOT MEAN SQUARE ERROR OF ALTERNATIVE MODES, RELATIVE TO 12-MONTHS-AHEAD ADJUSTMENT

(Values in the table are the ratios of the RMSE statistic for the mode indicated divided by that for 12-months-ahead; * denotes rank of mode currently in use.)

Series (Periods of Observations)	Rank and Ratio for Alternative Modes			
	Concurrent	1-Month-Ahead	6-Months-Ahead	12-Months-Ahead
CON-PRAOTH (Jan., 1974 - Dec., 1976)	1 (.95)	(.99)	3 (.99)	4*

Table 4B: AVERAGE ABSOLUTE DIFFERENCE OF MONTH-TO-MONTH PERCENTAGE CHANGE OF ALTERNATIVE MODES, RELATIVE TO 12-MONTHS-AHEAD ADJUSTMENT

(Values in the table are the ratios of the AADM statistic for the mode indicated divided by that for 12-months-ahead; * denotes rank of mode currently in use.)

Series (Periods of Observations)	Rank and Ratio for Alternative Modes			
	Concurrent	1-Month-Ahead	6-Months-Ahead	12-Months-Ahead
CON-PRAOTH (Jan., 1974 - Dec., 1976)	1 (.86)	2 (.93)	3 (.95)	4*

Table 5A: ROOT MEAN SQUARE ERROR OF ALTERNATIVE MODES RELATIVE TO 12-MONTHS-AHEAD ADJUSTMENT

(Values in the table are the ratios of the RMSE statistic for the mode indicated divided by that for 12-months-ahead; * denotes rank of mode currently in use.)

Series (Years of Observations)	Rank and Ratio for Alternative Modes			
	Concurrent	1-Month-Ahead	6-Months-Ahead	12-Months-Ahead
CON-BPNC1 (67-74)	4 (1.14)	1 (.96)	1 (.96)	3*
CON-BPNE1 (67-74)	2 (.96)	1 (.95)	2 (.96)	4*
CON-HSNC1 (71-74)	4 (1.03)	1 (.97)	2 (1.00)	2*
CON-HSNC5 (71-74)	1 (.80)	2 (.99)	2 (.99)	4*

Table 5B: AVERAGE ABSOLUTE DIFFERENCE OF MONTH-TO-MONTH PERCENTAGE CHANGE OF ALTERNATIVE MODES, RELATIVE TO 12-MONTHS-AHEAD ADJUSTMENT

(Values in the table are the ratios of the AADM statistic for the mode indicated, divided by that for 12-months-ahead; * denotes rank of mode currently in use.)

Series (Years of Observations)	Rank and Ratio for Alternative Modes			
	Concurrent	1-Month-Ahead	6-Months-Ahead	12-Months-Ahead
CON-BPNC1 (67-74)	4 (1.08)	2 (.97)	1 (.95)	3*
CON-BPNE1 (67-74)	1 (.85)	2 (.94)	3 (.98)	4*
CON-HSNC1 (71-74)	2 (1.01)	3 (1.06)	4 (1.07)	1*
CON-HSNC5 (71-74)	1 (.75)	2 (.98)	2 (.98)	4*

Table 6: RATIO OF COMPARISON STATISTICS FOR CONCURRENT ADJUSTMENT, RELATIVE TO 12-MONTHS-AHEAD ADJUSTMENT, BY YEAR

(Table values are indicated statistic for concurrent divided by that for 12-months-ahead.)

Year	Series			
	CON-BPNC1		CON-BPNE1	
	RMSE	AADM	RMSE	AADM
1967	1.10	.67	.76	.86
1968	.93	.88	.69	.63
1969	1.81	1.44	.72	.70
1970	1.30	1.60	.78	.91
1971	1.80	1.29	2.02	1.53
1972	1.11	1.15	.72	.79
1973	1.00	.94	1.20	.97
1974	1.02	1.00	1.40	.56 1/
Average (67-74)	1.44	1.08	.96	.85
	CON-HSNC1		CON-HSNC5	
	RMSE	AADM	RMSE	AADM
1971	1.06	1.15	.96	1.05
1972	.89	.94	.64	.78
1973	1.05	.89	.77	.50
1974	1.11	1.09	.94	.74
Average (71-74)	1.03	1.01	.80	.75

1/ This unusually low value is an artifact of a very low AADM value for concurrent adjustment in 1974.

average option, for five years there were substantial reductions in RMSE (1967-1970; 1972), and all but 1971 showed reduction in AADM with concurrent adjustment, resulting in overall improvements of 4% in RMSE and 15% in AADM for this series.

The housing starts series have forty-eight observations total for each series. FOR CON-HSNC1, the RMSE is reduced with concurrent adjustment only in 1972, and the AADM is reduced for two of the years (1972, 1973). Since the overall averages are, however, over 1.00, this indicates that concurrent adjustment with the presently-used 3x9 moving average would not be recommended for this series (see, however, the discussion in Section 5.3 on shorter moving averages). For the series CON-HSNC5, all four years show improvement in RMSE with concurrent adjustment, and all but 1971 show improvement in AADM. The overall averages indicate a 20% reduction in RMSE, and 25% reduction in AADM for this particular series.

These results were not what was expected for concurrent adjustment based on the experience with the previous eighteen series, which led to investigations of the definition of the true seasonal adjustment used in the evaluation statistics, via a simulated series, and investigating the use of shorter moving averages.

5.2: Simulated series

In the comparisons described above, the definition of the true seasonal adjustment used in the evaluation statistics was chosen to be the X-11 final seasonal adjustment when sufficient data were available to use symmetric filters. In series with the characteristics mentioned above for these four construction series, it is possible that such a choice could be deficient. To evaluate this, a simulated series with a rapidly-changing trend, a seasonal with changing amplitude, and a strong irregular was analyzed, whose components and overall structure is displayed in diagram 1.[7/]

The true[8/] trend times irregular (equivalent to the seasonally adjusted series) was known for this series, and a comparison possible to the final X-11 seasonal adjustment. Table 7 shows the results for evaluating concurrent adjustment relative to twelve-months-ahead adjustment, under the two definitions of the true seasonal adjustment, i.e., the true trend x irregular versus X-11 final seasonal adjustment. While the yearly results vary somewhat, the results are generally consistent, and the statistics over all observations (1967-1974) are in agreement. This suggests that the evaluation results for the construction series (and also for the other series) are not misleading because of the particular definition chosen for the "correct" seasonal adjustment (i.e., the X-11 final adjustment).

5.3: Evaluation of shorter moving averages

The characteristics of the series, in particular the rapidly changing amplitude of the seasonal, suggested shorter moving averages might be a viable alternative to the presently-used 3x9 moving averages, when employing concurrent adjustment. The four construction series were re-evaluated for concurrent adjustment in conjunction with the default 3x5 moving averages, and the results were

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7/ Trading-day effects were ignored in the simulated series; a multiplicative model was assumed, i.e., trend x seasonal x irregular = unadjusted series.

8/ Many definitions of seasonal and trend can lead to the same composite series; the truth is indeterminate, strictly speaking.

compared to the present practice of twelve-months-ahead adjustment and 3x9 moving averages. Table 8 presents the evaluation statistics for this alternative adjustment[9/] of the concurrent mode with 3x5 moving averages.

In Table 8, only the two housing starts series show improvement with concurrent adjustment with the 3x5 moving averages, over the twelve-months-ahead, 3x9 moving average adjustment. However, a comparison with Table 6, where concurrent adjustment with 3x9 averages is compared to the twelve-months-ahead, 3x9 adjustment, reveals that the 3x9 averages in conjunction with concurrent adjustment offer the most improvement over present practice for the series CON-HSNC5. Thus, only one series, CON-HSNC1, warrants the use of shorter moving averages in conjunction with concurrent adjustment, for the time period of study.

5.4: Summary for Construction series

On the basis of the results shown and investigations pursued for the Construction series, concurrent adjustment can be recommended for three series with the presently-used options: CON-PRAOTH, CON-BPNE1 and CON-HSNC5. One series, CON-HSNC1, would provide improvement with concurrent adjustment if shorter moving averages are employed. One series does not benefit from concurrent adjustment in the experimental period, under either moving average evaluated: CON-BPNC1.

9/ Note that the definition of the true seasonal adjustment in the numerator of the tabled statistic is the X-11 final adjustment with 3x5 moving averages, while the definition in the denominator is the X-11 final adjustment with 3x9 moving averages. This difference in definitions does not change the conclusions drawn from Table 8, (they are the same when the denominator is the X-11 final adjustment with 3x5 moving averages), and permits direct comparison of the alternative with what is presently done in adjusting these series.

6. Conclusions and Remarks

Based on the analysis presented above, the alternative of concurrently adjusting with Census X-11 is an improvement over the present practice of using twelve projected seasonal factors for seasonal adjustment. The amount of improvement is on the order of 17% reduction in the root mean square error, and 20% reduction in the average absolute difference of month-to-month percentage changes. The use of the X-11 final adjustment as the definition of the true seasonal adjustment in the evaluation statistics was determined to be a reasonable choice. With certain series, the analysis shows that exploration of other options than those presently in use by the economic division is warranted in conjunction with the use of concurrent adjustment.

Several issues surrounding concurrent adjustment are presently being evaluated, which arise when the operational implementation of concurrent adjustment is considered. The use in this study of the final, unadjusted data for the twenty-three series was very important to isolate the possible improvement with concurrent adjustment due solely to improved estimation of the seasonal component. As mentioned in Section 2 above, however, the first-released, unadjusted data is often the "advance" or "preliminary" unadjusted figure, which is subject to revision in succeeding months. Although re-evaluating the series in the same manner for improvement with alternative modes with the advance and preliminary numbers simulated each month will confound the results with data revisions in the unadjusted numbers, it is an important issue that is in the process of being evaluated. Also, the question of which revised seasonally adjusted estimates are to be published is under study by the economic divisions. Finally, a responsible means of providing the best statistics to the public and at the same time upholding public confidence in the procedure is paramount and an other important issue being thoroughly explored.

Table 7: SIMULATED SERIES
3X9 MOVING AVERAGES, 1960-1966 BASE PERIOD,
DATA ENDING IN DEC. 1979

(Table values are the ratio of the concurrent adjustment statistic to the 12-months-ahead adjustment statistic.)

Year	Root Mean Square Error		Average Absolute Difference of Month-to-Month Percentage Change	
	Standard Defined as:		Standard Defined As:	
	Final X-11	True TxI	Final X-11	True TxI
1967	.78	.79	.57	.71
1968	.81	.83	.79	.82
1969	.86	.88	.79	.91
1970	.77	.88	1.05	1.13
1971	.81	.91	.95	.99
1972	.67	.76	.68	.73
1973	.82	.87	1.10	.89
1974	.97	.87	1.08	.95
Avg (67-74)	.81	.84	.87	.88

Table 8: COMPARISON OF STATISTICS FOR
CONCURRENT ADJUSTMENT, 3x5 SEASONAL MOVING AVERAGES, VERSUS PRESENT PRACTICE

(Table values are the ratio of the statistic for concurrent, 3x5 moving averages (the alternative) divided by the statistic indicated for 12-months-ahead, 3x9 moving averages (present practice). Also indicated is whether that value is lower (<) than, higher (>) than, or equal to (=), the corresponding value in Table 6 comparing concurrent adjustment, 3x9 moving averages with present practice.)

Year	Series			
	CON-BPNC1		CON-BPNE1	
	RMSE	AADM	RMSE	AADM
1967	2.09 >	1.44 >	.70 <	.86 =
1968	2.00 >	1.59 >	1.03 >	.84 >
1969	1.73 <	1.64 >	1.10 >	1.09 >
1970	1.69 >	3.00 >>	1.07 >	1.16 >
1971	1.73 <	1.62 >	2.07 >	1.48 <
1972	1.18 >	1.69 >	.98 >	.90 >
1973	.81 <	.80 <	1.95 >	1.28 >
1974	.85 <	1.02 >	1.29 <	1.14 >
Average (67-74)	1.17 <	1.43 >	1.18 >	1.05 >

	CON-HSNC1		CON-HSNC5	
	RMSE	AADM	RMSE	AADM
1971	.88 <	1.00 <	1.01 >	1.08 >
1972	.86 <	.99 >	.97 >	.98 >
1973	.85 <	.74 <	.73 <	.60 >
1974	.90 <	1.07 <	.67 <	1.28 >
Average (67-74)	.87 <	.96 <	.90 >	.83 >

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[4] Geweke, J. (1978), "An Efficient Method for Revising Seasonally Adjusted Time Series," Technical Report, Madison, Wisconsin: University of Wisconsin - Madison, Social Science Research Institute.

[5] Kenny, P. B. and Durbin, J. (1980), "Local Trend Estimation and Seasonal Adjustment of Economic and Social Time Series," Journal of the Royal Statistical Society, series A, 144, Part 4.

[6] National Commission on Employment and Unemployment Statistics. (1979), Counting the Labor Force, Washington, D. C.: U. S. Government Printing Office.

[7] Seasonal Adjustment of the Monetary Aggregates, Report of the Committee of Experts on Seasonal Adjustment Techniques. (1981), Washington, D.C.: Board of Governors of the Federal Reserve System.

[8] Shiskin, J., Young, A., and Musgrave, J. (1967), "The X-11 Variant of the Census Method II Seasonal Adjustment Program," Technical Paper 15, Washington, D.C.: U. S. Department of Commerce, Bureau of the Census.

[9] Young, Allan. (1968), "Linear Approximations to the Census and BLS Seasonal Adjustment Methods," Journal of the American Statistical Association 63, June, 445-457.

Appendix: Selected Series Used in the Evaluation of Concurrent Adjustment Study

Code Name	Title
Business	
RAUTODLRS	Retail sales of motor vehicle and miscellaneous automotive dealers
RFURNDLRS	Retail sales of furniture and home
RGROC	Retail sales of grocery stores
RTAUTO	Total retail sales of automotive dealers
WFURN	Wholesale sales of furniture and home furnishings
Construction	
CON-BPNC1	Building Permits, North-Central Region, Single Family Units
CON-BPNE1	Building Permits, North-East Region, Single Family Units
CON-HSNC1	Housing Starts, North-Central Region, Single Family Units
CON-HSNC5	Housing Starts, North-Central Region, Units of Five or More Families
CON-PRAOTH	Value Put in Place, All Other Private Construction (not classified otherwise)
Foreign Trade	
FTDXUCAN	Exports to Canada
FTDXUCARSC	Exports of Cars to Canada
FTDXUJAPAN	Exports to Japan
FTDXULAR	Exports to Latin American Republics
FTDXUWH	Exports to the Western Hemisphere
FTDXU2	Exports, SITC Section 2, Crude Materials, Inedible (except fuel)
Industry	
INS21VS	Value of Shipments: Steam Engines and Turbines
INS36VS	Value of Shipments: Radio and TV
INS46VS	Value of Shipments: Railroad Equipment
INS63TI	Total Inventories: Fats and Oils
INS8ØUO	Unfilled Orders: Newspapers, Books and Periodicals
INS86VS	Value of Shipments: Fertilizer

APPENDIX A: Characteristics of Selected Series Used in the Evaluation of Concurrent Adjustment Study

Series	Months for Cyclical Dominance		X-11 Test for Seasonality		Month-to-Month Contributions (in %) of Components to Variance of Original Series 4/					
					First Run			Last Run		
	First Run	Last Run	First Run	Last Run	I	S	TD	I	S	TD
RAUTODLRS	3	3	54	78	9	61	28	9	56	33
RFURNDLRS	2	2	126	178	3	63	32	4	57	37
RGROC	2	2	54	90	2	18	79	3	18	77
RHARDWARE	3	3	237	219	3	83	13	3	82	14
RTAUTO	3	3	57	83	8	59	31	8	57	33
WFURN	2	3	105	126	4	65	30	6	62	31
CON-BPNC1[1]	(8)	4	173	555	12	82	6	10	84	6
CON-BPNE1[1]	5	5	174	420	8	87	4	12	80	6
CON-HSNC1[1]	4	(7)	100	223	14	82	3	20	77	3
CON-HSNC5[1]	(8)	(9)	11	24	48	49	3	46	52	1
CON-PRAOTH	2	2	11	21	38	36	0	30	44	0
FTDXUCAN	3	3	53	112	17	74	6	13	79	6
FTDXUCARSC	5	5	18	46	30	67	0	25	73	0
FTDXUJAPAN	4	4	3[2]	5[2]	48	12	36	57	18	21
FTDXULAR	6	4	3[2]	10	71	18	6	54	32	8
FTDXUWH	4	3	17	44	35	55	7	19	70	8
FTDXU2	3	3	18	48	45	50	0	34	55	5
INS21VS[3]	5	(8)	21	27	18	81	0	22	77	0
INS36VS[3]	3	3	65	75	12	86	0	14	85	0
INS46VS[3]	3	3	8	15	41	53	0	40	55	0
INS63TI	4	3	24	54	27	68	0	20	74	0
INS8ØUO	2	2	24	32	22	61	0	18	70	0
INS86VS[3]	3	3	118	143	12	86	0	14	84	0

1/ With 3x9 seasonal moving averages

2/ X-11 deems these F statistics significant at the 1% level (3.097, 5.302 and 2.394 respectively) but empirical guidelines suggest this is too low to be assured of an adequate seasonal adjustment by X-11.

3/ Trading-day adjustment is done at the company-report level, rather than with X-11.

4/ The value for trend is omitted from the table. Values are from the output table F2 in the X-11 output.

APPENDIX A: Summary of Series Characteristics

Months-for-Cyclical Dominance

MCD for both runs = 2 or 3 : 13 series

MCD for both runs = (3), 4, 5, 6 : 6 series

(CON-BPNE1, FTDXUCARSC, FTDXUJAPAN, FTDXULAR, FTDXUWH, INS63TI)

MCD for both runs = 7 or more : 1 series

(CON-HSNC5)

Of the 3 remaining series:

MCD goes from 8 to 4 for CON-BPNC1

MCD goes up (4 to 7, 5 to 8) for CON-HSNC1 and INS21VS, respectively

X-11 Test for Stable Seasonality

Two series have questionable seasonality. FTDXUJAPAN has a very low F statistic for both runs, which are significant by X-11 standards, but empirical guidelines suggest the values are too low to be assured of an adequate seasonal adjustment by X-11.

FTDXULAR has a low F statistic for the first run, and a marginal value for the last run (refer to comment for FTDXUJAPAN above).

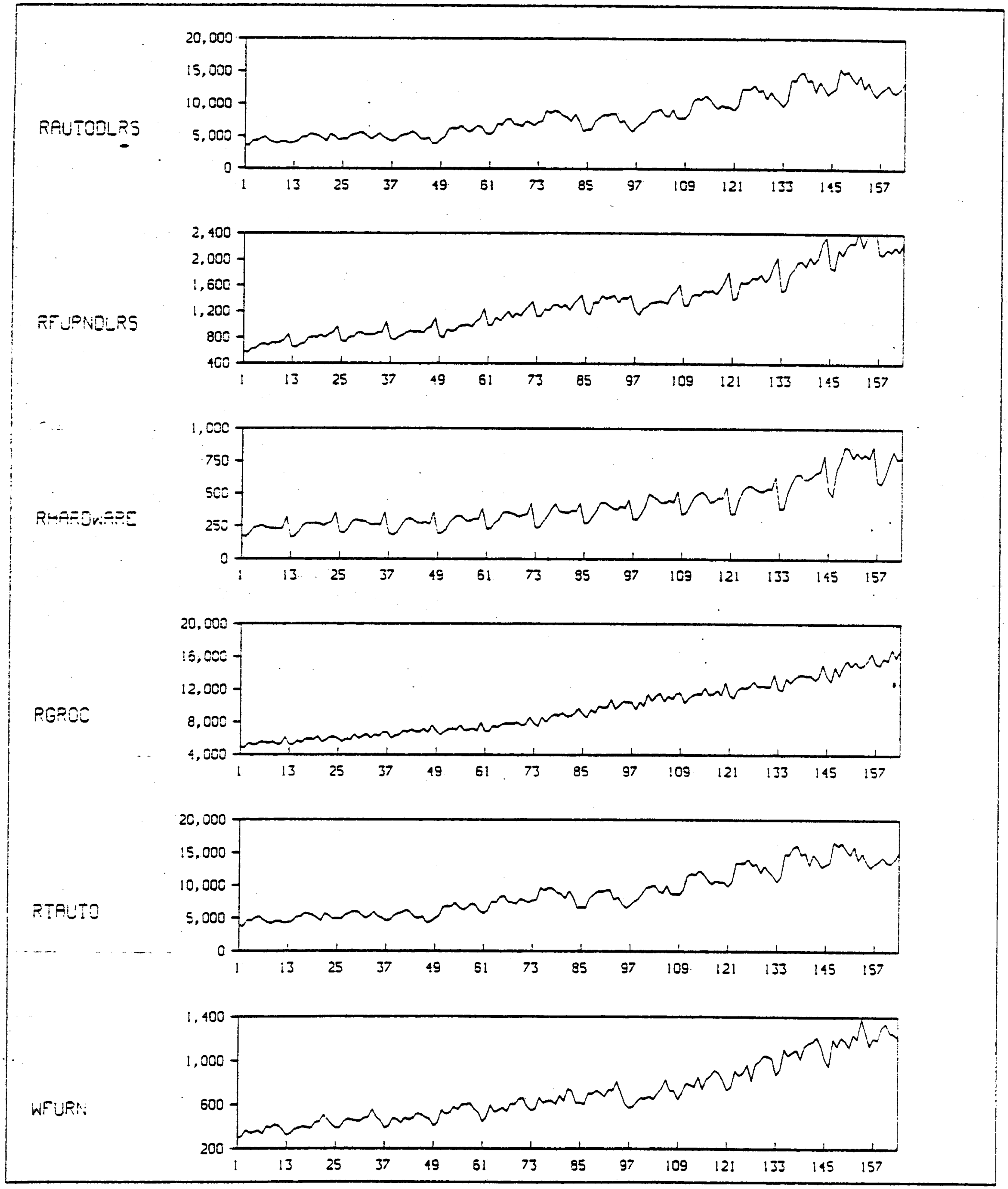
See also the summary of contributions to variance (below) for these series.

Contributions to Variance

The relative (percent) contributions of the components to the original series do not change much from the first run to the last run. Therefore, the summary is based on the last run, as follows:

Let %S, %I stand for the precentage contribution to the variance of the seasonal and the irregular, respectively. Several categories based on these and twice their respective percentage contributions are constructed.

1. %S > twice %I : 17 series
2. Twice %I > %S > %I: 3 series (INS46VS, FTDXU2, CON-PRAOTH)
3. %S ≅ %I: 1 series (CON-HSNC5)
4. Twice %S > %I > %S: 1 series (FTDXULAR)
5. %I > twice %S: 1 series (FTDXUJAPAN)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10,000
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800
400
RHARDWARE
1,000
750
500
250
0
RGROC
20,000
16,000
12,000
8,000
4,000
RTAUTO
20,000
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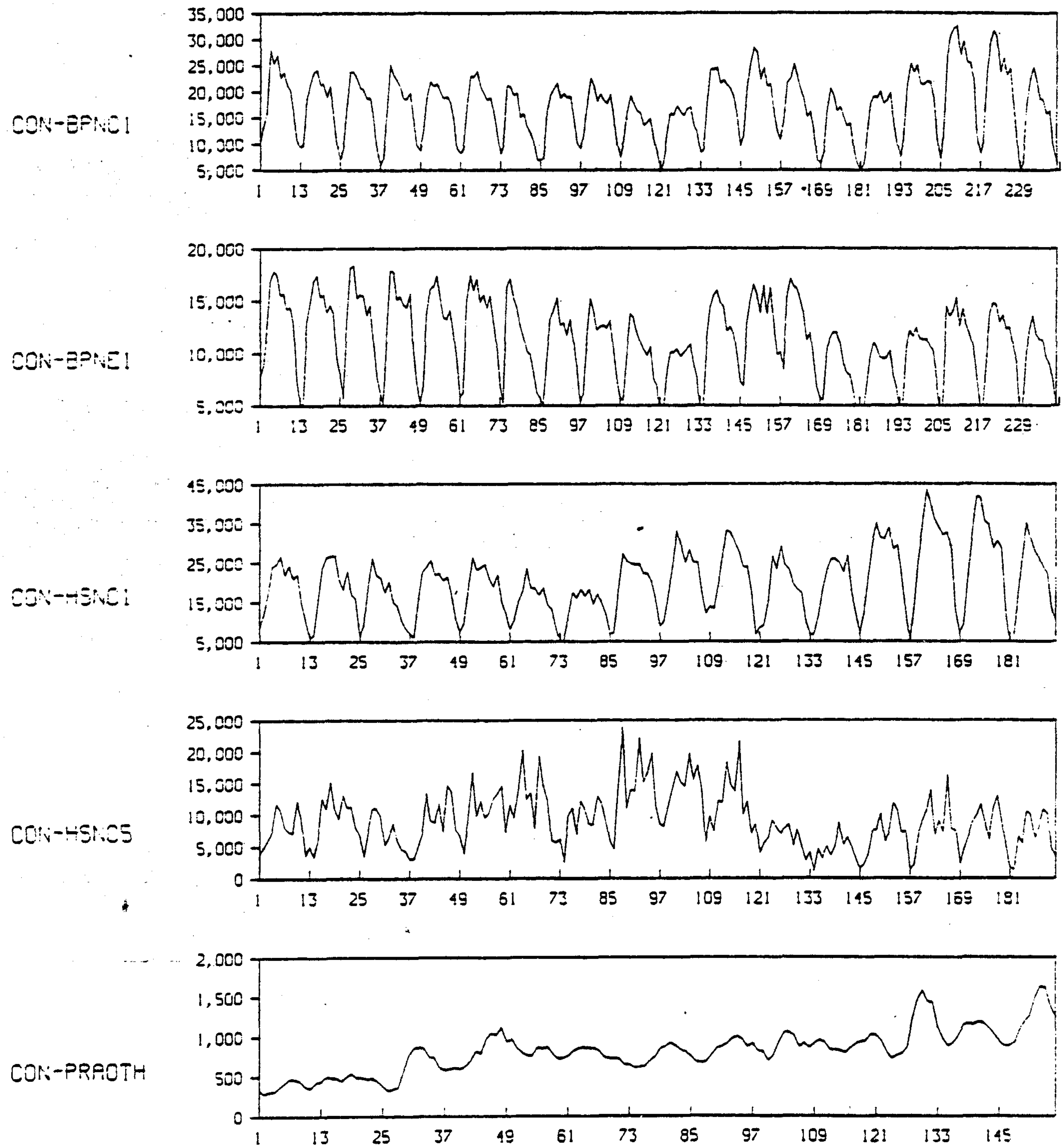
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5,000
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CON-BPNE1
20,000
15,000
10,000
5,000
1 13 25 37 49 61 73 85 97 109 121 133 145 157 169 181 193 205 217 229
CON-HSNC1
45,000
35,000
25,000
15,000
5,000
1 13 25 37 49 61 73 85 97 109 121 133 145 157 169 181
CON-HSNC5
25,000
20,000
15,000
10,000
5,000
0
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CON-PRAOTH
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1,000
500
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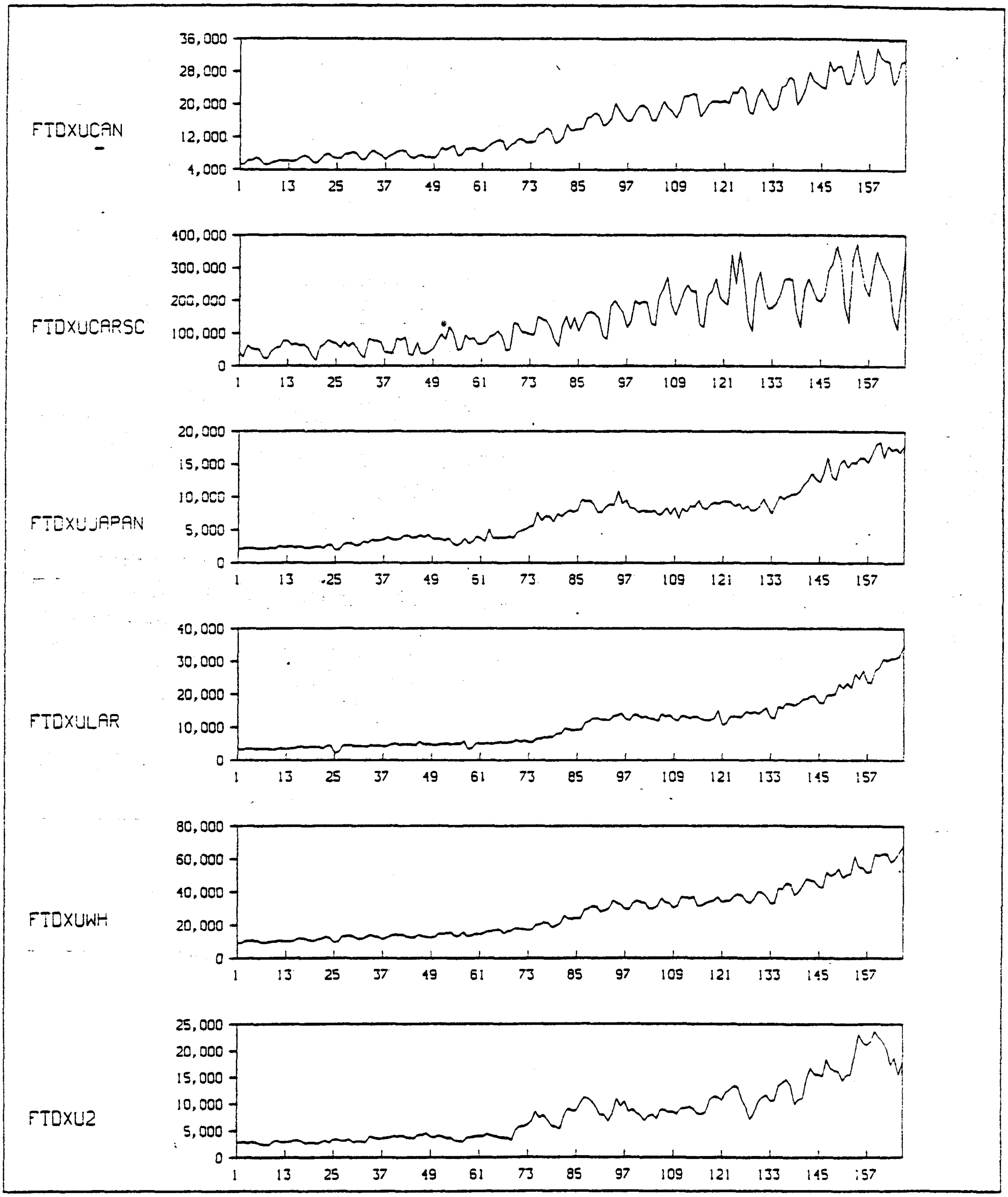
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FTDXULAR
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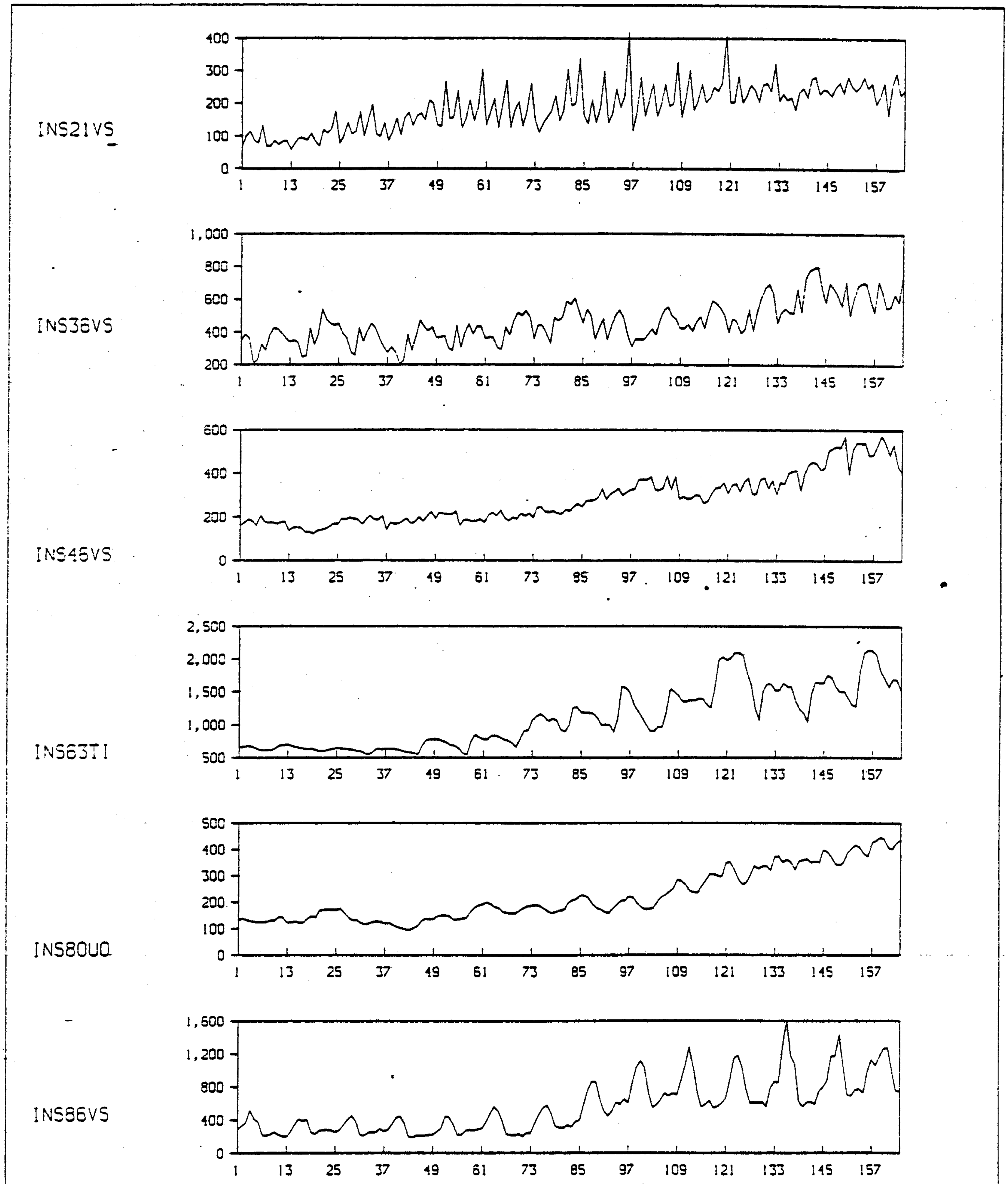
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INS80U0
0 100 200 300 400 500
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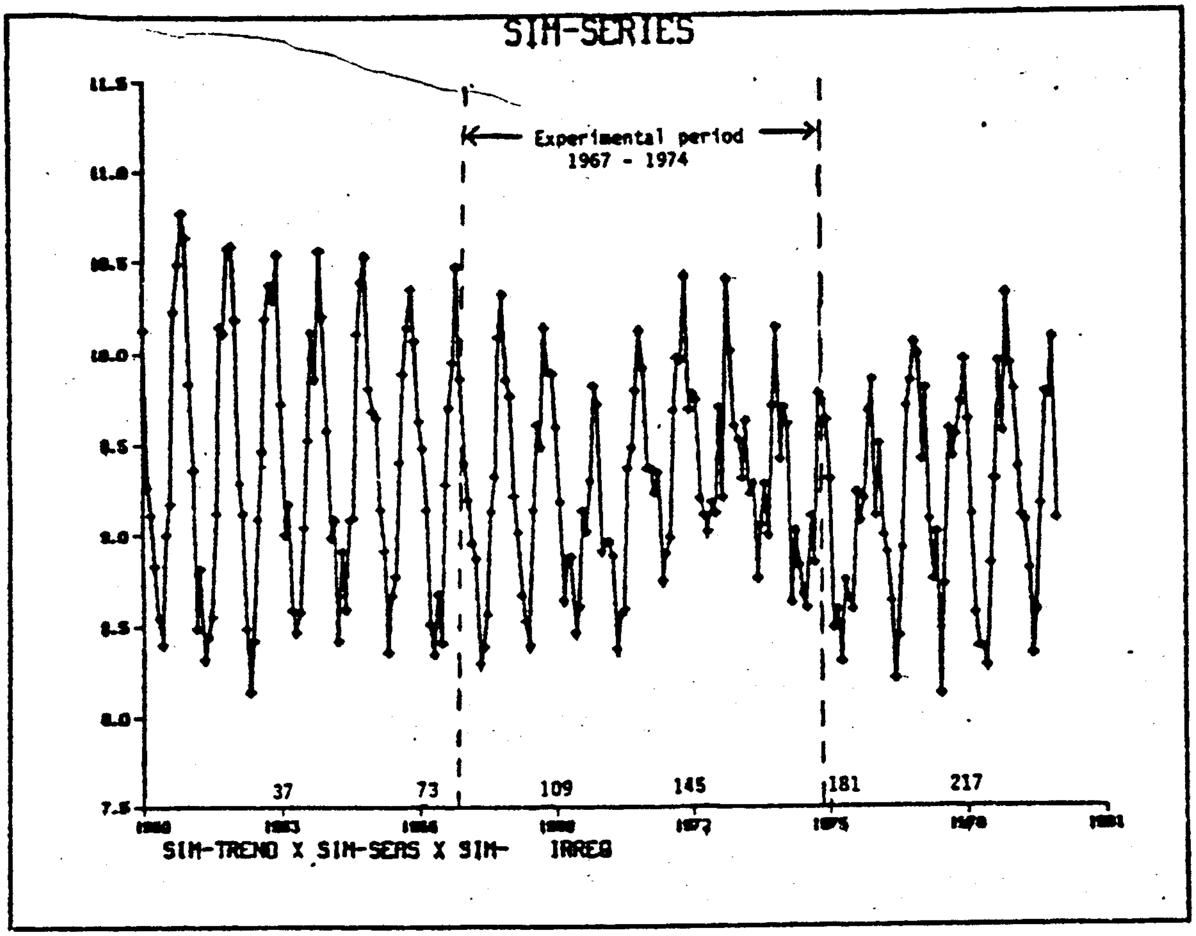
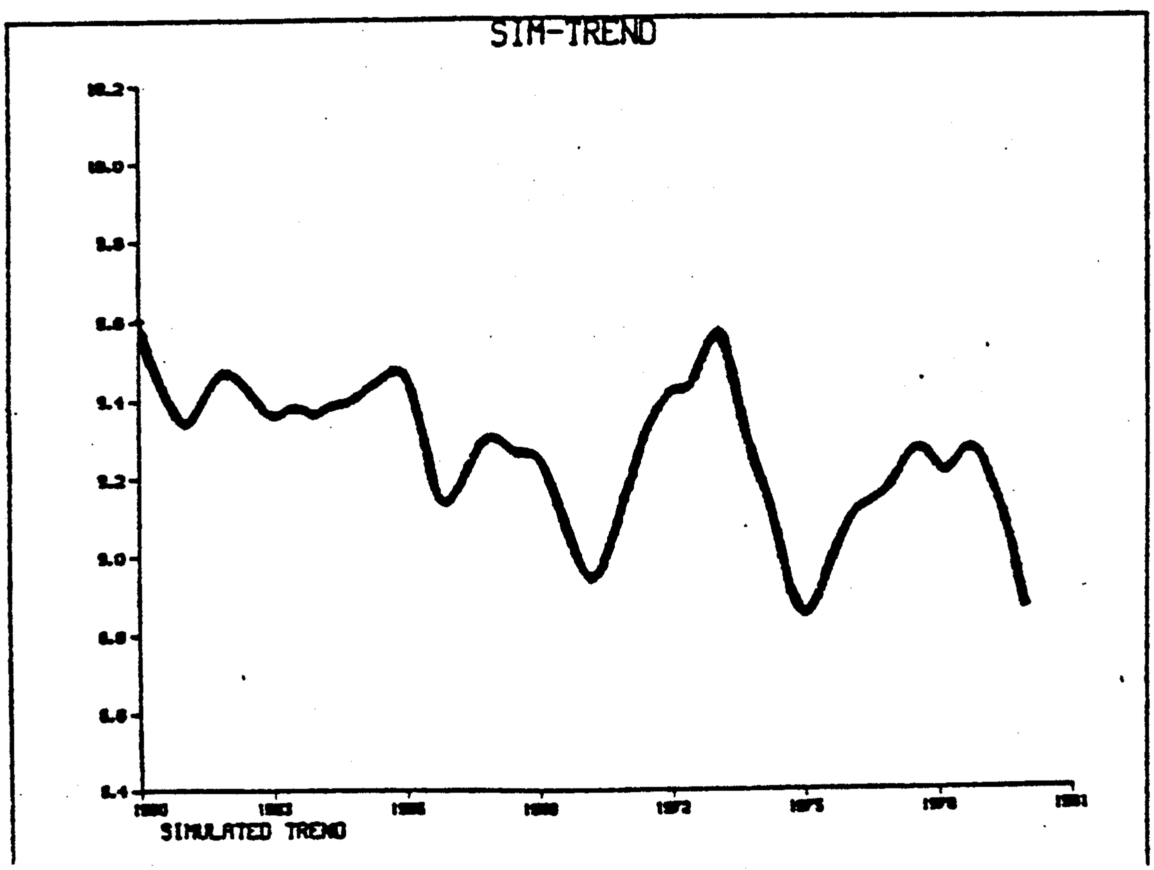
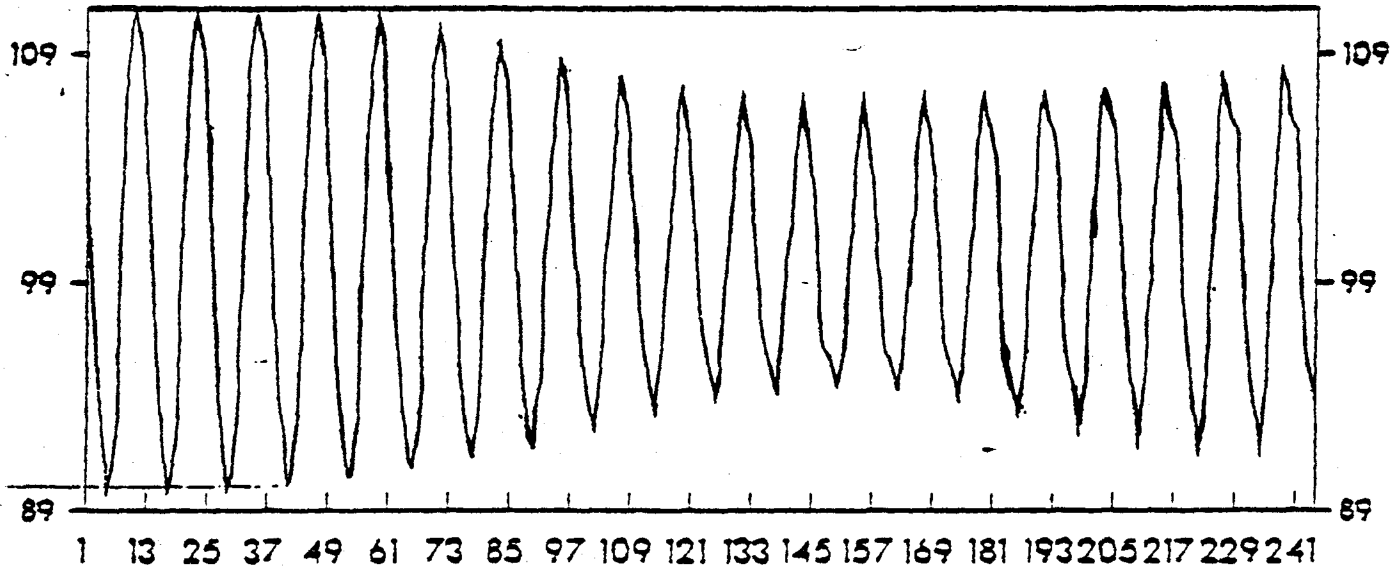
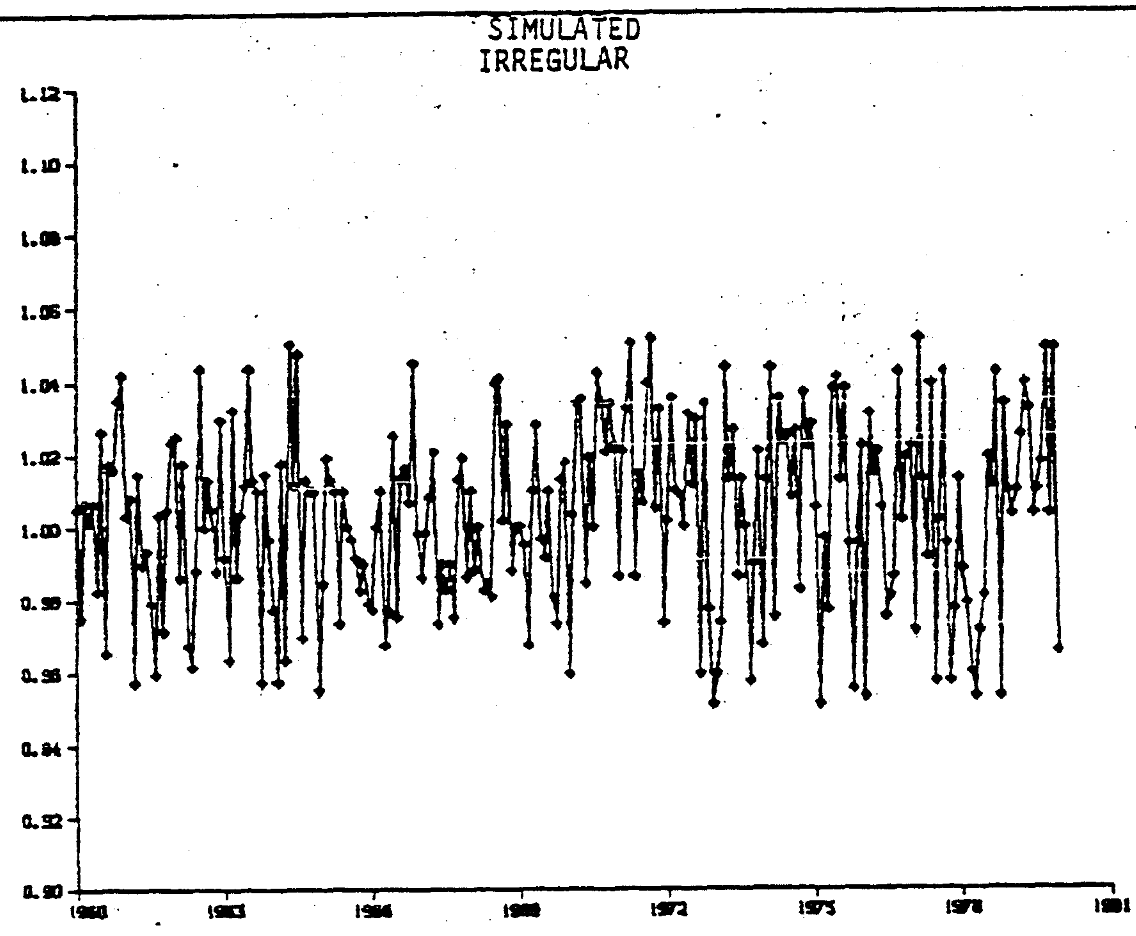
SIMULATED SERIES AND COMPONENTS





SIMULATED SEASONAL





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